

# SUSTAINABLE AGRICULTURE FOR SMALL-SCALE FARMERS: A FARMING SYSTEMS PERSPECTIVE

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## ABSTRACT

*Agriculture in developing countries has the following important characteristics; farms are small, and they are threatened with the degradation of resources and the environment. In most of the developing countries of Asia, land holdings do not usually exceed 1 ha.*

*Deterioration of the environment and natural resources includes deforestation, land degradation, misuse of pesticides and chemicals, and the loss of genetic resources. Shifting cultivation is a major cause of deforestation. Heavy applications of pesticides, including insecticides, herbicides and fungicides, are inducing the build-up of resistance to insect pests and the elimination of natural enemies. At the same time, they pose toxicological problems for human beings. The loss of genetic resources caused by extensive deforestation and adoption of uniform modern crop varieties increases the risk of agricultural production in the long term by electing the use of a narrow genetic base for many important crops.*

*Generally, the present technology for agriculture in Asia and Pacific uses the high yielding varieties (HYV) of the Green Revolution. HYV requires high-input farming, which excludes small-scale farmers. It is rich farmers who have been the main beneficiaries. Furthermore, it reduces the output of protein-rich grains and pulses which contribute to a balanced diet for the rural poor.*

*To implement sustainability in agriculture, technology for farmers should conserve the resource base. Furthermore, adoption of technology by farmers requires a broad understanding of the farmer's situation. The concept of Farming Systems Research and Development is needed, to include on-farm research with farmer participation, a strong linkage between research, extension and farmers, and the development of low-external-input farming technology which emphasizes soil and water conservation.*

*It is recognized that the root causes of environmental degradation are social and institutional in nature. Therefore, measures to address the problem will involve an adjustment of policies and institutional structures. The major thrust of the strategy for sustainable agriculture must aim at eradicating poverty.*

## INTRODUCTION

### The Role of Agriculture

For thousands of years, agriculture has been the economic activity which is most essential to human survival and well-being. It has also been the economic sector which most affects, and is most dependent on, the natural environment (FAO 1991a). The region of Asia and the Pacific has nearly 23% of

the world's total land area and about 30% of the world's arable land, but 56% of the total world population and 72.5% of the world's agricultural population (FAO 1991b).

As the human population continues to increase, agriculture is not fulfilling its vital function of feeding people, providing other basic agricultural commodities and generating stable incomes. The report of the FAO/Netherlands Conference on Agriculture and the Environment (FAO 1991a) pointed

out that more than 500 million people are facing difficulty in earning a living and are undernourished. Higher demand as a result of population growth and urbanization, as well as the lack of alternative opportunities in rural areas, is putting pressure on agriculture to increase production, resulting in degradation of the environment. Deforestation, erosion, desertification and the loss of biological diversity, as well as various forms of pollution, all threaten the ability of agricultural systems to even maintain their present level of production, let alone increase it.

### **THE DETERIORATION OF RESOURCES AND THE ENVIRONMENT**

The degradation of the physical resources needed for agricultural production are causing strong concern. While this might not have much effect on the agricultural production of the present generation, it will affect the ability of future generations to produce their food supply.

The Asian and Pacific Region has seen some success in agricultural development over the past two decades. Agriculture is the most important economic activity for most countries in the region, its share of the GDP being as high as 55-60% in some cases. The rate of economic growth for the region averaged 7% per annum, or 5.3% per head of population, between 1980 and 1988. Agricultural GDP also grew at the impressive rate of 5.4%, and output per head by 4% per annum (FAO 1991b).

### **THE IMPORTANCE OF SUSTAINABILITY**

However, several studies have indicated that Asia and the Pacific have reached their safe limit for the horizontal expansion of agricultural production. Over the coming decades, the need for food, fiber and other agricultural products, as well as energy, has to be served for a population which is not only rapidly increasing but also rapidly becoming urbanized and expecting a higher standard of living. Therefore, the resource base should be used realistically and sustainably, to meet the need of all the community with equity.

Sustainable agriculture and rural development has been defined by FAO as

“..... The management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable develop-

ment (in agriculture, forestry, and fisheries sectors) conserves land, water, plant and animal genetic resources, and is environmentally non-degrading, technically appropriate, economically viable and socially acceptable”

(FAO 1991a).

### **SMALL FARMS**

Agriculture in developing countries has the following two important characteristics. Farms are generally small, and most countries are suffering from a degradation of resources and the environment. Sustainable agricultural practices which are suitable for developing countries must take into consideration the fact that population growth rates are high, resulting in an increase in food demand at a rate of 3-5% per year (Dent 1989). This rapid increase in population has caused farmers to expand into marginal areas and make more intensive use of marginal land, resulting in the degradation of land and water, and causing poverty, malnutrition and a lower standard of living.

### **CHARACTERISTICS OF SMALL-SCALE FARMS**

The definition of a small farm is obviously based on the size of the farm holding. Small farms are usually defined as those smaller than the average farm size at a provincial or national level (Dent 1989). However, farm size alone is not always a good criterion for categorizing farmers. Farmers who own 1 ha of irrigated land are generally more prosperous than those who own 2 ha of land in a drought prone area of low productivity. In most developing countries of Asia, the average land holding ranges from 1 to 2 ha.

It has been estimated that out of the agricultural population of developing countries (Africa, Latin America, Near East, and Asia) in 1985, 54% (817 million) were small-scale farmers, while another 12% were landless laborers. Table 1 shows the estimated number of small-holders and landless laborers in developing countries between 1980 and 1985. It is alarming to see that the number of small-scale farmers and landless laborers is increasing.

The Asian and Pacific region contains 56% of the world's population, of which well over half (61%) depends on agriculture for a livelihood. However, the region has only 31% of the world's agricultural land. The land:man ratio is the lowest in the world and is becoming steadily lower, falling from

0.28 ha/person<sup>-1</sup> to 0.16 ha/person<sup>-1</sup> between 1963 and 1986. This can be compared with the average of 1.62 ha/person in the rest of the world (FAO 1991c).

This situation is even worse than at first sight, because the majority of farmers occupy a disproportionately small proportion of the total arable area. In India, which has about 500 million people dependent on agriculture, more than half (57%) of the farm holdings were less than 1 ha in size, and altogether covered only 12% of the total area. In contrast, only 2.4% of land holdings were larger than 10 ha, but these accounted for about 23% of the total arable land.

### LANDLESS FARMERS

In several countries of the region, the average size of land holdings continues to fall with the fragmentation of land holdings. The average size of farms was seen to decline in several Asian countries between 1970 and 1980: from 0.92 down to 0.88 ha in Bangladesh, from 2.28 to 1.82 ha in India, from 0.64 to 0.59 ha in Indonesia, and from 3.6 to 2.6 ha in the Philippines. At the same time, the number of smallholdings increased significantly. There has also been an acceleration in the number of farm workers with either no land at all, or too little land for a viable farm.

In order to compensate for the reduction in farm size, several governments have tried to intensify land use, especially through irrigation. Increased returns led to increased investment in irrigation facilities such as wells and pumps. The results included a growing discrepancy in production and income between irrigated areas and those dry areas which did not share the benefit of land-augmenting technology; high and rising land prices; the persis-

tence of disguised share-cropping and of tenancies without any records which might be used to implement land reforms; the fragmentation of smallholdings; an increase in landlessness; and a rapid rate of deforestation and the erosion of common resources.

It should be understood that any increase in yield in Asia and the Pacific cannot be achieved through an increase in the land area farmed. The only possible way of improving agriculture is through an increase in productivity, yet the number of small-scale farmers has generally increased as the size of farm holdings has shrunk. This further intensifies the challenge of raising the production levels on small farms through the development and adoption of new technology.

### CONSTRAINTS TO SUSTAINABLE AGRICULTURE

FAO estimates that by the year 2000, the global population will be 25% higher than in the mid-1980s (FAO 1991b), and that 90% of this population increase will be in developing countries. It will be necessary to increase the supply of food and other agricultural products to meet their needs. At the moment, many of the methods being used to increase production are damaging to natural resources and the environment.

#### Deforestation

The rapid loss of forest cover is possibly the most serious environmental threat in the region. During the period 1976-1980, the average annual rate of deforestation was 1.815 million ha, or 5000 ha per day. Table 2 shows the average annual

Table 1. Estimated numbers of smallholders and landless laborers, 1980 and 1985 (in millions)

Region	Smallholder population		Landless laborer population	
	1980	1985	1980	1985
Africa	172	190	17	19
Latin America	63	63	18	18
Near East	47	48	15	14
Asia	481	516	121	129
<b>Total</b>	<b>763</b>	<b>817</b>	<b>171</b>	<b>180</b>

Source: FAO 1988. The impact of development strategies for the rural poor

deforestation in Asian countries during these five years.

Since the trend still continues today, it is clear huge areas are being converted to non-forest areas every year. Rao (1989) estimated that unless this activity is slowed or halted, by the year 2000 some 36 million ha of forest land in the Asian and Pacific region will have been converted to other uses.

The main cause of deforestation is shifting cultivation, which supports 30 million people in various parts of the world. The shorter cropping cycles of traditional shifting cultivation, and the unorganized and spontaneous encroachment onto forest land by lowlanders, reflect the increasing demand for cultivable land among the landless and the unemployed rural poor. There are also organized forms of settlement, generally government sponsored such as the transmigration program in Indonesia, and the World Bank aided settlement projects in Peninsular Malaysia where forest is being cleared and the land planted in oil palm and rubber.

### Land Degradation

One of the most important components of sustainable agriculture is an adequate soil resource

Table 2. Average annual deforestation in Asian and Pacific countries, 1976-1980

Country	Deforested area (ha)
Bangladesh	8,000
Bhutan	2,000
Brunei	7,000
India	147,000
Indonesia	550,000
Kampuchea	15,000
Laos	125,000
Malaysia	230,000
Myanmar	95,000
Nepal	84,000
Pakistan	7,000
Papua New Guinea	21,000]
Philippines	101,000
Sri Lanka	25,000
Thailand	333,000
Vietnam	65,000
<b>Total (16 countries)</b>	<b>1,815,000</b>

Source: Rao 1989

base to provide the nutrients and moisture essential to plant growth. In many areas, population pressures are forcing farmers to cultivate marginal land and fragile soils. Dent (1989) reported that the proportion of permanently cropped land compared to the total land area in the Asian and Pacific region was 15% in 1987, while the estimated proportion of land free from soil related constraints was only 14.2%. The region as a whole appears to have reached or passed the safe limits for the horizontal expansion of agricultural production.

Table 3 shows the estimated extent of degraded land in selected countries in the Asian and Pacific region. On a percentage basis, India, Vietnam, China, Laos, Thailand and Indonesia were among the worst affected. Most of the land degradation came from erosion, in particular the kind called "accelerated erosion", caused by human activity, in which soil losses occur much faster than new soil can be formed so that a kind of deficit spending begins of the topsoil.

In addition to the large quantities of nutrients lost through soil erosion, "mining" of the soil caused by the inadequate replenishment of nutrients removed by higher and more frequent harvests could reach catastrophic levels in the region, if corrective measures are not taken in time. The region's annual rice production of 400 million mt, for example, contains nearly 20 million mt of plant nutrients. As a result of poor resource management in many parts of the region, most of the nutrients removed in crops are not returned to the soil. This represents a serious threat to sustainability, and will eventually lead to significant soil degradation.

### Effect of Water Use

Irrigation continues to play a vital role in giving higher and more stable yields, particularly in arid and semi-arid regions where rainfall is scanty and erratic. While expanding the irrigation system is an essential part of agricultural development in many countries, severe problems with irrigation have been reported. A number of irrigated areas have become unusable due to salinity. Table 6 shows the extent of salinity in some countries of Asia and the Pacific (Yadav 1989).

Irrigation water disturbs the hydrologic equilibrium, and discharges substantial amounts of groundwater, with a consequent rise in the local water table. Millions of hectares in several irrigated projects are reported to be suffering from waterlogging.

In relation to irrigation, it is noteworthy

Table 3. Estimated extents of degraded land for selected countries in Asia and Pacific in 1981

Unit: 1000 ha

Country	Total land area	Arable & permanently cropped areas		Estimated degraded land area	
		Ha	Percentage of total	Ha	Percentage of total
Bangladesh	13,391	9,164	68	989	7.4
Mainland China	932,641	96,976	10	280,000	30.0
India	297,319	168,990	57	148,100	49.8
Indonesia	181,157	21,220	12	43,000	24.0
Laos	23,080	901	4	8,100	35.0
Myanmar	65,754	10,060	15	210	3.2
Pakistan	77,088	20,706	27	15,500	17.3
Philippines	29,817	7,930	27	5,000	16.8
Western Samoa	283	122	43	32	11.3
Sri Lanka	6,474	1,887	29	700	10.8
Thailand	51,089	20,050	39	17,200	33.7
Tonga	72	48	67	3	4.5
Vietnam	32,536	6,470	20	15,900	48.9

Source: Dent 1989

that periodic shortages of water occur throughout the developing world, even though the annual volume of water received through the hydrological cycle is far in excess of the needs of the present world population. Rainfed agriculture gives highly variable yields, resulting in severe problems of food security and price instability. Nevertheless, this is the system used for two-thirds of the agricultural production of the developing world (FAO 1991c).

### Pest Problems and Pesticide Use

FAO estimates that up to 35% of the losses in annual crop production worldwide are the result of pests. When these losses are combined with postharvest losses, they account for almost one-half of the world's potential food supply. The advances in agricultural technology that are being used to raise production, such as shorter fallow periods, intensive crop rotation, and the replacement of mixed cropping by the large-scale monoculture of genetically uniform varieties, have for a number of crops resulted in the escalation of pest problems (Gaston 1989).

One intractable pest problem in many developing countries is weed control. Much of the field preparation and subsequent cultivation is being carried out to reduce weed infestation, while during the

cropping season, a great deal of manual labor is used to keep weeds at as low a level as possible. If there not enough labor for hand weeding, weed control is late and inadequate unless herbicides are used. Problems of pests and weeds have led to the extensive use of chemical pesticides in developing countries. Initially pesticides, including herbicides, were regarded as a beneficial means of abolishing famine and eradicating vector-borne diseases. Subsequently, the gradual development of resistant pests, and the evidence of undesirable side-effects on non-target species and human beings, have caused widespread concern.

The major groups of pesticides used are herbicides (44%) insecticides (32%), and fungicides (18%). Herbicides are most widely used in the United States, fungicides in Western Europe, and insecticides in the Asian and Pacific region (Gaston 1989).

The latest available statistics estimate global pesticide sales at U.S.\$ 16 billion in 1985 (3.1 million mt), with an average annual increase of 4.5% (Asian Development Bank 1987). It is estimated that 20%, equivalent to 600,000 mt annually, are used in developing countries (Mowbrary 1988). The regional distribution of pesticide imports between 1972 and 1984 is shown in Table 5.

The increased use, and sometimes misuse,

of pesticides has had a number of unfavorable effects (FAO 1991c). The first is that insect pests have developed resistance as a result of the heavy use of insecticides, a problem which has grown enormously over the past two decades. Resistance is also increasingly found in plant pathogens and weeds. Secondly, the injudicious use of pesticides has resulted in the destruction of natural enemies that help keep insect pests under control, causing pest resurgence and secondary pest out-breaks. Thirdly, in addition to ecological disturbances, the increased use of pesticides poses toxicological problems. WHO in 1986 estimated that there were 1.1 million cases of unintentional pesticide poisoning and 20,000 deaths a year. Fourthly, heavy applications of unsuitable pesticides too soon before harvest are resulting in high pesticide residues in food. Last but not least, it should be noted that there are numerous side-effects of pesticide abuse, such as fish-kills, cattle poisoning and the indirect impacts on beneficial insects, polli-

nators and soil organisms.

### The Loss of Genetic Resources

Genetic resources are the building blocks with which new varieties are made. Hence, their availability to plant breeders is absolutely necessary for the further development of crops to meet the ever-diversifying needs of man (Singh 1989). Extensive forest clearance and the large-scale adoption of uniform modern varieties are eroding the range of genetic resources. An all-out effort must be made to conserve and utilize genetic resources in a rational manner, to avoid a conflict between development and conservation.

For development to be sustainable, there is a need to conserve and manage the biological resource base, much of which has unknown potential. Future needs for breeding and crop diversification cannot be predicted in the face of changing climates,

Table 4. Extent of salt affected soils in some countries of Asia and the Pacific

Unit: Million ha			
Country	Saline area	Country	Saline area
Bangladesh	3.0	Australia	357.3
Myanmar	0.6	Kampuchea	1.3
India	23.8	Indonesia	13.2
Pakistan	10.7	Malaysia	3.0
Sarawak	1.5	Vietnam	1.0
		Thailand	1.5
		<b>Total</b>	<b>461.2</b>

Source: Yadav 1989

Table 5. Value of pesticide imports, world and by region, 1972-1984

Region	1972	1984	Increase (%)
Million dollars			
Soviet Union	132	552	318
North America	142	535	277
Asia	314	1,132	261
Europe	824	2,014	144
Africa	269	522	94
Oceania	30	47	57
Latin America	340	503	48
<b>World</b>	<b>2,051</b>	<b>5,305</b>	<b>159</b>

Source: FAO Trade Yearbooks, Rome: 1977 and 1985 cited by Postel (1987)

new agricultural production systems, and unknown future human requirements. Not only has man already lost part of the genetic resource base, he is also subjecting the production system to high risk by electing to use only a narrow genetic base for many of his most important crops. Consequently, the genetic base of crop varieties is becoming increasingly narrower (FAO 1991c).

## TECHNOLOGY FOR SUSTAINABLE AGRICULTURE

### The Impact of Present Improved Technology

#### *The Green Revolution*

Obviously, the Green Revolution made a notable contribution to raising the production of rice and wheat by small-scale farmers, particularly in Asia and the Pacific. The high-yielding varieties (HYVs) of rice released in the 1960s increased the productivity of rice by about 70%, and of wheat by 150%. The HYVs are responsive to very high applications of fertilizer, and are efficient producers under intensive management conditions (RAPA 1989).

One indirect effect of the Green Revolution was to reduce the output of protein-rich grains and pulses which contributed greatly to ensuring a balanced diet for the rural poor (FAO 1991b). These crops were no longer competitive in terms of financial returns per hectare. The Green Revolution has also raised several sustainability issues. Although the upward trend in yield has been maintained over the past three decades, the rate of increase is slackening, largely because of deteriorating soil fertility and the high incidence of pests and diseases associated with monoculture. The social impact of the Green Revolution has also sometimes been harmful. Since HYVs require high inputs such as fertilizer, irrigation water and pesticides, as well as intensive management, large landowners with plenty of capital were the main beneficiaries. Attracted by the high returns which the new seeds made possible, landowners tended to begin farming their land directly, sometimes exacerbating the problems of landlessness and rural poverty.

Other types of technology which give high yields but have a negative impact on the environment, such as heavy applications of pesticides, monoculture, and extension of irrigation systems, have already been discussed. We must question how long our natural resources can meet the need for an

increased output of agricultural commodities, before drastic degradation of the resource occurs and productivity falls even below its present levels.

## PRODUCTION TECHNOLOGY FOR THE FARMER

We have discussed the impact of modern agriculture on the environment and the constraints facing farmers, particularly Asian and Pacific smallholders. Another important aspect concerning smallholders and how they can farm their land in a sustainable way is related to production technology.

Several points should be emphasized regarding the development of technology, in particular the limited land holdings and capital of smallholders, and their rising populations. Farmers should not have to invest heavily into inputs to improve yields or maintain the productivity of their farms. Because the environment and socio-economic situation of each farmer are location specific, farmer-based technology should be developed (Fig. 1).

FAO has reviewed some of the improved agricultural technology suitable for smallholders in a sustainable system.

- Exploitation of biological nitrogen fixation, through increasing use of leguminous plants or non-symbiotic ferns (*Azolla*) and nitrogen-fixing blue-green algae (*Anabaena*).
- Improved grazing management, including the use of fodder crops and temporary pastures in crop rotations.
- Increasing use of integrated pest management which avoids harming natural enemies and reduces the use of chemicals.
- Increasing use of rhizobium inoculation on legume crops grown before or after rice.
- Adaptation of mixed cropping, or the use of varietal mixtures, to mimic the diversity of natural ecosystems. Increased productivity based upon the combined yield of crops is also important.
- Developing alternative energy sources for use by small-scale farmers and other poor people in rural areas.

## ADOPTION OF TECHNOLOGY BY FARMERS

Once technology has been generated, the main objective is to introduce it to farmers for adoption. A huge amount of technology generated

by researchers has not been accepted by farmers, simply because farmers feel that it is impractical. Recently, the technique of Farming Systems Research and Development has been introduced with the purpose of bringing an understanding of the farmer's situation to researchers before technology is developed, so that their work is more useful to farmers.

The following guidelines are considered important in the adoption of technology by farmers.

- Technology should be tested under farm conditions, and recommendations must be made only after consultation with the farmers concerned. They must take fully into account the farmer's circumstances, focusing on the local farming system and the related processing and marketing components. There should be frequent communication between the researcher, the extension worker and the farmer.
- There is an urgent need to develop and promote technology that increases or sustains productivity at a lower cost and for a lower labor input, and which does not harm the environment.
- Soil and water conservation and other measures to achieve sustainable development should, where possible, be designed to benefit the farmer in the same year they are carried out, otherwise they are unlikely to be widely adopted by other farmers. Simple water harvesting methods can meet this requirement, as can certain forms of minimum tillage.
- Emphasis should be placed on low external input farming systems, such as the integration of crop and livestock production systems to provide manure and draught animal power, to reduce residue problems from fertilizers and pesticides, and lower the cost of external production inputs.

## CHANGES TOWARDS SUSTAINABILITY

In evolving more sustainable production systems, agriculture and rural development efforts should be directed towards three essential goals.

- Food security,
- Employment and income generation in rural areas, in order to eradicate pov-

erty.

- Natural resource conservation and environmental protection.

It has been recognized that the root causes of environmental degradation are social and institutional in nature. Measures to address the problem will require integrated strategies which involve an adjustment of policies, values, and institutional structures. The major thrust of the strategy for creating the conditions for sustainability for the poor must aim at eradicating poverty (FAO 1991d).

Measures to promote sustainability should include the following:

- There must be active participation by rural people in the development of integrated farming systems, by means of organizations such as agricultural cooperatives. Such groups will help prevent an increase in the influence of the middleman.
- There must be a decentralization and a recognition of the role of farmers, their families and local authorities in decision-making, including incentives for initiatives by local communities.
- Clear and fair legal rights and obligations must be allocated with regard to the use of land and other natural resources, including land reform where necessary. Such allocation should pay particular attention to the important role of women as decision makers, food producers and food providers.
- Pressure on natural resources should be relieved by investment into improving, rehabilitating and conserving them, so that they can be used safely and productively.
- Agricultural policies should be adjusted to promote production systems that can help attain the objective of sustainability. This includes promoting the demand for crops and livestock which can be produced sustainably.
- More attention should be paid to safeguard human health and environmental quality in relation to the use of dangerous pesticides and other chemicals.
- More sources of off-farm income such as food processing and handicrafts are needed in rural areas to prevent the migration of farmers to urban centers.

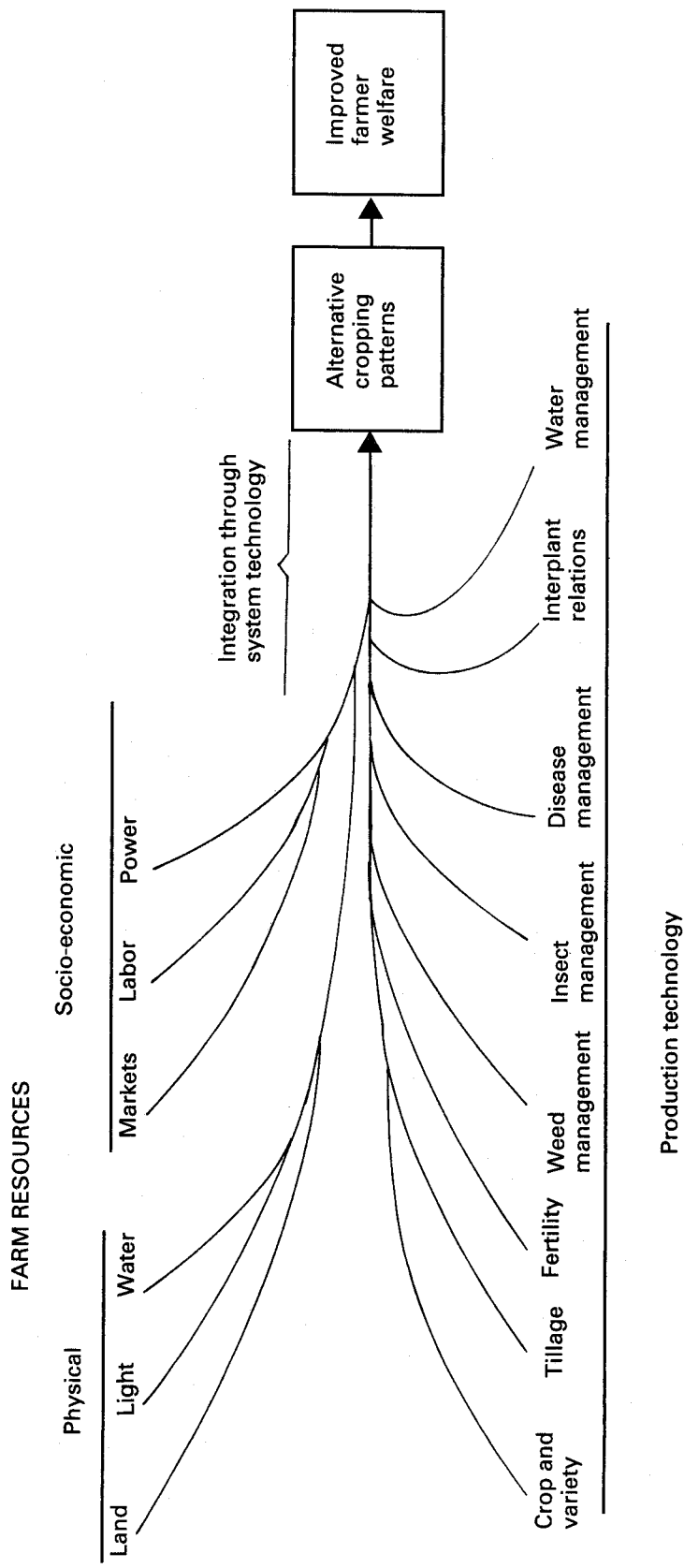


Fig. 1. Conceptual outline of cropping systems approach

Source: Harwood 1973



## DISCUSSION

During the discussion following the presentation of Dr. Aphi Phan's paper, Dr. Othman asked whether the development in both Thailand and Malaysia of the livestock industry was compatible with sustainable agriculture. Dr. Aphi Phan replied that, although agriculture in Thailand was traditionally thought of as crop-based, the production of crops alone involves too high a risk for small-scale farmers, particularly in rainfed and upland areas. Large-scale livestock production in a ranching system was unsuitable for Thailand, but integrated crop-livestock systems on small farms were often very successful, since they give a more stable income and offer the farmer a greater range of resources. He added that for these reasons, integrated crop-livestock production is now being emphasized in Thailand, particularly in the north of the country.

Dr. Hsieh mentioned that he had visited a farm based on a natural farming system in Thailand, and had found that the soil was in poor condition and there was a water deficit. He asked about the policy of the Thai government with regard to sustainable agriculture. Dr. Aphi Phan replied that the effect of agriculture on the environment was a major concern in Thailand. The Thai government has a policy of trying to restore the environment in areas where agriculture has led to deforestation and erosion. He was not sure to what extent this emphasis on conservation was based on the need for sustainable agriculture, since in many cases land was being used for recreation rather than for agriculture. He also noted that the Thai government still allows activities which seem to run counter to a policy of conservation, such as the unrestricted import of agricultural chemicals. Villagers often do not understand the dangers of such chemicals and use them in an inappropriate way which is harmful to human health and the environment. Dr. Mizuno agreed that on-farm research is very valuable, and suggested that it could play an important role in educating farmers to make agriculture sustainable. He asked whether this approach had been successful in Thailand, and Dr. Aphi Phan replied that several government programs which encouraged slash-and-burn farmers to farm their land on a long-term basis had achieved some success.

Since the government wanted farmers to stay on their farms rather than move to Bangkok, it wanted farmers to be content with their living and working conditions. Government departments therefore now tend to study local farmers intensively before introducing any new technology, and to involve farmers at the planning stage. Dr. Umali commented that two kinds of agricultural scientists were needed, one type which dealt with basic science and knowledge for its own sake, and the other which used science to solve practical problems. In a poor country such as the Philippines it is the second type of scientist that is urgently needed, who is willing to work with ordinary people, and whose social philosophy was based on the principle that agricultural research should both begin and end with the farmer. He was glad that several papers presented during the session, including that of Dr. Aphi Phan, had emphasized this second, more practical branch of agricultural science, and felt that if more scientists of this kind were available, Asia would have fewer problems in carrying out technology transfer.