

Chapter 2

Intensification of Crop–Livestock Farming Systems in East Africa: A Comparison of Selected Sites in the Highlands of Ethiopia and Kenya

M. Kindu, A.J. Duncan, D. Valbuena, B. Gérard, L. Dagnachew, B. Mesfin, and J. Gedion

Abstract Mixed crop–livestock farms in the highlands of East Africa are undergoing a process of intensification but the constraints to intensification and the opportunities to overcome those constraints are not well understood. Survey activities were conducted from 2010 to 2011 in three sites in the highlands of Ethiopia and Kenya to (1) compare the extent of crop–livestock intensification, (2) assess constraints to intensification, and (3) explore options to overcome these constraints. Eight villages in each site were selected for the survey at two sites in Ethiopia (Kobo and Nekemte) and one (Kakamega) in western Kenya. The sites represented a gradient of productivity, increasing from the relatively extensive production system in Kobo to the more intensive production seen in Kakamega. Representative groups of 10–20 farmers were identified and interviewed in each village to gather quantitative group-level data at the village level. Results showed that the application of manure and the use of inorganic fertilizers and improved seeds were more pronounced in Kakamega and Nekemte than in Kobo. Unlike the two Ethiopian sites, 10 % of the households in the Kakamega site owned crossbred cattle. The level of

M. Kindu (✉) • A.J. Duncan

International Livestock Research Institute (ILRI), P.O. Box 5689, Addis Ababa, Ethiopia

e-mail: K.Mekonnen@cgiar.org

D. Valbuena

Wageningen University, Wageningen, The Netherlands

B. Gérard

International Maize and Wheat Improvement Center (CIMMYT), Mexico

L. Dagnachew

Oromia Agricultural Research Institute (OARI), Bako Research Centre,
Wollega Zone, Bako, Ethiopia

B. Mesfin

Amhara Regional Agricultural Research Institute (ARARI), Sirinka Research Centre,
North Wollo, Woldia, Ethiopia

J. Gedion

Kenya Agricultural Research Institute, Kakamega, Kenya

intensification varied among the three sites mainly due to variations in market options and the availability of water and system-oriented technological options. Because of complexity and variation, different solutions are called for in different contexts. Dealing with some of the issues, for example, the water and technological options in Kobo, the market issue in Nekemte and the population-related issues and technological options in Kakamega, could lead to a more sustainable intensification of crop–livestock farming in the respective study sites.

Keywords Villages • Crop and livestock technologies • Trends on inputs and services use • Sustainability

Introduction

Small-scale crop–livestock farms represent a large fraction of the rural population in the East African highlands. However, the level and pace of intensification vary among regions, villages and farms. Variations in crop–livestock intensification relate to different rates of population increase, economic opportunities, cultural preferences, climatic events, lack of capital to purchase crop and livestock inputs and labour constraints.

Population increase has caused the fragmentation of agricultural land, and the conversion of land use from grazing and forest to agriculture in the East African countries. As a result, soil degradation through nutrient mining is becoming a major problem, though much of it is reversible with better integrated land management practices (Sanchez 2002).

Diversified income sources are the key to the generation of capital and subsequently contribute to the purchase of crop and livestock inputs, providing a potential route to more intensified production. The sources of income for the study site in Kenya were found to be more diversified than in the two Ethiopian sites (Duncan et al. (2012) Unpublished project sites report). Jayne et al. (2001) also reported a 50 % off-farm income generation for households in Kenya and a 12 % off-farm income share for Ethiopia. The increased diversity of income from different sources in the Kenyan site is due to the relatively developed and diversified economy, which enables farmers to use more crop and livestock inputs than in the Ethiopian sites.

The evolution of crop–livestock interactions in sub-Saharan Africa follows four major phases. These are the pre-intensification phase (crops and livestock are independent activities), the phase that corresponds to the emergence of crop–livestock interactions, the diversification phase and the specialization phase (Powell and Williams 1993). Studying the level of crop–livestock intensification in the East African sites helps the identification of where on this continuum farms currently lie, the assessment of gaps and opportunities, and the development of short to long-term interventions to move farmers towards more intensified production. The objectives of this study were to (1) compare the extent of crop–livestock intensification in terms of inputs utilization and access to markets and services, (2) assess the constraints to intensification, and (3) explore options to overcome these constraints in three sites in the highlands of Ethiopia and Kenya.

Methodology

Study sites: Three mixed crop–livestock farming system study sites were identified in two East African countries (Ethiopia and Kenya) to conduct studies on crop residues. Kobo and Nekemte sites represented the north eastern and western parts of Ethiopia whereas Kakamega represented the western parts of Kenya. The three sites were purposively selected to capture the maize and sorghum crop-based systems. Maize–beans are the dominant crops in Kakamega, maize–teff in Nekemte and sorghum–teff in Kobo. The sites represent a gradient of productivity with Kakamega being the most productive site and Kobo the least productive. Nekemte is a highland site with an altitude range of 1,748–2,418 masl. In terms of soil characteristics Vertisol is the dominant soil type in Kobo. This soil has more clay content; it cracks during the dry season and holds much water during the rainy season. On the other hand, the dominant soils in Nekemte and Kakamega are acidic; they fix phosphorus and make it unavailable to crops. A broad characterization of the three sites is shown (Table 2.1).

Village selection criteria were developed and applied in East Africa using images from Google Earth. Eight villages were selected in each of our three sites. The selection scheme was as follows: near–near: near to road, near to market; near–far: near to road, far from market; far–near: far from road, near to market; and far–far: far from road, far from market. For each category, two villages were selected by scrutinizing aerial images from Google Earth. A village survey instrument was prepared and tested in each regional site with research partners to ensure a thorough understanding of the questions. Village land area, cropping pattern, use of cropping technologies, types of crop residues, use of crop residues, trends in crop residue use, main constraints to crop production, number of adult animals in the village, composition of feed intake for ruminants and frequency of meeting of development agents with villagers are some of the guiding points included in the questionnaire. Representative social groups of 10–20 farmers were identified in each village and they responded as a group during the final village survey. A total of 24 villages were considered in the three sites (Table 2.2).

Table 2.1 Description of the three study sites in East Africa

	Kobo	Nekemte	Kakamega
Altitude (masl)	1,416–1,634	1,748–2,418	1,426–1,719
Major soil types	Vertisol	Nitisol	Oxisol
Mean annual rainfall (mm)	768	1,037	2,009
Mean annual temp (°C)	30	29	28
Total village population	330–2,250	196–391	400–5,000
Total village HHs	66–450	35–70	80–1,200
Total village land (ha)	77–910	74–164	200–900
Total cultivated land (ha)	66–280	61–149	160–810
Major crops	Sorghum, teff	Maize, teff	Maize, beans
TLU (tropical livestock unit)	141–1,004	69–213	121–673

Note: *masl* meter above sea level, *ha* hectare, *TLU* tropical livestock unit, *hhs* households, *mm* millimeter

Table 2.2 Study villages in East Africa (Ethiopia and Kenya)

No.	Nekemte	Kobo	Kakamega
1	Beko	Mesgid Genda	Mahiakalo
2	Gombo Boneya	Genfo	Muraka
3	Mandara Bake	Keyu Garia	Mukhonje
4	Kibi	Koba	Bukhatsi
5	Boneya	Hamusit	Ematere
6	Bata	Ayinama	Mabanga
7	Lugo	Hormat	Ataku
8	Gajo	Chorie	Bukondi

Results and Discussion

Farming Systems at the Three Sites

Cereal production accounted for a higher percentage of the allocated cultivated land in Kobo and Nekemte than in Kakamega (Table 2.3). Production of legumes in terms of the percentage of area coverage and number of households growing legumes was more pronounced in Kakamega than in Kobo and Nekemte. This has implications in soil fertility management and ecosystem sustainability.

The diversity of horticultural crops grown in Kakamega and the percentage of households involved in such farming were considerable. The number of households growing horticultural crops in Nekemte was also quite significant although the percentage of land allocated to them was small. The increased diversity of horticultural crops in Kakamega can be associated with proximity to input and output markets, access to credit, availability of germplasm and an adequate amount of rain (Sindi 2008).

Fallowing was practised in both Nekemte and Kakamega. Most households in western Kenya, including Kakamega, practised natural and improved fallows for short periods. The fallow system practice in Kakamega facilitates the restoration of soil nutrients that are depleted by intensive cropping. In western Kenya, about half of the farmers leave 10–25 % of their cropland fallow during the short-rains period (Amadalo et al. 2003). The need to exercise natural or improved fallow to improve soil fertility is not a priority in Kobo compared with Nekemte and Kakamega. The cultivated land in Kobo was concentrated in valley bottoms where soil transported by water erosion from the nearby mountains is deposited. The fallowing in Nekemte was longer and natural, i.e., without the deliberate inclusion of leguminous plants. It was also practised on agricultural lands where the soil was exhausted from continuous cultivation and soil acidification.

About 10 % of the households in Kakamega kept crossbred cattle whereas all the households in Kobo and Nekemte kept only indigenous cattle (Table 2.2). Although the demand for improved animal genetic resources such as crossbred cows had increased in the three sites, the response from the supply side was poor. Poor market conditions for animal products and increased prices of inputs also discouraged farmers from owning more crossbred cattle.

Table 2.3 Land area allocated to growing crops and the types of cattle kept by households at the three East African sites

Parameter	Kobo	Nekemte	Kakamega
<i>Cropping system (Area ha)</i>			
Cereals	963 (97)	581 (74)	1,238 (31)
Legumes	19 (2)	13 (2)	859 (22)
Oil crops	nd	54 (7)	nd
Horticultural crops	5 (1)	24 (3)	1,776 (44)
Fallow	nd	107 (14)	133 (3)
<i>Households keeping cattle (%)</i>			
Cross breeds	0.0	0.0	9.6
Indigenous breeds	100.0	100.0	90.4

NB: Nd refers to no data; Numbers in parentheses represent percentage of area coverage

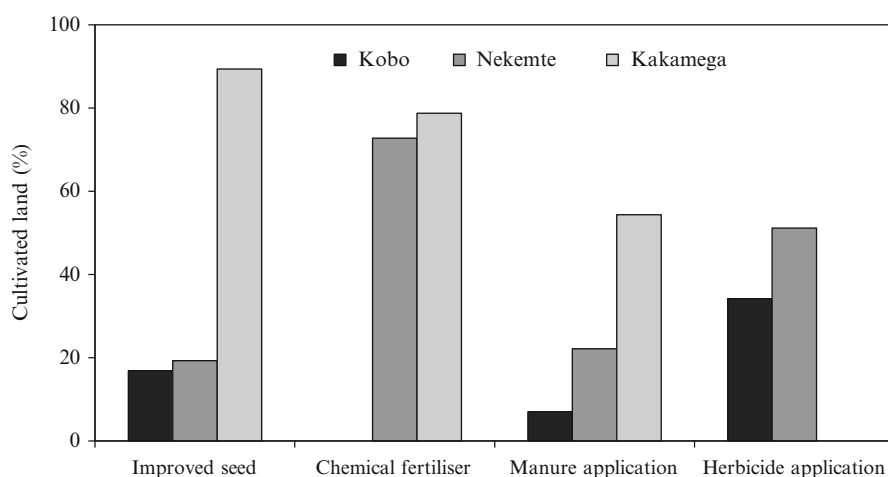


Fig. 2.1 Use of cropping technologies in the three sites in East Africa

Use of Cropping and Livestock Management Technologies at the Three Sites

The percentages of cultivated land that received chemical fertilizers in Nekemte and Kakamega were quite significant when compared to the Kobo site (Fig. 2.1). High rainfall, the nature of the soil type (P-fixing) and the production systems tended to compel the farmers to apply chemical fertilizers to sustain the productivity of crops in Nekemte and Kakamega. Most cultivated lands in Kakamega were planted with improved seeds. Weeds in Kobo and Nekemte were controlled by hand weeding and herbicide application. On the other hand, a large proportion of the cultivated lands in Kakamega depend on hand weeding for weed control. Manure application for managing soil fertility was very limited in the two Ethiopian sites as cow dung was one of the sources of energy for cooking food.

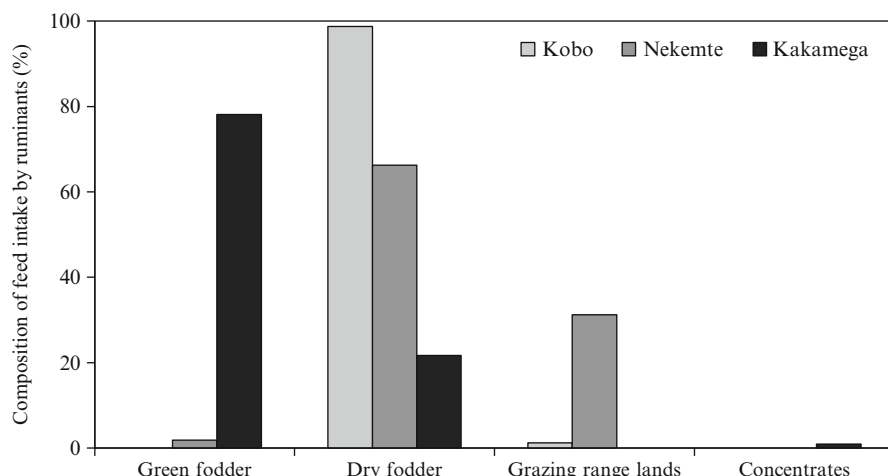


Fig. 2.2 Use of dry season livestock feed sources in the three sites in East Africa

Dry fodder (crop residues + stubble grazing) constituted 99 % of ruminant dry season feed intake in Kobo and green fodder (Napier grass + crop residues) constituted 78 % in Kakamega (Fig. 2.2). Residues from cereal crops and pulses combined with post-harvest stubble grazing accounted for over 90 % of all feed in the Ethiopian highlands (de Leeuw 1997). Growing and marketing of Napier grass was a common practice in most parts of western Kenya. The green fodder from Napier grass appeared to exist in the dry, rainy and harvest seasons. Napier grass was one source of cash income for the smallholder farming communities. It was commonly grown as strips and block plantings in the farmlands, on roadsides and in other niches. The contribution of concentrates (mainly composed of industrial by-products) to total livestock diet was found to be minimal across the three sites.

Constraints for Crop–Livestock Intensification

The intensification of crop production is constrained by weeds, diseases and pests high prices of inputs and low prices for outputs whereas livestock production is limited mainly by feed shortages, diseases and endo- and ecto-parasites (Figs. 2.3 and 2.4).

Rainfall distribution and intensity are highly variable in Kobo compared with Kakamega and Nekemte. The occurrence of drought is also very common in Kobo and the surrounding areas. Farmers plant different varieties of crops depending on the timing of the onset of rain. If the rain starts very early, they plant long-maturing varieties. Short-maturing varieties can be seen in most crop fields when there is a

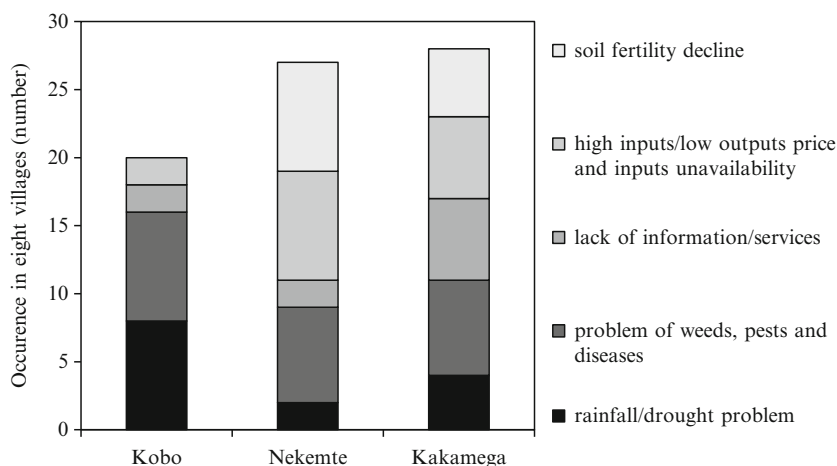


Fig. 2.3 Main constraints of crop production in the three sites in East Africa

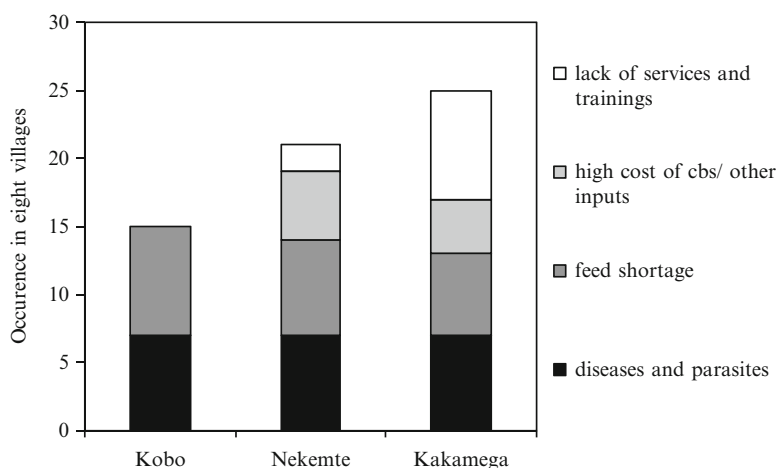


Fig. 2.4 Main constraints to livestock production in the three sites in East Africa

late onset and inadequate rainfall. Farmers also plant intermediate crop varieties during an average rainy season. The productivity of the varieties is different in terms of grain and crop residues. The long-maturing varieties, e.g., sorghum and teff, produce higher yields of grain and crop residues that can be used for various competing uses (Hailu Terefe 2011). The availability of alternative varieties also increases farmers' flexibility to respond to climate, market and social variations (di Falco et al. 2010).

Soil nutrient depletion has become a common feature in the East African countries although the degree varies from site to site. The problem is prevalent in Nekemte and Kakamega due to the acidic nature of the soil and other associated constraints. The dominant soils in Kakamega District, such as the Acrisols,

Ferralsols and Alisols, are acidic. These three soil types constitute 79 % of the total area of the district (Mandere 2003). Plant nutrient deficiencies and toxicities of Al (aluminium), Mn (manganese) and hydrogen ion (H^+) exist in acid soils. Soil acidity is one of the factors contributing to the low yields of crops and crop residues (Sanchez et al. 1997).

Weeds, insects and pests affected the productivity of crops and crop by-products in all three sites. The most important weeds in Kobo were *Striga* spp. and *Parthenium hysterophorus*. *Striga* is a parasite mostly affecting sorghum, maize and teff. *Parthenium hysterophorus* colonizes arable lands, bare areas along roadsides and heavily grazed pasture. When animals graze the harmful *Parthenium* weed, milk becomes bitter. Estimates of crop losses from weed infestation in Ethiopia reach up to 40 % (Kebede Desta 2000). Stem/stalk borers were the most important insect pests of maize in Kakamega and Nekemte, and of sorghum in Kobo. In Kenya, stalk borers causes losses of 14 % of maize production nationwide (Groote et al. 2001).

High input prices (fertilizer, improved seeds) and low output prices (cash and staple crops and by-products) were common issues in Nekemte, Kakamega and Kobo although the level of the problem varied among the three sites. The problem is associated with the lack of infrastructure, such as road networks. The inadequacy of the road system, which is most important for market development in terms of the distribution of inputs and output to and from farms, is the most serious infrastructural constraint facing agricultural development. As a result of the poor road networks, smallholder farmers depend on inefficient forms of transportation including the use of animals. Underdeveloped rural roads and other key physical infrastructures have led to high transport costs for agricultural products to the market as well as for farm inputs, thus reducing the farmers' competitiveness.

Agricultural information and service delivery through extension was less efficient in Kakamega than in Kobo and Nekemte. The findings of the present study also showed that the villagers in Kakamega met extension experts once a month at the maximum and once a year at the minimum. On the other hand, 50 % of the villagers at Kobo (four villages) met development agents daily and the other 50 % (four villages) had access to extension service providers on a weekly basis. The frequency of meetings with extension experts in the last 10 years has also shown an increasing trend in the Kobo and Nekemte sites. The trend of access to extension experts in Kakamega showed no net change. The allocation of 3–4 development agents at Kebele level had improved the frequency of their meetings with farmers in the Kobo and Nekemte sites.

Shortages of animal feed and the incidence of diseases and parasites significantly affected livestock productivity in almost all the study sites. Animal feed became scarce mainly during the dry season. As a result, animals died at an early age; they provided a low milk yield and draught power, and were marketed at a low price (Kindu 2001). The two major livestock diseases of economic significance in Africa in general are trypanosomiasis and tick-borne diseases (Latif 1992). Both affect subsistence and commercial farmers and limit the exploitation of productive land. Present methods of vector and disease control remain inadequate, costly and pose environmental problems (Latif 1992).

Potential Options to Overcome Constraints to Crop–Livestock Intensification

- Producing enough biomass: this can be achieved through the use of cropping technologies (water harvesting, irrigation, improved crop varieties) and intensive farming.
- Introducing compatible and high-value perennial crops; this would generate income for the poor farmers and improve the year-round soil cover.
- Implementing an integrated farming approach: this would help local communities to better address a number of issues at a time. It can also facilitate the search for alternative sources for various issues, e.g., alternative feed and fuel sources to save more crop residues for covering the soil and improving its fertility.
- Enhancing the knowledge of farmers: better management and the efficient use of land and water resources would boost crop and livestock productivity. This can be done through various capacity building schemes such as farmer-to-farmer informal visits, field visits, agricultural shows, demonstrations, farmers' exchange visits, advertisements, leaflets, posters and booklets, radio programmes, TV programmes, training, awareness-raising especially among policymakers and meetings/workshops (Owenya et al. 2001).
- Promoting participatory learning approaches: farmer field schools, for example, would strengthen farmers' understanding of the principles underlying intensive farming using various inputs and services.

Conclusion and Recommendations

The three study sites in East Africa had different levels of crop–livestock intensification because of variability in rainfall, in the adoption of crop and livestock technologies, and in access to input/output markets. Crop intensification was limited in all three sites with traditional low-input practices predominating. However, there was some evidence of the better use of improved seeds, chemical fertilizer and manure application for crop production in Kakamega. Green fodder was the dominant feed source in Kakamega while dry fodder (crop residues) dominated in Kobo. Nekemte was intermediate in terms of the importance of dry fodder resources. Concentrate feeding was minimal in all sites although very limited feeding of concentrates was evident in Kakamega. Dealing with some of the constraints that affect production could lead to a more sustainable intensification of crop–livestock farming in the East African highlands.

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