IFA-FAO AGRICULTURE CONFERENCE

"Global Food Security and the Role of Sustainable Fertilization"

Rome, Italy, 26-28 March 2003

COMMERCIAL FARMS IN SOUTHEAST ASIA

Thomas FAIRHURST
PPI-PPIC, SINGAPORE

PPI-PPIC – Potash and Phosphate Institute, 126 Watten Estate Road, Singapore 287599
Email: tfairhurst@eseap.org

IFA-FAO AGRICULTURE CONFERENCE
Rome, Italy

"Commercial Farms in Southeast Asia"

Paper by Thomas Fairhurst
PPI-PPIC

I. Introduction

The importance of commercial agriculture lies in its potential to contribute to economic development, food security and export earnings in developing countries, where agriculture continues to be the largest employer. Successful and dynamic commercial farming forms the backbone of rural development by creating opportunities for providers of goods and services in the private sector, and justification for public sector investments in improved infrastructure and communications. It is axiomatic that a prosperous commercial agriculture sector is the precursor of general economic development in rural areas.

Farming systems are not static but rather evolve in response to changes in various '*internal*' and '*external*' factors. Internal factors include the effect of changes in population pressure on production methods and efficiency. External factors take account of the impact of changes in the market place on the choice of crops, the effect of the price of agricultural commodities and production inputs (credit, fertilizers, agrochemicals, planting material) on farm economics, and the impact of improved technology on productivity and profitability. As we shall see, the production centers for many agricultural commodities have relocated in recent years in response to changes in the opportunity cost of labor and land.

A broad distinction can be drawn between subsistence agriculture, where food is produced for domestic use and there is no immediate need for the farmer to participate in the market economy, and commercial agriculture, where most of the goods are produced and marketed in return for payment in line with the laws of supply and demand. Commercial agriculture does not necessarily imply the use of more intensive production techniques. There is a general move towards intensified commercial agriculture systems with greater carrying capacity, however, in response to increased population pressure and where there is a requirement to increase efficiency in order to maintain a competitive position in the market place.

Commercial agriculture is now the predominant form in Southeast Asia and only a small, and shrinking, minority of farmers is engaged in purely subsistence agriculture. Two extremes of farming systems can by illustrated by comparing rice farming in Java and mixed farming in Kalimantan in Indonesia. In parts of Java triple-cropped rice systems that yield a total of >20 t rice year have evolved on fertile soils well supplied with irrigation water in response to very high population pressure, small farm size and the growth in demand for rice (Figure 1).

A farmer with, say, 0.2 ha produces sufficient rice for about 20 adults or 3-4 families. By contrast, slash and burn agriculture is practiced in parts of Kalimantan where the population density is small, infrastructure is poorly developed and farm size is generally much greater (Figure 1). Low intensity 'jungle' rubber is common in slash and burn agriculture in Kalimantan and whilst most rubber farmers also cultivate some upland rice (for subsistence), income from rubber sales is required to purchase part or most of their domestic rice requirements. Thus, most farms in Southeast Asia participate in the market economy and can be considered at least partially commercial according to the definitions of (Ruthenberg, 1980).

Figure 1

One of the characteristics of agriculture in Southeast Asia is the polarization between the enormous number of farmers with very small amounts of land (<1 ha) and the large-scale plantation companies with operations stretching over hundreds of thousands of hectares. Thus, a distinctive and important feature of agriculture in Southeast Asia is the almost complete absence of the medium scale growers that are common in developing countries in South America. Some crops are grown almost exclusively in small holdings (e.g., maize, rice, cassava) whilst others can be found in at both ends of the farm size spectrum (oil palm, sugarcane, rubber). Farm size has important consequences in terms of technology development and extension. For example, most of the agronomic research work carried out in oil palm is funded and controlled by the estate sector but there is often insufficient attention given to adjusting technology developed for the estate sector for use in smallholdings.

This paper will consider some of the issues that impact upon commercial agriculture development in developing countries by reference to six crops that make a significant contribution to food security (rice), cash crops (maize) and export earnings (oil palm, rubber, sugarcane, cassava), using examples from within the region of Southeast Asia.

II. Background conditions in agriculture development in Southeast Asia

We will first consider several important and generic factors that impact on all the six 'commercial' crops to be included in this appraisal before investigating each crop in turn. Perhaps the single most important issue is the dwindling availability of arable and permanently cropped land as populations continue to increase and often very fertile arable land adjacent to urban centers is taken out of agriculture by urban sprawl and industrial development. The ratio of population to the amount of permanently cropped and arable land in the eight agricultural economies in Southeast Asia has decreased significantly over the past forty years (Figure 2). On average, the availability of arable and permanently cropped land in Southeast Asia is now 0.18 ha caput^{-1}. It should be remembered that this 'land availability index' takes into account the very considerable increase in the amount of arable and permanently cropped land in Southeast Asia over the past forty years.

Figure 2
Over the same period there has been a considerable increase in the amount of irrigated land but there has been very little increase in the past ten years except in Myanmar and Thailand (Figure 3). Water as much as land availability is likely to constrain further increases in the amount of irrigated land in the region and more efficient water use will be required in existing irrigated land in future.

Figure 3
At the same time there is now tremendous pressure to avoid further depletion of the region's forest and wetland reserves, areas with irreplaceable value in terms of biodiversity and ecological function in the regional and global ecosystem. Therefore, we cannot expect large increases in agricultural land over the next twenty years, particularly if remaining forest and wetlands are preserved successfully (FAO, 2003). The *only* way that growing populations' demand for food can be satisfied, then, is by intensification of cropping systems on existing land and further increases in productivity through the introduction of high yield agricultural technology. Yet there is also widespread opposition to some of the technologies that have potential to increase yields and there is an apparent but tacit unwillingness amongst some prominent institutions to recognize the importance of adequate fertilizer use in meeting the goals of the intensification (McNeely and Scherr, 2001; World Bank, 2003).

There has been legitimate and understandable concern over the possible introduction of genetically modified (GM) crops in Southeast Asia but this should not lead to outright rejection of the evidently promising GM crops already in the pipeline. Asia's present food security is now totally reliant on the cultivation of a few modern rice varieties, introduced as part of the Green Revolution in the 1960s. There was much concern in the 1970s over perceived negative impacts of the Green Revolution in terms of its capacity to benefit large farms at the expense of small ones and the implications on sustainability of relying on a few high yielding varieties (HYVs). Since then, Asia has adjusted to the post-Green Revolution world and the region continues to enjoy improved food security in spite of increasing populations. GM crops clearly have the potential to provide great benefits in the developing world and a Luddite reaction to their introduction in Southeast Asia is not appropriate. Instead, a cautious and measured response is advocated which incorporates a balanced assessment of the potential benefits and risks of the new technologies.

III. Developments in area planted and yield for selected commodities

The prospect of further increases in potential yield in commercial crops through plant breeding is perhaps of less consequence in the medium term than the yawning gap between the site-specific attainable yield and average actual yields for major crops in Southeast Asia. The size of yield gaps for rice, maize, oil palm rubber, cassava and sugarcane in Southeast Asia show that there is still much potential to increase productivity on existing agricultural land (Figure 4). More effort should be placed on the analysis of yield gaps at scales from country to local agro-ecological zone to identify areas where there will be large returns in terms of closing present yield gaps through investments in intensification and yield maximization.

In a useful study of yield gaps in rice in Indonesia, (Makarim, 2003) found much larger yield gaps in Sumatra and Sulawesi compared with Java (Figure 5). Both the area planted and the yield gap must be taken into account when developing research and development strategies for a particular crop. Thus, whilst yield gaps may be larger in Sulawesi and Sumatra, a small increment in yield over the large area of rice planted in Java has a much greater effect on total rice production than a larger increase in yield over the smaller areas planted in Sulawesi and Sumatra.

Figure 4

Figure 5

How can scientists and extension workers provide robust advice to growers without access to basic information on the agronomic factors that drive productivity? Information on spatial and temporal variability in these factors is required at national, district and farm level and much can be gained by implementing geographic information systems (GIS) containing all relevant data in formats that are convenient to maintain and update. A minimum dataset for includes a crop's geographic distribution, long term records of productivity and input use based on data collected in farmers' fields and supporting information of agroclimatic conditions. Such information is generally lacking in Southeast Asia at regional, national and district level.

We will now illustrate developments in area cultivated and yield by reference to the performance of the six selected commercial crops in Indonesia (Figure 6)

Figure 6

The area planted to **rice** has increased continuously over the past forty years with strong support from the government of Indonesia (GOI) and international lending institutions for the development of irrigated rice schemes and in support of increased cropping intensity during the 1960s and 1970s (Figure 6a). There are indications that the planted area may actually decrease in the next ten years, however, as farmers in the major rice bowls switch to the cultivation of more profitable fruit and vegetable crops and rice land is lost to urban and industrial development. Yields increased up to the mid-1980s (when rice self-sufficiency was obtained) but have since stagnated. Since the political reforms of the late 1990s, the government no longer has such a tight grip on the production factors affecting the performance of rice farmers who are now more concerned with meeting profitability goals than the production targets set by local governments, as was practiced in the past. The cultivation of rice in irrigated and rainfed rice systems in Southeast Asia can now be considered *mostly* a commercial farming activity, rice food security in Indonesia and the region now depends on the production of rice in Vietnam and Thailand, the region's two major rice exporters (Figure 7).

Figure 7

Thailand's rice exports have increased continuously over the past twenty years and exports from Vietnam have grown rapidly since the reforms begun with *Doi Moi* in 1997. Over the past five years, however, there has been a rapid increase in the requirement for rice imports in Indonesia, Philippines and Malaysia with total average annual imports of about 5 million tonnes over the period 1995-2000 in these three countries (Figure 7).

It is likely that rice exports from Vietnam and Thailand may decrease over the next ten years as the opportunity cost of labor increases and in response to crop diversification driven by governments as well as market forces. Most likely, rice exports from Myanmar will increase, as there is still scope for further yield intensification in Myanmar's irrigated rice system where fertilizer use is far below agronomic requirements.

The area planted to **oil palm** has shown spectacular growth in terms of the area planted but there has been little progress in terms of crop yield improvement, in spite of the availability and introduction of improved planting materials (Figure 6b). One explanation is that crop expansion has occurred in areas with poor soils and more marginal climatic conditions (i.e., in Southern Sumatra and Kalimantan) where yield potential is clearly smaller compared with more favored areas in North Sumatra where the industry was first developed in the early part of the 20^{th} Century. A second factor that helps to account for stagnating yields is the apparent difficulty of maintaining high agronomic standards during a period of rapid expansion in the area planted.

The amount of land planted to **maize** in Indonesia fluctuates widely from year to year, in response to wide variations in price. Yields have increased continuously, however, and this is related to the progressive replacement of local varieties with improved open pollinated varieties and hybrids together with improvements in general crop agronomy and fertilizer use (Maamun *et al.*, 2001) (Figure 6c).

The GOI promoted the relocation of the **sugarcane** industry from fertile soils in Java, where the crop was grown by smallholders under intensive management in rotation with rice under irrigated conditions, to the low fertility status soils of the outer islands, where the crop is cultivated in state owned and private sector plantation companies and out grower schemes under rainfed conditions. The area planted to sugarcane increased continuously up to the mid 1990s but has since declined partly due to poor sugar prices (Figure 6d). Yields have decreased steadily over the past forty years and particularly since the 1970s due to the shift in production from Java to the outer islands. It is important to note, then, that productivity in 'commercial' sugarcane production in the outer islands has not been able to compete with the smallholder production systems in Java where labor-intensive crop care methods resulted in exceptionally large cane yields in the 1960s.

There has been an increase in the proportion of **cassava** grown to produce raw material for the starch industry and a reduction in the area planted for subsistence use in Indonesia. Overall, however, the total area planted to cassava has decreased continuously over the past forty years (Figure 6e). As with maize, the planted area fluctuates widely from year to year and this relates to the volatility of starch prices and thus the price offered in the market place for cassava roots. Yields have increased continuously, due mainly to the introduction of higher yielding cultivars and increased fertilizer use in commercial cassava production systems.

A considerable increase in the area planted to **rubber** over the past twenty years is explained by the impact of a number of large rubber smallholder projects implemented by GOI with support from international lending agencies (Levang, Paper submitted August 1996) (Figure 6f). Yields increased from 1961 to the early 1990s but have since stagnated as less intensive smallholder production systems have increased in importance with the decline in the plantation rubber sector. Smallholder producers now dominate the industry, however, as commercial plantation companies have progressively replaced their rubber plantings with more profitable oil palm plantings.

3.1 Commodity prices and trade policies

A review of developments and trends in commercial agriculture in Southeast Asia would be incomplete without a brief reference to global trade arrangements. In spite of the long-term decline of agricultural commodity prices in real terms (Fry, 2000), large fluctuations in prices and lack of subsidies, tropical crop commodities produced in Southeast Asia have been very successful in markets in the European union (EU) the United States (US) and Asia. One of the most significant constraints to commercial agriculture development, however, is the effect that agricultural subsidies paid to growers as well as tariffs and trade barriers imposed by countries in the EU and the US have on the competitiveness of farmers in Southeast Asia. For example, Indonesia continues to import much of its requirement for maize and soybean from the US at artificially low prices because of price support provided to farmers in the US. Similarly, the EU imposes often-unreasonable tariffs and trade barriers on commodities such as coffee and cocoa that are imported from developing countries.

In a recent speech, Nicholas Stern, Chief Economist at the World Bank noted that:

"*It is hypocritical to preach the advantages of trade and markets and then erect obstacles in precisely those markets in which developing countries have a comparative advantage. That hypocrisy does not go unnoticed in developing countries. The recent Farm Bill in the United States and the recent agreement in Europe to delay the reform of the Common Agricultural Policy are deeply damaging.*"

Agricultural subsidies in Europe and North America amount to about US$ 300 billion per year, about six times the total amount of the Organisation for Economic Development (OECD) development assistance provided to less developed countries. Agricultural subsidies suppress world prices and thus undermine developing country exports and earnings. It is estimated that their elimination would increase global trade in agriculture by about 17% and increase total annual rural incomes in low and middle-income countries by about US$ 60 billion or about 6%. Countries in more developed countries could thus achieve development goals and increase the market for industrial goods by removing subsidies and tariffs that presently work against the development of commercial agriculture in Southeast Asia and elsewhere. Even if existing tariffs are removed, however, it is likely that commodities produced in developing countries will in future face closer scrutiny in terms of the impact that related production systems have on the environment.

It should also be remembered that commodity prices have a strong influence on technology adoption, particularly by small-scale commercial farmers and it can be argued that increased prices due to the removal of present price distortions would encourage farmers in developing countries to adopt high yield agriculture technology by reducing the risks associated with new technology adoption.

3.2 Soil fertility recapitalization

Poverty alleviation and the environment are the key issues on the agenda of the major international lending institutions and non-governmental organizations. In Southeast Asia, human poverty and environmental degradation are both strongly related to soil infertility and poor commercial farmers on poor soils produce small yields and degrade the natural resource base. In Southeast Asia these farmers are mostly located in the uplands where environmental degradation, including forest depletion due to slash and burn agriculture, soil erosion, and uncontrolled surface run-off result not only in reduced *in situ* soil fertility but also off-site damage and reduced productivity in neighboring lowland areas. The predominantly commercial agriculture in the lowlands is thus somewhat dependent on the establishment of sustainable (and more commercial) agriculture in the uplands.

Of particular concern is widespread phosphorus (P) deficiency in upland areas where soils are often strongly P-fixing and large inputs of P fertilizer are required to recapitalize soil P stocks. Numerous trials and demonstrations have shown the benefits of soil P recapitalization in terms of increased crop yields, reduced soil erosion and surface run-off, improved biological N_2 fixation, reduced risk, and increased farm income (Dierolf *et al.*, 2001; Sri Adiningsih and Fairhurst, 1998). The benefits of soil fertility recapitalization appear to be self evident to the plantation sector where soils are rehabilitated during the immature phase of plantation crop development. Large amounts of P fertilizer are applied during the immature phase of crop establishment in rubber and oil palm (Table 1) and provide the foundation for the development of highly productive and sustainable agriculture. It should be remembered that there is no P removal during the immature phase and thus, provided losses due to surface run-off and erosion are prevented by soil conservation, the P added as fertilizer contributes to building up a larger amount of P in the crop nutrient cycle.

Such large inputs are mostly beyond the means of small farmers and for this reason it is common to find smallholders that have planted up oil palm and rubber but the crops have failed to reach harvest maturity due to severe and uncorrected P deficiency.

Table 1. Soil P capitalization in oil palm, rubber (modified after (Goh and Chew, 1995).

	kg P ha^{-1}	
Growth stage	Oil palm	Rubber
Nursery	1-2	4-6
Legume cover plants	60-90	100-120
Planting hole	10	20
Immature period	100-150	60-80
Total P	171-252	184-226

Large tracts of land abandoned to anthropogenic savannah land has been converted into very productive oil palm plantations in Kalimantan and Sumatra following the replenishment of soil P stocks. As mentioned above, smallholders cultivating similar soils are not able to purchase the fertilizer inputs required for soil fertility recapitalization and are thus often trapped in a cycle of low yields, low incomes and environmental degradation (Greenland *et al.*, 1994) (Figure 9).

Figure 8

Furthermore, small farmers in the outer islands of Indonesia are being displaced from their land because they lack the capital and know-how to develop P deficient soils for agriculture and are thus easily persuaded to sell their land to plantation enterprises well endowed with the capital required to develop the land properly. It is therefore surprising how little governments and international banks have invested in the replenishment of soil fertility as a means of building up natural resource capital, overcoming poverty, increasing productivity and protecting the environment in spite of compelling arguments presented in the literature (The World Bank, 1994; Vanlauwe *et al.*, 2002). Robert Fox, the noted soil chemist observed: '*A man cannot lift himself by his bootstraps if he has no boots'* (Fox, 1988). There is a danger that present poverty alleviation efforts in Southeast Asia funded by the World Bank and the Asian Development Bank will not succeed as long as the farmers' potential to increase their income by increased crop productivity is constrained by the chronic soil phosphorus deficiency endemic in Southeast Asia's uplands.

IV. Crop case studies

We will now review the characteristics of six major commercial crops cultivated in Southeast Asia.

4.1 Rice

Rice occupies a unique position and role in the agriculture of Southeast Asia and occupies a range of positions in farm economies from a purely subsistence role (upland rice) to a fully commercial crop (part of the irrigated rice system).

Productivity is up to one hundred times greater in irrigated rice systems compared with upland rice where poor yields and the requirement for prolonged fallow periods reduce land productivity to very low levels (Table 2).

Irrigated rice (double and triple rice cropping) accounts for 75% of global rice production, although it is grown on only 42% of the total area planted to rice (Figure 9).

Figure 9

Research has so far failed to deliver sustainable models for upland rice production and it is expected that upland rice in slash and burn farming systems will become obsolete as upland farmers become better integrated in the developing market economies of Southeast Asia.

Table 2. Comparison of the productivity of four different rice systems

System	Yield (t ha^{-1})	Crops $year^{-1}$	Fallow period	Productivity (t ha^{-1} $year^{-1}$)
Irrigated rice	5.0	2.5	0	12.5
Deep water rice	1.0	1	0	1.0
Rainfed rice	2.5	1	0	2.5
Upland rice*	1.0	1	8	0.125

**Grown in slash and burn systems usually on sloping land*

Average rice yields must increase substantially to sustain overall food security in Southeast Asia over the next twenty years to accommodate increased populations but also the land taken out of rice production due to urban sprawl and crop diversification (more lucrative crops like maize, flowers, vegetables, and fruit substituted for rice). Throughout Asia irrigated rice is now heavily fertilized, but the large amount of N-fertilizer applied is not balanced by the application of K and P fertilizers. Wet season crops can reach levels of 4.5 to 5 t ha^{-1} and dry season crops can range from 6 to 8.5 t ha^{-1}. A network of on-farm experiments in China, India, Thailand, Indonesia and Vietnam coordinated by the International Rice Research Institute (IRRI) has shown that yields can be increased by an average of 0.5 t ha^{-1} when site specific nutrient management techniques, including more balanced supply of fertilizer nutrients and better timing and splitting of N fertilizer, are introduced (Dobermann and Cassman, 2002).

In Malaysia, the government is working with small scale rice farmers to increase field size by combining individual farmers fields into larger holdings. This in turn will allow for better land leveling (and increased productivity) as well as more possibilities for mechanization (planting, weeding, harvesting).

We can foresee greater private sector involvement in agricultural extension in the future with public-private sector partnerships in seed production, fertilizer, farm machinery, and other inputs. The private sector is expected to provide more of the relevant technological information required by farmers but adequate oversight from government agencies will be required.

4.2 Cash crops

Cassava and maize are important cash crops in Southeast Asia and both crops have adapted to changes in market forces in the region. Cassava and maize have changed from their status as food crops to sources of starch for industrial use and livestock feed respectively. Sugar cane was one of the first tropical crops to be adapted to large-scale plantation farming (Humbert, 1963).

4.3 Maize

Food consumption in Southeast Asia is driven by population growth, per capita food requirements and changing dietary preferences as a result of economic growth. Human diets are in the process of rapid change in Southeast Asia with increasing consumption of meat, fruit and vegetables. This trend has led to rapid expansion in livestock production and, as a result, the requirement for maize as a component of livestock feed has increased dramatically. Until quite recently, maize was grown in Southeast Asia as a subsistence crop or for use in backyard livestock enterprises. Today, maize is used mainly for the production of livestock food in Philippines, Thailand and Vietnam (where pork is the major meat source) whilst in Indonesia, maize continues to be an important part of human diets (Table 3).

Southeast Asia is presently a net importer of maize but the deficit could be eliminated through the introduction of high yield technology, particularly in agro-ecological zones with high production potential. Impressive yield gains have been demonstrated in the Philippines, Thailand, Vietnam and Indonesia where adapted hybrids have been introduced together with site-specific crop management practices (Maamun *et al.*, 2001). As mentioned above, a major impediment to technology adoption is the effect of low and volatile prices on risk-averse small-scale farmers. Furthermore, imported maize more closely meets the requirements of the animal feed manufacturing industry for uniform raw materials in terms of grain size and moisture content at present. Capital investments are therefore required in post-harvest facilities (storage, drying) in order to improve the market links between small growers and animal feed manufacturers and drive further intensification.

Table 3. Maize utilization in selected countries in Southeast Asia (1996-1998) (Maamun *et al.*, 2001)

Country	Utilization (M t)	Per capita consumption (kg)	Use		
			Food	Feed	Other
Indonesia	9.9	38.0	78	6	16
Philippines	4.6	7.3	11	76	13
Thailand	4.4	0.5	<1	96	3
Vietnam	1.5	4.1	20	74	6
All Asia	**158**	**11.8**	**20**	**67**	**13**

4.2.2 Cassava

Cassava's role in Southeast Asian agriculture is important both for food security (e.g., Eastern Indonesia) and as a commercial crop (Thailand, Sumatra, Vietnam). Products enter a diverse range of markets including processed human food and livestock feed materials, as well as industrial applications that utilize products derived from starch (Hershey *et al.*, 2000). Cassava's is now less important for food security in Southeast Asia, and can now be considered an important commercial crop with the potential to act as a catalyst for development due to the growing demand for cassava in food products, industrial starch applications and animal feed, and the opportunities for export of cassava pellets and starch.

Furthermore, since cassava is mostly grown by poor farmers on marginal land, the benefits of the transfer of improved technology are skewed in favor of lower income groups in areas where the natural resource base is under threat, an important consideration when ranking crops in terms of the potential for investments in research and development to impact on the rural poor. Changes in trade policy will result in increased competition from other sources of starch and energy but cassava's versatility in terms of its range of product applications will help to retain its competitive advantage.

Cassava is a bulky commodity and improvements in rural infrastructure could provide growers with improved access to markets for produce and easier access to production inputs including fertilizers, which have been shown to be the input providing the greatest economic return (Hershey *et al.*, 2000). A 20% increase in economic yield could be achieved by the introduction of new varieties with greater starch content and improved processing and marketing.

4.2.3 Sugarcane

Rising incomes in Asia will greatly expand the demand of sugar for direct consumption and to produce manufactured products. As mentioned above, a major restructuring of the sugarcane industry is underway in Indonesia as the formerly pre-eminent position of Java as the centre of sugarcane production is taken over by the outer islands. Technology has now been developed to produce large yields of sugar on land formerly considered unsuitable for sugar cane production (Fox *et al.*, 1990; Mutert, 1997). As sugar cane often competes with other food crops (mainly rice) for land, a greater deficit in locally produced sugar in Indonesia is to be expected in the future, unless full support is given to expansion of the area planted on acid upland soils in the Outer Islands.

Thailand is now the largest producer of sugarcane in Southeast Asia, and became the world's second largest sugar exporter in 1996. In spite of poor water availability and drought prone soils, Thailand now achieves the largest yields in the region (NaRong, 2000). More than 200,000 farmers in Thailand grow sugar cane for the country's 46 sugar mills under a government-sponsored system that assigns growers 70% and millers 30% of the total net revenue. The policy of a two-tier price system in Thailand where the domestic price is fixed at a higher level than the world price has helped to drive the expansion of the sugarcane industry in Thailand (NaRong, 2000), but results in a shortage of sugar on the domestic market when the world price is higher than the domestic price.

The pricing system has also contributed to excessive processing capacity in Thailand (rent dissipation) with mills encouraging farmers to switch to sugarcane by providing pre-season credit. In this instance, price intervention has helped to develop the sugarcane industry but not without inducing other problems. In the medium term it is likely that the subsidies on domestic production will be removed and small-scale farmers must improve production efficiency to remain competitive.

4.3 Tree crops

The major commercial tree crops (coffee, cocoa, coconut, oil palm, tea, pepper, rubber) are a very important part of the commercial agriculture sector in Southeast Asia and together account for 21 M ha land (about 8% agricultural land) and US$ 6.3 billion in export earnings for the eight agricultural economies of Southeast Asia. Oil palm accounts for about 28% of the land planted to these crops but almost 60% of the export earnings whilst rubber occupies a similar amount of land but only 6% of the export earnings for tree crops (Figure 10).

Figure 10

Tree crop development is generally capital intensive and requires active participation of national and international banks to finance crop establishment, infrastructure development and processing facilities, which range from US$ 1,000-3,500 ha^{-1}. It should be remembered, however, that a large part of Indonesia's rubber output is produced in 'jungle rubber' farms established by smallholders with little capital input. Jungle rubber is a low risk, flexible farming system that suits farmers in Sumatra and Kalimantan with poor access to credit and inputs. Productivity is low in jungle rubber (<0.5 t ha^{-1}) compared with rubber smallholdings established with more productive clones and fertilizer inputs and farmers can be expected to intensify their rubber plantations as infrastructure and access to credit and inputs improves.

Commercial plantations are major employers in rural areas of Southeast Asia, particularly in Malaysia and Indonesia where much of the plantation sector is located (e.g., >0.5 million people employed directly in the Malaysian palm oil industry). Properly managed plantation developments provide employees with housing, hospitals, clinics, shops, schools, community facilities, and clean water as well as major improvements in rural road networks. The tree crop sector is characterized by a well-organized research and development system driven by productivity goals. An important feature of tree crops is that the soil is protected by a permanent vegetative cover (ground vegetation, legume cover plants, leaf litter), and soil conservation measures are installed to reduce soil erosion and excessive surface water run-off. There is a requirement to enforce legislation to prevent replacement of forest by tree crops and encourage tree crop development on areas already cleared of forest and abandoned to anthropogenic grassland (Sri Adiningsih and Fairhurst, 1998; von Uexküll, 1990; von Uexküll and Mutert, 1995).

4.3.1 Oil palm

The area planted to oil palm has increased rapidly over the past thirty years due to the availability of large areas of suitable land in Malaysia, Indonesia and Thailand and in response to growth in the demand for vegetable oil in India and China. The total area planted to oil palm and under harvest in Southeast Asia is now about 5 M ha.

Unlike West Africa, where the crop is grown both as a commercial and a subsistence crop, oil palm is grown solely as a commercial crop in Southeast Asia and up until the mid 1960s most of the crop was established in plantations with capital, and expertise brought in from Europe. Since then the oil palm industry has diversified, and large areas are now established under smallholders and by plantation houses in the region. In the 1960s, there were a number of major initiatives to develop nucleus estate smallholder schemes in Indonesia (Nucleus Estate Smallholder Scheme, NESS) and Malaysia (Federal Land Development Agency, FELDA).

Smallholders (often migrants from poor regions) were provided with a soft loan for an established oil palm plantation (2–4 ha) and a starter home. Produce was delivered to the nucleus estate processing facility that also often provided essential inputs (fertilizers, seedlings for replanting) and the smallholder obtained the freehold for the land after completing loan repayments. More recently the proliferation of processing facilities in both Indonesia and Malaysia has led to the creation of a more open market for oil palm fruit bunches and this has resulted in considerable growth in the independent oil palm smallholder sector in Indonesia, Thailand and Malaysia.

The oil palm leads the way in terms of precision agriculture technology development and implementation in Southeast Asia. Agronomic databases coupled with GIS provide managers with the decision support tools that help the manager identify those areas in large estates where yield gaps are large and a return on investments in labor, inputs and management time will be greatest (Fairhurst *et al.*, In press).

Vegetable oil consumption in Asia is low when compared with rates in more developed countries (Figure 11) and the demand for vegetable oils is expected to grow further, in line with economic development. We can thus expect the oil palm, as the most efficient vegetable oil crop, to continue to play a major role in the oil and fats supply chain in the long term.

Figure 11

4.3.2 Rubber

Since the beginning of the 20th Century rubber has been an important cash crop for small farmers and plantation firms in many parts of Southeast Asia. In Malaysia the industry expanded continuously during the 1960s and 1970s with the development of smallholdings and plantations in Peninsular Malaysia. Rubber became uncompetitive in Malaysia during the 1980s, however, due to increased labor costs and most plantation rubber has been now been replanted with more profitable oil palm. Rubber is now almost exclusively a smallholder crop in Malaysia, and yields are now smaller when compared with Indonesia. As a result, Malaysia now imports almost 0.5 M t year^{-1} rubber as raw material for its manufacturing base, built up when Malaysia was the largest rubber producer in the region.

As a result of rapid area expansion and increasing yields, Thailand has now surpassed Indonesia and Malaysia in terms of total production, area planted and yield (Figure 12). Exports from Thailand have now reached 685,000 t per year, worth an estimated US$ 260 million in foreign exchange. Indonesia has increased the area planted though a large number of smallholder expansion projects but yields have stagnated at about 0.6 t ha^{-1}. Of the 3 M ha of rubber in Indonesia, 2.5 M ha is classified as 'jungle' rubber producing small yields (0.5-1.0 t ha^{-1}) of poor quality rubber. If these farmers are to remain competitive, jungle rubber must be replanted with modern high yielding materials but this requires major investments in credit, infrastructure and extension.

Figure 12

4.4 Conclusions

We have attempted to illustrate some generic issues that relate to agricultural development in Southeast Asia by reference to six important commercial crops grown widely in the region (Table 4). Based on commonly accepted definitions, most agriculture in Southeast Asia can be considered commercial and we can expect that subsistence farming will further decline in the next ten to twenty years. Pressure on land will continue to increase in Southeast Asia as the potential to increase the area under agriculture decreases and populations continue to expand. Thus, successful curtailment of wetland and forest destruction will drive the requirement for further intensification on existing agricultural land.

Southeast Asia must maintain a cautious but open-minded approach to the introduction of GM crops, which have the potential to increase the productivity and competitiveness of some agricultural commodities in the region.

There is strong evidence of crop substitution and crop relocation in Indonesia and elsewhere in Southeast Asia that can be related to changing opportunity costs for labor and land, government policy, and changes in domestic demand for commodities and their prices on the world market. Thus, the relocation of Indonesia's sugarcane production base from smallholder systems in Java to plantation holdings in the outer islands where less costly land was available for development, has been accompanied by a considerable decrease in average yields.

Rubber has relocated from Malaysia to Indonesia and Thailand in response to changes in the relative opportunity cost of labor. In Indonesia rubber is seen increasingly as a smallholder crop due to the conversion of rubber into oil palm in large estate companies. Whilst yields of rice, cassava, maize and rubber have increased, yields of sugarcane have decreased, due to the removal of a large part of the production base to less fertile soils in the outer islands. Yields oil palm have stagnated due to expansion into less favored areas and deficiencies in crop care and agronomy.

In much of Southeast Asia there is a requirement to recapitalize soil fertility (in particular for phosphorus) before profitable and sustainable commercial agriculture can be established. In the long-term, however, irrespective of improvements in agricultural technology the development of commercial agriculture will be strongly influenced by policies in Europe and North America relating to farm subsidies and tariffs imposed on agricultural commodities.

Table 4. Key points for commercial agricultural development in developing countries.

- **Subsidies** paid to farmers in Europe and North America, and **tariffs** imposed on commodities produced in developing countries and imported into more developed countries are a major constraint on development.
- Farmers require guidance on suitable technology. The private sector will play an increasingly important role in **extension services** in the future.
- Commercial agriculture includes a very wide range of **farm sizes** from 0.2 to 200,000 ha. Scale is not necessarily linked to efficiency.
- Commerical farmers must have access to **credit** via reliable and efficient providers.
- Secure **land rights** and credit are essential for farmers investing in crops with a long gestation (e.g., rubber, oil palm).
- Crops grown for export must be linked efficiently to **markets** and require efficient **infrastructure**.
- Farmers are flexible and respond rapidly to changes in **market conditions**. Crops relocate according to changes in the opportunity cost of labor and emerging possibilities for crop diversification and substitution.
- Elements of **precision agriculture** should be integrated in large-scale commercial farming systems in Southeast Asia.

V. References

Dierolf, T., Fairhurst, T. and Mutert, E. (2001) *Soil Fertility Kit: A Toolkit for Acid, Upland Soil Fertility Management in Southeast Asia*. Potash & Phosphate Institute (PPI), ProRLK, GTZ GmbH, Singapore, 149pp.

Dobermann, A. and Cassman, K. G. (2002) Plant nutrient management for enhanced productivity in intensive grain production systems of the United States and Asia. *Plant and Soil*, **247,** 153-175.

Fairhurst, T., Rankine, I. R., Gfroerer-Kerstan, A. D., McAleer, V., Taylor, C. and Griffiths, W. (In press) A conceptual Framework for Precision Agriculture in Oil Palm Plantations. In: Fairhurst, T. and Hardter, R. (eds.) *The Oil Palm. Management for Large and Sustainable Yields*. PPI/PPIC-IPI, Singapore,

FAO (2003) *World agriculture: towards 2015/2030 an FAO perspective*. Food and Agriculture Organisation. London. 432p.

Fox, R. L. (1988) Phosphorus - A Basic Nutrient for Soil Improvement. In: Pretty, K. M. and Dowdle, S. F. (eds.) *Proceedings of the International Conference on the Management and Fertilization of Upland Soils in the Tropics and Subtropics.* Chinese Academy of Sciences and The Ministry of Agriculture, Animal Husbandry and Fisheries of the People's Republic of China, Nanjing, 7-11 September 1986, pp.57-63.

Fox, R. L., Bosshart, R. P., Sompongse, D. and Lin, M. L. (1990) Phosphorus requirements and management of sugarcane, pineapple and bananas. In: *Symposium on Phosphorus Requirements for Sustainable Agriculture in Asia and Oceania*. International Rice Research Institute, 6-10 March 1989, pp.409-425.

Fry, J. (2000) A Global Perspective of the Sugar Industry. In: Keating, B. and Wilson, J. (eds.) *Intensive Sugarcane production: meeting the Challenge beyond 2000*. CAB International, Brisbane, Australia, pp.1-16.

Goh, K. J. and Chew, P. S. (1995) Direct Application of Phosphate Rocks to Plantation Tree Crops in Malaysia. In: Hellums, D. T. (ed.) *IFDC Workshop on Direct Application of Phosphate Rock and Appropriate Technology Fertilizers in Asia: What Hinders Acceptance and Growth*. Institute of Fundamental Studies & International Fertilizer Development Center (IFDC), Kandy, Sri Lanka, 20-24 February1995, pp.59-76.

Greenland, D. J., Bowen, G., Eswaran, H., Rhoades, R. and Valentin, C. (1994) *Soil, Water, and Nutrient Management Research - a New Agenda*. (IBSRAM Position Paper), International Board for Soil Research and Management, Bangkok, Thailand, 72pp.

Hershey, C., Henry, G., Best, R., Kawano, K., Howeler, R. and Iglesias, C. (2000) Cassava in Asia. In: *Proceedings of the Validation Forum on the Global Cassava Development Strategy*. Food and Agriculture Organisaiton, International Fund for Agricultural Development, Rome, 26-28 April 2000, pp.184.

Levang, P. (Paper submitted August 1996) From Rags to Riches in Sumatra: How Peasants Shifted from Food Self-Sufficiency to Market-Oriented Tree Crops in Six Years. *Bulletin of Concerned Asian Scholars*,

Maamun, M. Y., Suherman, O., Baco, D., Dahlan, M. and Subandi (2001) Impact of Breeding Research on Maize Production and Distribution in Indonesia. In: Gerpacio, R. V. (ed.) *Impact of Public- and Private-Sector Maize Breeding Research in Asia, 1966-1997/98*. CIMMYT, pp.53-65.

Makarim, A. K. (2003) *Bridging the Rice Yield Gap in Indonesia.* Central Research Institute for Food Crops. http://www.fao.org/DOCREP/003/X6905E/x6905e0a.htm (accessed 10 February 2003)

McNeely, J. A. and Scherr, S. J. (2001) *Common Ground Common Future. How Ecoagriculture Can Help Feed the World and Save Biodiversity*. International Union for Conservation of Nature and Natural Resources. Washington DC. 28p.

Mutert, E. W. (1997) The role of nutrient management in South East Asia's sugar production. In: *Proceedings of the First Asia Pacific Sugar Conference and Exhibition*. PICC, Manila, Philippines, 18-22 August 1997,

NaRong, V. (2000) The Thai sugar industry: crisis and opportunities. *Thailand Development Research Institute Quarterly Review*, **15,** (3), 8-16.

Ruthenberg, H. (1980) *Farming Systems in the Tropics*. 3rd ed. Clarendon Press, Oxford, 424pp.

Sri Adiningsih, J. and Fairhurst, T. (1998) The Use of Reactive Phosphate Rock for the Rehabilitation of Anthropic Savannah in Indonesia. In: Johnston, A. E. and Syers, J. K. (eds.) *Nutrient Management for Sustainable Food Production in Asia:IMPHOS-AARD/CSAR International Conference in Asia and IFA-FADINAP Regional Meeting*. Bali, Indonesia, 9–12 December 1996, pp.159–174.

The World Bank (1994) Role of Phosphorus in Agriculture. In: *Feasibility of Phosphate Rock as a Capital Investment in Sub-Saharan Africa: Issues and Opportunities*. World Bank/IFA/M.I.G.A., pp.9-37.

Vanlauwe, B., Diels, J., Sanginga, N. and Merckx, R. (eds.) (2002) *Integrated Plant Nutrient Management in Sub-Saharan Africa: From Concept to Practice.* CABI Publishing, New York, 352p.

von Uexküll, H. R. (1990) Phosphorus Important in Rehabilitation of Anthropic Savanna (Alang-alang Land). *Better Crops International*, (June), 12-15.

von Uexküll, H. R. and Mutert, E. W. (1995) Rehabilitation of anthropic savanna. In: Tiessen, H. (ed.) *Phosphorus in the Global Environment. Transfers, Cycles and Management*. (SCOPE 54), John Wiley & Sons, Chichester, pp.149-154.

World Bank (2003) *Organic Farming.* World Bank. http://lnweb18.worldbank.org/ESSD/essdext.nsf/26ByDocName/CropsOrganicFarming (accessed 10 February 2002)

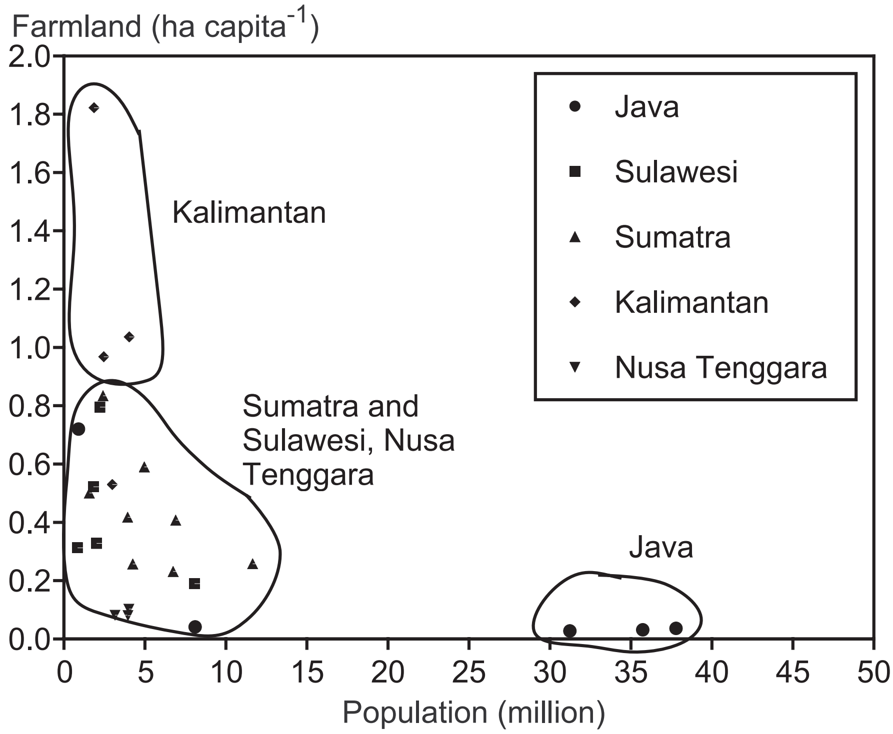

Figure 1 Availability of farm land and population by province and region in Indonesia.

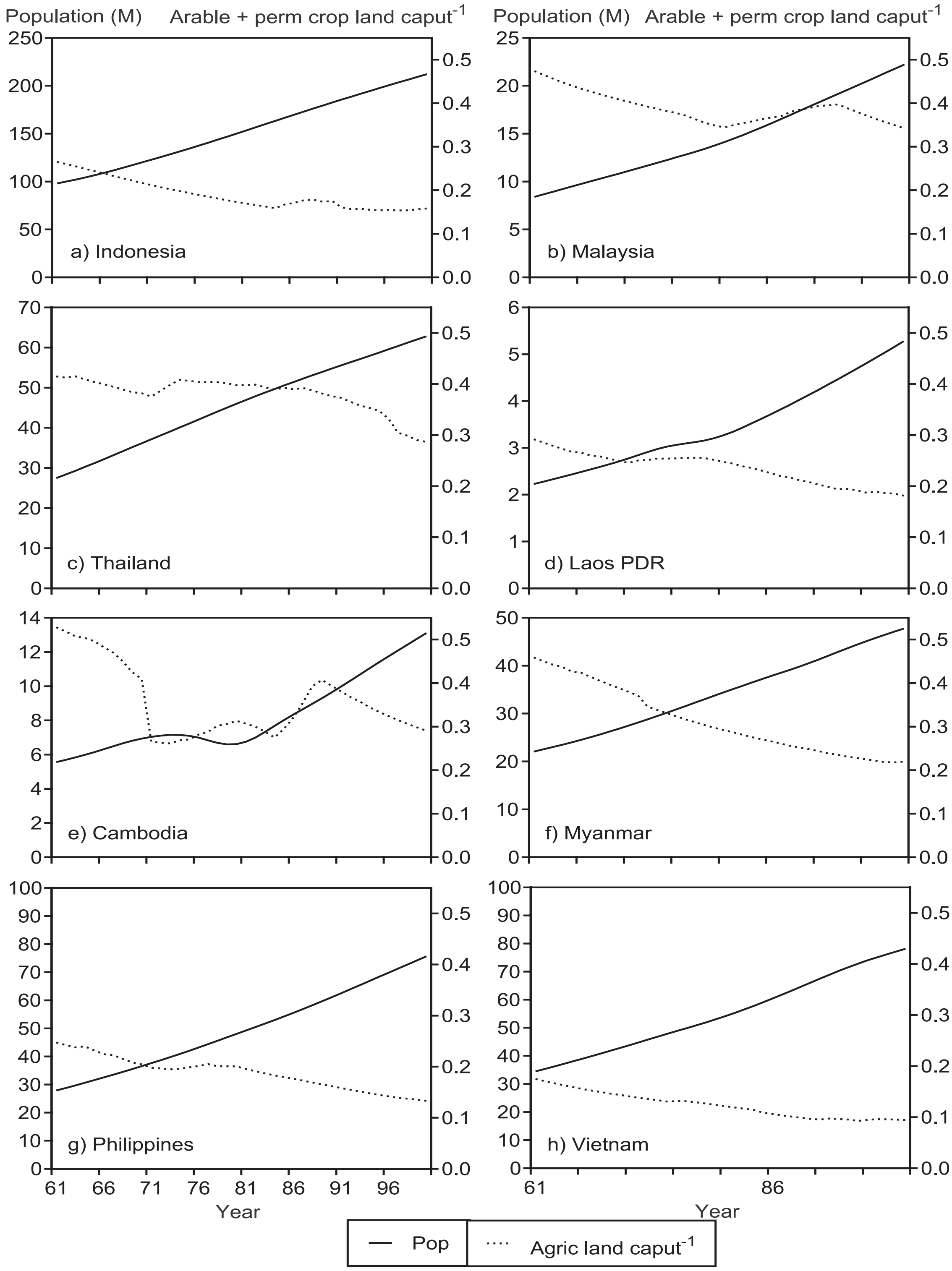

Figure 2 Changes in population and availability of arable and permanently cropped land in six Southeast Asian Countries (FAO, 2003)

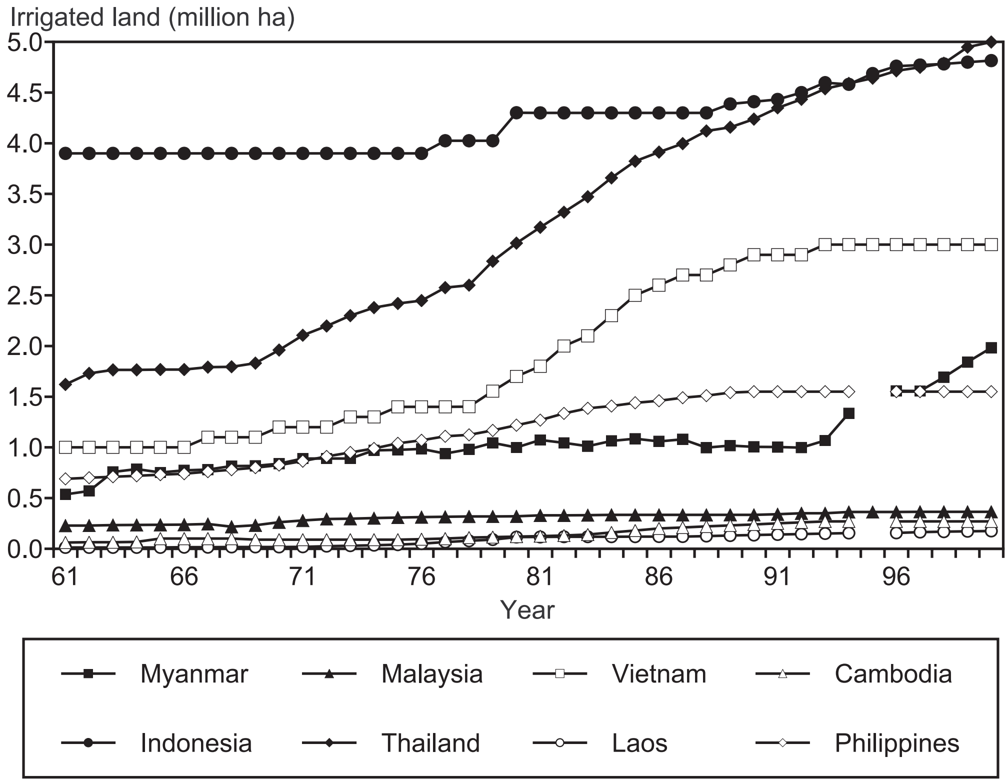

Figure 3 Amount of irrigated land in Southeast Asian countries, 1961–2000 (FAO, 2003).

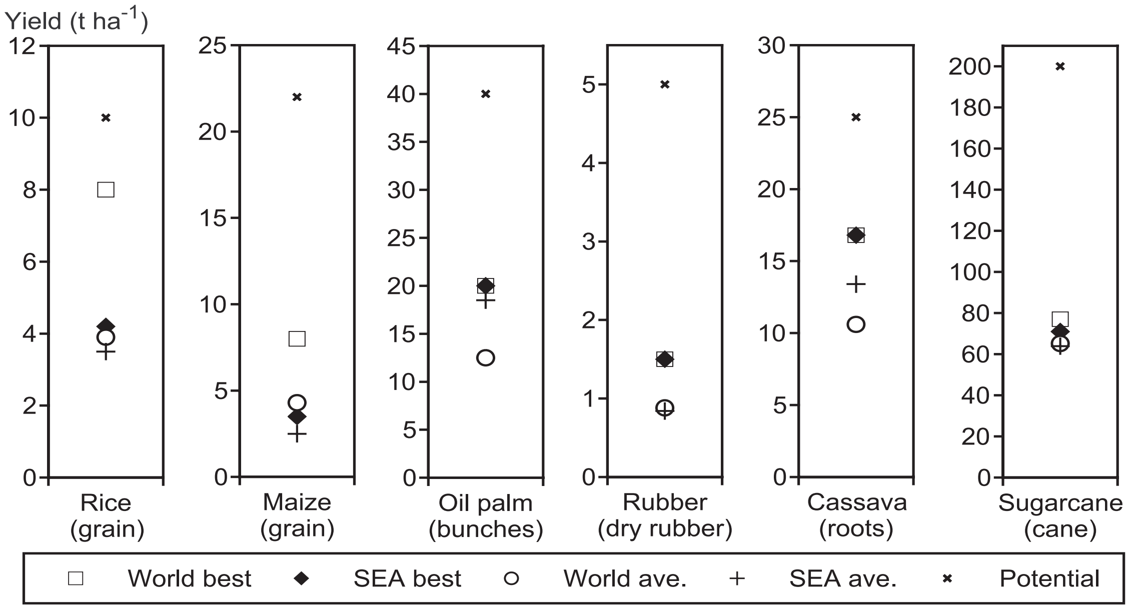

Figure 4 World and Southeast Asian best and average yields for rice, maize, oil palm, rubber, cassava and sugarcane.

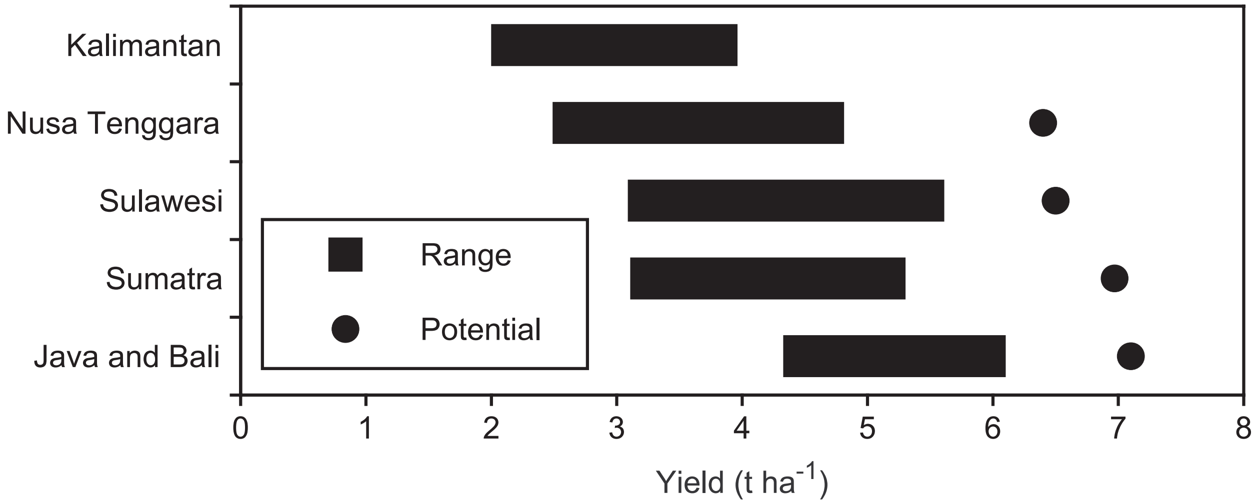

Figure 5 Yield gaps in major rice bowls in Indonesia (Makarim, 2003)

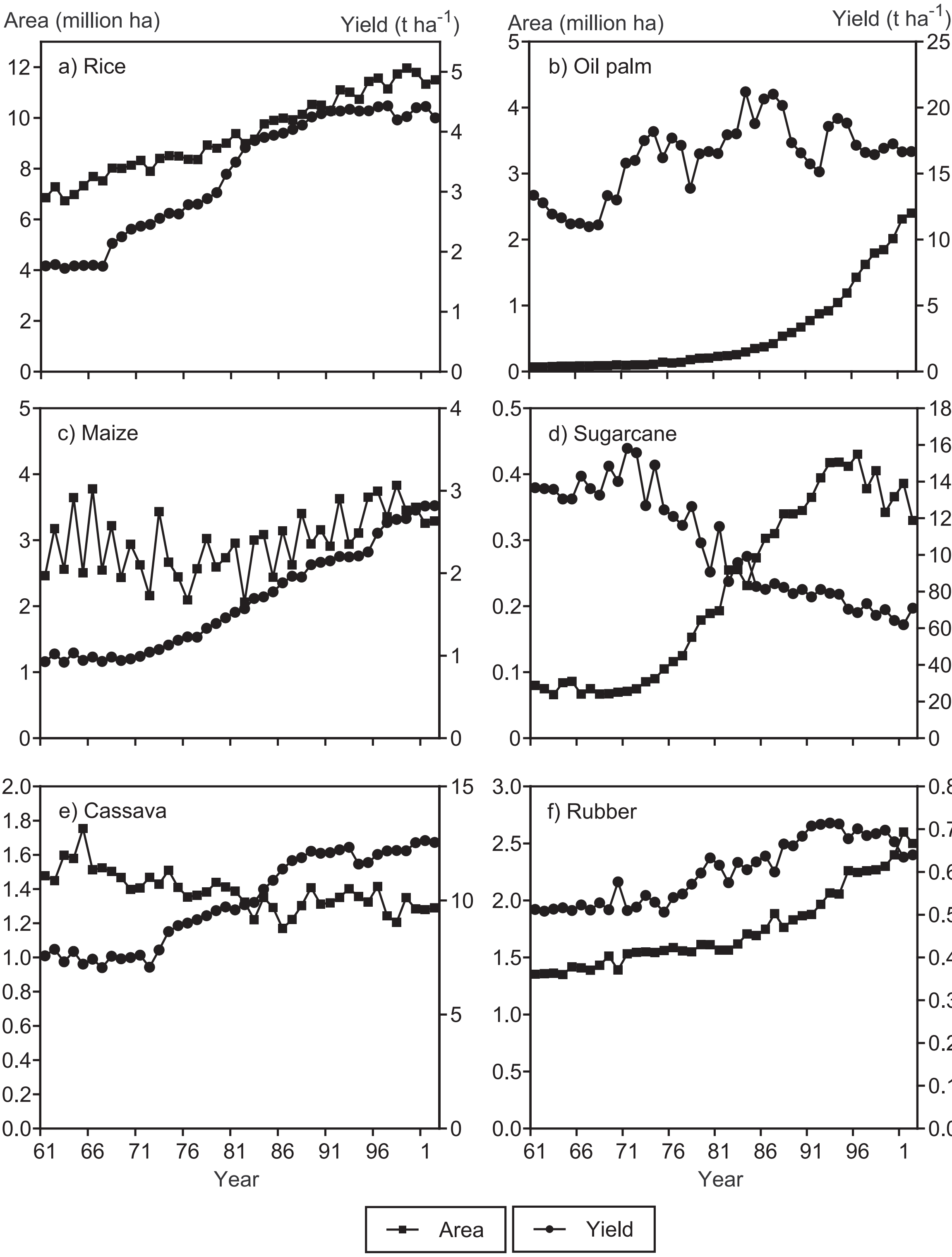

Figure 6 Yield and area planted for rice, oil palm, maize, sugarcane, cassava and rubber in Indonesia (FAO, 2003)

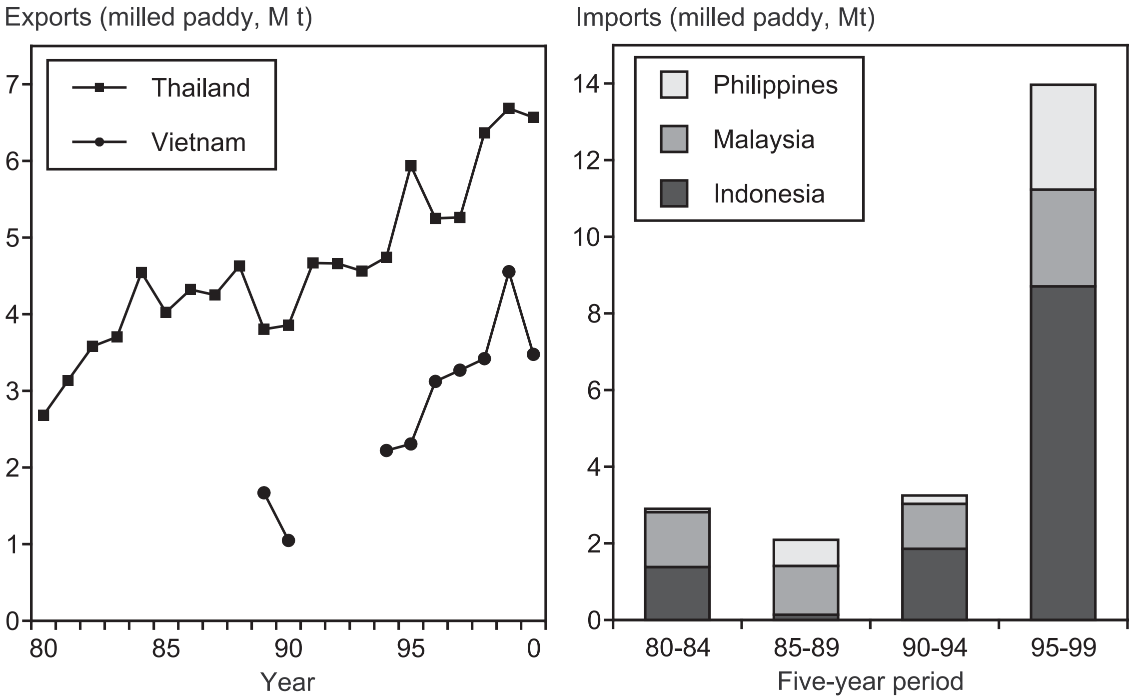

Figure 7 Rice exports from Thailand and Vietnam and rice imports in Philippines, Malaysia and Indonesia (1980-2000) (FAO, 2003).

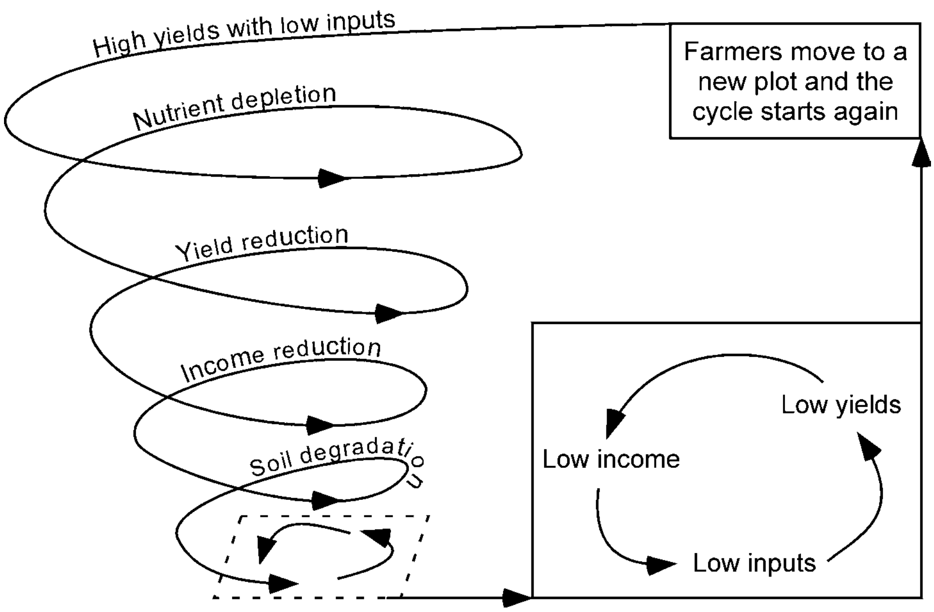

Figure 8 The downward spiral to the poverty trap for upland farmers is closely related to poor soil fertility (Greenland et al., 1994).

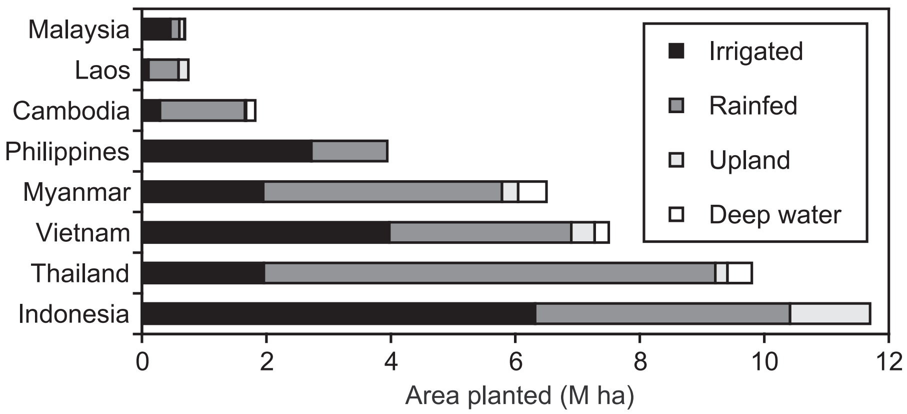

Figure 9 Area planted to rice under four major cultivation systems in Southeast Asia.

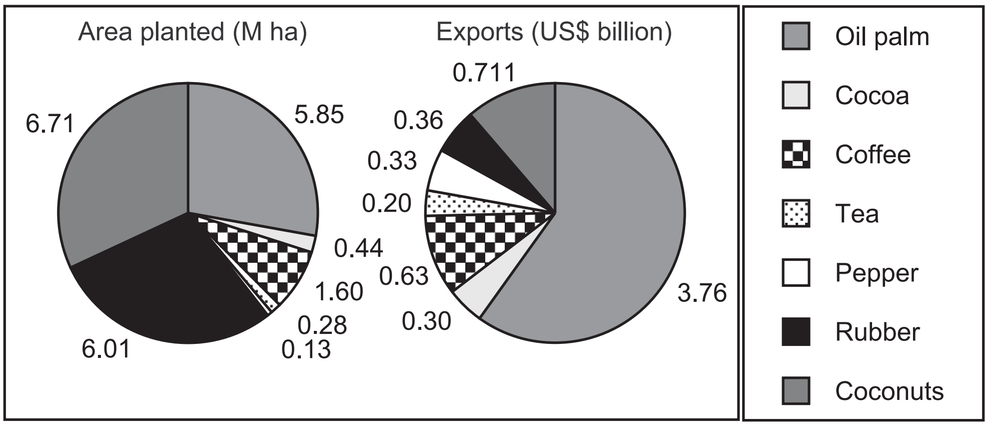

Figure 10 Area planted and export earnings from rubber, oil palm, cocoa, coffee, tea and pepper in Southeast Asia in 2001 (FAO, 2003).

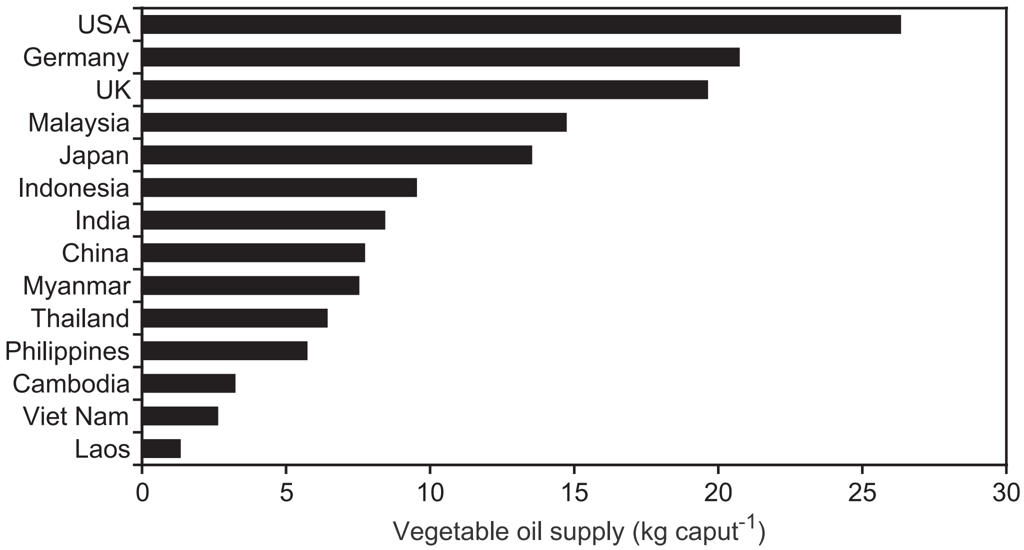

Figure 11 Consumption of vegetable oil in selected countries (FAO, 2003).

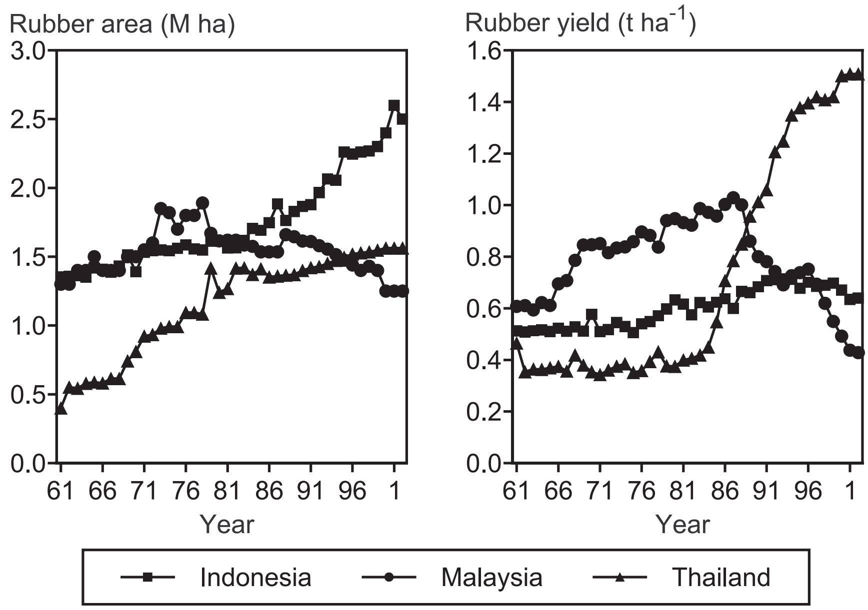

Figure 12 Area planted to rubber and rubber yields in Indonesia, Malaysia and Thailand (FAO, 2003).