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Land Use and Agroforestry in Thailand with Special Reference to the Southern Region

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ABSTRACT

Thailand is a tropical monsoon country in South East Asia. About 39 and 29.5% of the total land area (51.3 million ha) are farm holding land and forest land; and 64% of the surpassing 52 millions population is agriculture population. Per capita income of the agriculture population is c. 1:8.5 of the non - agriculture population. The major cultivated crops are paddy, field crops, fruit trees, tree crops and vegetables, etc.

Land productivity is low and population growth is high which make a considerable pressure on the available cultivated land. As a result, forest land was markedly encroached for expansion of cultivated land, which caused a severely damage to the ecology and natural resources. At present, Thailand's soil is subjected to degradation and erosion. Reforestation and agroforestry have been operated to sustain the rate of deforestation, but still lags behind.

Four main types of agroforestry are practised throughout Thailand. Agrisilvicultural system, Silvopastoral system, Apisilvicultural system and Pisci-silvicultural system. For Southern Thailand, horticulture crop likes fruit trees and rubber are integrated in the system instead of field crops. Up-to-date, Apisilvicultural system seems to be the most productive system for this region, whilst Pisci-silviculture received less attention.

INTRODUCTION

Physical environment

Location

Thailand is located centrally in the Indochinese Peninsula of Southeast Asia (Lat. 5° 40′ to 20° 30′ N, Long. 97° 70′ to 105° 45′ E) The total area of the country is 513,985 km^2 (c.185,000 $mile^2$ or 51.3 million ha), approximately the same size as France. The country is axe-shaped, with a long panhandle extending southward along the Malay Peninsula. It has common frontiers with Laos on the north and east, with Burma on the north and west and with Cambodia on the Southeast. Peninsular Thailands bounded on the south by Malaysia.

The country is geographically divided into four major regions: North, Northeast, Central, and South. The North region is mountainous with low winter temperature where temperate crops like strawberry and peach can be grown. The sprawling Northeast plateau is largely bordered by the Maekong River, where the world's oldest Bronze Age civilization flourished some 5,000 years ago.

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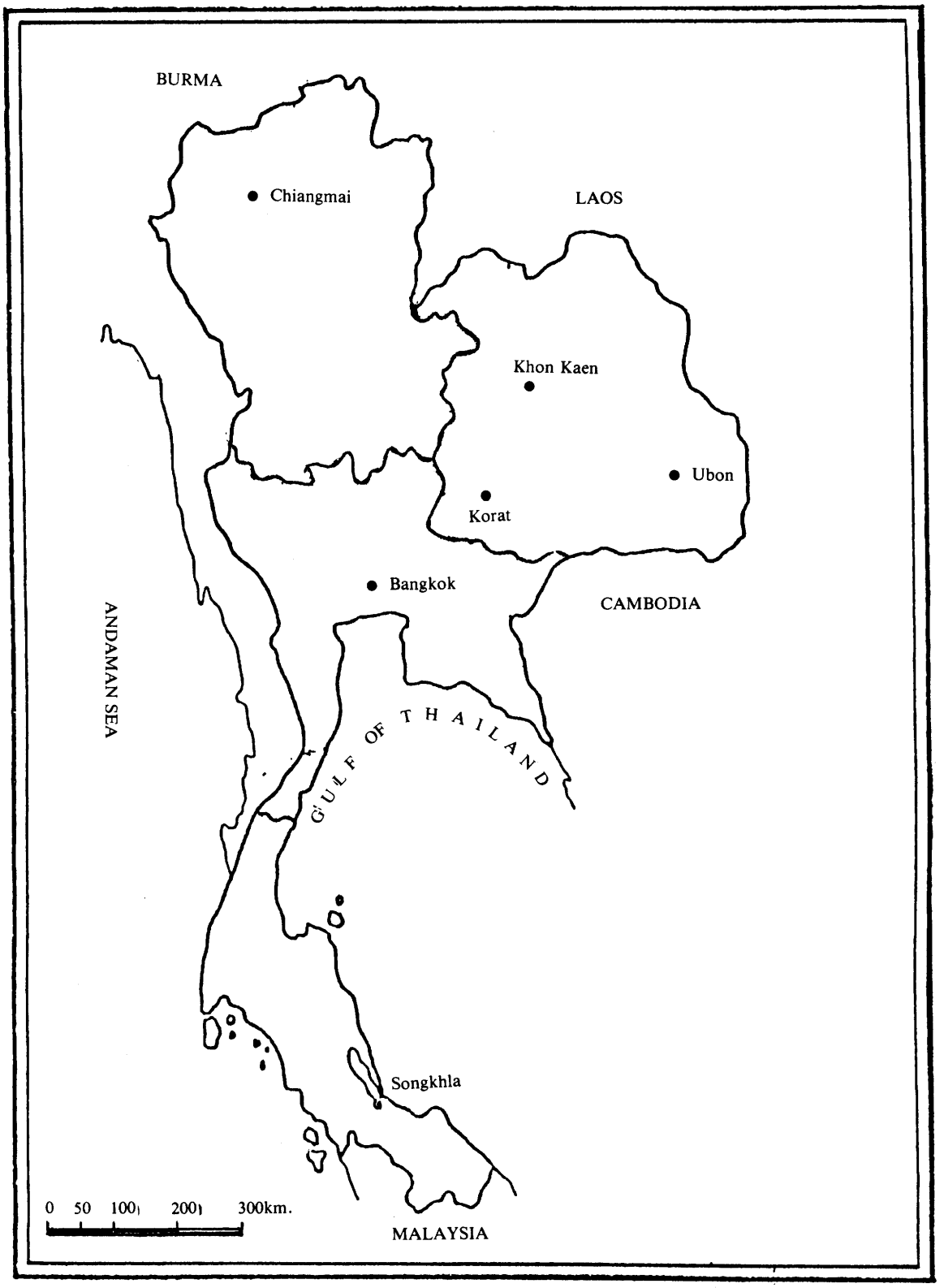

Physiographic regions of Thailand.

The Central Plain is one of the world's most fertile fruits and rice-growing areas. Rice is the staple food, major crop and major export. The peninsular South has scenic beauty which complements economically tin mining, rubber cultivation and fishery.

Climate

Thailand has two distinct climates: a tropical savanah climate in most parts of the country, and a tropical monsoon climate in the South and Southeast regions. There are three well-defined seasons : hot season (March to May), rainy season (June to October) and cool season (November to February).

The annual rainfall over most of the country averages between 1,240 and 1,370 mm with greatest rainfall in the Northeast, but the Isthmus and the Southeast average 2,313 and 2,423 mm per annum, respectively.

The mean maximum temperatures have a narrow range, between 31.5°C and 33.2°C while the mean minimum is 19.9°C in the North, 21.0°C in the Northeast and up to 23.5°C in the Southeast.

Land Use

Thailand is well endowed with cultivated land, which represents some 65 percent of the country's total area. The land-use in different regions in 1984 is presented in Table 1. The economic structure of the country can be classified into two main components : agriculture and non-agriculture. The total area of agricultural land (farm holding-land and forest land) is approximately 35.2 million ha. Agriculture is the major and is of prime importance to the socio-economic of the country in view of consumption, production, exports and population. About 64% of the total population (52.8 million) engage in agricultural sector (CDPADP, 1986). Agricultural land use can be classified by the following types of crops : paddy 11.8 million ha (58.9%), field crop 4.8 million ha (24%), fruit trees and tree crops 1.9 million ha (9.6%), vegetables and flowers 0.06 million ha (0.3%) and grasslands 0.1 million ha (0.6%).

Forest land vs. cultivated land

Land use is a dynamic process. It changes over time due to a number of factors, eg. increasing population, change in cropping systems and technology, etc. Forest land changed drastically with a tremendous reduction in the forest area and a remarkable expansion of cultivated land for field crops in all regions except the South where forest trees and tree crops are most important. The great expansion of cultivated land during the period 1960 – 1985 has been made possible due to the tremendous reduction in the forest area.

In 1960, the structure of agriculture in Thailand changed from subsistence to large scale farming. Rice is the most important crop with the planted area increasing from 6.4 million ha or 64,000 km^2 in 1960 (OAE, 1984) to 13.3 million ha or 132,800 km^2 in 1983 (AIT 1983). The planted area of other export-oriented upland crops, such as cassava, sugar cane and corn, has also increased. Cassava and sugarcane have had a very high growth rate in terms of area cultivated and quantity produced because of the high returns. The search for new land becomes the principal method of raising income. As a result of forest clearance after logging operations, crop cultivation in the highlands, uncontrolled expansion of cultivation and encroachment by hilltribe squatters upon forest reserves, the forest area of the country decreased from 50% in 1960, to 29% in 1985 (RFD, 1985). However, despite heavily encroached of forest land, farm size remained rather stable (TDRI, 1986).

Table 1. Land utilization and type of land holding of Thailand 1984.

Unit : 1,000 ha

Land utilization	Northeast	North	Central	South	Whole country
Total land	16,885.4	16,964.4	10,390.1	7,071.5	51,311.5
Forest land	2,476.2	8,531.4	2,564.0	1,579.7	15,151.3
Farm holding land	8,652.8	4,535.4	4,575.9	2,286.1	20,050.2
Farm size	0.0037	0.0035	0.0051	0.0035	0.0042
Number of farm	316.1	201.1	140.2	101.1	758.5
Housing area	169.4	105.8	104.7	63.7	443.6
Paddy land	5,927.2	2,701.6	2,414.3	782.4	11,825.5
Field crops	1,887.0	1,424.4	1,471.4	22.3	4,805.2
Fruit tree & tree crops	104.5	149.5	379.0	1,296.5	1,929.5
Vegetable & flowers	16.7	16.3	26.9	5.5	65.6
Grass land	70.8	10.3	30.0	9.9	120.4
Idle land	353.6	97.5	72.0	61.3	584.4
Other land	123.5	29.9	78.0	44.4	275.9
Unclassified land	5,756.5	3,897.6	3,250.2	3,205.7	16,110.03

Office of Agricultural Economic, 1986.

The growth of population at a relatively high rate during 1960 – 1975 period put considerable pressure on the limited amount of available land. The Land Development Department estimated that only 52% of total land area (26.9 million ha) are suitable for agriculture, and most of that land has already been utilized (AIT, 1983).

Land Productivity

Land productivity in Thailand has been rather low, and, in some cases, has been declining. For instance, average yield per ha of major rice in 1982 – 1986 is only 1894 kg ha^{-1}, which is c. three times less than that of Japan, USA and Taiwan (TDRI, 1986). Yield of rice also varies by regions, ranging from 1512, 1700, 2275 to 2419 kg ha^{-1} in the Northeast, South, Central and North, respectively. However, most of the rice production is produced in Central Plain (80%).

Population Growth

Despite population control programmes, the country's population continues to increase, from a scant eight millions in 1911 surpassing to 52 million marks in 1985. Population growth imposes ever-growing pressure on agricultural land and other natural resources. At present, the per capita arable land is down to only 0.49 ha, plus some 0.15 ha of marginal land, and this area is getting smaller with each child born, almost two per minute (TDRI, 1986). Per capita income of agricultural population is generally low, average ฿ 5,378 in 1985 relative to ฿ 45,702 of the non-agricultural population (ratio 1 : 8.5; DPADP, 1986). Per capita income of agricultural population by regions from 1981 to 1985 was in the range of ฿ 3,242, 5,793, 8,040 and 8,970 for Northeast, North, South and Central, respectively.

The pace of urbanization has also been very rapid. At least ten percent of Thais live in a single urban concentration, the Bangkok Metropolis (1,500 km^2, c. 0.3% of Thailand's total surface area). The fertile land is also being converted into new urban settlements and industrial sites.

Land use planning

The Royal Thai Government has long realized the importance of land use planning. The First National Economic Development Plan (1960 – 1966) stated that half of the country should be kept as forest or preservation areas, the rest being progressively developed for agriculture and other activities. Currently, three regional land use plans have been published, for the Northeast, East and Central Regions. There is evidence both of degradation and erosion of Thai soils. The degradation of soils can be caused by physical, chemical, biological, socioeconomic and institutional factors. In isolation or in combination, directly or indirectly, such factors alter the soil's potential for sustained or increase agricultural production.

Soil erosion is one of the most pressing natural resource problems in Thailand. Srikhajon *et al.* (1980) indicated that c. 17 million ha nationwide suffer from a medium or high degree of soil erosion, particularly upland areas where slopes are greater than 5% (Table 2).

Soil loss from forest management is less than from swiddening and continuous rice cultivation. The effect of producing one crop of rice every 10 years was to increase soil loss by 1.5 – 1.7 times the losses typical in a Dry Dipterocarp Forest (Attaviroj, 1986 cited in TDRI, 1986).

Forest clearing is commonly identified as a prime cause of soil salinization (ADAB, 1977; Moormann and van Bremen, 1978).

Table 2. Areas affected by soil erosion in Thailand.

Category	Soil Loss ($kg\ ha^{-1}yr^{-1}$)	Area (ha)	Land Use
Very slight	62 – 6,250	18,995,518	Forest, paddy
Slight	6,312 – 31,250	14,444,188	Forest, rubber, orchards, paddy
Moderate	31,312 – 125,000	4,145,969	Rubber, orchards, field crops, forest + field crops
Severe	125,062 – 625,000	6,819,308	Rubber, orchards, field crops, forest + field crops, shifting-cultivation
Very severe	625,062 – 6,041,562	6,265,134	Field crops, forest + shifting cultivation field crops
Others	—	729,882	Coastal area, mangrove forest, shrimp farms, etc.
Total	—	51,400,000	

Source : Srikhajon *et al.*, 1980.

Intensity of Land Use

Land use in Thailand is traditionally extensive rather than intensive. Monocropping is very common (Table 3) especially in rainfed areas. Land use has been less intensive mainly due to the lack of irrigation facilities. Even though there has been considerable investment in irrigation, only about 15% of the total cultivated area is under irrigation. Further more, the area is concentrated in the Central Plain and in the North where the larger projects are located. The irrigated area in the Central Region in 1984 covered 1,929,677 ha compared to 870,871.8 ha in the North, 552,454 ha in the Northeast, and 35,577 ha in the South (OAE, 1986).

Extensive agriculture has also been possible because, over the past two decades, the rate of expansion of agricultural land was higher than that of the population growth. However, this can not long continue into the future. If agricultural production is to be increased, improvements in land productivity are essential. The major potential for increased cropping intensity will be in irrigated areas in the Central Plain and in the North.

Another factors influencing land use intensity are the farm-gate prices of major crops such as rice, soybean, and vegetables. As for rainfed areas, particularly in the Northeast, new cropping systems are required if increased cropping intensity is to be realized. For the South, with high rainfall, integration of field crops and horticulture crops including livestocks, bee-keeping in forest and fruit plantations should be emphasized.

Land Allocation and Land Reform

The Government has supported land allocation programs on public land since 1938. These were designed to establish new villages on virgin lands, primarily to settle landless families or to resettle those displaced from sensitive areas by flood, dam inundation or other factors. The Royal Forest Department has been implementing its forest village program, aiming to reforest denuded uplands which have been encroached upon by squatters. A key feature of the program is the regrouping of farmers into villages on the borders of forest reserves. The results of land settlement, land reform and other activities are given in Table 4.

Table 3 : Cropping land use index, 1984/1985.

Region	Arable land area	Single cropping area	Double cropping area	Tripple and over cropping area	More than one cropping area	Intensity of cropping area
1	2	3	4	5	6	7
Northeast	100	88.28	2.45	0.22	2.67	93.84
North	100	85.76	17.27	0.51	17.78	121.83
Central	100	87.96	18.46	1.04	19.50	128.00
South	100	84.50	4.19	0.49	4.68	94.35
Whole Country	100	86.62	10.59	0.56	11.15	109.50

Source : Division of Policy and Agricultural Development Plan, 1986.
Note : Column 6 = Col.4 + Col.5; Col.7 = Col.3 + (2×col.4) + (3×col.5).

Table 4 : Land allocation by major settlement programs, 1984.

Name of Program	Total	
	Area (ha)	Families
Self-help land settlement	2,097,882	128,972
Land co-operatives	2,029,886	69,485
Land reform	1,812,131	81,257
Land allocation	3,281,471	274,100
War veterans	32,221	1,633
Land development projects	178,962	14,359
Forest villages	334,493	2,089
Forest community development	199,918	23,129
Cultivation rights	6,360,449	624,048
Total	16,327,413	1,219,072

Source : Division of Research and Planning, Agricultural Land Reform Office, Ministry of Agriculture and Cooperatives, 1986.

Land Tenure

Land may be devided into land owned privately and land owned by the state. Privately-owned land can be issued with land titles in 4 forms:- Title Deed (full ownership), Certificate of Utilization (put land to use), Preemptive Certificate (temporary occupation of land) and Claim Certificate (made use of land prior to 1954). In the public or state land, especially in the national forest reserves, land rights have been given to squatters in the form of land use permit. The government permits squatters occupying land in national forest reserves to claim cultivation rights to 2.4 ha of land, and to lease from the Royal Forest Department any additional area, up to a combined total area of 8 ha. This type of document can not be used as collateral for a loan or as a quarantee.

Reforestation

Apart from the encroachment of forest land by landless farmers, hill tribesmen and other shifting cultivators, Thailand's forest has also been destroyed and is being destroyed by badly managed official logging and illegal logging. The government is well aware of these destructions. A number of designed strategies has been devised and adopted to halt or at least slow the process of deforestation which includes reforestation and agroforestry. Table 5 shows the areas of man-made forests established by government and private sectors. However, the rate of reforestation has lagged behind the rate of deforestation. To date, the total area of reforestation has been running at a similar rate every year (TDRI, 1986).

Table 5 : Forest plantation of government and private sectors from beginning to 1985.

Unit : km^2

Region	Royal Forest Department	Concessionaire's Reforestation	Total
North	2,367.7	557.7	2,925.4
Northeast	770.8	222.6	770.8
Central + East	686.0	169.5	855.5
South	394.5	232.0	626.5
Total	4,219.0	1,181.8	5,400.8

Source : Planning Division, RFD 1986.

Agroforestry in Thailand

Small-scale plantation work, mainly based on teak *(Tectona grandis)* started at the beginning of the century by the Royal Forest Department (RFD), Ministry of Agriculture and Cooperatives (MOA). The designed strategies was modified from the "Taungya system" of Burma and was known as "Taungya plantation system". Large-scale reforestation began in 1961. In 1978, the Forest Industry Organization (FIO), a government enterprise subordinate to MOA supported the RFD reforestation program by commencing the "Forest Village or Modified Taungya system or Socio-agri-sylvic system" which incorporated multiple-land use into practical forest management. The operation integrates agricultural crops and animal activities with forest to serve the rural development target and promote the social and economic development of encroaching communities. Up-to-date, there are four types of agroforestry operate in Thailand : Agrisilviculture, Sylvopastoral culture, Apisilviculture and Pisci-silviculture.

Due to developing wood shortages over the last decade, fast-growing tree plantations have been promoted. There are about 26 tree species such as pine, persian lilac, eucalypt, leucaena, casuarina, acacia, duabanga, and mahogany.

Agroforestry in Southern Thailand

The main topography of the South region is characterized by the coastal plains, whilst the rest is mountainous and undulating. Forest types are mainly Tropical Evergreen-Rainforest of c. 14,328 km^2 (RFD, 1986). The principal tree species are mostly *Dipterocarpus.* This region occupied the greatest mangrove forest area, i.e. 2,119 km^2. The coastal plain supports *Borassus* palms, coconut plantations, rubber plantations and a wide varieties of fruit trees.

Agrisilviculture

Southern farmers have been experiencing with rubber plantation, horticulture crops eg. coffee, cashew nut, etc. and other fruit trees eg. banana, jackfruit, lemon, etc. for a long time. The best strategies of reforestation and agroforestry in this region is to use local skills and local horticulture plant species integrate in the forest land. So the Agrisilvicultural system in this region is markedly different from other regions of Thailand. However, the theory and

Table 6 : Agri-silvicultural system practised in Southern Thailand by FIO (Pothitai, 1986).

Plantation	Forest tree species	Horticulture crop			Planting method
		spacing (m)	species	spacing (m)	
1. *Dipterocarpus alatus*	*Dipterocarpus alatus*	2×8	coffee	3×3	AR
		or 3×8	rubber	3×8	AR
2. *Melia azadarach*	*Melia azadarach*	4×4	coffee	4×4	AR
		4×4	cocoa	4×4	AR
		2×8	cocoa	3×3	AR
3. *Leucaena leucocephala*	leucaena (giant type)	4×4	coffee	4×4	AR
		2×8	cocoa	2×8	AR
		2×8	rubber	3×8	AR
		2×8	cashew	4×4	AR
4. Eucalyptus	*Eucalyptus* spp.	2×8	rubber	3×8	AR
5. *Intsia palembanica*	*Intsia palembanica*	2×8	rubber	3×7	AR
6. Mixed forest	*Alstonia macrophylla* *Casuarina equisetifolia* *Eucalyptus* spp.	4×8	cashew	4×8	AR
7. Mixed forest	*Dipterocarpus alatus* *Leucaena leucocephala*	3×8	rubber	3×8	AR
8. Mixed forest	*Dipterocarpus alatus* *Casuarina equisetifolia* *Alstonia macrophylla* *Melia azadarach* *Eucalyptus spp.*	3×12	rubber	4×15	AR

AR = Alternate rows.

objective are remained. Forest tree species like *Eucalyptus* spp., *Leucaena leucocephala* (giant type), *Casuarina equisetifolia, Melia azadarach.* etc. show good compatability with horticulture plants (Pothitai, 1986). Spacing of forest trees and horticulture crops depend on leaf canopy, height and root system of the combined species. Some works done in the South was summarized in Table 6. However, for the beneficial and efficiency of land-use, it is recommended to combine field crops in the first year of this system.

Silvopastoral System

The expansion of the livestock industry in plantation crop areas is one of the most promising developments in recent decades (Humphreys, 1978). Introducing native cattle to smother weeds in forest plantation is effectively practised by FIO without any special managment i.e. introducing pasture species (Pothitai, 1986). This practice has many advantages : excludes weeding cost and effectively eradicates noxious weed such as *Imperata cylindrica,* prevents forest fire which frequently occurs during the

dry season, fertilizes the land with animal dung and urine and get extra income from animals. Record of surpassing income from confining animals to *Eucalyptus* plantation was *c.* 1,000 to 1,680 ฿/head/yr (1 US$ = ฿ 25).

Grazing should be done when *Eucalyptus* was at least 2m tall or 2 years old to prevent animal browsing young eucalypt shoots. Physical damage occurred to eucalypt trees was found at rate of 3% relative to 5% for *Casuarina equisetifolia* (Sathapornpong, 1979).

A review of the Silvopastoral system practised in Southern Thailand is presented in Table 7.

Other natural herbaceous species which are commonly found in florest plantations apart from *Imperata cylindrica* and *Bambusa* spp. include *Axonopus affinis, Chrysopogon orientalis, Cyrtoccocum* sp., *Desmodium ovalifolium, Microstegium ciliatum, Ottochloa nodusus, Oplismenus burmanni, Paspalum conjugatum, Rottboellia exaltata* and *Setaria Verticelata* (Manidool, 1985).

Many plantation and fruit orchard areas in Thailand are introducing exotic pasture species. This includes forest plantation (Ruangpanit and Pongumphai, 1986); cashew nut plantation (Ungsrivong and Singhapong

Table 7 : Stocking rate of animals at different forest plantations in Southern Thailand (Pothitai, 1986).

Plantation	Plant species	Spacing (m)	Year	Cattle		Weed species
				Stocking rate (head rai^{-1})	grazing management	
1.	*Eucalyptus* spp.	2×8	5	5.6	no	I
2.	*Eucalyptus* spp.	4×4	3	10	rotation	I
3.	*Eucalyptus* spp.	2×4	2	6	no	I,B
4.	*Eucalyptus* spp.	2×4	1	5.4	rotation	I
5.	*Eucalyptus* spp.	2×8	4	2.2	rotation	I
6.	*Eucalyptus* spp.	2×4	2	4.6	no	I
7.	*Alstonia macrophylla*	4×4	7	10	no	I,B
8.	*Eucalyptus* spp.,	4×4	2	8.3	rotation	I
	Melia azadarach	2×8	6			
9.	*Eucalyptus* spp.,	2×4	1-2	9	rotation	I,B
	Cashew nut	4×4	2			
10.	*Acacia auriculacformis*	2×4	5	1.6	no	I,B
	Eucalyptus spp.	2×4	5			
	Alstonia macrophylla	4×4	6			
11.	*Acacia auriculaeformis*	4×4	4	10	rotation	I
	Eucalyptus spp.	4×4	4			
	Dipterocarpus alatus	4×4	4			

I = *Imperata cylindrica*
B = *Bambusa* spp.
1 ha = 6.25 rai

1983 a,b); coconut plantation (Manidool, 1986), Sweet tamarind plantation (Mekangwarn *et al.*, 1983); Kapok plantation and lumyai orchard (Humphreys, 1978), etc. This practice can be achieved at relative low cost since the primary land development operation has already been carried out and will lead to greater income and to greater security of income to the farmers.

Pasture species

Humphreys (1978) suggested that sod forming grasses eg. *Brachiaria decumbens* are preferable to tall bunch grass such as *Panicum maximum* since the coconuts are more visible on the ground. However, Manidool (1986) reviewed works in the South as follow: Guinea *(P.maximum)* and Signal *(B.brizantha)* performed well on poor soil, shady areas of coconut plantation on a cut-and-carry system, whilst Para grass *(B.mutica)* grew well on more fertile soil and competed well with weeds. On coastal areas, poor soils with less light intensity on ground surface, Cori grass *(B.miliniformis)* showed better adaptation and response to fertilizer. In older coconut plantation (c. 22 yr.) with more light transmission, Ruzi grass *(B.ruziziensis)* performed well on medium and fertile soils whilst high rates of seeding and fertilizer gave better results. The pure sward of Ruzi grass withstood fairly heavy grazing (2.5 head ha^{-1}) with a dense stand after two years grazing. However, the recommended stocking rate for a mixed pasture of Signal *(B.decumbens)* and Centro in coconut plantation at this region is 1.5 head ha^{-1}.

In 4-5 years old cashew plantation (8 × 8 m. spacing) nine tropical pasture grass and legume species produced unfavourable growth and yield (Manidool, 1986), although Guinea and Signal grasses showed best adaptability. Similar result was reported in the close canopy of other cashew orchard (Ungsriwong and Singhapong, 1983).

In rubber plantation, Mekungwarn *et al.* (1983) found Centro to be superior to Calopo and Pueraria. It is drought resistance and persists throughout the year.

Ruangpanit (1987) reported that *S.hamata* cv. verano, *Macroptilium atropurpureum* and *C.pubescens* are the most promising pasture legume species for over-sowing in the open secondary forest. The total dry matter yield of Centro and *M.atropurpureum* in *Melia azedarach* plantation at other region was 1,116 and 805 kg ha^{-1}, respectively (Ruangpanit and Pongumphai, 1986).

Not only livestock can be integrated in plantation, Thaipanich (1986) believed that integrated duck to plantation crops is another alternative which is promising and attracts income. Duck fed on weed species and fertilized the crops with droppings. The overall input of this enterprise was c. 15.8% less than the sole crop.

Apisilviculture

The apiculture industry in Thailand ranges from traditional honey hunting which causes destruction to bee colonies (Buranapawong, 1987) to large scale commercial bee-keeping using modern frame hives. Dennis (1962) reported that the "jungle" of Southeast Thailand is rich in honey producing flora, and Prehn (1980) agreed that coconut is the most important and the major source of nectar. A list of wild and cultivated species was cited (Buranapawong 1987) which includes cashew nut, rose apple *(Eugenia jambos)*, mango, kapok, Sap-sua *(Eupatorium odaratum)*, tamarind, para rubber *(Hevea brasiliensis)*, and rambutan *(Nephelium lappaceum)*, etc. The forest species which produce prolific flowers with a long flowering period are *Eucalyptus* spp., *Leucaena leucocephala* and *Anacardium occidentale* (Pothitai, 1987).

For Apisilviculture practice, consideration of a suitable site for bee in plantation is crucial. The plantation should have adequate supply of water, food and flowering trees for the beneficial of honey collection. Besides, bee requires enough sunlight and shade, protection from dryness and wind. The native bee varieties are superior to the introducing varieties with a low cost of keeping (Pothitai, 1987). The most common honeybee species are *Apis dorsata* and *A. florea* (Buranapawong, 1987). Hundreds of combs are collected each week in some area (Akratanakul, 1976), the amount of honey from each colony rarely exceeds 1 kg. The income from honey in this system averaged 120 – 150 ฿/month/hive (Pothitai, 1987). For FIO experienced, Apisilviculture is the most productive agroforestry system which markedly increased the income of forest villagers and the standard of living.

Pisci-silviculture

Aquaculture had developed considerably since the beginning of the century and contributed about 5-10% of the total fishery production of the country in recent years. Freshwater aquaculture was developed a long time ago, but coastal aquaculture is much more recent. In brackish water areas, typically in or around estauries and mangroves, such species as prawns, shrimp or sea bass are raised.

The aquaculture practice in Thailand are :- pond culture, cage culture, ditch culture and ungrown-paddy field fish culture. Pond culture is commonly practised throughout the country and usually applied as monoculture or polyculture integrated with agricultural crops and animal husbandry (Tabthipwon, 1987). Raising duck with fresh water fish *(Pangasius micronema)* is another promising practice (Thaipanich, 1986), and the cost of fish production was reduced to 60.83%.

The most popular cultivated species are mainly indigeneous fish and prawn. Recently the fresh water giant prawn *(Macrobrachium rosenbergie)* are the most attractive species among farmers whilst tiger prawn *(Penaeus monodon)* and white shrimp *(P. Merguiensis)* are most favourable cultivated species in coastal area.

Mangrove forest serves as nursery and feeding grounds for many marine species of commercial importance. Approximately 99,206.4 ha, or 30% of Thailand's mangrove forests have already been destroyed by conversion to other uses during the part 25 years (TDRI, 1986). The main conversion of mangrove forest have been to aquaculture, mining, salt pond construction and other activities, including agriculture, urbanization, industrial sites and harbors. It has been noticed that the total fish catch in many mangrove and estaurine areas is decreasing. The number and scale of impoundment on mangrove areas for brackish water culture especially shrimp farm has increased rapidly since 1981 (Tabthipwon, 1987). This is partly due to the low cost and ease of management in these areas. The total aquacultural land in mangrove area is about 38.3% of the total conversion area. In order to slow the clearance of mangrove land for aquaculture ponds, adoption of the multiple-use management approach to combine mangrove plantation with aquaculture operation should be emphasized.

CONCLUSION

Although agroforestry has been practised in Thailand for decades, it is promising and has many advantages in term of land use and rural income, it does not receive much attention. At present, scientists, scientific informations, skills and experiences are still limited.

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