CROP-LIVESTOCK INTERACTION FOR SUSTAINABLE FOOD CROP PRODUCTION IN TROPICAL AFRICA*

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INTRODUCTION

The main concern of this training course is with sustainable food crop production system in the humid and sub-humid tropics of Africa. Food crop production is only one component of the entire production system in the two ecological zones.

A system consists of its agro-ecological and socioeconomic components and interactions among them (so that the whole is greater than the sum of its parts). The interactions are neither linear nor unidirectional, so a certain degree of change at any point in the system may generate different degrees of change in different directions. Therefore, it is essential that any discussion on sustainable food crop production is conducted within a system's framework taking into account the interactions of this component with other components. However, we will deal with the interaction of food crop production with another component, livestock production ,and the potentiality of this interaction for sustainable food crop production.

Sustainability

Conway (1985) defined productivity, stability, sustainability and equitability as the four properties of any agro-ecosystem. Then he defined sustainability as the ability of a system to maintain productivity in spite of a major disturbance, such as is caused by intensive stress e.g., the effect of soil erosion or farmers' indebtedness or by a large perturbation e.g. a drought or a food or a new pest. Monotonic decline in productivity may indicate lack of sustainability. A system which is productive, stable and equitable is also likely to be sustainable.

The main focus of this definition is agro-ecological sustainability although it is recognized that the source of disturbance may be agro-ecological or socio-economic.
We will examine whether, and how, crop-livestock interaction may contribute to productivity, stability and equitability and hence sustainability of food crop production in the humid tropics.

Crop-livestock Interaction for Sustainability

Crop-livestock interaction may be complementary or competitive. Complementarity occurs when one sector provides production inputs to the other. Examples are the use of manure and draft power for crop production, and the use of crop residues, weeds from crop fields and crop processing by-products as animal feeds. Production of grass or grain or tree legumes as relay crops or in association with regular crops may also give rise to complementarity by enhancing both crop and livestock yields. Investment of income from one to the other sector may also create complementarity.

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Crop and livestock may compete for land and labour resources. In the short run, conflict may occur over, for example, high quality grazing and dry season vegetable production in lowland valleys, or irrigation may remove land from pasture. In the long-run, population growth causes crops to replace pasture, reducing grazing quantity and perhaps quality. Competition for labour occurs with intensification of farming. Manuring, fodder production and animal husbandry require more labour inputs than pastoral herding. If wages rise, because of intensification of farming or of urban demand, then competition for labour is exacerbated. Crop residues may be used as animal feed or as mulch for soil. Depending on their productivity, these two use may compete in some circumstances.

Crop-livestock interaction may contribute to sustainable crop production in the following ways.

a) It is generally accepted that a given amount of land can support more people under a crop-livestock system than under either crop or livestock system, because of higher aggregate output under crop-livestock system. Thus crop-livestock system may provide more adequate and nutritionally appropriate diet for a larger population. The importance of higher aggregate production through interaction increases with population growth and as arable crop farming push livestock to marginal lands and reduce marginal productivity of both crop and livestock. The compression of slash and burn systems into shorter fallow cycles, deforestation and overgrazing have led to soil erosion and destruction of natural habitat. Under such a situation crop-livestock interaction has much to contribute to stable increase in both food crop and livestock production.

b) High tech agriculture based on agrochemicals practiced in the developed countries has become a major source of environmental pollution and a significant risk for human and animal health and wildlife. Major environmental threats emanating from agriculture are soil erosion, leaching and associated effects on water quality. In spite of its high productivity, high tech agriculture may not be the most efficient, cost-effective way of producing food. As tropical Africa gradually moves away from subsistence to commercial agriculture, the pitfalls of high tech agriculture may be avoided or minimized by encouraging crop-livestock interaction in the early stage. Too much dependence on agrochemical components of high tech agriculture at the present stage of African agriculture may make it more unstable and risky and because of the inequitable access to resources, the benefits of high tech is also likely to be inequitably distributed.

c) Crop-livestock interaction may allow diversification of production, consumption and investment, and contribute to stability of the system by minimizing risk, employing and distributing benefits to more people.

Livestock in the Humid and Sub-Humid Zones

Livestock production in the humid and sub-humid zones is generally restricted by trypanosomiasis and other diseases yet the humid and the sub-humid zones together account for about 25 percent of ruminant livestock population, 27 percent of meat and 19 percent of milk production in Africa. With increased humidity, the proportion of land area free of tsetse fly that cause trypanosomiasis decrease. Consequently there are fewer cattle, goat and sheep with increasing humidity (Table 1). There is also a change in the species mix with cattle decreasing more rapidly than small ruminants, and goats gaining predominance over sheep, with increased humidity.

Table 1: Share of humid and sub-humid zones in the land and livestock resources of Africa

	Sub-humid	Humid
Area (%)	21.7	18.5
Area free of tsetse fly (%)	6.9	1.9
Population (%)	24.9	21.1
Population density per km^2	15.0	15.0
Livestock population (%)		
Cattle	22.2	6.0
Sheep	13.6	7.9
Goat	16.2	9.2
All ruminants	17.5	7.8
Ruminants per km^2	15.2	8.0
Livestock output (%)		
Meat	20.9	6.1
Milk	14.7	3.9

In the humid zone, most animals are of trypanotolerant breeds and they are raised under crop-livestock mixed farming under same management. Most households have only small ruminants and they typically generate about 15 percent of household income. Animals are generally free-roaming but in high population density areas confinement, tethering, cut-and-carry feeding are practiced. In the sub-humid zone, livestock is produced under ranching, pastoral range and various forms of crop-livestock systems.

a) Crop-livestock systems are land use systems in which livestock husbandry and cropping are practiced in association. The systems may include sole livestock farming practiced in proximity to and functional association with crop farming, and crop livestock mixed farming under the same management with various degrees of mixes.
b) Pastoral range system is based on grazing natural or semi-natural vegetation. The main livestock product is milk and dairy products and the main function of livestock is subsistence. Management involves adaptation of the feed requirements of the animals to the environment through migration and communal grazing. Nomadic, transhumant and agro-pastoralists from the semi-arid zone come to the sub-humid and humid zones in the dry season in search of better pasture and water.
c) Ranching is a labour-extensive undertaking in one or two livestock species producing a marketable commodity, mainly live animals for slaughter and/or for milk. Livestock management involves grazing within fixed boundaries. Ownership may be private, parastatal, cooperative or companies, and lease

arrangements may also prevail. The main function of livestock is provision of cash income.

A large number of animals in the sub-humid zone are raised under pastoral range systems and for that reason, the zone actually supports more animals than is recorded in the animal number and output share of this zone. In more recent times, tsetse control measures, increasing bush clearance for arable crop production and other measures have continuously reduced the intensity of tsetse infestation. This gives the pastoralists an opportunity to move well into the humid zone. An increasing number of pastoralists are settling in the derived savannah zone and becoming mixed farmers.

The degree of integration of crop and livestock production systems may influence the form in which crop-livestock interaction takes place. Crop-livestock interaction may be non-existent under the ranching system unless crop is produced alongside livestock raising. Under the pastoral range system, exchange of grain for milk and milk products is the principal form of crop-livestock interaction because fallowing for fertility-restoration is cheaper for crop growers while herding is cheaper for pastoralists. Crop residues may have little value as feed and manure may have little value as fertilizer. However, higher population density and the need for increased arable farming may push pastoralists to marginal lands and both pastoral and ranching systems may compete with arable farming for land. Crop-livestock systems provide greater opportunities for important complementary and competitive relationships to develop between cropping and livestock production. When crop and livestock production are separately pursued, crop-livestock interactions occur through market and contracts. For example, pastoralists may graze crop residues in exchange for night paddoking animals in crop farmers' fields. Crop farmers may invest in cattle and hire pastoralists for herding them. Complementarity is most efficiently employed when crop and livestock production are integrated on the same farm. Under such a system intensive recycling is practiced between crop and livestock sub-systems.

Examples of Crop-livestock Interaction for Sustainability

The alley farming and fodder bank technologies developed by ILCA in the humid and sub-humid zones, respectively, are two cases in which crop-livestock interaction is complementary. Alley farming is a farming system whereby leguminous fodder trees or shrubs (such as Leucaena and Gliricidia) are planted in rows 4m apart with food crops planted in between the hedgerows. Before planting and sometime during cropping (as trees begin to shade food crops) the coppice re-growth is pruned and spread on the soil surface as mulch or green manure. Some of the pruning taken during the cropping season and all during the dry season could be fed to livestock in a cut-and-carry system as supplementary feed to a basal diet of grass or other high energy feed. The food crop can additionally benefit from livestock when manure from the pens is eventually returned to the cropland. In a system where a basal diet of <u>Panicum</u> <u>maximum</u> and cassava peel for sheep and goats is supplemented with Leucaena and Gliricidia mix (1:1 w/w) lamb growth rates to weaning and to 24 weeks of age is increased. The nitrogen concentration in the dung of sheep and goats on supplementary diet of Leucaena and Gliricidia increased linearly with increasing amount of the leguminous fodder fed. The implication is that a food crop farmer with alley farm can increase his farm cash earnings by feeding some of the fodder to his animals. Fertility and hence productivity of his soil can be improved by returning manure.

Alternatively, ruminant livestock (sheep, goats, cattle) could be allowed to graze pasture or crop residues in between the alleys and browse the trees during the dry season when feed is scarce and of poor quality. Another time when alley cropping plots could be grazed is a fallow period lasting one or two years when no food crops will be planted in the alleys. When the alley farming idea was first conceived, it was thought that the technology would eliminate completely the fallow phase of the traditional shifting cultivation or bush fallow rotation. But evidence available now from ILCA and IITA indicates that some period of rest or fallow will be beneficial to the trees and obviously to the soil.

Beginning 1982, ILCA embarked on separate studies with Leucaena and Gliricidia to determine the effect of short-term fallow periods in alley farming system on soil fertility restoration and crop production. Using Leucaena as the fodder tree specie, one study specifically compared soil chemical properties and maize crop yields under continuous cultivation (without trees), continuous alley cropping, and a rotation of alley cropping with fallow (sheep grazing and browsing within alleys). Soil organic carbon and total nitrogen content showed only slight decline in alley cropping and alley grazing plots whilst under continuous cropping without trees the drop was significant compared to the values at start of the study. Maize grain yield in grazed fallow/alley cropping rotation system, in a more favourable cropping year, was about 35 and 55% higher than was obtained in continuous alley cropping and conventional no tree cropping, respectively. The greater maize grain yield in alley cropping following a short term grazed fallow is certainly due to soil fertility build-up through decomposition and mineralization of dead plant biomass and a fallow factor. Nevertheless the presence of sheep on the fallow land also enhanced nutrient recycling through the dung that was returned to the soil in the course of grazing.

Fodder bank is a system in which forage legumes are established and managed at very high density to provide dry season supplementation for ruminant livestock. The forage legumes which have been studied intensively for their suitability in fodder banks are Stylosanthes Guianensis cv. Schofield, S. Guianensis cv. Cook and S. hamata cv. Verano. The fodder bank technology has led to highly significant reduction in animal live-weight losses during the dry season. Animals generally lose weight during the long dry season of the sub-humid zone when pasture quality and quantity decline sharply.

Fodder bank plots can be returned to cropping sometime after establishment and grazing. Invariably crop yields on fodder bank plots returned to cropping had been one-and-half to two fold better than on adjacent plots. A study that compared labour required for cropping maize on land previously used as fodder bank and adjacent fallow lands found that fodder bank soils was easier to ridge than adjacent natural fallow. This is clearly related to the soil structure improvement capabilities of the Stylosanthes used in fodder banks. Maize grain yields inside fodder bank were 4.6t/ha compared to 2.5 t/ha outside the fodder bank in that study. Another study found that transplanting sorghum on ridges in fodder banks produced 1.5 times more grain than when planted outside fodder bank.

Fodder bank plots are intended to serve as strategic feeding systems utilized to increase a farmer's cash income since the value of milk will be higher during the dry season. The animals grazing the fodder bank will also effect a recycling of nutrients through their dung which will be voided onto the land. The higher manure value of the dung could be a factor contributing to the increased crop yield inside a fodder bank plot.

Further Reading

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