


No. 4

BASIC DESIGN STUDY REPORT
ON
THE THA NGON REHABILITATION
AND
RURAL DEVELOPMENT PROJECT
IN
THE LAO PEOPLE'S DEMOCRATIC REPUBLIC

MARCH 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

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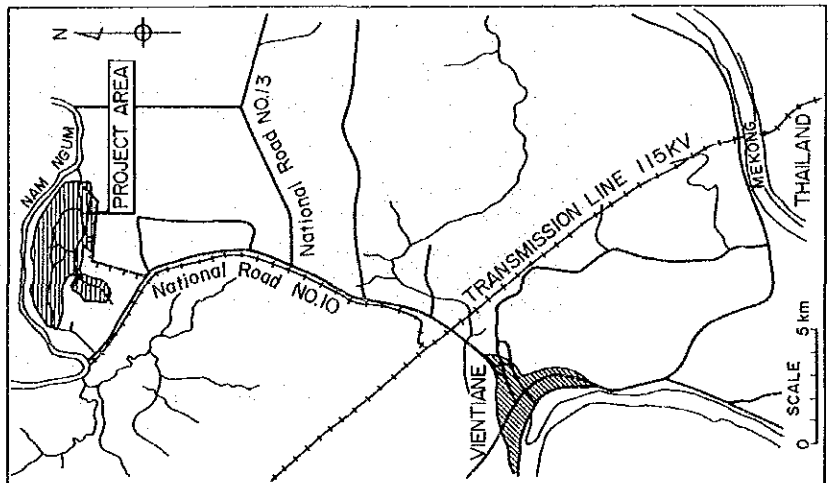
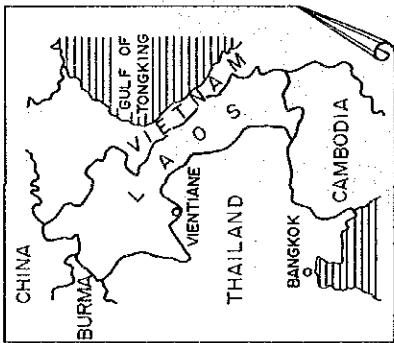
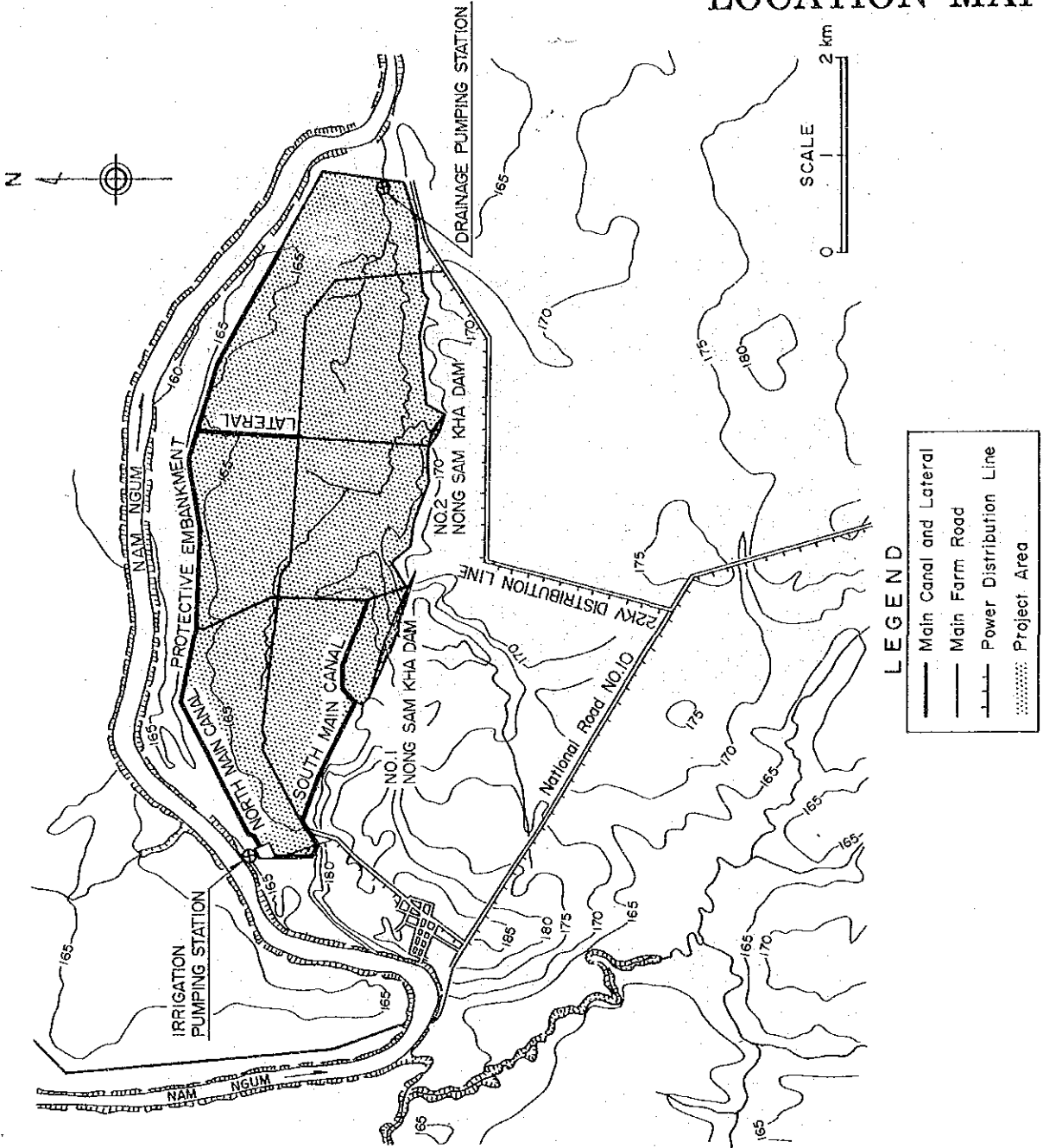
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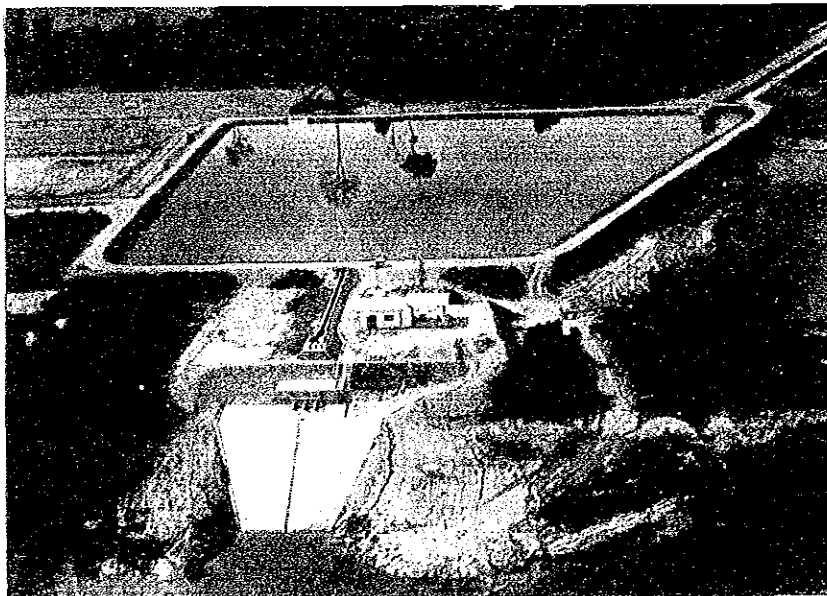
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LOCATION MAP

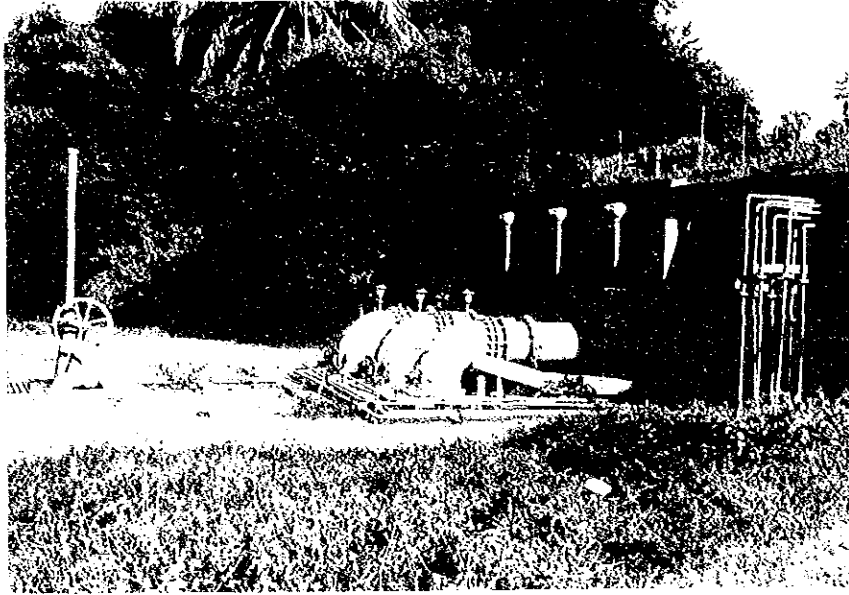




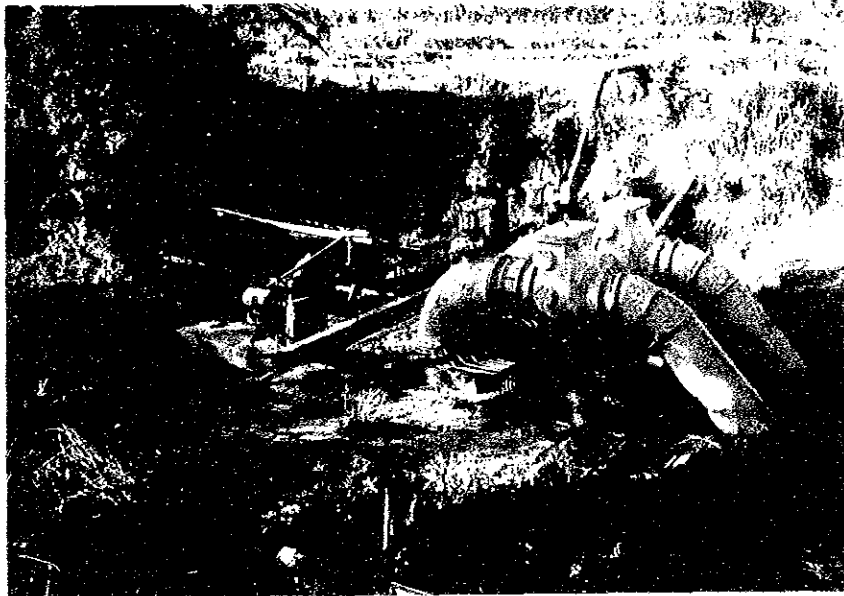
Overall View of Tha Ngon Scheme (Completion Stage, 1974)



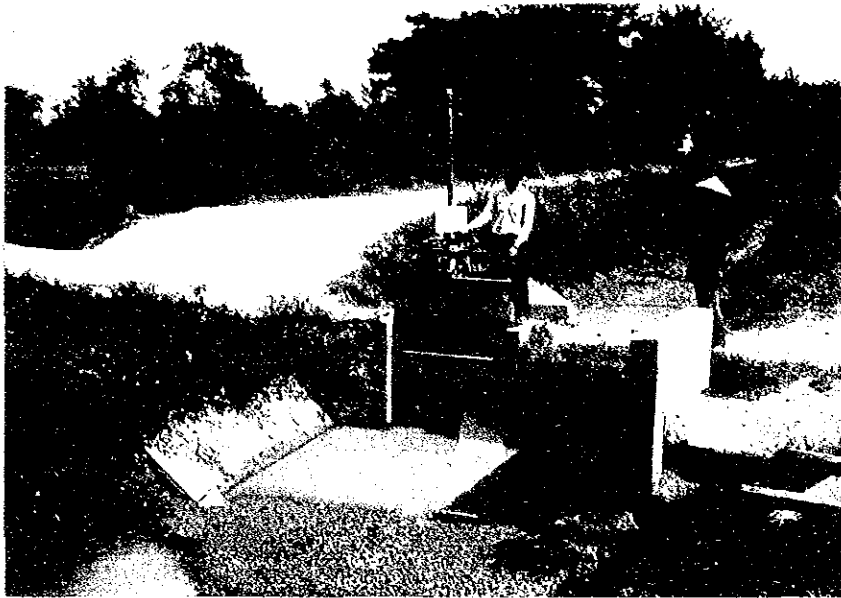
Overall View of Irrigation Pump Station and Regulating Pond
(Completion Stage, 1974)



Irrigation Pump Station (Oct. 1986)



Drainage Pump Station (Oct. 1986)



North Main Irrigation Canal and Related Structure
(Oct. 1986)



Farm Land and Farm Road (Oct. 1986)

PREFACE

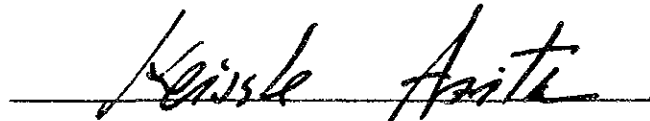
In response to the request of the Government of The Lao People's Democratic Republic, the Government of Japan has decided to conduct a basic design study on the Tha Ngon Rehabilitation and Rural Development Project and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent a survey team headed by Shinsuke OTA, International Cooperation Division, Ministry of Agriculture, Forestry and Fisheries to Laos from October 24 to November 23, 1986.

The team had discussions on the Project with the officials concerned of the Government of Laos and conducted a field survey necessary for the basic design study. After the team returned to Japan, further studies were made and a draft report was prepared. For the explanation and discussion of it, a mission headed by Mr. Hiroshi MANABE, Grant Aid Cooperation Division, Bureau of Economic Cooperation, Ministry of Foreign Affairs was sent to Laos from January 14 to January 23, 1987. As a result, the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of The Lao People's Democratic Republic for their close cooperation extended to the team.

March 1987

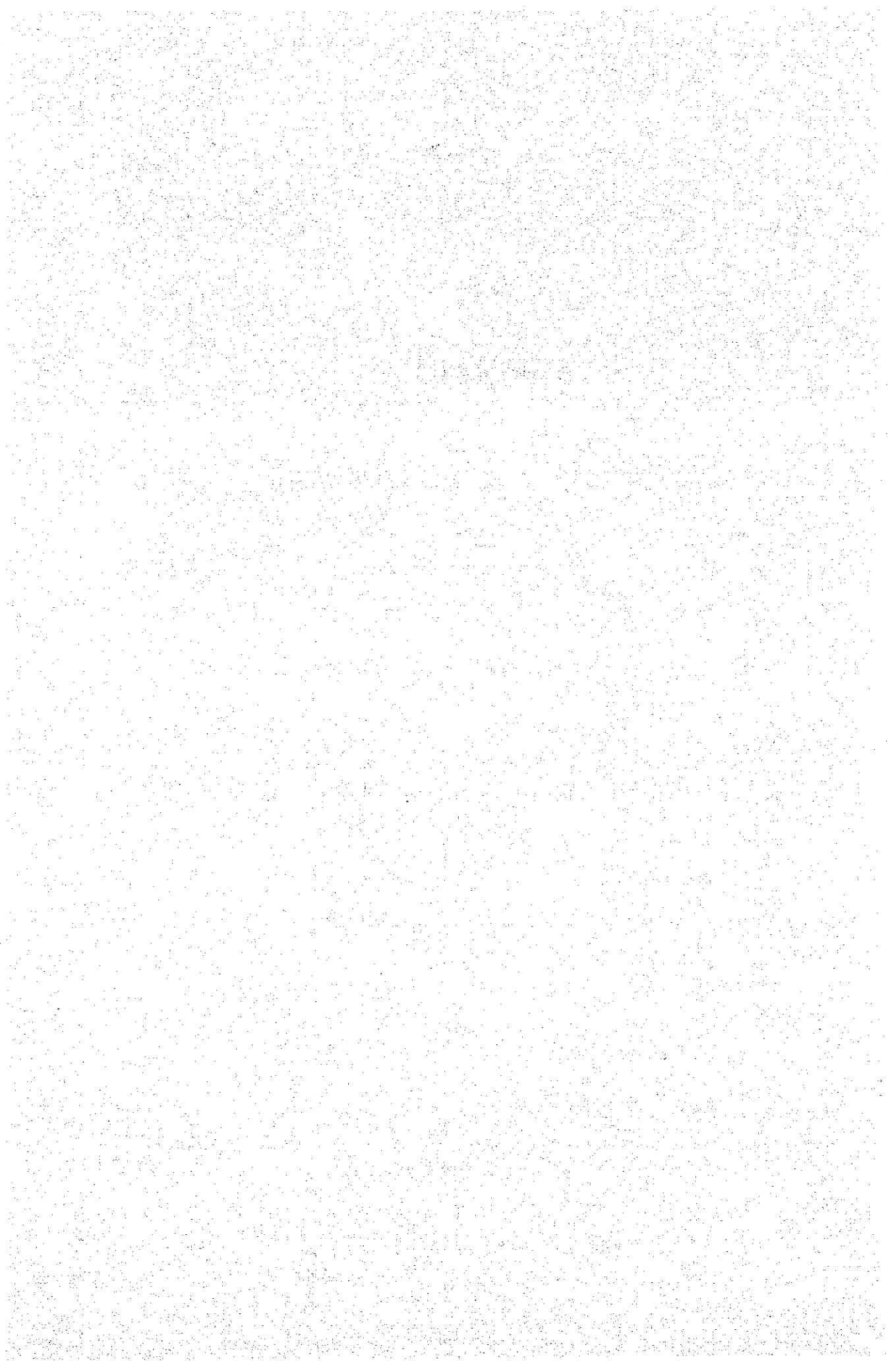
A handwritten signature in black ink, reading "Keisuke Arita", is written over a horizontal line.

Keisuke ARITA

President

Japan International Cooperation Agency

SUMMARY



SUMMARY

The Lao People's Democratic Republic (Lao PDR) is a land-locked country with an area of 236,800 km². Stretching more than 1,000 km in a north-south direction, the country is bordered by Vietnam in the east, Kampuchea in the south, Thailand in the west and Burma and China to the north. Lao PDR is blessed with abundant natural resources, such as hydropower, forestry, agricultural land, surface water, minerals, etc. as compared with other developing countries. However, its economic growth is hindered by such constraints as unstable climate, low population density, land-locked topography of the country, insufficient basic economic infrastructures, weak domestic savings, etc. The Gross Domestic Product (GDP) in 1985 was about US\$489 million, and per capita income was US\$135.

Agriculture in Laos accounts for about 62% of GDP and plays an important role in the national economy. In fact, the agricultural sector grew favorably during the period of the first Five-Year Plan (1981 to 1985) with an annual growth rate of 4.7%. In 1984, the estimated rice production per capita of 226 kg exceeded the state self-sufficiency norm of 180 kg per person. However, differences in per capita rice output among provinces still remain. In addition, most rice cultivation is under rainfed conditions and its production depends on unstable weather conditions. Considering the present road network and transportation system, it is one of the basic policies for agriculture in Lao PDR to secure regional self-sufficiency in food. Exploitable surface water resources are available in large quantities and could be used to irrigate about 600,000 ha. However, irrigation development is minimal in contrast to this potential. Supplemental irrigation during the wet season is conducted only in about 50,000 ha. Because of fuel shortage, inadequate water management and lack of incentives to farmers, only about 8,000 to 10,000 ha have been cropped during recent dry seasons.

The Government of Lao PDR gives a top priority to the agricultural sector, particularly irrigation, and the transportation and telecommunication sectors in the second Five-Year Plan (1986-1990). Investment in both sectors in the said Plan will make up about 64% of total investment (35% in the agricultural sector). The main objectives of agricultural development in the said Plan are (i) to secure self-sufficiency in rice production and maintain adequate security stocks; (ii) to diversify agriculture by expanding production of non-rice crops and of livestock and fishery products - for domestic consumption and for export; (iii) to increase exploitation, and to improve conservation of forest resources, with particular emphasis on controlling and gradually reducing slash and burn agriculture; and (iv) to expand collectivization of agricultural production activities.

The Tha Ngon Irrigation Scheme (the Scheme) with an area of about 800 ha is located about 25 km north of Vientiane, the capital of Lao PDR. Construction of the Scheme were started in 1971 and completed in 1974 by the Government of Lao PDR with financial assistance from the Asian Development Bank (ADB) and technical assistance of Japan. Since 1974, the Scheme has accumulated important experience in operation of a modern irrigation system. In the recent years, however, the irrigation and drainage facilities have seriously deteriorated their functions due to poor maintenance and the irrigated area is only about 300 ha in the wet season. The Government of Lao PDR has laid great emphasis on rehabilitation of the Scheme in the framework of small and medium scale irrigation development in the Vientiane plain, considering that (i) the Scheme already has modern irrigation and drainage facilities; (ii) since the required works are only rehabilitation of main facilities, it should be possible to get a quick return with a small investment cost and; (iii) after rehabilitation, the Scheme could have a great impact, as a pilot project, on other irrigation development projects in the Vientiane plain, especially since the Scheme is located near Vientiane. Under such situations, the Government of Lao PDR requested the Government of Japan to extend grant aid for the Tha Ngon Rehabilitation and Rural Development Project (the Project) including improvement and development of rural infrastructures for the existing six (6) villages in and around the Scheme.

In response to the request, the Government of Japan sent, through the Japan International Cooperation Agency (JICA), a basic design study team to Laos from October 24 to November 23, 1986. The team surveyed and investigated the project area to grasp the present conditions and constraints, collected the data required for the basic design study and had a series of discussions with the Ministry of Agriculture, Forestry, Irrigation and Cooperatives (MAFIC) which will be the implementation agency of the Project.

Through the discussions in Laos and studies in Japan, the following objectives of the Project were clarified:

- (1) The Project will contribute, as a pilot project with the modern irrigation and drainage facilities, to agricultural development in the Vientiane plain through its rehabilitation works,
- (2) The Project will contribute to improvement of living standards and social welfare and expansion and reinforcement of existing cooperatives in and around the project area through construction of rice processing and storage facilities and of a rural water supply system, and by improvement of farm and rural roads. In addition, the Project will be cited as a model project for collectivization of agricultural production activities, and
- (3) The Project will contribute to training of operation and maintenance staff in Laos through operation and maintenance of the project facilities.

Furthermore, as a result of studies on the request, it was confirmed that the Project is in line with the agricultural policies of the second Five-Year Plan, and that it would have significant benefit as a pilot project for agricultural development in the Vientiane plain.

The project components consist of:

1. Rehabilitation of Tha Ngon Scheme

- | | | |
|------------------------------------|---|--|
| (1) Irrigation pump station | : | overhaul and replacement of pump equipment and repair of equipment, and repair of related facilities |
| (2) Regulating pond | : | repairing intake gate and embankment |
| (3) Irrigation and drainage canals | : | rehabilitation of main irrigation and drainage canals and their related structures |
| (4) Drainage pump station | : | overhaul of pump equipment and repairing of related facilities |
| (5) No.1 Nong Sam Kha dam | : | repairing of intake gate and construction of intake structure |
| (6) Supply of equipment | : | O&M equipment and farm machinery |

2. Rural Development in and around Tha Ngon Scheme

- | | | |
|--|---|---|
| (1) Farm roads | : | improvement of farm and rural roads |
| (2) Rice processing & storage facilities | : | construction of rice processing facilities (750 kg/hr each) and storage facilities (floor area of 800 m ² in total) for three villages |
| (3) Rural water supply system | : | construction of rural water supply system for four villages and construction of tube-wells with manual pumps for three villages |

The Project will be implemented in two phases. The first phase will take 13 months from signing of the Exchange of Notes (E/N) to completion. The second phase will take 21 months from signing of E/N to completion. The preliminary cost of works to be executed by the Government of Lao PDR (extension of electric power line) is estimated at about Kip 3,650 thousand. The annual operation and maintenance cost of the proposed organization is estimated at Kip 11,980 thousand.

After implementation of the Project the direct benefits will include: increase of rice production and farmer's income, improvement of rural traffic and transportation, improvement of rice processing and rice quality, stabilization of self-sufficiency, improvement of rural living environment, etc. Indirect benefits will include expansion and reinforcement of cooperatives,

demonstration and extension effects, improvement of social welfare, etc. Thus, the Project will contribute to rapid improvements of villages in and around the Tha Ngon Scheme.

In view of the great impact the project will have on other irrigation developments, the early implementation of the Project is extremely desirable. In addition, the scale of the Project is considered to be appropriate for the grant aid of Japan.

To properly and effectively operate and maintain the facilities to be rehabilitated and constructed under the Project, it is recommended that the Government of Lao PDR should take prompt procedures to establish an adequate O&M organization.

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DRAWINGS

ABBREVIATIONS AND UNITS OF MEASUREMENT

| | | |
|---------|---|--|
| ADB | : | Asian Development Bank |
| EDL | : | Electricite du Lao |
| FAO | : | Food and Agriculture Organization |
| IBRD | : | International Bank for Reconstruction and Development |
| IDA | : | International Development Association |
| IMF | : | International Monetary Fund |
| JICA | : | Japan International Cooperation Agency |
| Lao PDR | : | Lao People's Democratic Republic |
| MAFIC | : | Ministry of Agriculture, Forestry, Irrigation and Cooperatives |
| MFA | : | Ministry of Foreign Affairs |
| SPC | : | State Planning Committee |
| UNDP | : | United Nations Development Programme |

1. Length and Height

| | | |
|-----|---|---------------------|
| mm | : | millimeter |
| cm | : | centimeter |
| m | : | meter |
| km | : | kilometer |
| MSL | : | mean sea level |
| EL | : | elevation above MSL |

2. Area

| | | |
|-----------------|---|-------------------|
| cm ² | : | square centimeter |
| m ² | : | square meter |
| km ² | : | square kilometer |
| ha | : | hectare |

3. Volume

| | | |
|----------------|---|----------------------------------|
| ℓ | : | liter (= 1,000 cm ³) |
| m ³ | : | cubic meter |
| MCM | : | million cubic meter |

4. Weight

| | | |
|----|---|------------------|
| mg | : | milligram |
| g | : | gram |
| kg | : | kilogram |
| t | : | ton (= 1,000 kg) |

5. Time

| | | |
|-----|---|--------|
| sec | : | second |
| min | : | minute |
| hr | : | hour |
| yr | : | year |

6. Electric Measures

| | | |
|-----|---|---------------|
| kV | : | kilovolt |
| kW | : | kilowatt |
| kWh | : | kilowatt-hour |
| MW | : | megawatt |
| MWh | : | megawatt-hour |
| GWh | : | gigawatt-hour |

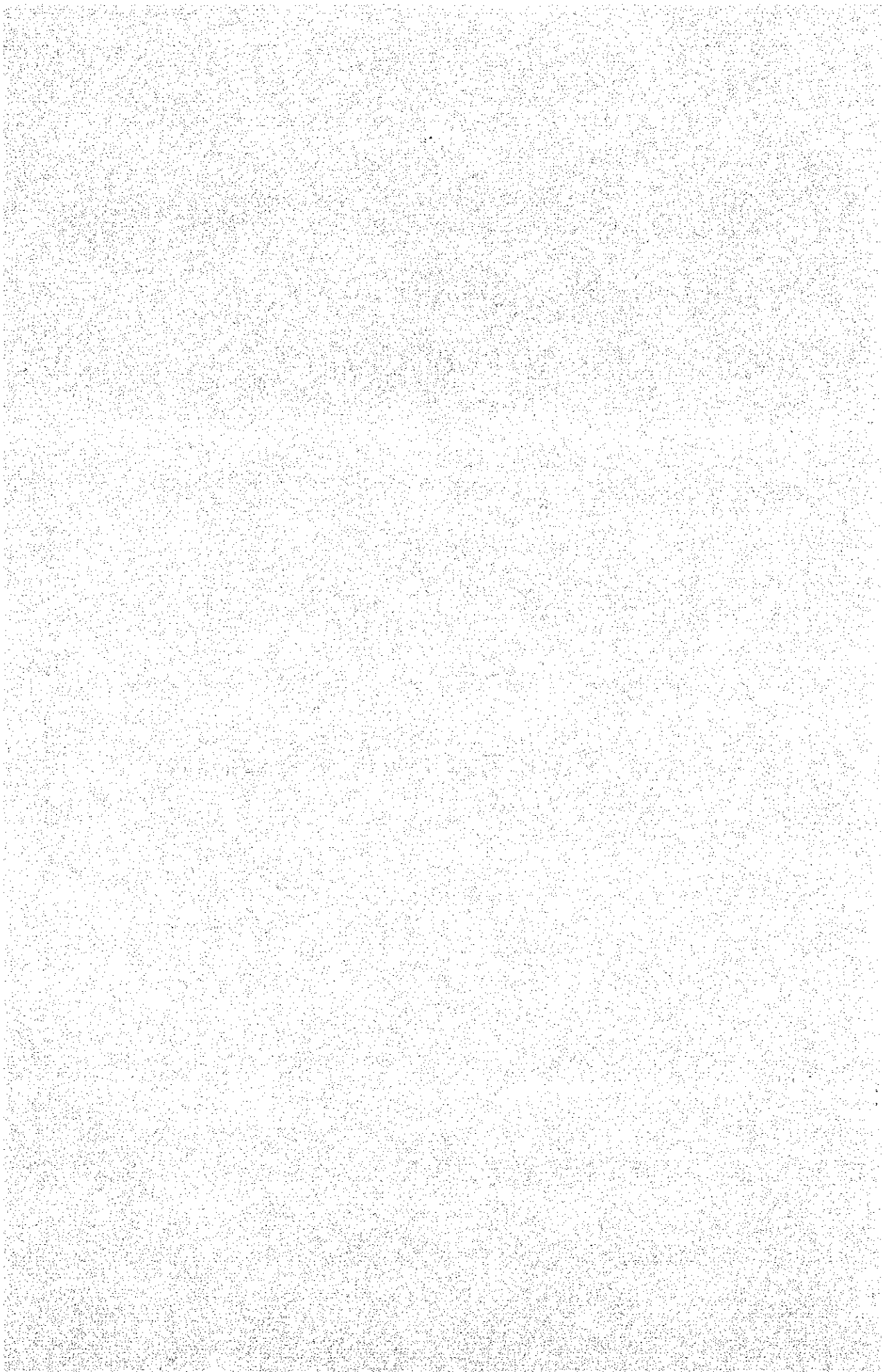
7. Other Measures

| | | |
|---------------------|---|------------------------------|
| % | : | percent |
| HP | : | horse power |
| °C | : | degree centigrade |
| m ³ /sec | : | cubic meter per second |
| ℓ/sec/ha | : | liter per second per hectare |
| cm/sec | : | centimeter per second |
| ton/ha | : | ton per hectare |
| ppm | : | part per million |
| no(s) | : | number(s) |

8. Currency

| | | |
|------|---|------------------------|
| US\$ | : | US Dollar |
| Kip | : | Local currency in Laos |

1. INTRODUCTION



1. INTRODUCTION

The Tha Ngon Irrigation Scheme (the Scheme) with an area of about 800ha is located at about 25km north from Vientiane, the capital of The Lao People's Democratic Republic (Lao PDR). The construction works of the Scheme were commenced in 1971 and completed in 1974 by the Government of Lao PDR with financial assistance from Asian Development Bank (ADB) and technical assistance of Japan. In addition, the Government of Japan dispatched numbers of Japanese experts and volunteers to Laos during the period from 1970 to 1977 through the programs of technical cooperation and Japan Overseas Cooperation Volunteers, and they established a pilot farm of about 100 ha in the Scheme area and trained the Laotian staff through the operation and maintenance of the pilot farm.

Since 1974, the Scheme has cumulated important experience in operation of modern irrigation system. In the recent years, however, remarkable damages on the irrigation and drainage facilities due to poor maintenance have deteriorated their functions; the irrigated land is only about 300 ha in the wet season.

The Government of Lao PDR has laid a great emphasis on the rehabilitation of the Scheme in the framework of the small and medium scale irrigation development in the Vientiane plain because of the following reasons:

- The Scheme already has the modern irrigation and drainage facilities,
- Since the required works are only rehabilitation of main facilities, it is expected to get quick return with small investment cost, and
- The Scheme to be rehabilitated will have a great impact as a pilot project on the other irrigation development projects in the Vientiane plain, because the Scheme is located near Vientiane.

Under such situations, the Government of Lao PDR requested the Government of Japan in April, 1986 to extend a grant aid for the Tha Ngon Rehabilitation and Rural Development Project (the Project) including improvement and development of rural infrastructures for existing six (6) villages in and around the Scheme. In response to the request, Japan International Cooperation Agency (JICA) dispatched a preliminary survey team to Laos from June 25 to July 18, 1986. The preliminary survey team confirmed that the Government of Lao PDR has strong intention of rehabilitating the existing irrigation and drainage facilities and improving the rural conditions through provision of rural road, rice processing and storage facilities and a rural water supply system in existing villages in and around the Scheme.

Since various agricultural benefits and favorable socio-economic impacts are expected from the implementation of the Project, JICA decided to proceed with the basic design study of the Project. The basic design study team was despatched to Laos from October 24 to November 23, 1986. The team surveyed and investigated the project area to grasp the present conditions and constraints, collected the data required for the basic design study and had a series of discussions with the Ministry of Agriculture, Forestry, Irrigation and Cooperatives (MAFIC) which will be the implementation agency of the Project.

The main works executed by the team in Lao PDR are as follows:

- Explanation and discussions on the Inception Report,
- Preparation and signing of Minutes of Discussions,
- Data collection required for the basic design study,
- Site survey and investigation to grasp the present conditions and constraints in the project area, and
- Confirmation of the request from Lao PDR.

The related data to the field survey of the team in Lao PDR are shown in the attachments.

This report presents the results of the basic design study on the Tha Ngon Rehabilitation and Rural Development Project.

2. BACKGROUND OF PROJECT

2. BACKGROUND OF PROJECT

2.1 National Development Plan

(1) General situation

Lao PDR is a land-locked country with an area of 236,800 km². Stretching more than 1,000 km in a north-south direction, the country is bordered by Vietnam in the east, Kampuchea in the south, Thailand in the west and Burma and China to the north. About 80% of the country is mountainous ranging in height between 200 to 3,000 m, which makes internal and external communications difficult and costly for its 3.6 million inhabitants. The cultivable land is about 18,400 km² which correspond with 8% of the total land.

The climate is tropical monsoon and is characterized by two pronounced seasons, the wet season from May to October and the dry season from November to April. The average annual rainfall at Vientiane, the capital of Lao PDR is about 1,600 mm, of which about 90% is concentrated during the wet season. The annual mean temperature at Vientiane is about 26°C and the maximum temperature reaches to about 40°C in April. The annual mean relative humidity is about 75%.

According to the census, the population in 1985 is about 3.58 million and the density is about 15 person/km². The annual growth rate of population is estimated at 2.9%. The population by province is shown in Table 2.1. About 60% of the population live in the lowlying area near the Mekon river and its main tributaries, while the remaining in the mountainous area.

Table 2.1 POPULATION BY PROVINCE (1985)

| Province | Male | Female | Total |
|----------------------|-----------|-----------|-----------|
| Vientiane prefecture | 193,136 | 184,273 | 337,409 |
| Phongsaly | 59,925 | 63,059 | 122,984 |
| Luang Namtha | 46,435 | 50,593 | 97,028 |
| Oudomasay | 90,570 | 96,545 | 187,115 |
| Bokeo | 26,360 | 28,565 | 54,925 |
| Luang Prabang | 146,202 | 149,273 | 295,475 |
| Houaphan | 104,740 | 105,181 | 209,921 |
| Sayaboury | 109,763 | 113,843 | 223,611 |
| Xiang Khoang | 80,611 | 80,978 | 161,589 |
| Vientiane | 132,572 | 131,705 | 264,277 |
| Bolikhanxay | 59,931 | 62,369 | 122,300 |
| Khammouane | 102,040 | 111,422 | 213,462 |
| Savannakhet | 263,856 | 279,577 | 543,611 |
| Saravan | 88,240 | 99,275 | 187,515 |
| Sekong | 24,657 | 26,252 | 50,909 |
| Champassak | 195,240 | 207,801 | 403,041 |
| Attapeu | 32,837 | 36,794 | 69,631 |
| Total | 1,757,115 | 1,827,688 | 3,584,803 |
| Percent Distribution | 49.0 | 51.0 | 100.0 |

Source: 1985 census data

(2) Economic situation

Lao PDR is blessed with abundant natural resources, such as hydropower, forestry, agricultural land, surface water, minerals, etc. as compared with the other developing countries. However, its economic growth is hindered by such constraints as unstable climate, low population density, land-locked topography of the country, insufficient basic economic infrastructures, weak domestic savings, etc. The Gross Domestic Product (GDP) in 1985 was about US\$ 489 million, and per capita income was US\$135.

(3) National development plan

Since the return of peace, unity and genuine independence in 1975, Lao PDR has been involved in building the foundations of a socialist economy based on the specific socio-economic conditions of the country:

- predominance of a traditional economy of small scale agricultural production,
- low level of economic and socio-cultural infrastructure, and
- after-effects of a long war of national liberation.

In this context, through two development plans (Three-Year Plan 1978-1980 and First Five-Year Plan 1981-1985), the country has been involved in a policy of developing its agriculture and timber resources. The goal is i) to become self-sufficient in basic food commodities and to have a surplus of certain agricultural products for export, ii) to develop commerce with the aim of exchange between city and countryside, in order gradually to bring the farmers into the cash nexus, and iii) to go beyond the backward state of the existing traditional economy through the growth of commerce and communications.

The principal objectives of the first Five-Year Plan were the followings:

- to increase agricultural and forestry production so as to provide enough food for consumption and to increase exports of timber,
- to increase industrial production,
- to improve the economic basic infrastructure by expanding internal transport and constructing route 9 to reach the port of Da Nang in Vietnam; developing the distribution network for electricity; and improving the capacity to maintain equipment and capital,
- to improve the internal distribution of goods,
- to increase the number of state enterprises and state controlled cooperatives so as to consolidate the leading role of the socialist sector in the economy,
- to increase, through taxation, exports and foreign aid, the mobilization of resources for investment,
- to expand the education and training system and improve the health system, and
- to improve economic management and organization.

The annual achievements and the targets of the first Five-Year Plan (1981-1985) is shown as follows.

Table 2.2 ACTUAL ACHIEVEMENTS AND THE 1981-85 PLAN TARGETS

| | (Annual growth rate in percentage) | |
|------------------------------|------------------------------------|----------------------|
| | Plan targets 1980-85 | Estimated 1980-84 |
| Agriculture | 4.2 | 4.7 |
| Industry of which: | 17.0 | -1.6 |
| Electricity | ... | 1.3 |
| Mining | ... | 5.8 |
| Manufacturing | ... | -7.5 |
| Construction | ... | 23.0 |
| Transport and communications | 13.1 | 7.2 |
| Commerce | 11.8 | 4.4 |
| Other (housing, etc.) | ... | 3.5 |
| Net material product | 7.0 | 5.0 |

Source: Lao PDR, Country Economic Memorandum, July 15, 1986, World Bank

The major achievement of the 1980-84 period was the increase in agricultural output, mainly because of increased paddy output in 1984. The paddy self-sufficiency was reached in 1984. However, despite the rapid growth of agricultural output in 1980-84, there is little evidence that state investment in the sector contributed much to it. State farms have not been profitable or very productive; only about one-third of the 32,000 ha of land nominally developed for dry season irrigation is actually cultivated in the dry season and yields are no higher than the lowland paddy average in wet season. The investment returns of other sectors were much less than initially expected.

Following the first Five-Year Plan, the Government of Lao PDR drafted the second Five-Year Plan (1986-1990). The draft 1986-90 Development Plan is under review by Government. It is expected to be submitted for final approval by the Party Congress in November, 1986. The development priorities are oriented as follows:

- acceleration of development and exports to achieve food self-sufficiency, reduced non-food imports and improvement of balance of payments (export of agricultural, timber, mining, energy and industrial products, particularly to convertible countries),
- improvement of transportation and communication sectors, and
- strengthening of management and development of human resources.

The measures required to reach the above priority objectives are shown below:

(1) Economic measures

- better use of the existing equipment and infrastructures, upgrading them if necessary,
- selection of small scale and high-return projects,

- increased and systematic use of measures to stimulate production (price and service supports to benefit state, cooperative and private producers),
- diversified and increased production, particularly in agriculture, and
- better utilization of local raw materials for the development of agro-industries and the wood industry.

(2) Financial measures

- stabilization and reduction of the budget deficit by limiting the least essential expenses and by increasing certain fiscal and semi-fiscal revenues, and
- improvement of the balance of trade and the balance of payments by promoting exports.

(3) Measures to control inflation

- reduction of expansion in the money supply,
- control of the debt levels of the public sector,
- increase of the domestic share in the national revenue assigned to savings, and
- change of the price and subvention policy.

(4) Measures to planning capabilities and management of the economy

- establishment of a viable statistical apparatus,
- development of the coordination of economic policy and external aid,
- improvement of capacities for selection, execution and evaluation of projects,
- rationalization of administrative structures and state enterprises, and
- rationalization of the functional framework of the private sector.

Investment costs of projects identified for the 1986-90 period is shown in Table 2.3.

Table 2.3 INVESTMENT COSTS OF PROJECTS

| | Investment Cost in 1985 prices (US\$ 106) | Percentage |
|-------------------------------------|---|--------------|
| A. Agriculture | 127.0 | 34.7 |
| - Rainfed rice and other crops | 185.0 | 5.1 |
| - Livestock and fisheries | 27.5 | 7.5 |
| - Irrigation | 70.6 | 19.3 |
| - Training and others | 10.4 | 2.8 |
| B. Industry, Mines and Energy | 77.2 | 21.1 |
| - Manufacturing | 9.7 | 2.7 |
| - Forestry | n.a. | n.a. |
| - Mining | n.a. | n.a. |
| - Energy | 66.6 | 18.2 |
| - Others | 0.9 | 0.2 |
| C. Transport and Telecommunications | 106.0 | 29.0 |
| D. Commerce | 13.4 | 3.7 |
| E. Housing and Water Supply | 14.8 | 4.0 |
| F. Education | 13.9 | 3.8 |
| G. Health | 13.2 | 3.6 |
| Total | 365.5 | 100.0 |

Sources: Lao PDR, Country Economic Memorandum, July 15, 1986, World Bank

As indicated in Table 2.3, the Government of Lao PDR gives a top priority to the agriculture sector, particularly irrigation, and the transport and telecommunication sectors. In agriculture, the objectives would be to: i) secure self-sufficiency in rice and maintain adequate security stock; ii) diversify agriculture by expanding production of non-rice crop and of livestock and fishery products-for domestic consumption and for export; iii) increase exploitation and improve conservation of forest resources, with particular emphasis on controlling and gradually reducing slash and burn agriculture; and iv) expand collectivization of agricultural production activities.

2.2 Agricultural Situation

(1) Land and land use

Intensity of land use is very low. Only about 3% of the total land area is regularly cultivated although about 8% is considered to be cultivable. Of the approximately 800,000 ha of cropped area, an estimated 285,000 ha (or 35%) is under a slash and burn agricultural system, with upland rice as the major crop. Altogether, rice accounts for 89% (687,000 ha) of annually cultivated cropland and virtually all of the lowland area. Other important annual crops are maize 4%, pulses 3% and root crops 1.6%. Coffee (18,000 ha) and other perennial tree crops occupy about 3% of total cropland area.

(2) Irrigation

Exploitable surface water resources are available in large quantities and could be used to irrigate about 600,000 ha. However, irrigation development is minimal in contrast to this potential. Supplemental irrigation during the wet season is conducted only in about 50,000 ha, mostly from small diversion weirs with very little water delivery capacity or control. Another 25,000 to 70,000 ha that has received some development for irrigation is apparently not used. About 20,000 ha receive relatively reliable water supplies and have improved primary and secondary systems, permitting some degree of water control. Most of this area, including about 10,000 ha served by pumps on the Mekong and some main tributaries, can be irrigated during the dry season, albeit with low efficiency because of incomplete structures and tertiary systems. Because of fuel shortages, inadequate water management and lack of incentives to farmers, only about 8,000 to 10,000 ha have been cropped during recent dry seasons. The irrigation area by each province is shown below.

Table 2.4 AREA IRRIGATED IN 1985 BY PROVINCE

(Unit: ha)

| Province | Lowland Area Development for irrigation | | | | |
|----------------------|---|---------------|---------------|---------------|---------------|
| | Cultivated lowland | Rainy season | | Dry season | |
| | | Capacity | In use | Capacity | In use |
| Phongsaly | 4,450 | 1,400 | 980 | 820 | - |
| Luang Namtha | 4,400 | 3,960 | 3,960 | 1,840 | 20 |
| Bokeo | 3,010 | - | - | - | 5 |
| Oudomsay | 6,960 | 1,100 | 800 | 150 | 20 |
| Luang Prabang | 8,290 | 51,120 | 3,730 | 1,660 | 525 |
| Sayaboury | 167,760 | 9,500 | 6,400 | 1,000 | 470 |
| Houaphan | 7,610 | 2,500 | 2,000 | 1,200 | 530 |
| Siang Khoang | 15,210 | 5,400 | 5,000 | 1,100 | - |
| Vientiane | 36,970 | 3,435 | 1,235 | 450 | 275 |
| Vientiane Prefecture | 36,980 | 27,390 | 14,965 | 6,080 | 6,000 |
| Bolikhamxay | 12,500 | - | - | -755 | 5 |
| Khammouane | 38,400 | 2,155 | 715 | 2,500 | 75 |
| savannakhet | 88,110 | 2,600 | 2,000 | 2,385 | 1,720 |
| saravan | 31,130 | 5,850 | 3,970 | - | 200 |
| sekong | 550 | - | - | 3,010 | - |
| Charnpassak | 79,250 | 3,840 | 1,445 | 20 | 240 |
| astopeu | 9,660 | 50 | 50 | - | 0 |
| Total | 396,250 | 74,290 | 47,250 | 22,970 | 10,095 |

Source: Lao PDR, Country Economic Memorandum, July 15, 1985

(3) Farming practices

Agriculture makes very little use of powered machinery or other modern inputs. State farms and cooperatives own the 1,050 four-wheel and 50 hand tractors and associated tillage equipment in the country, and only about half of the tractors are in operating condition. Planting, weeding, harvesting and threshing are done manually. Improved variety seeds are used on only about 5% of cultivated land. Chemical fertilizer use over 1983-85 averaged about 1,700 tons p.a., 2.2 kg/ha of cropland, and it was applied almost exclusively to rice nurseries in irrigated areas. About 40 tons of insecticides are available annually.

Government policy with respect to provision of agricultural inputs reflects the overall socialist structure and efforts to expand public ownership and control in agriculture. That is, supply of modern inputs (fertilizers and other agricultural chemicals, fuels and machinery) is a state monopoly and first priority in obtaining inputs is given to the state and cooperative farms.

(4) Farm management structure

Most of the agricultural economy is characterized by subsistence cropping supplemented by small scale livestock, handicrafts and petty commerce largely outside the control of Government. Exploitation of cropland remains largely in the private sector, with some 250,000 private farms controlling 615,000 ha (77% of the total). Some 180,000 ha (22%) by 50 state farms. Administration and management of the state sector in agriculture are centralized, with planning, budgeting and execution of all significant economic activity subject to Central Government control.

Private Farms: Most of the rural population live in small villages and obtain most of their sustenance from individually held subsistence farms. There are very few landless laborers in rural areas. The average rural household size is estimated to be about six persons, with an average of about 2.5 to 3 persons per family in the work force. Farm size varies with quality of land and size of household, however it is rare for the cultivated area in a farm to exceed 4 ha. Virtually all farmers produce rice (85% glutinous) sufficient for their own family use before allocating any land or labor time to other crops.

Ownership of all land is retained by the Government, however access and effective control rests on tradition rather than law. In the more intensively cultivated rice growing areas such as the Vientiane and Savannakhet plains, land tenure is relatively stabilized and paddy field holding clearly defined. In shifting cultivation, which constitutes nearly all the cropped land outside the more fertile river plains, land tenure is very loose and is based largely on traditional semi-nomadic cultivator principles.

Cooperatives: About 40% (160,000 ha) of the lowland rice area is now in cooperatives, at least officially, and almost one-half of all farm families are cooperative members. At present there is no direct governmental management of cooperative affairs, although all investment decisions by cooperatives must receive government clearance. Cooperatives are governed by an elected committee of members who, in turn, appoint the cooperative manager. As an experiment, individuals and small groups within some cooperatives are assigned specific land areas on a long-term basis and permitted to work as more-or-less independent production units. They must fulfill modest quotas based on average yields by land quality for the whole cooperative, keeping surpluses for themselves.

State Farms: Altogether there are about 50 state farms; 38 controlled by provincial governments, 6 by the Ministry of Agriculture Forestry, Irrigation and Cooperatives (MAFIC) and the rest by the army and other ministries. The state farms are specialized agricultural estates which employ permanent wage-workers, and temporary workers from neighboring private or cooperative farms during peak labor periods.

There is, as yet, little experience with large-scale farming in the Lao PDR, and, as for the cooperatives, an appropriate organizational structure for the state farms is still being worked out. At present, each farm is managed by a two-to-five member committee made up of cadres responsible for particular farm activities, e.g., land development, mechanization, crop production and administration. However, the Government's decision to collective agricultural production reflected in creation of the state farms and cooperatives, puts an additional degree of pressure on the extremely limited management resources.

(5) Production

In 1984, agriculture - including livestock, forestry and fisheries - produced goods valued at about 16.3 billion kip (US\$464 million at the official commercial exchange rate of 35 kip/\$), 63% of gross domestic product at current prices. This is up from about 61% of GDP in 1980. It provided roughly 50% of the inputs used by domestic manufacturers and accounted for 14% of convertible currency export earnings (90% of non-electricity exports) and 68% of barter trade. The sector provided about 70% of total employment and was the main income source for about 85% of the population. The production of major crops is shown in Table 2.5.

Table 2.5 AREA, YIELD AND PRODUCTION OF MAJOR CROPS

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 (est.) |
|-------------------------------|---------|---------|---------|---------|---------|-------------|
| Area ('000 ha) | | | | | | |
| Paddy | 724.3 | 738.5 | 731.2 | 664.3 | 648.5 | 679.7 |
| Rainfed lowland area | 426.9 | 433.2 | 435.0 | 399.3 | 360.0 | 396.2 |
| of which: | | | | | | |
| Irrigated area | (7.7) | (6.5) | (5.6) | (6.0) | (8.5) | (10.1) |
| Upland area | 297.4 | 305.3 | 296.2 | | 286.2 | 283.4 |
| Vegetables | 5.2 | 5.4 | 5.6 | 265.0 | 5.5 | 5.5 |
| Maize | 28.3 | 30.9 | 31.6 | 5.6 | 28.5 | 30.3 |
| Cotton | 7.0 | 7.1 | 7.2 | 29.8 | 7.2 | 7.4 |
| Coffee | 6.5 | 7.7 | 7.7 | 7.2 | 8.2 | 18.0 |
| Tobacco | 4.0 | 4.4 | 4.4 | 8.2 | 3.9 | 5.0 |
| Root crops | 9.1 | 11.0 | 12.0 | 3.7 | 11.9 | 12.3 |
| Groundnuts | 10.7 | 11.3 | 11.5 | 11.7 | - | - |
| Mung beans | 2.9 | 3.0 | 3.0 | 11.3 | - | - |
| Soybeans | 4.8 | 5.5 | 5.5 | 3.0 | 5.8 | 7.0 |
| Tea | 0.1 | 0.1 | 0.1 | 4.8 | - | - |
| Sugarcane | 0.9 | 0.9 | 0.9 | 0.1 | 1.9 | 3.0 |
| Yield (ton/ha) | | | | | | |
| Paddy | 1.4 | 1.56 | 1.49 | 1.51 | 2.04 | 2.1 |
| Rainfed lowland area | (1.65) | (1.81) | (1.67) | (1.75) | (2.25) | (2.57) |
| Irrigated area | (1.44) | (1.89) | (21.18) | (2.07) | (2.51) | (2.69) |
| Upland area | (1.13) | (1.18) | (1.18) | (1.09) | (1.33) | (1.35) |
| Vegetables | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 | 8.2 |
| Maize | 1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 |
| Cotton | 0.7 | 0.7 | 0.7 | 9.7 | 0.7 | 0.6 |
| Coffee | 0.7 | 0.7 | 0.7 | 0.6 | 0.5 | 0.5 |
| Tobacco | 4.2 | 4.3 | 4.5 | 4.2 | 4.2 | 4.3 |
| Root crops | 8.8 | 8.8 | 8 | 8.1 | 8.1 | 8.1 |
| Groundnuts | 0.7 | 0.8 | 0.8 | 0.8 | - | - |
| Mung beans | 0.6 | 0.6 | 0.6 | 0.6 | - | - |
| Soybeans | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.8 |
| Tea | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Sugarcane | 26.6 | 26.6 | 27.9 | 26.6 | 27.6 | 27.7 |
| Production ('000 tons) | | | | | | |
| Paddy | 1,053.1 | 1,154.7 | 1,092.4 | 1,001.4 | 1,321.0 | 1,428.0 |
| Rainfed lowland area | 705.5 | 782.2 | 730.5 | 700.1 | 919.2 | 1,019.4 |
| Irrigated area | 11.1 | 12.3 | 12.4 | 122.5 | 21.3 | 27.2 |
| Upland area | 337 | 360.2 | 349.5 | 288.8 | 380.4 | 381.4 |
| Vegetables | 42.6 | 43.6 | 44.9 | 44.3 | 45 | 45.6 |
| Maize | 28.3 | 32.8 | 34.7 | 312.9 | 33.9 | 36 |
| Cotton | 4.9 | 5 | 5.2 | 5 | 5.1 | 4.7 |
| Coffee | 4.4 | 5 | 5.2 | 5.3 | 5.7 | 5.9 |
| Tobacco | 216.6 | 19.1 | 19.7 | 15.5 | 16.5 | 22 |
| Root crops | 80.3 | 97.1 | 95.8 | 95.7 | 98.6 | 100 |
| Groundnuts | 7.9 | 8.7 | 9.2 | 8.7 | - | - |
| Mung beans | 1.6 | 1.7 | 1.8 | 1.8 | - | - |
| Soybeans | 3.3 | 3.9 | 4.2 | 3.5 | 3.6 | 5.3 |
| Tea | 0.03 | 0.05 | 0.05 | 0.06 | 0.06 | 0.07 |
| Sugarcane | 23.5 | 24.1 | 25.7 | 28.8 | 54.5 | 83.1 |

Source: Lao PDR, Country Economic Memorandum, July 15, 1986, World Bank

In 1984, the estimated paddy production per capita of 226 kg exceeded the state self-sufficiency norm of 180 kg per person. As shown in Table 2.6, however, differences in per capita paddy output among provinces still remain. In addition, most of paddy cultivation is made under rainfed condition and production depends on the weather condition.

Table 2.6 ESTIMATED RICE SURPLUSES AND DEFICITS BY PROVINCE, 1984

| Province | Population ¹ | Rice | Per | Surplus (+) or Deficit (-) | |
|-----------------|-------------------------|--|----------------------|----------------------------|--------------------------|
| | ('000 persons) | production ² ('000 tons) (kg) | capita production | ('000 tons) | (kg/capita) ³ |
| Phongsaly | 120 | 21.1 | 176 | +0.5 | -4 |
| Luang Namtha | 95 | 19.8 | 208 | +2.7 | +28.0 |
| Bokeo | 54 | 10.5 | 194 | +0.8 | +14.0 |
| Oudomsay | 183 | 38.6 | 211 | +5.7 | +31.0 |
| Luang Prabang | 289 | 53.8 | 186 | +1.7 | +6.0 |
| Sayaboury | 219 | 42.6 | 194 | +3.1 | +14.0 |
| Houaphan | 205 | 47.5 | 232 | +10.7 | +52.0 |
| Xiang Khoang | 158 | 35.2 | 223 | +6.8 | +43.0 |
| Vientiane | 259 | 71.8 | 277 | +25.1 | +97.0 |
| Vientiane Pref. | 369 | 58.7 | 159 | -7.7 | +21.0 |
| Bolikhamsay | 120 | 28.4 | 237 | +6.8 | +57.0 |
| Khammouane | 209 | 51.2 | 245 | +13.6 | +65.0 |
| Savannakhet | 532 | 112.9 | 212 | +17.0 | +32.0 |
| Saravan | 184 | 50.6 | 275 | +17.5 | +95.0 |
| Sekong | 50 | 6.2 | 124 | -2.8 | -56 |
| Champassak | 394 | 127.2 | 323 | +56.3 | 143 |
| Attapeu | 68 | 15.8 | 232 | +3.5 | +52.0 |
| Total | 3508 | 792.6 (kg) | 226 | +161.4 | +46.0 |

¹ March 1985 census data adjusted to mid-1984 using the estimated current growthrate of 2.9% p.a.

² Paddy production estimates converted to rice equivalent assuming a 60% milling rate.

³ Relative to the Government's standard of 180 kg of rice per capita (300 kg of paddy).

Source: Lao PDR, Country Economic Memorandum, July 15, 1986, World Bank

Reproductive rates for cattle are very low and the stock is almost all unimproved. Off-take rates are apparently no more than 2-3% for the buffalo and cattle herds, about 5% for hogs. Animal production is still almost exclusively a backyard industry with the main products being pork, chicken and eggs for home consumption and village level sales, while buffalo and oxen are widely used as draft animals. Natural fishery resources (fish, frogs and other aquatic animals) are found throughout the country. The annual catch is estimated to be almost 30,000 tons, and fishery products are a small but important cash income source for many families.

Table 2.7 LIVESTOCK AND FISHERY PRODUCTION, 1984

| | Number ('000) | Production ^{/1} (tons) |
|-----------------------------|------------------|------------------------------------|
| Buffalo | 935 | 5,000 |
| Cattle | 545 | |
| Pigs | 1,360 | 15,000 |
| Sheep and Goats | 60 | 200 |
| Chicken and Ducks (eggs) | 6,100 | 22,000 |
| Fish, etc. | - | 12,000 |
| | | 28,000 |

^{/1} Production estimates based on per capita consumption.

Source: Lao PDR, Country Economic Memorandum, July 15, 1986, World Bank

(6) Institutions

The institutions concerned with agriculture, reflecting the immediate history of the country, suffer from a lack of adequately trained personnel and facilities. MAFIC is the main agency responsible for agricultural development and provision of services. It has about 4,000 employees, of whom 230 have university training or equivalent experience and 1,700 have technical secondary school training. Each province also has an agricultural department answering to the provincial governor, with divisions similar to the departments in MAFIC. Collectively they have a staff complement roughly equivalent to the Ministry's although they have almost no university-trained personnel and a generally lower quality staff.

Agricultural research, extension and education are the responsibility of MAFIC. Because of lack of funding, staffing and facilities, these functions are performed at a far below adequate level. Research consists of a few controlled variety trials while most extension and teaching/training is performed by MAFIC officials on a part-time basis.

The main problem plaguing all institutions with responsibilities for agriculture is the lack of adequately trained and experienced personnel. For most of the critical management and technical decision-making tasks that have to be done to design effective sectoral programs, there is a shortage of qualified people. Almost all of the 230 university-level employees of MAFIC are in administrative positions and most cannot devote any time to dealing with working-level activities or problems. The very few professionally trained people that are actively involved in lower management and technical levels are young and have only few years of experience.

(7) Price policies and marketing

Price policies for agriculture affect almost all commodities. The Government establishes its own procurement prices and maintains retail price ceilings by regulation and by direct sales in the major markets. Government procurement of rice is about 5% of production: it collects an additional 3% of output in agricultural (paddy land) taxes levied at rates ranging from 100 to 160 kg of paddy per ha, depending on land quality (See Table 2.8).

Table 2.8 PADDY LAND TAXES

| TAX | YIELD |
|-----------|----------------------|
| 160 kg/ha | 3.1 - 3.5 ton/ha |
| 140 kg/ha | 2.8 - 3.1 ton/ha |
| 120 kg/ha | 2.5 - 2.8 ton/ha |
| 100 kg/ha | less than 2.5 ton/ha |

Source: MAFIC

Pricing and procurement of other crops is similar to the procedures. However, in general very small amounts are procured both absolutely and relative to total production, i.e., most fruits and vegetables, maize, root crops, beans and oilseeds, tea, tobacco, cotton and livestock and fish products are small-scale enterprises for home consumption or free market trade in the villages. Only for coffee, wood and forest products (cardamon, benzoin and sticklac), which are traded by government monopoly, are pricing policies of significance.

Transportation of agricultural products among Vientiane and provinces is mainly made by trucks. However, the marketing of agricultural products has such constraints as poor road network, lack of vehicles, shortage of fuel, etc.

2.3 Foreign Aid

External assistance has played and continues to play a critical role in the Lao PDR economy. Virtually all investment and a significant portion of recurrent expenditures are financed externally, as is a substantial program of technical assistance. The following table shows the capital and technical assistance from the external countries and agencies.

Table 2.9 TECHNICAL AND CAPITAL ASSISTANCE (1985)

| | (Unit : US \$ 1,000) | | |
|-----------------------|----------------------|---------------------|--------------------|
| | Technical Assistance | Capital Assistance | Total |
| (1) Bilateral Aid | 6,655 | 10,077 | 16,737 |
| Main Country | 4,216 ¹ | 6,950 ² | |
| (2) Multilateral Aid | 9,555 | 8,040 | 17,595 |
| Main Agency | 7,180 ³ | 5,460 ⁴ | |
| (3) Others | 119 | 6,308 | 6,427 |
| Total | 16,329 | 24,425 | 40,754 |
| ¹ : Sweden | ² : Japan | ³ : UNDP | ⁴ : IDA |

Source: Report on Development Co-operation, Lao PDR 1985, United Nations Development Program, Vientiane, July 1985

2.4 Tha Ngon Irrigation Scheme

The Tha Ngon Irrigation Scheme was initiated in 1966 by the Government of Lao PDR with technical assistance of Japan and realized in 1974 with assistance of Japanese experts and volunteers and financial assistance from Asian Development Bank (ADB).

The main features of the Scheme are as follows:

- (1) Paddy field : 800 ha
- (2) Irrigation pump : 3 units of submersible pump with a discharge capacity of 32.4 m³/min. including 1 stand-by unit

- (3) Drainage pump : 2 units of submersible pump with a discharge capacity of 52 m³/min.
- (4) Irrigation canal :

| <u>Canal</u> | <u>Length</u> |
|--------------------|-----------------|
| North main canal | 6,100 m |
| South main canal | 2,700 m |
| Lateral canal | 900 m |
| Sub-lateral canal | 4,000 m |
| Farm-lateral canal | 32,300 m |
| <u>Total</u> | <u>45,000 m</u> |
- (5) Drainage Canal : 23,970 m in total length
- (6) Farm road :

| <u>Road</u> | <u>Width</u> | <u>Length</u> |
|----------------|--------------|-----------------|
| Main road | 6.0 m | 24,800 m |
| Secondary road | 4.0 m | 29,000 m |
| <u>Total</u> | | <u>53,800 m</u> |
- (7) Flood protection dike :

| | |
|-------------|---------|
| Crest width | 2.0 m |
| Length | 9,200 m |
- (8) Nong Sam Kha dam and wasteway :

| | |
|----------------|------------------------|
| No. 1 Dam | |
| Type | Homogeneous earth fill |
| Max. height | 8.1 m |
| Crest width | 4.0 m |
| Crest length | 1,132.0 m |
| No. 2 Dam | |
| Type | Homogeneous earth fill |
| Max. height | 7.8 m |
| Crest width | 4.0 m |
| Crest length | 478.0 m |
| No. 1 Westeway | |
| Length | 1,700 m |
- (9) Power distribution line : 22 kv, 10 km in total length

Since 1974, the Scheme has cumulated important experiences in operation of modern irrigation system. In the recent year, however, remarkable damages on the facilities have deteriorated project functions due to poor maintenance; irrigated land in the wet season in 1985 is only 300 ha.

2.5 Request of Grant Aid

In the framework of small and medium scale agricultural development in the Vientiane plain, the Government of Lao PDR request the Government of Japan to extend a grant aid for the Tha Ngon Rehabilitation and Rural Development Project. The request consists of:

(1) Rehabilitation of irrigation and drainage facilities

(i) Irrigation pumping station

- dredging of inlet and protection works for inlet,
- replacement of a unit of submersible pump,
- overhaul of two (2) units of submersible pump, and
- repairing of an intake gate.

(ii) Regulating pond

- protection work against water seepage, and
- replacement of intake gate for north main canal.

(iii) Main and lateral irrigation canals

- concrete lining for north main canal of 6.1 km and repairing of turnout and check structures of 19 nos. in total,
- concrete lining for lateral canals of 0.9 km and reconstruction of related structures of 4 nos., and
- concrete lining for sub-lateral canal of 9.4 km and reconstruction of related structures of 22 nos.

(iv) Drainage canals

- dredging of Nong Sam river, and

- dredging of existing canals of 8.0 km

(v) Drainage pumping station

- overhaul of two (2) units of submersible pump, and
- repairing of related structures (concrete works).

(vi) No. 1 Nong Sam Kha Dam

- repairing of existing intake structure and construction of new intake structure (for 50 ha), and
- improvement of existing spillway

(vii) Supply of Operation and Maintenance equipments and spare parts

a) supply of O/M equipments,

- shovel w/cramshell 1 no.
- backhoe 2 nos.
- swamp bulldozer 2 nos.
- motor grader 1 no.
- tractor w/dump trailer 4 nos.

b) supply of spare parts for the above O/M equipment and pumping equipment.

(2) Rural development works

(i) Farm roads

- improvement with laterite pavement of existing farm road of 20.6 km,

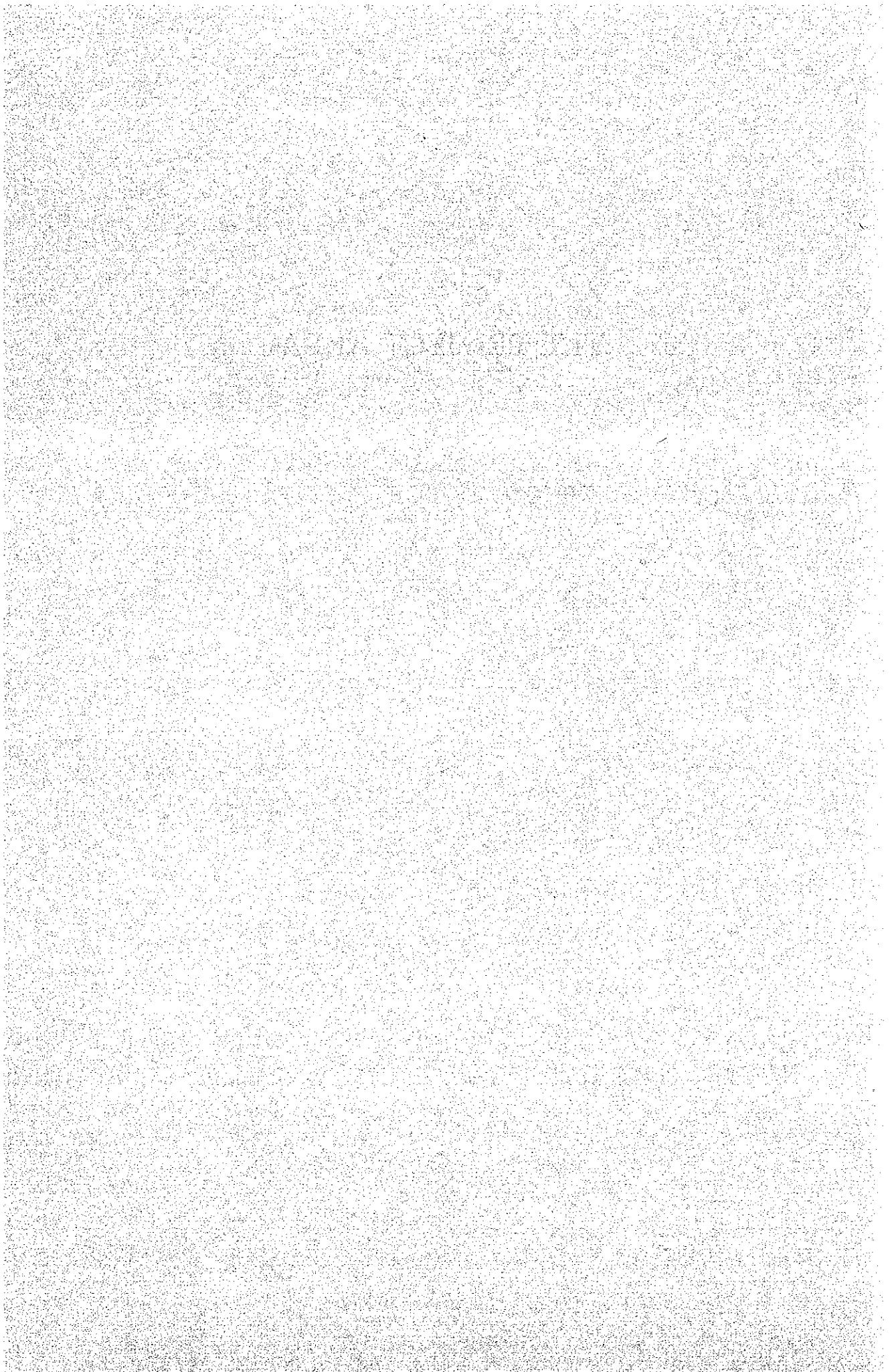
(ii) Rice mill plant and store house

- construction of three (3) rice mill factories of 300 m² in total.
- supply of three (3) sets of rice mill plants with milling capacity of 20 ton/day.
- construction of required facilities such as connection road, electricity lines (4.5 km in total).
- construction of three (3) store houses with storing capacity of 500 ton.

(iii) Water supply system

- construction of six (6) tube-wells for 1,000 persons per unit, pumping houses,
- supply of pumping equipment, pipeline and related equipment, and
- construction of electricity line of 2.2 km in total.

3. THE PROJECT AREA



3. THE PROJECT AREA

3.1 Location and Topography

The area of Tha Ngon Irrigation Scheme including its surrounding area (the project area) is laid on the right bank of the Nam Ngum river. The project area is located about 25 km north from Vientiane, the capital of Lao PDR. The area is a flat plain with an elevation between 160m and 170m. There exist six (6) villages in and around the project area. Two villages (Keng Khai and Tha Som Mo) are situated in north, two villages (Oudom Phol and Lat Khouay) in south and two villages (Tha Ngon and Ban Na) in west.

3.2 Meteorology and Hydrology

The climate of the project area is broadly divided into two seasons, i.e. the wet season (May to October) and the dry season (November to April). The annual mean rainfall at Tha Ngon is about 1,760 mm and 90% of the rainfall are concentrated in the wet season. The monthly mean temperature at Vientiane varies from 21⁰C in December to 30⁰C in April and the maximum temperature reaches to 40⁰C in April. The monthly mean relative humidity is rather high changing from 63% to 83% and the average maximum relative humidity is never below 90%.

The main water source of the Tha Ngon Irrigation Scheme is the Nam Ngum river. The Tha Ngon water level station has the catchment area of 16,500 km². The said station is located about 3.2 km upstream of the irrigation pumping station of the Scheme. The monthly mean discharge at the Tha Ngon station varies from 275 m³/sec in April to 1,716 m³/sec in September. These discharge are enough for maximum irrigation water requirement of 1.083 m³/sec of the Scheme.

3.3 Population

The total population of existing six (6) villages in and around the project area is about 6,600 or 1.8% of population in the Vientiane prefecture. The population of each village is shown below.

Table 3.1 POPULATION BY VILLAGE

(Unit: person)

| Village | Household | Population | | Total |
|------------|-----------|------------|--------|-------|
| | | Male | Female | |
| Tha Ngon | 498 | 1,333 | 1,264 | 2,597 |
| Ban Na | 192 | 549 | 563 | 1,112 |
| Tha Som Mo | 91 | 314 | 290 | 604 |
| Oudom Phol | 158 | 389 | 497 | 886 |
| Lat Khouay | 190 | 538 | 476 | 1,014 |
| Keng Khai | 78 | 210 | 222 | 432 |
| Total | 1,207 | 3,333 | 3,312 | 6,645 |

Source: MAFIC

Most of people are living at the southern hills and northern natural levee of the Nam Ngum river.

3.4 Soil and Soil Classification

The soils in the project area are divided into two soil groups: the Recent Alluvial Immature Soil Group and Ancient Alluvial Lateritic Soil Group. Recent Alluvial Immature Soil Group is a young and mostly immaturated soils with origin of most recently deposited materials transported by the Nam Ngum river and its tributary. Moreover, this soil group is divided into two sub-groups: Nature Levee Soils and Hydromorphic Soils. The nature levee soils distribute along the bank of the Nam Ngum river. Hydromorphic soils occur on the broad flat alluvial lowland behind the nature levee soils. The Ancient Alluvial Lateritic Soils Group develops in the mid-slope of the hilly area covering southern part of the Tha Ngon Irrigation Scheme. These soils are fairly matured soils derived from anciently deposited materials.

From the standpoint of the soil fertility, workability, conservability, irrigability, drainability and land capability, the soils within the project area are evaluated as following five rating classes.

Table 3.2 LAND CAPABILITY CLASSIFICATION AREA

| Class | Soil Group | Description | Area Proportion | |
|-------|---|---|-----------------|-----|
| | | | (ha) | (%) |
| I | Recent alluvial natural levee soils (Loamy surface soil/ loamy sub-surface soil area) | . Very deep soil depth, . Medium texture, . High workability, . High irrigability, . High drainability, . Non erodability, . Considerable rich in inherent fertility, . Rarely flood, . Very suitable for common crop production, | 98 | 12 |
| II-A | Recent alluvial ulei soils (Loamy surface soil/ clayey sub-surface soil area) | . Very deep soil depth, . Medium to fine texture, . Considerable workability, . Slightly high irrigability, . Slightly low drainability, . Non-erodability, . Slightly rich in inherent fertility, . Annually flooded lowland, | 476 | 57 |
| II-B | Ancient alluvial lateric soils (Sandy surface soil/ grovelly sub-surface soil area) | . Deep soil depth, . Medium texture, . Medium workability, . Considerable irrigability, . High drainability, . Slightly erodability, . Slightly poor in inherent fertility, . Never flooded, . Suitable for irrigated farming | 12 | 1 |
| III | Recent alluvial ulei soils (Clayey surface soil/ clayey sub-surface soil area) | . Slightly shallow soil depth, . Considerable coarse texture, . Considerable workability, . Slightly poor irrigability, . High drainability, . Considerable erodability, . Poor in inherent fertility, . Suitable for fallow irrigated farming in upland crops | 250 | 30 |
| IV | Ancient alluvial lateric soils (Sandy surface soil/ grovelly sub-surface soil area) | . Very shallow soil depth, . Very rough texture, . Low workability, . Low irrigability, . High drainability, . Slightly drainability, . Poor in inherent fertility, . Non suitable for irrigated farming of common crops, . Suitable for land-use of perennial crops and pasture, | 4 | - |

3.5 Irrigation and Drainage Facilities

An inventory survey on the existing facilities of the Scheme was made to grasp the present conditions of facilities, degree of their deterioration, etc. The followings were clarified through the inventory survey.

(1) Irrigation pump station and its related structures

(i) Intake structure

The field survey of the intake structure was made and it was found that the sands were deposited in front of the inlet of intake structure. The deposited quantity was estimated at about 150 m³. The rivetment of the inlet channel was partly damaged due to scouring.

Since 1977, the intake gate has never maintained and checked. The spindle of gate is corroded. The gate is still functioning water tightness, but its paint is deteriorated.

(ii) Submergible pumps and related facilities

No.1 pump has not been operated since 1985 due to leakage of insulation oil, while Nos. 2 and 3 are operated daily in shift of half day. It is considered that the mechanical seals have been damaged and the oil has leaked through the damaged part of seals. The oil leakage of Nos. 2 and 3 pumps is arising too, but its quantity is small. Each insulation resistance of Nos. 1, 2 and 3 is 5.5 M ohm, 50 M ohm and 20 M ohm, respectively.

(2) Inlet channel to the regulating pond.

(i) Outlet tank

During the field survey period, two units of irrigation pump were operated to investigate the capacity of the outlet tank. As a result, it was found that the capacity of outlet was not enough for the water discharge pumped by two units. The outlet structure itself is also deteriorated.

(ii) Inlet channel to the regulating pond

The flow capacity of inlet channel is not enough to meet with the water discharge pumped by two units. Since the measuring structure (Parshall flume) is closely provided at the outlet tank, it is not functioning.

(3) Regulating pond

In order to investigate the leakage of water from the regulating pond, the irrigation pump operation was stopped for three (3) days and the water level of regulating pond was observed. As a result, it was observed that the water level fell at 34 cm for three (3) days. The percolation rate was estimated at 3 to 4 mm/day taking the evaporation from the water surface of regulating pond into consideration. The sand of about 200 m³ was deposited in front of the inlet of regulating pond.

The intake gate of north main canal was partly damaged, particularly the spindle of gate. The water tightness of gate was also deteriorated.

(4) Main irrigation canals and lateral canals

Most of main irrigation and lateral canals are deteriorated their functions due to scouring and damage of inside slope by poor maintenance. Particularly, the deterioration of lateral canals is remarkable. They are covered with thick silt, grasses and trees.

The related structures to canals are not so deteriorated and damaged, while the gates of such structures as turnouts and checks are remarkably damaged. There are no gate in complete condition. At present, the water control at the structures on the sub-lateral canals is made by wooden stop logs. These structures should be replaced by the other types from viewpoint of water management.

(5) Drainage canals

The Nong Sam Kha river and its tributaries, the main drainage canals of the Scheme, are deteriorated and damaged due to thick grasses and trees on the both banks, fishnets and fishweir on the river bed, silting of sands, etc. According to the information from farmers, the river maintenance has never been carried out. The fishnets and fishweirs have also never been controlled.

The drainage canals in the paddy fields are also silted up due to collapse of inside slopes of canals. The related structures are not deteriorated and damaged. Only crossing pipes for roads are deteriorated or plugged by sand and silts.

(6) Drainage pump station

(i) Submergible pumps and related facilities

The insulation oil leakage was observed at the valve flanges, and the oil level gauge for No.2 pump was damaged. The drainage pumps have a automatic operation system to work by detecting water level. The pumps, however, has been operated by manual because the water level gauge is out of order. The pump impellers were worn and the insulation resistance of both motors were 10 M ohm.

As for the facilities of outdoor switchyard, the condition was almost same as the irrigation pump station. It is remarkable that the wire has been used instead of power fuse. The fence of outdoor switchyard is lost.

Since the panels in operation house have not been cleaned and maintained, the same troubles of the irrigation pump station are arising. The condition of operation house is worse than the irrigation pump station.

(ii) Related concrete structures

There exists more or less silting on the inlet canal of drainage pump station, while the inlet structure is still good condition. The rivetment of outlet channel is mostly damaged. The flap valve at the outlet channel is still good, except for deterioration of painting.

(7) No.1 Nong Sam Kha dam

The gate of intake structure at No.1 Nong Sam Kha dam can not be operated due to damage of hoist. The gate leaf is also damaged and is not functioning against the water tightness.

(8) Flood protection dike

The flood protection dike is provided along the Nam Ngum river. The embankment of dike still keeps good condition. There are partly damaged embankments, which are cut by farmer for constructing their path.

3.6 Agriculture in Project Area

(1) Land tenure

The agricultural lands in the project area are broadly divided into i) state farm land, ii) cooperative farm land, iii) private farm lands or governmental lands and iv) fish culture land. In the private farm land, private farmers are made paddy cultivation under rainfed condition. The governmental land is mainly non-cultivation land in the swampy area.

Table 3.3 PRESENT LAND TENURE

(Unit: ha)

| State Farm | Fish Pond | Cooperative Farm | | | | Private or Governmental Farm | Total |
|------------|-----------|------------------|------------|------------|--------|------------------------------|-------|
| | | Tha Som Mo | Oudom Phol | Lat Khouay | Ban Na | | |
| 103 | 48 | 273 | 97 | 128 | 30 | 161 | 840 |

Source: Study Team Estimate

(2) Land use

The present land use in the project area consists of paddy land, upland crop land, land for facilities, cemetery and others. According to the information of MAFIC, the irrigation areas in 1985 are 248 ha for the wet season and 141 ha for the dry season, respectively. In the wet season, private farmers cultivate paddy under rainfed condition. The cultivation area, however, is not clear. The following table shows the paddy cultivation area in both seasons.

Table 3.4 PADDY CULTIVATION AREA

(Unit: ha)

| Cultivation Season | State Farm | Cooperative | | | | | Total |
|--------------------|------------|-------------|------------|------------|------------|------------------------|-------|
| | | Ban Na | Tha Som Mo | Oudom Phol | Lat Khouay | Keng Khai ^Δ | |
| Wet Season | 64 | 30 | 115 | 35 | 48 | 12 | 304 |
| Dry Season | 25 | 10 | 50 | 8 | 15 | 7 | 115 |

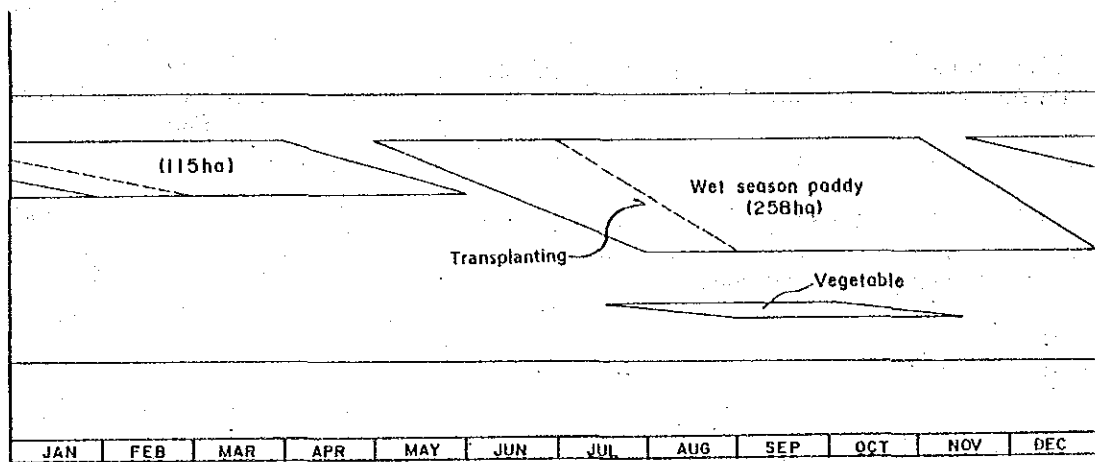
^Δ: Keng Khai village does not yet organize a cooperative and use the private farm land.

Source: MAFIC

(3) Cropping pattern

Land preparation for the wet season paddy is commenced from the end of April or May. Land preparation is carried out by tractor or buffalo and oxen. Nursery bed is prepared from the end of May to the middle of July and transplanting is carried out between the end of June and the end of August. The paddy plants flower between the late September and the end of October depending on the variety. Harvesting occurs about 45 days after flowering from the late October to the end of December considering with the beginning of the dry season cultivation. The present cropping pattern is shown in the following figure.

Fig. 3.1 Present Cropping Pattern



Most of varieties grown in the irrigated area are glutinous and of the improved varieties like IR-16 and IR 789-98. The traditional local varieties are prevailing in the non-irrigated area. The chemical fertilizer use is not common and farm labor is provided by the family with additional help from relatives.

(4) Farm machinery

Agriculture in the project area is generally not mechanized, except for a few cases of land preparation. Furthermore, a significant portions of tractors owned by cooperatives and state farm have fallen into diuse due to lack of spare parts and poor maintenance. Taking the present labor force into consideration, the farm mechanization will be essential for the project area. The following table shows the present situation of farm machinery in the project area.

Table 3.5 FARM MACHINERY

| Machinery | State Farm | Tha Ngon | Ban Na | Tha Som Mo | Oudom Phol | Lat Khouay | Total |
|-----------------|------------|----------|--------|------------|------------|------------|-------|
| Tractor (65HP) | - | - | - | 3 | - | - | 3 |
| Tractor (80HP) | 5 | 1 | 1 | 3 | 1 | 1 | 12 |
| Disc-plow -7 | 3 | 1 | 1 | 2 | 1 | 1 | 9 |
| Disc-plow -3 | 2 | - | - | - | - | - | 2 |
| disc-harrow -22 | 4 | - | - | 1 | - | - | 5 |
| Disc-harrow -18 | 2 | 1 | 1 | 1 | 1 | 1 | 7 |
| Rotary | 2 | - | - | 1 | - | - | 3 |
| Ditcher | 1 | - | - | - | - | - | 1 |
| Wedden-harrow | 1 | - | - | - | - | - | 1 |
| Power-sprayer | 1 | - | - | - | - | - | 1 |
| Trailer 4t | 4 | - | - | 4 | - | - | 8 |
| Thresher | - | - | - | 1 | - | - | 1 |
| Motor-sprayer | - | - | - | 4 | - | 1 | 5 |
| Hand-sprayer | - | - | - | - | - | 5 | 5 |
| Water Pump | - | - | - | 2 | - | - | 2 |
| Truck 6t | - | - | - | 1 | - | - | 1 |
| Truck 4t | - | - | - | 4 | - | - | 4 |
| Truck 1t | - | - | - | 1 | - | 1 | 2 |
| Jeep | 1 | - | - | - | - | - | 1 |
| Bus 6 seats | 1 | - | - | - | - | - | 1 |
| YAMAHA -125 | 2 | - | - | - | - | - | 2 |
| YAMAHA -80 | 1 | - | - | - | - | - | 1 |

Source: MAFIC

(5) Yield and production

The crop production in 1985 in the Scheme is shown in Table 3.6. The paddy yields in the wet season vary from 1.4 ton/ha to 3.1 ton/ha and the average yield in the Scheme is 2.1 ton/ha, which is same as the average yield in Lao PDR. The average yield of 1.5 ton/ha in the dry season is considerably lower than the yield in the country. During the field survey, the yield survey for the paddy in 1986 wet season was carried out by the Study Team. The sample points of 18 were selected for the survey. According to the survey results, the yields at 18 points vary from 1.10 ton/ha to 4.32 ton/ha. The average yield is 2.47 ton/ha.

Table 3.6 YIELD AND PRODUCTION OF SCHEME

| | State Farm | Ban Na | Tha Som Mo | Oudom Phol | Lat Khai | Keng Khai | Total/Average |
|-------------------|------------|--------|------------|------------|----------|-----------|---------------|
| Wet Season (1985) | | | | | | | |
| Paddy | | | | | | | |
| Area (ha) | 50 | 30 | 90 | 33 | 38 | 7 | 148 |
| Yield (ton/ha) | 1.7 | 3.1 | 2.5 | 1.4 | 1.7 | 1.7 | 2.1 |
| Production (ton) | 85 | 92 | 225 | 46 | 64 | 12 | 525 |
| Maize | | | | | | | |
| Area (ha) | - | - | 8 | 2 | 10 | 5 | 25 |
| Yield (ton/ha) | - | - | 2 | 1.9 | 2.1 | 3 | 2.2 |
| Production (ton) | - | - | 16 | 3.8 | 21 | 15 | 55.8 |
| Vegetable | | | | | | | |
| Area (ha) | 14 | - | 17 | - | - | - | 31 |
| Yield (ton/ha) | - | - | - | - | - | - | - |
| Production (ton) | - | - | - | - | - | - | - |
| Dry Season (1985) | | | | | | | |
| Paddy | | | | | | | |
| Area (ha) | 25 | 10 | 50 | 8 | 15 | 7 | 115 |
| Yield (ton/ha) | 2 | 2.2 | 1.2 | 0.8 | 1.8 | 1.2 | 1.5 |
| Production (ton) | 50 | 22 | 60 | 6 | 27 | 8 | 173 |

Source: MAFIC

(6) Livestock and fishery

The major livestock by villages in 1985 in and around the project area are shown in Table 3.7. The buffalo and oxen play an important role in farm operation and transportation as motive power, and also in meat food supplies.

Table 3.7 LIVESTOCK BY VILLAGE

(Unit: head)

| | Oxen | Buffalo | Pig | Poultry |
|------------|------|---------|-----|---------|
| Tha Ngon | 425 | 213 | 195 | 1537 |
| Ban Na | 305 | 250 | 76 | 1025 |
| Keng Khai | 70 | 65 | 32 | 722 |
| Tha Som Mo | 73 | 36 | 25 | 827 |
| Lat khouay | 150 | 220 | 60 | 680 |
| Oudom Phol | 76 | 52 | 48 | 390 |
| Total | 1099 | 836 | 436 | 5181 |

Source: MAFIC

The fish farming is conducted in the project area covering an area of about 29 ha in net with support of UNDP, FAO and the Mekong Committee. The fish pond area is divided into

two areas : nursery pond with an area of 7 ha and production pond with an area of 22 ha. The water to the pond is supplied from the regulating pond through its spillway. The amount of supplied water is about 57,000 m³/month, once every week (5 to 10 hours). Its water charge is about 0.5 kip/m³. The fishes cultivated in the pond are mainly indian carp and chinese carp. At present, 27 persons are working in the fish pond. The balance of incomes and expenditures in 1985 are as follows:

Table 3.8 BALANCE OF INCOME AND EXPENDITURE

| | | | (Unit: Kip) |
|-----------------|------------------------|--|-------------|
| Item | | | Amount |
| (1) Income | | | |
| Fry | Kip 1.5 x 1,000,000 | | 1,500,000 |
| Fish | Kip 114/kg x 35,000 kg | | 3,990,000 |
| Others | Training fee, etc. | | 1,072,000 |
| Sub-total | | | |
| (2) Expenditure | | | |
| Fertilizers | | | 536,000 |
| Laobur | | | 751,200 |
| marketing fee | | | 719,800 |
| salaries, etc. | | | 4,515,500 |
| Sub-total | | | 6,522,500 |
| (3) Balance | | | 39,500 |

Source: MAFIC

(7) Rice processing facilities and storages

There exist seven (7) rice processing facilities in and around the project area.

Table 3.9 EXISTING RICE PROCESSING FACILITIES

| Village | Number of Facilities | Remarks |
|------------|----------------------|--------------------------------------|
| Tha Ngon | 4 | 750 kg/hr: 2 nos., 200 kg/hr: 2 nos. |
| Ban Na | 1 | 200 kg/hr |
| Tha Som Mo | 1 | 200 kg/hr (engine driven) |
| Lat Khouay | 1 | 200 kg/hr (engine driven) |
| Total | 7 | |

Source: MAFIC

Rice mill plant is made in Thailand. Small plant with the capacity of 200 kg/hr is unpopular, because there are much broken milled rice.

There exist the rice storage facilities of 747 in number as shown in Table 3.10. Total storage capacity is about 3,000 ton.

Table 3.10 EXISTING STORAGE FACILITIES

| Village | Capacity | | Total |
|------------|-----------------|-----------------|-------|
| | less than 5 ton | more than 5 ton | |
| Tha Ngon | 181 | 103 | 284 |
| Ban Na | 53 | 81 | 134 |
| Keng Khai | 26 | 18 | 44 |
| Tha Som Mo | 55 | 13 | 68 |
| Lat Khouay | 52 | 78 | 130 |
| Oudam Phol | 84 | 3 | 87 |
| Total | 451 | 296 | 747 |

Source: MAFIC

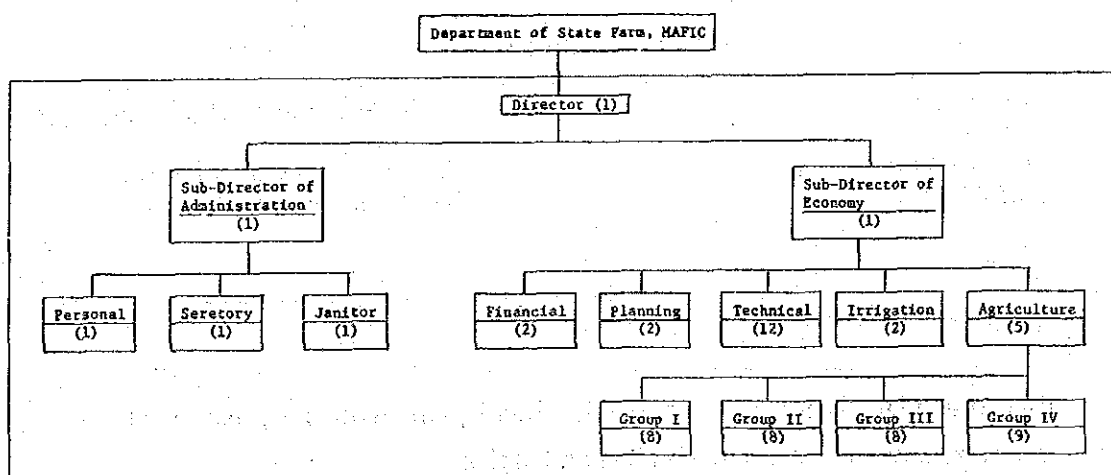
(8) Agricultural support services

(i) State farm

Generally, the state farm is responsible for agricultural research, seed multiplication of improved varieties, training of staff, support of agricultural production. The activities of state farm in the Scheme, however, are limited to the water management of the Scheme, operation and maintenance of facilities of the Scheme, and agricultural production in the own land of 105 ha.

The organization structure of state farm is shown as follows:

Fig. 3.2 Organization Structure of State Farm



Note: Number of staff 60
 Male 54
 Female 6

Groups I to III are responsible for growing crops and Group IV has responsibility for operation of agro-machinery. The total staff engaged in the state farm is 60 persons as of November, 1986.

(ii) Agricultural extension

An extension worker is assigned for each village. The extension worker, however, is still substantially under-staffed, particularly at the field level. At present, the number of field extension workers and their facilities are not sufficient to cover the whole project area.

(iii) Cooperative

At present, five (5) cooperatives are organized by each village in and around the project area.

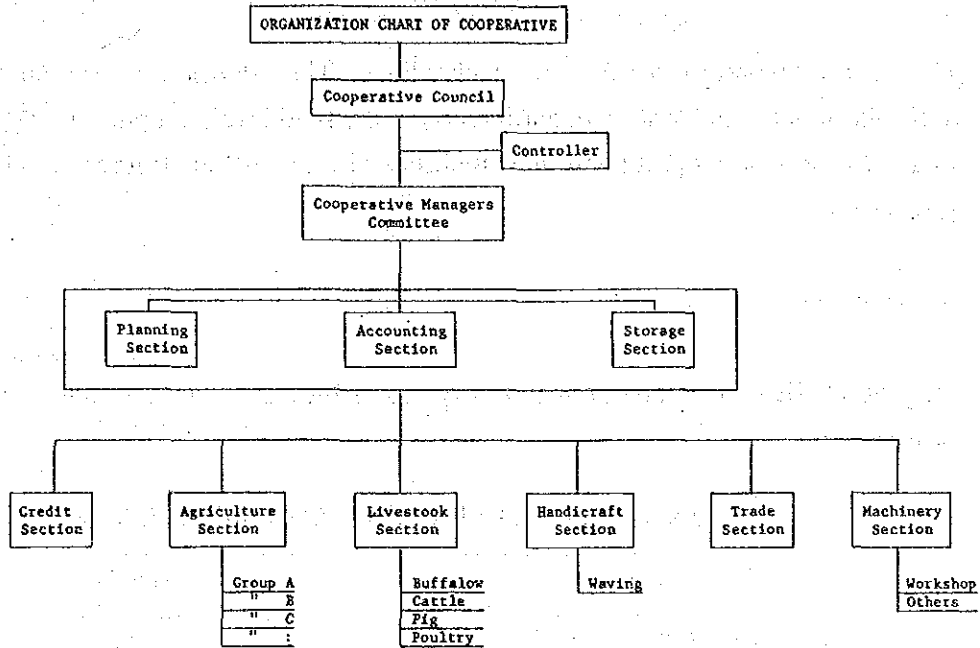
Table 3.11 COOPERATIVE AND MEMBER

| Cooperative | Member |
|-------------|--------|
| Tha Ngon | 40 |
| Tha Som Mo | 288 |
| Ban Na | 122 |
| Oudom Phol | 71 |
| Lat Khouay | 109 |
| Total | 630 |

Source: MAFIC

The activities of cooperative are not agricultural production, but also handicraft, store, livestock, credit, etc. The organization structure of cooperative is shown as follows.

Fig. 3.3 Organization Structure of Cooperative



(9) Agricultural marketing

Most of the agricultural economy in Lao PDR is characterized by subsistence cropping supplemented by small scale livestock, handicrafts and petty commerce largely outside the control of Government. Therefore, the lively marketing is no carried out. In case of rice, about 10% of total production are collected by the Government as government procurement and tax levy. The remaining is for home consumption. A part of home consumption rice is marketed, but its quantity is very small. The uplandcrops, such as maize, vegetable, etc. are also marketed in the region of their production place. Table 3.12 shows the income and expenditure of the Tha Som Mo cooperative. It is considered that this balance shows the farm economy in the project area.

Table 3.12 INCOME AND EXPENDITURE OF THA SOM MO COOPERATIVE

| Item | Production (ton) | Amount (Kip) |
|--------------------------------|--|-----------------|
| 1. Income | | |
| (1) Agricultural income | | |
| -Rice | 300 | |
| -Maize | 13.75 | 178,785 |
| -Cassave | 20 | 160,000 |
| -Sugarcane | 80 | 200,000 |
| -Contract of land preparation | | 336,000 |
| Sub-total | | 874,785 |
| (2) Other income | | |
| -Handicraft | | 1,182,881 |
| -Work shop | | 704,858 |
| -Carpenter | | 185,058 |
| -Reparing of house | | 120,000 |
| -Selling of meat | | 250,200 |
| -Transportation, etc. | | 617,500 |
| Sub-total | | 5,058,725 |
| Total | | 5,933,510 |
| 2. Expenditure | | |
| Rice | 109 ton (seed, fertilizer, insecticide, water charge, tax) | |
| Cash | Kip 5,672,067 (salaries, depreciation of machine, materials) | |
| 3. Balance | | |
| Rice | $300 - 109 = 191$ ton | |
| Cash | $5,933,510 - 5,672,067 =$ Kip 261,443 | |

Source: Tha Som Mo cooperative

3.7 Social Infrastructures

(1) Road network

The road network in and around the project area consists of the asphalt paved road and laterite paved road. The Route No.10 paved with asphalt runs on the west of the project area from south to north. Through the Route Nos. 13 and 10, it takes about 30 minutes by car from Vientiane to the project area. The laterite paved road branched off from the Root No.10 runs on the south of the project area and connect with the drainage pump station which is located on the east of the project area. There exist both the Oudom Phol and Lat Khouay villages along this road. The road condition is mostly good, except for the part near the

drainage pump station where both sides of road are covered with grasses and trees and its surface is damaged.

A paved road with asphalt and gravels is branched off from the Route No.10 near the crossing points of the Route No.10 and the Nam Ngum river and connects with the fish pond. The road is well maintained.

The main farm roads in the project area are partly damaged, where both sides of roads are covered with grasses and trees. Particularly, a part of No.1 main farm road is heavily covered with grasses and trees extending over 3.4 km out of total length of 9.6 km, and it has lost the road function due to improper surface drainage. A part of No.1 main farm road (1.2 km) from the beginning point of I-N13 sub-lateral canal to the drainage pump station is completely broken by the Lat Khouay cooperative and an irrigation canal is constructed on the surface of the road.

(2) Domestic water supply

The inhabitants of the villages in and around the project area depend on the water supply from the shallow wells, springs, irrigation canals of the Scheme, the Nam Ngum river, etc. At present, each village has the following numbers of the shallow well.

Table 3.13 NUMBER OF SHALLOW WELL

| Tha Ngon | Ban Na | Tha Som Mo | Oudom Phol | Lat Khouay | Keng Khai | Total |
|----------|--------|------------|------------|------------|-----------|-------|
| 90 | 45 | 4 | 7 | 156 | 4 | 306 |

Source: MAFIC

The depths of shallow well are about 2 to 10 m. Most of the wells dry up in the dry season, especially 3 to 4 months in late dry season. In the dry season, the inhabitants utilize water of the Nam Ngum river and the swamps around the project area. About 60% of the existing wells are unsanitary due to intrusion of rain water and drained water. The water shortage of both Tha Som Mo and Keng Khai villages is not so serious, because the inhabitants use water from the Nam Ngum river and spirings at the river bank.

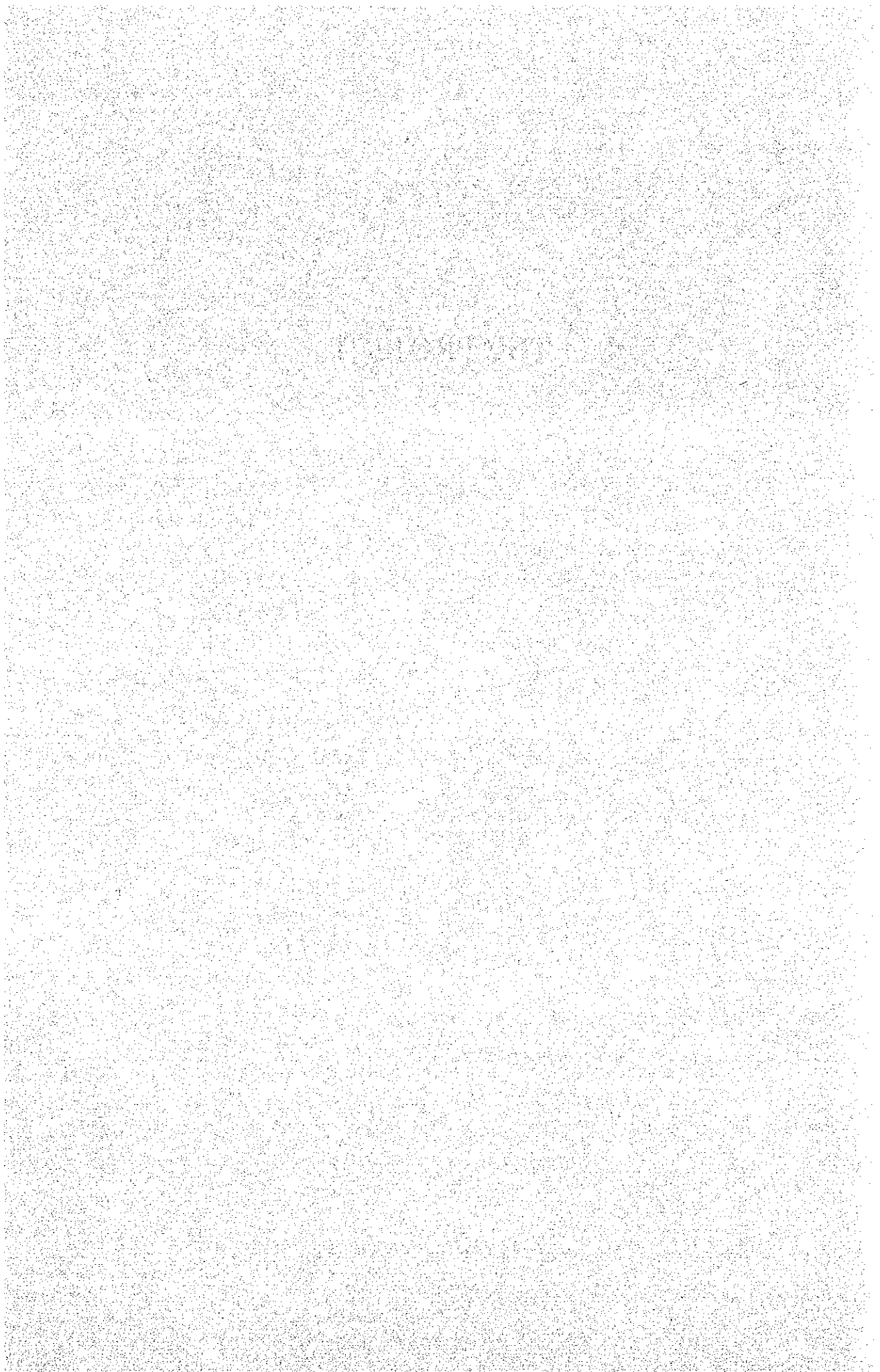
The yields of the deep well at the Pig Multiplication Center (38 m) and the deep well of the Tha Ngon Restaurant (48m) are 1.0 l/sec and 0.8 l/sec, respectively. According to the investigation for the deep wells in the Vientiane plain, it is said that the water of wells more than 100 m in depth is salty.

During the field survey, the Study Team took a water sample from the existing wells (deep well: 3, shallow well: 2) and water quality analysis was made in Japan. As a result, the water quality is good for drinking.

(3) Electricity

The existing electric power line of 22 kV runs near four (4) villages such as Tha Ngon, Ban Na, Oudom Phol and Lat Khouay. The line will be extended to the Tha Som Mo village.

4. THE PROJECT



4. THE PROJECT

4.1 Objectives of the Project

The Tha Ngon Irrigation Scheme was realized in 1974 as a model of irrigation development in the Vientiane plain extending over the banks along the Mekong river and the Nam Ngum river. Since a change of government in 1975, the deterioration of irrigation and drainage facilities is in progress due to poor operation and maintenance by insufficient budget, lack of experienced staff, etc. On the other hand, the Government of Lao PDR has laid great emphasis on the agricultural development in the second Five-Year Plan (1986-1990) following the first Five-Year Plan (1981-1985). The main policies for agricultural development in the second Plan are i) to secure the self-sufficiency in rice and to maintain adequate security stock, ii) to diversify the agriculture, and iii) to expand collectivization of agricultural production activities (increase of cooperatives). In accordance with these policies, the Government of Lao PDR is formulating the plans for rehabilitation of existing agricultural infrastructures and small and medium agricultural development with low investment and high return.

Under such a situation, the Government of Lao PDR requested the Government of Japan to extend a grant aid for the Tha Ngon Rehabilitation and Rural Development Project in the framework of the small and medium scale agricultural developments in the Vientiane plain, considering i) the Project already has modern irrigation and drainage facilities, ii) the Project has the advantages of low investment cost and quick return, and iii) the Project is located near Vientiane and will give much impacts on other projects as a pilot project in the Vientiane plain.

The objectives of the Project are as follows:

- (1) The Project will contribute as a pilot project with the modern irrigation and drainage facilities to the agricultural development in the Vientiane plain through its rehabilitation works,
- (2) The Project will contribute to improvement of living standard and social welfare and expansion and reinforcement of existing cooperatives in and around the project area through construction of rice processing and storage facilities and of a rural water supply system, and by improvement of farm and rural roads. In addition, the Project will be cited as a model project for collectivization of agricultural production activities, and

- (3) The Project will contribute to training of operation and maintenance staff in Laos through operation and maintenance of the project facilities.

4.2 Study of the Request and Project Components

According to the request of Lao PDR, the project components are broadly divided into rehabilitation works of the Tha Ngon Scheme and rural development for existing six (6) villages in and around the project area. The main reasons of deterioration of irrigation and drainage facilities for the Scheme are as follows:

(i) **Insufficient budget**

At present, the operation and maintenance of the Scheme are carried out by the staff of the state farm in the Scheme. The O&M activities, however, are limited to operation and maintenance for the irrigation and drainage pump stations. Their main activities are concentrated on the agricultural production in their own land of 103 ha. According to the information in the field, the operation and maintenance cost for the facilities is nothing.

(ii) **Lack of O&M staff**

The state farm, at present, has the staffs of 60 persons in total. Most of the staffs are laborers for agricultural production. Only two (2) staffs are engaged in the operation and maintenance of both irrigation and drainage pump stations. Subsequently, irrigation and drainage canals and farm roads are much deteriorated.

(iii) **Lack of O&M knowledge**

Since there are no experienced staffs for operation and maintenance, importance of operation and maintenance is not recognized by the staff of state farm.

(iv) **Lack of periodic check and maintenance**

Periodic check and maintenance for pump equipment and related instruments have never been done.

(v) **Lack of understanding of O&M by the central government**

It seems that the Government of Lao PDR has not laid much emphasis on the operation and maintenance of the project facilities, considering the insufficient budget and experienced staffs for O&M practices. Recently, the importance of O&M practices, however, is being recognized by the Government of Lao PDR.

Taking the above situations into consideration, the request of Lao PDR for the grant aid of Japan is studied putting emphasis on the followings:

- (i) The facilities to be rehabilitated should easily be operated and maintained by the Laotian staffs taking the present their technical level on O&M practices into consideration.
- (ii) The materials used for civil works of rehabilitation and the equipment and instruments will be selected taking easy repairing by the Laotian engineers against re-damage after rehabilitation into consideration.
- (iii) In principle, the deteriorated facilities should be rehabilitated to the original.
- (iv) The important facilities for operation of the Scheme should be studied for their rehabilitation plan even no request of Lao PDR.

The operation and maintenance plan of the Project is described in detail in Chapter 6.

(1) Rehabilitation of Tha Ngon Scheme

(i) Irrigation pump station

According to the request of Lao PDR, replacement is required for No. 1 pump, and overhaul is required for the others. No. 1 pump is now unoperated due to the insulation oil leakage. Electrical or mechanical defects will not be arising on the motor and pump. No. 1 pump, however, had been out of order in 1977, and the oil leakage from the pump casing hole was the cause of trouble. The hole of pump casing was covered by stainless steel plate. Considering such past accident on No. 1 pump and the deterioration on material of repaired part, No. 1 pump casing should be replaced to give the pump a long life. The overhaul including replacement of pump casing will cost the same case of replacement. Therefore No. 1 pump will be newly manufactured in accordance with the request by Lao PDR.

As for No. 2 and 3 pumps, the parts of shaft are considered to be worn, thus the overhaul is required.

Although no request was submitted, since some parts of panels in operation house were damaged or deteriorated, such defect parts should be replaced. The operation house is also damaged, namely door, window, ceiling, painting, etc.

Through the field survey, it was found that the capacities of outlet tank and inlet channel to the regulating pond were insufficient to meet with the water pumped by two units and their structures also were deteriorated.

(ii) Regulating pond

To investigate the seepage from the regulating pond, the water level of the pond was observed for three (3) days. Consequently, the seepage loss is estimated at 3 to 4 mm/day taking the evaporation from the water surface of the pond into consideration. From the above figures, it is judged that the protection works of seepage is not necessary. According to the field survey, the silts and sands of about 200 m³ are deposited at the outlet portion of the inlet channel from the pump station to the pond. The dredging works are required for the deposited silts and sands. Since the intake gate of the north main canal at the pond is much deteriorated, the gate will be replaced in accordance with the request of Lao PDR.

(iii) North main canal and lateral canal

According to the results of inventory survey, since the irrigation canals are mostly damaged, the repairing works will be required. Considering the easy operation and maintenance in future, the repairing works by concrete lining will be done. For proper water management, lateral canal of 5 km shall be newly constructed. For effective use of the Noi Nong Sam Kha dam, the sub-lateral canal of 0.5 km shall be newly constructed for the area of 13.8 ha. As for the related structures, the gates of turnout and check structures are mostly damaged or broken. Repairing of damaged parts or replacement of gate are necessary.

(iv) Drainage canal

According to the field survey, the flow capacities of the Nong Sam Kha river and its tributaries which are used as the drainage canals, are deteriorated due to grasses and

trees covered on the banks, fish nets and fish weirs on the channels, deposited silts and sands on the channels, etc. The flow capacities of the drainage canals in the paddy fields are also deteriorated due to deposited silts and sands on the canals, deterioration and damage of related structures, etc. The main constraint of irrigation farming in the project area is the improper drainage of paddy fields. In accordance with the request of Lao PDR, improvement of the drainage canals shall be required for proper irrigation farming.

(v) Drainage pump station

According to the insulation tests in the field, the insulation values of two pumps are 10 M ohm each. Both impellers, however, are much worn. The overhaul shall be done for both pumps. Since the operation house is the same condition as one of the irrigation pump station, the repairing of operation house will be necessary. The rivetment of pump outlet is completely damaged. It should be replaced.

(vi) No. 1 Nong Sam Kha dam

The existing gate of intake structure at the dam is completely damaged and deteriorated. The replacement of gate is necessary. An intake structure shall be newly constructed for water supply to the area of 13.8 ha.

(vii) Supply of operation and maintenance equipment

A part of farm roads and rural roads in and around the project area are remarkably damaged and deteriorated due to poor maintenance. Consequently, the traffic in the wet season is impossible except for the large tractor, which results in difficulty of farming. There are no equipment for repair and maintenance of the irrigation and drainage canals. The operation and maintenance equipment including the farm machinery should be supplied dividing into the purpose of use. For selection of equipment, the engine and spare parts are as similar as possible.

(2) Rural development

(i) Farm road

According to the results of inventory survey, a part of main farm roads in the project area is remarkably damaged and the traffic of vehicle is impossible even in the dry

season. Most of farm roads are in difficulty of traffic in the wet season. Consequently, the main farm roads shall be repaired with laterite pavement for all weather traffic. The two existing rural roads should be improved to connect with the main farm roads for transportation of agricultural production and goods.

(ii) Rice processing and storage facilities

At present, there exist only seven rice processing facilities in and around the project area. One half of the existing facilities are concentrated to the Tha Ngon and Ban Na villages. As for the storage facilities, most of existing storage facilities are private facilities of small scale. To meet with the increased rice production after rehabilitation, the reinforcement of storage facility is required for the villages or cooperatives in and around the project area. Since the Tha Ngon village has no farm land in the Tha Ngon Scheme and four rice processing facilities, both rice processing and storage facilities are not necessary for the village. The Keng Khai village does not yet organize the cooperative and the peoples of the village cultivate the paddy in the private land of the Tha Ngon Scheme. Subsequently, it is judged that both rice processing and storage facilities are not required for the village. Furthermore, the people of the Keng Khai village can use the facilities of the Tha Som Mo village which is located near the Keng Khai village. The peoples of the Ban Na have only the land of 30 ha in the Tha Ngon Scheme and can use the facilities of neighboring Tha Ngon village. From the above studies, the rice processing and storage facilities should be constructed for the Tha Som Mo, Oudom Phoi and Lat Khouay villages which have large agricultural lands in the Tha Ngon Scheme and only poor and small rice processing and storage facilities.

(iii) Rural water supply system

The four villages such as the Lat Khouay (new), Oudom Phoi, Ban Na and Tha Ngon, are located at the elevated areas south or north of the Tha Ngon Scheme. Domestic water shortage of the above villages is serious in the dry season, particularly in late dry season (3 to 4 months), because most of the existing shallow wells dry up in the dry season. Consequently, the rural water supply system with deep tube-well (50 m deep) should be provided for the four villages.

On the contrary, the houses in the Tha Som Mo (old and new), Keng Khai and Lat Khouay (old) villages along the Nam Ngum river are widely scattered. The construction of rural water supply system for the villages is not economical, because of necessity of long pipe line. The peoples in the above villages can use the water of the

Nam Ngum river, springs along the river and the north main canal even in the dry season. The present water use in the villages is insanitary. Subsequently, the tube-wells with manual pump (15 to 20 m deep) for emergency use will be provided for the villages.

Based on the above study results, the preliminary plan of the Project is shown in Table 4.1 comparing with the request of Lao PDR. The detailed rehabilitation plan with the study of the request is shown in Table 4.2.

Table 4.1 COMPARISON OF REQUEST AND GRANT AID PLAN

| Request | Grant Aid Plan | Reason |
|--|--|---|
| <p>1. Rehabilitation of The Ngon Scheme</p> <p>1 Irrigation pump station</p> <p>1.1 Dredging works of inlet channel and protection works of inlet channel</p> <p>1.2 Replacement of a unit of submersible pump</p> <p>1.3 Overhaul of two units of submersible pump</p> <p>1.4 Repairing of an intake gate</p> | <p>1. Rehabilitation of The Ngon Scheme</p> <p>1 Irrigation pump station</p> <p>1.1 Dredging works of inlet channel and protection works of inlet channel</p> <p>1.2 Replacement of a unit of submersible pump</p> <p>1.3 Overhaul of two units of submersible pump</p> <p>1.4 Repairing of an intake gate</p> <p>1.5 Repairing of operation house including control panel, spare parts, door, window etc.</p> | <p>Operation house is deteriorated and damaged, and it is necessary for the operation house to rehabilitate so as to make an adequate operation of irrigation pump.</p> |
| <p>2 Regulating Pond</p> <p>2.1 Protection works against water seepage</p> <p>2.2 Replacement of intake gate for north main canal</p> | <p>2 Regulating Pond</p> <p>2.1 No protection works for seepage</p> <p>2.2 Replacement of intake gate for north main canal</p> | <p>According to the field investigation, the percolation rate from the pond is estimated at 3 to 4 mm/day. Consequently, it is judged that the protection works are not required for water seepage.</p> |
| <p>3 Main and Lateral Irrigation Canals</p> <p>3.1 Concrete lining for north main canal and repairing of related structures</p> <p>3.2 Concrete lining for lateral canals and repairing of related structures</p> <p>3.3 Concrete lining for sub-lateral canals and repairing of related structures</p> | <p>3 Main and Lateral Irrigation Canals</p> <p>3.1 Concrete lining for north main canal and repairing of related structures</p> <p>3.2 Concrete lining for lateral canals and repairing of related structures</p> <p>3.3 Concrete lining for sub-lateral canals and repairing of related structures</p> <p>3.4 New construction of sub-lateral canals (concrete lining)</p> | <p>Sub-lateral canals would be newly constructed in the paddy fields where at present, irrigation water is not supplied, from viewpoint of water management.</p> |
| <p>4 Drainage Canals</p> <p>4.1 Dredging of Nong Sam Kha river and its tributaries and reconstructing of related structures</p> <p>4.2 Dredging of existing drainage canals</p> | <p>4 Drainage Canals</p> <p>4.1 Dredging of Nong Sam Kha river and its tributaries and reconstructing of related structures</p> <p>4.2 Dredging of existing drainage canals</p> | <p>Main constraint for operation of the Tha Ngon Scheme is improper drainage. The farming condition would be much improved by dredging of drainage canals and reconstructing of related structures.</p> |
| <p>5 Drainage Pump Station</p> <p>5.1 Overhaul of two units of submersible pump</p> <p>5.2 Repairing of related structures</p> | <p>5 Drainage Pump station</p> <p>5.1 Overhaul of two units of submersible pump</p> <p>5.2 Repairing of related structures</p> <p>5.3 Repairing of operation house including control panel, spare parts, door, window, etc.</p> | <p>Operation house is deteriorated and damaged same as operation house for irrigation pump.</p> |
| <p>6 No.1 Nong Sam Kha dam</p> <p>6.1 Repairing of existing intake structure and construction of new intake structure</p> | <p>6 No.1 Nong Sam Kha dam</p> <p>6.1 Repairing of existing intake structure and construction of new intake structure</p> | <p>For proper water management, an intake structure should be newly constructed.</p> |

| Request | Grant Aid Plan | Reason |
|---|---|--|
| <p>7 Supply of Operation and Maintenance Equipment and Spare Parts</p> <p>7.1 Supply of O & M equipment</p> <p>(1) Shovel with cranshell 1 no. (2) Backhoe 2 nos. (3) Swamp bulldozer 2 nos. (4) Motor grader 1 no. (5) Tractor with trailer 4 nos. (6) Supply of spare parts for the above O & M equipment and pump equipment</p> | <p>7 Supply of Operation and Maintenance Equipment and Spare Parts</p> <p>7.1 Supply of O & M equipment</p> <p>As shown in Table 4.3, the required equipment including spare parts is selected for future O & M of the Scheme, irrigation and drainage facilities and farm roads.</p> | <p>At present, the farm road is deteriorated and damaged which results in the difficulty of farming operation due to impassableness in the wet season except for the farming tractor. Consequently, the O & M equipment is selected for repairing of farm roads in the wet season. Since lack of spare parts for the Scheme is serious, necessary parts are selected taking similarity of engine into consideration.</p> |
| <p>ii. Rural Development</p> | | |
| <p>1 Farm Road</p> <p>1.1 Improvement with laterite pavement of existing farm road</p> | <p>1 Farm Road</p> <p>1.1 Improvement with laterite pavement of existing farm road</p> <p>1.2 Improvement of existing rural road</p> | <p>Improvement of existing rural road is necessary to connect with the farm road net work in the project area and to be easy in transportation of agricultural production and goods.</p> |
| <p>2 Rice Processing and Storage Facilities</p> <p>2.1 Construction of three rice processing facilities</p> <p>2.2 Supply of three sets of rice mill plants</p> <p>2.3 Construction of connection road and electric power line</p> <p>2.4 Construction of three store houses</p> | <p>2 Rice Processing and Storage Facilities</p> <p>2.1 Construction of three rice processing facilities</p> <p>2.2 Supply of three sets of rice mill plants</p> <p>2.3 Construction of connection road without electric power line</p> <p>2.4 Construction of three store houses</p> | <p>Processing and storage capacities would be determined taking future rice production in the project area into consideration. Construction of electric power line should be made by the Government of Lao PDR as stated in Minutes of Discussions.</p> |
| <p>3 Rural Water Supply System</p> <p>3.1 Construction of tube wells, pump house and distribution pipe lines for six villages</p> | <p>3 Rural Water Supply</p> <p>3.1 Construction of tube wells, pump houses and distribution pipe lines for four villages (The Ngon, Ban Na, Oudom Phol and Lat Khouay), and construction of tube wells with manual pumps for three villages (Keng Khai and Tha Som Mo, and old Lat Khouay)</p> <p>3.2 Non construction of electric power line</p> | <p>Water supply for both Keng Khai and Tha Som Mo villages is not economical, because the houses are widely scattered. Even in the dry season, the said villages can use the water from the Nam Ngum river and springs along the river. However, the tube well with manual pump should be provided for emergency purpose taking public sanitation into account. Construction of electric power line is not necessary, because of construction of tube well with manual pump.</p> |

Table 4.2 STUDY OF REQUEST AND REHABILITATION PLAN

| Request | Study of Request | Rehabilitation Plan |
|--|--|--|
| I Rehabilitation of Tha Ngon Scheme | | |
| 1 Irrigation Pump Station | | |
| (1) Dredging of silts and sands in front of inlet channel and in inlet channel | (1) According to the field survey, the silts and sands of about 150 m ³ are deposited in front of the inlet channel. Some quantities of silts and sands may be deposited in the inlet channel. | (1) In early March, the deposited silts and sands will be excluded by man power constructing the temporary dike in front of the inlet channel. |
| (2) Repairing of intake gate | (2) The screwed part of spindle and gears of hoist corroded. The strength of screwed part is getting weak. The remaining parts, such as gate leaf, guide frame and hoisting shafts, are considered to have enough strength. | (2) Replacement of the hoist, spindle cover and screwed part of spindle. |
| (3) Rivetment of inlet channel | (3) Existing rivetment of inlet channel is partly damaged due to scouring. | (3) Repairing of rivetment by concrete. |
| (4) Rehabilitation of submersible pump | (4) No.1 pump is not operated because of leakage of insulation oil. The control panel for No.1 pump is also out of order due to the control auxiliary relays and timers damaged and no spare parts. The cause of oil leakage from No.1 pump is considered due to wear of the mechanical seal. Wears and damages will arise on the other parts such as bearing, ball nuts, casing ring, impeller, etc. As for Nos. 2 and 3 pumps, almost parts are worn, and oil leakage was observed from No.3 pump, although both pumps are still operated. No.1 pump has the case of oil leakage through the hole on pump casing in 1977. Thus the pump casing should be replaced on this rehabilitation. The overhaul including replacement of pump casing will cost the same of new manufacturing. Therefore, No.1 pump should be totally renewed. | (4) The followings are the outline of rehabilitation for the pumps. a. Replacement of No.1 pump b. Overhaul of Nos. 2 and 3 pumps c. Cleaning of insulation oil tanks and replacement of fittings d. Repair and repaint for oil pipes and supports e. Repair of air valve |
| (5) Supply of spare parts | (5) Some spare parts are insufficient and the remainder is stored under bad condition. | (5) The spare parts will be supplied. |

| Request | Study of Request | Rehabilitation Plan |
|------------------------------------|--|--|
| (6) No request | <p>(6) The oil level gauge, compound gauge, pressure transmitter and water level gauge are missing or out of order. Since the water level gauge and oil level gauge are essential for automatic shut down of pump operation in emergency case, the gauges must be replaced by new one. A water level gauge should be furnished in suction pit to detect abnormal low water instead of pressure transmitter, because the pressure transmitter will be easily broken unless the exact maintenance is done.</p> | <p>(6) The followings are the outline of rehabilitation plan.</p> <ol style="list-style-type: none"> a. Replacement of oil level gauge b. Replacement of water level gauge in discharge side c. New furnishing of water level gauge in suction side |
| (7) No request | <p>(7) The coatings of discharge pipes are damaged and rusted.</p> | <p>(7) The discharge pipes will be repainted.</p> |
| (8) No request | <p>(8) Even if some lifting equipment is furnished near the pump pit, truck crane is required for loading the pumps to transport to repairing shops, because it is impossible to carry out the overhaul work of motor beside the pump pit. The truck crane is available in Vientian, and the overhaul of pumps performed once for some years will be made by borrowing the truck crane. The access road should be repaired for such heavy equipment.</p> | <p>(8) The lifting facility will not be constructed, but the access road will be repaired.</p> |
| 2 Inlet Channel to Regulating Pond | | |
| (1) No request | <p>(1) Through the field survey, it was found that the capacity of outlet tank was not enough to meet with the water discharge pumped by two units. The structures are also deteriorated.</p> | <p>(1) Replacement of outlet tank</p> |
| (2) No request | <p>(2) The flow capacity of inlet channel to the regulating pond is also not enough against the water discharge pumped by two units. The deterioration of structure is in progress. Since the measuring structure (Parshall flume) is closely provided at outlet tank, it is not functioning.</p> | <p>(2) Replacement of inlet channel to the regulating pond including the measuring structure.</p> |

3 Regulating Pond

- | | | |
|---|--|---|
| <p>(1) Protection works for seepage</p> | <p>(1) According to the observation result, the water level of regulating pond fell 34 mm in total for three days. The seepage loss is estimated at 3 to 4 mm/day taking evaporation into consideration. Consequently, it is judged that the protection works for seepage are not necessary.</p> | <p>(1) Protection works for seepage are not necessary.</p> |
| <p>(2) Repairing of intake gate for north main irrigation canal</p> | <p>(2) The cover of spindle is damaged. The screwed part of spindle and gears of hoist are corroded. The water tightness of gate is also deteriorated.</p> | <p>(2) Replacement of gate leaf and hoist and painting of guide frame. Replacement of connecting structure to the main canal.</p> |
| <p>(3) No request</p> | <p>(3) There exists a hole (2.0m x 1.0m and 1.7m in depth) on the spillway. Measures for safety are required.</p> | <p>(3) A net made by iron will be provided for a hole.</p> |
| <p>(4) No request</p> | <p>(4) There exist an intake structure which is mostly damaged.</p> | <p>(4) Removal of intake gate</p> |
| <p>(5) No request</p> | <p>(5) According to the field survey, silts and sands of 200 m³ are deposited in front of the inlet of regulating pond. Embankment of pond is partly damaged.</p> | <p>(5) Dredging of deposited silts and sands and repairing of embankment of pond.</p> |

4 Main and Lateral Irrigation Canals

- | | | |
|---|--|---------------------------------------|
| <p>(1) Repairing of north main canal with concrete lining</p> | <p>(1) At present, operation and maintenance of irrigation facilities are insufficient and technical level of O&M is low. Taking future O&M and water management into consideration, it is essential to introduce the concrete lining of irrigation canal into the Project for simplification of O&M and reduction of O&M works. The concrete lining will also contribute to prevention of seepage from the canal.</p> | <p>(1) Concrete lining of 6.1 km.</p> |
|---|--|---------------------------------------|

| Request | Study of Request | Rehabilitation Plan |
|--|---|---|
| (2) No request | The areas commanded by the south main canal | (2) Rehabilitation of the south main canal is not required. |
| (3) Repairing of lateral and sub-lateral canals with concrete lining | (3) At present, both sides of lateral and sub-lateral canals are covered with heavy grasses and the canals are mostly buried by silts and sands. Concrete lining is required for the same reason as the above 4 (1). | (3) Concrete lining of 0.9 km for the lateral canal and concrete lining of 3.3 km for the sub-lateral canals. |
| (4) No request | (4) The area of about 50 ha commanded by the south main canal could be irrigated from No.6 turnout on the north main canal by constructing a sub-lateral canal with concrete lining. | (4) Construction of new sub-lateral canal (I-N6) of 2.0 km with concrete lining. |
| (5) No request | (5) The length of existing sub-lateral canal is about 1.8 km in maximum. It is too long for proper water management. It is better to construct two sub-lateral canals along the No.2 main farm road from view point of proper water management. | (5) Construction of two sub-lateral canals (I-N10-1 and I-N10-3) with concrete lining, 2.1 km long in total. |
| (6) No request | (6) A part of the area commanded by a sub-lateral canal (I-N6) would be irrigated from the No.1 Nong Sam Kha dam by constructing a new intake structure, taking the elevation of paddy field into consideration. | (6) Construction of a new sub-lateral canal (I-NS) with concrete lining, 0.5 km long. |
| 5 Related Structures on the main and lateral canals | | |
| (1) Related structures on north main canal | (i) Turnouts - N-1 turnout (a) Gate: A gate should be installed because of no gate. (b) Structure: Since flow capacity is too large, it is necessary to reduce the flow capacity and to install a staff gauge for measuring device. | (a) Installation of new gate (Dia.200 mm) (b) Repairing of existing structure for installation of new gate (Dia.200 mm) and installation of staff gauge. |

| | |
|--|--|
| - N-2 turnout (a) Gate: Same as N-1 turnout (b) Structure: Same as N-1 turnout | (a) Same as N-1 turnout (b) Same as N-1 turnout |
| - N-3 turnout (a) Gate: Same as N-1 turnout (b) Structure: Same as N-1 turnout | (a) Same as N-1 turnout (b) Same as N-1 turnout |
| - N-4 turnout (a) Gate: Missing of hoist (b) Structure: Necessity of a staff gauge | (a) Replacement of gate leaf and hoist (b) Installation of staff gauge |
| - N-5 turnout (a) Gate: Same as N-4 turnout (b) Structure: Necessity of repairing of damaged pipe | (a) Same as N-4 turnout (b) Replacement of pipe (2.5 m long) |
| - N-6 turnout (a) Gate: The screwed part of spindle is corroded. (b) Structure: Elevation of structure is high. | (a), (b): Rehabilitation will be made taking construction plan of new sub-lateral (I-N6). |
| - N-7 turnout (a) Gate: Same as N-6 turnout (b) Structure: Present condition is still good. Necessity of staff gauge | (a) Replacement of hoist, spindle and gate leaf. (b) Installation of staff gauge |
| - N-8 turnout (a) Gate: Same as N-6 turnout (b) Structure: Transition of outlet is damaged. Necessity of staff gauge. | (a) Same as N-7 turnout (b) Repairing of transition of outlet & installation of staff gauge |
| - N-9 turnout (a) Gate: Gate leaf and hoist are damaged (b) Structure: Elevation of structure is high. Necessity of staff gauge. | (a) Replacement of gate leaf and hoist (b) Water level will be adjusted by the check gate (N-4). Installation of staff gauge. |

- N-10 turnout

- (a) Gate C): Gate leaf and hoist are damaged
L), R): Hoist is lost.
(b) Structure: Necessity of staff gauge

- (a) C): Replacement of gate leaf and hoist.
L), R): Replacement of hoist, spindle and gate leaf
(b) Installation of staff gauge

- N-11 turnout

- (a) Gate: Hoist is damaged

- (a) Replacement of hoist, spindle and gate leaf

- (b) Structure: Necessity of staff gauge

- (b) Installation of staff gauge

- N-12 turnout

- (a) Gate: Hoist and spindle are lost
(b) Structure: Necessity of staff gauge

- (a) Replacement of hoist, spindle and gate leaf
(b) Installation of staff gauge

- N-13 turnout

- (a) Gate: Condition of gate is still good.
(b) Structure: Necessity of staff gauge.

- (a) Replacement of only spindle cover
(b) Installation of staff gauge

No request

Three sets of spindle cover will be supplied.

(ii) Check structures

(ii) Check structures

- N-1 check structure

- (a) Gate: Hoist is damaged.
(b) Structure: To protect the flood dike, a
approach shall be provided.

- (a) Replacement of hoist
(b) The approach will be connected with the flood dike from
the check with a slope of 1 to 3.

- N-2 check structure

- (a) Gate: Same as N-1 check structure
(b) Structure: Same as N-1 check structure

- (a) Same as N-1 check structure
(b) Same as N-1 check structure

- N-3 check structure

- (a) Gate: Same as N-1 check structure
(b) Structure: Same as N-1 check structure

- (a) Same as N-1 check structure
(b) Same as N-1 check structure

- N-4 check structure

- (a) Gate: Most of the gate parts are damaged
(b) Structure: Same as N-1 check structure

- (a) Replacement of gate leaf, hoist and guide frame
(b) Same as N-1 check structure

| | | |
|-------------------------|---|---|
| | <p>- N-5 check structure</p> <p>(a) Gate: Most of gate parts are damaged</p> <p>(b) Structure: Same as N-1 check structure</p> | <p>(a) Replacement of gate leaf, hoist and guide frame</p> <p>(b) Same as N-1 check structure</p> |
| | <p>- N-6 check structure</p> <p>(a) Gate: The check with stop log should be changed into the check with gate.</p> | <p>(a) Installation of gate</p> |
| <p>(iii) No request</p> | <p>(b) Structure: Deterioration is in progress</p> <p>(iii) Side spillway</p> <p>At present, a stop log is provided on the crest of side spillway, because the crest elevation is lower than the design water level of canal. Most of stop logs are lost. To improve the water tightness, the crest of side spillway should be heightened more than the design water level.</p> | <p>(b) Replacement of the check structure with gate</p> <p>(iii) Repairing of side spillway</p> <p>- The elevation of crest will be 5 cm higher than the design water level of canal.</p> |
| <p>(iv) No request</p> | <p>(iv) Washing basin</p> <p>Water of the north main canal is used by people for domestic purpose. To protect the side slope of canal, a washing basin shall be provided.</p> | <p>(iv) Construction of washing basin</p> <p>A concrete step with width of 1.0 m will be constructed.</p> <p>- N-1 washing basin 150 m downstream of N-1 turnout on the left bank</p> <p>- N-2 washing basin Just downstream of N-2 turnout on the left bank</p> <p>- N-3 washing basin 10 m downstream of N-1 side spillway on the left bank</p> <p>- N-4 washing basin Just downstream of N-6 turnout on the both banks</p> <p>- N-5 washing basin 40 m downstream of N-6 turnout on the both banks</p> |

(v) No request

(v) Disordered turnout pipe

There exist six (6) disordered turnout pipe in the north main canal provided by the farmers. These pipes should be removed for proper water management and maintenance of the canal.

(v) Removal of disordered turnout pipe

- PVC pipe (Dia.200 x 1) at D-N5 on the right bank
- PVC pipes (Dia.200 x 2) at I-N7 on the right bank
- PVC pipe (Dia.200 x 1) at D-N8-R1 on the right bank
- Steel pipes (Dia.80 x 2) at 40 m downstream of N-8 turnout on the left bank.
- PVC pipe (Dia.500 x 1) at I-N10-L1-A on the right bank
- PVC pipe (Dia.500 x 1) at I-N11-R1 on the right bank

(vi) No request

(vi) Foot bridge

The houses are scattered along the north main canal from the beginning point to N-10 turnout. Farmers provide the timber bridge to cross over the canal. A foot bridge should be provided to maintain the side slope of the canal and to facilitate the passage to the paddy field for farmers.

(vi) Construction of foot bridge

The foot bridge will be provided at 10 places along the north main canal from the beginning point to N-10 turnout.

(2) Related structures of lateral canal

(i) Repairing of turnout structures (2 nos.)

(i) Turnout structures

- L2-1 turnout structure

(a) Gate: Hoist is lost.

(b) Structure: Deterioration is in progress. Necessity of staff gauge

(a) Replacement of hoist, spindle and gate leaf

(b) Replacement of structure
Installation of staff gauge

(ii) Repairing of check structures (2 nos.)

(ii) Check structures

- L-1 check structure

(a) Gate: Existing stop log should be changed into gate.

(b) Structure: Necessity of replacement due to installation of gate

- L-2 turnout structure

(a) Gate: completely damaged

(b) Structure: Same as L2-1 turnout

(a) Replacement of gate

(b) Same as L2-1 turnout

(a) Installation of gate

(b) Replacement of structure

(3) Related structures of sub-lateral canal
(Replacement of structures of 22 nos.)

- L-2 check structure

(a) Gate: Same as L-1 check

(b) Structure: Same as L-1 check

(a) Same as L-1 check

(b) Same as L-1 check

(i) Turnout structures

Since existing turnout structures on the sub-lateral canals (I-N13 & I-N10-2) are of box type with stop log, the water management is not able to make properly. Most of the structures are damaged and buried under silts and sands. Taking future operation and maintenance into consideration, these structures should be changed into the turnout structures with gate. The turnout structures on the new sub-lateral canals (I-N6, I-N10-1, I-N10-3, I-NS) should also be of the same type as the said turnout structures.

(i) Replacement of turnout structures

The turnout structures with free flow will be constructed as follows:

I-N13 sub-lateral canal: 2 nos.
I-N6 sub-lateral canal: 8 nos.
I-N10-1 sub-lateral canal: 2 nos.
I-N10-2 sub-lateral canal: 4 nos.
I-N10-3 sub-lateral canal: 3 nos.
I-NS sub-lateral canal: 1 no.

Total 20 nos.

(ii) Check structures

For proper water management, a check structure should be provided just downstream of a turnout structure and existing check structures of stop log type should be changed into the check structure of gate type.

(ii) Replacement of check structures

I-N13 sub-lateral canal: 1 no.
I-N6 sub-lateral canal: 7 nos.
I-N10-1 sub-lateral canal: 1 no.
I-N10-2 sub-lateral canal: 2 nos.
I-N10-3 sub-lateral canal: 2 nos.

Total 13 nos.

(iii) Cross drain

Two (2) cross drains are required on the sub-lateral canal (I-NS) newly constructed for drainage of rain water from the southern hills. The catchment areas of two cross drains are 6 ha each.

(iii) Construction of cross drain

The type of new cross drains will be the same type as the existing cross drains in the project area. The diameter of pipe will be more than Dia.600 mm for easy operation and maintenance.

6 Drainage Canal

(1) Dredging of the Nong Sam Kha river and its tributaries (8.8 km in total)

(1) Nong Sam Kha river and its tributaries
The Nong Sam Kha river and its tributaries are deteriorated their flow capacity due to grasses and trees covered on both banks, fish nets and fish weirs on the channels and deposited silts and sands on the channels. According to the information from farmers, since 1974, the river maintenance has never been carried out. The fish nets and fish weirs have also not been controlled. Under such situations, dredging works are required and periodic river maintenance is also required.

(1) Dredging of the Nong Sam Kha river and its tributaries

- Nong Sam Kha river 8.1 km
- No.1 branch 1.8 km
- No.1-1 branch 0.2 km
- No.2 branch 1.6 km

Total 11.7 km

(2) Dredging of drainage canal (8.0 km in total)

(2) Drainage canal
The sections required for dredging are determined based on the results of topographic survey.

(2) Dredging of drainage canal

- D-N13 0.7 km
- D-N12 0.9 km
- D-N9 0.2 km
- D-N8 1.2 km
- D-C1 0.5 km

Total 3.5 km

7 Related Structures of Drainage Canals

(1) Replacement of related structures on the Nong Sam Kha river and its tributaries (5 nos.)

(1) Related structures on the Nong Sam Kha river and its tributaries
The effective width of existing bridges is 3.0 m, while the width of disc-hallow, which is used in the project area, is about 3.0 m. The disc-hallow can be lifted in moving. Consequently, existing bridge is not obstructive for passage of disc-hallow. The cross drains on the tributaries are deteriorated and damaged.

(1) Replacement of cross drain

- No.1 branch 1 no.
- No.1-1 branch 1 no.
- No.2 branch 1 no.

| Request | Study of Request | Rehabilitation Plan |
|-------------------------|---|---|
| (2) No request | (2) Related structures on the drainage canals Most of cross drains are deteriorated and damaged. | (2) Replacement and construction of cross drain - D-N13 No.1 replacement No.2 replacement - D-N12 No.1 replacement No.2 replacement - D-N9 No.1 replacement - D-N8 No.1 replacement No.2 replacement - D-C1 C1 construction C2 replacement The following cross drains shall be replaced due to construction of new sub-lateral canal of LN10-3. - D-N14 No.1 - D-N13 No.3 |
| 8 Drainage Pump Station | (1) Submersible pump | (1) The followings are the outline of rehabilitation for the drainage pumps. a. Overhaul of two pumps b. Repainting of discharge pipes c. Cleaning of insulation oil tanks and replacement of fittings d. Repair and repaint for oil pipes and supports e. Repair of air valve f. Repair of duct for cables and pipings |
| | (1) The outside coating of pump is damaged but the pumps are still in good condition, as the pumps have been mainly in dry and the operating time have been short compared with the irrigation pumps. The wearing of impeller is observed and the parts for shaft are also considered to be wear, because no maintenance has been conducted since the completion of pump installation. The overhaul of pumps is required considering the present condition. | |

| Request | Study of Request | Rehabilitation Plan |
|--|---|---|
| (2) No request | (2) The oil level gauges are out of order and should be replaced. The pumps are not operated by automatic control but by manual, due to the out of order of water level gauge. The operator must stay in the operation house during operating the drainage pumps. | (2) The followings are the outline of rehabilitation plan. a. Replacement of oil level gauge b. Replacement of water level gauge |
| (3) Supply of spare parts | (3) Some spare parts are insufficient. | (3) The spare parts will be supplied. |
| (4) No request | (4) As for the trashracks, repair of paint is necessary. | (4) The trashracks will be repaired. |
| (5) Related concrete structures (i) Repairing of rivetment of outlet (ii) No request | (5) Related concrete structures (i) Rivetment of outlet is mostly damaged. (ii) For operation and maintenance of outlet structures, an approach step by concrete is necessary. | (5) Repairing of related concrete structures (i) Replacement of rivetment of outlet (ii) Provision of concrete approach step. |
| (6) No request | (6) The damages on flap valves were not observed except coating. | (6) Three flap valves will be checked and repainted. |
| 9 No.1 Nong Sam Kha Dam | | |
| (1) Repairing of existing intake structure | (1) Existing intake structure (i) Gate: Hoist is broken (ii) Structure: Wooden operation deck is damaged. | (1) Repairing of existing intake structure (i) Replacement of hoist, spindle and gate leaf (ii) Operation deck will be replaced by concrete slab. |
| (2) Improvement of existing spillway | (2) Existing spillway is still in good condition. If the increase of storage capacity will be required for extension of irrigation area by the dam, the crest of spillway will be heightened because of simple operation. | (2) If the increase of storage capacity will be required, the crest of spillway will be heightened. |