

INTEGRATED PRODUCTION SYSTEMS

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Summary

Agriculture will remain critically important despite its declining contribution to the national economy. Demand for agricultural and particularly animal products will increase with better economic status of most developing countries. However, as input sources of land, feed resources, and labor become increasingly scarce for animal production, new technologies will be required to improve the efficiency of the production systems. Systems analysis is the methodology to be used to evaluate and plan for the future development of integrated production systems. This methodology applies a holistic approach and considers many disciplines and components in complex agriculture production systems.

1. Agricultural Industry and Land Use

Tropical regions of the world comprise a vast land area of agriculture, most of which is found in humid tropics area of Southeast Asia, South America, and some parts of Africa. About 68% is forest and woodland. The remaining area is arable land, land under permanent crops, and irrigated land. Much of the increases in agricultural production in the past have been due to expansion of cultivated areas. Agricultural development has long been regarded as practically synonymous with land development. For example, rubber, oil palm, and rice are the major crops and oil-palm products and rubber have each contributed significantly to gross domestic product in Malaysia. However, due to the rapid rate of industrialization and growth of the non-agricultural sectors, the proportional contribution of the agricultural sector to gross domestic product has been steadily declining. Nevertheless, agriculture continues to be a supplier of food, a significant source of rural employment, and the main national employment of developing countries as well as accounting for export earnings from the major

agricultural commodities: rubber, palm oil, cocoa, pepper, canned pineapple, and coconut oil. More serious thought has to be given to planning agricultural development in these countries. This would include systematic and efficient management of land resources for increasing agricultural productivity at farm levels, as well as conserving forest resources for future generations.

The agro-climatological conditions of most developing countries like Malaysia favor cultivation of tree crops such as rubber, oil palm, cocoa, and coconut over annual crops and livestock farming, and thus the legacy of a tree-crop agriculture and its associated large-scale land development. In the post-independence era with the emerging threat of strong competition from synthetic rubber, oil palm, coconut, and cocoa were promoted as alternatives to rubber in a crop diversification strategy. Of these three, oil palm gained popularity most rapidly because of its higher returns and lower labor (and therefore cost) requirements than rubber. In Malaysia, land development schemes, notably Federal Land Development Authority (FELDA) and others such as the various state schemes, took over latter-day plantation-scale land development, and there was a predominance of land utilization for export crop cultivation such as oil palm, rubber, and cocoa, in which oil palm is the most popular crop.

Food, including livestock and minor crops, has always been the concern of smallholders, and agriculture in this sub-sector has mainly been a subsistence-type venture. As more and more land is devoted to export crops, it is also inevitable that there will be less land suitable for the expanded production of food crops and livestock. There is an obvious need to boost food crop and livestock production. Firstly, because an enormous expenditure is incurred importing food and feedstuffs. Secondly, because the demand for food commodities (including livestock products, which in turn will swell the volume of required feedstuffs) is expected to grow at a rate commensurate with that of the population in the case of the more basic food items such as rice and sugar, and at a much faster rate in the case of fruits, vegetable, and livestock products, due to the increasing standard of living. It is a nation's duty to ensure that its growing citizenry has access to reasonably cheap and nutritious food. The production of food (and feed) crops should therefore not be put at a disadvantage as far as their location and cultivation on suitable soils are concerned.

Potential areas and resources for livestock (ruminant) development in the future will be integrated with crop commodities such as ruminant and primary crops integrated production systems, utilization of agricultural by-products as animal feed, and rearing animals on reclaimed (tin tailings land) or idle land such as right-of-way of gas pipelines.

2. Integrated Systems

New concepts need to be created, explored, and introduced for agriculture to remain competitive with other industries in developing countries. The new millennium approach for agriculture production systems in most tropical or developing countries must be an integrated one. Efficiencies and economies will come by sharing land space, labor, management, professionals, products and by-products utilizations, and infrastructures for production of multiple commodities.

2.1. Integrated Livestock–Crop Production System

Grazing animals on land used simultaneously for crop production is commonly known as integrated or “zero-land” livestock production system. Similar systems for the production of timber and food crops or animals on the same land unit are called *agroforestry*. Sometimes the latter is distinguished as *sylvo-pastoralism*. This system offers great promise yet its potential is only slowly being realized. The system has several advantages over integrated crop production, including improved fertility of the land through the return of dung and urine, control of waste herbage or weed growth, and reduced use of herbicides, easier management of the crop, and distinct possibilities of increased crop yields per unit area. Also, the sale of animals and their products adds to the returns from the systems. In other words, this system offers more efficient resource utilization.

In Malaysia, several livestock production systems have been ventured and investigated, such as open improved pastures, intensive feedlot systems, and extensive systems of smallholders. The development of livestock through integration with plantation crops such as oil palm, rubber, and coconut shows particular promise. The system demonstrates that feeds such as the undergrowth or ground vegetation that form part of the ecosystem of oil palm, rubber, and coconut cultivation and that are the critical factor in ruminant production may be made available at a lower cost than other, conventional, monoculture animal production systems or other extensive animal production systems. Further advantages to animal production are that the canopy provides shade that reduces the heat stress problem facing animals in the tropics.

The natural botanical composition and quality of herbage (undergrowth) under oil palm and other crop plantations are constantly changing because of many interacting factors such as light, soil type, palm age or crop age, species interaction, and agronomic management. Most of the factors influencing the botanical composition and also the nutritive value of the herbage under palm/crop canopy are not fully exploited and it is really impossible to describe the complex interaction in the changing ecosystem of undergrowth. The dynamic changes in this ecosystem can best be explained through a systems approach that considers the many interacting factors affecting herbage growth. The availability of undergrowth is essential for integrating ruminants into oil palm and crop plantations and this type of production system has the advantage of diversifying income and controlling weeds.

Little research has been conducted on animal–crop integration production systems. Most smallholder livestock are raised on natural pasture or herbage that is mainly available from crop plantations, along roadsides or irrigation ditches and on paddy fields during the off season. Thus, livestock production in conjunction with tropical plantation crops is established practice. Most of the work to date has involved the integration of cattle with coconuts and oil palm plantations but recent work in Malaysia has demonstrated considerable potential for the integration of sheep in young rubber plantations, and deer in forestry re-plantations using *Acacia mangium*. Other plantation crops, with the possible exception of forest plantations, are of lesser significance in terms of potential for integration with livestock.

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Biographical Sketch

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