Part 1 Agrarian Characteristics in Lower Northeast Thailand

CHAPTER II
AGRARIAN SYSTEM
IN LOWER NORTHEAST THAILAND

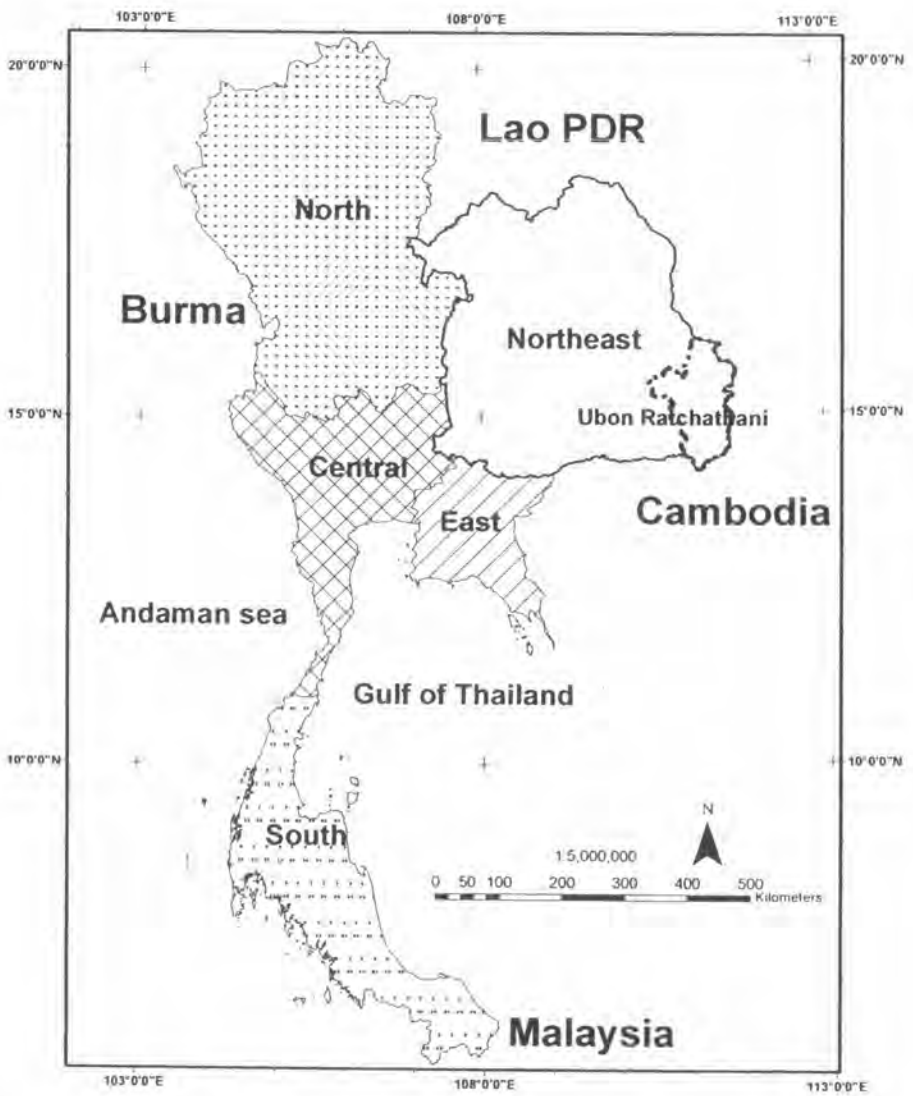
In Thailand, agriculture, particularly rice production, is a backbone economic sector; in fact, Thailand is the world's largest rice exporter. 20% of farm land is categorized as rice-producing area (Office of Agricultural Economics, 2007). The northeast, the largest region both in terms of area and population, contributes an extensive share of land and labour to agricultural production. The evolution of this large agricultural based region has been influenced by ecological changes, economic incentives, and technological and infrastructure improvements leading to the emergence of various regional agrarian systems. An agrarian system is defined as a historically constituted mode of exploitation of the environment, durably adapted to the bioclimatic conditions of a given area and corresponding to the social conditions and needs at that moment.

Because the current agricultural landscape and land use is an historical product driven by past interactions between socioeconomic changes and agroecological dynamics, this evolving process must be understood to assess the initial situation at the beginning of the research. In this chapter, the dynamics of the agrarian system in the lower northeast region is presented to provide knowledge on these interactions at national, regional and provincial levels. General characteristics of the northeast, or "Issan", region regarding land utilization, and demographic and economic dimensions are also compared to other regions to highlight its specific nature. The socioeconomic and biophysical settings are specifically addressed to state the importance of these foundations influencing the current regional looks. The rice ecosystem, the dominant use of land in this region, is further described. The chapter closes with a presentation of recent agricultural transformations and land use change at the provincial level.

2.1. The Northeast Region of Thailand

The Kingdom of Thailand has been known as the "Golden Land", in recognition of the high productivity of its farm lands and forests that benefit from the

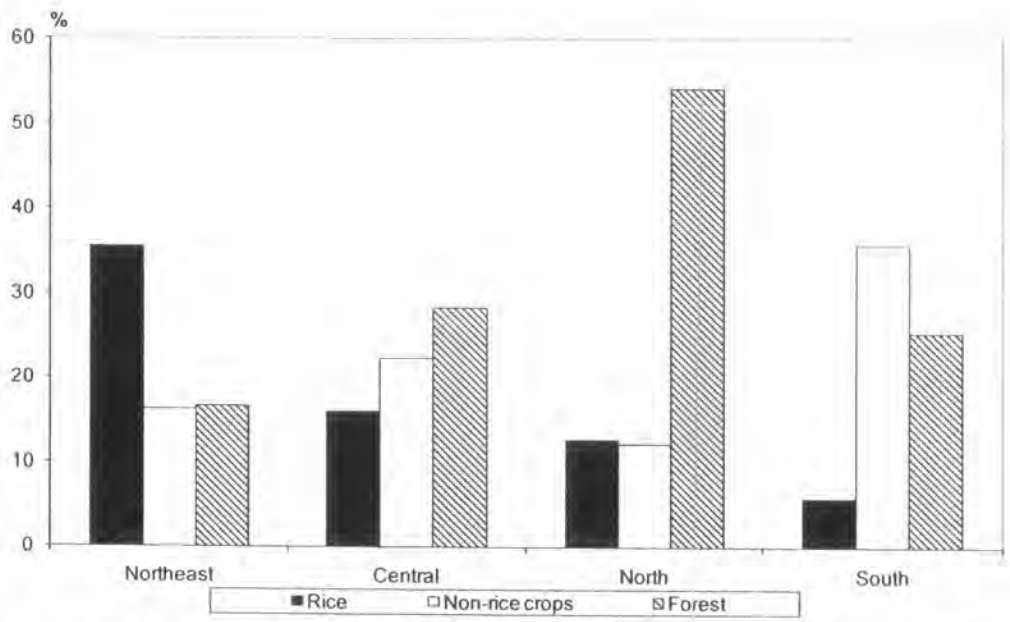
southwest wet monsoon from April to October. Based on geographic diversification, Thailand is divided into five regions: North, South, Central plain, East and Northeast (Figure 2.1). However, when the socioeconomic and demographic dimension is referred, the East is often considered a part of the Central plain. The northeast is the largest plateau in Southeast Asia (Mackill, Coffma et al., 1996). Lao PDR borders the north and east, and Cambodia borders the south, covering one third of the 513, 000 km^2 country size.



Source: Thailand on a disc 1996, Thailand Environment Institute (TEI).

Figure 2.1 Map of Thailand displaying five regions and its neighbouring countries.

This region is the largest rice producing area counting for 35% of total rice production land in Thailand with a small portion of forest cover compared to other regions (Figure 2.2). Rice producing area is preferably cultivated in large undulating shallow depressions, while non-rice crops such as cassava, kenaf and sugarcane are found in upland areas. A few dense tropical forests are conserved as national parks, located in the mountain range in the west, and in areas along the international border between Thailand and neighbouring countries, including the southern and southeastern regions of Ubon Ratchathani province.



Source: Agricultural Statistics of Thailand, Centre for Agricultural Information, Office of Agricultural Economics, Ministry of Agriculture and Co-operatives, Bangkok.

Figure 2.2 Percent of rice, non-rice crops, and forest areas by region, Thailand (2005).

In 2005, Thailand's population was estimated at 65 million making it the nineteenth populous country in the world (Library of Congress, 2007). Demographic records from the National Statistics Office show the estimates of Thailand's age structure in 2005. 23.9% of inhabitants are less than 15 years old, 68.6% are 15-64 years old, and 7.5% are 65 and older. Thai society is generally considered to be fairly homogeneous; 80% of the population is Thai, including related Thai ethnic groups such as Thai-Lao (Laotian) and Thai-Khmer. Another 10% are ethnic Chinese, and 3% are Malay, leaving 7% uncategorized. The largest share of the population resides

in the northeast region with over 21 million inhabitants and a population density of 126 persons per square kilometer (Table 2.1).

Table 2.1 Population, density and households from registration census by regions, Thailand (2005).

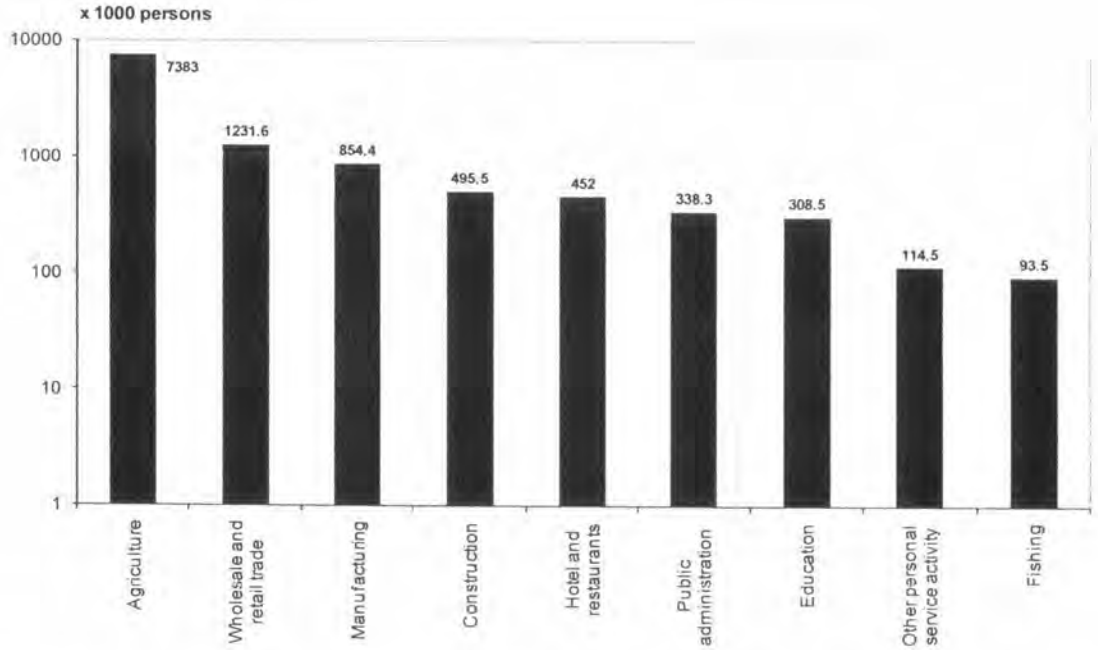
Region	Population (x1000)			Area (km^2)	Density per km^2	Number of household (x1000)
	Total	Male	Female			
Northeast	21,328	10,647	10,681	168,855	126	5,350
Central	15,031	7,368	7,663	102,336	147	5,322
North	11,884	5,879	6,005	169,644	70	3,768
South	8,517	4,219	4,298	70,715	120	2,485
Bangkok	5,659	2,706	2,953	1,569	3,607	2,092
Whole Kingdom	62,418	30,819	31,599	513,120	122	19,017

Source: http://www.nso.go.th/eng/pub/keystat/key03/Chapter1.xls Department of Local Administration, Ministry of Interior, Bangkok.

The agricultural sector occupying the largest share of farm land in the northeast is managed by about 7.4 million northeasterners (Figure 2.3). However, the revenue generated by this sector is not enough to reduce the level of regional poverty as shown by the decrease of Gross Domestic Product (GDP) in the farming sector (Figure 2.4). As indicated by high incidences of poverty, the northeast remains the all-time poorest region in the kingdom (Figure 2.5). More details on this topic are provided below.

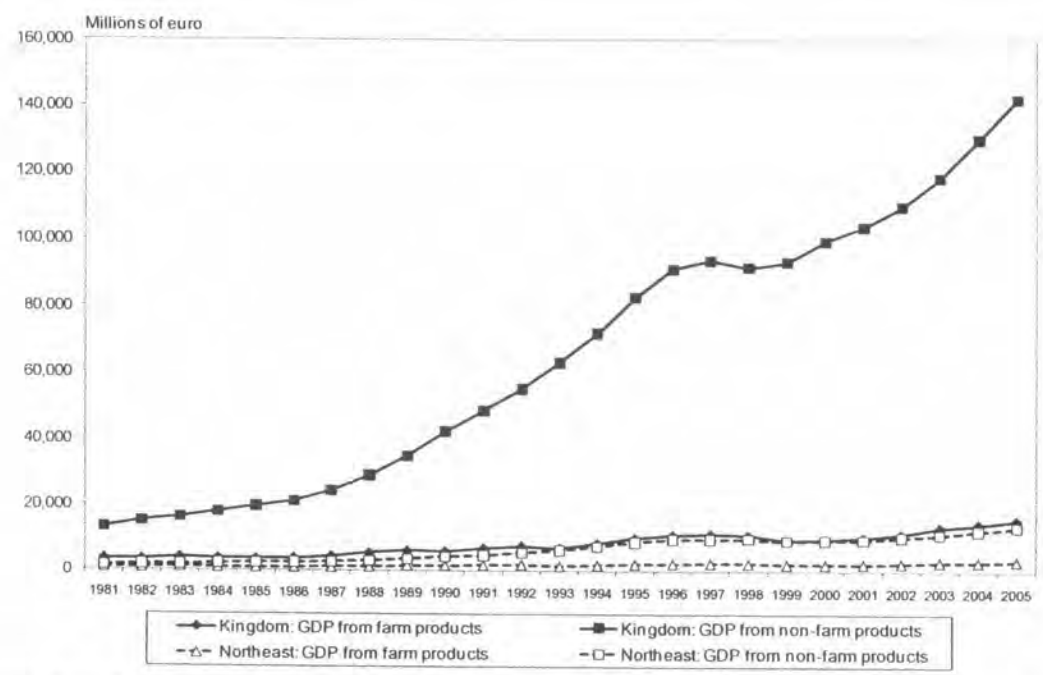
Regarding the regional demographic characteristics, the number of out-migrants is relatively high compared to other regions. This region contributed more than a third of all interregional migration in 2005 (Figure 2.6). Much of these out-migrants travelled to Bangkok and its periphery to work in industrial and service sectors. (Matsumura, Isarabhakdi et al., 2003). The flow of labour migration can be considered as a common response to the regional poverty as rural households look for additional cash income to help meet their basic needs.

To understand the high rate of poverty in this large agricultural-based economy that in turn leads to a high migration rate, it is essential to look at the regional socioeconomic characteristics in relation to poverty.



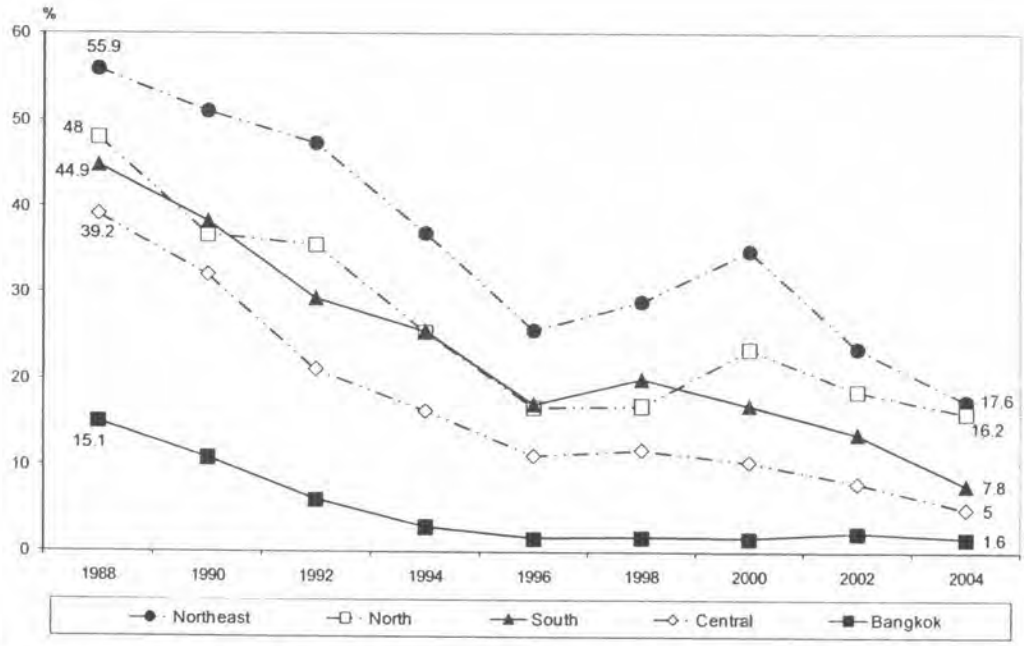
Source: Labour Force Survey Quarter 4/2005, National Statistical Office, Ministry of Information and Communication Technology, Bangkok.

Figure 2.3 Number of workers employed by economic sectors in northeast Thailand (2005).



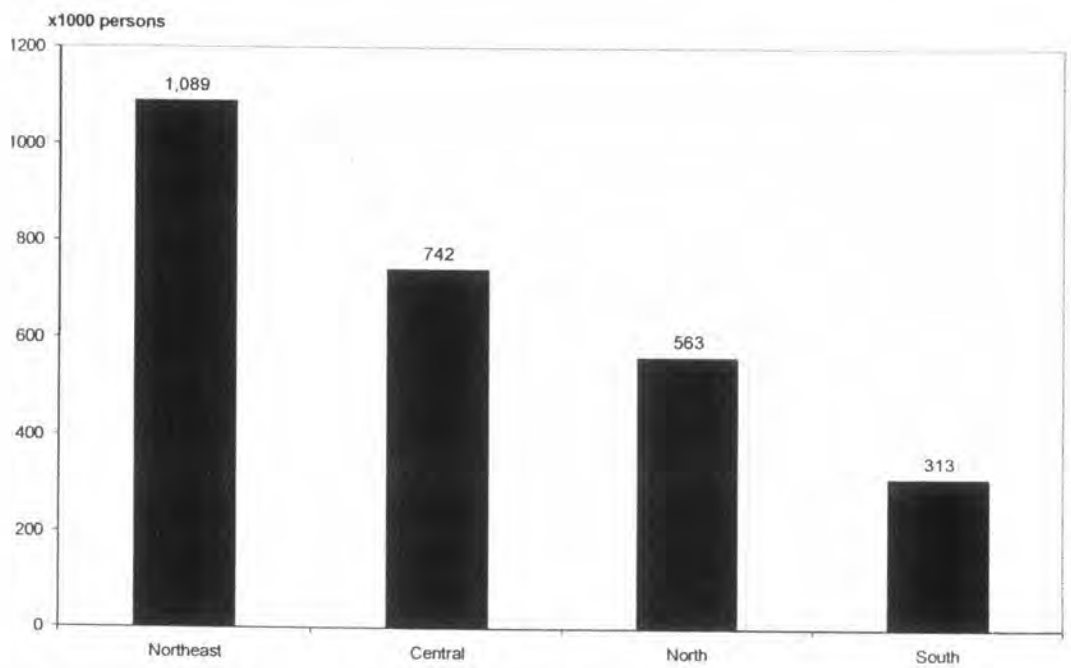
Source: Gross Domestic Product of Thailand 1980-2001 and 2005 edition, Office of The National Economic and Social Development Board (NESDB), Office of the Prime Minister, Bangkok.

Figure 2.4 Evolution of Gross Domestic Product (GDP) generated by farm and non-farm sectors at national and regional level (1981-2005).



Source: Statistic Year Book 2006, National Statistical Office, Ministry of Information and Communication Technology, Bangkok.
Note: Thailand measures poverty incidence at household level by comparing per capita household income against poverty line which is the income level that is sufficient for an individual to enjoy the society's minimum standard of living.

Figure 2.5 Evolution of poverty incidence by region, Thailand (1988-2004).



Source: Department of Local Administration, Ministry of Interior, Bangkok.

Figure 2.6 Number of out-migrants by region, Thailand (2005).

2.2. Socioeconomic Characteristics

The region's evolution has been based on agricultural and technological development interventions, influenced by the state's policies, markets, and human resource coming from a mix of diverse ethnic groups and cultures. The regional socioeconomic dynamics including demographic changes, economic transformations, and state policy implementations are all partly responsible for the emergence of persistent regional poverty among north-easterners.

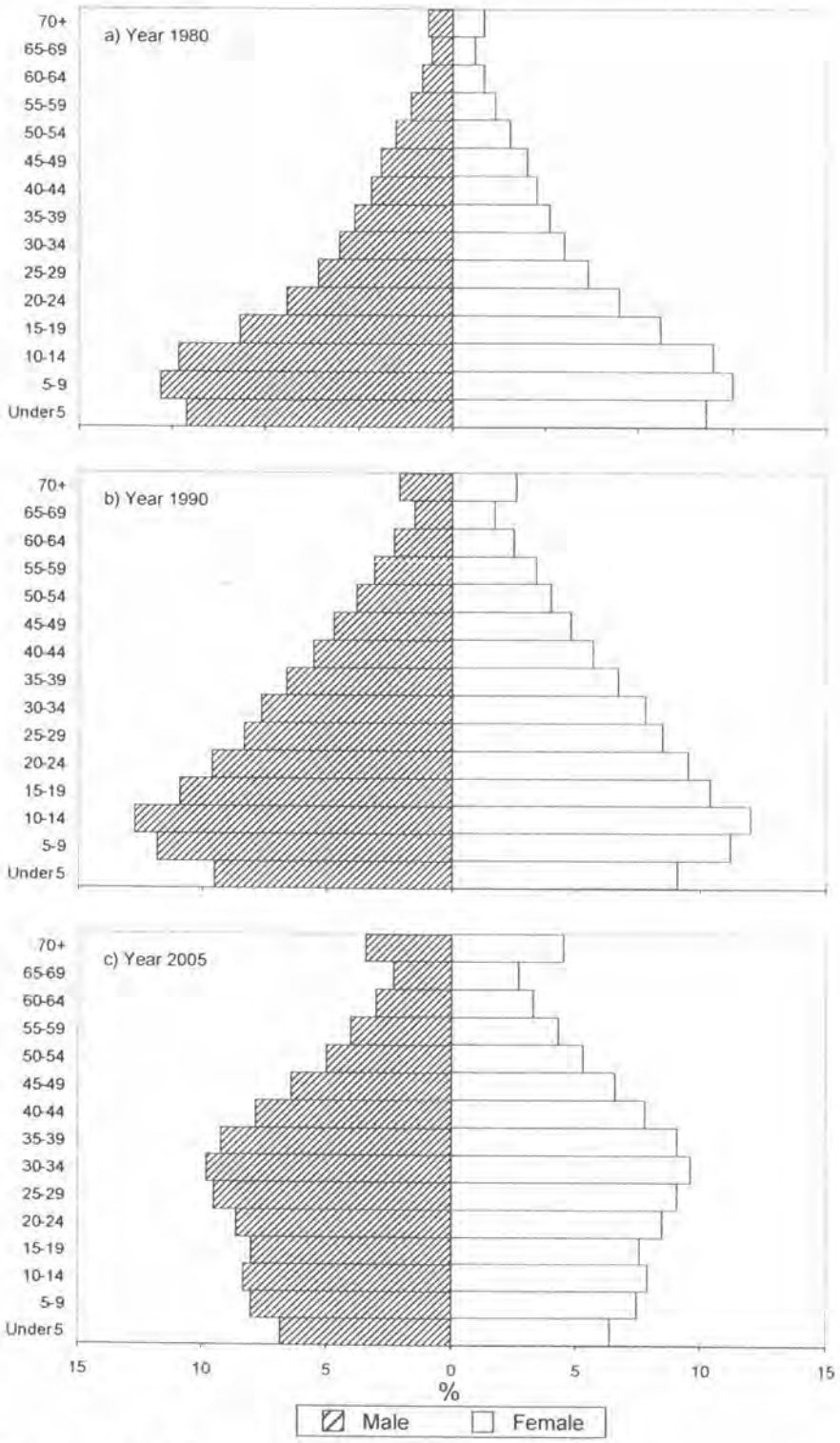
2.2.1. Ethnic Groups and Evolution of Population Structure

The regional population is dominated by Thai-Lao ethnic rural dwellers concentrated in the provinces of Nakorn Ratchasima, Khon Kaen, Udon Thani and Ubon Ratchathani, while a significant minority of Khmer people lives in the southern part of the region, along the border with Cambodia (Figure 2.7). The culture and means of subsistence of the ethnic Lao is strongly linked RLR cultivation as indicated by the sequence of traditional festivals, along with rice-growing practices in villages (Faculty of Economics Kasetsart University, 2000). But, with regard to this cultural aspect, these ethnic Lao farmers are also well known to be adaptive and fast learners to new settlements. Therefore, they still make up a large share of interregional migration compared to other groups (Promjuy, Panvisit et al., 2003).

Source: Adapted from northeast provincial boundary map, Geographic Information System Centre, Faculty of Engineer, Ubon Rajathanee University, Ubon Ratchathani (2002).

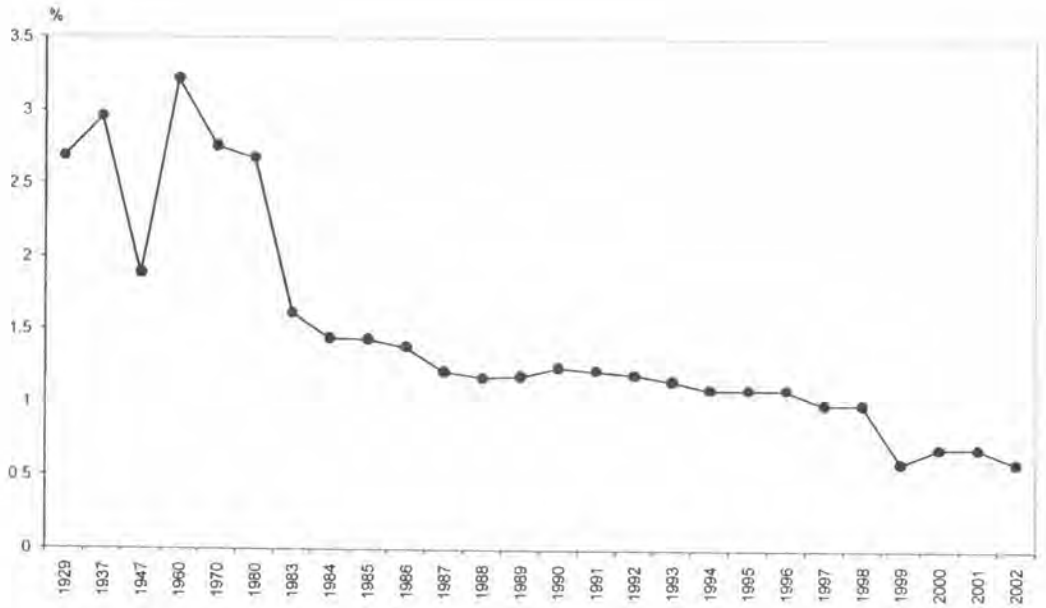
Figure 2.7 Map displaying the distribution of ethnic groups throughout the northeast region of Thailand.

In 2005, the regional population structure consisted of 24% of inhabitants aged less than 15 years, and 8% aged older than 65 years. Compared to the population structure in 1960, the number of elderly increased while the number of inhabitants whose age was less than 15 years old decreased (Figure 2.8). This demographic transition is due to a successful family planning program launched at the national level by the Thai government in 1968 (Figure 2.9), and the improvement of public health as seen in the decrease of infant mortality (Table 2.2).



Source: a) Household Survey, Minister of Interior, Bangkok.
b) Thailand Population Census, Central Statistic Office, National Economic Development Board, Bangkok.
c) Health Information Unit, Bureau of Health Policy and Strategy, Ministry of Public Health, Bangkok.

Figure 2.8 Northeast population pyramids comprised of 5-year age groups for both sexes, Thailand (1980, 1990, 2005).



Sources: Public Health Statistic A.D. 1984, Bangkok (1929-1980).
Public Health Statistic A.D. 1993, Bangkok (1983-1991).
Public Health Statistic A.D. 2005, Bangkok (1992-2005).

Figure 2.9 Evolution of the rate of natural population increase, Thailand (1929-2002).

Table 2.2 Birth, death and infant morality rate in Thailand (1963-2005).

	Year					
Rate	*1963* [1]	*1975* [1]	*1991* [2]	*1995* [2]	*2000* [2]	*2005* [2]
Live birth [a]	35.7	28.4	17	16.2	12.5	13
Death [a]	8.2	5.9	4.7	5.5	5.9	6.4
Infant mortality [b]	37.9	26.3	8.3	7.2	6.2	7.6

Sources: [1] Statistic country profile for administrators, 1979, Bangkok.
[2] Health Information Unit, Bureau of Health Policy and Strategy, Bangkok.
Notes: [a] Live birth and death rates are number of live births and deaths per 1,000 populations.
[b] Infant mortality rates are number of infant death per 1,000 live births.

Table 2.3 Life expectancy in Thailand (1963-2005).

	Year					
Gender	*1963-1967* [1]	*1974-1975* [1]	*1985-1990* [2]	*1991-1995* [2]	*1996-2000* [2]	*2000-2005* [2]
Male	53.9	57.9	61.75	66.48	67.36	68.15
Female	58.6	63.6	67.5	71.04	71.74	72.39

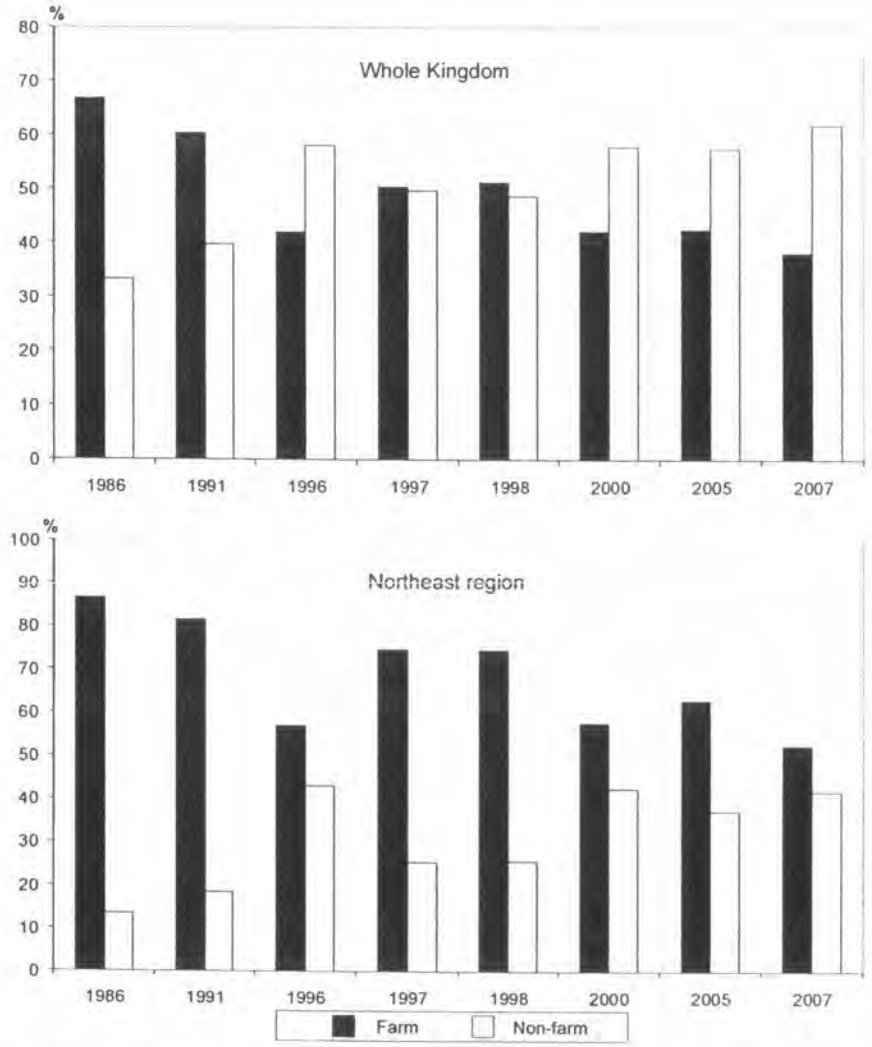
Sources: [1] Statistic country profile for administrators, 1979, Bangkok.
[2] Health Information Unit, Bureau of Health Policy and Strategy, Bangkok.

Population growth is now slow. As a consequence of this low natural rate and better health care leading to longer life expectancy (Table 2.3), the population structure is likely to contain a more elderly proportion of people and a lower proportion of working aged people. This could lead to serious labour shortages in the future.

2.2.2. Evolution from Agricultural-based to More Export-led Economy and Poverty

Since the early 1960s, Thailand has experienced a pattern of economic development characterized by rapid growth in population, income, income per capita, and productivity. National economic reforms resulted in changes to Thailand's former backbone economic sectors; Thailand's economy moved from one based on agriculture and self-reliance to an economy led more by industry, service sectors and exports (Manarangsan, 2002). As a result of being more and more market-oriented, systems of rural self-subsistence declined and agricultural products became more vital in trading for cash. However, the benefits of Thailand's recent economic growth are not equally distributed to all regions. During Thailand's economic boom in 1986-96, the northeast's farming sector produced a decreased share of GDP, while GDP of the non-farm sectors increased (Figure 2.4). There was also a flux of workers moving from the farming sector to the non-farming sector. In the northeast, 88% of the labour force worked on the farm in 1991; this share decreased sharply to 56% in 1996 (Figure 2.10). This type of labour transference shows a serious problem regarding income disparity among regions in relation to industrial and service sectors.

In June 1997, Thailand's economic bust caused a sudden increase in unemployment and new workers could not enter the market. The crisis affected people in rural areas because most of the households depended more and more on off-farm incomes. The economic crisis also caused hundreds of thousands of migrants to return to their rural homes after losing their jobs, and many reverse migrants returned to the northeast region (Subhadhira, Simaraks et al., 2004). Workers in the farm sector increased in 1997 while the number of non-farm workers decreased (Figure 2.10). However, in 2000, the portion of labour between the two sectors was similar to the situation in 1996 since the Thai economy had partially recovered. This indicates the tight link between economic growth and labour migration because the northeast people need to find more profitable employment than agriculture to increase household income.



Source: The Labour Force Survey, National Statistical Office, Ministry of Information and Communication Technology, Bangkok.

Figure 2.10 Labour force changes in the farm and non-farm sectors in Thailand and the northeast region (1986-2007).

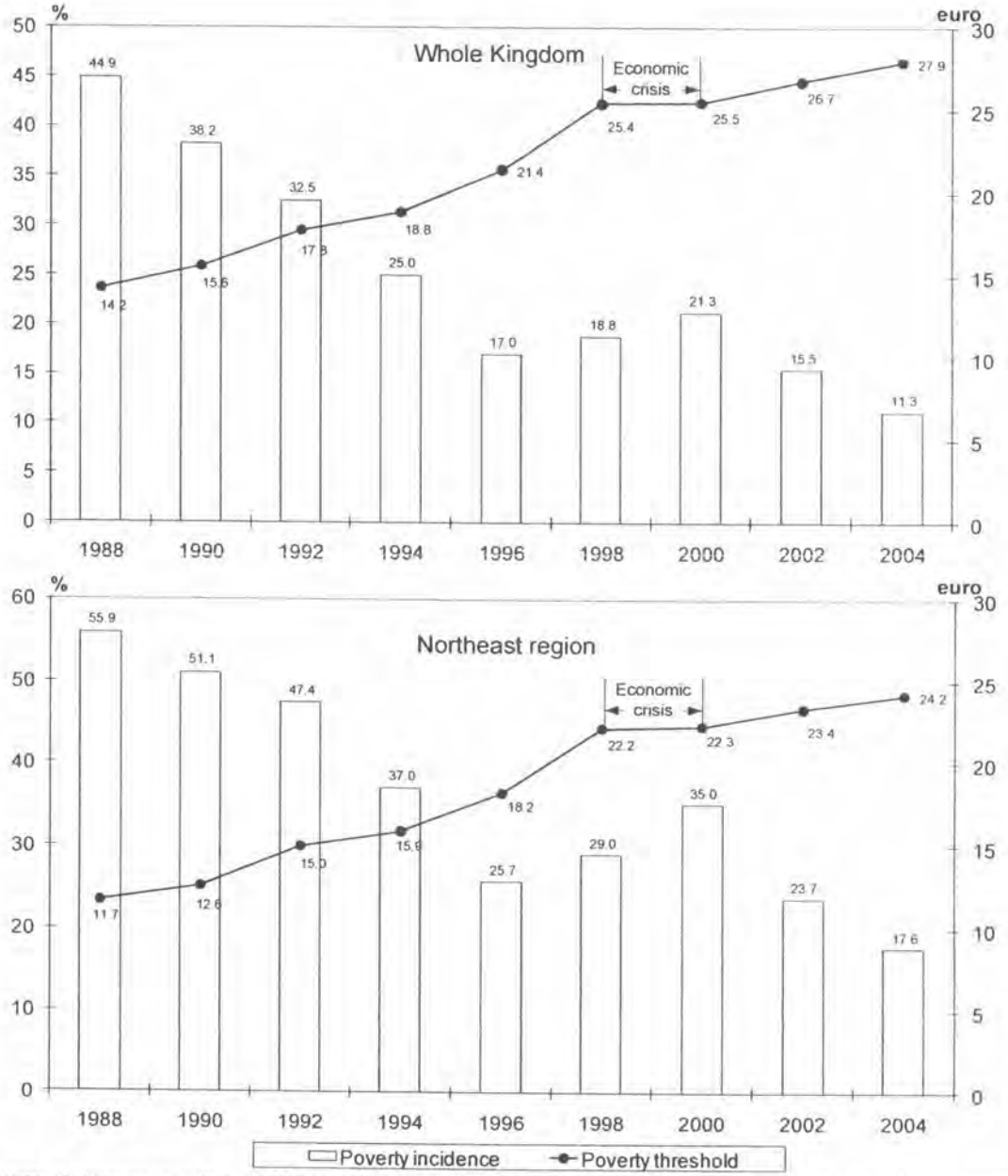
Regional poverty has long been a problematic issue as indicated by longstanding high rates of labour migration (Feeny, 2003). Half a century ago, the great majority of Thai citizens were in poverty. However, during the past decades, economic development in Thailand has been successful in alleviating the incidence of absolute poverty; this reduction is defined as the gradual decrease in the number of people whose income lies below the poverty line (Na Ranong, 2000). In spite of the impressive achievement of poverty reduction, the numbers of poor in the northeast region, where one third of Thailand's population resides, is still high. In 2004, 17.6%

of the northeast's population had a per capita income less than the official poverty line[3], compared to the national level of only 11.3% (Figure 2.11). This suggests that the northeast region has received limited benefits from the rapid economic growth.

The persistent regional poverty is confirmed by studies by state agencies carried out to identify target villages under the national poverty alleviation policy. The objective was to eliminate poverty and improve Thai people's lives in equitable and balanced ways under the "Sufficient Economy" concept initiated by His Majesty the King of Thailand (National Economic and Social Development Board, 2003). Currently, the Royal Thai government is developing an "area-based approach" to better pinpoint geographic areas where poor populations are concentrated. This project came under the management of the CDP-PAM (Country Development Partnership in Poverty Analysis and Monitoring) the World Bank, in collaboration with the Thailand Development Research Institute (TDRI), the Office of National Economic and Social Development Board (NESDB) and the National Statistics Office (NSO); the project's main aim was to construct the first poverty map for Thailand using the World Bank method (Jitsuchon, 2001). As defined in the national plan, around 40% of all the targeted poor villages at national level were located in the northeast region (Table 2.4).

Currently, this agriculture-based region is responsible for a large share in the export of rice, field crops, and tree plantations. According to the recent OAE report (2007) rice, sugarcane, cassava, maize, kenaf and Para rubber are listed as major economic plants in this region (Figure 2.12). However, sugarcane and maize are rarely produced in the lower northeast because the low-lying landform is less favourable for these crops. Household income commonly comes from the sale of rice and cassava. Para rubber plantations are increasing in response to its high price in the market. But this plant has limitations due to its high investment (availability of land and cash) costs, and long growth (7 years) harvesting cycle. Only better-off farmers can afford to grow it.

[1] The official poverty line of Thailand in 2004 was 1,300 baht (28 euro) per head per month assessed by the National Economic and Social Development Board (NESDB), Bangkok.



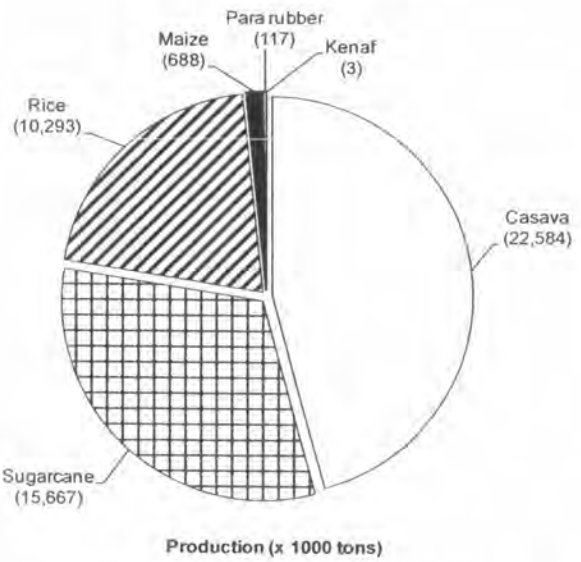
Source: Socioeconomic Survey, National Statistical Office, complied by National Economic and Social Development Board (NESDB), Bangkok.

Figure 2.11 Evolution of poverty incidences and official poverty thresholds (1988-2004).

Table 2.4 Regional distribution of poverty in the 9th National Economic and Social Development Plan

Region	*Province*	*Districts*	*Sub-districts*	*Target villages*	*Percent of target villages*
Northeast	19	320	1,878	6,676	39.9
North	17	193	1,235	5,806	34.7
Central	25	195	841	3,012	18.0
South	14	138	532	1,241	7.4
Whole Kingdom	75	846	4,486	16,735	100

Source: http://poverty.nesdb.go.th/Province/pov_area.htm the 9th National Economic and Social Development Plan



Source: Agricultural Statistics of Thailand, Centre for Agricultural Information, Office of Agricultural Economics, Ministry of Agriculture and Co-operatives, Bangkok.

Figure 2.12 Share of major crop and para rubber production in northeast Thailand (2006).

2.2.3. Household Characteristics and Sources of Income

As one fourth of the people in northeast Thailand are engaged in the low profit agricultural sector, a farm survey by the Office of Agricultural Economics (Office of Agricultural Economics, 2007) found that around 2.7 millions households were resource-poor farmers with an average size of land holding at 3.2 ha. Rice, glutinous for Laotian and non-glutinous for Thai and Khmer ethnic groups, is a main staple cereal in the local household food systems but its production contributes only 17-20% of the total cash income. Apart from rice, the northeast region is also producing more and more industrial cash crops (cassava, sugarcane, maize) but this economic activity

is limited in the lower northeast. Rice is produced on most small holdings to reduce household expenses. These resource-poor farmers often encounter insufficient cash flow to meet basic human needs and face very serious indebtedness (Table 2.5).

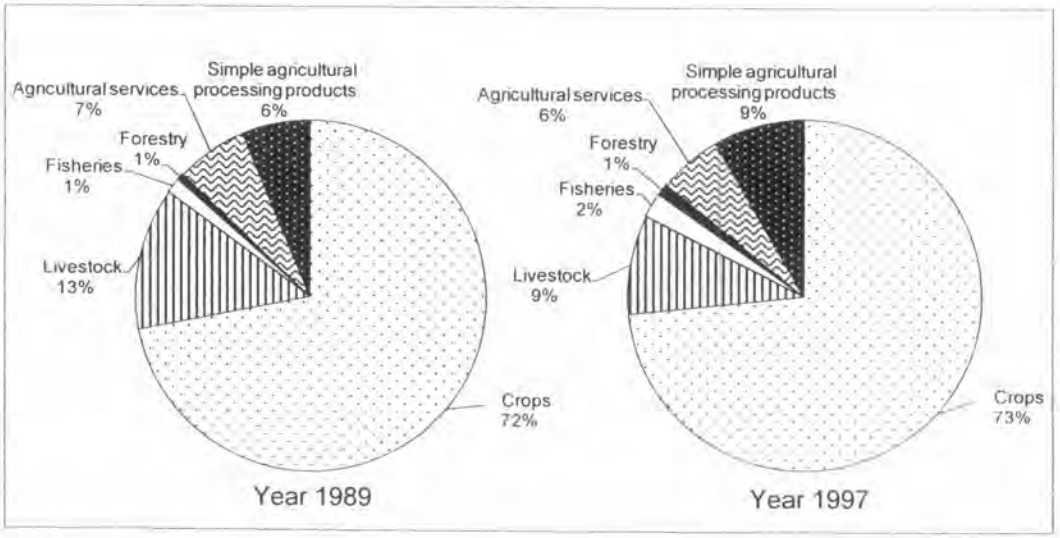
Table 2.5 Recent average economic characteristics of farming households in northeast Thailand (2000-2004).

	Year		
Household characteristics	*2000*	*2002*	*2004*
Size	3.9	3.7	3.7
Farm holding size (ha)	3.6	3.5	3.4
Monthly income (euro)	173	206	225
Monthly expenditure (euro)	145	168	189
Amount of debt (euro)	1,167	1,467	1,851

Source: Statistic Year Book 2006, National Statistical Office, Ministry of Information and Communication Technology, Bangkok.

A common response to this unfavourable economic situation is labour migration in order to find more profitable employment in urban areas. Once some family workers move out, the household needs to adapt its farming strategy and practices to deal with family labour scarcity. More labour-intensive farm activities are either abandoned or downsized. Figure 2.13 shows that the share of labour-intensive livestock production decreased between 1989 and 1997.

The relative poverty of people living in the northeast can be considered as a result of the low profitability of the agricultural-based economy. Labour migration from this region plays a key role in alleviating poverty by securing more income from the non-farm sectors. The expected higher income at a receiving region such as Bangkok is seen as a major pull factor. Based on neoclassical economic theory, the key push factor driving resource-poor farmers to migrate are unfavourable environmental conditions at the sending region. In the case of this large agricultural-based region, it always refers to low agricultural productivity as a result of unfavourable agroecological conditions.



Source: Office of the National Economic and Social Development Board (NESDB), Office of the Prime Minister, Bangkok.

Figure 2.13 Recent changes in composition of the Gross Domestic Product (GDP) from the northeast's farm sector[4].

2.3. Biophysical Settings

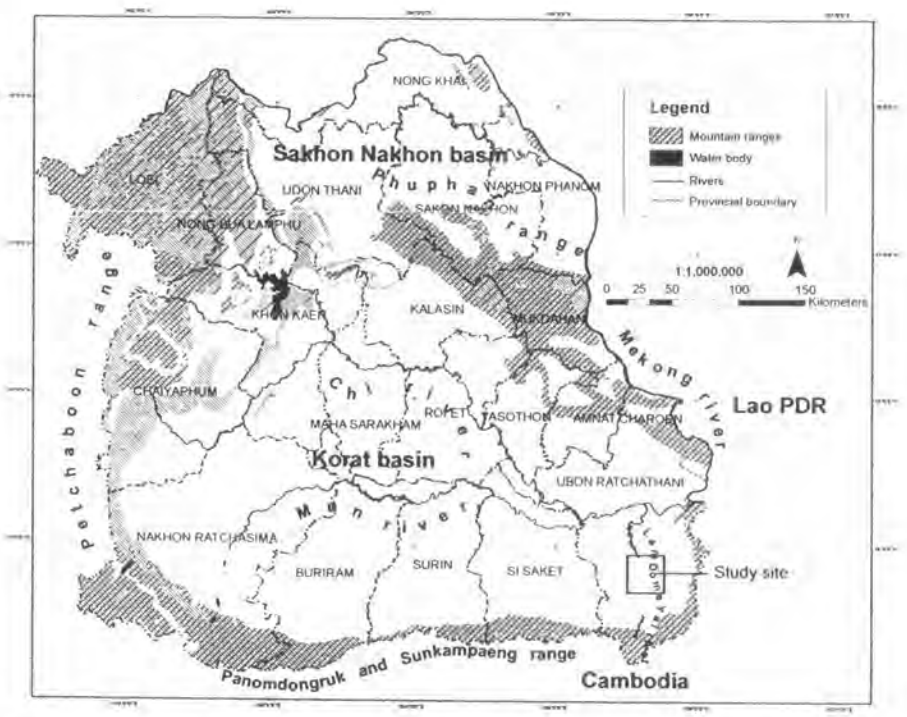
The northeast biophysical conditions are an important cause of low agricultural productivity. The climate and soil constraints, the limitations of irrigation systems, and the improvement of transportation all influence the current characteristics of land and water resources in the region. This section presents these components of the regional biophysical system in relation to low farm productivity leading to high poverty rates at regional level.

2.3.1. Geology, Geomorphology, Landform and Soil Conditions

The geomorphologic process originates the soil conditions in relation to landforms, which feature key constraints on agricultural yield, and impede the usefulness of irrigation infrastructures. Geologically, the northeast consists of a massive Cretaceous sandstone plateau (United Nations, 2001). An extensive outcrop of Mesozoic rock occurs on the Korat Plateau rimmed by an escarpment which forms ridges rising from 600-1,000 meters above mean sea level (Cooper, Harbert et al., 2000). The Korat

[4] Updated data are available but the sub-categories of farm sector are grouped into two types; 1) agriculture, hunting and forestry, and 2) fishery, which cause difficulty when comparison was carried out by using data surveyed before 1997.

Plateau has a "sauce-pan morphology" and is gently undulating between 150 and 500 meters above mean sea level (Piyasin, 1995). The region is divided into two depositional basins by the Phuphan Range (Figure 2.14). The upper part from the northwest to southeast is the Sakhon Nakhon Basin covering one-fifth of the region. The lower part contains two main rivers, the Chi and Mun, which are situated in the Korat Basin.

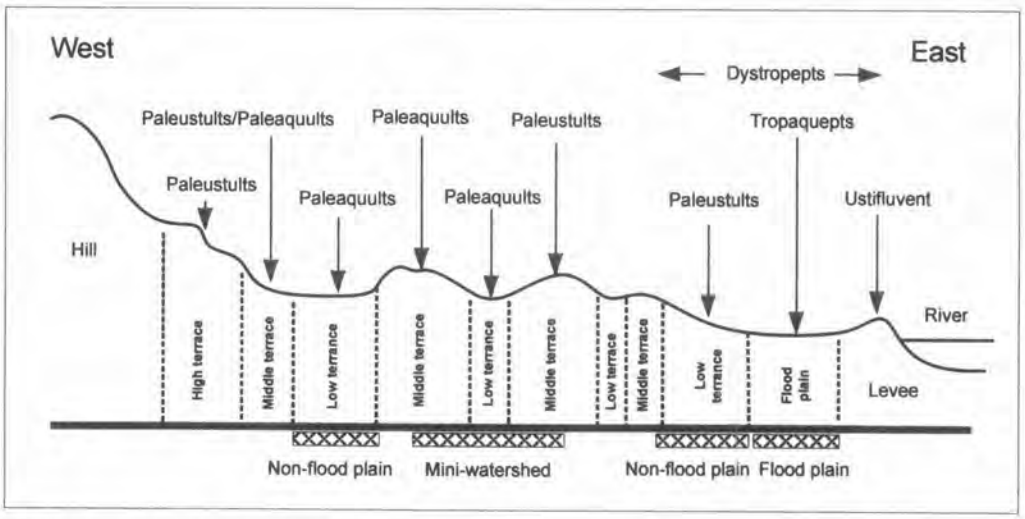


Source: Adapted from northeast regional topographic map, Geographic Information System Centre, Faculty of Engineering, Ubon Rajathanee University, Ubon Ratchathani (2002).

Figure 2.14 Simplified topographic map displaying two major depositional basins, Sakhon Nakhon and Korat basins of northeast Thailand.

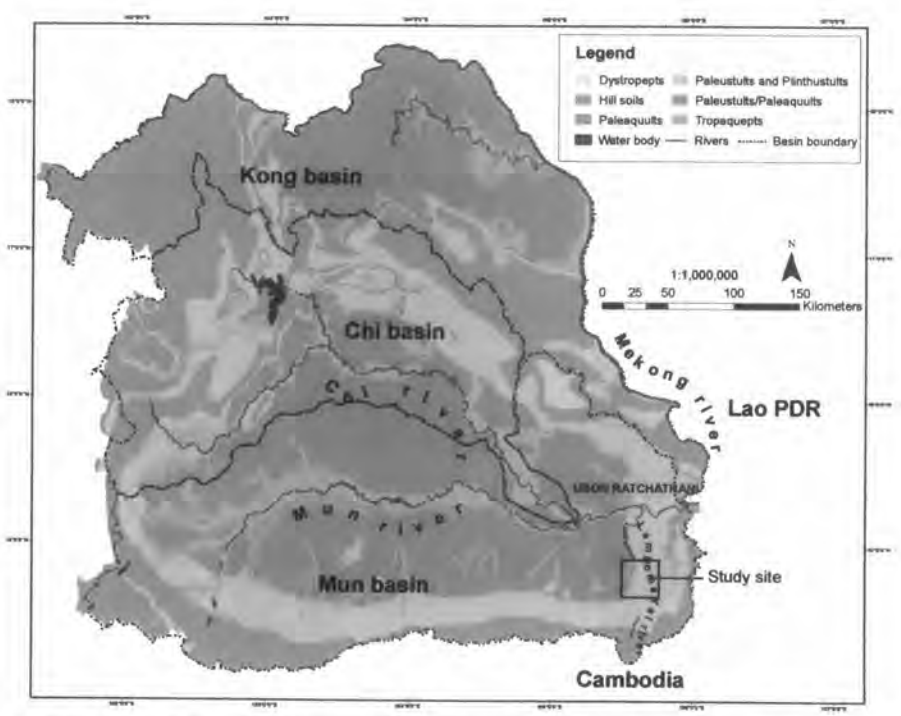
The topography of the northeast region consists of rivers, levees, flood plains, low terraces (non-flood plains), undulating middle terraces, and high terraces (hills and mountains). In general, the land is rolling with elevation decreasing from the west to the east and down to the Mekong River. Different landscape patterns are composed of different soil types creating constrained agroecosystems (Figure 2.15). According

to the study by Limpinuntana (2001), more than 65% of the land in the northeast is covered by the Paleaquults and Paleustults (Figure 2.16).



Source: The Northeast Agriculture Extension Centre (1995).

Figure 2.15 Transect of typical soils in relation to landform found in the northeast of Thailand.



Source: Adapted from northeast geological map, Geographic Information System Centre, Faculty of Engineering, Ubon Rajathanee University, Ubon Ratchathani (2002).

Figure 2.16 Simplified soil map of northeast Thailand.

The Paleaquults are poorly drained and saturated at certain times of the year and are used for RLR cultivation. These soils are found in the low terraces of undulating land and non-flood plains. The Paleustults, often found on the higher terraces, have a sandy texture with low water holding capacity. They are dry for more than 90 days per year, and they are used to grow upland crops such as cassava, sugarcane and kenaf.

The alluvial soils, the Ustifluvents, Tropaquepts and Dystropepts, lie along the Chi and Mun Rivers. The Ustifluvents cover the natural levees while the others are found on the adjacent flood plain. The Tropaquepts, characterized by their fine to medium textures are well drained, and slightly acid and used primarily for horticulture crops. The Dystropepts are fine textured and poorly drained soils. Most soils found in this region have a low level of physical and chemical fertility and limited potentials for crop production. Key soil parameters of a typical regional soil series, Nam Pong, found in Ubon Ratchathani province, indicate its very coarse texture, deficiencies in major nutrients, low organic matter content, low water-holding capacity, and low cation exchange capacities (Table 2.6).

Table 2.6 Properties of Nam Phong series of soils in Det Udom district, Ubon Ratchathani province.

Soil parameter	*Range*	*Mean*
Particle size distribution : 0-30/35 cm (%)		
Sand	88.2 - 94.6	90.9
Silt	3.6 - 9.4	6.5
Clay	1.7 - 3.6	2.6
Particle size distribution : 30/35-60/70 cm (%)		
Sand	88.0 - 95.4	91.2
Silt	3.1 - 10.3	6.7
Clay	1.4 - 4.5	2.1
pH (1:1)	3.9 - 5.2	4.2
Organic matter content (%)	0.39 - 1.79	0.85
Total N (%)	0.02 - 0.08	0.04
Extractable P (Bray II, ppm)	6.1 - 19.0	9.8
Extractable K (ammonium acetate, pH7, ppm)	5.0 - 12.6	8.6
CEC ($meq100g^{-1}$)	0.32 - 1.28	0.83

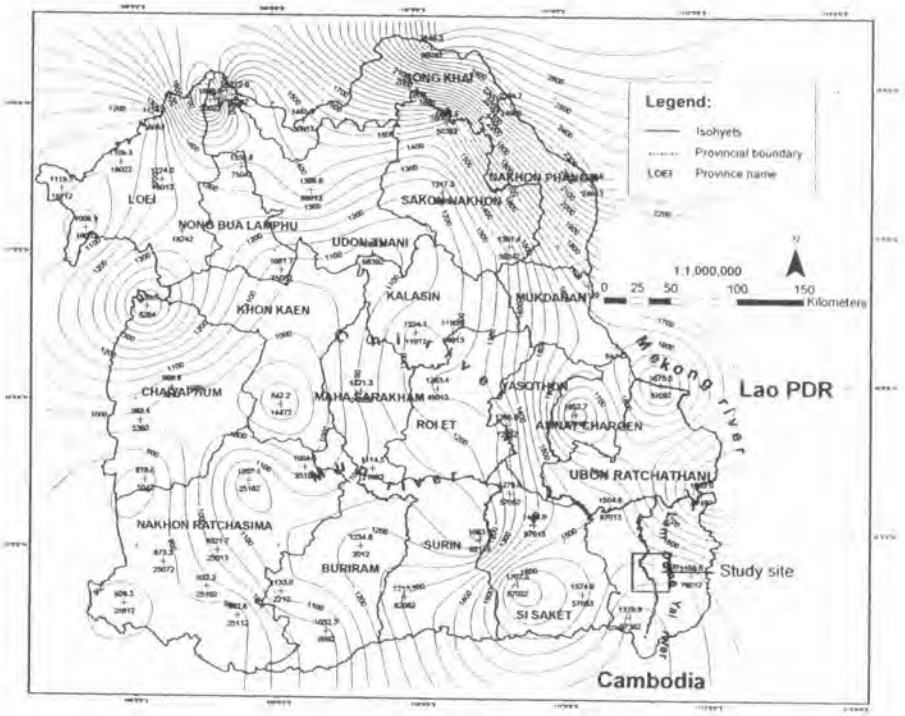
Source: Hampichitvitava and Trébuil, 2000

However, it is not only the rolling landforms and poor soil quality that are limiting agricultural production. Climatic conditions, in particular, the erratic rainfall distribution also limit farming activities and generate additional risk of crop failure in this region.

2.3.2. Climatic Conditions

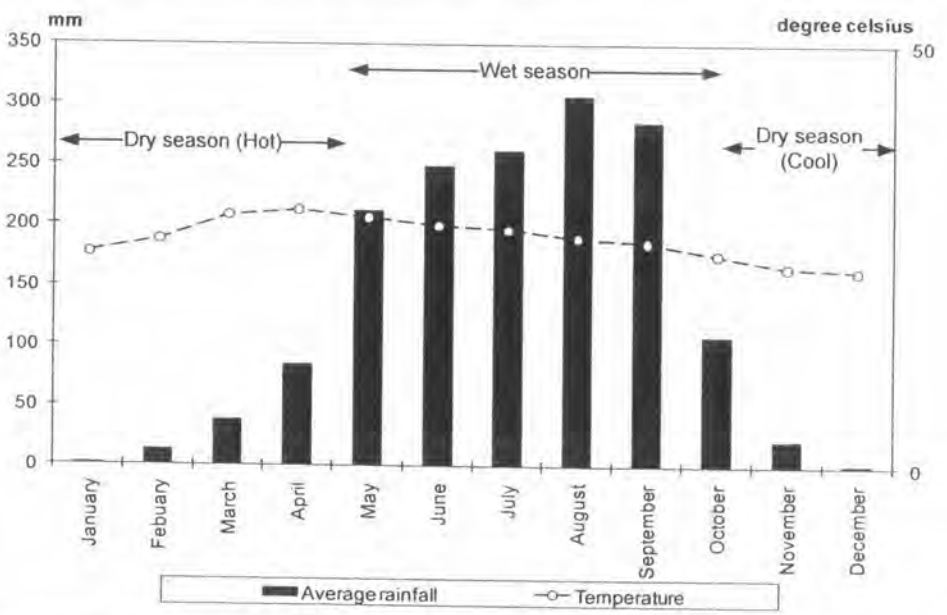
Thailand's climate is under the influence of seasonal monsoons that determine its major seasons. Average rainfall in the northeast region is 1,200 mm per year, which is similar to other regions. Spatially, rainfall is higher in the northeastern part of the region and gradually decreases westwards up to Nakorn Ratchasima province in the southeast (Figure 2.17). These rainfall patterns result from the mountain ranges on the west blocking the wet monsoon. Also, the western part of the region receives less rainfall generated by tropical depression, which is downgraded from the typhoon of the Pacific Ocean, bringing heavy rain to the upper Northeast and North during August to September. But, northeast farmers still suffer from frequent droughts alternating with floods in low-lying areas.

The southwest monsoon brings moisture from the Indian Ocean during the wet season from May to October. But probability of high rainfall is found only for two months: August, and September (Figure 2.18). At the end of the wet season, the dry and cold northeast monsoon from mainland China settles in November. Consequently, this region faces very dry and very hot conditions for about 6 months until April. At the beginning of the rainy season (May-July), the occurrence of rainfall is highly unpredictable and early season drought in June and July is likely to happen when rice seedlings have to be transplanted (Figure 2.19). Moreover, a late season drought can also occur in September and October during the RLR reproductive phase. High rainfall and a water table that has risen up close to the surface in August and September limit the effects of dry spells during this period. However, devastating floods may occur if exceptionally high rainfall results from depressions following downgraded cyclones originating in the South China Sea. The groundwater level generally recedes quickly after mid-October making rice susceptible to the risk of late season drought in higher paddies causing significant yield reduction.



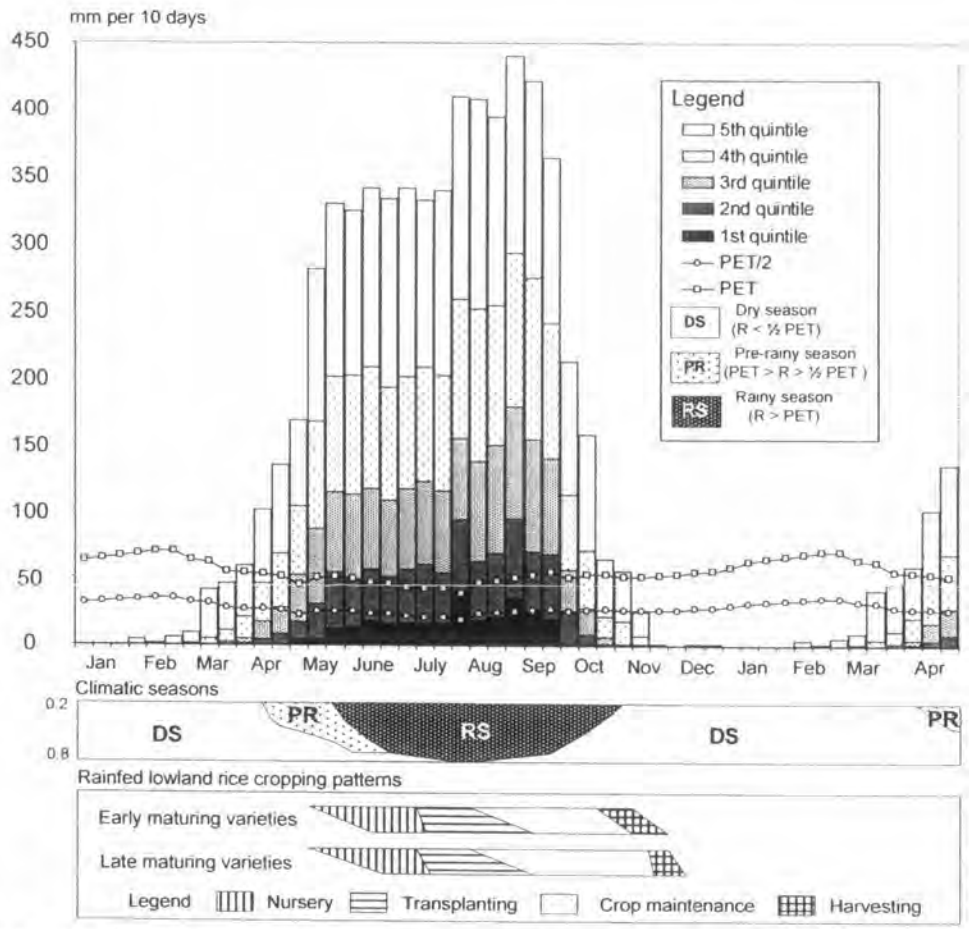
Source: Adapted from northeast regional rainfall distribution map, Geographic Information System Centre, Faculty of Engineering, Ubon Rajathanee University, Ubon Ratchathani (2002).

Figure 2.17 Annual rainfall distribution in the northeast of Thailand and location of the research site in Lam Dome Yai watershed, Ubon Ratchathani province.



Source: Regional Meteorological Centre, Ministry of Information and Communication Technology, Ubon Ratchathani.

Figure 2.18 Average monthly rainfall quantity and temperature of Ubon Ratchathani province, Thailand.



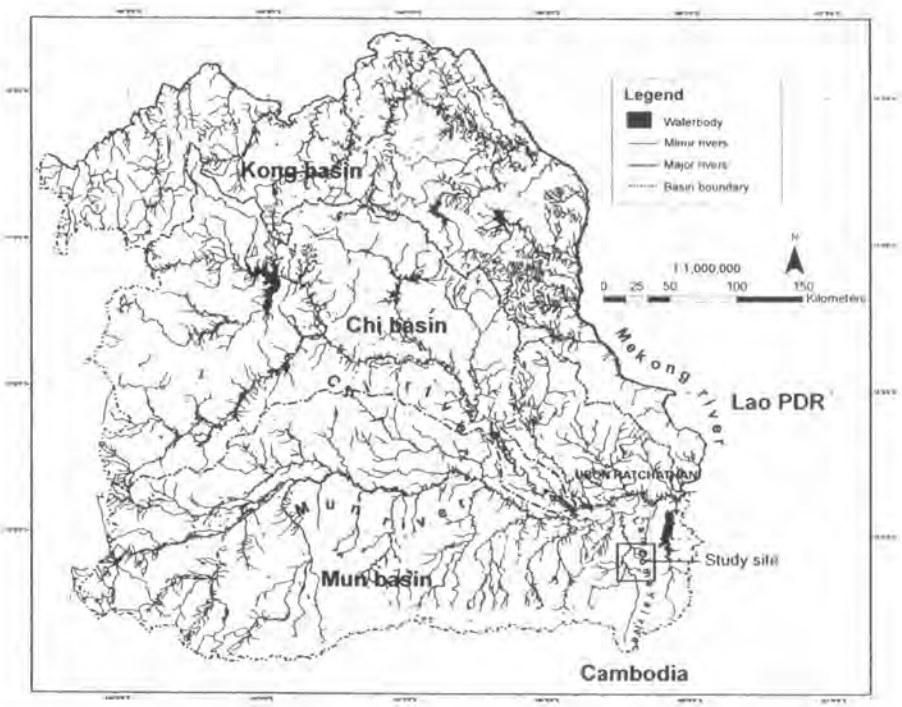
Source: Regional Meteorological Centre, Ministry of Information and Communication Technology, Ubon Ratchathani.

Figure 2.19 Frequential climatic analysis of Ubon Ratchathani province and related RLR cropping patterns (1954-2003).

Supplementing water during dry spells is a way to alleviate drought stress. Therefore, many irrigation infrastructures have been implemented to improve water availability, but the effectiveness of these infrastructures is very limited because of unfavourable topographic and soil characteristics. Thus, the rainwater amount and its distribution still play a crucial role in determining agricultural yields. But erratic rainfall distribution has farmers adapting their cropping calendar and practices to different field conditions (upper, middle, lower paddies) such as soil moisture and water accessibility.

2.3.3. Hydrosystem and the Evolution of Irrigation Infrastructure

Based on the regional hydrosystem, the northeast consists of three major basins: the Kong, the Chi and the Mun basins (Figure 2.20). All tributaries in the Kong Basin flow eastwards into the Mekong River. The Chi and Mun are main rivers of the Chi and Mun basins respectively. These two rivers originate at Phetchabun and Dong Prayayen mountain range in the western part of region, separating the Central plain and the northeast region. The Chi River joins the Mun River in Ubon Ratchathani province, flowing eastwards to join the Mekong River at the Thai-Lao PDR border. The Mun Basin is the largest one with a coverage area of 69,711 km^2, followed by 57,422 km^2 for the Kong Basin and 49,477 km^2 for the smallest Chi Basin (Wirojanagud and Sriwaoramat, 2000).

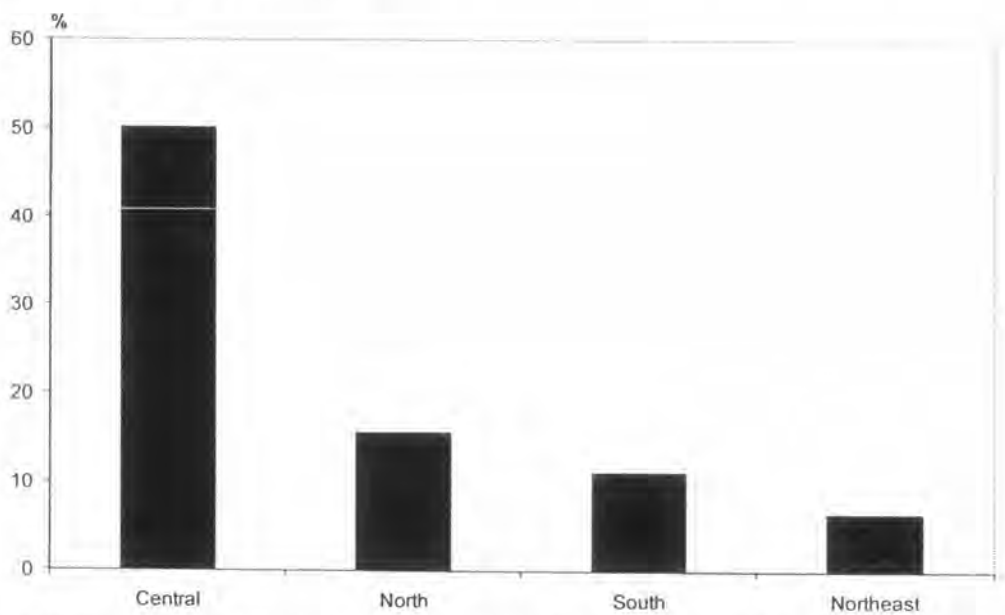


Source: Adapted from northeast regional hydrosystem map, Geographic Information System Centre, Faculty of Engineering, Ubon Rajathanee University, Ubon Ratchathani (2002).

Figure 2.20 Hydrosystem map displaying three major basins, Kong, Chi and Mun, in northeast Thailand.

Irrigation infrastructures have been built to improve water availability for agricultural production and generate hydropower electricity throughout the kingdom,

but the northeast region received less attention in the early days. Water improvement schemes have allocated resources to this region since 1960, but the usefulness of and access to irrigation facilities is still very limited. Although the northeast has the largest rice producing area of the country, only 6% of its paddy fields were irrigated in 2005 (Figure 2.21). Inadequate access to irrigation forces agricultural production to depend mainly on highly variable rainfall and successful crops are still relying on "a bet on the monsoon" approach.



Source: Agricultural Statistics of Thailand, Centre for Agricultural Information, Office of Agricultural Economics, Ministry of Agriculture and Co-operatives, Bangkok.

Figure 2.21 Share of irrigated farm land by region, Thailand (2005).

Before the 1960s, all the major irrigation projects in Thailand were located in the central and northern regions. The northeast hydrosystem was neglected until the systematic development of irrigation systems began with the first National Economic Development Plan (1961-1966). The first large-scale irrigation project completed in the northeast in 1965 was the Nam Phung Dam in Sakhon Nakohon province, upper northeast Thailand. Following this project, the Chi-Mun Basin saw the construction of the Ubolrattana, Sirinthorn and Chulaporn hydropower dams and reservoirs, and a number of irrigation dams and weirs, including the Lam Pao, Lam Pra Phloeng, Lam Takhong, and Lam Nang Rong dams. The Pak Mun Dam is the latest multi-purpose irrigation project and started to operate in 1994 (Table 2.7).

In 1978, a water policy for the northeast region was planned in the National Master Plan. It followed a two-pronged approach: (i) the effective distribution of available water resources from large reservoirs and reliable rivers to the people adjacent to these sources, and (ii) the development of small water resource projects to meet basic water requirements of the local communities living some distance away from large reservoirs and reliable rivers (Asian Institute of technology, 1978; The World Commission on Dams, 2000). As a result, more medium-sized irrigation projects were constructed in the northeast region. Between 1980 and early 2000, some of those projects were located in Ubon Ratchathani province (Table 2.8).

Table 2.7 Medium-to-large scale irrigation infrastructure built in northeast Thailand (1965-1994).

Completed in year	*Project name*	*Primary purpose*	*Location*		*Storage capacity* ($10^6 \times m^3$)	*Irrigation area (ha)*
			District	*Province*		
1965	Nam Phung Dam [1]	Hydroelectricity	Phupan	Sakon Nakhon	165	na
1966	Ubolrattana Dam [1]	Hydroelectricity	Ubolrat	Khon Kaen	2,263	48,000
1969	Lam Pao Dam [2]	Irrigation	Muang	Kalasin	2,450	50,288
1969	Lam Phra Phloeng [2]	Irrigation	Pak Thong Chai	Nakhon Ratchasima	152	na
1969	Lam Takong Dam [2]	Irrigation	Si Que	Nakhon Ratchasima	324	20,406
1971	Sirinthon Dam [1]	Hydroelectricity	Sirinthon	Ubon Ratchathani	1,996	24,320
1972	Chulabhon Dam [1]	Hydroelectricity	Khonsan	Chaiyaphum	188	11,376
1982	Lam Nang Rong Dam [2]	Irrigation	Lahansai	Buriram	150	18,098
1994	Pak Mun Dam [1]	Hydroelectricity	Khong Chiam	Ubon Ratchathani	na	25,600

na: not available
Source: [1] Electricity Generating Authority of Thailand, Ministry of Energy, Bangkok.
[2] Royal Irrigation Department, Ministry of Agriculture and Co-operatives, Bangkok.

Table 2.8 Medium scale irrigation schemes built in Ubon Ratchathani province (1951-2003).

Completed in year	*Project name*	*Type*	*Location*		*Storage capacity*	*Planned irrigated area*	*Actually irrigated area*	*Actual/Predicted irrigated area*	*Cost*
			Sub-district	*District*	($10^6 \times m^3$)	*(ha)*	*(ha)*	*(%)*	*(x 1000 euros)*
1951	Nong Lao Hin	Reservoir	Sank Hao	Khung Nai	2.3	160	107	67	na
1953	Hua Wang Deang	Reservoir	Pho Sai	Phibunmungsaharn	0.7	88	88	100	na
1953	Nong Chang Yai	Reservoir	Hua Raue	Muang, Ubon	7.7	720	689	96	na
1953	Sa Ming	Reservoir	Nong Bok	Laosuekok	1.0	120	23	19	na
1984	Hua Tum Kae	Reservoir	Kum Chareon	Trakarnphutphon	13.7	1,863	1,863	100	na
1986	Lam Dome Yai	Reservoir	Muang Det	Det Udom	1.6	240	na	na	550
1987	Hua Jun La	Reservoir	Klom Pradit	Num Yeun	16.9	2,000	2,000	100	na
1988	Lower Hua Phalan Sua	Reservoir	Klom Pradit	Num Yeun	27.7	932	932	100	na
1994	Hua Wang Yai	Reservoir	Klom Pradit	Num Yeun	8.0	576	na	na	na
1999	Hua Bang Koy	Weir	Kam Pom	Khemmarat	1.0	320	na	na	780
2003	Hua Den Ha	Reservoir	Hua Kar	Bunthank	12.0	na	na	na	na
2003	Hua Saphongnoi	Reservoir	Hua Kar	Bunthank	15.0	na	na	na	na

na: not available
Source: Irrigation Office, Region 7, Royal Irrigation Department, Ministry of Agriculture and Co-operatives, Ubon Ratchathani (2006)

Because the topographic and soil characteristics of the northeast are not well suited to large-scale irrigation projects, the current water resources development plan in the Chi-Mun Basin confirms a strategy centred on the development of small-scale water resources (Khon Kaen University, 1994; Progress Technology Consultant Co. Ltd., 2005). For instance, in Ubon Ratchathani province, small-scale irrigation infrastructures at the community level have been encouraged since 1981 (Table 2.9).

Table 2.9 Small scale irrigation infrastructure built in Lam Dome Yai watershed, Ubon Ratchathani province (1978-2002).

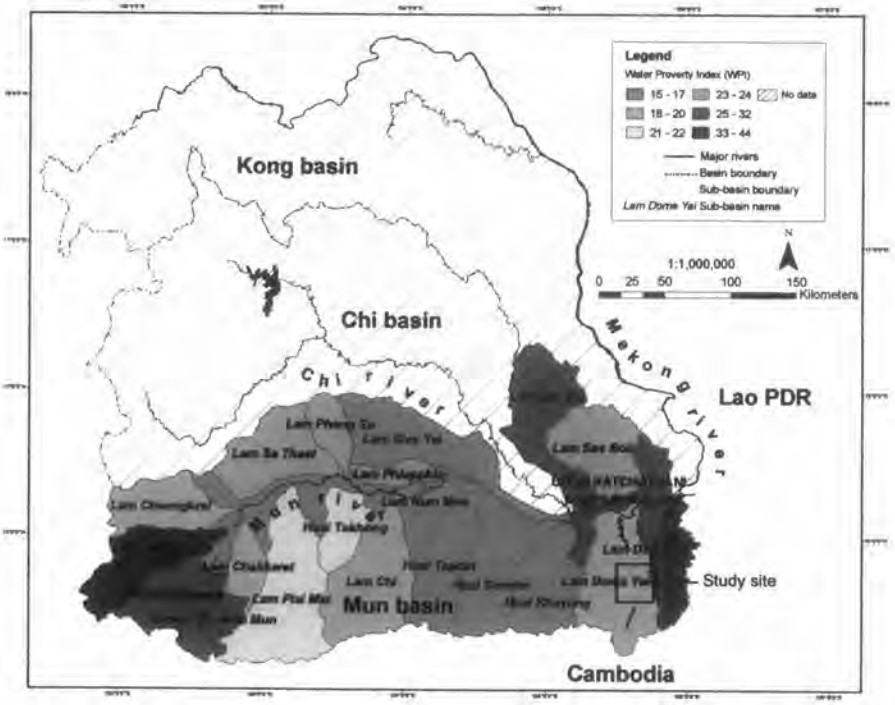
Completed in year	Project name	Type	Location		Storage capacity	Irrigation area	Number of benefiting Households	Cost
			Sub-district	District	(m3)	(ha)		(x 1000 euros)
1978	Beng Tha Chang	Reservoir	Tha Chang	Sawangweerawong	650,000	96	na	na
1980	Hua Pai	Weir	Rai Tai	Phibunmungsaharn	320,000	80	na	na
1980	Hua Kha	Reservoir	kang Dome	Sawangweerawong	322,000	160	na	na
1981	Hua Hin Siew	Weir	Kumkrang	Det Udom	108,360	32	280	60
1981	Hua La Long	Weir	Kumkrang	Det Udom	63,000	24	650	30
1981	Hua Oum	Reservoir	Na Chaluai	Na Chaluai	380,000	32	40	40
1981	Hua Sun	Reservoir	Na Chaluai	Na Chaluai	800,000	48	2,400	46
1981	Hua Bon	Weir	Song	Nam Yun	180,000	24	na	na
1982	Hua Ar Rong	Weir	Somsa-ard	Det Udom	320,000	80	534	33
1982	Hua Can	Weir	Na Suang	Det Udom	320,000	16	564	38
1982	Hua Lok	Reservoir	Na Chaluai	Na Chaluai	350,000	3	240	46
1983	Hua Can	Weir	Na Suang	Det Udom	320,000	16	170	38
1983	Hua Hin Siew	Weir	Phon Ngam	Det Udom	240,000	32	250	51
1983	Hua Bua	Weir	Klang	Det Udom	320,000	19	120	41
1983	Hua Chaluai	Reservoir	Na Chaluai	Na Chaluai	1,104,000	192	400	65
1983	Hua Pun	Reservoir	Ban Toom	Na Chaluai	1,354,200	32	100	66
1983	Hua Song	Reservoir	Song	Nam Yun	150,000	48	na	na
1983	Hua Sun (North)	Reservoir	Na Chaluai	Na Chaluai	530,000	na	na	na
1984	Hua Sadok	Reservoir	Na Yea	Na Yea	1,941,909	32	na	na
1984	Hua Damrong	Reservoir	Kee Lek	Nam Khun	1,457,311	96	na	na
1984	Hua Chorm	Weir	Kreng	Det Udom	320,000	32	160	42
1984	Kud Ngo	Reservoir	Muang Det	Det Udom	427,280	8	250	44
1984	Hua Pun	Reservoir	Na Chaluai	Na Chaluai	130,600	56	400	106
1984	Hua Non Yang	Reservoir	Tha Pao	Nam Khun	127,740	48	na	na
1984	Hua Rong Tan	Reservoir	Na Chaluai	Na Chaluai	200,000	80	na	na
1984	Hua Aum	Reservoir	Na Chaluai	Na Chaluai	853,000	80	na	na
1985	Hua Keng Aom	Reservoir	Na Reung	Na Yea	408,000	32	na	na
1985	Hua Bua	Weir	Klang	Det Udom	320,000	19	120	77
1985	Hua Aree	Weir	Nong Aum	Tungsriudom	320,000	8	na	na
1986	Hua Rad	Reservoir	Pu Pue	Nam Yun	416,800	32	na	na
1987	Hua Som	Reservoir	Phiboon	Nam Khun	214,476	160	na	na
1988	Hua Chaluai	Reservoir	Ban Tum	Na Chaluai	401,615	32	500	67
1989	Hua Som	Weir	Kud Rue	Tungsriudom	320,000	32	na	na
1989	Hua Tha Koy	Reservoir	Song	Nam Yun	910,000	48	na	na
1990	Hua Jan	Reservoir	Na Reung	Na Yea	267,000	320	na	na
1990	Hua Tiam	Weir	Non Somboon	Na Chaluai	320,000	32	190	107
1990	Nong Kd Vien	Reservoir	Ko Kong	Samrong	162,170	2	na	na
1991	Nong Kam Phak Wan	Reservoir	Sawang	Sawangweerawong	201,700	na	na	na
1992	Hua Bua Tiam	Weir	Klang	Det Udom	320,000	80	400	174
1992	Hua Ta Kod	Weir	Ban Toom	Na Chaluai	320,000	32	492	156
1992	Hua Som	Weir	Ko Saard	Nam Khun	320,000	80	na	na
1992	Hua Sun	Reservoir	Tha Chang	Sawangweerawong	4,040,000	16	na	na
1993	Hua Aree	Weir	Nong Aum	Tungsriudom	320,000	80	na	na
1995	Hua Karm	Weir	Meung Det	Det Udom	320,000	128	251	122
1995	Hua Fung Deang	Weir	Yang	Nam Yun	320,000	64	na	na
1997	Hua Fung Deang	Reservoir	Tha Kao	Nam Khun	320,000	64	na	na
2001	Hua Kao San	Weir	Na Suang	Det Udom	320,000	16	na	na
2002	Hua Som	Weir	Phiboon	Nam Khun	61,000	128	na	na

na: not available
Source: Irrigation Office, Region 7, Royal Irrigation Department, Ministry of Agriculture and Co-operatives, Ubon Ratchathani (2006)

At the household level, the development of on-farm water resources based on tens of thousands of small farm ponds (storing a maximum of some 1,260 m^3 of water), under the responsibility of the Agricultural Land Reform Office (ALRO), Ministry of Agriculture and Co-operatives, has been well-adopted by farmers during the past 15 years.

A study conducted by the Progress Technology Consultants (2005) quantified and ranked the water-related poverty of each of the sub-basins in the Mun Basin by use of the Water Poverty Index (WPI). The WPI has been conceived as an interdisciplinary index integrating both physical and social parameters in a structured framework to identify and assess poverty in relation to water resource availability (Sullivan and Meigh, 2007). A low WPI score means a higher degree of poverty in relation to water resources. A low WPI also indicates that agricultural production is not only constrained by the natural conditions but also by poor water management. In this WPI assessment of that study, there were some shortcomings due to the lack of relevant environmental data to meet WPI criteria. However, the study is useful in that it provides an overview of water- poverty relations in the Mun Basin. In this basin, low WPI assessments have been recorded in many rainfed sub-basins in contrast to the sub-basins with large dams, such as Lam Takong and Lam Dome Noi where the Lam Takong and Sirinthon dams are located respectively (Figure 2.22). This figure also shows that the Lam Dome Yai watershed is adjacent to a high WPI, the Lam Dome Noi watershed. But the Lam Dome Yai is still among relatively low WPI sub-basins because of the unavailable irrigation network from the Sirinthon reservoir.

Irrigation projects in the northeast are likely to evolve from a state-controlled and centralized type of management (large dams) to a more decentralized, often individual type of management like in the case of small farm ponds. However, water accessibility through irrigation is still not region-wide. Relying on erratic rainfall causes instability of farm production leading to insecure household income. These resource-poor farmers have to find other sources of income through off-farm employment, which becomes more convenient due to the well connected transportation network.



Source: Adapted from northeast regional hydrosystem map, Geographic Information System Centre, Faculty of Engineering, Ubon Rajathanee University, Ubon Ratchathani (2002), and Water resource management plan in the Mun Basin, Progress Technology Consultant Co. Ltd. (2005).

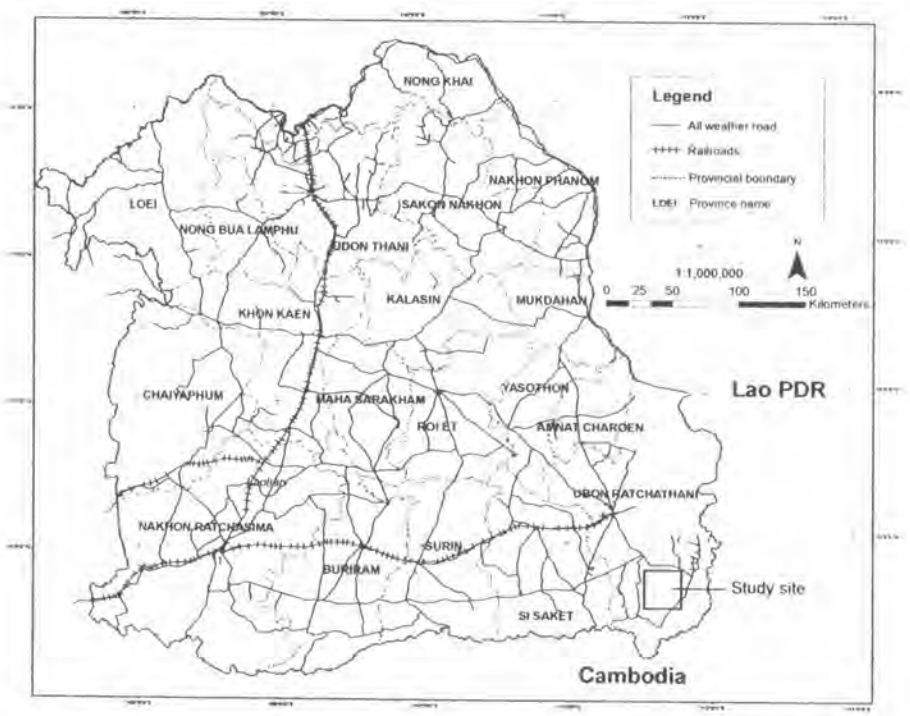
Figure 2.22 Water Poverty Index (WPI) of sub-basins in the Mun Basin, lower northeast Thailand (2005).

2.3.4. Change in Communication Infrastructure and People Mobility

Transportation links emerge to serve the increasing degrees of commercialization and industrialization, raising health and education standards, and changing government policies (Hornby and Jones, 1993). These links increasingly become an important interacting component to support commodity transportation and to stimulate people mobility.

The most convenient way to deliver agricultural inputs and products across the northeast region is the road network. Other types of transportation, such as trains, are hardly accessible because they serve only a few provinces. Historically, the regional transportation system was planned to mainly serve the purpose of military defence during the "Vietnam War" and to move labour to urban areas and factory sites in the central and eastern regions.

Completed in 1992, the railway was the first main transportation system to connect Bangkok and Nakhon Ratchasima, followed by Nong Khai in the northern part, and Ubon Ratchathani in the southern part (Promjuy et al., 2003). However, this early development stagnated, limiting accessibility to railway. Only two main railway tracks link ten provinces in the northeast to Bangkok. In contrast, the road network has been extensively developed to link the region with Bangkok through regional hubs in Nakhon Ratchasima and Khon Kean provinces (Figure 2.23).



Source: Adapted from northeast regional transportation network map, Geographic Information System Centre, Faculty of Engineering, Ubon Rajathanee University, Ubon Ratchathani (2002).

Figure 2.23 Road and railway networks in northeast Thailand.

The road network has been continuously upgraded during the past decades. Its current high quality is an important factor in the delivery of agricultural inputs to remote areas and collection of farm products; moreover, it facilitates the flow of workers from any village to large cities because of its accessibility.

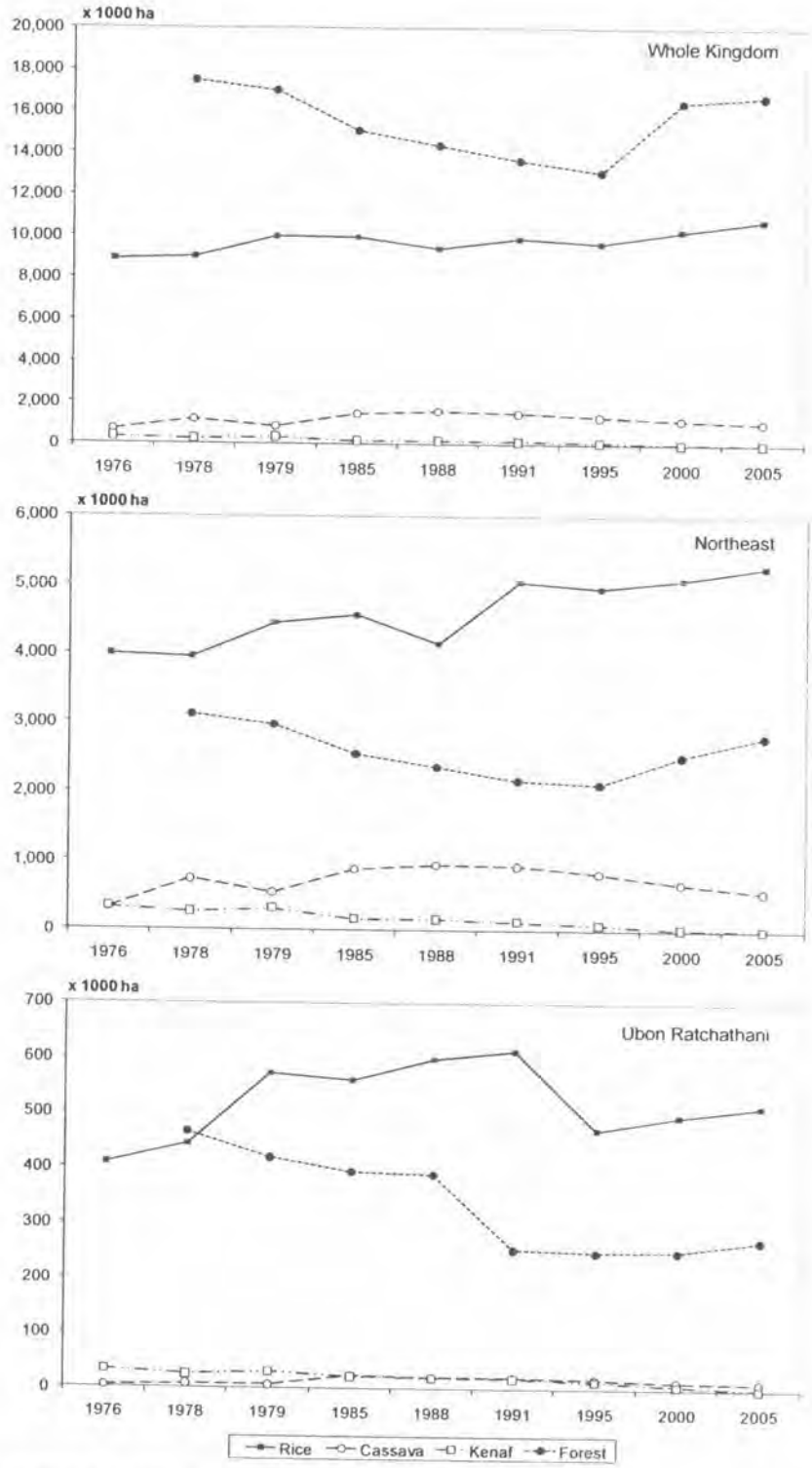
2.3.5. Land Use

National population and economic growth and expanding options for the use of modern technologies have influenced changes in land use and land cover. Figure 2.24

shows that during 1970-90, the forest cover decreased because of the demand for timber and farming land. Up until the 1970s, the northeast region was the largest producer of cassava and kenaf. After the 70s, the production of kenaf decreased rapidly due to declining prices while cassava was promoted because of the high demand from the European Union until the late 80s. The forest area stabilized following a ban on logging in 1989 and launch of a reforestation policy by the Thai government.

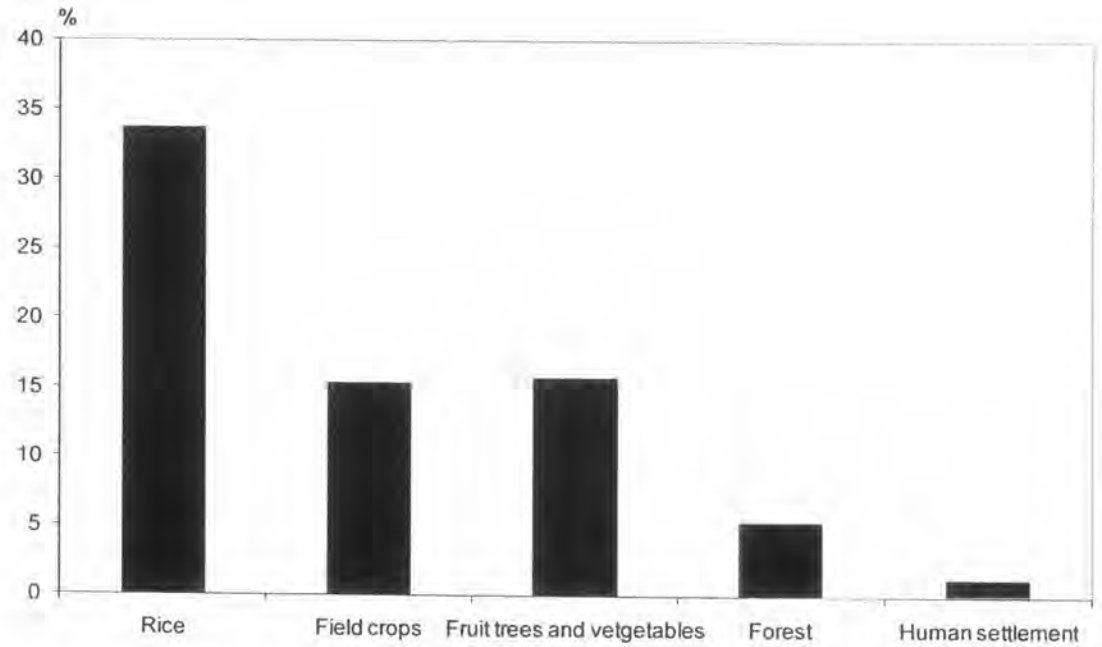
The northeast farm land covers about 8.9 million ha with rice occupying one third of this area (Figure 2.25). Nevertheless, there are various regional agroecosystems determined by landform characteristics related to different soil conditions and water availability. The hill lands are found in mountainous areas of the southern part at the Panomdongruk and Sankampaeng ranges, the west at the Petchaboon range, and the north at the Phuphan range. The soils found in these areas are more fertile than other systems (KKU-Ford Cropping System Project, 1982). Consequently, the hill lands generally produce good yields of maize, upland rice and various crops in the rainy season.

The mini-watershed is the most common agroecosystem throughout the northeast region covering about 4.9 million ha. Four micro-landscapes are defined in a mini-watershed. The upper, middle and lower paddies and the upland area for cash crop production (Grandstaff, 1988; Polthanee, 1997). The non-flood plains cover about 2.9 million ha on the lower terrace, with clayey and fertile soils, and sufficient water accumulation for rice transplanting in July or August. Moreover, with a heavy clay layer beneath the top soil, the water table is only 1-2 metres preventing water loss through infiltration (KKU-Ford Cropping System Project, 1982). This agroecological zone is suitable for RLR cultivation. The flood plains cover about 1.1 million ha along the Chi and Mun Rivers and are inundated by the annual flood caused by the overflowing of the river banks. The pattern of cultivation is very similar to the non-flood plains, RLR being the main crop with a subsequent crop of vegetables on part of the land. Because 85% of rice in the northeast is grown under rainfed conditions (Jongdee et al., 2006), the characteristics of RLR ecosystem and common local farming practices in mini-watersheds need to be precise.



Source: Agricultural Statistics of Thailand, Centre for Agricultural Information, Office of Agricultural Economics, Ministry of Agriculture and Co-operatives, Bangkok.

Figure 2.24 Evolution of production areas for rice, cassava, kenaf, and forest area in Thailand, the northeast region (1976-2005).



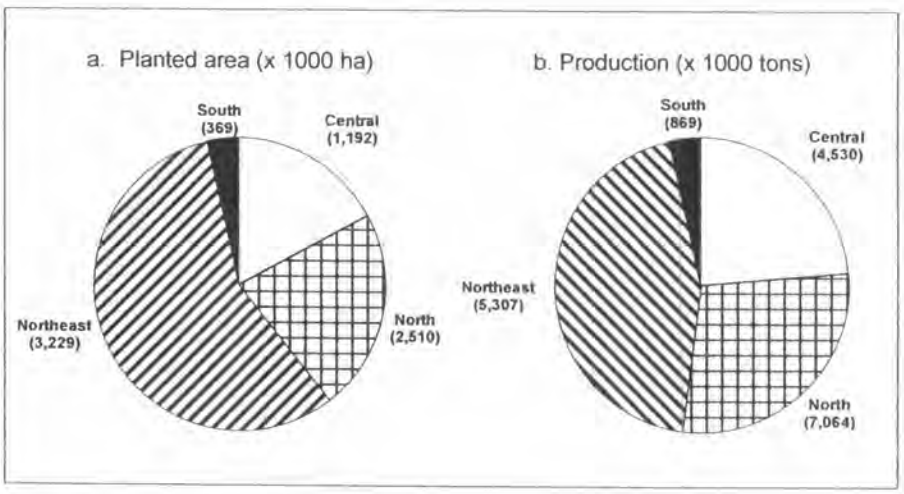
Source: Agricultural Statistics of Thailand, Centre for Agricultural Information, Office of Agricultural Economics, Ministry of Agriculture and Co-operatives, Bangkok.

Figure 2.25 Main type of land use in northeast Thailand (2005).

2.4. Characteristics of Rainfed Lowland Rice Production

The world's 40 million ha of RLR account for 29% of rice land and 19% of rice supply (Wade, Fukai et al., 1999). Most of the RLR areas are located in Asian countries, particularly in the South and Southeast. Nearly 75% of the rice produced in the wet season is grown in rainfed areas where monsoon rain is the only source of water supply (Food and Agriculture Organization, 2004). Out of about 10 million ha of rice land in Thailand, RLR is the predominant type, accounting for 67% of the total rice land area; RLR accounts for one third of rice land in the northeast region (Jongdee et al., 2006). The rainfed lowlands are defined as areas where rice is grown in unirrigated, level to slightly sloping bunded fields that have non-continuous flooding of variable depth and duration caused by rain water (Wade, 1999; Zeigler and Puckridge, 1995). RLR production occupies the largest portion of the region rice-producing area, but because of unreliable rainfall distribution and relatively poor soils, it generates a lower production at an average of 1.8 t ha^{-1} (Somrith, 1997) compared to other regions (Figure 2.26). In 2007, the Office of Agricultural

Economics, Ministry of Agriculture and Co-operatives, reported that rice productivity in the northeast was 2.1 t ha^{-1} and 2.7 t ha^{-1} at national level.



Source: Agricultural Statistics of Thailand Centre for Agricultural Information, Office of Agricultural Economics, Ministry of Agriculture and Co-operatives, Bangkok.

Figure 2.26 Rice planted area and production by region (2007).

2.4.1. Mini-watershed Characteristics

Local farmers manage their farm production based on the differences of landform reflecting soil types and water availability (Figure 2.27). In a mini-watershed, the uplands account for 20-30% of the area and consist of unbunded fields where cassava, sugarcane, kenaf and upland rice are cultivated; the uplands are also favoured for cattle grazing and house settlement. The upper paddies where cultivation depends critically on rainfall are used to produce early-maturing rice only in some years. Some farmers grow direct-seeded rice in this area to avoid the problem of insufficient water availability at rice transplanting. There are some farmers producing one or two non-rice upland crops during the rainy season in upper paddies. The middle paddies probably contain the most productive land since farmers have more water control with less risk of flooding. In lower paddies, farmers commonly grow late maturing rice varieties every year during the rainy season. Rice-based cropping systems dominate the middle and lower paddies; in some years and in more limited areas, they also dominate upper paddies if water is available.

2.4.2. Local Agricultural Practices in Rainfed Lowland Ecosystems

The soil and water characteristics of different landforms play a role in the selection of different cropping systems and farming practices (Figure 2.27). The middle and lower paddies are planted with rice, followed by vegetables in some areas. Figure 2.28 shows cropping calendars of different agroecological zones found in northeast Thailand. For rice-based cropping systems, land preparation and rice establishment normally start in mid-June. Water in farm ponds is sometimes used to supply nurseries for early rice establishment in May. But the water is mainly used to alleviate drought effects if a dry spell occurs. Farmers are likely to use the transplanting technique and choose to grow medium to late maturing varieties including the famous aromatic jasmine rice in its glutinous variety (RD6) or non-glutinous (KDML105) type. Some rice farmers use direct seeding in areas where water is likely to be inadequate such as upper paddies. Labour scarcity also drives farmers to save time by broadcasting seeds.

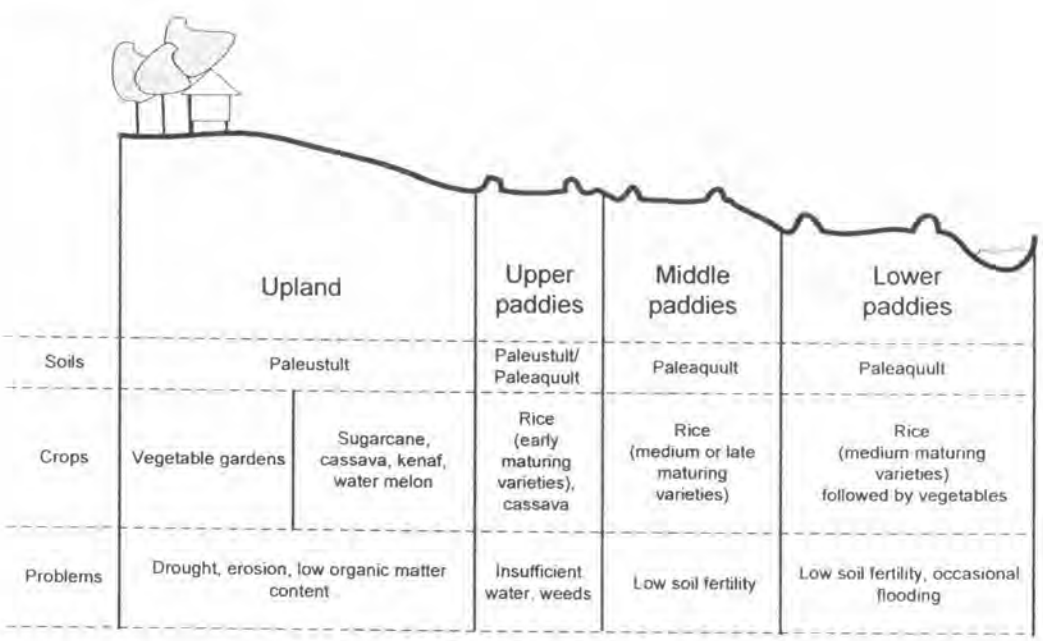
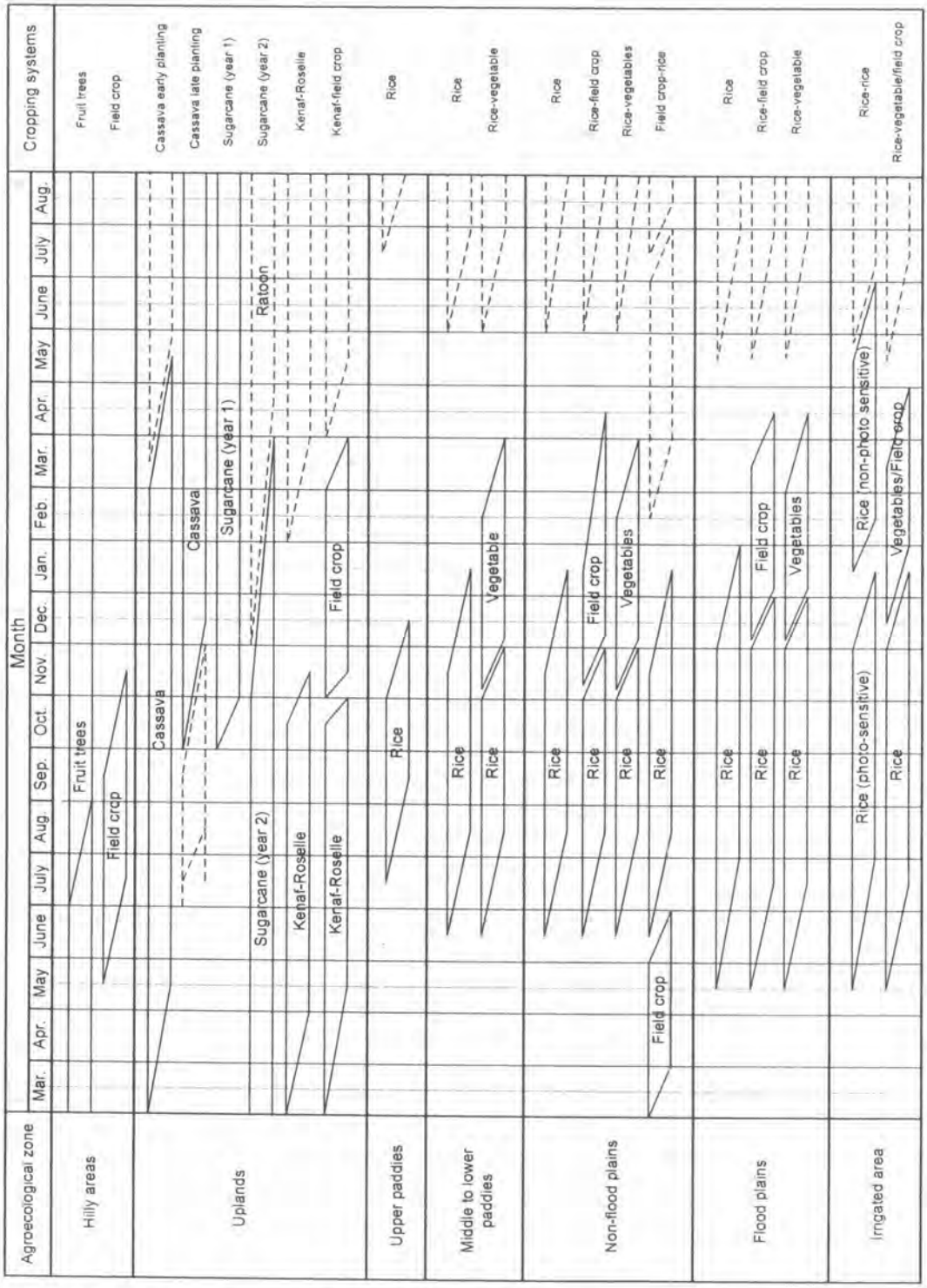


Figure 2.27 Cropping system, soil and ecological problems in relation to spatial organization of mini-watershed in rainfed lowland rice ecosystems of northeast Thailand.



Source: Adapted from An agro-ecosystem analysis of northeast Thailand (KKU-Ford Cropping System Project, 1982) and Natural resource management issues in the Korat Basin of Northeast Thailand: An overview (Limpinuntana, 2001).

Figure 2.28 Cropping calendars and main crops in relation to different agroecological zones in northeast Thailand.

Transplanting activity starts once the rice seedlings are 30 days old and the soil in the paddies is saturated. After farmers begin transplanting, the length of this activity mainly depends on the availability of family labourers. To allow rice to accumulate enough biomass, farmers usually complete transplanting before mid-September. The early maturing types are always transplanted first in upper paddies that are close to a temporary storage cottage and farm pond, followed by transplanting late maturing rice in lower paddies. This local rice-transplanting practice is carried out in response to the decreasing water level in paddies when harvesting time comes.

According to the agronomic traits of photosensitive rice varieties, early maturing rice ripens in late-October to early November. At this time, water logged in upper paddies usually dries out allowing the farmers to harvest rice more easily and with lower risks of the paddies getting wet causing a lowering of quality. In late November (21st November for KDML 105), farmers begin to harvest late maturing types that are commonly produced for sale. Therefore, farmers with high land and labour ratio usually hire additional labourers because the sooner they can finish harvesting, the higher the paddy quality, which in turn leads to higher prices at sale. These cropping systems and common farming practices have emerged from the agricultural evolutions influenced by natural changes related to demographic, political, and socioeconomic factors. The next chapter will specifically address the recent agricultural transformations and land use changes at the study site.