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TROPICAL INTERCROPPING SYSTEMS: WHAT IS THEIR FUTURE?

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ABSTRACT

This paper examines the relevance of a temperate region model in intercropping in the tropics and outlines the success of tropical intercropping systems in maintaining biodiversity and controlling pest populations. It then discusses the need for research to develop crop varieties for intercropping systems which take into consideration planting and harvesting technologies

RÉSUMÉ

Le présent article examine l'importance d'un modèle de climat tempéré sur l'agriculture mixe dans un zone tropicale. Il retrace aussi les succès enregistrés par les systèms d'agriculture mixe dans le maintien de la biodiversité et la lutte contre les ravageurs. La recherche et de créer des technologies en vue de mettre en point des variétés culturales appropiées aux systèmes d'agriculture mixe sans perdre de vue les questions relative aux techniques de culture et méthodes de recolte.

Will highly complex multiple cropping systems play an important role in the future of tropical agriculture? At the recent Crop Science Conference for Eastern and Southern Africa, a noted scientist from the region posed this question: "Are efficient intercrop systems just an intermediary step to future mechanized, high-input rotational monocrop systems?" This is a valuable challenge, because it recognizes that success in agriculture today is measured against a temperate region model widely used in North America, Western Europe and other industrialized areas. The "green revolution" that boosted rice yields in Asia would appear to confirm the relevance of this model for the tropics. An entire generation of African and Latin-American scientists trained in temperate region universities has accepted this paradigm. Countless technical experts have reinforced this narrow view of agriculture in their short-term tours of national research programmes and tropical universities.

We do not challenge the credentials of these experts, nor their motivation in trying to solve the immediate food crises that face many developing countries. Well-meaning technical people in the field and policy makers in each capital are trying their best to enhance food production, income and well being of the rural population. This success, however, has been in a few limited areas with fertile soils, adequate and well developed infrastructure. There have been some with cash crops, where farmers could afford the inputs, and where export earnings gave governments incentives to provide credit, roads and technical assistance. What is wrong with this model, and why has it not been more widely successful?

It is time to challenge the relevance of an approach that was designed for temperate regions, highly fertile soils, one cropping season per year and a relatively predictable climate. Many tropical soils are highly weathered and infertile. The temperature may permit crop growth through the entire year. However, rains are unpredictable, both in the time of onset and seasonal distribution. A large number of people engaged in agriculture provide valuable human resources for intensive management of crops and animals. Do we need an agriculture system that is unique to these natural and human resources?

The traditional multiple cropping systems that have evolved over centuries in the tropics may provide some clues of how future agricultural systems might be designed. Where soil fertility and organic matter are low, the use of several crops with different rooting patterns and growth cycles can promote vertical nutrient cycling. Introducing more legumes and other seed-producing or cover crops into the sequence can further enhance nutrient capture and storage for use by crops. Animals can use fodder and non-marketable crop products and return manure to the land. Systems that include several species during the year planted in close proximity can enhance total biomass production and nutrient cycling. However, they may be difficult to mechanize or implement on a large scale.

Crop production is difficult in the tropics, where favourable conditions promote pest development. Unlike in the temperate areas, there is no winter to help reduce pest populations before the next cropping season. In temperate regions, monoculture cropping systems have been successful where weeds have been controlled by basic land preparation, appropriate herbicides and crop cultivation. Some plant pathogens and harmful insects have also been controlled by chemical pesticides, genetic resistance in crops, or integrated pest management practices. In general these pest control strategies have had limited sustainability in monocultures, partly because resistance to chemical control has evolved in many pest species. Pest incidence appears to be less in most intercropping systems (Trenbath, 1993). Several crop species in mixture occupy several niches in the field; thus, there are fewer niches for the colonizing weeds to occupy, compared to a newly introduced crop monoculture. Nutsedge has only become a serious weed in the tropics when monoculture maize is treated continuously with atrazine-based herbicides that control other weeds, but not nutsedge. Intercropping provides a range of habitats for favourable insects, those which can help control pests. Without insecticides, the beneficial insects are present to help in pest management. Improved management of undesirable pest species can be enhanced by research on how to combine crop cultivars, cover species and residue management in tropical systems. Little work has been done in this area. In addition, pesticides are often poorly applied or containers used in inappropriate ways for food or water storage.

Although considerable research has been done on intercrops – spacing trials, relative densities, fertilizer responses, relative planting dates, a large proportion of the effort has been spent in comparing intercrop systems with their monocrop components. A review of more than 100 reports revealed that about 40% of the space was dedicated to sole crops to allow calculation of land equivalent ratios (Fukai, 1993). Most likely, the researchers designing the intercrop trials were hoping to prove to their more traditionally oriented colleagues that their research was important. In fact, it is difficult to design a valid comparison of this sort, because we have several decades of improving crops and practices for monoculture and only a limited experience with improving intercropping systems' yields. The real priority should be to increase multiple crop productivity or stability. This can be achieved by management of intercrops to maximize their complimentarity and synergism, and to minimize competition between them (Midmore, 1993). For example, onset of competition between intercrops can be delayed by judicious choice of planting date (Hallugalle and Willat, 1987; Willey *et al.*, 1983) and planting crops of contrasting demand.

What should the researcher include? Only limited work has been done on breeding crops for intercrop systems. Genotype by cropping system interaction studies give some indication that selection for specific stress conditions and intercrop combinations could be successful, especially for the under story crops. Much needs to be learned about nutrient cycling and crop complementarity in mixtures. Reduced tillage can drastically reduce the placement of weed seed where it has favourable conditions to germinate and grow. Cover crops and residue management to break the fall of rain, trap and store moisture and enhance soil organic matter need to be explored. Research must also focus on developing planting and harvesting technologies; in fact, lack of such technologies is widely cited as limiting usage of intercropping on large scale farms. Indeed Osiru and Willey (1972) have argued that crop mixtures become increasingly difficult to manage when mechanization is introduced thus offsetting possible advantages of mixtures such as reduced pest and disease build-up. There is a wealth of indigenous knowledge about the management of fertility, weeds and insects by planting other crops or non-crop species in the field. We need to talk to farmers to learn about such practices and then organize trials to test their broad applicability.

In working with farmers, especially in Africa, scientists quickly become convinced that most food crops, vegetables and fruits near the home, and small animals are managed by women. For the successful design and implementation of a research programme on multiple cropping, it is essential that women be involved in the choice of crops and practices, the evaluation of results and the extension of this information to others. The current interest in on-farm research needs to be extended to involve farmers in the complete process of discovery and it will be important to demystify the research process to make it more accessible. Women who farm will be a great help in envisioning the entire cropping and crop/animal system, helping us to focus on the key interactions and suggesting how systems can be improved.

Finally, why will intercropping systems remain important in the future, as infrastructure improves, fewer people are available on the farm, education helps to solve the short-term problems of improper input use, and mechanization seems essential? In fact, the potentials of improved intercropping systems in the unique conditions of the tropics could be developed by a relevant research programme such as that described above. A new pattern of systems will be designed that are appropriate to the climate, soils, food needs and social structure of communities in the tropics. These alternative systems are likely to be more sustainable than the current mechanized and labour efficient systems that prevail in developed countries. It is even possible that such systems will provide models for temperate agriculture as we design renewable resource efficient systems that run on sunlight. This can open a new direction for research and development in agriculture that has some hope of supporting the future human population while preserving a liveable environment.

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