THE KINGDOM OF THAILAND

AGRICULTURAL LAND REFORM OFFICE

FEASIBILITY STUDY ON SUKHOTHAI INTEGRATED AGRICULTURAL AND RURAL INFRASTRUCTURE DEVELOPMENT PROJECT

MAIN REPORT




AUGUST, 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

THE KINGDOM OF THAILAND
AGRICULTURAL LAND REFORM OFFICE
FEASIBILITY STUDY ON SUKHOTHAI INTEGRATED AGRICULTURAL AND RURAL INFRASTRUCTURE DEVELOPMENT PROJECT
MAIN REPORT
AUGUST, 1990
JICA

THE KINGDOM OF THAILAND

AGRICULTURAL LAND REFORM OFFICE

FEASIBILITY STUDY
ON
SUKHOTHAI INTEGRATED AGRICULTURAL
AND
RURAL INFRASTRUCTURE DEVELOPMENT PROJECT

M A I N R E P O R T

AUGUST, 1990

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

P R E F A C E

In response to a request from the Government of the Kingdom of Thailand, the Japanese Government decided to conduct a Feasibility Study on the Sukhothai Integrated Agricultural and Rural Infrastructure Development Project and entrusted the Study to the Japan International Cooperation Agency (JICA).

JICA sent to Thailand a Study Team headed by Mr. Junichiro Nakajima, Sanyu Consultants Inc., from July to October, 1989 and from December, 1989 to January, 1990.

The Team held discussions with the officials concerned of the Government of the Kingdom of Thailand and conducted field surveys. After the Team returned to Japan, further studies were made and the present report was prepared.

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

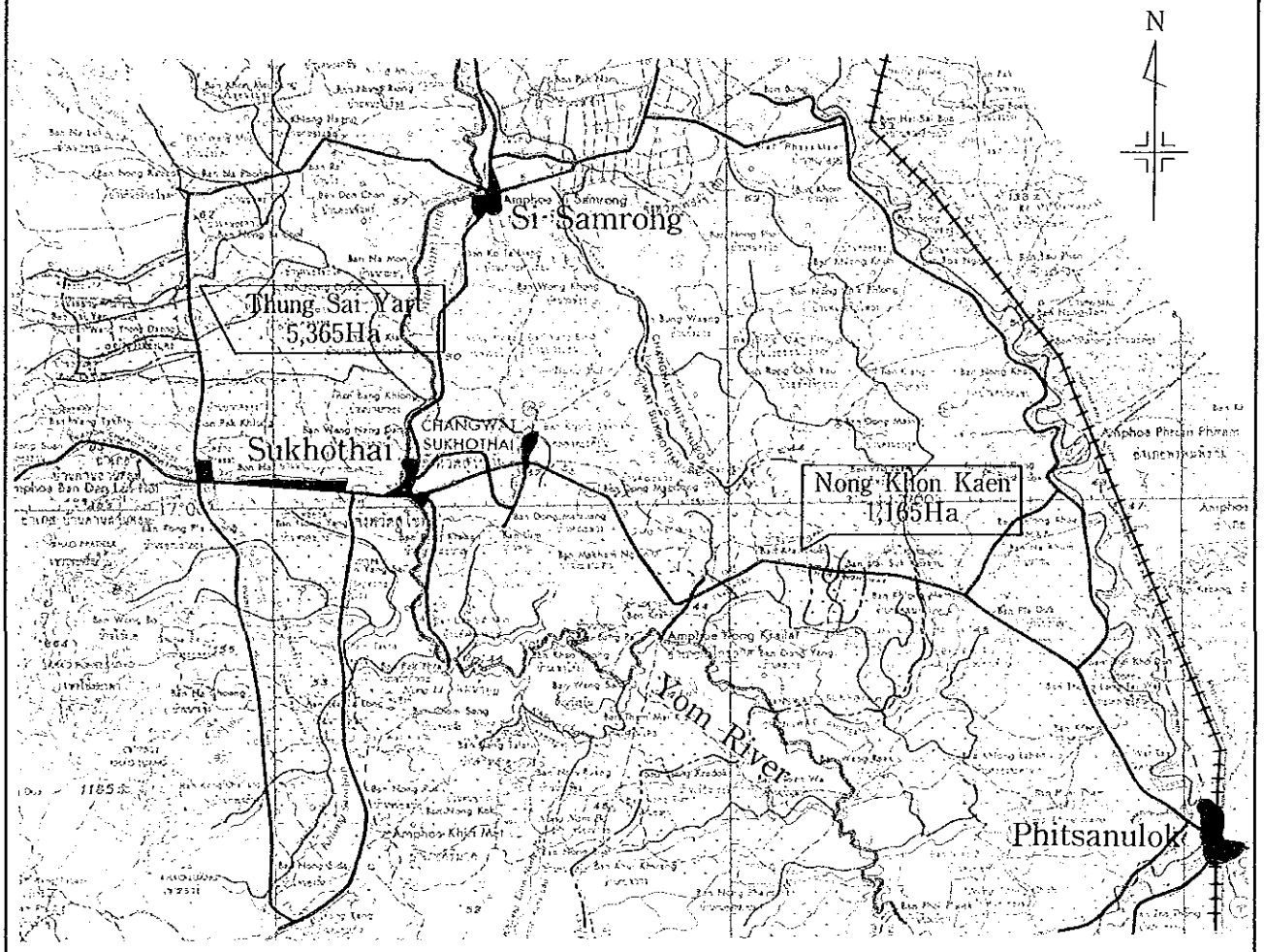
I wish to express my sincere appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the Study Team.

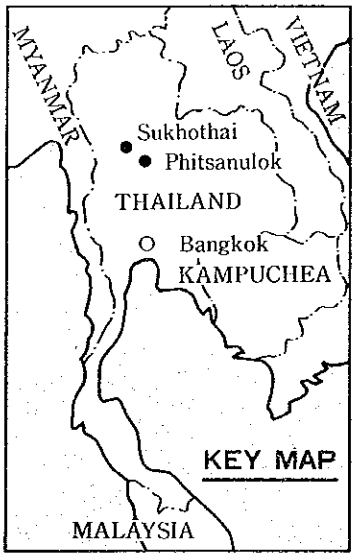
August, 1990

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

LOCATION MAP





LEGEND

- Study Area
- Road
- Railway
- River
- Changwat Boundary
- Town

SCALE

0 5 10 15 20km

GENERAL PLAN OF NONG KHON KAEN AREA

LEGEND

[Proposed Agricultural Infrastructure]

- Reservoir
  - II, III, VII ; Type Number
  - S; Swamp Rehabilitation
- Weir
- Weir with Gate Facility
- Protection Dike
- Canal Dredging & Dike
- Dike Crossing Culvert
- Dual-purpose Canal
- Main Farm Road (Rehabilitation)
- Lateral Farm Road (New Construction)
- Branch Farm Road (New Construction)

[Proposed Rural Infrastructure]

- Domestic Water Supply with Piped System
- High-Voltage Power Line
- Multi-Purpose Hall

[Proposed Post-Harvest Facility]

- Multi-Purpose Storage

[Miscellaneous]

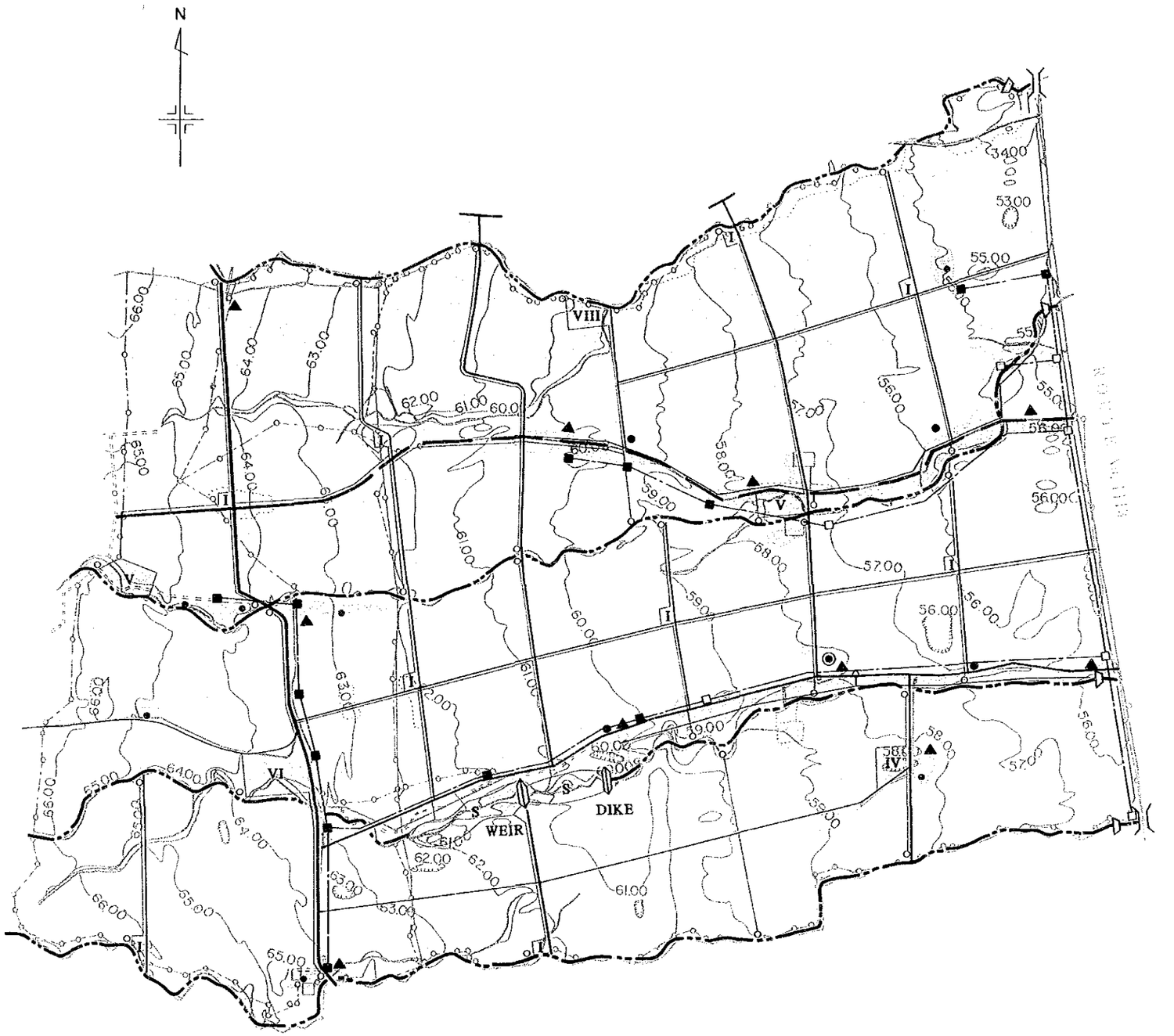
- ER — Existing Reservoir
- Existing Road
- Existing Well
- Existing High-Voltage Power Line
- Village

Study Area

SCALE

0 500 1,000 m

GENERAL PLAN OF THUNG SAI YART AREA



LEGEND

[Proposed Agricultural Infrastructure]
- Reservior
  - I ~ VIII; Type Number
  - S; Swamp Rehabilitation
- Weir
- Canal Dredging & Dike
- Dike Crossing Culvert
- Dual-purpose Canal
- Farm Road
  - Main (New Construction)
  - Main (Rehabilitation)
  - Lateral (New Construction)
  - Branch (New Construction)
  - Branch (Rehabilitation)
- Bridge

[Proposed Rural Infrastructure]
- Domestic Water Supply with Piped System
- Domestic Water Supply with Hand Pump
- High-voltage Power Line
- Multi-Purpose Hall
- Meeting Hall

[Proposed Post-Harvest Facility]
- Multi-Purpose Storage

[Miscellaneous]
- Existing Road
- Existing High-Voltage Power Line
- Village

Study Area

SCALE
0 1,000 2,000

SUMMARY, CONCLUSION AND RECOMMENDATION

SUMMARY, CONCLUSION AND RECOMMENDATION

1. BACKGROUND OF THE PROJECT

1.1 Thai Economy

National Economy

For the 20 years since the implementation of the First NESDP in 1961, the Thai economy has grown with an average annual rate of 7 %, however, after the Second Oil Crisis it has been ranging from 4.0 to 6.3 % until 1986. During this period, the industrial sector's share in GDP increased from 10.5 % in 1960 to 19.8 % in 1985 on the contrary, the agricultural sector's percentage decreased from 38.9 % to 17.4 %. In 1985, the GDP was 41.7 billion dollars and the per capita GDP was 806 dollars showing a steady rate of growth each year. However, the regional disparity of per capita GDP is so large between the capital region (2,319 dollars) and others, the northern region (522 dollars). Improvement of the disparity is one of the major theme in the 6th Plan.

The domestic factors behind the stable growth of the Thai economy are; (1)construction of infrastructure such as roads, electricity, etc., (2) progress in the diversification of agricultural products, and (3) progress in industrialization. Construction of infrastructure became the basis for the resultant development of agriculture and industry. Thai agriculture has diversified from the paddy monoculture to inclusion of new upland crops such as maize, cassava, sugar cane, kenaf, etc., which contributed to the improvement in farmer's income and at the same time earned foreign currency as an export item.

Regional Economy

The northern region has the area of 169,644 Km^2, one third of the whole Kingdom. The region consists of 17 provinces and Sukhothai province in which the study areas are located is one of them. In 1985 the northern region has population of 10.4 million, about 20 % of the whole Kingdom.

As of 1987, Sukhothai can be administratively divided into 9 Amphoes, 82 Tambols, 651 Mubans. Most of people in the northern region and Sukhothai province earn their living by growing rice, cotton, tobacco, beans and canes, etc. Besides, inland fishery, livestock raising and cottage industry are also the occupations that much income to the population. In 1985, the GPP in Sukhothai province was 7,426 million Baht, in which agricultural sector's share decreased from 51 % in 1980 to 35 % in 1985, showing wider disparity in income between urban and rural areas, year by year.

1.2 Sixth National Economic and Social Development Plan

General Description

The National Economic and Social Development Plan (NESDP) has started in 1961, and the 6th NESDP covers the period from October 1986 to September 1991. In order to solve various problems accumulated by implementation of the former five plans, the 6th plan is characterized as an adjustment one, and it stresses strongly to change her development pattern from expansion in quantity to enrichment in quality. For that purpose, the following basic policies have been formulated including two overall targets, three main strategies and 10 working programs as follows:

(1) Two targets

a) Set up the economic growth target to be an average of more than 5 % per year.

b) Development of human quality to enable to progress in social development and create peace and fairness in society.

(2) Three Strategies

a) Increase efficiency and capability in country development include human resources development, science and technology and natural resources development.

b) Increase efficiency, improve quality in production, marketing, technology and reduce production costs to be able to better compete with other countries.

c)Promote the income distribution and wider distribution of development of benefits to the region and rural areas, especially the low income groups.

(3) Ten working programs

a) Economic and financial stabilization program

b) Program to develop human resources, society and culture

c) Natural resources development and environmental management program

d) Science and technology development program

e) Program to improve management and review the government's role in the development process

f) State enterprises development program

g) Program to develop production, marketing and employment generation system

h) Basic service development program

i) Urban and specific zones development program

j) Rural development

Rural Development Program in the Sixth NESDP

To support the overall development targets which cover economic expansion, income distribution, social services development and improvement in the quality of life of the rural population, the following importance of the rural development program in the Sixth Plan are determined.

a)Emphasize on the target area which specified by the province.

b)Lift up the living standard of rural population covering the backward areas, middle-level and progressive areas.
The government sector should concentrate on the backward and middle-level areas, while promote the private sector to invest more in the progressive areas.

c)Adjust the rural development management mechanisms to unite every sector and become more integrated, cooperated in solving basic problems of rural community, increasing the production income by using the appropriate technology.

d)Promote the role of rural people organization and the population in making decision and solving their own problems and the community's as well as encourage them to be able to help themselves.

1.3 Specific Feature of Land Reform Area

Under the current land holding system in Thailand, number of landless farmer is estimated at about one million households. Most of them are forced to individually settle, reclaim and commence farming activities in public lands or forests without legalized land holding right. Most of the settled land is being disregarded from any development, in which land productivity, farming technology and farm income are quite inferior in comparison to other advanced areas, due to insufficient of poor provision of agricultural and rural infrastructures. Under such circumstances, Thai government promulgated the agricultural land reform act for the purpose of promoting issuance of title deed to the landless farmers through zoning and formulating land use plan. Under the law, about 970,000 rais (155,000 ha) are declared as the land reform area in 1988. Agricultural Land Reform Office (ALRO) is obliged to perform such plans as allocation of land, provision of necessary infrastructure and income generation for farmers.

1.4 Request of the Study

While an incremental agricultural production in Thailand had been attained through expansion of farm land to be converted mainly from forest land, it is necessary to change toward the policy aiming an increase in land productivity of the existing farm land, because no more conversion of forest to farm land is permissible. On the other hand, crop diversification including upland crops has become urgent theme under Thai agricultural policy, because water resources for irrigation have become very tight in the whole Kingdom, and oversupply of paddy is prevailing in the world market.

ALRO is, presently, promoting its basic plan that ALRO selects an model area for rural development in the land reform area in which independent farmers are to be brought up through allocation of farm land

and provision of necessary infrastructure for farming, taking the natural and social conditions of the model area into consideration. ALRO has selected two public lands of Thung Sai Yart and Nong Khon Kaen in Changwat Sukhothai as a model for the rural development.

While it is considered rather difficult to apply a development approach to be formulated in the model areas to ALRO's areas in whole Thailand due to their different characteristics, it could be applicable in the lower north region of Thailand. In the region, similarity can be identified in natural conditions such as climate, soil, etc., in less favor of water resources for irrigation having annual rainfall of about 1,000 mm, and in longer distance from Bangkok, large consumption base of farm products.

ALRO is planning to implement and promote an agricultural and rural development on the basis of the following three development levels;

Level-1: Provision of basic agricultural infrastructure so as to meet with farmers' subsistence level (Basic Development Model);

Level-2: Provision of water supply and marketing facilities which aims to increase farmers' income and to improve living conditions, in addition to provision of the infrastructure of Level-1 (Rural Development Model);

Level-3: In addition to the Level-2, more improvement for conditions of agricultural production and living with land consolidation (Land Consolidation Model)

Rural communities on the basis of rainfed agriculture have been formed in Thung Sai Yart, and those based on irrigated agriculture by using groundwater in Nong Khon Kaen. ALRO is supposing to develop Thung Sai Yart with the Level-2 and Nong Khon Kaen with Level-3. However, the said levels have wider definition and ALRO has not a definite technical criteria yet which is to be required for determining development standard in the implementation of integrated rural development in ALRO's areas. Therefore, it is included as one of component of this study, to carry out technical transfer on development concept, staged development method, implementation program through the feasibility study.

2. The Study Areas

2.1 Natural Condition

Location

Nong Khon Kaen is located in the Amphoe Khong Krailat in Changwat Sukhothai, which lies along the primary road route 12 connected between Sukhothai and Phitsanulok, and its study area is 1,165 ha. Thung Sai Yart is located in the Amphoe Ban Dan Lan Hoi and Muang in Changwat Sukhothai, which is adjacent to the secondary road route 1113 leading to the primary road route 12 and its study area is 5,365 ha.

Natural condition

Nong Khon Kaen is surrounded by very flat area with elevation from 41.2 to 42.2 m. Thung Sai Yart is in relatively uniform geography with gentle slope of about 1/700 to 1/1,000 from west to east. Elevation is from 56 to 66 m.

Both areas are in a vast plain in the Chao Phraya basin, of which geology is infilled with unconsolidated and very low consolidated deposits which are formed in Alluvium, Pleistocene in Quaternary and upper Tertiary.

The climate is a tropical monsoon type, with maximum and minimum temperatures of approximately 35 ℃ in March to May and 15 ℃ in December to January. Annual rainfall is 1,260 mm and 1,035 mm in Nong Khon Kaen and Thung Sai Yart, respectively, with wet season from May to October and dry season from November to April. During wet season, 90 % of annual rainfall occurs.

Soil Series covering the Nong Khon Kaen is Nakhon Pathom (Np) which occupies about 72 % of the total area. The other is Saraburi (Sb). In Thung Sai Yart, the major soils are Chian Rai (Cr), Nakhon Pathom (Np), Kamphaeng Saen (Ks), which occupy about 97 % of the total area. They are good soils for paddy production and would be suitable for upland crops.

2.2 Socio-Economic Condition

According to data of NESDB, while number of household and population are 565 and 3,099, respectively, and an average household size becomes 5.5 persons in Nong Khon Kaen, those are 753 and 3,851 and an average household size becomes 5.1 persons in Thung Sai Yart.

In these areas, main occupation is an agriculture as well. About 86 % of total household, 488 in Nong Khon Kaen and 92 %, 691 households engage with agriculture. In addition, 71 households in Nong Khon Kaen and 28 households in Thung Sai Yart are engaging with other than agriculture, due to favourable location of the former area.

2.3 Present Agriculture

Land Use

The annual report of Sukhothai DOAE shows very little changes in land and reform patterns in both Thung Sai Yart and Nong Khon Kaen Study areas. This indicates that the land use and land reform has already stabilized to a high degree. In both study areas, paddy field occupies about 90 % of the areas.

Farming Practice and Cropping Pattern

(1) Nong Khon kaen

The average farm size is 2.5 ha, in which paddy is predominant crop. In the area, irrigation water by shallow wells is available for both wet and dry seasons. However, average paddy yield during wet season is rather low at 2.2 to 3.3 tons per ha. On the other hand, dry season paddy cropping depends on the groundwater, and the groundwater table has been lower due to overpumping by existing shallow wells.

(2) Thung Sai Yart

The average farm size is 4.1 ha, in which 99 % of land is under rainfed paddy field. Because of unstable rainfall pattern in the

beginning of wet season as well as inundation in the later part of wet season, farmers grow LV (Photo-sensitive) by transplanting method. Average paddy yield is quite low at 1.0 ton per ha, due to extensive cultivation.

Post-Harvest and Marketing

In both the areas, about 75 % of harvested paddy are sold and they are presently purchased and milled by local middlemen and local rice mills and then transported to Bangkok rice buyers. Since there exists no storage for paddy and rice, wet season paddy is harvested from November to next January and most of them are marketed within one month after harvest. During the period, farmgate price of paddy is lower than annual average price by 6 to 7 %, because of oversupply in the market.

Supporting Services and Farmers' Organization

Generally, systematization rate of agricultural cooperative as low as 18 % in Thailand. In Changwat Sukhothai, there are 16 agricultural cooperatives, at least one cooperative in each Amphoe. All these agricultural cooperatives are located in the central part of the respective Amphoe, far from the Study areas, therefore, no farmers in the Study area does participate in any agricultural cooperatives.

An agricultural extension is under DOAE. In Amphoes Muang Sukhothai and Khong Krailat, since the coverages by one extension worker is too big and vast, desirable extension services could not be presently expected.

Agricultural crediting system

In Thailand, sources of agricultural credit are composed of public sector including BAAC and commercial banks as well as private one. Although farmers are willing to borrow from the former, their procedure and conditions are rather severer than the latter. Therefore, farmers are using the private sources in spite of rather higher interest rate of 2 % per month.

2.4 Hydrology and Water Resources

There are some small canals with width of 10 to 20 m, of which run-off are observed in wet season. Their amounts are estimated based on the run-off simulation models, as follows.

Area	Catchment Area (km^2)	Annual Run-off (MCM)
Nong Khon Kaen	100.1	5 - 33 (14)
Thung Sai Yart	423.6	22 - 88 (41)

( ); Average

Run-off is used for fishery ponds and irrigation/drainage facilities have been constructed in the upper basins. Amount of run-off, therefore, is liable to be unstable for irrigation use. Seasonal run-off available may be fluctuated by a project on water resources in the upper basins.

In Nong Khon Kaen, groundwater is used for irrigation and domestic water, with 169 of shallow wells and two deep wells, respectively. Annual pumping discharge from the shallow wells within the area is estimated at approximate 6 MCM. On the other hand, annual amount of recharge is assumed at around 3 MCM. Overpumping, therefore, is brought about in the area, so that groundwater table is decreasing recently. In Thung Sai Yart, there are thirty-two shallow wells and eleven deep wells for only domestic use. Deposits of this area are mainly composed of clay and clayey sand and sand layers to be aquifers are poor for irrigation use.

In Nong Khon Kaen, low-lying cultivated land of 35 % of whole area is subject to flood/inundation due to backwater from Yom river and insufficient drainage capacity. Severity is assumed that average inundation depth is from 0.4 to 0.6 m for a duration of about one month. In Thung Sai Yart, agricultural land adjacent to the road route 1113 of 23 % of whole area, is liable to flooding, of which severity is assumed that average inundation depth is from 0.6 to 0.8 m for a duration of about one week.

2.5 Agricultural Infrastructure

Irrigation and drainage facilities is small scale canals, ponds, swamps and shallow wells, which are used as a supplemental water resources facilities for neighboring agricultural land. Storage water of these facilities is lifted by portable pumps into each field. After pumping, plot-to-plot irrigation is applied. Shallow well is also used individually. Irregular cross section and meandering alignment of the existing canals due to sedimentation shall be improved to utilize surface water for irrigation purpose.

There are ten and five farm roads in Nong Khon Kaen and Thung Sai Yart, respectively. Some of them are poor with no pavement, narrow track and no connection each other. In the both areas, improvement of road network shall be required for better farming practices, in parallel with improvement of irrigation/drainage facilities.

Cadastral map shows that farm plots are allocated temporarily at 532 and 2,106 in Nong Khon Kaen and Thung Sai Yart, respectively. Their average size is from 12 to 15 rai and most of them are strip of land. One plot is divided into some small fields by border, according to actual farming practices by each farmer. Most of plots are hardly equipped with irrigation and drainage facilities and access roads. Those physical constraints have prevented each farmer to improve their daily farming practices.

2.6 Rural Infrastructure

Village water supply

Construction of water supply facilities are promoted by PWA in Thailand. In Nong Khon Kaen, piped supply system with deep well as a water source have been provided for 172 of households in the two villages along the road route 12. Expansion of service area, however, is difficult because of limited capacity of the present facilities. Water supply facilities in Thung Sai Yart are eleven deep wells and thirty-two shallow wells with handpump or bucket, which have been constructed by villagers or ALRO. Service area, however, is limited in the neighboring

of the wells and the number of well is too less to cover the whole area. Remainder is dependent on rain water stored in rain-jars.

Rural-electrification

In Thailand, rural electrification is promoted by PEA, in response to request from farmer, and, electrification rate in Sukhothai Province is around 80 %. Current rate in Nong Khon Kaen is more than 90 % in two villages and from 48 to 70 % in the other villages. In Thung Sai Yart, its rate is low at around 30 % in two villages and the other villages have no electric services.

Nong Khon Kaen has telephone set at the Tambol office as a communication facility. But, there is no facility in Thung Sai Yart. Postal matter for villagers is processed through the village chief's house where a mailbox is provided.

Principal transportation in the areas is done with the roads 12 and 1113 leading to the cities of Sukhothai and Phitsanulok.

Social infrastructure

A health center covered with regional medical care is located in Nong Khon Kaen and tow centers are in Thung Sai Yart, which are provided with medical equipment, facilities and staff based on national standards on service areas and population.

There are one and five elementary schools in Nong Khon Kaen and Thung Sai Yart, respectively, which meet with national requirements.

Villager's meetings are held in the existing temples. Facilities for meetings shall be required as community activities vitalizes.

3. Basic Policy for Development

3.1 Development Objective

The main purpose of this study is to conduct feasibility study on an integrated agricultural and rural development, and then the study results shall be a model for development in other land reform areas (about 56,000 ha), especially those in the lower north region of Thailand.

The specific feature of the land reform area is that since landless farmers settled individually into public lands or forests without any legal support, systematic agricultural and rural infrastructures has been insufficiently or poorly provided, resulted in low agricultural productivity and inferior living environment. ALRO is basically responsible for (a)allocation of land, (b)provision of necessary infrastructures and (c)income generation for farmers.

Under the situation, the following development objectives have been, basically, established for this study;

(a) to increase farmers' income and to minimize their regional differentials through establishment of landed farmer
(b) to fulfill the basic human needs

3.2 Development Approach for the Study

The development approach in this study is summarized as (a)review of present condition, (b)project objective, (c)application of development level, (d-1)constraints identification, (d-2)farmers' needs, (e) development strategies, (f)development model, (g)alternative study on development model, (h)project formulation, (i)implementation program, (j) project cost and benefit and (k)project evaluation. Since three stages of ALRO's development level cover wide range respectively, the following relation between the level and its application has been formulated;

Level	ALRO's Basic Concept	Application under Study
1	Provision of basic agricultural infrastructure so as to meet with farmers' subsistence level	Area which has limited water resources for agricultural production and is not blessed with market condition
2	Provision of water supply and marketing facilities which aims to increase farmers' income and to improve living conditions	Area which has possibility to develop water resources and is blessed with marketing condition
3	In addition to the Level-2, more improvement for condition of agricultural production and living with land consolidation	From both natural and social conditions, area which has high development potential

3.3 Development Constraints

Development constraints against the appointed development level are summarized by four major planning aspects as follows:

Physical Planning

(1)Since several north-south roads in Nong Khon Kaen and east-west ones in Thung Sai Yart are provided with lower density, and roads across the existing roads have not been developed.

(2)In Thung Sai Yart, it requires more water for paddy cultivation due to not enough leveling in one farm plot.

Agricultural Development

(1)In the areas to be flooded or inundated in the later part of wet season, farmers are forced to grow photosensitive paddy (L.V.), and the paddy yield depend upon amount of rainfall at the period.

(2)Usually, height of seedlings in nursery bed becomes too high beyond proper length for transplanting because of unreadiness in the paddy

field, and then top of them are cut, resulted in lower yield.

(3)The required longer time for harvesting works unable to utilize residual moisture in the field, and soil becomes too hard to be plowed by hand tractors.

(4)In Nong Khon Kaen, groundwater table has been lower every year due to overpumping by the existing shallow wells. The bigger suction level causes the more requirement of fuel and finally it would be afraid that the existing shallow well could not function.

Social Infrastructure

(1)According to water quality test of the test wells, groundwater in both areas has some problems for drinking purpose, and it is necessary to provide a water treatment facility in the village water supply.

(2)In some part of Nong Khon Kaen and greater part of Thung Sai Yart, rural electrification as one of basic minimum needs are not provided.

Supporting Services

(1)Farmers should rely on local merchant, resulted in less bargaining power for selling their products, due to unavailability of free access to market in terms of control under financial support by them.

(2)Usually, farmers rely on private sources of crediting in spite of higher interest rate than institutional one which sometimes lose timing for crediting.

(3)Since farming is, basically, practiced independently and/or individually, farmers have less bargaining power to buy farm input, and agricultural extension activities are extensively carried out to individual farmers due to lack of the extension staff.

3.4 Farmers' Needs

According to the sample survey for 200 farmers, as for the constraints on farming practice, the respondents in both the areas appeal lack of irrigation water and lack of agricultural credit with 1st and 2nd rank, respectively. Accordingly, their requests to agricultural infrastructure are provision of irrigation facilities as 1st rank, followed by provision of farm road and land leveling.

In connection with crop diversification, respondents in Thung Sai Yart have rather stronger intention to introduce upland crop cultivation. As for constraints on upland crop cultivation, lack of irrigation water, unsuitable soil condition and lack of knowhow as well as extension services are replied.

Beneficial farmers would be mostly cooperative to the project implementation. However, about 20 to 30 percent of respondents show their unwillingness to cooperate with changing location of and reshaping own land as well as bearing the project cost.

3.5 Development Strategy and Model

In order to attain the above development objectives, the following strategies are fully considered and then basic project plans have been formulated, with consideration of the development constraints as mentioned above.

(a)To stabilize paddy production in wet season and improvement of its profitability;
(b)To increase efficiency in land and water utilization;
(c)To secure farmers' income in dry season;
(d)To provide rural infrastructures; and
(e)To establish and promote farmers' organization

(2) Development model

Under the said development strategies, the following development components are taken into consideration for the promotion of an integrated agricultural and rural development in the study areas;

(a)Agricultural infrastructure development plan

i) water resources development, ii) irrigation and drainage facilities, iii) farm roads, and iv) on-farm facilities

(b)Agricultural development plan

i) proposed cropping pattern, ii) farming plan

(c)Rural infrastructure development plan

i) village water supply, ii) rural electrification, iii) social infrastructure

(d)Supporting services

i) post-harvest and marketing facility, ii) training package program

Since the component of rural infrastructure should be dealt as one of basic minimum needs, no alternative development plan has been made. Other three components relate one another closely, and the following three development models have been alternatively examined (See Tables 4-2 and 3).

Model-1: Only basic development to be required to meet with the applied level is planned, in keeping the existing production and living activities. Due to low level of development, the required cost is not so much.

Model-2: Fundamentally the same concept of Model-1 is applied, but higher development level for the component (a) is to be applied and hence that for (b) and (d) would be heightened.

Model-3: Intensified farming shall be introduced by incorporating more number of farmers within the applied development level through more investment cost than Model-2.

Taking ALRO's basic policy and intention of beneficial farmers into consideration, it is judged appropriate to formulate the proposed project on the basis of the Model-2, after comprehesively examining the respective model from technical, social and economical viewpoints.

4. THE PROJECT

4.1 Water Resources Development Planning

Surface water development planning

Water resources available is surface water and groundwater. Storage facilities for surface water is planned in the both areas for effective use of run-off in wet season. Its function is to store initial water requirement for wet paddy and to extend irrigable area in dry season with storage water possible. Its capacity, therefore, is planned based on the relation between amount of excess run-off available and irrigable area, and the following conditions for facility construction; (1) It will be impossible to construct a large scale storage facility with full operation throughout the year under the present flat topographic condition. Storage, therefore, is in some small ponds. (2) In relation to land loss for new ponds and other facilities, procurable land will be limited at 1.0 to 2.0 % of whole area, (3) Existing swamps and canals are usable as a storage facility by means of dredging.

(1) Nong Khon Kaen

Total storage capacity is planned at 0.94 MCM with improved swamps, canals and newly constructed ponds.

(2) Thung Sai Yart

In a normal year, maximum irrigable area is limited at 50 to 55 % of the whole area with the largest storage pond possible and effective use of run-off, due to limited run-off discharge. Total capacity of pond is planned at 5.0 MCM, taking account of unstable amount of run-off and procurable area.

In the both areas, some of improved swamps or ponds are usable as a inland fishery pond, in which fish culture such as Nile Tilapia and Common Carp, is expected. As a result of study, surface water development planning is as follows.

Area	Total capacity (MCM)	Irri. pond	(Irri.+Fishery)pond
Nong Khon Kaen	0.95	11	3
Thung Sai Yart	5.00	11	4

Groundwater development planning

(1) Nong Khon Kaen

Under the current condition of overpumping, alternative plan is considered as follows; (1) The existing shallow wells are being used under the condition that annual pumping discharge is controlled at less than 3.0 MCM of annual recharge. (2) New deep wells are constructed for stable water supply. In this area, the above plan-(1) is applied, taking account of higher construction cost, impact to the surrounding area, future way of groundwater management and organization for fair water distribution arise from the plan-(2). Pumping discharge, therefore, should be managed in the future. Management way shall be practiced through various activities in the training programs proposed in this study.

(2) Thung Sai Yart

Groundwater use is not planned for irrigation, but for domestic.

4.2 Agricultural Development Plan

Taking into consideration such development strategies as (a)to stabilize and to increase productivity and profitability in wet season paddy, (b)to efficiently utilize land and water, and (c)to secure farm income during dry season, as well as the social constraints in the areas, crop selection has been made and then proposed cropping pattern be formulated. In the drainage improvement area, HYV paddy shall be mostly introduced, and also upland crop during dry season after paddy where irrigation water is available. In addition, fruits shall be experimentally introduced.

Selected crops and their target yield are summarized below.

Sub-project	Crop	Area (ha)	Yield (t/ha)	Production (ton)
Nong Khon Kaen	Paddy (HYV)	900	4.9	4,410
	Soybean	310	1.8	558
	Vegetable (Leaf)	60	18.0	1,080
	Vegetable (Fruit)	30	23.0	690
	Fruits	40	15.6	624
Thung Sai Yart	Paddy (HYV)	2,180	4.2	9,156
	Paddy (LIV)	380	3.4	1,292
	Paddy (LV)	2,200	1.2-2.5	3,043
	Soybean	660	1.8	1,188
	Fruits	40	15.6	624

Cultivation practice for newly introduced crops shall be extended to farmers through demonstration of F.T.S.S.

For farming pattern, it is planned that every farmer is able to expand his cultivated area independently through avoiding concentration of labor requirement. In Thung Sai Yart, it is planned to widen paddy cultivation period through cooperative water management as well as mutual work system, because peak for farm labor requirement arises during transplanting and harvest times.

Mechanized farming for upland crop cultivation shall be based on the present small size tractor system, practicing working sequence of pre-irrigation - ploughing - harrowing. However, it is proposed to experimentally introduce medium-size tractor system in F.T.S.S., from viewpoint of saving irrigation water, because the small size tractor system requires additional water for pre-irrigation.

In consideration of efficient agricultural extension activity, reduction of production cost, strengthening of farmers' bargaining power, it is prerequisite to systematize crop production groups as farmers' organization through which cooperative purchasing and marketing farm input/output and mutual working system would be carried out.

4.3 Agricultural Infrastructure

Irrigation and Drainage

(1) Nong Khon Kaen

Irrigation agriculture shall be practiced in whole area with the various water sources such as wells, ponds and swamps. For the purpose of that, dual purpose canals leading to the ponds or swamps are planned as a irrigation and drainage facilities. Surface water is lifted individually by portable pump of each farmer from canal to farm. Pumping water by well shall be conducted directly into farm as the present. But, its amount could be cut down at around 60 % and 47 % of the present in wet and dry season, respectively, in case of proposed cropping plan.

Measures for drainage problem are planned as follows;

(a)construction of dike and sluice gates for protection of flood intrusion from downstream area. (b)improvement of the existing canals for adequate drain of excess run-off.

(2) Thung Sai Yart

As well as Nong Khon Kaen, dual purpose canals are planned to extend irrigable area by means of effective connection with constructed ponds. Limited water resources, however, restricts irrigation agriculture to partial area along the water storage facilities, as mentioned in 4.1. Its irrigable area would be around 2,600 ha and 700 ha in wet and dry season in a normal year, in case of proposed cropping plan. Remainder is forced to be rain-fed field.

The following measures are planned for drainage problems (a) construction of drainage facilities under the road 1113 and (b)improvement of the existing canals, which are capable of draining off designed peak discharge from upper basin.

Improved canals are also planned with storage function for effective use of run-off.

Farm road planning

Farm road networks are planned in the both areas for better farming and living activities. Improvement level has been examined based on the way of operation and maintenance of constructed facilities, potentiality of irrigation agriculture and future farming system, and the present road network. As a result of study, road density is planned to be improved at from the present 13.3 m/ha to 30.0 m/ha and from 6.2 m/ha to 15.0 m/ha in Nong Khon Kaen and Thung Sai Yart, respectively.

Land consolidation planning

Way of improvement of on-farm facilities shall be formed based on development target, farmer's intention and constraints for improvement. In the both areas, plot realignment and land leveling are not planned in the whole farm plot.

Road and canal systems are basically formed along the present plot boundaries. In some areas, however, their routes may require not along the boundaries but within the present plot to avoid meandering their non-systematic system. Such cases shall be attended with disposition for substitute plot through arrangement among beneficial farmers. Land leveling may be carried out in partial area, if necessary.

4.4 Rural Infrastructure Development

Village water supply

Two water supply systems are applied in the areas. One is a piped water supply system with deep well in the gathering villages relatively and the other is a cooperative use deep well with handpump in remote or isolated villages, from viewpoint of construction cost and operation, maintenance method of the facilities. Groundwater quality test shows that color and iron contents are higher than that of the standard in Thailand. Treatment facility, therefore, is also planned in both systems.

Area	Facility	Number of Village	Population
Nong Khon Kaen	Piped water supply	5	818
Thung Sai Yart	Piped water supply	4	2,375
	Cooperative deep well with handpump	6	561

Rural electrification

Target for electrification rate is projected to be 90 % in the both areas, taking account of the future plan in Sukhothai and the present electrification conditions in Nong Khon Kaen. As a result of the study, the number of household to be supplied with electricity is planned at 50 in Nong Khon Kaen and at 399 in Thung Sai Yart. Facility is consisted of high-voltage power lines to the required villages, low-voltage power lines within the villages and connecting lines to each household. Electrification work shall be carried out in cooperation with PEA.

Social infrastructure

Facilities for education and rural health are not planned in both areas, because the present conditions for both components meet with the national requirement.

Related to public sanitation, propagation of sanitation information and improvement of sanitation facility are necessary to promote environment improvement in the areas. In order to propagate their concepts, health center and group activities play major roles. From viewpoint of facility, it is important to improve the facility to prevent leak of human waste and to clean the environment. In the planning, toilet with tank, therefore, are supplied to the all households without it, of which number is 60 and 518 in Nong Khon Kaen and Thung Sai Yart, respectively. Installation works shall be done by the beneficiaries themselves.

Meetings shall be held actively in the future to encourage farmer organization, improvement of farming practices and living conditions. In this study, therefore, multi-purpose halls for various training and education activities and meeting facility for convenient gathering are planned as a rural community.

4.5 Supporting Services

For the realization of the effect arising from an integrated rural development project, it is not always sufficient to provide such hardware as agricultural and rural infrastructure. Further, ALRO is obliged to secure income of beneficial farmers after development of the hardware. In this project, it is prerequisite that same significance as on the hardware, should be placed on the strengthening and enrichment of software, which includes an agricultural extension on such diversified crops as upland crops and fruits, institutional supporting services including farmers' organization, and so on.

For the purpose of strengthening and enriching the software part, it is planned to newly establish "Farmers Training and Strengthening Station (F.T.S.S.)", of which main objectives are (a)systematizing farmers, (b)guiding and training farmers, (c)introducing concept of marketing farm products, and (d)managing demonstration farms. From viewpoint of the project organization, the hardware component of F.T.S.S. shall be implemented under the responsibility of the field sub-project office (ALRO), on the other hand, the software component be managed and supervised by the Project Working Committee. F.T.S.S. is responsible for firstly training those governmental officials concerned who shall be a leader as well as trainer of farmers, secondly educating and training a leading farmer and thirdly educating and training general farmers. During the project implementation stage, the F.T.S.S. shall look to proper experts including foreign one for assistance, and then the activities shall be succeeded under a leadership of those government officials who would complete the training course.

4.6 Physical Planning

Under the component wise development plan as stated above, physical planning for each facility are carried out on the basis of the following policy:

- Facilities are to fulfill their function for their own aim.
- Facilities are to be designed following the structural form and criteria in Thailand.

The main facilities to be constructed under the project, are (a) water resources ones, (b)irrigation and drainage ones, (c)inundation/flood protection ones, (d)farm road networks and (e)on-farm facilities under the agricultural infrastructure component, (f)village water supply, (g) rural electrification, (h)public health and (i)rural community under the rural infrastructure component, and multi-purpose storages under the post-harvest and marketing component.

4.7 Project Cost

The construction works shall be basically carried out by the contract basis. The initial project cost is composed of (a)construction cost, (b)project administration, (c)consulting services, (d)training package program, (e)project monitoring activity, (f)physical contingencies, and (g)contingency for price escalation. Total initial project cost is estimated at 453.30 million Bahts, of which foreign and local currency portion are estimated at 325.44 and 127.86 million Bahts, respectively. The contingency for price escalation is estimated at 98.47 million Bahts, about 22 % of the total project cost. For the direct cost of agricultural infrastructure component in Nong Khon Kaen and Thung Sai Yart is 31,875 and 35,625 Bahts per rai, respectively.

5. IMPLEMENTATION PROGRAMME

5.1 Implementing Organization

The specific feature of the integrated rural development project is, generally, to cover various component. In order to smoothly and satisfactorily implement this project, it is, therefore, planned to establish a project coordinating committee at the three levels of the government, namely, Project Executive Committee, Project Coordinating Committee and Project Working Committee. Under the committees, ALRO shall be an executing agency of the project. And ALRO shall appoint a project director, a project manager and a field project manager and establish field sub-project offices.

Since it is one of important components to enrich the so-called software aspect, "Farmers Training and Strengthening Station (F.T.S.S.)" shall be established under the management and supervision of the Project Working Committee. In order to assist ALRO and the committee, it is planned to mobilize consultants. It is also planned to mobilize a monitoring team whose main activity is to monitor progress of project implementation in comparison of the planned schedule and to review and arrange problems and constraints against project implementation. Through the monitoring activity, it can be obtained valuable information which could contribute to the current project implementation as well as the future similar project as a feedback system. Since this monitoring activity requires fairness, it is desirable to mobilize the third party like a university in Thailand.

5.2 Implementation Schedule

As for overall project implementation schedule, it is planned to allocate seven years after completion of the feasibility study including necessary procedure for fund arrangement, detailed design and tendering. Thus, the real construction period is scheduled for four years.

5.3 Organization for Project O & M

During the project implementation, in parallel with development

and construction of various facilities, intensified program for strengthening and training governmental officials including ALRO staff and farmers, will be carried. Under the program, it can be expected to establish operation and maintenance organization of project facilities by mainly farmers themselves. Although it is one of way to organize the respective O & M organization, because each facility has different beneficiaries, it is more effective and efficient to establish a unified O & M system from viewpoints of effective operation and management of the project. Therefore, it is planned to establish an agricultural land reform cooperative in both Nong Khon Kaen and Thung Sai Yart, respectively, under Sukhothai Land Reform Office and the proposed Project O & M Committee at Changwat level. In the beginning, these cooperatives would start as set-up committee composing of several farmers' groups as its sub-committee. The farmers' groups responsible for O & M of the respective facility would continue their activity for enrichment of the cooperative's systematization, in parallel with performing their daily obligation.

6. PROJECT EVALUATION

6.1 Economic Evaluation

Tangible benefits in monetary terms in this project are those arising from crop sector and fishery in storage ponds. In every case, these benefit are calculated as an incremental net production value (N.P.V.) between "with project" case and "without project" case. For the estimation of the N.P.V., the economic prices have been applied, and annual benefit in Nong Khon Kaen and Thung Sai Yart is worked out 8.38 and 28.95 million Baht, respectively.

After deducting the price contingency from the estimated financial initial investment cost, the economic cost has been estimated at 312.25 million Bahts, by applying the conversion factor of construction. Similarly, the economic cost of operation and maintenance after completion of the project is estimated at 1.95 million Bahts per year.

On the basis of four years of gestation period until attaining full benefit and a period of analysis of 30 years in considering

synthetic durable life of various major facilities, the economic internal rate of return (E.I.R.R.) for the Project is calculated at 7.9 %. The E.I.R.R. is, economically, justifiable taking into consideration the nature of the integrated rural development which usually includes intangible benefits in the component of social infrastructure development.

The sensitivity analysis has been carried out as testing the project risks. In case of decrease in crop yield by 10 %, the E.I.R.R. goes down by 2.5 %, and it become lower by 1.6 and 1.5 % in cases of decrease in storage volume in the proposed farm pond and decrease of crop prices, respectively. In case of the agricultural infrastructure component only, it is slightly higher 9.1 %.

6.2 Financial Analysis

In order to evaluate a financial impact on beneficial farmers through implementation of the project, farm budget analysis for typical farm has been made in cases of "without" and "with" project. The average size of the typical farm is 16 rais (2.56 ha) in Nong Khon Kaen and 25 rais (4.0 ha) in Thung Sai Yart. Typical farming patterns are divided by block in case of the former area and by availability of irrigation water in the latter. The preliminary result of the financial analysis reveals that those farmers under rainfed condition in Thung Sai Yart can enjoy only 2,720 Bahts of farm economic surplus, and the other farmers do 13,000 to 21,500 Baht.

In addition to the above analysis, an economic farm size has been studied in considering several cases of cost recovery. The results show that under irrigated condition and cost recovery case of annual O & M cost plus direct construction cost of post-harvest facility as well as a half of that of agricultural infrastructure, economic farm sizes are mostly same as the typical farm sizes in respective sub-project area, while under rainfed condition and cost recovery case of annual O & M cost plus direct construction cost of post-harvest facility only, it is same as the typical farm size in Thung Sai Yart.

7. Conclusion and Recommendation

7.1 Conclusion

The basic concept of the project follows the policy of the 6th NESDP. Furthermore, the project formulation has been carried out on the basis of incorporating intention of beneficial farmers and actual condition of the area as well as the institutional system and engineering capability of ALRO under MOAC who will be an executing agency of this project.

Those development concept derived from this study could be applicable to other ALRO's areas especially those in the lower north Thailand which have similar characteristics with these study areas, as a model for rural development through introduction of diversified agriculture under rainfed condition.

Through the implementation of this project, it could be expected that not only the related staff with this project in ALRO would progress their engineering ability, but also ALRO would acquire operational and managerial capability as well as coordinating ability among those agencies concerned for project implementation. Therefore, it would be easy for ALRO to continuously promote an integrated rural development in other land reform areas.

Generally, since the land reform area is, as its specific feature, provided with poor or insufficient agricultural and rural infrastructures and not favored with efficient water resources for irrigation, the economic feasibility of this project is a little lower than the other irrigation projects. However, the proposed project definitely contributes to increase farmers' income and to upgrade their living condition in depressed rural area, which is a basic policy for rural development in Thailand.

7.2 Recommendation

Judging from the thorough examination on the results of the feasibility study as mentioned above, it is recommended to promptly

implement the proposed project with duly attention to the following items:

- As revealed in the sensitivity analysis, it is necessary to positively tackle with strengthening and enrichment of institutional supporting services such as establishment and systematization of farmers' organization, intensified agricultural extension, agricultural credit, and so on. In this connection, it is prerequisite to realize the proposed agricultural land reform cooperatives and farmers training and strengthening station (F.T.S.S.).

- In order to secure more reliable water resource, it is necessary to coordinate various interests within the region, taken into consideration the project impact to outside the study areas. In this context, it is expected for proposed project coordinating committees to show their leadership. Furthermore, in connection with various problems which would take place during the project implementation, guidance and advice to be given by the proposed monitoring team as feedback system shall be fully reflected from time to time.

- For the smooth and successful implementation of the project, it is prerequisite to have positive participation of beneficial farmers. Since it is key point to secure a site for project facilities, those farmers who should submit their farm land for the said lot, shall be provided with substitutive land and/or enjoy exemption or reduction of the burden for project cost recovery. In addition, it is prerequisite to obtain consent of beneficiaries through sufficient explanation on the project plans in advance.

- To realize prompt commencement of the project implementation and to shorten the overall implementation period, it should be performed to implement preparatory works soonest possible such as ground survey, geological investigation, mapping work and so on.

C O N T E N T S

Page

LIST OF TABLES

LIST OF FIGURES

APPENDICES

Abbreviatin and Measures

Abbreviation	
ADB	Asian Development Bank
AIT	Asian Institute of Technology
ALRO	Agricultural Land Reform Office
BAAC	Bank for Agriculture and Agricultural Cooperatives
CIF	Cost, Insurance and Freight
℃	Degree Centigrade
DA	Department of Agriculture
DCP	Department of Cooperative Promotion
DOAE	Department of Agricultural Extension
DOF	Department of Fishery
DOH	Department of Health
DOLA	Department of Local Administration
DTEC	Department of Technical and Economic Cooperation
EC	European Community
E.I.R.R.	Economic Internal Rate of Return
EL	Elevation
FAO	Food and Agriculture Organization
FC	Foreign Currency
FOB	Free on Board
F/S	Feasibility Study
FY	Fiscal Year
GDP	Gross Domestic Product
GNP	Gross National Product
GPP	Gross Provincial Product
GRP	Gross Regional Product
Hp	Horsepower
HWL	High Water Level
HYV	High Yielding Variety
IBRD	International Bank for Reconstruction and Development
IEC	Irrigation Engineering Center
JICA	Japan International Cooperation Agency
KV/kv	Kilo Volt
KW/kw	Kilo Watt
KWH/kwh	Kilo Watt Hour
LC	Local Currency
LIV	Local Improved Variety
LV	Local Variety
LWL	Low Water Level
MD	Meteorological Department
MOAC	Ministry of Agriculture and Cooperatives
MOI	Ministry of Interior
MSL	Mean Sea Level
NESDB	National Economic and Social Development Board
NESDP	National Economic and Social Development Plan
NSO	National Statistics Office

OAE	Office of Agricultural Economy
O & M	Operation and Maintenance
PCC	Project Coordinating Committee
PEA	Provincial Electricity Authority
PEC	Project Executive Committee
PH	Potential of Hydrogen
PPM	Parts Per Million
PWA	Provincial Waterworks Authority
PWC	Project Working Committee
RID	Royal Irrigation Department
SSIP	Small Scale Irrigation Project

Measures

Length

mm	millimeter(s)
cm	centimeter(s)
m	meter(s)
km	kilometer(s)

Acreage

rai	1,600 m^2 = 0.16 ha
sq.cm	square centimeter(s)
sq.m	square meter(s) = m^2
sq.km	square kilometer(s) = km^2
ha	hectare = 10,000 m^2 = 6.25 rai

Capacity

lit.	liter = ℓ
cu.m	cubic meter = m^3
MCM	Million Cubic Meter

Weight

g	gram(s)
kg	kilogram(s)
ton	metric ton

Others

cm/sec	centimeter per second
m/sec	meter per second
km/sec	kilometer per second
cu.m/sec	cubic meter per second

CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 Introduction

In accordance with the scope of work for the Feasibility Study on Sukhothai Integrated Agricultural and Rural Infrastructure Development Project concluded between the Japan International Cooperation Agency (JICA) and Agricultural Land Reform Office (ALRO), Ministry of Agriculture and Cooperatives (MOAC) of Thailand on December 21, 1988, the Study has been commenced in mid-July, 1989. After fully incorporating the comments on the draft final report which were raised by Thai side, this final report has been prepared.

As for the project planning, the necessity of integrated agricultural and rural infrastructure development for the purpose of achievement of agricultural land reform is understood to be as follows;

(1) To enable farmers to have their own land for cultivation.

(2) To increase the agricultural production and improve credit and marketing facilities to ensure better economic and social conditions for the farmers.

(3) To promote farmers' organizations in order to foster growth of the agricultural economy.

(4) To promote education, public health, public utilities and public facilities for rural betterment.

(5) To reduce the income gap between the rural and urban population.

The development policy mentioned above follows the objectives of "the Sixth Five Year National Economic and Social Development Plan" (1987-1991) established by NESDB.

After submission of the draft final report, it is scheduled to have discussion meeting on the contents of the report with Thai officials concerned and to prepare the final report by incorporating comments from Thai side.

1.2 Background

In the Kingdom of Thailand, an incremental agricultural production has been attained through expansion of farm land to be converted mainly from forest land, and hence the rate of forest against the national land has dropped under 30 %. Therefore, it is necessary to change toward the policy aiming an increase in land productivity of the existing farm land, because of no more conversion of forest to farm land is permissible. On the other hand, crop diversification including upland crops has become urgent and important theme under Thai agricultural policy, because water resources for irrigation to improve the land productivity have become quite tight in the whole Kingdom, and profitability of paddy at both national and farmer levels has stagnated due to its oversupply in the world market.

In 1988, the agricultural land reform area in both the public lands and forests accounts for about 970,000rai (155,000 ha) in the whole Kingdom. As specific feature of the above areas, farmers individually settled, reclaimed and commenced farming in the public lands or forests without any legal support, and thus land productivity, farming technology and farm income are quite inferior in comparison to other advanced areas, due to insufficient and poor provision of agricultural and rural infrastructures. Under the circumstances, in order to stabilize public welfare and to secure employment opportunity and income for the farmers, Thai government is promoting her policy which aims to establish landed farmers through the land reform and to introduce diversified agriculture.

ALRO is presently planning to bring up independent farmer through (a)selecting suitable area for land reform as a model, (b)allocating farm land to landless farmer with necessary infrastructures, taking into natural condition as well as rural infrastructure in the selected area into consideration, and then to gradually expand such model project over the country. Conditions for selecting a model area are (a)public land (including private land purchased by ALRO), (b)poor agricultural production, (c)no or insufficient rural infrastructure and (d)easiness to show demonstration effect. Under the conditions, two model areas (Thung Sai Yart and Nong Khon Kaen) in Sukhothai Province have been selected and proposed.

While it is considered rather difficult to apply a development approach to be formulated in the model areas to other ALRO's area overall Thailand taking into consideration their different characteristics and circumstances, it could be applicable in the lower north region of Thailand. Similarity in the said region is that they have similar natural conditions such as climate, soil, etc., are less favourable with water resources for irrigation having annual rainfall of approximately 1,000 mm, and are located far from Bangkok, large consumption base of farm products. According to 1986 data, there are 15 land reform area in the public lands and forests of the lower north region, having total area of about 350,000 rais (56,000 ha) and about 20,000 households (See Table 1-1).

ALRO is planning to implement and promote an agricultural and rural development on the basis of the following three development levels;

Level-1: Provision of basic agricultural infrastructure so as to meet with farmers' subsistence level (Basic Development Model);

Level-2: Provision of water supply and marketing facilities which aims to increase farmers' income and to improve living conditions, in addition to provision of the infrastructure of Level-1 (Rural Development Model);

Level-3: In addition to the Level-2, more improvement for conditions of agricultural production and living with land consolidation (Land Consolidation Model)

Rural communities have been formed on the basis of rainfed agriculture due to lack of water resources in Thung Sai Yart area and on the basis of irrigated agriculture by using groundwater in Nong Khon Kaen area. Thus, ALRO is planning to apply the Level-2 and Level-3 for Thung Sai Yart and Nong Khon Kaen, respectively.

However, the said respective level covers wider range and then their definition is not so clear. In addition, ALRO is, presently, seeking a technical criteria applicable for implementing integrated rural development in the land reform areas. Therefore, it has been also requested by ALRO to carry out technical transfer in relation with

Table 1-1 Agricultural Land Reform Area in Lower North Thailand (Public Land)

Name of Areas	Name of Province	Acreage (rai)	No. of Household	Holding[1] Size (rai/HH)	Paddy[1] Yield (Kg/rai)	Net Cash[1] Income (Baht/HH)
Tung Kokwua Common Use Land	Kampheng Phet	4,701	287	54.16	372	21,630
Sala Prong Daeng Common Use Land	- ditto -	6,892	308	N.A.	N.A.	N.A.
Dong Wat Kut - Tung Namhong Common Use Land	- ditto -	2,820	170	N.A.	N.A.	N.A.
Chumnum Wang Chompu Common Use Land	- ditto -	6,000	220	N.A.	N.A.	N.A.
Klong Muang Common Use Land	- ditto -	1,463	30	N.A.	N.A.	N.A.
Khao Sung - Khao Puak - Khao Chang Fub Forest	Nakhon Sawan	128,806	5,376	51.19	248	37,291
Bung Narang Forest	Phichit	138,280	6,023	59.54	328	16,812
Wang Pong - Chon Daen - Wang Kampaeng Forest	Phetchabun	39,507	1,384	43.64	398	31,153
Suan Sak - Tha Chai Forest	Sukhothai	31,906	2,151	42.57	252	7,759
Nong khon Kaen Common Use Land	- ditto -	7,283	753	40.29	208	32,016
Tung Sai Yart Common Use Land	- ditto -	33,535	565	34.17	163	10,876
Tungkalo Foreat	Uttaradit	3,767	572	30.37	383	19,151
Specific Purpose Development Area	Uthai Thani	6,317	271	N.A.	N.A.	N.A.
Thapsalao Forest	- ditto -	48,464	2,266	29.27	283	19,603
Khao Bangkrack - Tung Po Forest	- ditto -	4,095	196	27.08	334	12,075

Source: Selected Data on Land Reform Areas, ALRO, September 1986
Note: [1] Figures of Amphoe (District) which includes the respective land reform area

development concept, staged development approach, implementation program, and so on, through execution of the feasibility study on the both areas.

In compliance with the official request of Thai Government in July 1987 and consideration of the background mentioned above, Japanese Government conducted a preliminary survey, through which the Scope of Work has been concluded by and between the both Governments in December 1988.

1.3 Objective of the Study

As a model project for integrated rural development on the basis of introduction and promotion of upland crop cultivation, the main objective of the study is to conduct the feasibility study on the Integrated Agricultural and Rural Infrastructure Development Project in both areas of Thung Sai Yart and Nong Khon Kaen of Sukhothai Province, of which major component is development of agriculture including upland crop promotion, agricultural infrastructure, rural infrastructure and so on. In addition, technology transfer shall be made through preparation of basic criteria for comprehensive planning, implementation programme, project evaluation and operation and maintenance of the facilities as well as on-the-job training including opening of seminar.

1.4 Study Area

The Study area is consist of two public lands of Thung Sai Yart having 33,535 rai (5,365 ha) and Nong Khon Kaen, 7,283 rai (1,165 ha), located in Sukhothai Province.

CHAPTER 2 SOCIO-ECONOMIC BACKGROUND

CHAPTER 2 SOCIO-ECONOMIC BACKGROUND

2.1 National Economy

2.1.1 Current National Economical Situation

For the 20 years since the implementation of the First Economic and Social Development Plan in 1961, the Thai economy has maintained an average annual rate of growth in real terms of 7 %, however, due to several factors including the effects of the Second Oil Crisis to the annual economic rate of growth since then has been ranging from 4.0 to 6.3 % until 1986. Thai economic policy has changed from the former high economic growth to stable one. During this period, the industrial sector's share in GDP has grown from 10.5 % in 1960 to 19.8 % in 1985 on the contrary, the agricultural sector's percentage decreased from 38.9 % to 17.4 %, and the sector was surpassed by the industrial one.

In 1984, the GDP was 41.7 billion dollars and the per capita GDP 806 dollars showing a steady rate of growth each year. However, the regional disparity is large, compared to the 2,319 dollars per capita GDP of the capital, the Northern Region's 522 dollars (23 % of the capital's) and the Sukhothai Province's 533 dollars (23 %).

Although the agriculture sector's percentage of GDP is declining, agricultural products still occupy approximately 50 % of the total export value. The principal items for agricultural export are rice, tapioca, natural rubber, maize, sugar, etc., and especially since tapioca (a starch extracted from cassava) is an important export item it is given special attention from its relationship to irrigation development.

The domestic factors behind the stable growth of the Thai economy are; (a)construction of infrastructure such as roads, electricity, etc., (b) progress in the diversification of agricultural products, and (c) progress in industrialization. Construction of infrastructure became the basis for the resultant development of agriculture and industry. Industrialization succeeded through a policy of gradually developing the import substitution based light industries. The Thai economy passed through a stormy period of increasing financial deposit, external debt,

etc., during the upheaval of the world's economy caused by the oil crises among others. However, in recent years penetration of economic policies such as devaluation of the Baht, reduction in overseas interest rate, etc., have resulted in a bright outlook.

Agriculture developed from the monoculture type production of paddy to production of new upland crops such as maize, cassava, sugar cane, kenaf, etc., which contributed to the improvement in farmer's income and at the same time earned foreign currency as an export item for a while. However, Thai agriculture is being forced to introduce new step of diversified farming because of lower demand and import restriction on the said diversified crops.

2.1.2 Current National Agriculture Situation

(1) Farm land

In 1986, the farm land area was 20,121 thousand hectares and the forest area was 15,151 thousand hectares which was equal to 39.2 % and 29.5 % of the national area, respectively. Looking at the change in respective areas over the past 10 years, farm land has increased from 35 to 39.2 % of the national area and on the contrary the forest area has declined from 40.8 to 29.5 %. Of the reduction in forest area of 5,770 thousand hectares, 25.6 % or 1,475 thousand hectares is presumed to be utilized for the cultivation of cassava, sugar cane, pineapple, etc.

The paddy area is 11,986 thousand hectares or 23.4 % of the national area and has hardly increased over the years. Second crop rice cultivation has become possible in certain regions through the construction of irrigation facilities. Farm land utilized for fruit trees, vegetable cultivation and grassland covers an area of 2,159 thousand hectares or 4.2 % of the national area. In comparison with other principal Southeast Asian countries the percentage of forest area to the respective national area is 66 % in Japan, 64 % in Indonesia and 40 % in Philippines. The forest area in Thailand is extremely low and its increase is urgently required for conservation of land and water.

(2) Agricultural production

Previously, Thai agriculture centered on paddy cultivation in the Central Region, in recent years this has rapidly diversified to upland cultivation of cash crops. Looking at the production volume of the main crops for 1985/86 gives the following order, rice 19,568 thousand tons, sugarcane 24,776 thousand tons, cassava 17,226 thousand tons and maize 4,686 thousand tons. These crops are for domestic consumption and at the same time are main agricultural products for export which also include natural rubber, coconuts, etc.

(3) Agricultural population and agricultural organizations

In 1984, the number of agricultural households in Thailand was 4,750 thousand and the agricultural population was 33,540 thousand persons and continues to increase. Compared to the whole country, agricultural households accounted for 54.7 % of the total number of households and agricultural population accounted for 64.7 % of the total population. This population increase has created a hindrance to the growth of the rural economy due to the lack of employment opportunities. Agricultural cooperatives are established at the district level carrying out purchasing and marketing activities, however, their financial base is weak and membership does not exceed 17.5 % of the agricultural households.

2.2 Regional Economy

2.2.1 Population Statistics

The area of the northern region is comparatively largest comparing with other region with the area of 169,644 square kilometres, just about one third (1/3) of the total area of the country. The region consists of 17 provinces and Sukhothai province in which the study areas are located is one of them. In 1982 the northern region accounted for 20.28 % of the total population of the country and in 1985 accounted for 20.06 %. During the same period the population of the northern region increased at an average annual rate of 1.86 % from 9,833,727 persons in 1982 to 10,391, 368 persons in 1985 while the total population of the country increased at an average annual rate of 2.22 % from 48.490 million persons in 1982

to 51.796 million persons in 1985.

2.2.2 Administrative Division in Sukhothai Province

As of 1987, Sukhothai can be administratively divided into 9 Amphoes, 82 Tambols, 651 Mubans. Local administration consists of Provincial Administrative Organization, 2 municipalities and 11 sanitary districts.

2.2.3 Economic Growth

Most of people in the northern region and Sukhothai province earn their living by growing rice, some kinds of vegetable crops, such as cotton, tobacco, beans and canes. Besides, inland-water fishery, livestock raising and cottage industry are also the occupations that much income to the population. In 1985, the GPP in Sukhothai province was 7,426 million Baht and the real GDP growth was 6.8 % per annum since 1980. The growth of agricultural sector was 3.8 % over the same period, resulted in that the share of the sector decreased from 51 to 35 %.

2.2.4 Existing Condition of Income Distribution

According to the village survey held by National Statistical Office in 1986, income distribution in Sukhothai province is summarized as follows;

		Households	%
Total	Baht/year	93,842	100.0
Under 6,000	Baht/year	24,718	26.3
6,000-10,000	Baht/year	24,071	25.7
10,000-20,000	Baht/year	14,589	15.5
Over 20,000	Baht/year	8,338	8.9
Unknown	Baht/year	2,126	23.6

2.3 Sixth National Economic and Social Development Plan

2.3.1 Previous National Development Plans

A quarter of a century has passed since the birth of the first plan, during this time the economy attained an average annual growth rate of nearly 7 %. As a result, the GDP of 53,984 million Baht in 1960 increased 19 times by 1985 to 1,047,292 million Baht and the per capita income increased 10 times from 2,106 Baht to 20,263 Baht over the same period. In the field of social development, taking education as an example, an elementary school has been established in almost every sub-district (Tambol) and a high school in almost every District (Amphoe). Also, in the field of public health, District hospitals cover 86 % of the Districts, public health clinics have been established in 98 % of the sub-districts and basic public health services have reached more than 90 % of the country's villages.

Along with the steady progress in socio-economic development several problems have been revealed, they are;

a) slowing down of the economic rate of growth
b) increase in the labor force population and lack of employment opportunities
c) deficit in trade and finances
d) increase in the congestion of capital area and regional disparity
e) deterioration of natural resources and environment
f) continuing to promote improvement in living standards and social development

2.3.2 Brief of the Sixth NESD Plan

The Sixth Plan covers the period from October 1986 to September 1991. In order to solve various problems accumulated by implementation of the former five plans, the 6th plan is characterized as an adjustment one, and it stresses strongly to change her development pattern from expansion in quantity to enrichment in quality. For that purpose, the following basic policies have been formulated including 2 overall targets, 3 main strategies and 10 working programs as follow:

Two targets

a) Set up the economic growth target to be an average of more than 5 % per year.

b) Development of human quality to enable to progress in social development and create peace and fairness in society.

Three Strategies

a) Increase efficiency and capability in country development include human resources development, science and technology and natural resources development.

b) Increase efficiency, improve quality in production, marketing, technology and reduce production costs to be able to better compete with other countries.

c) Promote the income distribution and wider distribution of development of benefits to the region and rural areas, especially the low income groups.

Ten working programs

a) Economic and financial stabilization program
b) Program to develop human resources, society and culture
c) Natural resources development and environmental management program
d) Science and technology development program
e) Program to improve management and review the government's role in the development process
f) State enterprises development program
g) Program to develop production, marketing and employment generation system
h) Basic service development program
i) Urban and specific zones development program
j) Rural development

2.3.3 Rural Development Program in the Sixth Plan Period

To support the overall development targets which cover economic expansion, income distribution, social services development and improvement in the quality of life of the rural population, the following

importance of the rural development program in the Sixth Plan are determined.

Strategies

a) Emphasize on the target area which specified by the province.

b) Lift up the living standard of rural population covering the backward areas, middle-level and progressive areas.
The government sector should concentrate on the backward and middle-level areas, while promote the private sector to invest more in the progressive areas.

c) Adjust the rural development management mechanisms to unite every sector and become more integrated, cooperated in solving basic problems of rural community, increasing the production income by using the appropriate technology.

d) Promote the role of rural people organization and the population in making decision and solving their own problems and the community's as well as encourage them to be able to help themselves.

2.3.4 Status of Agricultural Land Reform in the Sixth Plan

As for this item, the following description can be transcribed from the said plan, Chapter 1 (Introduction) of the plan says that; Rural development was accorded an extremely high priority in the Fifth Plan and will be given even higher priority in the present plan.

Chapter 2, Result of past performance and development issues says that; The problem of landless still prevails with more than one million rural households occupying land without legal title deeds, while the population of 3,683 villages, each compressing more than eight(8) households does not possess any land at all: They either have to rent land, or illegally occupy national reserves and permanent forests would form the basis for solving the land use problem and accelerate the process of issuing land title deeds.

2.4 Agricultural Land Reform

2.4.1 Background

As Thailand is an agricultural country and the great part of the population is engaged in agriculture, land is essential factor in the development of national socio-economic conditions. Unfortunately Thai land tenure system has caused inequitable distributions of income. As a result, a great number of farmers are poor and in debt. They mostly become tenant and landless farmers. Poverty is, therefore, widespread in rural areas. In addition, the population continues to increase at a rapid rate and as a result land resources become even more limited. Hence, the Agricultural land reform Act B.E.2518 was promulgated and the Agricultural Land Reform Program was launched in order to solve those problems. The program came into effect in March 1975.

Nearly 15 years have passed since Land Reform Act was promulgated. After that social and economic conditions surrounding agriculture changed remarkably but importance of land reform never changes. In order to meet with changed situation the Act was revised and came into effect in September 1989.

2.4.2 Meaning and Objectives of Land Reform

Agricultural land reform means improvements made in connection with rights and holdings in agricultural land, including housing arrangement in such agricultural land, by allocating the state-owned land or land purchased or expropriated from landowners who do not make use of such land by themselves or own land in excess of their rights in accordance with the Land Reform Act, to farmers who do not own land or own too little land to produce adequate income to meet the cost of living, and to farmer institutions.

Assistance shall be provided by the Government in terms of agricultural occupation development as well as production and marketing improvement, etc.

The major objectives of agricultural land reform are;

a)To enable farmers to have their own land for cultivation;

b)To increase the agricultural production and improve credit and marketing facilities to ensure better economic and social conditions for farmers;

c)To promote farmers' organization in order to foster growth of the agricultural economy;

d)To promote education, public health, public utilities, and public facilities for rural betterment; and

e)To reduce the income gap between the rural and urban population.

2.4.3 ALRO's Role and Responsibilities

ALRO's role and responsibilities can be be roughly divided into the following three categories;

1)Land distribution by ALRO;

2)Basic infrastructures development by ALRO and/or coordinating with other government agencies concerned; and

3)Income generation by ALRO and/or coordinating with other government agencies concerned and the private sectors.

CHAPTER 3 THE PROJECT AREAS

CHAPTER 3 THE PROJECT AREAS

3.1 Natural Condition

3.1.1 Location

Nong Khon Kaen

The study area is located in the Amphoe Khong Krailat in Changwat Sukhothai, 25 km east of town of Sukhothai, which lies along the primary road route 12 connected between Sukhothai and Phitsanulok, and its study area is 1,165 ha.

Thung Sai Yart

The study area is located in the Amphoe Ban Dan Lan Hoi and Muang in Changwat Sukhothai, 19 km northeast of town of Sukhothai, which is adjacent to the secondary road route 1113 leading to the primary road route 12 and its study area is 5,365 ha.

3.1.2 Geography and Topography

Nong Khon Kaen

The study area is surrounded by very flat area and its average ground slope is about 1/4,000 from north to south and elevation ranges from 41.2 to 42.2 m. There are two canals in the area. One is Noi canal, which flows from north to south. The other is Yai canal, which joins with Noi canal at the center of the area. Ban Mai canal flows from west to east, along the boundary of study area. Noi and Ban Mai canals joins at the south boundary and flows into Yom River at about 10 km downstream. Villages are mainly located in high land area along the roads and canals.

Thung Sai Yart

The study area is surrounded by relatively uniform geography with gentle slope of 1/700 to 1/1,000 from west to east, and elevation is from 56 to 66 m. Mountain area is located at about 20 km west behind the study

area, which forms watershed of four canals in the area. These canals are tributaries of Yom River and join with Yom at about 12 km east. There are villages scattered along the roads and canals.

3.1.3 Geology

(1) Outline of geology

Upper Chao Phraya plain is infilled with unconsolidated and very low consolidated deposits which are formed in Alluvium, Pleistocene in Quaternary and upper Tertiary. These deposits are composed of sand, gravel and clay. The thickness is more than 500 m in the center of the plain and approximate 200 m even in Thung Sai Yart area. Basement rocks covered with the above deposits are composed of sedimentary, phyroclastic, metamorphic and igneous rocks in Mesozoic and older era.

(2) Geology in the study area

Geology is composed of sand, clay and their alternation. In Nong Khon Kaen, many aquifers of sand layers are found. But in Thung Sai Yart, poor aquifers with many distributions of clay and clayey sand layers are found.

Nong Khon Kaen

The horizontal deposits of this area are composed of clay, sand, sand with gravel and their alternation in Alluvium and Pleistocene in Quaternary.

Sand and clay layer at around 34 m in depth may form the boundary between Alluvium and Pleistocene, according to the geological condition and the blow numbers of Standard Penetration Test.

Thung Sai Yart

The horizontal deposits of this area are composed of clay, clayey sand, little sand and their alternation, which are inferred to be Pleistocene except for surface deposit, according to the geological

condition and the blow numbers.

3.1.4 Meteorology and Hydrology

(1) Rainfall

Ban Dan Lan Hoi (59062) and Kong Krailat (59042) were selected as representative rainfall stations.

1) Annual rainfall

Thung Sai Yart is located in one of Thailand's low rainfall areas and has relatively low annual rainfall of 1,000 mm. In comparison, Nong Khon Kaen has annual rainfall of around 1,200 mm, 20% more than Thung Sai Yart.

MEAN ANNUAL RAINFALL IN STUDY AREA

Year	Thung Sai Yart	Nong Kong Kaen
1952 - 1957	-	1,050
1958 - 1967	-	1,260
1968 - 1977	1,000	1,280
1978 - 1987	1,070	1,360
1952 - 1987	1,035	1,260

Note: observation period - Thung Sai Yart 1966 - 1987
Nong Kong Kaen 1952 - 1987

2) Seasonal rainfall

The Study Areas have a rainy season between May and October and a dry season between November and April. Thung Sai Yart has rainfall of 912 mm (88% of the annual rainfall) in the rainy season and 125 mm in the dry season. In comparison, the Nong Khon Kaen has rainfall of 1,130 mm (90% of the annual rainfall) in the rainy season and 127 mm in the dry season. Rainfall in May in Thung Sai Yart is comparatively low. Both areas have less than 100 annual rainy days which is much lower than the 122 days for the Phitsanulok Station (1956 - 1985).

(2) Other meteorological conditions

Other meteorological conditions are outlined below based on the observation at the Phitsanulok Station under the Meteorological Department.

1) Evaporation

The mean annual evaporation is 1,560 mm. Since the Study Area is located slightly northeast of Phitsanulok, the evaporation is assumed to be slightly lower than that of Phitsanulok. March and April have relatively large evaporation of around 310 mm while July, August and September have relatively low evaporation of around 94 mm.

2) Temperature

Monthly mean temperature is stable throughout the year. Maximum temperature is approximately 35℃ during March and May and minimum temperature is approximately 15℃ during December and January.

3) Relative humidity

The annual mean relative humidity is 75%. It is high in July, August and September at around 85% and low in March and April at around 60%.

4) Wind

Prevailing wind is generally from the south throughout the year, except north wind during October and December. The wind speed is high between April and May compared to the other months.

(3) Run-off discharge

Run-off conditions in the Study Areas were represented by Y.26 (Lam Pang) located nearby and were compared with the flow data recorded at Y.3A (Sawan Khalok) in Yom River.

1) Annual run-off

Annual run-off is 105 MCM at Y.26 and 2,687 MCM at Y.3A, run-off coefficient of both stations is almost same at around 12%.

2) Seasonal run-off

Run-off generally occurs between May and November during which most of the run-off does during months of September and October. Other months have little run-off. The run-off temporarily drops in July at Y.26, showing a different run-off pattern to that of Yom River. Monthly run-off is shown in Table 3-2.

3.1.5 Soil and Land Classification

(1) Soil condition

Nong Khon Kaen

The land in Nong Khon Kaen area is mainly classified into (a) semi-recent terrace and (b) old levee as shown below:

Land Category	Soil Series	Area (rai)	%
1. Semi-recent terrace	Saraburi (Sb)	2,068	28.4
2. Old levee	Nakhon Pathom (Np)	5,215	71.6
Total		7,283	100.0

A generalized brief notes on the soil series are given below;

1) Saraburi series (Sb)

The Saraburi soils are brown or yellowish brown clays which are nearly neutral chemically in the surface and may be calcareous in the subsoil. These soils crack deeply when dry and swell a great deal when wet. The cracking and swelling of these soils results in a slow turnover of the deeper soil horizons and prevent these soils from becoming highly leached in the surface. These soils are somewhat difficult to till. However, they are good soils for rice production and if irrigated, could be successfully used for grow

Table 3-1 Monthly Rainfall in Study Area

Month	Thung Sai Yart			Nong Khon Kaen		
	Rainfall (mm)	Monthly ratio (%)	Seasonal rainfall (mm)	Rainfall (mm)	Monthly ratio (%)	Seasonal rainfall (mm)
Apr	54.4	5.2		50.4	4.0	
May	172.5	16.7	May - July	168.5	13.4	May - July
Jun	110.3	10.7	390.4	159.8	12.7	486.7
Jul	107.7	10.4		157.9	12.5	
Aug	127.3	12.3		220.0	17.6	
Sep	249.2	24.1	Aug - Nov	264.8	21.1	Aug - Nov
Oct	146.9	14.2	521.9	159.1	12.6	684.7
Nov	32.6	3.1		27.6	2.2	
Dec	7.6	0.7		2.5	0.2	
Jan	7.0	0.6		7.1	0.6	
Feb	3.7	0.4		17.9	1.4	
Mar	16.6	1.6		21.6	1.7	
Total	1,035.4	100.0	912.3	1,259.2	100.0	1,171.1

Note: Observation period Thung Sai Yart 1966 - 1987
Nong Khon Kaen 1952 - 1987
Seasonal rainfall is average by each season.

Table 3-2 Monthly Runoff

Month	Y.26			Y.3A		
	Amount of runoff		Seasonal runoff	Amount of runoff		Seasonal runoff
	(MCM)	(mm)	(MCM)	(MCM)	(mm)	(MCM)
Apr	0.1	0.2		14.5	0.7	
May	9.9	12.6	May - July	82.2	4.1	May - July
Jun	13.3	16.9	25.3	127.7	6.4	447.7
Jul	4.1	5.2		237.7	11.9	
Aug	8.2	10.4		628.0	31.5	
Sep	32.1	40.9	Aug - Nov	848.5	42.6	Aug - Nov
Oct	25.2	32.1	74.5	440.9	22.1	2114.3
Nov	9.0	11.5		197.2	9,9	
Dec	1.9	2.4		59.6	3.0	
Jan	0.6	0.8		28.3	1.4	
Feb	0.2	0.3		13.2	0.7	
Mar	0.0	0.0		9.1	0.5	
Total	104.6	133.2	99.8	2,687.0	223.9	2562.0

Note: Observation period Y.26 1980 - 1987 (Catchment area = 785 Km²)
Y.3A 1968 - 1988 (Catchment area = 19,936 Km²)
Seasonal raifall is average by each season.

upland dry season crops such as corn, soybean or peanut.

2) Nakhon Pathom Series (Np)

Nakhon Pathom soils are formed from semi-recent riverine alluvium and found on low terraces. Relief is flat to nearly flat with a micro-relief caused by the presence of scattered termite mounds. They are clay to silty clay soils in which the subsoil is slightly finer textured than the surface. The surface is dark grayish brown and the subsoil is mottled brown and gray. The surface soil is slightly acid to medium acid surface over neutral to moderately alkaline subsoils. Drainage is generally poor, but soils deeply dry up in the dry season. They are good rice land and would, with irrigation, be suitable for such crop as soybean, corn or cotton.

Thung Sai Yart

From the physiography point of views, the land in this area are classified into the following three categories;

Land Category	Area (rai)	%
1. Semi-recent terrace	17,686	52.7
2. Old levee	14,939	44.6
3. Low terraces of old alluvium	910	2.7
Total	33,535	100.0

The major soils covering the study area are those on (1) semi-recent terrace and (2) old levee. They occupy about 97% of the total area. The soils on (3) low terraces of old alluvium is relatively small but marginal for crop production.

A total of four "Soil Series" is identified on the land categories, on the basis of existing data and field survey. (Details of these soil series are compiled in Appendix C-1)

Soil Series	Area (rai)	%
Chiang Rai (Cr)	17,686	52.7
Nakhon Pathom (Np)	11,362	33.9
Kamphaeng Saen (Ks)	3,577	10.7
Ban Dan (Bd)	910	2.7
Total	33,535	100.0

1) Chiang Rai Series (Cr)

Chiang Rai soils have a light yellowish brown silty clay loam surface layer and a light yellowish brown or light gray silty clay or clay subsoil. They classified as Typic Paleaquults on flat lower part of the low terrace. They occupy about 17,686 rai or 52.7% of the total study area. The soils are poorly drained and slow permeability. The surface runoff is slow. The soil reaction is medium to strong acid (pH 5.0 - 6.5). They are good soils for paddy production and if irrigated during dry season could be used for upland crop such as soybean.

2) Nakhon Pathom series (Np)

Specific characteristic of the soil series is same as described in Nong Khon Kaen area.

3) Kamphaeng Saen series (Ks)

The Kamphaeng Saen soils are soils of old levees and are formed from semi-recent alluvium. The soil texture is loam or clay loam in the surface soils overlaying clay loam subsoils and quite well drained soils. The soil reaction from slightly to medium acid (pH 5.5 - 6.0) in the surface soils and neutral to alkaline (pH 7.0 - 8.0) in the subsoils. These soils are mainly good for upland crops including an orchard and also good for paddy as well.

4) Ban Dan series (Bd)

Ban Dan soils are silty loam to clay loam with poor drainage. The soil reaction of the surface is medium to strong acid (pH 6.0 - 5.5). These soils are mainly good for upland crop but oftenly lack of water in dry season.

(2) Land classification

Nong Khon Kaen

Soils of the area are mainly of old levees. The land suitability classified by DLD indicated that it comprises of only one mapping unit (No. 5) of the whole study area. The areas under mapping unit No. 5 is about 7, 813 rai. The soil fertility under these mapping unit is from medium to low. (Details of mapping unit is given in Appendix C-1)

Thung Sai Yart

The soils of the area are mainly semi-recent terrace in origin. About 53% belong to Chiang Rai series which have clay loam topsoils. Nakhon Pathom series are found in about 34% of the area comprising old levee soils, characterized by clay loam surface. Both soil series are of low in food nutrients and are marked by poor drainage and waterlogging problems during the wet season. According to the classification method of land suitability, this area is classified into the following six mapping units:

Mapping Unit	Soil Fertility	Area (rai)	%
4	medium	3,467	10.3
5	medium	6,402	19.1
6	low	15,445	46.1
15	medium	3,590	10.7
16	medium	2,104	6.3
17	poor	2,527	7.5
Total		33,535	100.0

(3) Residual Soil Moisture

In order to grasp soil moisture content which is available for dry season cropping after wet season paddy, periodical soil sampling was made and laboratory test was carried out during the Phase II period. As the results, it was identified that the residual moisture content in the root zone could be available during the month of December. However, it is pointed out that hand tractor may not plow some soils of which the surface become harder quickly after drying up (Details are given in Appendix C-1).

3.2 Socio-Economic Condition

3.2.1 Population and Household

(1) Nong Khon Kaen

According to the survey on social development conducted by NESDB for preparation of the Sixth NESDP, number of household and population are 565 and 3,099, respectively, and an average household size becomes 5.5 persons.

Household and Population by Village

Village No.	Name of Village	Household	Population		
			Male	Female	Total
1	Bang Crob	73	185	180	365
2	Mai Suk Kasem	154	482	389	871
3	Mai Suk Kasem	122	403	389	792
4	Na Taew	78	192	205	397
5	Mai Photheng	138	192	205	674
	Total	565	1,592	1,507	3,099

(2) Thung Sai Yart

According to the same information for Nong Khon Kaen, number of household and population in those villages concerned to the Study areas are 753 and 3,851, respectively. Accordingly, an average household size becomes 5.1 persons.

Household and Population by Village

Village No.	Name of Village	Household	Population		
			Male	Female	Total
1	Wang Thong Daeng	131	381	395	776
2	Sai Yart	227	517	756	1,273
4	Roa Rang Ngam	109	242	256	498
7	Sam Nak	114	271	280	551
3	Lan Do	46	119	102	221
6	Lam Thong	126	246	286	532
	Total	753	1,776	2,075	3,851

3.2.2 Socio-Economic Condition

(1) Nong Khon Kaen

In this area, main occupation is an agriculture as well, 360 households are solely engaging with the agriculture and 128 are engaging with more than two occupations including an agriculture. In addition, 45 households are engaging with public offices and private enterprises as an employee, 26 with an enterprise, 2 with cottage industry and 4 with others. There exist 17 shops and no rice mill in the area. In connection with standard of education, 1,243 persons are the level with accomplishing the compulsory education only, 348 persons having any level of education, 1,498 persons with others as well as not identical, and 10 adults are illiteracy.

(2) Thung Sai Yart

In this area, main occupation is an agriculture, and about 92 % or 691 households are engaging with farming activity. However, 189 farm households engage with other occupation to secure off-farm income during dry season when it is very difficult to obtain irrigation water. In addition, there are 26 households who engage with public offices and private enterprises as an employee, 2 with an enterprise, 32 with more than two occupations and 2 with others. There exist 25 shops and no rice mill. In connection with standard of education, 2,476 persons are the level with accomplishing the compulsory education only, 648 persons having any level of education, 722 persons with others and 5 adults are illiteracy.

3.2.3 Results of Farm Enquete Survey

In order to grasp intention of beneficial farmers in the Study areas, the farm enquete survey has been carried out by selecting 200 sample farmers. The results are summarized in the following.

As for the constraints on farming practice, the respondents in both the areas appeal lack of irrigation water and lack of agricultural

credit with 1st and 2nd rank, respectively. The 3rd rank is the poor condition of farm road and the pest and disease in Thung Sai Yart and Nong Khon Kaen, respectively. Accordingly, their requests to agricultural infrastructure are provision of irrigation facilities as 1st rank, followed by provision of farm road and land leveling as 2nd and 3rd.

In connection with experience and future expectation for upland crop cultivation, while it feels that respondents have rather strong intention to introduce upland crop cultivation in Thung Sai Yart, rate of expecting farmer is lower than that of experienced farmer in Nong Khon kaen. The reason for the latter is obvious from that farmers in the area prefer to grow paddy even during dry season, due to present recovery of international price of rice. As for constraints on upland crop cultivation, lack of irrigation water, unsuitable soil condition and lack of knowhow as well as extension services are replied in order in Thung Sai Yart, and similarly unsuitable soil condition, lack of knowhow as well as extension services and less profitability than paddy in Nong Khon kaen.

Judging from the first aggregation, beneficial farmers would be mostly cooperative to the project implementation. However, about 20 to 30 % of respondents show their unwillingness to cooperate with changing location of and reshaping own land, and similarly about 20 % give negative answer for bearing the project cost. Therefore, careful attention should be paid to make its demonstrate effect of a pilot project more remarkable.

3.3 Present Agriculture

3.3.1 Land Use

The 1988 agricultural report on land use and land reform prepared by Sukhothai Agriculture Office for wet and dry season cropping, shows that very little changes in land and reform patterns in both Thung Sai Yart and Nong Khon Kaen Study areas. This indicates that the land use and land reform has already stabilized to a high degree in both study areas. However, in Nong Khon Kaen area during the dry season, varieties of crop were grown in the past five years but from crop year 1987/88 rice has been the main crop up to the present.

The main land use patterns show that rice is practiced on most all the land of the low terraces in both study areas. Some other upland crops especially vegetables are also cultivated but only to a small extent in both the areas. Mixed orchards are generally localized near by the housing in the village areas. In all areas there are scattered trees. Forested areas, or what in left as forest intermingle somewhat with the bush and swamp areas and generally the mixed orchard areas but these areas are quite small compared to the total study areas. The present land use is summarized below;

Present Land Use

(Unit: rai)

Category	Thung Sai Yart	Nong Khon Kaen
Paddy field	31,385 (93.6%)	6,406 (88.0%)
Upland field	273 (0.8%)	150 (2.1%)
Sub-total	31,658 (94.4%)	6,556 (90.1%)
Residential & Others	1,877 (5.6%)	727 (9.9%)
Total	33,535 (100.0%)	7,283 (100.0%)

Note: Adapted from Amphoe Agriculture Report (1987/88) and ALRO Annual Report (1987)

3.3.2 Farming Practice

(1) Nong Khon Kaen area

The objective area extends along the national road No. 12 and at the northern part of a bifurcation point of Noi canal. The land holding per household in the area is about 2.5 ha on an average, about 98 % of which is cultivated with paddy.

1) Paddy cropping

The fields which can be grown with both the wet and dry season paddy occupy about 50 % of the total paddy fields. The wet season paddy is mostly cultivated by the broadcasting as direct sowing. RD7 and RD23, non-photosensitive HYV are grown in the northern area, while photosensitive local varieties are cropped in the southern low-lying land.

For the wet season paddy, direct sowing by broadcasting is practiced for a period between mid-May and mid-July. And harvesting works are commonly practiced from mid-October to mid-November except some western part fields where paddy is harvested lately in mid-December.

The dry season paddy is cultivated in about 50 % of the area with HYV and by broadcasting in wet field. Sowing lasts from early December to mid-January, and harvesting season is from early April to mid-May.

Plowing and puddling are commonly carried out with hand tractors. And some farmers use large-size tractors as contract basis. In the universal use of the tractors, some farmers use them as prime movers of the shallow-well pumps for irrigation, or other purposes. Most of farm labor is thrown into manual harvesting works and water control works. Threshing works are made by mechanical threshers on the contract basis and manual threshing works can seldom be seen in the area.

2) Upland cropping

Upland crops are grown in only 25 ha, and mungbean, corn, etc. are cropped in the wet season. As dry season crops, some farmers in both villages of Na Taew and Mae Phothong grow watermelon, but the cropping acreage has not been expanding due to serious damage by pest. Besides, there are some vegetable crops found for family consumption in the small-size upland fields around the residential areas of the villages, and a few full-grown banana, mango trees, etc. found in the mixed forests in and around the villages.

3) Animal husbandry

Buffaloes as draft animals have been decreased remarkably in their number, and cattle for fattening have become very few in number of head per household as well. Some farmers in Mai Suk Kasem (1) and (2) have been breeding cattle by five to six head per household, but it can not be expected to expand the breeding scale in future

due to limit in supply of crude feeds. Besides the above, some farmers are raising swine, ducks etc. in the residential quarter, although quite small in scale (Refer to Appendix C-2).

(2) Thung Sai Yart area

The village areas extend along the major linking roads between villages. The average land holding of the area is about 4.0 ha per household, about 99 % of which is rainfed paddy fields.

1) Paddy cropping

Photosensitive local varieties are grown by transplanting and extensive farming method due to unstable rainfall conditions in the beginning of wet season. In Klong Saket village, about 50 % of the rainfed fields are grown with paddy by broadcasting on dry field.

Seedling on nursery and direct seeding are practiced in a period from mid-May to end-July, and transplanting is carried out from mid-June to mid-August. Commonly, harvesting works last from mid-October to end-November, whereas to mid or end-December in the northeastern part of the area.

Plowing and puddling are carried out by hand tractor, while harvesting works are made manually in sickling paddy plants at top of the stem. Sickled paddy is laid on ridges of the fields for sun-drying. Threshing works are carried out by large-size threshing machines from Sawan Khalok as contract basis, and manual threshing works can be seldom observed in the area.

2) Upland cropping

In some highly elevated areas in Lan Du and Klong Saket, upland cropping, although very small scale, are grown due to restriction from limited water resources for irrigation. The crops grown are mungbean, black bean, etc. In addition, a few vegetable cropping can be seen around the residential areas for family consumption, and some fully-grown mango trees or other fruit-trees are found in the

mixed forests.

3) Animal husbandry

Very few buffaloes as draft animals are bred in the area, while some farmers in Lan Du raise cattle for fattening. Besides the above, swine, chicken, ducks, etc. are kept in small scale in the residential areas.

3.3.3 Cropping Pattern and Production

(1) Nong Khon Kaen area

1) Cropping pattern

The present cropping pattern of the objective area is shown as Figure 3-1. There are two types of paddy cropping as wet season cropping in rainfed fields and dry season cropping by shallow-wells pumping irrigation, each cropping acreage for which is almost 50 %, respectively.

The wet season mono-culture paddy is sown at the early wet season when rainfall is unstable and the direct broadcasting sowing is practiced in the dry fields. In the low-lying areas, transplanting method is applied by using the surface flow. In both cases, non-fertilized extensive farming is carried out with local varieties in most of the area.

In the clay loam soils of the Saraburi Series of the northern part, watermelon is grown in about 5.0 ha after wet season paddy cropping.

Mechanized farming works are carried out by hand tractor, and manual harvesting works occupy about 43 % of the total works in the present cropping pattern, which shows a considerably large share of the manual works (Refer to Appendix C-2).

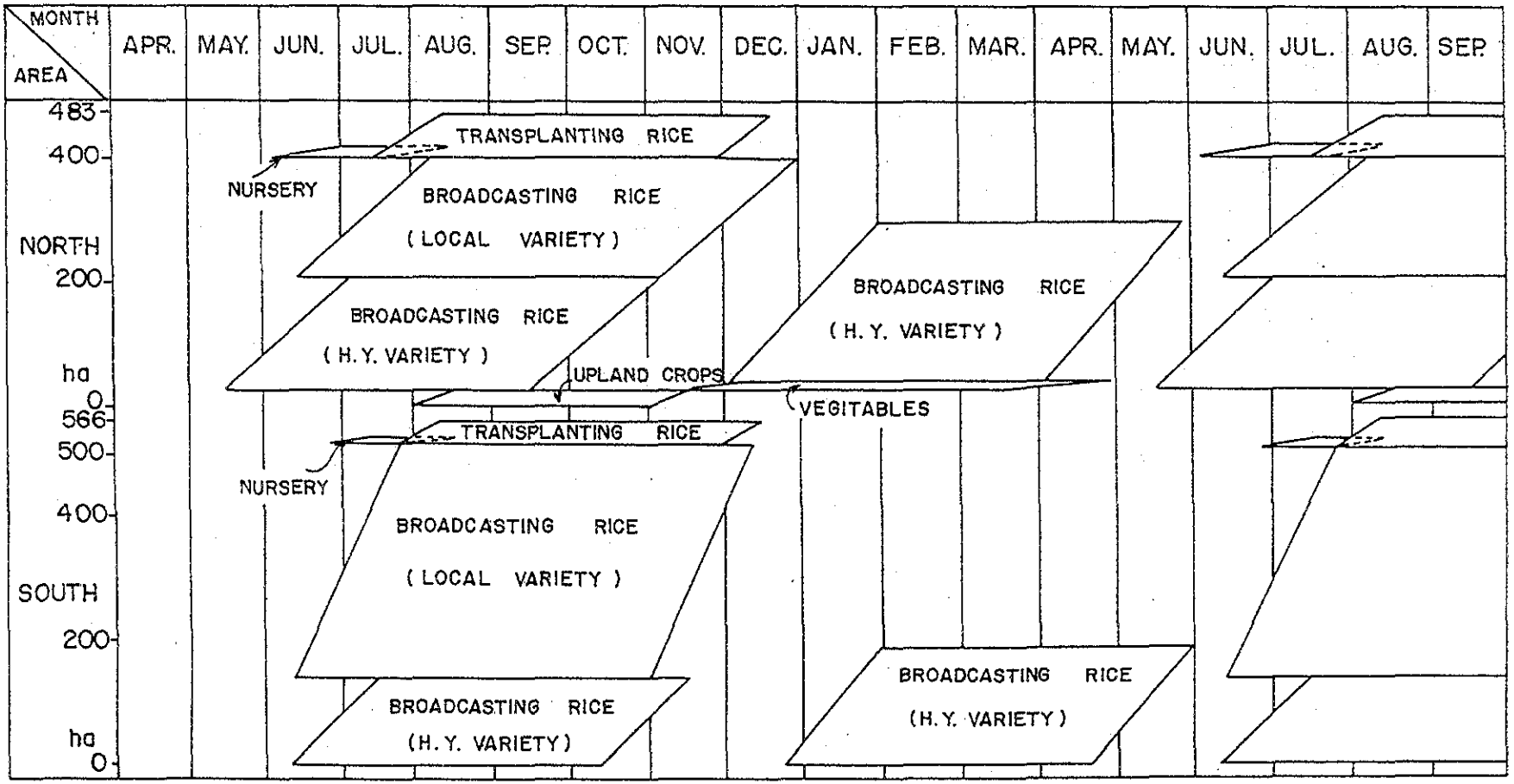


Figure 3 - 1 PRESENT CROPPING PATTERN IN NONG KHON KAEN

2) Farm production

The farm production by crops in the area can be shown as Table 3-3.

In the areas irrigated by shallow-well water supply, introduction of various farming technology for HYV cropping has been practiced. On the other hand, excessive use of groundwater for dry season cropping has caused lowering the groundwater table to become an obstacle for HYV cropping in the wet season.

The paddy cropping rate by areas is shown as follows.

		Northern Area(%)	Southern Area(%)
Wet Season Paddy			
Broadcasting (Dry)	LV	10	30
Broadcasting (Flood)	HYV	34	20
Transplanting	LV	4	2
Dry Season Paddy			
Broadcasting (Flood)	HYV	28	20

The average yield of wet season paddy by direct broadcasting on dry fields is as low as 2.0 - 2.2 ton per ha, due to mainly drought. On the other hand, that of HYV cropped by shallow well irrigation is 4.6 ton per ha with proper fertilization methods.

(2) Thung Sai Yart area

1) Cropping pattern

The present cropping patter is illustrated in Figure 3-2. And paddy cropping is practiced in all rainfed fields of 5,021 ha by transplanting method (about 92 %) and dry broadcasting method (8 %).

The farmers in this area are the paddy mono-culture one.

The local farming practices are made for LV mostly without fertilization by transplanting. Generally speaking, the extensive farming is carried out in the area. Mechanized farming is applied

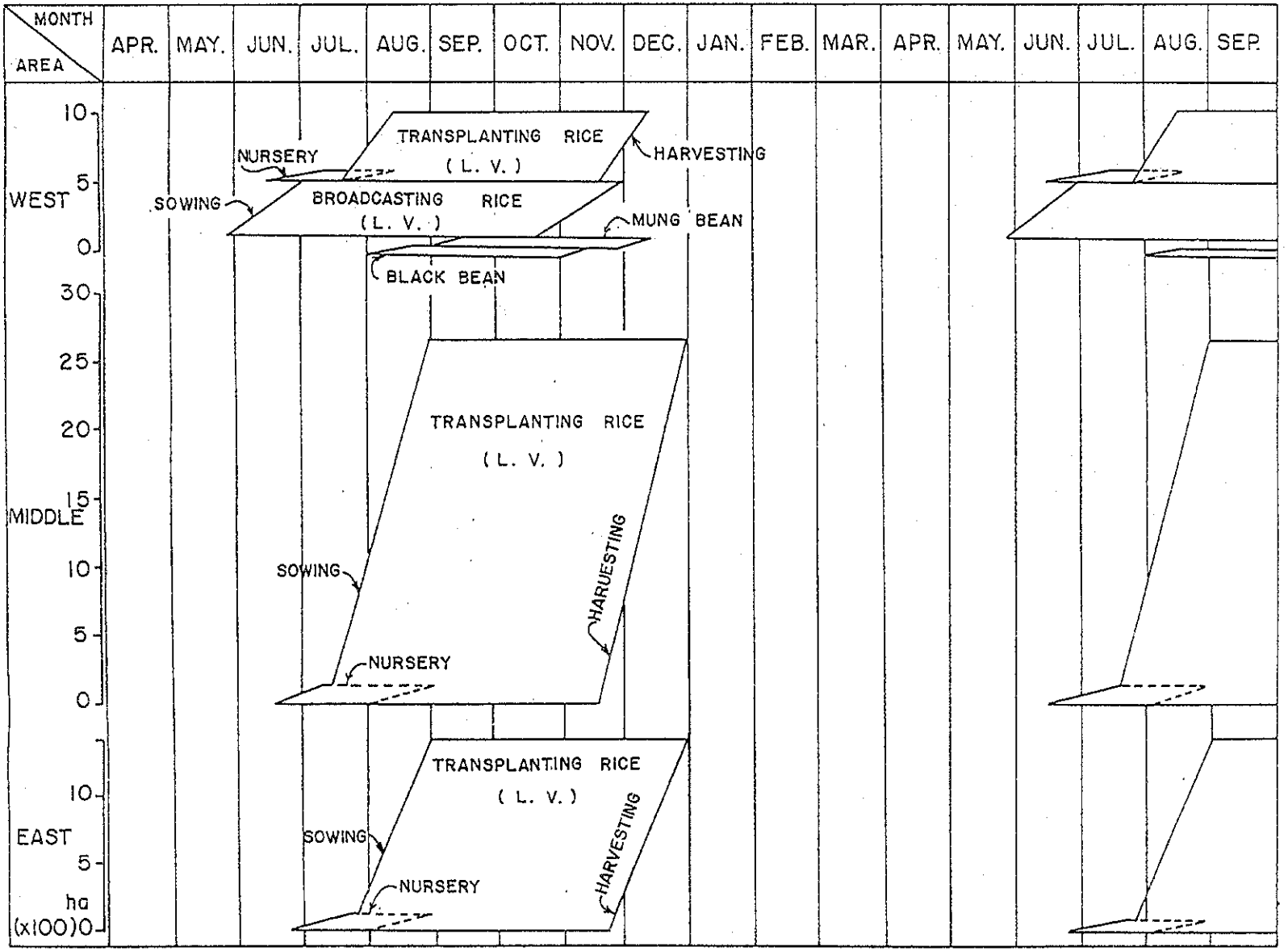


Figure 3 - 2 PRESENT CROPPING PATTERN IN THUNG SAI YART

Table 3-3 Crop Production by Development Model (Nong Khon Kaen)

Area	Crops	Present & Proposed Condition											
		Present Condition			Model - 1			Model - 2			Model - 3		
		Area (ha)	Yield (t/ha)	Production (t)	Area (ha)	Yield (t/ha)	Production (t)	Area (ha)	Yield (t/ha)	Production (t)	Area (ha)	Yield (t/ha)	Production (t)
North	Paddy (T.P & B.C-L.V)	136	2.2	299	-	-	-	-	-	-	-	-	-
	Paddy (B.C-L.I.V)	-	-	-	-	-	-	-	-	-	-	-	-
		312	3.3	1,029	-	-	-	-	-	-	-	-	-
	Paddy (B.C-H.Y.V)	219*1	4.6	1,007	500	4.9	2,450	420	4.9	2,058	450	4.9	2,205
	Soybean	24*2	1.0	24	220	1.8	396	240	1.8	432	390	1.8	702
	Vegetables (a)	-	-	-	-	-	-	60	18.0	1,080			
	Vegetables (b)	5*3	23.0	115	30	23.0	690	30	23.0	690	60	23.0	1,380
South	Paddy (T.P & B.C-L.V)	333	2.2	733	-	-	-	-	-	-	-	-	-
	Paddy (B.C-L.I.V)	-	-	-	30	3.4	102	-	-	-	-	-	-
		244	3.3	805	-	-	-	-	-	-	-	-	-
	Paddy (B.C-H.Y.V)	198*1	4.6	910	460	4.9	2,254	480	4.9	2,352	450	4.9	2,205
	Soybean	-	-	-	70	1.8	126	70	1.8	126	420	1.8	756
	Fruit trees	-	-	-	40	15.6	624	40	15.6	624	70	15.6	1,092
Total	Paddy (T.P & B.C-L.V)	469	2.2	1,032	-	-	-	-	-	-	-	-	-
	Paddy (B.C-L.I.V)				30	3.4	100	-	-	-	-	-	-
		556	3.3	1,835	-	-	-	-	-	-	-	-	-
	Paddy (B.C-H.Y.V)	489*1	4.6	2,249	960	4.9	4,700	900	4.9	4,410	900	4.9	4,410
	Soybean	24*2	1.0	24	290	1.8	520	310	1.8	550	810	1.8	1,458
	Vegetables (a)	-	-	-	-	-	-	60	18.0	1,080	60	23.0	1,380
	Vegetables (b)	5*3	23.0	115	30	23.0	690	30	23.0	690			
	Fruit trees	-	-	-	40	15.6	620	40	15.6	620	70	15.6	1,090
Cultivated Area (ha)		1,049			1,030			970			970		
Cropped Area (ha)		1,549			1,350			1,340			1,840		
Cropping Intensity		147*4			131			138			190		

*1 Due to over-pumping by existing shallow wells (in Dry Season). *2 Mungbean *3 Water melon

only to those works by tractors. Transplanting and harvesting are made in manual works, which are as heavy as about 75 % of all paddy cropping works.

2) Farm production

The farm production of the objective area is shown in Table 3-4.

Wet Season Paddy

	West(%)	Mid.(%)	East(%)
Transplanting (LV)	10	54	28
Dry Broadcasting (LV)	8	-	-

The wet season paddy production is unstable due to annual rainfall fluctuation. And furthermost, drought, pest, insects, etc. give the crops such serious damages that the average annual production is as low as 0.9 - 1.1 ton per hectare as shown in Table 3-4. Gross sale value of paddy is very low as 6,700 - 11,600 Baht per farm, according to the farm economic survey.

3.3.4 Post-Harvest and Marketing System

(1) Paddy

1) Production and disposal

Farmers in the both Study areas are mostly paddy growers. And about 20 % of paddy harvested are disposed for their self-consumption, about 5 % are stored as seeds for the next crop, and the rest 75 % are sold for markets. For the reference, marketable surplus of paddy in the Lower North Thai including Changwat Sukhothai is 73.6 % and 26.4 % are disposed for seed stock and self-consumption.

Table 3-4 Crop Production by Development Model (Thung Sai Yart)

Area	Crops	Present & Proposed Condition											
		Present Condition			Model - 1			Model - 2			Model - 3		
		Area (ha)	Yield (t/ha)	Production (t)	Area (ha)	Yield (t/ha)	Production (t)	Area (ha)	Yield (t/ha)	Production (t)	Area (ha)	Yield (t/ha)	Production (t)
West	Paddy (T.P-L.V)	534	1.0	534	520	1.2	624	380	1.2	456	300	1.2	360
	Paddy (B.C-L.V)	420	1.0	420	-	-	-	-	-	-	-	-	-
	Paddy (T.P-H.Y.V)	-	-	-	360	4.2	1,512	440	4.2	1,848	520	4.2	2,184
	Soybean	44*1	1.2	52	60	1.8	108	120	1.8	216	320	1.8	576
Middle	Paddy (T.P-L.V)	2,710	1.0	2,710	1,560	1.2	1,872	1,200	1.2	1,440	950	1.2	1,140
	Paddy (T.P-H.Y.V)	-	-	-	1,080	4.2	4,536	1,400	4.2	5,880	1,600	4.2	6,720
	Soybean	-	-	-	180	1.8	324	380	1.8	684	1,020	1.8	1,836
East		-	-	-	410	1.2	492	310	1.2	372	260	1.2	312
	Paddy (T.P-L.V)	1,357	1.0	1,357	410*2	2.5	1,025	310*2	2.5	775	260*2	2.5	650
	Paddy (T.P-L.I.V)	-	-	-	290	3.4	986	380	3.4	1,292	450	3.4	1,530
	Paddy (T.P-H.Y.V)	-	-	-	250	4.2	1,050	340	4.2	1,428	360	4.2	1,512
	Soybean	-	-	-	80	1.8	144	160	1.8	288	480	1.8	864
	Fruit trees	-	-	-	20	15.6	312	40	15.6	624	80	15.6	1,248
Total		-	-	-	2,490	1.2	2,980	1,890	1.2	2,260	1,510	1.2	1,810
	Paddy (T.P-L.V)	4,601	1.0	4,601	410*2	2.5	1,020	310*2	2.5	770	260*2	2.5	650
	Paddy (B.C-L.V)	420	1.0	420	-	-	-	-	-	-	-	-	-
	Paddy (T.P-L.I.V)	-	-	-	290	3.4	980	380	3.4	1,290	450	3.4	1,530
	Paddy (T.P-H.Y.V)	-	-	-	1,690	4.2	7,090	2,180	4.2	9,150	2,380	4.2	9,990
	Soybean	44	1.2	52	320	1.8	570	660	1.8	1,180	1,820	1.8	3,270
	Fruit trees	-	-	-	20	15.6	310	40	15.6	620	80	15.6	1,240
Cultivated Area (ha)			5,065			4,900			4,800			4,700	
Cropped Area (ha)			5,065			5,220			5,460			6,500	
Cropping Intensity			100			107			114			138	

*1 Mungbean *2 be effective by drainage

2) Paddy marketing

Although the domestic paddy market in Thailand is almost free, it is clearly remarkable that there is no specification or grade for paddy sold by farmers. While paddy were directly marketed to paddy buyers in Bangkok through local middlemen and then brought into rice mills, most of farmers' paddy are presently purchased and milled by local middlemen and local rice mills and then transported to Bangkok rice buyers.

Since there exists no agricultural cooperative in the Study areas, farmers are used to market their paddy through not an agricultural cooperative but local merchants. According to the report prepared by Chiang Mai University in 1979, marketing channel of paddy are summarized as follows;

1. Local merchant within same village:	21%
2. Local merchant outside village but: within same Amphoe:	38%
3. Local merchant outside Amphoe:	25%
4. Agr. Coop., Land Owner, Others:	12%

3) Paddy/rice storage and rice mill

In Changwat Sukhothai, there are 32 paddy/rice warehouses with total capacity of 16,000 tons under the Sukhothai Agricultural Cooperative Federation, of which 16 are owned by the agricultural cooperatives, 12 by the land settlement cooperatives and 4 by the federation's rice mill. In addition, there are three paddy warehouses owned by the three agricultural cooperatives in Amphoes Sawan Khalok, Si Samrong and Ban Don Lan Hoi, of which structure is of concrete floor, one-story and wooden frame, having average capacity from 300 to 500 tons.

The Sukhothai Agricultural Cooperative Federation has a rice mill with daily capacity of 42 - 45 tons, of which processing plant was introduced from West Germany about 15 years ago. According to 1987 report, total operating hour was 2,305 for 202 day's operation, and total paddy processed was about 5 million tons (24.6 tons per day).

Adjacent to the Study areas, there are three rice mills with daily capacity from 15 - 40 tons in Amphoe Muang Sukhothai which are privately owned and operated. In addition, respective village has small rice mill with daily capacity between 2 - 6 tons, in which farmers ask to mill paddy for their home consumption.

4) Paddy price fluctuation

Generally, wet season paddy is harvested from November to next January in accordance with its maturity. According to 1976 data in the Lower North Thailand, it took about 26 days from harvesting to threshing, and whole marketable paddy was sold within one month period. Therefore, farmers are forced to sell their paddy at lower price.

3.3.5 Supporting Services and Farmers' Organization

(1) Agricultural Cooperative

In Changwat Sukhothai, there are 16 agricultural cooperatives of which an ordinary agricultural cooperative accounts for 10, a water use cooperative does 4, a land reform and a pig holder ones do 1, respectively. Out of 16 cooperatives, 6 are located in Amphoe Sawan Khalok, 3 each in Amphoe Si Samrong and Amphoe Si Satchanalai and one each in other Amphoes. Besides these, there are 6 land settlement cooperatives which are under Department of Cooperative Promotion.

Main activity of these agricultural cooperatives is crediting, followed by purchasing farm input and daily necessities only a little. Only one agricultural cooperative is handling paddy collection from farmers.

All these agricultural cooperatives are located in the central part of the respective Amphoe, far from the Study areas, therefore, no farmers in the Study area does participate in any agricultural cooperatives.

(2) Farmers association

The Farmers' Association of Thailand (FAT) has been established as a section of Department of Agricultural Extension (DOAE), of which main objective is to organize every farmers into a farmers group and/or small size production group and to perform the following items;

- Promotion of farming improvement and technical guidance
- Crediting
- Supply of farming input
- Collection and marketing of farm products

In Changwat Sukhothai, there are 57 farmers' group, 315 farmer housewife groups and 121 young farmer groups, of which number of membership is 3,842, 5,119 and 2,803, respectively. Generally, activity of these groups is not satisfactorily performed.

In the Study areas, there is no registered farmers' group, but in Thung Sai Yart, three groups for paddy farming, a fruit producer group and a beef cattle breeding group are now under preparation as an optional group.

(3) Agricultural extension services

The Department of Agricultural Extension has 10 divisions in the central office, 6 regional offices and 73 Changwat offices and 725 Amphoe offices, under which there are 5,631 Tambol level extension workers.

In Changwat Sukhothai, there are 117 DOAE officers of which 72 are extension workers, consisting of one Changwat office and 9 Amphoe offices. Though one extension worker is principally being assigned to one Tambol, it can be seen that one extension worker should cover two Tambols.

In Amphoes Muang Sukhothai and Khong Krailat, one extension worker should averagely cover the followings;

Average Coverage by One Extension Worker

Coverage	Muang Sukhothai	Khong Krailat
1. No. of village	7 - 8	15 - 16
2. No. of household	1,571	2,018
3. Farm land (rai)	28,471	33,070

As such, since the coverages by one extension worker is too big and vast, desirable extension services are not presently expectable. One contract farmer for every ten farmers is appointed, who is responsible for delivering guidance and message of the extension worker.

(4) Agricultural crediting system

In Thailand, sources of agricultural credit are composed of public sector as well as private one. While the private sector including local merchants, products collectors and so on occupies rather big share in the credit system, BAAC of the public sector plays also very important role. BAAC is lending not only directly to farmers but also through agricultural cooperatives and agricultural groups.

According to BAAC Sukhothai branch office, farmers who receive services from BAAC are 24,652 as an individual client and 18,637 households and 2,253 households as a membership of agricultural cooperatives and agricultural groups, respectively. The rate of client farmers against total number of farmers in Changwat Sukhothai is 46.7 % which is a little lower than the national average of 50.2 %.

According to the extension worker who is responsible for Tambol Ban Mai Suk Kasem, situation of farmers' borrowing from different sources is as follows;

Credit Source	Farmers	
	Number	Percent
Local Merchant	246	30 %
Relatives	263	32
BAAC	189	23
Agri. Coop.	82	10
Local Bank	41	5
Total	821	100

While interest rate of local merchant is very high as 2 % per month (24 % per year) compared to 12.5 % per year available in BAAC, other conditions applied by the former such as guarantee and collateral are softer with quicker transaction. Generally, there is no difference in the credit conditions between BAAC and agricultural cooperatives, farmers prefer credit from BAAC due to shorter evaluation period by three days more than agricultural cooperatives. It is needless to say that farmers can not obtain their credit at the same time from both BAAC and agricultural cooperatives.

The credit conditions available in BAAC are summarized in the following;

Term and Purpose	Interest (%/year)	Loan Period (year)	Collateral
Short-term - for production - other agri. purposes	12.5	1 - 1.5	1 group guarantee 2 bank deposit 3 land mortgage
Medium-term - agricultural working assets	12.5	3 - 5	same as above
Long-term - fixed assets	11.5	15 - 20	1 gove't bond 2 land mortgage 3 two personal guarantee

3.4 Water Resource and Hydrology

3.4.1 Surface Water

Run-off simulation models were made, on the basis of the observed discharge data at Y.26 and basin rainfall to assume the run-off characteristic of both areas, because there is no observation station.

Nong Khon Kaen

There are Noi and Ban Mai canals. Catchment area of the two canals is 100.1 Km^2 and has very flat topography with paddy field. Daily run-off from 1968 to 1987 was simulated based on the model. The result shows that annual run-off is from 5 to 33 MCM, average is 14 MCM and amount from July to October in wet season is 10 MCM, 71 % of annual run-off. Surface water is hardly expected in dry season.

Thung Sai Yart

Four canals flow in this area, scale of which is small with width of around 10 m and depth of 1.0 to 2.0 m. Run-off is variable depending on basin rainfall and it hardly appears in dry season. Catchment area is 423.6 Km^2, which has uniform topography with gentle slope except mountain area in upper part. According to the run-off analysis, annual run-off is 20 to 88 MCM, averaging 41 MCM.

There is Ramphan canal located at 5 to 10 km south outside the study area, which has stable amount of run-off, compared with the above four canals. Although its canal may be useful as a new water resources, some weirs and reservoirs have already been constructed along the canal to use run-off inside the basin. Therefore the Ramphan canal could not be a permanent water resource for the study area, without coordination among those agencies concerned.

In upper basin, fishery ponds and irrigation/drainage canals have been constructed to utilized run-off. After construction of these facilities, amount of run-off is liable to be decreasing at the beginning of rainy season.

3.4.2 Groundwater

(1) Present condition of groundwater use

Groundwater is used for irrigation and domestic water in Nong Khon Kaen and for only domestic water in Thung Sai Yart.

Present condition of the existing wells are as follows;

Area	Type of well	Nos. of well	Remarks
Nong Khon Kaen	Borehole(Deep well)	2	-Domestic use only -Depth; app.70 m -Handpump, Submersible pump with tank and service pipe
	Jet well(Shallow well)	169	-Irrigation and domestic use -Depth; 16-30 m -Suction pump
Thung Sai Yart	Borehole(Deep well)	11	-Domestic use only -Depth; 24-131 m -Handpump
	Dug well(Shallow well)	32	-Domestic use only -Depth; 3-18 m -Well bucket, small electric pump

(2) Water level, discharge and water quality

Nong Khon Kaen

Water levels in the shallow wells fluctuate, showing the lowest in around May and highest in around September or October. Water levels measured in May, 1989 were from 9.97 m to 13.32 m below the ground surface and from 8.52 m to 12.21 m in September, 1989. Water levels in the northern parts are higher than in the southern parts.

Pumping discharge for irrigation from one shallow well is generally from 300 to 400 m^3/day and total discharge from all shallow wells within the study area is inferred approximate 6 MCM per year. On the other hand, amount of recharge is assumed at around 3 MCM. Water levels, therefore, is decreasing recently. As a result of this, improvement of shallow wells is being carried out by farmers to remove their pumping position as water level decreases.

There are no clear differences among water quality in shallow and deep wells. But, turbidity and iron are considerably over the water quality criterion for drinking water in Thailand. But it is possible to treat them for drinking water. There may be no problem for irrigation use.

Thung Sai Yart area

Water levels in shallow wells are measured from 2 m to 6 m below the ground surface and those in deep wells are from 11 m to 16 m. As a result of water quality test, turbidity and iron are exceeding the criterion. But it is possible to treat them for drinking water as same as the case in Nong Khon Kaen.

Concerning the availability for irrigation water, groundwater may not be suitable for irrigation use, according to the value of Sodium Adsorption Ratio(SAR). It is better to check them again, if they would be used, because a few water samples from shallow wells have unsuitable water quality due to high value of SAR for irrigation water.

(3) Result of pumping test

Result of pumping test in the wells drilled are as follows;

RESULTS OF PUMPING TEST

	Nong Khon Kaen (JT-1)	Thung Sai Yart (JT-2)	Thung Sai Yart (JT-3)
Maximum discharge(m^3/hr)	86.00 *	10.50	50.00
Static water level (m)	9.96	13.40	12.34
Dynamic water level (m)	17.54	29.28	32.34
Draw down (m)	7.58	15.88	20.00
Specific capacity(m^3/hr/m)	11.35	0.661	2.50
Transmissivity (m^2/min)	$3.0\text{-}8.0\times10^{-1}$	$3.3\text{-}7.5\times10^{-2}$	$8.5\text{-}10.1\times10^{-2}$
Storability	$1.2\text{-}4.4\times10^{-3}$	$2.9\text{-}6.6\times10^{-4}$	$1.0\text{-}1.4\times10^{-3}$

Note: * Maximum capacity of pump utilized in the test.
Detailed are shown in Appendix B-2.

3.4.3 Flood/Inundation and Swamp

Nong Khon Kaen

Low-lying cultivated land of 35 % of whole area is subject to flood/inundation. In west low-lying land, inundation takes place due to concentrical inflow of excess water from upstream field and insufficient drainage capacity for withstanding its condition. In east low-lying land, insufficient capacity of Ban Mai canal and backwater from Yom River obstructs appropriate drainage for growing of paddy. Severity is assumed that average inundation depth is from 0.4 to 0.6 m for a duration of about one month, depending on downstream condition. Remaining area is not subject to any significant flooding.

In Ban Mai canal, dredging of 3 km downstream of the study area is planning by RID with completion year of 1990.

Two swamps are located in the area, which are contributive as a supplemental water resource facility. Average depth is ranging from 0.5 to 1.0 m and capacity is assumed at 0.02 to 0.03 MCM.

Thung Sai Yart

Agricultural land adjacent to the secondary road route 1113 is liable to severe flooding. As a result of interviews to farmers, it is

assumed that 23 % of the whole area is subject to flooding/inundation and its average depth is from 0.6 to 0.8 m for a duration of 7 days. And, it was also reported that most of the farm land had not experienced severe flooding, before construction of neighboring secondary road.

There are many pipe culverts and bridges under the road. Total capacity of these facilities is estimated at around 74 m^3/s. And, drainage capacity of four canals is assumed at around 41 m^3/s, based on the cross sections and canal slopes. On the other hand, run-off analysis shows that peak discharge is around 162 m^3/s. Therefore, improvement of existing drainage facilities shall be required to catch up with peak drainage discharge.

3.5 Agricultural Infrastructure

3.5.1 Irrigation and Drainage Condition

Nong Khon Kaen

Cultivation of wet season paddy takes place by using uncertain rainfall, run-off and shallow wells and storage water is lifted from canals, swamps and small ponds with small portable pump. Withdrawal from shallow wells for dry season paddy is utilized as dry season progresses.

Area is provided with no systematic irrigation system and plot-to-plot irrigation is applied. Existing canals are used as a dual-purpose canal. Systematic canal network for both of pumped and surface water shall be required.

Thung Sai Yart

Almost agricultural land is in rain-fed field and plot-to-plot irrigation is practiced in all land. In the limited paddy field, supplemental water is lifted directly from neighboring canals, bollow pits and ponds by portable pumps. And, lack of canal system often causes inundation in wet season.

3.5.2 Irrigation and Drainage Facility

There are canals, ponds, swamps and culverts, as a dual-purpose facilities with both functions of irrigation and drainage. Whole facilities have irregular cross-section and meandering alignment due to sedimentation and small dikes across in the canals. They shall be improved so as to utilize surface water. In those facilities in Nong Khon Kaen, the pond constructed by DLD is not useful at present due to no significant catchment area and lack of collecting channels.

3.5.3 Farm Road

Nong Khon Kaen

This area is serviced by three main roads run from north to south and seven sub-roads. Main roads are connected to the route 12 and have laterite coverage with width of 4.0 m. Condition of sub-roads are poor due to narrow track and no connection with any main roads. Road density is estimated at 13.3 m/ha.

Thung Sai Yart

Present farm road network is consisted of two main roads and five sub-roads. One of main roads has laterite coverage with width of 6.0 m, but, remainder are poor with no pavement. At present, some improvement works are being implemented by ALRO. After implementation, road density will be only 6.2 m/ha.

New construction of road network shall be further required to realize more effective farming activities, in both the areas.

3.5.4 On-Farm Facilities

Nong Khan Kaen

Cadastral map shows that the number of farm plots is 532 and a width of allocated plot is mostly in a range of 30 to 200 m in short side and 200 to 600 m in long side and its average size is 12 rai. Farm plots

along the canal are allocated as its short side is close to that canal, in order that all plots possible are accessible to storage water in the canal. One farm plot allocated is divided into some farming fields by boundary ridges, according to actual farming practice by each farmer.

Thung Sai Yart

Cadastral map shows that the number of farm plots is 2,106 and a width is mostly in a range of 30 to 100 m in short side and 200 to 1,000 m in long side and its average size is 15 rai, though some of plots are larger than 25 rai. Condition of on-farm facilities is the same as the Nong Khon Kaen.

Most of plots hardly equipped with inlet and outlet facilities of irrigation/drainage and access road. Those physical constraints has prevented each farmer to improve daily farming practices.

3.6 Rural Infrastructure

3.6.1 Number of Farming Households and Population Served

The number of farming households and population to be served, is based on statistical data of NESDB. It must be noted, however, that residents of Lan Du in Thung Sai Yart area and four villages, excluding Na Taew in Nong Khon Kaen area live in and outside the study areas. Residents in Lam Thong of Thung Sai Yart also live outside the area. In addition, existence of five isolated villages have been confirmed during the study. Therefore, rural infrastructure planning is limited to villagers residing in the area. But, village along the northern boundary in Thung Sai Yart have been excluded from the planning, since their administrative body lies outside the area. Number of households and population confirmed in the study are 284 households and 1,528 population in Nong Khon Kaen and 609 and 2,936, respectively, in Thung Sai Yart.

3.6.2 Village Water Supply

(1) Nong Khon Kaen

Piped water supply system with deep well has been provided by PWA for 172 households in the two villages. Expansion of service area by this system is, however, difficult, considering the limited supply capacity under the forced condition in staggering water supply hours.

In the other villages, rain jars are used to store rainfall for domestic use. But, it is liable to lack in water at the end of dry season.

(2) Thung Sai Yart

Water supply facilities are eleven deep wells and thirty two shallow wells with hundpump or bucket, which have been constructed by villagers or ALRO. Service area is, however, limited in the neighboring of the wells along the existing canals and the number is too small to cover the whole area.

Remainder is dependent on rain water stored in jars. Surface water stored in the canals and pond is also used for domestic use. But, it is unstable due to uncertain rainfall pattern.

3.6.3 Rural Electrification

In Thailand, rural electrification is promoted by local PEA upon request from farmers.

(1) Nong Khon Kaen

There are 22-KV power lines along the route 12 and three main roads in the area. Low-voltage power lines are located in virtually all parts of the villages, and electrification is possible quickly if villagers so request. However, the current electrification rates is from 48 % to 70 %, compared to 90 % in two progressive villages. Difference among villages is distinctively large.

(2) Thung Sai Yart

In order to electrify the two villages of Wang Thon Daeng and Sam Nak, a 22-KV power line has been constructed along road No. 1113 and main road in the southern section toward Sam Nak. However, installation of low-voltage lines has not progressed, and electrification in the two villages averages roughly 30 %.

Moreover, extension works of the 22-KV power line are under way. According to PEA, the rate after completion of the works will rise to 50 %.

Other villages are not electrified at all.

3.6.4 Communication and Transportation

Communication facility in the area is the telephone installed at the Tambol Office in Nong Khon Kaen. There are non in Thung Sai Yart. Also, a post office is located at Amphoe Office. Postal pick-up delivery is not provided to each household, and postal matter for villagers is processed through the village chief's house where a mailbox is located.

Road No. 12 leading to the cities of Sukhothai and Phitsanulok is a paved asphalt road and is 10 m wide. At present, bridge expansion work is in progress to meet with increasing traffic capacity.

Road No. 1113 is linked to Road No. 12 and hence to Sukhothai, which is 9 m wide and covered only with laterite, but asphalt paving is currently in progress.

3.6.5 Social Infrastructure

(1) Rural health

One health center providing regional medical care, promotion of hygiene and health care counseling is located in Nong Khon Kaen, and two similar centers in Thung Sai Yart. The health centers are equipped with medical equipment, facilities, and staff based on national standards on their respective service areas and target populations. For serious

ailments, local residents are sent to urban hospitals with more extensive medical facilities.

Installation of any communication facilities for emergency is desired.

(2) Public sanitation

Improvement activities for sanitation are conducted by health centers. Foul water, however, is drained into canal on fields. There are 60 and 518 households in Nong Khon kaen and Thung Sai Yart, respectively, which have no lavatory or simplified toilet with storage tank. Waste of excrements will result in a change and worse of the living environment.

(3) Education

Schools inside the area are only elementary schools, and higher institutions such as junior high and high schools are located in urban areas. There is one elementary school in Nong Khon Kaen and five in Thong Sai Yart. There are a total of 52 classes, and the school zones meet national requirements such as commuting time of within 45 minutes for most students.

(4) Rural community

Villagers' meetings are held in the temples, but demand for facilities exclusively for meetings will be on the rise as community activities vitalize. Also, facility for public information activities is lacking.

CHAPTER 4 THE PROJECT

CHAPTER 4 THE PROJECT

4.1 Development Concept

4.1.1 Development Objective

The main objective of the study is not only to conduct a feasibility study on integrated rural development in the Nong Khon Kaen and Thung Sai Yart areas, but also to be a model for development method to other land reform areas, especially to those in the lower north Thailand which have generally similar condition with the study areas.

The specific feature of the land reform area is that systematic agricultural and rural infrastructures have not been sufficiently provided, because farmers have settled in the public land or forest without legal support, and commenced farming by reclaiming the land by themselves. Therefore, the agricultural productivity is rather low and the living environment is inferior. When developing land reform areas, the development plan should be established within the demarcation of area taking into consideration external effect of the project plan to outside the area. In the land reform activity, ALRO is responsible for (a)to allocate land to farmers, (b)development and provision of agricultural and living infrastructure, and (c)creation and increase of farmers' income.

Under such circumstances, the basic objective of developing the study areas is established as follows:

(a)to increase farmers' income and to reduce their regional differential

(b)to fulfill basic minimum needs

4.1.2 Application of Development Level to the Study

In order to attain the said development objectives in the study areas, the study works has been carried out on the basis of work flow as shown in Figure 4-1. Since definition of the ALRO's development level mentioned in Clause 1.2 of Chapter 1 is not so clear, the following concept to apply the level to land reform areas has been adopted under this study.

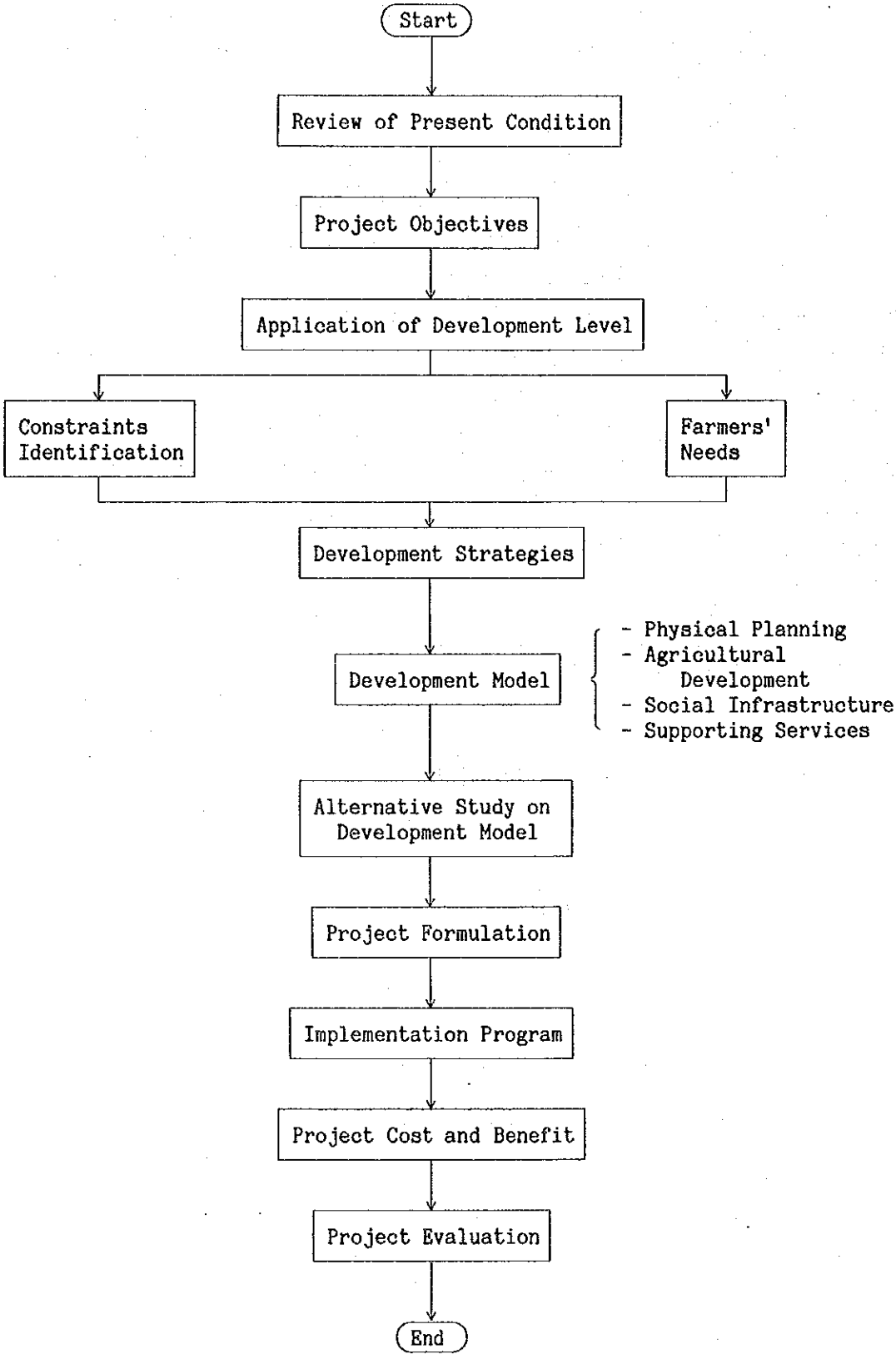


Figure 4-1 STUDY METHOD OF F/S FOR SUKHOTHAI I.A.R.I.D. PROJECT

Level	ALRO's Basic Concept	Application under Study
1	Provision of basic agricultural infrastructure so as to meet with farmers' subsistence level	Area which has limited water resources for agricultural production and is not blessed with market condition
2	Provision of water supply and marketing facilities which aims to increase farmers' income and to improve living conditions	Area which has possibility to develop water resources and is blessed with marketing condition
3	In addition to the Level-2, more improvement for condition of agricultural production and living with land consolidation	From both natural and social conditions, area which has high development potential

And Table 4-1 shows general relation between the development level and development items of infrastructure.

4.1.3 Development Constraints

Development constraints against the appointed development level are summarized by four major planning aspects as follows:

Physical Planning

(1)Since several north-south roads in Nong Khon Kaen and east-west ones in Thung Sai Yart are provided with lower density, and roads across the existing roads have not been developed, (a)it requires longer time for farmers' going to and back from farm plot, (b)it does more labor power and time for transporting farm products from farm plot to marketing point, and (c)access of medium-size farm tractor is rather difficult.

(2)In Thung Sai Yart, it requires more water for paddy cultivation due to not enough leveling in one farm plot.

Table 4-1 Development Model and Infrastructure to be Improved

Items	Infrastructure Facilities to be improved		
	Level-1	Level-2	Level-3
Agricultural Infrastructure			
- Water resources	Weir, Dredging of swamp, Storage pond,	Shallow well, Deep well,	Reservour, Pumping station
- Road	Extention of road density, pavement		
- Irrigation/drainage	Improvement of the existing canal,	New construction of canal, Sluice gate, Pumping station, Dike	
- Soil conservation	Catch drain, Vegetation,	Weir/Dam , Land leveling	
- Land consolidation	Land distribution		Plot reallocation, Land leveling
- Warehouse		Agricultural warehuose, Material storehouse, Processing facility	
Living environment			
- House	Settlement, Supply of residential material		
- Rural water supply	Supply of rainjar,	Cooperative use facility (well, pond), Piped water supply system	
- Electrification	Power line, Connection line with meter		
- Marketing facility		Procurement of daily use shop and marketing place	
Public sanitation			
- Health center	Construction of center, Supply of necessary facilities/equipment		
- Sanitation facility		Supply of toilet material,	Treatment facility
Education, Culture			
- Meeting facility		Meeting, Training, Propagation facility	
- School	School, Education facility		
- Library, Culture facility		Park, Playground,	Recreation facility

Note ; Facility to be improved is basically based on the Table, depending on the characteristics of development area.

Agricultural Development

(1)In the areas to be flooded or inundated in the later part of wet season, farmers are forced to grow photosensitive paddy (L.V.) with longer maturity period, and transplanting time lies on the beginning of wet season with unstable rainfall pattern, and hence the paddy yield depend upon amount of rainfall at the period.

(2)Usually, height of seedlings in nursery bed becomes too high beyond proper length for transplanting because of unreadiness in the paddy field, and then top of them are cut, resulted in lower yield. On the other hand, No water management is practiced, coping with proper timing of watering/drainage for plant growing stage, due to keeping rainfall in the field as long as possible.

(3)The required longer time for harvesting works unable to utilize residual moisture in the field, and soil becomes too hard to be plowed by hand tractors.

(4)In Nong Khon Kaen, groundwater table has been lower every year due to overpumping by the existing shallow wells. In this connection, the bigger suction level causes the more requirement of fuel and finally it would be fare that the existing shallow well could not function.

Social Infrastructure

(1)According to water quality test of the test wells, groundwater in both areas has some problems for drinking purpose, and hence it is necessary to provide a water treatment facility in village water supply plan which is based on the groundwater.

(2)In some part of Nong Khon Kaen and the greater part of Thung Sai Yart, rural electrification as one of basic minimum needs are hardly provided.

Supporting Services

(1)Farmers should rely on local merchant, resulted in less bargaining power for selling their products, due to lack of post-harvest facility and unavailability of free access to market in terms of control under financial support by local merchant.

(2)Usually, farmers rely on private sources of crediting in spite of higher interest rate than institutional one which sometimes lose timing for crediting.

(3)Since farming is, basically, practiced independently and/or individually, farmers have less bargaining power to buy farm input, and agricultural extension activities are extensively carried out to individual farmers due to lack of the extension staff.

The results of farmers' enquete survey has been described in para. 3.2.2 of Chapter 3 of this report.

4.1.4 Development Strategy and Model

(1) Development strategy

In order to attain the above development objectives, the following strategies are fully considered and then basic project plans have been formulated, with consideration of the development constraints as mentioned above.

(a)To stabilize paddy production in wet season and improvement of its profitability;

- Provision of supplemental irrigation water, especially in the beginning of wet season
- Mitigation of flood/inundation in the later part of wet season
- Reduction of crop production cost and strengthening of marketability

(b)To increase efficiency in land and water utilization;

- Positive utilization of residual moisture and surplus surface water at the later part of wet season
- Introduction of shorter maturity variety of crops

(c)To secure farmers' income in dry season;

- Acquisition of cultivable area and irrigation water during dry season
- Introduction and promotion of upland and horticultural crops cultivation

(d)To provide rural infrastructures;

- Supply of stable and good quality of water for drinking
- Provision of road network
- Rural electrification
- Establishment of rural community

(e)To establish and promote farmers' organization;

- Strengthening of agricultural extension services (especially for upland crop cultivation)
- Repletion of agricultural crediting system
- Organizing and promotion of water user group/association, agricultural cooperatives and so on

(2) Development model

Under the said development strategies, the following development components are taken into consideration for the promotion of an integrated agricultural and rural development in the study areas;

(a)Agricultural infrastructure development plan

- water resources development,
- irrigation and drainage facilities,
- farm roads, and - on-farm facilities

(b)Agricultural development plan
- proposed cropping pattern,
- farming plan

(c)Rural infrastructure development plan
- village water supply,
- rural electrification,
- social infrastructure

(d)Supporting services
- post-harvest and marketing facilities,
- training package program

Since the component of rural infrastructure should be dealt as one of basic minimum needs, no alternative development plan has been made. Other three components relate one another closely, and the following three development models have been alternatively examined (See Tables 4-2 and 3).

Model-1: Only basic development to be required to meet with the applied level is planned, in keeping the existing production and living activities. Due to low level of development, the required cost is not so much.

Model-2: Fundamentally the same concept of Model-1 is applied, but higher development level for the component (a) is to be applied and hence that for (b) and (d) would be heightened.

Model-3: Intensified farming shall be introduced by incorporating more number of farmers within the applied development level through more investment cost than Model-2.

Taking ALRO's basic policy and intention of beneficial farmers into consideration, it is judged appropriate to formulate the proposed project on the basis of the Model-2, after comprehensively examining the respective model from technical, social and economical viewpoints.

Table 4-2 Concept of Development Model for Nong Khon Kaen (1/4)

Development Component: Physical Plan

Development Menu	Present Condition	Development Model		
		Model-1	Model-2	Model-3
Dredging existing canal, Construction of weir	L=9.3 km poor capacity sedimentation meandering	L=9.3 km 2 weirs	Same as Model-1	Same as Model-1
Dredging existing swamps	2 swamps & 1 pomd Total capacity=0.19 MCM Sedimentation	Dredging of 2 swamps Total capacity=0.37 MCM	Dredging of 2 swamps Total capacity=0.37 MCM	Dredging of 2 swamps Total capacity=0.44 MCM with pumping station
Construction of farm roads and canals	Road=15.5 km Road desnity=(13.3 m/ha) Low density, partly narrow & no pavement	L=25.4 km (21.8 m/ha) New : 9.8 Km Rehabil.: - Existing: 15.6 Km	L=33.0 km (28.4 m/ha) New : 21.1 Km Rehabil.: 3.8 Km Existing: 8.1 Km	L=45.1 km (38.7 m/ha) New : 33.7 Km Rehabil.: 3.8 Km Existing: 7.6 Km
Construction of sluice gates at terminal point of Ban Mai canal	Nothing	3 sluice gates and dike	Same as Model-1	Same as Model-1
Construction of storage ponds	Nothing	No plan	8 ponds (capacity=0.3 MCM) Some ponds for inland fishery	1 pond (capacity=0.45 MCM) with pumpimg station Some ponds for inland fishery
Construction of irrigation and drainage canals	Nothing	Dual purpose canal L= 9.8 Km	Dual purpose canal L= 31.7 KM	Irrigation: 41.7 Km Draiange: 33.0 Km
Construction of wells	169 shallow wells	Existing shallow wells (Private use)	Existing shallow wells (Private use)	17 deep wells (Cooperative use)
Land levelling and plot re-shaping	Non-systematic plot	No plan	Partial area for new construction of road, canal, pond, etc.	Whole area

Table 4-2 Concept of Development Model for Nong Khon Kaen (2/4)

Development Component: Agricultural Development

Development Menu		Present Condition	Development Model		
			Model-1	Model-2	Model-3
Basic Plan	Drainage Problem		Change paddy variety (L.V. → H.Y.V.)	Same as Model-1	Same as Model-1
	Securing irrigation water (Proper pumping & Surface water development)		Change variety of wet season paddy + Expansion of dry season cropping area/Introduction of diversified crops	Same as Model-1 and Improvement of crop yields	Same as Model-2
Total Area					
Cultivated Area		A : 1,049 ha	A : 1,030 ha	A : 970 ha	A : 970 ha
Others		A : 116 ha	A : 135 ha	A : 195 ha	A : 195 ha
Total		A : 1,165 ha	A : 1,165 ha	A : 1,165 ha	A : 1,165 ha
Wet Season Cropping					
Paddy (L.V.)		A : 469 ha	A : 30 ha	A : -	A : -
Paddy (H.Y.V.)		A : 556 ha	A : 960 ha	A : 900 ha	A : 900 ha
Mungbean		A : 24 ha	A : -	A : -	A : -
Total		A : 1,049 ha	A : 990 ha	A : 900 ha	A : 900 ha
Dry Season Cropping					
Paddy		A : 141 ha*	A : -	A : -	A : -
Soybean		A : -	A : 290 ha	A : 310 ha	A : 810 ha
Vegetables (Leaf+Fruit)		A : 5 ha(Watermelon)	A : 30 ha	A : 90 ha	A : 60 ha
Total		A : 146 ha	A : 320 ha	A : 400 ha	A : 870 ha
Perennial Crops					
Orchard (Fruit trees)		A : -	A : 40 ha	A : 40 ha	A : 70 ha
Total Cropped Area		A : 1,195 ha	A : 1,350 ha	A : 1,340 ha	A : 1,840 ha
Cropping Intensity (%)		114	131	138	190

* On the basis of proper pumping amount by existing shallow wells

Table 4-2 Concept of Development Model for Nong Khon Kaen (3/4)

Development Component: Social Infrastructure

Development Menu	Present Condition	Development Model		
		Model-1	Model-2	Model-3
Domestic water supply	2 villages: with piped water system, Other villages: Rain Jar Shortage of water	Piped water supply system: (Deep well, treatment plant, elevated tank, delivery pipes) For 5 villages, 160 households, 818 persons with total length of pipe: 7,350 m		
Rural electrification	208 households (73% of total household)	Construction for 50 household (after improvement: 91%) High voltage line: 900 m, Transformer: 2 unit, Low voltage line: 1,300 m, Extension line and meter: for 50 households		
Village hall	Temple	1 village hall for multi-purpose use (224 m^2, with rural radio system and wireless telephone)		
Toilet facility	224 households provided	Material supply for 60 households		

Table 4-2 Concept of Development Model for Nong Khon Kaen (4/4)

Development Component: Supporting Services

Development Menu	Present Condition	Development Model		
		Model-1	Model-2	Model-3
Training Package	None	Execution of training program under F.T.S.S. (Farmers Training & Strengthening Station)	Execution of intensified Training program and Establishment of farmers' organization under F.T.S.S.	Same as Model-2
Crop production group	None	Soybean production group Vegetable production group Fruit production group	Same as Model-1	Same as Model-1
Water users' group	None	Not necessary	Only for O & M of facilities by limited beneficiary	O & M of facilities, fair water distribution, collection of water charge
Agricultural Land Reform Cooperative (A.L.R.C.)	None	Not proposed	In the beginning, to form a committee for establishing the cooperative and to assist various farmers' groups	Same as Model-2
Agricultural extension	Extensive services to individual farmer	Same as "Present Condition"	Same as Model-1 plus intensi intensive services through crop production groups	Intensive services through crop production groups
Institutional agricultural credit	Mixed source from instiurional or private	BAAC's direct crediting to individual farmer	Same as Model-1 plus through production groups/A.L.R.C.	BAAC's crediting through production groups/A.L.R.C.
Construction of multi-purpose storages (Capacity: 100 tons and 72 m^2/storage)	None	4 numbers	4 numbers	4 numbers

Table 4-3 Concept of Development Model for Thung Sai Yart (1/4)

Development Component: Physical Plan

Development Menu	Present Condition	Development Model		
		Model-1	Model-2	Model-3
Dredging existing canals	4 main & sub-canals, Total length=58.8 km, poor capacity, meandering	4 canals L=40.4 km	4 canals L=40.4 km	4 canals L=40.4 km
Dredging existing swamps	2 places, Total capacity=1.0 MCM with sedimentation	Dredging of 2 places Total capacity=1.4 MCM	Dredging of 2 places Total capacity=1.4 MCM	Dredging of 2 places Total capacity=1.8 MCM with pumping station
Construction of farm roads	L=33.4 km Road density=(6.2m/ha) Low desnity, partly narrow width & no pavement	L=46.3 km (8.6 m/ha) New : 10.9 Km Rehabil.: 9.3 Km Existing: 26.1 km	L=51.6 km (13.5 m/ha) New : 50.5 Km Rehabil.: 7.2 Km Existing: 15.1 km	Same as Model-2
Construction of drainage facilities under road 1113	33 pipe culverts 2 bridges 1 box culvert	Same as "Present Condition" plus New construction of 2 bridges	Same as "Present Condition" plus New construction of 2 bridges	Same as "Present Condition" plus New construction of 2 bridges
Construction of storage ponds	19 small ponds (capacity=0.17 MCM)	No plan	14 ponds (capacity=2.3 MCM) Some ponds for inland fishery	7 ponds (capacity=6.6 MCM) with pumping station Some ponds for fishery
Construction of irrigation and drainage canals	No canal	Dual purpose canal L=20.2 km	Dual purpose canal L=63.0 km	Irrigation: L=42.9 km Drainage: L=48.2 km
Land levelling and plot re-shaping	Non-systematic plot	No plan	Partial area for new construction of road, canal, pond, etc.	Partial area for new construction of road, canal, pond, etc.

Table 4-3 Concept of Development Model for Thung Sai Yart (2/4)

Development Component: Agricultural Development

Development Menu		Present Condition	Development Model		
			Model-1	Model-2	Model-3
Basic Plan	Drainage Problem		Change paddy variety (L.V. → H.Y.V.)	Same as Model-1	Same as Model-1
	Securing irrigation water (Surface water by pond)		Change variety of wet season paddy + Expansion of dry season cropping area/Introduction of diversified crops	Same as Model-1 and Improvement of crop yields	Same as Model-2
Total Area					
Cultivated Area		A : 5,065 ha	A : 4,900 ha	A : 4,800 ha	A : 4,700 ha
Others		A : 300 ha	A : 465 ha	A : 565 ha	A : 665 ha
Total		A : 5,365 ha	A : 5,365 ha	A : 5,365 ha	A : 5,365 ha
Wet Season Cropping		Rainfed	Rainfed / Irrigated	Rainfed / Irrigated	Rainfed / Irrigated
Paddy (L.V.)		A : 5,021 ha	A : 2,900 ha / 290 ha	A : 2,200 ha / 380 ha	A : 1,770 ha / 450 ha
Paddy (H.Y.V.)		A : -	A : - / 1,690 ha	A : - / 2,180 ha	A : - / 2,380 ha
Mungbean		A : 44 ha	A : - / -	A : - / -	A : - / -
Total		A : 5,965 ha	A : 2,900 ha / 1,980 ha	A : 2,200 ha / 2,560 ha	A : 1,770 ha / 2,830 ha
Dry Season Cropping					
Paddy (H.Y.V.)		A : - -	A : - / -	A : - / -	A : - / -
Soybean		A : - -	A : - / 320 ha	A : - / 660 ha	A : - / 1,820 ha
Total		A : - -	A : - / 320 ha	A : - / 660 ha	A : - / 1,820 ha
Perennial Crop					
Orchard (Fruit trees)		A : -	A : 20 ha	A : 40 ha	A : 80 ha
Total Cropped Area		A : 5,065 ha - (Total 5,065 ha)	A : 2,900 ha 2,220 ha (Total 5,220 ha)	A : 2,200 ha 3,260 ha (Total 5,460 ha)	A : 1,770 ha 4,730 ha (Total 6,500 ha)
Cropping Intensity (%)		100	107	114	138

Table 4-3 Concept of Development Model for Thung Sai Yart (3/4)

Development Component: Social Infrastructure

Development Menu	Present Condition	Development Model		
		Model-1	Model-2	Model-3
Domestic water supply	Private shallow wells Rain jar Water shortage Inferior water quality	Piped water supply system: 4 villages, 496 households and 2,375 persons (Deep wells, treatment facility, elevated tank, delivery pipe with length: 23,320 m Deep wells with handpump: 7 wells, 6 villages and 113 households (Deep well, hand pump)		
Rural electrification	151 households (25% of total household)	Construction for 399 households (after improvement: 90%) (High voltage line: 12,300 m, transformer 25 units, low voltage line: 12,000 m, extension line and meter: for 404 households)		
Meeting rooms	Temple	4 meeting houses for 4 villages (126 m^2, wooden structure with rural radio sysytem and wirelss telephone), out of which shall have function of multi-purpose hall with 176 m^2		
Toilets	91 household provided	Material supply for 518 households		

Table 4-3 Concept of Development Model for Thung Sai Yart (4/4)

Development Component: Supporting Services

Development Menu	Present Condition	Development Model		
		Model-1	Model-2	Model-3
Training Package	None	Execution of training program under F.T.S.S.	Execution of intensified training program and Establishment of farmers' organization under F.T.S.S.	Same as Model-2
Crop production group	None	Soybean production group Fruit production group	Same as Model-1	Same as Model -1
Water users' group (WUG)	None	Not necessary	Only for O & M of proposed facilities by limited beneficiaries	O & M of facilities, fair distribution of water, collection of water charge
Agricultural Land Reform Cooperative	None	Not proposed	In the beginning, to form a committee for establishing the cooperative and to assist various farmers' groups	Same as Model-2
Agricultural extension	Extensive services to	Same as "Present Condition"	intensive services through production groups/W.U.G.	Same as Model-2
Institutional agricultural credit	Mixed source from either institutional or private	BAAC's direct crediting to individual farmer	Same as Model-1 plus through production groups/A.L.R. Cooperative	BAAC's crediting through production groups/A.L.R. Cooperative
Xonstruction of multi-purpose storage (Capacity: 100 tons and 72 m^2/storage)	None	10 numbers	10 numbers	10 mumbers