CHAPTER - 2

GENERAL ECONOMIC AND AGRICULTURAL BACKGROUND

2.1 LAND AND POPULATION

Thailand is located in the tropical monsoon zone occupying the territory of about 514,000 km^2. The natural conditions of Thailand are much favourable for agriculture. About 108 million rai (17.3 million ha) or 34% of total land are used for agricultural purpose. About 73 million rai (11.7 million ha) are used for paddy cultivation. Out of remaining area of 35 million rai (5.6 million ha), 24 million rai (3.8 million ha) are cultivated with upland crops such as cassava, maize sorghum, tobacco, groundnuts, soybeans, mungbeans, sugar cane and vegetables, and 11 million rai (1.8 million ha) are planted with tree crops such as fruits, rubber, coffee and tea.

The Northern Region, in which the project area is located, occupies about 170,000 km^2 or 33% of the entire territory of Thailand. The cultivation area in the region is limited to 23.30 million rai (3.7 million ha) mainly due to its topography and vast natural reserved forests. These lands are mainly cultivated with paddy, soybeans, mungbeans, maize and tobacco.

The total population of Thailand is about 48 million in 1981, which correspond to 93 persons/km^2, whereas the total population of the Northern Region is about 9.5 million; 56 persons/km^2. The average population growth rate is 2.7% in the whole country and 2.4% in the Northern Region during the period of recent 12 years. The low growth rate in the region, as compared with that of whole country, is mainly attributed to out-migration. The proportion of working population in the agricultural sector to total working population is about 70% in the whole country and 80% in the Northern Region.

2.2 NATIONAL AND REGIONAL ECONOMY

Thailand has sustained an aggregate gross domestic product (GDP) growth rate of about 8% during the decade of 1970's in spite of negative impact of the oil crisis. The amount of GDP reached 674 billion Baht (US$29.3 billion) as of 1980, corresponding to the per-capita GDP of 14,350 Baht (US$624). While, the Northern Region shares only 14% of the GDP because of the low aggregate productivity. The per-capita income still remains at 9,400 Baht (US$409).

The GDP originating from agricultural sector grew at the rate of 5.6% per annum through the period of the Third Five Year National Economic and Social Development Plan (1972 - 1976). While, the growth rate of GDP during the period of the Fourth Five Year Development Plan (1977 - 1981) decreased to 3.1% per annum mainly due to the drop in the growth rate of production of crops and fisheries.

Both export and import values in recent years had substantially increased as shown in the following table:

(Unit: 10^6US$)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Export	827	1,076	1,580	2,466	2,377	2,980	3,490	4,085	5,298	6,529
Import	1,282	1,477	2,068	3,143	3,280	3,572	4,617	5,326	7,190	9,249
Balance	-455	-401	-488	-677	-903	-592	-1,127	-1,241	-1,892	-2,720

The export value increased at an annual rate of about 25.8% from 1971 to 1980, while the import value increased at the rate of 24.6% per annum in the same period, resulting in the expansion of inferior balance as shown in the above table.

The export structure of Thailand is characterized by its heavy dependence on the products in the primary sectors such as mining and agricultural sectors. Particularly, such agricultural products as rice and cassava have become the most important export-oriented goods. The share of agricultural products is predominant; 59% of the total export value in 1980. The following table shows the quantities and value of exported rice in the past 10 years.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Quantity (10^3tons)	1,590	2,100	850	1,016	951	1,973	2,946	1,607	2,797	2,800
Value (10^6US$)	143	218	176	481	287	422	656	511	764	956

Meanwhile, import of Thailand has rapidly been increased in recent years. The main import items are petroleum, material goods, capital goods and consumption goods, among which petroleum is predominant occupying about 31% of the total import value.

2.3 AGRICULTURE

Agricultural sector is still mainstay in the Thailand's economy and especially serves for the national economy through self-sufficiency of staple food and employment absorption. Furthermore, this sector makes great contribution to the export performance as mentioned in the preceding section.

Many kinds of crops have recently been diversified from paddy cultivation in Thailand. Among them, highly-ranked ten major crops picked up in terms of annual production value are paddy, fruits, cassava, rubber, maize and sorghum, vegetables, sugar cane, tobacco, groundnuts and soybeans. Among them, paddy remained top-ranked through the period of the Third and Fourth Five Year Development Plans; more than 40% of total added values of the agricultural products. But its share in the GDP has shown the gradual decline year by year, while vegetables, cassava, maize, sorghum and rubber have recently increased in the share.

Some crops among upland crops have recently faced marketing problems originated from unstable foreign market prices. Products of livestock, fisheries and forestry have a great prospect to expand their marketing shares, though these productions still remain low level as compared with domestic demands.

More than 80% of the planted areas are cultivated under the rain-fed conditions. The agricultural production in Thailand is therefore seriously affected by fluctuation of annual rainfall. In 1977 crop year, there occurred severe drought all over the country, resulting in serious drought damages on agricultural products. On the contrary, Thailand was hit by intensive floods and suffered from serious crop damages in 1980. These natural disasters must urgently be diminished by implementing irrigation and drainage works and flood control works.

2.4 AGRICULTURAL SUPPORTING SERVICES

A number of governmental and non-governmental organizations play a major role for improvement of rural life and increase of agricultural productions, through such intensification program as extension work, research, seed multiplication, credit, etc. Among these organizations, the Ministry of Agriculture and Cooperatives is systematically leading the agricultural supporting services for the farmers all over the country. The Community Development Department and the Accelerated Rural Development under the Ministry of Interior also supplementarily provide some of the agricultural support services for the rural population, in order to improve socio-economic condition as well as uplift of the living standard in the extremely backward areas.

The Royal Irrigation Department (RID) of the Ministry of Agriculture and Cooperatives is given responsibilities for planning, developing, operating and managing for most of the national and provincial level irrigation systems. RID was formed in 1904 and since then has constructed not only irrigation systems but also flood control and navigation systems. RID has 22 Divisions and 12 Regional Offices under the Director General with assistance of three Deputy Director Generals and two Chief Engineers.

2.5 NATIONAL DEVELOPMENT PLAN

In 1977 the Government of Thailand launched the Fourth National Economic and Social Development Plan in order to follow the Third Development Plan which had terminated in late 1976. Despite of the rapid strides of the development during the period of Fourth Development Plan, Thailand faced more serious and complex economic problems and social tensions, such as rural poverty, income disparities, deterioration of external financial position and increase of national defense burden. In order to overcome these economic and social problems, new development strategy and approach have been envisaged by the Government. Following the Fourth Development Plan which have created various socio-economic problems and terminated in late 1981, the outlines of the Fifth Development Plan was issued by the National Economic and Social Development Board in late 1981. The Development Plan mainly campaigns the following major objectives:

(1) to reduce absolute poverty and to accelerate rural development in backward areas,

(2) to maintain the economic and financial stability by emphasizing national austerity and expenditure control both in the public and private sectors,

(3) to restructure the production process both in agriculture and industry in order to accelerate the expansion of exports, reduction of imports and creation of additional employments,

(4) to adjust social structure in order to make it more stable, fair and safe and to provide more educational and employment opportunities for the poor, and

(5) to coordinate consistently economic development activities with national security management.

During last two decades under the First through the Fourth Development Plan, Thailand had sustained high economic growth rate with structural changes in production, foreign trade and the pattern of income distribution. The growth rate of the Tahi economy was averaged at greater than 7% per annum. This was mainly attained by the expansion and diversification of production and exports of agricultural and industrial outputs. But the high growth rate caused rapid deteriorations of forest, land, water and marine resources. While, the benefits had not been evenly spread over among various areas and economic sectors, and thus, this growth pattern had brought about a greater income disparity.

In due consideration of the current confronting issues and the economic trends in Thailand to be anticipated in the coming five years, the Government set forth the following development targets to alleviate the problems and to adjust the economic and social structures:

(1) The quality of life of the rural population should highly be developed, particularly in absolute poverty areas by channelling more financial and manpower resources of the Government to these depressed areas and by mobilizing the people's participation in the course of rural development. This target receives the highest priority in the Fifth Development Plan.

(2) The targets to both trade and current account deficits should be set at less than 60 billion Baht and 42 billion Baht respectively on an annual average.

(3) The target of GDP growth rate should be at 6.9% per annum in real term. Special emphasis is placed on the expansion of the agricultural sector at 4.7% to generate more income in rural area. The growth of agricultural sector must mainly be brought about in the backward and depressed areas to improve income distribution.

(4) Import target of oil should be reduced to zero growth.

(5) In order to control the national aggregate spending to an appropriate level, the strict targets of revenue and expenditures should be set forth.

2.6 AGRICULTURAL DEVELOPMENT PLAN

In order to achieve the shorter-run objectives of a rapid economic recovery and a greater degree of economic stability stipulated in the Fifth Development Plan, the following overall target and supporting policy measures were set forth in respect to agricultural sector.

(1) to attain the target of about 7% increase in the GDP, the value in agricultural sector is projected as,

i) overall target: annual increase by 5%

ii) crop production: annual increase by 5.9%

iii) livestock production: annual increase by 4.3%

iv) fisheries production: annual increase by 5.5%

v) forestry production: annual increase by 0.3%

(2) The Government puts more emphasis on the conservation of forest and watershed. The forests and national park, totalling about 65 million rai, should carefully be conserved by proper rehabilitation work. Furthermore, the reafforestation should be implemented at the rate of about 300,000 rai per annum to manage better watershed. Hence, expansion of farmland will be limited over the 5 years. In this connection, the strategy for agricultural development has to emphasize the structural improvement within the sector: production increase through crop intensification and further agricultural diversification will be promoted.

(3) In order to raise productivity of agriculture, the priority is given to the development of irrigation system and expansion of on-farm facilities as well as water resources development. In addition, emphasis is placed on soil improvement and strengthening agricultural support services.

CHAPTER - 3

THE PROJECT AREA

3.1 LOCATION

The four proposed sub-project areas under study scatteringly extend over the Phetchabun Province which is located at about 330 km north from Bangkok, the capital of Thailand, along the National Highway Route-1 and -21. Among them, the Huai Saduang Yai and Huai Khon Kaen irrigation sub-project areas are located at the eastern part of the Lom Sak district; about 45 km north from the Phetchabun municipality, while the Huai Yai and the Khlong Chaliang Lab irrigation sub-project areas are located at about 20 km due east of the Phetchabun municipality, capital of the province (LOCATION MAP).

3.1.1 Lom Sak Area

The Sri Chan service area is located at about 10 km northeast of the Lom Sak municipality and extends over the right bank along the Pasak river from the site of Sri Chan weir to the site of the Upper Pasak diversion weir. It is approximately bounded by the provincial road stretched out of the National Highway Route-203 on the east and the south, and by a natural creek on the north and the west. Administratively, the area comes under Tha Ibun township of the Lom Sak district (FIG. 3.1).

The Pasak Left Bank service area is located at 5 km due east of the Lom Sak municipality and extends over the left bank of the Pasak river. It is approximately bounded by the main stem of the Pasak river on the north and the west, by the existing main irrigation canal on the east and by Huai Bong on the south. All the area is fully covered by the Upper Pasak Left Bank Irrigation Project. It extends for about 14 km from north to south with an average width of 2 km. Administratively, the area comes under three townships of the Lom Sak district, i.e. Sak Long, Tan Diew and Ban Sok.

The Huai Khon Kaen service area is located at about 9 km east of the Lom Sak municipality. It is approximately bounded by the main irrigation canal of the Pasak Left Bank Project on the west and by the Khlong Daeng on the south. The northern and eastern boundaries are skirted with terrace lands extending along foot of eastern hilly ranges. The area extends for about 30 km from north to south and it is 2 km wide on an average. Administratively, the area comes under four townships of the Lom Sak district, i.e. Huai Rai, Ban Tiew, Ban Sok and Pak Chong.

3.1.2 Phetchabun Area

The Huai Yai service area is located at due east of the Phetchabun municipality and slenderly extends for about 15 km from west to east with an average width of about 2 km, astride the district road stretching out from the Phetchabun municipality to Huai Yai village. It is approximately bounded by the Huai Yai on the north, by the Huai Nam Sai on the south and by the Khlong Mai Daeng on the west. The eastern boundary is skirted by the existing paddy field extending close to the foot of eastern hill. Administratively, the area comes under four townships of the Phetchabun district, i.e. Huai Yai, Ban Khok, Dong Moon Leak and Sadiang.

Khlong Chaliang Lab service area is located at southeast of the Phetchabun municipality. In parallel with the Huai Yai area, it slenderly extends for about 10 km from east to west with an average width of 2 km, astride a district road aligned between the Phetchabun municipality and the Chaliang Lab village. It is approximately bounded by Khlong Chaliang Lab on the north, by low terrace land extending on the south and by the Khlong Kung on the west. The eastern boundary is extended to the foot of eastern hill. Administratively, the area comes under Na Pa township of the Phetchabun district.

3.2 NATURAL RESOURCES

3.2.1 Land Resources

About 845,000 rai (135,200 ha) of arable land resources are endowed in both the Lom Sak and the Phetchabun districts. Out of them, about 394,500 rai (63,100 ha) have been developed for paddy and upland crops cultivation. These lands slenderly extend from north to south along the both banks of the Pasak river. The remaining area of 450,500 rai (72,100 ha) of land resources extend in both skirts of hillsides and are scattered on the district boundary. These lands are mainly used for upland crop cultivation because of their soil, topography and irrigation water availability.

Furthermore, about 215,500 rai (34,500 ha) of uncultivable lands extend over both districts. These lands are presently covered with forest and bushes. In recent years some parts of forests and bushes have been illegally reclaimed for shifting cultivation in order to supplement the limited land resources, resulting in serious depletion of water resources in the tributaries of the Pasak river. Further extensive sprawl of reclamation in the watershed of tributaries causes serious water shortage all over the Pasak river valley. In view of water conservation, planless reclamation, particularly in the watershed area, should strictly be prohibited and the more intensive use of existing arable land should firstly be envisaged.

3.2.2 Water Resources

The Pasak river, one of the major tributaries of the Chao Phraya river, originates in high mountain ranges in the Loei and the Phetchabun Provinces, and flows down due southward for about 70 km to join the Phung river; the largest tributaries of the Pasak river. After their confluence in the vicinity of the Lom Sak municipality, the Pasak river takes its course due southward and traverses the vicinity of the Phetchabun, the Lopburi and the Saraburi, and debouches into the Chao Phraya river in the vicinity of the Ayuthaya.

The watershed of the Pasak river extends over about 15,700 km^2 or about 9% of the entire Chao Phraya river basin, at the confluence of the Chao Phraya river. The annual mean runoff recorded at the Kaeng Khoi amounts to about 2,440 million m^3, about 8% of the annual runoff of the entire Chao Phraya river basin. As given in FIG. 3.2, water gauging stations are installed in the main stream of the Pasak river and operated by the Royal Irrigation Department. Furthermore, one water gauging station was installed at Kaen Sida to collect data for hydropower development. These stations provide considerably reliable data on runoff along the main reaches of the Pasak river.

A number of tributaries flow in the main stream of the Pasak river. Eighteen medium scale irrigation projects have been recently reconnoitred by the RID, depending their water resources on the major tributaries among them. Out of them four tributaries, i.e. Huai Saduang Yai, Huai Khon Kaen, Huai Yai and Khlong Chaliang Lab, are picked out to undertake pre-feasibility and feasibility study on the medium scale irrigation development in the Upper Pasak river basin.

Huai Saduang Yai

The Huai Saduang Yai, a small tributary of the Pasak river, originates in the Mt. Phykok, Pnu and Bukpaen of about 700 m or so in altitude, and drifts down for about 30 km from east to west to join the main reach of the Pasak river in the vicinity of the Fund Dorn Village.

The total watershed of this tributary extends over about 96 km^2 at the proposed dam site which is located at about 1.5 km upstream from the confluence of the main stream of the Pasak river. The river channel totals about 28.5 km stretching from its origin to dam site. The river-bed gradient is relatively steep in the vicinity of the proposed dam site. No water gauging station has been installed so far in the watershed, and no data is available on runoff at all.

Huai Khon Kaen

The Huai Khon Kaen, the largest tributary among the four selected water sources, originates in the ranges of Mt. Huai Koh, Huai Hi, Pu Mok, Pu Nam Rin, Pa Lob, etc., 900 m above MSL, located in due east of the Lom Sak. It meanders for about 72 km westward to join the main stream of the Pasak river at the left bank, at about 24 km downstream from the Upper Pasak diversion weir.

The watershed of the tributary is located at due south of the Huai Saduang Yai watershed, extending to about 322 km^2 at the proposed dam site which is proposed at about 19.5 km upstream from its confluence with the Pasak river. The river channel totals about 53 km stretching out from its origin to the proposed dam site. The watershed is relatively better reserved, though sporadic land reclamation has been recently made by farmers for shifting farming in the hillside. No water gauging station has been installed so far in the watershed, and no data is available on runoff at the dam site.

Huai Yai

The Huai Yai originates in the ranges of Mt. Hingumn, Ponthong, Suiroi, Saliang Tatard, etc. of about 1,200 m in altitude and drifts down for about 47 km from northeast to southwest joining many small rivulets, and debouches into the main reach of the Pasak river in the vicinity of the Phetchabun municipality.

The watershed of the tributary is located at due east of the Phetchabun municipality and extends over about 75 km^2 at the dam site which is proposed at about 25 km upstream from the confluence of the Pasak river. The river channel totals about 47 km stretching from its origin to the confluence of the Pasak river. The river-bed gradient is rather steep in the vicinity of the proposed dam site. Water and soils in the watershed are likely to be relatively better reserved.

Khlong Chaliang Lab

The Khlong Chaliang Lab originates in the ranges of Mt. None Yang, Huai Rong, None Sra, Ta Boh, etc. of about 1,300 m in altitude and meanders for about 54 km from southeast to northwest joining many small rivulets and debouches into flat fan. Then, it splits into many distributaries developed across the fan.

The watershed of this tributary is located in due south of the Huai Yai watershed, extending to about 77 km^2 at the dam site which would be proposed at about 28 km upstream from the confluence with the Pasak river. The river channel of about 54 km stretches from its origin to the said confluence, about 26 km from its origin to the proposed dam site. The river-bed gradient is relatively steep in the vicinity of the proposed dam site.

The watersheds of these tributaries are demarcated as presented in FIG. 3.3. The Phetchabun district is a little more pluvious than the Lom Sak district. The mean annual rainfall in the Phetchabun is averaged at about 1,090 mm on the basis of the records from 1964 to 1980; and that in the Lom Sak is about 1,028 mm on the basis of the records from 1964 to 1980. The annual runoffs estimated from 1964 to 1980 are summarized in TABLE 3.1 and averaged as given below. The average runoff coefficient of the Lom Sak and the Phetchabun area is estimated to be 22.2% and 24.4% respectively.

	Watershed	Drainage Area (km^2)	Endowed Mean Annual Runoff (MCM)
i)	Huai Saduang Yai	96	22.4
ii)	Huai Khon Kaen	322	75.1
iii)	Huai Yai	75	19.9
iv)	Khlong Chaliang Lab	77	20.5

These tributaries are almost depleted throughout the dry season. Even during the rainy season, the flows in the tributaries widely fluctuate day by day owing to the consecutive droughts and cloud bursts in their watersheds. Thus, these tributaries do not function as the irrigation water sources for dry season crops at present, but contribute to supplemental irrigation water supply for wet season paddy. There have developed a lot of primitive village irrigation systems along the middle reach of each tributary. But, in order to effectively exploit the endowed water resources in each tributary, the wide-fluctuating riverflow should be completely regulated by constructing storage dam. Diversion type irrigation system seems not effective in the Upper Pasak river system in the light of the existing irrigation systems around the project site.

3.3 PHYSICAL FEATURES

3.3.1 Topography

The Pasak river valley slenderly extends north to south along the Pasak river with an average width of about 45 km. The plain extending over the left bank of the Pasak river is broadly divided into terrace, alluvial fan and recent alluvial flat.

Low terraces are scattered over the elevated area near the eastern hillside and are mainly covered with forests and uplands. Many small scale alluvial fans have been created by the tributaries which originate in the eastern hilly ranges and join the Pasak river. The fan is gently sloping from northeast to southwest with a topographic gradient of nearly 0.4%, and it has been developed mainly for upland cultivation. Its altitude ranges from 200 m to 170 m above MSL.

The recent alluvial flat shaped by fluvial action of the Pasak river slenderly extends along the bank of the Pasak river. The flat is topographically gentle and lowlying, and has been well-developed for paddy field. Its altitude varies from 160 m to 150 m above MSL.

3.3.2 Climate and Meteorology

Thailand belongs to the tropical monsoon zone. The climate in the Upper Pasak river valley is characterized by two distinctive seasons, i.e. wet and dry, according to the distribution of rainfall. The dry season is further subdivided into cool winter and hot summer according to the fluctuation of temperature.

The humid southwest monsoon prevails over the Upper Pasak valley. The wet season starts in May and lasts until October. The dry season commences in the northeast monsoon and lasts until April. The first half of the dry season from November to January is so called cool winter. Both temperature and humidity considerably decline during this period. Whereas, the second half of the dry season from February to April is, so called, hot summer.

The project area is blessed with favourable climatic conditions for the growth of various crops, excepting the uneven annual and seasonal distribution of rainfall. The seasonal trend of temperature in the project area is characterized by its relatively wide variation compared with the central and southern regions of Thailand. The annual maximum mean, minimum mean and mean temperature are 33.2°C, 21.0°C and 27.6°C respectively based on the records from 1951 to 1975 at the Phetchabun meteorological station. The maximum monthly mean temperature of 37.3°C occurs in April and the minimum monthly mean temperature of 14.7°C in January.

The annual mean rainfall is estimated to be 1,059 mm and the annual mean rainy days are averaged to 120 days based on the records from 1964 to 1980. About 90% of the annual rainfall concentrates during the 6 months of wet season. The maximum consecutive drought of 185 days was recorded in Lom Sak in 1967. The consecutive drought frequently hampers a stable agricultural production in the valley.

Annual mean pan evaporation of 1,808 mm is estimated on the basis of the records at the Phetchabun meteorological station by AIT. The maximum monthly mean pan evaporation reads 219 mm in April and the minimum monthly mean of 113 mm in September. About 54% of annual evaporation occurs in the dry season.

3.3.3 Geology

The project area is geologically situated in the eastern wing of tectonic basin, namely the Upper Pasak valley which extends in N-S direction with width of about 20 km. The Upper Pasak valley is a tectonic downwarp formed in the Paleozoic sedimentary rocks and has been filled since Tertiary by terrestrial deposits derived from the uplifted mountain ranges which bound to the valley with N-S trending marginal faults in the east and west.

The proposed four dam sites are wholly located in the foothills of the eastern mountain range, at which the tributaries of Pasak river emerge from mountainous steep ravines to the low rolling hilly land, dissecting the Paleozoic sedimentary rocks with formation of shallow valleys with wide flood plain and meandering river channels. The proposed canals are so aligned as to pass the diluvial gentle undulating land spread over the eastern part of Pasak valley.

As illustrated in the geological map (FIG. 3.4) and the stratigraphical table (TABLE 3.2), the project area is underlain by sedimentary rocks of Permian, Triassic and Tertiary and covered with the Pleistocene and Recent fluviatile deposits. The sedimentary rocks form a wide zonal structure extending in N-S direction and are mutually in unconformable relationship.

In the eastern mountainous range and the foothills, where the drainage basins, reservoirs and dam sites of proposed four dams are wholly located, Nam Duk Formation of Middle Permian extends in N-S direction forming a 20 - 30 km wide strip. The Nam Duk Formation is composed of primarily alternating beds of shale and sandstone folded along N-S trending axis. The Khorat Formation of Triassic distributes intermittently along synclinal axis forming higher mountain peaks. Intrusion of igneous rock (granite, diorite and gabbroic diorite) in the form of small stock is found within Permian formation.

In the western mountainous range of the valley, limestone of Pha Nok Formation of Lower-Middle Permian extends also in N-S direction with width of 500 - 700 m. This limestone is the most important source of riprap material and aggregates in the valley.

In the Pasak valley the Tertiary system limitedly distributes at about 1 km downstream of the Khlong Chaliang Lab dam site, and appears to be widely plunged beneath the Quaternary deposits. The Quaternary deposits consist of terrace deposits which widely spreads over the eastern part of the valley underlying the proposed canal routes and irrigation areas, and of alluvial deposits along the meandering belts of Pasak river and its tributaries.

3.3.4 Soils and Land Capability

1) Soils

The Upper Pasak study area of about 750 km^2 is located in the Upper part of the basin, mainly extending on the left bank of the Pasak river. From Physiographic viewpoint, the lands extending in the study area are classified into five categories, as given below, accompanying the respective covering areas:

	Land Category	Area (Rai)	Percentage (%)
1)	Flat alluvial plain of recent alluvium	150,500	32.2
2)	Low terraces and fans of semi-recent alluvium	71,120	15.2
3)	Low terraces of old alluvium	5,380	1.1
4)	High terraces of old alluvium	210,380	45.0
5)	Dissected erosion surfaces and hills	30,120	6.5
	Total	467,500	100

The major soils covering the Upper Pasak area are those on 1) flat alluvial plains and 2) low alluvial terraces and fans. These occupy about 47% of the total area. The soil developed on 4) high terraces and 5) dissected erosion surfaces and hills are not irrigable due to their steep topography and feature of sandy and/or gravelly shallow soil depth and low inherent fertility. The soils on 3) old low terraces are marginal for irrigated agriculture.

The soil distributing in the flat alluvial and semi-recent low terraces are identified into many soil series by the Land Development Department, the Ministry of Agriculture and Cooperatives. The major soils in this area are classified into seven soil series which are significant for agricultural use as given below, accompanying the respective covering areas.

		Area	
		(Rai)	(ha)
1)	Lom Sak	60,820	(9,730)
2)	Chaliang Lab	2,550	(410)
3)	Tha Phon	5,330	(850)
4)	Ban Pod	5,370	(860)
5)	Hang Dong	590	(90)
6)	Nakhon Pathom	23,190	(3,710)
7)	Dong Yang En	2,820	(450)
	Total	100,670	(16,100)

The Lom Sak and Nakhom Pathom series are predominant in this area. The generalized brief votes on both soils series are given below:

- The Lom Sak series are formed from recent riverine alluvium and occur on the lower part of the flat alluvial plains. They are characterized by very deep effective soil depth, clayey texture and relatively high inherent fertility. Soil reaction is medium acid to neutral. Drainage is generally poor either vertically and horizontally, but better in the dry season. This series are classified as Hydromorphic Alluvial Soils (National), Aeric Tropaquepts (USDA), or Eutric Gleysols (FAO/UNESCO).
- The Nakhon Pathom series are formed from semi-recent riverine alluvium and found on low terraces. The relief is flat to nearly flat with abundant micro-relief by termite mounds. They are deep, slightly acid to medium acid surface over neutral to moderately alkaline subsoils, and generally medium to fine textured. The drainage is generally poor, but relatively better in the limited dry season. The series are classified as Hydromorphic Non-Calcic Brown Soils (National), Aeric Tropaquepts (USDA), or Gleyic Luvisols (FAO/UNESCO).

2) Land Capability

According to the classification system developed in the Greater Mae Khlong multi-purpose project in 1968, the lands of about 113,000 rai extending in the relevant service areas are classified as given below, together with the respective covering areas:

(Unit: rai)

Classification	Sri Chan	Pasak Left Bank	Huai Khon Kaen	Huai Yai	Khlong Chaliang Lab	Total
Suitable for paddy (R1)	3,500	22,930	13,850	7,250	5,370	52,900
Less suitable for paddy (R2)	4,030	10,700	-	-	-	14,100
Restrictedly suitable for paddy (R3)	460	4,640	7,870	2,650	2,750	18,370
Less suitable for both paddy and upland crops (U2/R2)	-	2,550	11,670	3,320	840	18,380
Restrictedly suitable for upland crops (U3)	-	1,770	4,410	1,500	280	7,960
Others	-	110	1,160	320	-	1,590
Total	7,990	42,070	38,960	15,040	9,240	113,300

* The classification symbols are explained in ANNEX - III in details.

From the above table, about 103,750 rai excluding class U3 and others would be suitable for either rice or upland crops. These lands are most suitable for double cropping of rice or rice production in the rainy season and upland irrigated crops in the dry season, depending on the availability of irrigation water. The land-use survey shows that these lands suitable for rice production are nearly all in cultivation and used almost exclusively for rice.

3.4 INFRASTRUCTURES

3.4.1 Transportation

Three national highways are networked in the Phetchabun province. The trunkline R-21 extends for about 220 km from Sara Buri to Lom Sak by way of Wichiang Buri and Phetchabun after stretching out of the R-1. The R-203 further extends from Lom Sak and terminates at Loei. The R-12 jointing Phitsanulok with Khon Kaen traverses the Phetchabun province from east to west and comes across the R-21 in the vicinity of Lom Sak as shown in FIG. 3.5.

Many rural roads stretch out from the national highways and are networked in and around the project area. Most of these roads have been constructed by the Accelerated Rural Development Office aiming at the rural development. Some of the rural roads have been constructed by the Mobile Development Unit for the purpose of the security in northern part of the province. The width of the rural roads constructed by ARD varies from about 6 meters to 9 meters, and the width of the roads constructed by the MDU is nearly 6 meters.

Except the National Highway, greater parts of the existing roads are laterite-paved, but these roads are considerably deteriorated due to insufficient maintenance works. After intensive rainfall, some of them are not jeepable. In the limited flood season, tentative boat service supplement the unpassable roads to cross over the Pasak river and its tributaries.

3.4.2 Municipal Water Supply

Each village in and around the project area mainly depends its potable and domestic water resources on groundwater, ephemeral rivulets thereabout and rainfall. During the dry season, the village people get their drinking water from shallow well, since no rainfall is expected and all rivulets are completely depleted. The situation of potable water supply in the village is quite serious during the dry season.

The urban areas of Phetchabun and Lom Sak have installed modernized municipal water supply systems, depending their water resources on main stream of the Pasak river which is rather exhausted during the dry season. The situation of water supply in both urban areas is also quite serious especially during the dry season. To ease the serious situation, the Phetchabun municipality relys its municipal water of about 10,000 m^3 per day during four months of the dry season upon the Huai Pa Daeng reservoir which has been operated since 1977. However, the situation of municipal water supply in the Lom Sak municipality has been deteriorating year by year according as the expansion of urban area. New water resources development for municipal water is therefore indispensable especially for the Lom Sak municipality.

3.4.3 Irrigation and Drainage

The first activity for the irrigation development taken by RID in and around the project area is the construction of irrigation facilities in the Pasak Left Bank Project area with a net irrigation area of 31,460 rai (5,030 ha). The construction was started in 1953 and completed after spending 16 years. Following the completion of this project, RID took up the Huai Pa Daeng Project having dual purposes of irrigation water supply to 13,560 rai (2,170 ha) and municipal water supply of 1.5 MCM per annum. Its construction was initiated in 1969 and completed in 1978. Other major activities of RID in this area are the construction of Wang Bon and Huai Saen Nga diversion weirs. The commanding areas of these weirs are 2,000 rai (320 ha) and 2,500 rai (400 ha) respectively. These weirs were completed in 1979 and 1982 respectively, after spending one year. RID has just started the construction of Sri Chan diversion weir which commands 6,000 rai (960 ha).

In the project area there are many village-level irrigation facilities constructed by farmers themselves, depending their water sources on small tributaries of the Pasak river. Most of these systems serve only for supplementary irrigation in the rainy season. There are also tubewell irrigation systems with hand pumps provided by farmers themselves.

All the facilities constructed by RID, such as dam, diversion weirs and main and lateral canal systems are operated and maintained by RID. The annual budget allotted for these O & M works is about ฿80/rai for this year. Operation and maintenance works of the village-level irrigation systems are done by farmers themselves at their own cost.

In and around the project area, more than 25 water users' groups have been established on the lateral canal bases under the guidance of RID in case of the existing irrigation project and more than 15 water users' groups on the diversion weir bases on the farmers' own initiative in case of the village-level irrigation systems, but the project-base water users' association has not been organized yet in all cases. In the existing project areas, irrigation water is distributed to farms according to the irrigation schedule prepared in consultation with RID. As for the village-level irrigation systems, the irrigation schedule is prepared by farmers themselves.

Except the lower part of the Huai Yai sub-project area, the drainage conditions in the project area are generally good, because many dual-purpose canals (irrigation and drainage) have been networked over the area. The lower part of the Huai Yai sub-project area, for around 2 km inside from the Pasak river, is attacked by floods carried by the natural creek connecting the Pasak river for 2 times a year on an average. The flood usually stays there for about 2 - 3 weeks and its inundation depth is 0.3 - 0.7 m. Along the left bank of the Pasak river, the flood protection dike was constructed for about 2 km from Ban Tah Kok to Ban Tah Kok Pha, but its strength is not strong enough against the flood from the Pasak river and breaches once in several years. Due to this breach, the Pasak Left Bank service area suffers from flooding.

3.5 CURRENT SITUATION OF AGRICULTURE

3.5.1 Population and Family

The total population in the Lom Sak and Phetchabun districts is reported to be about 150,000 persons or 88.8 persons/km^2 and 157,000 persons or 50.8 persons/km^2 respectively in 1981. The average annual population growth rate is about 2.61% in Lom Sak district and about 2.72% in Phetchabun district from 1970 to 1981 respectively.

The following table shows the farm population and number of farm house-hold in the respective service areas, which are estimated on the basis of the data and information collected from Agricultural office at Lom Sak and Phetchabun and villages survey.

Service Area	Farm Population	Farm House-hold	Population per Farm House-hold
Sri Chan Service Area	3,380	610	5.5
Pasak Left Bank Service Area	17,740	3,230	5.5
Huai Khon Kaen Service Area	23,010	3,540	6.5
Huai Yai Service Area	6,110	1,110	5.5
Khlong Chaliang Lab Service Area	4,350	790	5.5
Total or Average	54,590	9,280	5.9

In the project area, the farm population is about 55,000 persons or 80% of the total population. The total number of farm household in the project area is estimated at about 9,300 in 1981. Average family size is estimated to be 5.9 persons, and available farm labor force per farm house-hold is in the range of 2 - 3 persons.

3.5.2 Land Tenure and Land Holding

In Phetchabun province, owner farmer is predominant occupying about 84% of the total households and about 85% of the total area in 1978. In Lom Sak and Phetchabun districts, owner farmers occupy about 91% and 78% of the total farm households and 93% and 77% of the total farmlands in 1978 respectively.

As for the land holding size in Phetchabun province, approximately 76% of farmers are in the range of 6 - 50 rai in 1978, and particularly the range of 15 - 30 rai occupies the highest percentage. About 10% of land holding farmers, however, possess more than 60 rai and occupy about 30% of the total farmlands in 1978. The average farm size is 19.2 rai in Lom Sak district and 25.1 rai in Phetchabun district in 1982.

Most of farmers have their farmlands scatteredly and their plot sizes are rather small; 1 - 2 rai in most cases. This land holding situation will disturb the farming in various aspects such as mechanized farming, transportation of farm inputs and outputs.

3.5.3 Present Land Use

The land use survey is carried out in the total project area of 113,300 rai (18,130 ha) consisting of 7,990 rai (1,280 ha) of the Sri Chan service area, 42,070 rai (6,730 ha) of the Pasak Left Bank service area, 38,960 rai (6,230 ha) of the Huai Khon Kaen service area, 15,040 rai (2,410 ha) of the Huai Yai service area and 9,240 rai (1,480 ha) of the Khlong Chaliang Lab service area.

The Sri Chan service area is provided with primitive irrigation facilities constructed by farmers themselves, and irrigated paddy cultivation is practiced in 4,900 rai, though stable paddy cultivation can not be expected even in the rainy season owing to unstable irrigation water source. About 1,200 rai are cultivated with upland crops such as mungbeans, tobacco and maize, and remaining lands of 1,800 rai are mainly occupied by orchard, villages, rivers, canals, roads and forest.

The Pasak Left Bank service area is provided with the irrigation facilities comprising 100 m long diversion weir, 24 km long main canal and 34.4 km long lateral canals. Irrigated paddy cultivation is predominant in the area, but stable paddy cultivation can not be expected even in the rainy season. About 26,100 rai are cultivated with paddy, and about 6,500 rai are cultivated with upland crops such as mungbeans, tobacco and maize. The remaining lands are mainly used as orchared garden, village yard and occupied by rivers, canals, roads and forest.

Rain-fed paddy cultivation predominates in the Huai Khon Kaen service area except some villages, where farmers have simple irrigation facilities, of which water resources are small streams and shallow wells, for the cultivation of paddy and upland crops such as tobacco and mungbeans. The cultivation area consists of about 20,000 rai of paddy fields and about 9,100 rai of upland fields. Paddy cultivation is practiced only in the rainy season, and its yield is rather low with large variance from year to year. The remaining lands are mainly occupied by orchard, villages, rivers, roads and forest.

In the Huai Yai service area, no notable irrigation facilities exist throughout the project area and paddy-cultivated area largely varies from year to year. The cultivated lands in this area mainly consist of paddy fields with a total area of 10,900 rai and upland fields with a total area of 540 rai. The remaining lands are mainly occupied by orchard, villages, rivers, roads and forest.

There is no notable irrigation facilities in the Khlong Chaliang Lab service area also, except in the upstream portion, where village-level irrigation facilities exist. Out of total area, about 7,300 rai are used for paddy cultivation and 300 rai are used for upland crop cultivation. The remaining lands are mainly used as orchard gardens and village yards.

3.5.4 Present Cropping Pattern

Paddy is the main crop in the project area, followed by mungbeans and tobacco. Rain-fed paddy cultivation predominates in the project area except the Sri Chan and Pasak Left Bank service areas, where irrigation farming is under practice. Four types of cropping patterns prevailing in the project area are shown in FIG. 3.6.

Type-1 pattern is predominant in the Sri Chan and Pasak Left Bank service areas. In these areas, paddy is planted from mid-June; onset of the rainy season. The planting period is extended over 2 months. The harvesting of paddy lasts for about 2 months from early November to late December, depending on varieties. Upland crops such as mungbeans and tobacco are planted from early January and harvested from early April to late April in case of mungbeans and from early May to late June in case of tobacco. Maize is also planted in comparatively large area in the dry season.

Type-2 pattern mainly prevails in the Huai Khon Kaen service area. Planting and harvesting periods of rainy season paddy are almost the same as those of the above-mentioned cropping pattern Type-1. Mungbeans and tobacco are cultivated in a limited area. These crops are planted after harvesting the rainy season paddy. Maize is planted in a large area in the dry season.

Type-3 pattern is predominant in the Huai Yai service area. Rainy season paddy is planted from the middle of June to middle of August, but this period varies from year to year depending on the rainfall pattern. Harvesting period of the rainy season paddy is from the beginning of November to the end of December. After harvesting the rainy season paddy, mungbeans and tobacco crops are cultivated in a limited area under rain-fed condition. Maize is also planted in a limited area in the dry season.

Type-4 pattern is predominant in the Khlong Chaliang Lab service area. In the rainy season, paddy is planted from the middle of June to the middle of August in general, but this period also varies from year to year depending on the rainfall pattern. The harvesting period of rainy season paddy is from the beginning of November to the end of December. After harvesting of rainy season paddy, mungbeans and tobacco are planted in a limited area as the dry season crops. In a limited area, maize is also planted in the dry season.

3.5.5 Farming Practices

The present farming practices in the project area are still conventional resulting in rather low yields of crops. Rain-fed cultivation prevails over the project area except the Sri Chan and the Pasak Left Bank service areas.

Both glutinous and non-glutinous varieties of rice are cultivated in the area. The high yield varieties of paddy have been introduced to the area less than 50% of the total area. Fertilizer is seldom applied to paddy cultivation because of residuals of fertilizer applied for tobacco cultivation in the dry season. A little amount of agro-chemicals; 0.1 liter/rai on an average, is applied one or two times a crop growing period.

Transplanting of paddy is done manually. In some cases, this work is done by community group organized by neighbourers or extended family level at free of charge. Harvesting of paddy is also done manually using sickle. Harvested paddy is spread over the threshing floor which is prepared beforehand and then threshed manually or using buffalos and cattles. Pedal threshers and engine-driven threshers are being introduced to the area.

Mungbeans are predominant crops in the project area. At present, native varieties are widely cultivated in the area. The new variety of U-tong No. 1 has recently been introduced to the area. Fertilizing and weeding are not carried out in the project area in general, but pest control is commonly practiced.

Tobacco is one of the most important cash crops in the project area. Burkley variety is prevailing in the area. Farmers in the project area have comparatively high cultivation techniques for tobacco, because the intensive guidance is being made by the field extension workers sent from Tobacco Monopoly Office and Agricultural Extension Office. Weeding is commonly practiced about 2-3 times manually. Fertilizers and agro-chemicals are applied usually. Especially, agro-chemicals are applied 3-4 times for a tobacco growing period.

Present amount of farm inputs and farm labor requirements are as shown in TABLE 3.3 and 3.4.

3.5.6 Crop Yield and Production

Present yields of paddy vary widely; 180 kg/rai to 700 kg/rai, depending on the variety, availability of irrigation water, amount of farm inputs, etc. particularly in the Huai Khon Kaen, the Huai Yai and the Khlong Chaliang Lab service areas. Yields of upland crops such as maize, mungbeans and tobacco also vary from year to year.

The following tables show the average yields and productions of major crops in the respective sub-project areas.

CROP YIELDS

(Unit: kg/rai)

Crops	Sri Chan	Pasak Left Bank	Huai Khon Kaen	Huai Yai	Khlong Chaliang Lab
Paddy					
- local varieties	500	500	440	440	440
- high yield varieties	650	650	550	550	550
Mungbeans	120	120	120	120	120
Tobacco	270	270	270	270	270
Maizu	420	420	420	420	420

CROP PRODUCTIONS

(Unit: tons)

Crops	Sri Chan	Pasak Left Bank	Huai Khon Kaen	Huai Yai	Khlong Chaliang Lab	Total
Paddy						
- local varieties	620	3,250	2,530	2,330	1,580	10,310
- high yield varieties	1,350	7,040	3,170	1,170	790	13,520
Mungbeans	100	520	170	100	90	980
Tobacco	170	880	390	60	100	1,600
Maizu	430	2,260	3,460	140	70	6,360

3.5.7 Livestock

Various kinds of livestock; buffalo, cattle, swine, goat, sheep, chicken and duck, are raised in the project area. At present buffalo and cattle are not playing so important role in land preparation, because many tractors have been introduced to the project area in recent years. One farm household raises 20-25 heads of chicken and duck on an average, which are mainly used for home consumption and to some extent sold in local market.

3.5.8 Marketing and Prices

The marketing flow structures for farm inputs and outputs in Thailand are broadly categorized in three major classes; local market, assembly or central market and terminal market. The local market exists in rural area. In this market all the products are traded by local merchant, broker, marketing cooperatives, factory, government agency (MOF and POW) and retailer. The assembly market exists in the suburbs of towns. The provincial merchants, brokers, factory representatives and retailers take part in the assembly market. The terminal market is Bangkok, which is operated by large brokers, wholesalers, factory representatives, cooperative federation (CMPF, MOF and POW), exporters and retailers. This market acts as a price leader and its market power largely affects the functions of local markets and assembly markets.

Major products in the project area are paddy, mungbeans and tobacco. Paddy currently produced in the area is mainly non-glutinous variety; about 84% of the total rice production. Glutinous rice has high palatability in the project area, and very few products are exported to the other provinces. Some high quality rice like Kao Hom is exported to the other areas, mainly Bangkok through the hands of rice millers or merchants.

The major crops other than paddy play an important role in farm economy as cash crops because of their high commercial values. Trading of these crops is conducted by quataman and the merchants who deal with them in forwarding and selling.

The seasonal fluctuation of local market price is relatively large mainly due to inadequate marketing system, limited storage facilities, etc. Particularly for paddy, the farmers are often compeled to sell these products to itinerant buyers immediately after harvesting, resulting in comparatively low selling price. The farm gate price of farm product varies from ฿2.5/kg to ฿3.2/kg for paddy, from ฿7/kg to ฿14/kg for mungbeans and from ฿25/kg to ฿35/kg for tobacco. TABLE 3.5 shows the average farm gate prices of major farm products and inputs in the project area.

3.5.9 Farm Budget

Based on the present farm gate prices of farm products and inputs prevailing in the project area, the present farm budget is estimated for each service area and summarized in the following table.

(Unit: Baht)

Items	Sri Chan and Pasak Left Bank	Huai Khon Kaen	Huai Yai	Khlong Chaliang Lab
Gross income	35,694	32,404	29,326	29,970
Outgo	34,908	32,357	29,273	29,921
Balance				
(capacity to pay)	786	47	53	49
(US$)	(34.2)	(2.0)	(2.3)	(2.1)

3.5.10 Tax and Water Charge

In Thailand, farmers traditionally do not pay any water charges directly except the some cases of temporary pumping systems which were provided by RID on farmer's request, but contribute indirectly by paying tax on surplus rice production, and export tax and export premium in addition to the payment to the Foreign Trade Development of Ministry of Commerce for rice export. Other than the above taxes, farmers have to pay a land tax according to the land grade of productivity and rural government taxes for large farm machinery, motorcycle and other luxury.

3.6 AGRICULTURAL SUPPORT SYSTEM

3.6.1 General

A number of governmental and non-governmental organizations play a major role for improvement of rural life and increase of agricultural productions. Among the organizations, Ministry of Agriculture and Cooperatives is systematically leading the agricultural supporting services for the farmers all over the country. The Community Development Department and the Accelerated Rural Development under the Ministry of Interior also supplementarily provide the agricultural support services for the rural population in rural area, and Thai Tobacco Monopoly (TTM) provides inputs supply with credit and marketing services for its contract tobacco growers.

3.6.2 Agricultural Extension

Despite the budgetary and administrative contributions undertaken by the Central Government, less tangible effects have been brought about in the aspect of agricultural extension in recent decade. To improve this depressed agricultural extension, the Government formulated the National Agricultural Extension Project in 1976 under the financial aid of the World Bank. This project was started in 1972 mainly aiming at strengthening of the institutional setups and the development of "training and visit" (TV) system.

The Phetchabun province has been covered by the early phase of the National Agricultural Extension Project, and successfully terminated in 1981. Through this project, five Subject Matter Specialists were attached to the provincial extension office, and 19 and 17 extension agents are stationed at the Phetchabun and Lom Sak district extension offices respectively. The ratio of extension agent to farm families is 1 to 1,120 in the Phetchabun district and 1 to 1,520 in the Lom Sak district.

The agricultural extension activities in the Phetchabun province have been distinctly improved through the introduction of the so-called TV system. The extension agent usually takes care of ten villages for agricultural extension. The staff of the extension agent regularly visits about 100 selected "contact farmers" on the fixed date and time, and, through them, indirectly trains about 1,000 farm families.

3.6.3 Agricultural Research

The Department of Agriculture is fully responsible for crop production research all over the country, having a network of 85 national research stations. The major function of the station comprises routine demonstration, on-farm experiment, improvement and production of seeds, etc. While, the RID operates six irrigation water use research stations which mainly conduct researches on consumptive use of water for crops, rotational irrigation practices, and cultivation experiment of upland crops and vegetables.

There is no research station in Phetchabun province, but several stations are operated around the province. The Phitsanulok Experimental Station is conducting the research for both paddy and upland crops. The Lopburi Experimental Station is responsible for the research for paddy, and the Tako Experimental Station in Nakhon Sawan province is conducting the research for various kinds of upland crops. The Chainat Research Station is a major center of the research on dry season irrigated farming. The Samchook Water Use Experiment Station in Suphan Buri province and the Phitsanulok Water Use Experiment Station are operated by RID to observe the proper irrigation water use. The data and information accumulated in the abovementions stations would fully be used for the project implementation and operation.

3.6.4 Farmers' Organization

1) Agricultural Cooperatives

The agricultural cooperatives were historically initiated in Thailand in 1916. Since then, the agricultural cooperatives have been institutionally developed through many amendments. In 1968, the Cooperative Societies Act was epockmakingly framed out in order to strengthen the unstable cooperatives. Under the act, the agricultural cooperatives primarily function for disbursement of credit at present, the main source of which mainly stems from the Bank for Agricultural Cooperatives (BAAC).

There set up six agricultural cooperatives in both districts concerned, three in the Phetchabun district and the remaining three in the Lom Sak district. The numbers of farmers joining the cooperatives total about 5,940 or 13% of the farm families in both districts. Most of the member of cooperatives are of middle-class.

Two representative cooperatives in both districts give the members a wide range of support, such as supply of credits, distribution of inputs and consumer goods, marketing, and formulation of agricultural projects and programs. For the members, the cooperatives usually arrange the credit with 14% of interest rate, on condition that 5% of the credit amount should be deposited in the cooperatives.

2) Farmers' Associations

The farmers' associations are generally established on the sub-district bases. The association mainly serves its member for the distribution of farm inputs with low price, the distribution of the technical advices on agricultural extension, and for the receipt of the credits on a group level from the bank for agriculture and agricultural cooperatives.

In both districts concerned, there set up 20 farmers' associations enrolling 3,100 members in the Phetchabun district, and 19 farmers' associations enrolling 2,500 members in the Lom Sak district, which correspond to 12% of total farm families. Meanwhile, 16 young farmers' groups and 22 farm wives' groups have recently been organized under the guidance of the Department of Agricultural Extension. The extension offices in both districts are leading the members of young farmers' groups for introducing modernized farming practices from the extension agents and the improvement of living conditions through the guidance of home economist dispatched by the said department.

3) Water Users' Association

The water users' association is organized under the guidance of the Royal Irrigation Department. The association is usually composed of several water users' groups which are set up on lateral canal bases and are responsible for the operation and maintenance of terminal irrigation system. There is no water users' association in both districts concerned, though some medium scale irrigation projects have been operated in both districts. Water users' groups have been independently set up in the medium scale irrigation schemes; six groups under the Huai Pa Daeng irrigation project and ten groups under the Pasak Left Bank irrigation project. Further detailed discussions on water users' association are given in ANNEX - VIII and IX.

3.6.5 Agricultural Credit

Agricultural credit to farmers is institutionally obtainable through three types of credit channel, i.e. the Bank for Agriculture and Agricultural Cooperatives (BAAC), commercial banks and cooperatives organizations. The credits from both banks are generally secured by mortagaging their owned land, personal guarantors and/or floating charges on crops or movable properties. The credit from the cooperatives is usually committed by expected crop production.

BAAC has 58 provincial branch offices and 479 district field units, and operated in all 72 provinces. The bank provides loans to the agricultural cooperatives, farmers' associations, and individual farmers. The loans from the bank to agricultural cooperatives and farmers' associations are usually made under credit line agreement renewed every five and three years respectively.

The bank outbranches provincial offices in the Phetchabun province, and further stretches out district field units in both Phetchabun and Lom Sak districts. Under the direct control of the provincial office, the district units assist borrowers in credit application, and contact them periodically to check their adherence to credit conditions, particularly on use of funds and repayment.

About 400 farmers' groups for credit of the bank have been set up in the Phetchabun district enrolling 6,600 farmers; about 31% equivalence of the total farm families in the district. While, about 230 farmers' groups have been set up in the Lom Sak district gathering 3,500 farmers; 14% equivalence of the district farm families. According to the recent information from the provincial office of the bank in Phetchabun, out of the total amount of credit disbursement, about 75% is lent to short-term, about 13% to medium-term and about 12% to long-term. The short-term credit is usually used for their seasonal production inputs: the medium-term credit is mainly used for purchasing hand-tractors, cattle, etc., and the long-term credit is mainly used for land consolidation and purchase of large scale farming machinery.

According to the guideline introduced by the Bank of Thailand, the commercial banks finance a predetermined portion of their total deposits to the agricultural sector. The present percentage is fixed at 11% since 1978. The rural branches of the commercial banks are also required to lend 60% of local deposits. There exist several commercial banks in Phetchabun municipality. The credits from the commercial banks are preferably lent to the farmers who exclusively supply tobacco to the Thai tobacco monopoly stations, the cooperatives, and to the joint liability groups.

3.6.6 Seed Multiplication and Distribution

Ministry of Agriculture and Agricultural Cooperatives (MOAC) is paying a special effort to seed multiplication and distribution especially for basic food crops, and Department of Agriculture (DOA) is responsible for production of foundation seed and breeder seed in its own experimental station. The foundation seeds produced in the experimental station are multiplied in the seed multiplication farm in the experimental station under DOA and in the seed center under Department of Agricultural Extension.

There exist two experimental stations near the project area; Lopburi and Phitsanulok Experimental Stations. These stations keep foundation seeds of paddy, and further the Phitsanulok Experimental Station has a function of breeding of paddy. Both stations multiply paddy seeds on their own seed multiplication farms and contract farmers' farms.

Around the Phetchabun province, there exist some seed centers; Seed Center No. 1 in the Phitsanulok province, Seed Center No. 5 in the Lopburi province and Seed Center No. 4 in Chai Nat province. The Seed Center No. 1 is the nearest station from the project area. This center products seeds of various crops such as paddy, maize, mungbeans, peanuts and cotton.

The seeds produced in the experimental stations are generally distributed to farmers through the extension offices of DAE. The Phetchabun provincial extension office distributed 6.3 tons of paddy seeds to Phetchabun district and 5.2 tons to Lom Sak district in 1982 under the paddy seed exchange program. On the other hand, the quality seeds produced in the seed centers are distributed to farmers through Marketing Organization for Farmers (MOF) of MOAC, agricultural cooperatives and farmers associations.

3.6.7 Other Agricultural Supporting Agents

1) Plant Protection Unit

The Plant Protection Unit (PPU) under the Plant Protection Division of DAE has a responsibility for the techniques of pest control and lending services of sprayer to farmers. PPU III in Phitsanulok has a direct responsibility for surveillance of pest control, collection and analysis of data, forecasting and warning on pest damages in three provinces; Phetchabun, Phitsanulok and Phitchit. PPU III also lends sprayer at the request of the farmers at free of charge. There are ten technicians in PPU III, and they give advices to farmers on chemical application together with sprayer lending service. They have also a responsibility to give technical assistance to the extention agents of DAE.

2) Thai Tobacco Monopoly

TTM, state enterprise, has two sub-branch offices under the Provincial Branch Office, each in Phetchabun and Lom Sak districts. These sub-branch offices provide input distribution services for tobacco growers. Inputs are generally sold on credit terms, and repayment of credit is made from the purchases of tobacco. TTM also provides technical services to their contract farmers (so called "quota-holders").

CHAPTER - 4

AGRICULTURE CONSTRAINTS

4.1 SUMMARY ON CURRENT SITUATION

The project area to be served by the four proposed reservoirs is covered with relatively well developed paddy field. Paddy cultivation in the project area is concentrated in the wet season and extremely limited in the dry season, because the dependable water resources are completely exhausted and depleted during the dry season. The cultivation is directly affected by total depth of annual rainfall. The planted area of paddy field widely fluctuates year by year depending on endowed rainfall and available river flow.

After harvesting wet season paddy at the cease of wet season, the farmers cultivate upland crops such as mungbeans, soybeans, tobacco, etc. in the limited paddy field, in which irrigation water readily available throughout growing stage of upland crops. It is quite rare that dry season paddy is planted as a second crop.

Some paddy fields extending in and around the project area are covered with village-level irrigation systems depending their irrigation water resources on small rivulets. But most of the paddy fields still remain under rainfed condition. The existing irrigation systems mainly developed by farmers themselves are primitive. The intake weirs of village-level irrigation systems have been constructed with timbers and cobbles. These weirs have been habitually washed away by intensive floods. While, perennial weirs have been also constructed with concrete along the Huai Yai and the Khlong Chaliang Lab by the provincial office. These weirs have been relatively better maintained.

All the irrigation canals aligned in the project area are unlined. These canals are deteriorated due to poor maintenance. The density of the existing canals networked in each area is very low. Besides serious shortage or irrigation water, equitable water distribution has not been practiced because of the low canal density in the project area.

No technical drainage system has been provided so far in each subproject area. Most of the existing canals have dual function of irrigation/drainage. This substantially contributes to repeated use of limited water resources.

The present farming practices in the area is still conventional. Very limited amounts of fertilizer; almost nil, and agro-chemicals are used for paddy cultivation. High yield varieties of paddy are only introduced in a limited area owing to the lack of dependable irrigation water supply. Upland crops are also traditionally cultivated mainly in the dry season. Negligible amounts of fertilizers and chemicals are applied for the crop cultivation.

The project area is not fully served by particular organization from the viewpoint of socio-economy at present. Especially, agricultural support services, namely, extension services, seed multiplication, agricultural credit, marketing system of agricultural inputs and outputs, farmers' organization, etc. are not so attractively organized.

4.2 CONSTRAINTS FOR AGRICULTURAL DEVELOPMENT

The project area is graced with extended land resources quite suitable for agricultural production. Nevertheless, the land productivity thereabout is still low because of various constraints for agricultural development. The major constraints foreseen are as follows:

1) Annual shortage and uneven seasonal distribution of rainfall,
2) Serious shortage of irrigation water resources,
3) Lack of perennial irrigation system,
4) Improper water management,
5) Improper application of agricultural inputs, and insufficient and improper control of diseases, insects and rats,
6) Insufficient agricultural support services,
7) Lack of farmers' organization and/or association,
8) Insufficient marketing system,
9) Insufficient farm road network, and
10) Scattered-type land holding pattern and small scale field plot.

The decisive constraints among them are serious shortage of irrigation water resources and lack of perennial irrigation system which fully serves equitable water management.

CHAPTER - 5

NEEDS OF PROJECT

5.1 IRRIGATION

Water resources are limitedly endowed in the Pasak river valley compared with the vast land resources thereabout. Existing irrigation projects under operation and construction in the valley cover about 893,000 rai (143,000 ha), corresponding to about 51% of total existing paddy field in the valley. Despite of the provision of irrigation system, most of them are still subject to serious shortage of irrigation water during the dry season. Furthermore, the vast paddy field of about 840,000 rai (134,000 ha) still remains under rainfed condition, resulting in low land-productivity mainly due to shortage of irrigation water. Hence, irrigation development has recently become pressing needs in the valley in order to improve the living standard of the rural population, most of which are engaged in agricultural activities.

5.2 FLOOD MITIGATION

The Pasak river valley is slender and bounded by mountain ranges on north, east and west. Flooding has periodically rushed into the valley every year and caused serious damages on agricultural crops and various infrastructures. Flood mitigation is therefore one of essential development sector in the valley. Creation of reservoir in the upperstream of Pasak river and its tributaries would decisively contribute to the flood mitigation. Regardless of the scale of the project, the flood mitigation should be envisaged in this basin.

5.3 DOMESTIC AND MUNICIPAL WATER SUPPLY

The domestic and municipal water supply in the Pasak river valley amounts to approximately 19 MCM per annum in total. This supply is extremely small compared with rural population in the valley (about 50 l/ day/capita equivalence). Most of rural population are depending their domestic and potable water on rainfall, natural river flow and tubewells. Therefore, present situation on domestic and municipal water supply is extremely aggravated during the dry season. Water resources for the domestic and municipal water must be urgently developed especially in and around the urban areas of the valley.

5.4 NAVIGATION

The downstream of the Pasak river substantially functions for inland navigation, jointing with the downstream of the Chao Phraya river. Some amount of maintenance flow must be habitually released from the upstream to the downstream of the Pasak river to stably maintain the river channel. Hence, in the water resources development in the Upper Pasak river basin, special attention should be paid to the navigation in the downstream of the Pasak river.

CHAPTER - 6

PROSPECTIVE DEVELOPMENT PLAN

6.1 BASIC DEVELOPMENT CONCEPTS

In conformity with the objectives of the National Economic and Social Development Plan, the Government mainly aims at amendment of disparity of incomes and attainment of people's public peace through the implementation of irrigation project. To attain the major objectives, the project would aim at extension of stabilized irrigated agriculture through exploitation of new water resources in tributaries.

(1) Agricultural Development

The basic concepts for agricultural development are,

i) Unit yield of wet season paddy would be increased through proper supplemental irrigation and introduction of improved technology of irrigated agriculture.

ii) Total planted area of wet season paddy would be stabilized with stable water supply depending on newly exploited water sources.

iii) The project must play a leading role for improvement of the living standards of extended rural population. In this context, extensive agriculture would be basically oriented as far as the economic feasibility of the project is sustainable.

iv) Crop diversification concept would be incorporated in the newly proposed cropping pattern in conformity with the Governmental policy.

v) Paddy would be planted only in the wet season due to limited exploitable water resources. During the dry season, only upland crops would be planted to save and effectively use exploited water resources. Optimal cropping intensity would be proposed in due contemplation of agro- and water economy.

vi) Socio-aspects should be highly regarded in implementation of medium scale irrigation project. Therefore, the project under study would be so formulated as to bring great impacts on farm economy in the backward areas.

(2) Water Resources and Irrigation Development

In order to realize the concepts for agricultural development above-mentioned, the following basic concepts for water resources development and irrigation development are envisaged as mentioned below:

i) The water resources endowed in the tributaries concerned would be developed by constructing storage dams to the maximum extent.

ii) Irrigation water resources are essential in the project area. No stable water source is available in the area for the time being excepting ephemeral small tributaries, the flow of which has been frequently intermittent in the dry season. In this view, the maximum development of endowed water resources would be orientated as far as topographic and geological conditions are allowable. Thus, in the study of the project, less attention would be given to the optimal water resources development.

iii) Potable, domestic and industrial water resources for the Lom Sak and/or Phetchabun municipalities would be considered if the exploited water resources are allowable.

iv) In principle, the exploited water resources would be used for irrigating the paddy fields extending due downstream of the exploited sites: the sub-project areas would be delineated in the paddy fields extending in the vicinity of the exploited sites.

v) Existing irrigation canal systems would be incorporated as they are. The existing intake weirs would be eliminated in principle, and instead, link canals would be aligned to integrate the existing village-level irrigation systems.

6.2 WATER RESOURCES DEVELOPMENT PLAN

6.2.1 Future Prospects of Water Resources in the Pasak River Basin

As discussed in the ATTACHMENT-1 of the Pre-Feasibility Study Report prepared by JICA in 1982, the water demand in the Pasak river basin is surely bound to increase year by year keeping pace with regional development, increase of population, change of agricultural structures, etc. in the Pasak river basin. Unless a proper policy for long-range water resources development is envisaged all over the river basin, the supply and demand of the water resources will be imbalanced in the basin in near future.

The exploitable water resources in the basin are assessed to be 1,200 MCM per annum in maximum in future. While, to clarify the future demand of water resources in the river basin, it is assumed that about 250,000 rai of potential land resources suitable for irrigated agriculture will be yearly planted under a limited crop intensity of 135%, and the population of about 200,000 will further increase in the river basin after 50 years, in proportion to the present demographic increase ratio in this region. Thus, it is conservatively forecasted that the future water demand in this basin will sharply increase up to 1,600 MCM per annum, about 160% equivalence of the current demand in the basin. About 400 MCM per annum of water resource will be deficient all over the basin. Actually, however, about 20% to 30% of the exploited water resources would be reusable, since the Pasak river basin extends slenderly from north to south. Therefore, the supply and demand of water resources will be balanced even at the full development stage of the basin, if a little scale-down of the potential projects is made. Otherwise, supplemental water resources must be exploited by a large scale transbasin works.

Water resources are one of basic re-cycling resources composing environment. To make effective use of the limited water resources, the saving and the rational use should be fully contemplated among rural population. As above-mentioned, the future demand of water resources in the basin will undoubtedly exceed the supply in the future. The following measures are essential in order to overcome the serious shortage of water resources in the basin:

(1) Cropping intensity should be severely restricted within 135% all over the basin.

(2) Irrigation water saving should be made all over the basin. The saving will be attainable through up-grading of irrigation system and betterment of irrigation water management.

(3) In the full development stage of the basin in the future, a large scale transbasin work should be implemented.

(4) Domestic, municipal and industrial water resources mainly depending on natural flow at present should be replaced by groundwater in the future.

6.2.2 Assessment of Endowed Water Resources

(1) Annual Rainfall

The rainfall data recorded in the Lom Sak rainfall station would be applied for rainfall analysis in the Huai Saduang Yai and the Huai Khon Kaen watersheds, since no rainfall has ever been recorded in the watersheds. For the similar reason, the rainfall data recorded in the Phetchabun rainfall station would be applied for rainfall analysis in the Huai Yai and the Khlong Chaliang Lab watersheds. These applied rainfall data surely bring about conservative results for water resources development and irrigation

planning since the basin rainfall in the hilly watershed is generally greater than that in the lowlying plain, in which both rainfall stations are located.

The rainfall records at the Phetchabun and Lom Sak rainfall stations are converted into runoffs by applying the runoff estimate chart which has been authorized in RID. This chart has various lines corresponding to the condition of watershed as shown in FIG. 6-1. The watershed of each tributary consists of rather rolling area and open forest, which coincides with line C in the chart. Therefore, the runoff of each tributary is estimated by using the line C. While, on the mainstream of the Pasak river, there exist two water gauging sites: one is located at Kaeng Sida covering the drainage area of 836 km^2 and the other is located at the Pasak diversion weir covering the drainage area of about 1,007 km^2. The annual runoff coefficients at these gauging stations are compared with the estimated ones mentioned above. The estimated annual runoff coefficients are in the range of those recorded at the above two stations.

The monthly runoff is produced by multiplying monthly rainfall by the runoff coefficient which is read on the line C. The annual runoff in each tributary is given in TABLE 3-1 together with the annual specific yield and the annual runoff coefficient, of which runoff indices are summarized as follows:

Tributary	Drainage Area (km^2)	Average Annual Runoff (MCM)	Average Annual Yield ($\ell/s/km^2$)	Average Runoff Coefficient
Huai Saduang Yai	96	22.4	7.4	22.2
Huai Khon Kaen	322	75.1	7.4	22.2
Huai Yai	75	19.9	8.4	24.2
Khlong Chaliang Lab	77	20.5	8.4	24.2

As given above, the average annual specific yield ranges from 7.4 to 8.4 $\ell/s/km^2$, and the average annual runoff coefficient varies between 22.2% and 24.4%.

6.2.3 Optimum Scale of the Development Plan

(1) Water Balance

To clarify the optimal scale of the exploitation of water resources and irrigation, a water balance study is made for various alternative plans on the basis of the monthly runoff for the range from 1964 to 1980 and the irrigation water demand estimated on the proposed cropping pattern, the cropping intensity and the irrigable area.

Strictly following the basic development concepts aforementioned, four alternative plans for each sub-project are selected for water balance study which is made by reservoir operation. In the reservoir operation, the irrigable area is iterated by fixing the reservoir capacity and the crop intensity until the supply and demand of water resources in the reservoir is fully balanced. The balanced components of each alternative are summarized in the following table. The details are given in ANNEX - VI.

Alternative	Component	Unit	Huai Saduang Yai	Huai Khon Kaen	Huai Yai	Khlong Chaliang Lab
-1	Useful Storage	(MCM)	21.0	23.4	6.4	1.5
	Cropping Intensity	(%)	135	135	135	135
	Irrigable Area	(ha)	4,700	4,300	1,200	130
-2	Useful Storage	(MCM)	21.0	23.4	6.4	1.5
	Cropping Intensity	(%)	150	150	150	150
	Irrigable Area	(ha)	3,500	3,500	900	60
-3	Useful Storage	(MCM)	27.0	30.0	13.3	6.7
	Cropping Intensity	(%)	135	135	135	135
	Irrigable Area	(ha)	5,400	5,100	1,800	1,200
-4	Useful Storage	(MCM)	27.0	30.0	13.3	6.7
	Cropping Intensity	(%)	150	150	150	150
	Irrigable Area	(ha)	4,200	4,100	1,500	900

(2) Evaluation

Based on the general layout of each alternative and agro-economic study, the cost and benefit of each alternative are estimated on the economic basis.

The evaluation for each alternative plan is made in terms of internal rate of return (IRR) and net present value (NPV) at the economic rate of 8%. The details are given in ANNEX - VI and the results are summarized as tabulated below:

Alter-native	Economic Index	Huai Saduang Yai	Huai Khon Kaen	Huai Yai	Khlong Chaliang Lab
-1	IRR (%)	14.5	13.6	15.1	9.4
	NPV (10^6 ฿)	504.3	706.9	223.3	21.6
-2	IRR (%)	17.6	14.5	15.3	8.8
	NPV (10^6 ฿)	721.6	791.0	219.0	11.2
-3	IRR (%)	14.3	13.8	14.6	10.2
	NPV (10^6 ฿)	567.1	841.9	293.8	92.2
-4	IRR (%)	17.3	15.1	15.5	10.3
	NPV (10^6 ฿)	862.8	1,000.5	331.4	93.1

(3) Selection of Definite Plan

Following the development concept established in the Pre-Feasibility Study, three main points below-mentioned are picked out for selecting the definite plan:

i) Low cropping intensity should be orientated for the definite plan in due consideration of future prospects of water supply and demand all over the basin.

ii) The alternative plan providing the most sizable reservoir should be possibly selected for the definite plan as far as topographic condition is allowable and stability of dam is sustainable.

iii) The MSIP should be socio-impacted. The alternative plan providing the most extended service area should be eligible.

Both IRR and NPV of each Alternative-3 are not the highest among the alternative plans, but sufficient for sustaining the economic feasibility under packaged condition and having immediate impacts on the regional economy. Furthermore, taking into account the three main points above-mentioned, the Alternative-3 would be finally selected under packaged condition for the definite plan.

6.3 AGRICULTURAL DEVELOPMENT PLAN

6.3.1 Delineation of Development Area

(1) Factors to be Considered for Delineation of Project Area

In delineation of the irrigation area specified in Section 6.2.3 hereof, the following factors are taken into consideration (ANNEX - III and VIII).

Land suitability classification:

Based on the evaluation of land suitability classification, the areas classified into the land class groups of R1, R2, R3, U2/R2 and U2/U3 are taken up as the area suitable for agriculture. In this evaluation, the affecting factors for the delineation are erodability of lands, topography, flooding condition, drainability of soils, fertility, soil depth for cropping and degree of soil acidity.

Present land use:

The present land use and vegetation of the area are taking into consideration as the important factors for the delineation, because these conditions have large effects on the relative difficulty in making land reclamation for the irrigation development.

(2) Criteria for Delineation

Within the area delineated in the above, the following criteria are established for the further delineation:

Criteria-1 Irrigation area should be selected in the vicinity of the dam site as far as possible.

Criteria-2 In order to reap the project return quickly and to save the capital investment, irrigation area should be selected in the existing paddy fields in principle.

Criteria-3 In case the water resources allow the further extension of irrigation area, such extension should be made over existing uplands with a priority of upper reach area.

(3) Delineation

Huai Saduang Yai sub-project area:

The lower basin of the Huai Saduang Yai is sharply undulating and partly used for cultivation of upland crops. Land resources for irrigated agriculture are limited and scattered in this basin. Following the criteria-2, therefore, the service area has to be found out in the further downstream area but the nearest from the dam. Immediately downstream from the confluence of the Huai Saduang Yai with the Pasak river, there exist the Sri Chan and the Pasak Left Bank irrigation areas; 6,000 rai (960 ha) and 31,440 rai (5,030 ha), of which irrigation water depend on the unstable and non-regulated natural flow of the Pasak river. These areas are selected as the service area of the Huai Saduang Yai reservoir. For the perennial irrigation of these areas, the Pasak flow is supplemented by the regulated flow from the reservoir. The reservoir capacity limits its service area to the total area of the Sri Chan irrigation area and 27,750 rai of the Pasak Left Bank irrigation area.

Huai Khon Kaen sub-project area:

According to the result of water balance study, the Huai Khon Kaen reservoir can cover about 31,880 rai (5,100 ha) of irrigation area. In the delineation of the above area, the remaining area of 3,690 rai (590 ha) in the Pasak Left Bank irrigation area is firstly be considered for its inclusion in the Huai Khon Kaen service area, and other 28,190 rai (4,510 ha) are selected in the lower basin of the Huai Khon Kaen. The service area delineated in the lower basin of the Khon Kaen extends for around 30 km southward along the main canal of the Pasak Left Bank irrigation area. Paddy fields occupy most of the service area thus selected.

Huai Yai sub-project area:

The exploited water resources limit the service area to 11,250 rai (1,800 ha), though the land resources suitable for irrigated agriculture are more than 19,000 rai. Following the criteria-1 and -2, the irrigation area is selected from upper to lower as far as 11,250 rai are obtained. Thus, the lower part of more than 7,000 rai is excluded from the irrigation area.

Khlong Chaliang Lab sub-project area:

This area also remains under similar condition to the Huai Yai area in view of the exploited water and the land resources. The same concepts contemplated for the delineation of the Huai Yai area are employed for the delineation of the irrigation area in the Khlong Chaliang Lab area. Thus, 7,500 rai (1,200 ha) of the irrigation area are delineated in the upper area of the Khlong Chaliang Lab basin.

6.3.2 Proposed Cropping Pattern

Paddy is selected as a main crop in the project area. In studying the proposed cropping pattern, the climatic condition, soil characteristics, topography, available amount of irrigation water source, agronomic characteristics on crops, predominant varieties of crops, availability of labour forces, farmers' desire and national policy for agricultural development are fully taken into consideration.

FIG. 6.2 shows the proposed cropping pattern for all the sub-project areas which is considered to be the most beneficial for the farmers within the limit of arable lands and water resources.

In this pattern, both glutinous and non-glutinous varieties of rice are proposed. The glutinous variety will be cultivated mainly for home consumption and the non-glutinous rice will be cultivated for export. In order to maximize the potential productivity and profitability of the land and water resources, high yield and tasty varieties of paddy are to be introduced as much as possible.

Cultivation of mungbeans and tobacco will also be introduced into the project area after harvesting paddy. Mungbeans are considered to be essential not only for local consumption but also for improvement of soil conditions, and tobacco is high-cash crop for export. These crops will largely improve the farm economy.

The sowing or transplanting periods and harvesting periods of the proposed crops are as shown in the following table:

	Crops	Nursery Period (days)	Transplanting or Sowing Period	Harvesting Period	Growing Period/1 (days)
(a)	Rainy season paddy				
	- Local variety	25 - 30	B. Jul. - E. Aug.	B. Nov. - E. Dec.	120
	- High yield variety	20 - 25	B. Jun. - E. Jul.	M. Sep. - M. Nov.	105
(b)	Mungbeans	-	B. Nov. - E. Nov.	M. Feb. - E. Feb.	70 - 80
(c)	Tobacco	30 - 40	M. Oct. - B. Nov.	M. Mar. - M. Apr.	120 - 150

Note: /1; after transplanting for paddy and tobacco or after planting for mungbeans