Proceedings of the 4th Biennial Conference
of the
African Farm Management Association

Farm and Farmer Organisation for Sustainable Agriculture in Africa

Edited by
Johann Laubscher

26 - 30 January 1998
University of Stellenbosch, South Africa

INTENSIFIED LIVESTOCK PRODUCTION AND ACHIEVING SUSTAINABLE AGRICULTURE AND FOOD SECURITY IN AFRICA

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ABSTRACT

If the viability and sustainability of smallholder agriculture is to be maintained and food security is to be enhanced in sub-Saharan Africa (SSA), intensified, market-oriented livestock production needs to be promoted. This paper presents empirical evidence to support this contention.

Twenty-five years ago there were half as many people in SSA as there are today and population is projected to increase by 2.6 times to 1,294 million in 2050. Growing population pressure on land in combination with traditional methods of farming (little use of modern inputs and low yielding crop varieties and low productivity breeds of livestock) lead to unsustainable practices that degrade land resources. Such practices result in low per capita food output and inadequate income to acquire sufficient food to ensure food security for many small-scale farmers.

Shifting cultivation and nomadic pastoralism were appropriate responses to ample land and scarce capital. Growing competition for land between crop and livestock farmers, limited access to technology and inputs, and absence of properly functioning markets then led to mixed crop-livestock farming systems as efficient and sustainable methods of food production. These traditional practices, however, are not sustainable in the face of increasing population pressure and do not make sufficient impact on food security. Major changes in the methods of production, including genetic improvement, are required.

Crop improvement leads to higher yields making more food available, but does not improve farmers' access to food much since it has little impact on incomes. When yields are up, prices usually decline due to the low-income elasticity for cereals. Attention has to be shifted from food production to an emphasis on improving the purchasing power of families at risk of malnutrition. This can be accomplished through intensification of livestock activities, which increase cash incomes.

More than half the population is expected to live in urban areas of SSA in 2050. Urbanisation increases demand for food of animal origin and provides an impetus for intensified, market-oriented livestock production such as using crossbreeding goats or cattle for dairy and/or meat production. Theory distinguishes two types of food insecurity - chronic and transitory. Market-oriented livestock activities have potential to improve both chronic and transitory food insecurity by providing more food, by raising purchasing power (via higher incomes from sales of livestock products) and by improving the stability of both production and income to ensure availability and access to food.

1. The problem and opportunity for livestock intensification

Twenty-five years ago there were half as many people in Sub-Saharan Africa (SSA) as there are today and population is projected to increase by 2.6 times to 1,294 million in 2050. Moreover, by 2025, over half of the population of SSA will have shifted to urban areas. The

resulting increase in demand for food creates a clear opportunity for the development of agriculture and a challenge in terms of contributing to greater food security while preserving the environment.

Food insecurity is a critical problem facing Sub-Saharan Africa and demand for milk and meat is not being met. In the 25-year period up until 1987, milk production grew by 3.2 percent in Sub-Saharan Africa, but consumption grew even faster. Despite weakening economies and foreign exchange constraints, imports were still 11% of consumption in 1989 (1.2 million tons) (Von Massow, 1989).

Even if the growth rate of milk production remains the same, at the present rate of population growth in Sub-Saharan Africa, the year 2015 would require 11 million tons of imported milk. In West Africa, local dairy production presently meets only 60% of demand. At current population growth rates, meanwhile, the demand for meat in urban areas in Sub-Saharan Africa is expected to grow at an annual rate of at least 4% through the year 2025, while meat production is presently growing annually at less than 3% (Winrock, 1992).

Most livestock in Sub-Saharan Africa are found integrated with crops in mixed systems. Growing competition for land between crop and livestock farmers is limiting grazing resources, as bottomlands and hillsides traditionally reserved for pasture are put into crop production. Evidence from the Highlands agro-ecological region shows that traditional low-input, low productivity livestock practices tend to use over 200% of the carrying capacity of the land. In the humid regions, livestock are blamed for deforestation as forests are cleared for grazing. In the semi-arid and sub-humid zones, meanwhile, as land becomes more constrained, livestock are being taken off the land and entrusted to nomadic herders during the crop season. As permanent-farming settlement has increased, transhumance has become more difficult. Property rights conflicts between traditional herders and crop farmers are increasing, as well as desertification especially around traditional livestock water sources. These traditional practices are not sustainable in the face of rapidly increasing population pressure.

This paper presents empirical evidence to support the contention that if the viability and sustainability of smallholder agriculture is to be maintained and food security is to be enhanced in sub-Saharan Africa (SSA), intensified, market-oriented livestock production needs to be promoted. Firstly, the vital role that livestock plays in agriculture as development progresses, is highlighted. Then the issue is addressed whether traditional livestock systems are capable of making much impact the sustainability of agriculture, as well as livestock intensification. The impacts of livestock on deforestation and desertification are then considered to further justify intensification, and then the impacts that intensified livestock production can make on food security are discussed. Next, the likely sequence of livestock and crop intensification and what determines this sequence is touched upon as it is essential to prioritise development efforts to increase the impacts of new livestock technologies. Lastly, the types of government support required to make intensified livestock production sustainable for smallholders are addressed.

2. Prospects for livestock development

Livestock has a unique role to play in maintaining the viability of agriculture as economic development takes place. As shown in Table 1, at the aggregate level, the importance of agriculture in overall economic output declines over time, but the importance of livestock in

agriculture increases. As incomes increase during development, the relative increase in the quantity demanded of animal products is greater than cereals because the demand for animal products is more income elastic. Thus, unlike the share of cereals, which declines over time in consumer diets, the importance of livestock products grows as development takes place.

Demand for animal products in SSA is likely to experience substantial growth over the foreseeable future. Besides growth in incomes, demand for animal products also depends upon population growth and demographic shifts that create markets. As shown in Table 2, of all the regions of the world, population in sub-Saharan Africa is growing most rapidly with annual growth rates in the 1990s projected to be 3.1%. Population shifts to urban areas of up to 50% in many sub-Saharan African countries over the next 30 years will result in substantial growth in demand for livestock products. Urbanisation tends to shift dietal preferences to foods of higher quality such as meat, milk and eggs (Delgado, 1991; Winrock, 1992).

The policy environment and incentives for domestic livestock production in sub-Saharan Africa, meanwhile, have been improving significantly in recent years (Williams, 1993). Previously trade policies encouraged imports of dairy products and cheap meat into Africa and discouraged development of domestic production (Von Massow, 1989, Williams, 1993). Policy changes on the part of the EU, the USA and other major exporters of livestock products under the GATT agreement have led to a decline in the dumping of milk. This pushed up world market prices, making African domestic production more competitive with imports from the developed countries, especially Europe (Delgado, 1991).

3. Potential benefits of better crop-livestock integration

In traditional mixed crop-livestock farming, improvement of the integration of livestock is a proxy for a series of small adjustments such as increased livestock numbers, more and better use of manure, and more and better use of animal traction. In these mixed systems, a critical issue is whether further improvements in crop-livestock interactions are viable alternatives to more intensive crop and livestock activities that depend on purchased inputs - whether improvement of mixed crop-livestock systems can have much impact on the productivity and sustainability of agriculture.

It is sometimes argued that manure is a better alternative for maintaining soil fertility than the use of purchased inputs such as inorganic fertiliser. Available manure, however, is usually not sufficient for maintaining soil fertility even when population pressure is low and animal stock very large. The grazing land required for enough livestock to provide the organic fertiliser to maintain soil fertility on one hectare of cropland can reach up to 10 hectares on average (Williams *et al.*, 1993). It is also not normally feasible under increasing population pressure to allocate more land for grazing animals and thereby increase livestock numbers.

With the disappearance of the fallow system and encroachment onto grazing lands, the large quantities of organic fertiliser required to attain even moderate levels of the basic soil nutrients cannot be achieved. At present manure also often replaces wood as a cooking fuel in many regions. The ability to increase the efficiency of manure use, moreover, is also limited in most areas of Sub-Saharan Africa. While manure can be managed more effectively by improved corralling and its efficiency increased through composting, the overall increase in terms of essential soil nutrients (nitrogen, phosphorus, and potassium) is small.

Intensified dairy production with crossbred cows on smallholder farms, meanwhile, can provide more manure to enhance soil fertility, but still not enough soil nutrients to increase crop production in a sustainable fashion. About 8-9 tons of manure equals about 100 kilograms of urea on average. Even though market-oriented production makes it possible for small-holders in intensified production to supplement the cows with purchased hay and concentrates, the average small-holder herd of crossbred cows in the Ethiopian Highlands still only averages about 5-6 cattle. Given an average farm size of 2.5 hectares, this size of herd can only produce enough manure to fertilise only about 1-1.5 hectares. Manure is thus expected to only be complementary to inorganic fertiliser rather than a viable substitute in the long run and even under intensification (McIntire *et al.*, 1992).

Another complementary role of livestock in integrated mixed farming is animal traction. Animal traction has historically been promoted in Sub-Saharan Africa as a means to expand area under cultivation, hence to increase labour productivity by saving labour. Animal traction to expand cultivated area has limited potential. Pingali *et al.*, (1987) have examined the conditions under which animal traction has been successfully introduced in Sub-Saharan Africa. These include the need to intensify the farming system, heavy soil types, and enough rainfall for a sufficiently long crop season to use the full capacity of animal traction, and good access to markets. Where higher value crops with complementary purchased inputs such as seed and fertiliser are highly profitable, the resulting peak periods of labour demand create a role for animal traction. The use of animal traction, therefore, will occur principally where crop production has been successfully intensified with increased purchased inputs, such as fertiliser and improved seed.

4. The environmental impacts of livestock

Often mistakenly, animal agriculture is seen as harmful to the environment. Global losses of tropical rainforest are a major international concern, including the associated effects of increased greenhouse gases and global warming. That livestock are a major factor in deforestation and desertification has become the conventional wisdom in the developed world and the resulting widespread controversy has affected donor contributions to livestock research and development. Empirical evidence, however, in both humid and sub-humid zones shows that the major impetus for expansion of agricultural land into forested areas is population growth combined with shifting cultivation (NRC, 1993). Furthermore, careful study has shown that it is not livestock, in and of them, which are the root cause of desertification.

Usually the root cause of environmentally degrading practices causing deforestation and desertification is poverty and lack of development, not livestock, or for that matter any other aspect of agricultural development. It is mainly poverty that drives farmers to exploitative resource-depleting practices (Vosti *et al.*, 1991). Raising farm incomes by cash revenue generating activities such as intensified livestock production can rather lead to a withdrawal from marginal lands that are susceptible to degradation. It can also lead to more sustainable use of land resources. Evidence from the Highlands zone shows that while traditional livestock herds tend to overgraze available pasture land more than twice, intensified dairying tends to match the carrying capacity of the land since supplementation of cattle is profitable (Shapiro *et al.*, 1994).

5. Intensified livestock's contribution to household food security objectives

Food security can be defined as the access by all people at all times to enough nutritionally adequate and safe food for an active and healthy life (FAO 1996). It encompasses the three aspects of availability, access (economic and physical), and stability. The level of household food security is a consequence of agricultural production for most small-holder farmers and incomes or poverty for the urban poor, rural landless, and farmers too small to produce enough food for subsistence. Gradual improvements in the integration of livestock into mixed systems include practices borrowed from best-farmer practices and other on-farm technology improvements. Ruttan (1991) has pointed out that the diffusion of best farmer practices leads to slow rates of growth, 1 to 2%, while population is growing in Africa at about 3%. Intensification through science-generated technology changes and increased use of cash inputs can lead to 3 to 4% growths. Major changes in the methods of livestock production, including improved fodder production, use of purchased concentrates, drugs and health services, and genetic improvement of animals, are required.

Increased market integration may occur with or without technological change, but technological change hardly occurs without commercialisation -- at least on either the factor-input side or the product-output side -- resulting in expansion of marketed surplus. In order to have sustainable effects on food security for the poor, the income stream resulting from technological change must reach them either through increased returns from their resources, employment expansion, or favourable food price effects (Von Braun and Kennedy, 1994). Income growth improves household and individual ability to acquire more food or better quality foods.

6. The impacts of intensified dairying on food security

Intensified market-oriented smallholder dairying offers important income-generating opportunities for smallholder peri-urban farmers in sub-Saharan Africa. Experience from Africa shows that the incomes of smallholder livestock producers in Africa who adopt intensified technologies for the production of meat or milk increase by 50-100% (Shapiro, *et al.*, 1995, Sanders *et al.*, 1996; Buta, 1997). In the Ethiopian Highlands, the returns to labour from dairying are up to three times higher than alternative crop activities (Buta, 1997). Returns from market-oriented small ruminant activities in the Sahel were found to be 24% higher than traditional activities and returns to capital are over 50% (Table 4). This is as high as off-farm activities such as trading and far higher than intensified crop production (Shapiro, 1994).

Evidence from the Ethiopian Highlands, as summarised in Table 3, shows that per capita food accessibility (quantity and quality of food available to the household from on-farm production and purchases valued in monetary terms) is over 50 percent greater in households with crossbred cows. Furthermore, similar results were found when the intensified dairying was carried out with dairy goats in a far harsher, more poverty-prone region. Increased milk production and daily sale of surplus was found to contribute to all three dimensions of food security -- availability, access, and stability. Besides increasing availability of and access to nutritious food through increased milk production and higher income, respectively, a steady flow of cash income from daily sale of milk contributed to seasonal stability of smallholder household consumption.

7. The sequence of the evolution of livestock and crop systems

Concentrating on crop improvement alone leads to higher yields making more food available, but does not improve farmers' access to food much, since it has little impact on incomes. When yields are up, prices usually decline due to the low-income elasticity for cereals. Attention has to be shifted from food production for subsistence to an emphasis on market-oriented activities that improve the purchasing power of families at risk of malnutrition. This can be accomplished through intensification of livestock activities. However, the likely sequence of livestock and crop intensification and what determines this is critical to understand how best to prioritise development efforts to increase the impacts of new livestock technologies.

On integrated mixed farms, ensuring adequate on-farm food production to meet the food requirements of the household tends to dominate cash income objectives during early attempts to promote intensified market-oriented livestock production. In making decisions whether to adopt market-oriented livestock technologies, smallholder mixed farmers, tend to continue to give precedence to food production because of lack of confidence in the functioning of markets. For instance, experience shows they normally will be reluctant to allocate land to forage production until crop production is increased substantially through the adoption of improved seed, fertiliser and perhaps other cash inputs (herbicide, insecticide). In general, there appears to be a necessary sequence in which the first step is the introduction of intensive technologies into the crop system. Increased cereal yields then make it possible to reallocate land to grow forages and substantially increase livestock productivity.

8. The occurrence of intensive specialised livestock activities

The sequence can be different, however, for peri-urban livestock activities. Intensified livestock activities relying on high levels of inputs both produced on-farm and purchased off-farm usually first occur near urban population centres. These include peri-urban dairying[1] and finishing operations for meat production. Here the income elasticity for livestock products are higher than for cereals, and access to urban markets results in high livestock prices. These livestock activities can be intensified due to the high prices whether or not crops are, even with the rising costs of land and other inputs also due to proximity to urban markets (McIntire *et al.*, 1992).

Intensified smallholder peri-urban dairying is developing rapidly all over the continent to serve population centres. Smallholder units are especially effective in peri-urban dairy production since it is labour and management intensive. Although dairy development is easier where disease pressure and climate are not major constraints, such as in the semi-arid and Highland regions, high prices enable smallholder peri-urban producers to take advantage of intensified feed technologies, better management practices, and preventive health technologies in higher rainfall regions. These feeding, management, and health measures enable dairy activities to expand even in wetter lowland and coastal areas.

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1. Peri-urban dairy is defined here as that dairy production and marketing occurring in the milkshed of an urban area. The critical development aspect of peri-urban dairying is that its location is demand-driven, rather than determined mainly by agro-ecological factors (Staal and Shapiro, 1994).

Finishing operations for meat production are also located in or around urban areas across the continent. Presently, these finishing operations function mainly as collection and marketing points near urban markets. Unlike in developed countries where finishing operations fatten animals to increase value added, in Sub-Saharan Africa animals are mainly fed in finishing operations to maintain weight while they are being held for sale when prices are higher during demand peaks. Nonetheless, these finishing operations still use a zero-grazing feeding technology similar to stall-feeding dairy cattle because land for grazing is not available where finishing takes place near consumer markets. Supplements such as purchased hay, straw, and industrial by-products are required. Although finishing operations are rarely smallholder operations so far, the hay and straw they purchase usually comes from smallholder mixed farms in peri-urban areas.

9. The requirements for livestock intensification

Intensified livestock production can only take place through commercialisation, which entails integration into and reliance upon input and output markets. Government support is especially important in the case of intensified livestock development (relative to crop agriculture) since the required investments in animals by farmers, as well as by processors and marketers, is large and can thus entail substantial risk. The success of small-holder dairying in Kenya provides evidence that the ability to sustain intensified dairying as a market-oriented activity for large numbers of smallholders requires marketing institutions and organisations, support services, and marketing infrastructure that would enable them to compete effectively.

The types of government support required for intensified livestock development include: public investment in infrastructure such as roads; collection, holding and storage facilities; information systems to improve market efficiency; regulations that facilitate market operations for the supply of inputs and the delivery of animal health services; and improved credit facilities. Institutional arrangements such a regulations governing transactions in inputs and dairy product markets determine transaction or non-monetary costs associated with marketing, as well as the level of uncertainty about product quality and availability. Sound public policies and investments create incentives for producers to invest in improved breeds, to purchase inputs to commercialise livestock activities and integrate them into the market economy, and to invest in on-farm capital such as barns and fencing.

The profits from intensified livestock activities increase substantially with institutional policy reform. For instance, research results showed that incomes from dairying in Kenya and Ethiopia could increase by up to 75% if market institutions such as marketing and credit regulations were liberalised. Important barriers to entry remain for small processors in both countries. Uncertain legality restricts the ability of processors to obtain credit. Non-price factors such as the dominance of the market, political power, and licenses and regulations continue to obstruct the positive effects of price policy liberalisation (Staal and Shapiro, 1996).

Organisations also play a critical role in encouraging livestock intensification and in making it sustainable for smallholders. By acting together in co-operative organisations, smallholders can achieve economies of scale in production, processing and marketing that can enable them to minimise transaction costs and marketing risks. Such organisations can also make possible more effective access to and functioning of support services such as credit, animal health, AI,

and extension.

A critical issue facing dairy development in SSA is how best to provide support services. Even in the present policy climate that favours privatisation, some services will have to be publicly supported. Given the sophisticated support services needed for dairying to be successful and the relatively large investments required for resource-poor smallholders to start dairy operations, an argument can be made for government support for some forms of health and AI services, credit schemes and training. Blood stock and skills provided by big producers had proven to be helpful in smallholder dairy development in Kenya. The existence and efficiency these services will be a critical factor on dairy development in most parts of Africa.

10. Conclusions

Growing population pressure in Sub-Saharan Africa will encourage structural changes to more intensive livestock systems. Better integrated crop-livestock systems needs to be replaced by more intensive and more specialised, crop and livestock systems to obtain rapid growth rates and to respond to the increasing demand for animal food products and soon for improved dietary quality as land becomes more scarce with the continuing population pressure.

Traditional mixed farming practices are not sustainable economically or environmentally in the face of growing population pressure and do not make sufficient impact on food security. Under growing population pressure on land, and in the absence of properly functioning markets that limits access to technology and inputs as well as outlets for production, low-input, low productivity mixed crop-livestock farming systems have resulted. Low use of modern inputs, low yielding crop varieties, and low productivity breeds of livestock result in low per capita food production that makes small-scale farmers food insecure and does not contribute to achieving food security for the urban poor. Such practices are also unsustainable, as they tend to overuse and degrade land resources.

Structural changes taking place in Sub-Saharan Africa can be expected to bring about technological change in milk and meat production over the next 5-10 years. Besides population growth and urbanisation, other factors pushing for shifts to more intensive, specialised production activities are the recent currency devaluation and price liberalisation. The relative prices of meat and milk to domestic cereals and traded commodities can be expected to rise over time.

Market-oriented, intensive smallholder dairying is likely to be one of the outstanding development success stories occurring in Africa over the coming 10-15 years. Moreover, beef production will eventually become more specialised and regionally concentrated as it has in other developing and developed countries. These stages include cow-calf and stocker operations in open-range systems in the arid and semi-arid regions, fattening on-farm and at collection or assembly points, and finishing near urban markets in all the agroclimatic zones. The main increases in purchased inputs for cow-calf operations are expected to be veterinary supplies. Fattening and finishing are expected to develop in relatively higher rainfall areas creating demand for forage, straw, hay, and residues grown on-farm. To encourage these changes will require promoting increased regional integration through the elimination of barriers to trade such as quotas and border taxes (Sanders *et al.*, 1996).

Meanwhile, neither people nor policy makers in poor countries will feel concerned about the protection of the environment or about other matters, such as conservation of biological diversity or animal rights. Not until a higher proportion of the population is able to satisfy its basic needs and the economic system develops a capacity to respond to the rapidly increasing demands for food products will there be a change. The immediate problem, therefore, is to introduce intensive technologies that raise productivity and incomes moving through NARS and technology transfer agencies onto farmers' fields. Developing country policy makers will then have the flexibility to respond to environmental concerns (Sanders *et al.*, 1996).

Table 1: Contribution of livestock to agriculture as countries develop (1988 Figures)

Developing Regions	Agricultural Share of GDP (%)	Livestock Share of Agricultural Output (%)
Africa	32	25
Asia	25	22
Latin America	12	38
Europe/North America	4	57

The population figures come from the World Bank News, April 1993 and the GDP figures come from USDA: World Agriculture - Trends and Indicators, 1990. The contribution of livestock to agricultural output was calculated.

Table 2: Population projections for SSA

Population	1990	2025	Increase/year (96%)
Total (millions)	498	1294	28
Urban (%)	29	54	69

Source: Adapted from World Bank (1992)

Table 3: Per capita food availability differences between households with local cattle only (LBC) and those with crossbred cows (CBC) at Selale, Ethiopia

Per Capita Annual Availability (in Eth Birr)		
Consumption items	LBC owners	CBC owners
Major staple cereals (barley-teff-wheat)	258	505
Other food crops	146	244
Non-dairy livestock and livestock products	63	43
Milk	15	20
Butter	35	57
Cheese	12	17
Total food availability	**529**	**886**
Leisure	35	17
Non-food items and services	160	143

Source: Adapted from Shapiro (1997)

Table 4: Comparison of potential income change and variability [a] due to expanded livestock marketing opportunity [b] at Kouka, Niamey region, Niger

Income Sources	Traditional Technologies		Expanded Marketing Opportunities		Income and change (%)
	Income (US$)	CV (%)	Income (US$)	CV (%)	
Crops	301	49	409	39	108 (+36)
Livestock	186	89	230	75	44 (+24)
Salaried Labour	16	62	14	14	-2 (-13)
Total Income (Per-Capita Income)	**503 (58)**	**63**	**653 (76)**	**54**	**150 (+30)**

[a] *Measured with the coefficient of variation*

[b] *Expanded livestock-marketing opportunities enables the use of cash inputs and results in increased flexibility in the timing of sales so higher prices can be realised. It also enables use of improved cultivars that result in higher and less variable crop income.*

Source: Shapiro, 1994.

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