Chapter 11

Livestock Production in Areas of High Pressure Crop-Livestock Farming Systems in the East African Highlands

Jeroen Dijkman
FAO, c/o International Livestock
Research Institute, Ethiopia

Introduction

Although highland environments (areas above 1,500 masl) only cover 4% of the total African continent (around 1 million sq.km), they are of significant importance in East Africa (Table 11.1). Not only can the majority of the highlands be found in this region, but they are also home to approximately 60-90% of the human and livestock population in the countries in which they are found (Table 11.2). Furthermore, as a result of their relatively high production potential and the importance of agriculture, they constitute the economic backbone of these countries.

In the majority of countries in the East African Highlands (EAH), human population is increasing at a rate of circa 3.5%. Although there is a gradual trend towards

Table 11.1: Highland area compared to total land area of selected East African countries

Country	Total land area sq.km	Highlands Area, sq.km	Highlands % of total
Ethiopia	1,221,900	489,700	40
Tanzania	939,701	190,000	20
Kenya	583,000	110,000	19
Uganda	243,000	30,000	12
Rwanda	243,000	22,250	9
Burundi	27,834	12,750	46

Sources: Jahnke 1983; Getahun 1991

Table 11.2: Estimated percentage of total population in highland zones of some selected East African countries

Country	Percentage of total population
Burundi	90
Ethiopia	90
Kenya	50-60
Rwanda	70-75
Uganda	60-65

Source: Getahun 1991; ILCA 1993; FAO 1998 increased urbanisation, 80 to 85% of the population can still be found in rural areas (Turner and Hyden 1993) (Figures 11.1 and 11.2). More people require more resources, and in most of the EAH the room for expansion is limited. The result is fragmentation of land and/or cultivation of marginal areas at the expense of grazing and forest land (Downing et al. 1990).

The situation with respect to changes in livestock numbers, however, is less uniform. The changes in livestock numbers between 1987 and 1997 in six EAH countries are shown in Table 11.3. The only country with sustained growth in numbers for all types of livestock is Uganda.

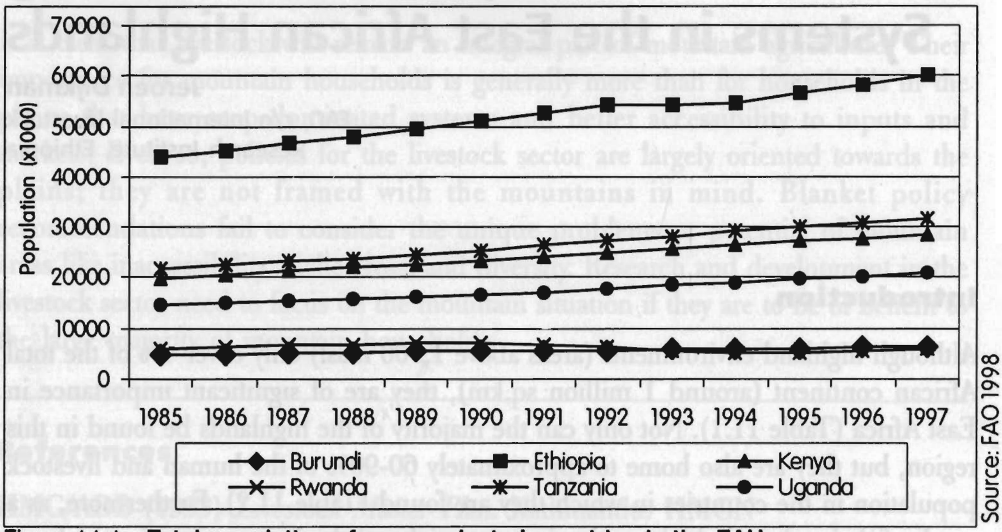

Figure 11.1: **Total population of some selected countries in the EAH**

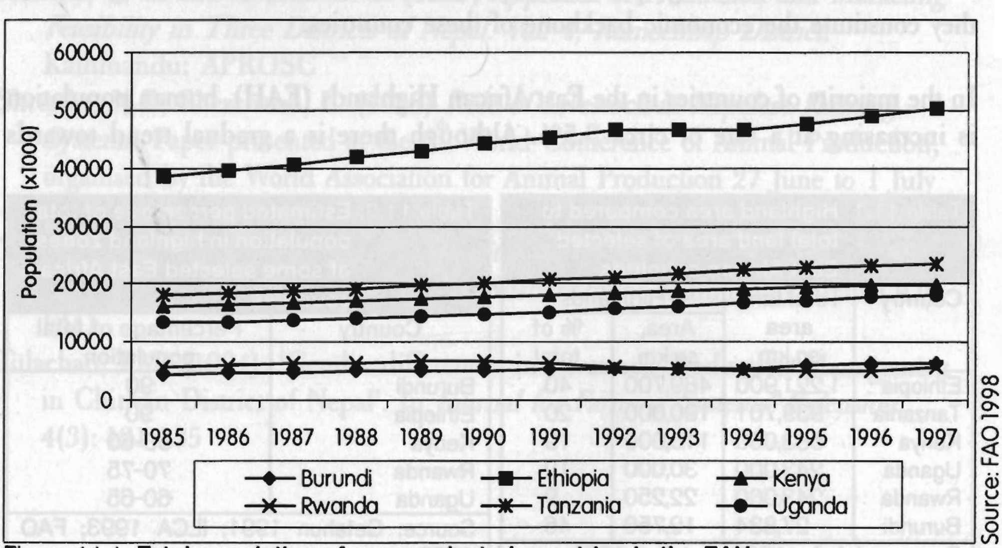

Figure 11.1: **Total population of some selected countries in the EAH**

Table 11.3: Estimated total livestock numbers (x 1000) in six EAH countries								
	Cattle		Pigs		Sheep/goats		Chicken	
	1987	1997	1987	1997	1987	1997	1987	1997
Burundi	422	400	80	80	1075	1240	4000	4000
Ethiopia	27000	29900	18	23	42000	3870	57000	55000
Kenya	12645	13414	94	108	12540	13400	22000	29000
Rwanda	583	465	105	80	1384	1170	1000	1000
Tanzania	12777	13370	290	335	11260	13637	17000	26000
Uganda	3905	5363	470	940	3903	5544	16000	22000
Source: FAO 1996, 1998								

The large increase in poultry numbers in some of the EAH countries is due largely to the expansion of commercial broiler and layer operations, which supply the growing urban markets. Pig production per se is of relatively low importance in the majority of countries under discussion as a result of religious and social taboos. The trends shown in Table 11.3 for Rwanda and Burundi are indicative of the continued process of population increase. In these countries the accompanying reductions in farm size and alterations in access to common pool resources have resulted in changes in livestock ownership patterns and herd and species' composition, leading to a significant reduction in total livestock units. As the links between livestock, vegetation, and soil are perceived to be indispensable to the survival of these systems, their breakdown or gradual disappearance would impede evolution towards continued intensification, higher productivity, higher investment, and sustainability. Most dramatically, this combination of high population growth, poverty, and resource degradation is widely indicated as one of the main causes of the atrocious 1993 civil war in Rwanda (see, for example, de Haan et al. 1997).

Whatever the specific country situation, however, even in the countries where total production in certain livestock sectors has increased (Table 11.4), these increases have, in general, not been able to keep pace with population increases, and only Uganda and Rwanda are showing marginal growth in per capita consumption of animal products. (Table 11.5). A lack of high quality protein in the diet of children and pregnant or lactating mothers can have severe consequences for the full development of human cognitive functions and productive potential.

Table 11.4: Estimated total production of animal products (x 100 MT) in six EAH countries												
	Beef		Mutton		Pork		Poultry		Milk (cows)		Hen eggs	
	1987	1997	1987	1997	1987	1997	1987	1997	1987	1997	1987	1997
Burundi	11	11	1	1	5	5	5	6	32	32	3	3
Ethiopia	206	236	79	80	1	1	72	73	631	740	78	74
Kenya	219	270	21	23	5	5	44	55	2055	2300	40	48
Rwanda	12	10	1	1	2	2	1	2	84	80	1	2
Tanzania	171	201	10	11	8	9	19	35	475	600	33	52
Uganda	59	89	7	10	25	52	25	36	342	469	13	18
Source: FAO 1996, 1998												

Table 11.5: Estimated food availability (KJ/capita/day) in six EAH countries								
	Food total		Animal products		Meat		Milk	
	1987	1996	1987	1996	1987	1996	1987	1996
Burundi	8443	7150	230	197	105	92	59	50
Ethiopia	6714	7723	448	402	213	209	134	109
Kenya	8485	8251	1139	996	331	289	687	582
Rwanda	8560	8966	239	247	80	88	134	130
Tanzania	9573	8489	599	536	222	197	167	155
Uganda	8816	8832	532	607	218	272	163	159
Source: FAO 1996, 1998								

Although indicative of the general trends, these rather gloomy statistics do not tell the complete story. In the past decade there have, for example, been several positive developments in market opportunities for smallholder livestock producers. These changes are best illustrated by looking at one such specific example.

Smallholder dairy

As a result of the increase of quotas in dairy production and a decrease in consumption in many western countries as a result of dietary concerns, world dairy production has been declining significantly (Staal and Shapiro 1996). At the same time, however, there has been an increased demand in many developing nations and an upward trend in nominal prices, which is expected to continue (Delgado et al. 1999). As a result of this, opportunities for African dairy producers are favourable and increasing. Further encouragement and intensification of the dairy industry would be particularly suitable in the EAH for a number of reasons: the climatic conditions are highly favourable to the keeping of high grade or crossbred dairy cattle; smallholder dairy farming complements most of the production systems prevalent in the EAH; the input and technology requirements are generally within the means of existing producers and markets; production is compatible with the sustainable use of the available land resources; and smallholders already play the largest role in East African milk production (Laurent and Centres 1990; Staal and Shapiro 1996; Ade Freeman et al. 1998).

In spite of these rather favourable conditions, the response to this development opportunity has been very different in the different EAH countries. This is best illustrated by comparing the current situation in Ethiopia and Kenya. Although both countries have a similar comparative advantage for smallholder dairy development, the actual evolution in both has been very different (Figure 11.3).

The reasons for the differences in the development in the two countries are listed below (van Schaik et al. 1996; Staal and Shapiro 1996).

- In Kenya, dairy development has been based on the use of crossbred and high grade animals, whereas in Ethiopia their numbers are negligible.

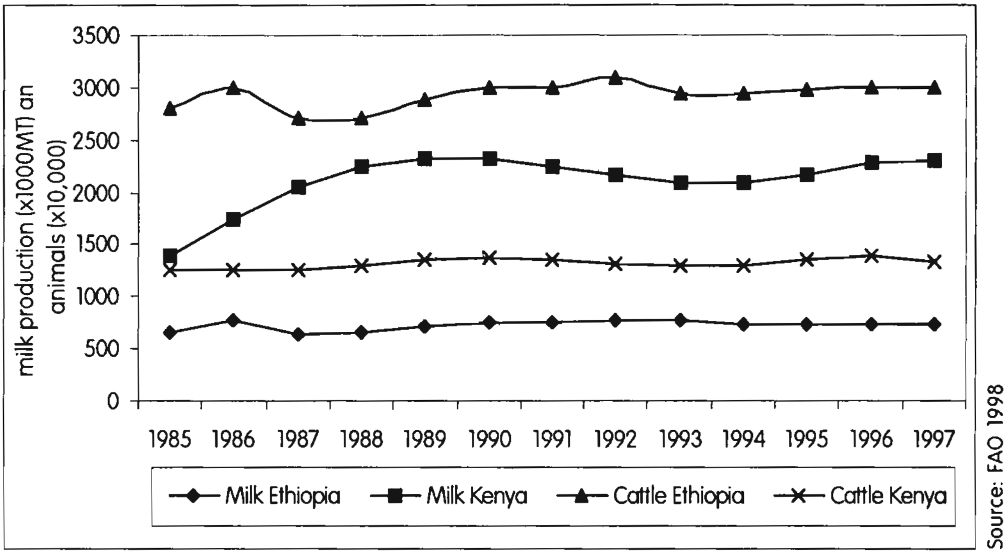

Figure 11.3: **Comparison of dairy production in Ethiopia and Kenya**

- The areas in Kenya where dairy farming is practised generally have a good infrastructure, which aids the marketing of perishable products such as milk (market access) and the access to information and inputs.
- In Ethiopia, most areas where dairy farming could be practised have a very limited infrastructure, and this has limited dairy operations to the peri-urban area of Addis Ababa.
- In Kenya the formal market is reasonably well developed (privatised) because export parity prices are paid and there is good development of collection and processing infrastructures and export of milk products.
- In Ethiopia, the formal milk market is hardly developed (less then 13% of all milk goes through the formal government controlled marketing channels) as prices are lower than export parity prices and government controlled, and there is no system for collection and processing.
- In Ethiopia, cooperatives have not been encouraged in any way. In Kenya, cooperatives have given farmers a voice in dairy policy, in addition to the other collective advantages.
- Services in Kenya are run by many private entrepreneurs, whereas in Ethiopia there are severe government restrictions that limit these developments.
- Changes in land tenure in Kenya have led to development of the use of land resources through shifts to rural production. In Ethiopia, however, all land is considered to be government property, which severely restricts inputs and development.

Although this is a rather specific example, it does illustrate some of the additional issues that can play a major part in the development or otherwise of particular livestock industries in different countries or regions, even when at first glance these countries or regions seem to have the same comparative advantage (Tiffen et al. 1994).

The EAH: Diverse Environments, Similar Problems?

There is great diversity between the various regions of the EAH. Nevertheless, some useful general lessons can be drawn from looking at the situation in the two major environments found. The main features are summarised below.

- The equatorial (tropical) highlands, near the equator. Farming is largely based on horticulture with intensive hoe cultivation and shows a high level of sustainability.

Some indigenous farming systems, such as the Enset-based farming and the Konso mixed farming systems in Southern Ethiopia, the Chagga system in northern Tanzania, and the smallholder mixed farming of the Central and Eastern highlands in Kenya, are able to support population densities exceeding 400 people per sq.km.

Agricultural growth and sustainability has been achieved through:
- soil conservation measures (structural and biological);
- organic matter, accumulation of manure, mulch, green manure, and/or crop residues;
- reduced or altogether eliminated fallow;
- use of chemical fertilisers (cash crops);
- increased crop diversity;
- integration of trees and animals with crop farming; and
- improved markets and marketing.

(Getahun, 1978, 1991; Fernandes et al. 1985; Messerli and Hurni 1990; Fowlie 1996)

- The subtropical highlands away from the equator. Farming is largely based on extensive cereal/livestock-based agriculture and shows a high degree of unsustainability in the face of an increased population and a declining natural resource base.

Historically, the EAH lacked effective national and regional land-use policies.
Cereal-based systems have largely remained unchanged.
Agricultural growth in these areas has been based on an expansion of the agricultural area at the expense of forest and grazing lands as well as shortening or eliminating the fallow period, resulting in extensive degradation.
The sustainability of these systems breaks down at population densities higher than 50 people per sq.km.

Out-migration from these highland areas to less productive semi-arid lands or into urban centres is a common phenomenon. In some countries governments have been compelled to embark on costly and often less than successful resettlement programmes.

(Lamb and Milas 1983; Dejene 1990; Messerli and Hurni 1990; Emana and Storck 1992; Grepperud 1996)

There are estimations that half of the arable areas in the Ethiopian highlands are moderately to severely eroded and that half of the remainder will need careful management to check soil depletion. Loss of topsoil has become common. Estimates suggest that, annually, about 2 to 3.5 billion tonnes of soil are lost from the Ethiopian highlands and some 20,000 to 30,000 ha of land abandoned by farmers (Saleem 1995; Shiferaw and Holden 1996).

If we compare the farming systems in the two environments described above, we can identify some of the specific conditions that have led to them developing in the way they have, and the influence that enabling circumstances (infrastructure, markets, services etc.) have on the potential sustainability of a system (Table 11.6). Although, generally speaking, the climatic conditions in the equatorial highlands are far more conducive to farming than in sub-tropical highlands, this is thought to have played only a secondary role in the differences in development.

Although the equatorial highland systems are considered to be far more sustainable as a result of their integration, diversification, and intensification, the continuing growth of human population in these areas requires additional interventions if they are to sustain even higher population densities. Various scientists (Christoffersen et al. 1989; Singh 1991; Powell et al. 1995) have proposed the following interventions:

- increased application of agroforestry including home gardens;
- more biological soil conservation;
- further integration of trees and livestock with food crops; and
- overall watershed-based land-use planning.

Table 11. 6: A comparison of the characteristics of equatorial and subtropical highland farming systems

Characteristic	Equatorial highlands (e.g., Kenya)	Subtropical highlands (e.g., N. Ethiopia)
Cash crops	Important (tea, coffee)	No cash crops, only livestock used as source of cash
Food crops	Roots and tubers, grain	Cereals, pulses, oil crops
Cropping system	Mixed	Monocultures
Livestock	Dairy farming	All classes for meat
Animal traction	None or minimal	Significant
Hired farm labour	Important	Insignificant
Produce marketed	Important (>50%)	Insignificant
Forestry, game reserves	Highly developed	Insignificant
Non-farm income	Important	Insignificant
Infrastructure	Well developed	Poorly developed
Land improvement efforts	High	Insignificant
Total income per farm	High	Very low
Production efficiency	High	Low

(Getahun 1978; Jones and Egli 1984; Rodriguez and Anderson 1988; Storck et al. 1991; Storck et al. 1997)

The sub-tropical highlands are already known to have unsustainable production technologies. Several scientists (Christoffersen et al. 1989; Getahun 1991; Singh 1991; Powell et al. 1995) have proposed various interventions such as the following:

- environmental rehabilitation through afforestation and soil conservation;
- reducing livestock numbers by replacing local breeds with fewer head of improved breeds;
- use of irrigated agriculture, and rehabilitation and use of land on the valley bottom;
- widespread introduction of agroforestry practices; and
- growing of trees on marginal lands.

Although it is comparatively easy to enumerate the steps required, the question that has to be asked is how likely it is that these measures will be implemented? In the light of the recent changes in the traditional methods of intervention in the agricultural sector (with use of price controls and state monopoly marketing boards, restraints on private sector involvement in processing and marketing, and an array of inhibitory measures such as export taxes, import tariffs, export and import licenses, and quotas and bans) towards increased market orientation of policies (with privatisation or dismantling of state-owned interests in production and distribution, liberalisation of trade and markets, land tenure protection and regeneration of natural forest resources, and increased attention to issues of poverty alleviation and social needs) that have occurred in the region at large, the prospects are probably relatively good (Assefa 1990; Anteneh 1991; Ehui and Lipner 1993; FAO 1998; LID 1999).

Integration of Livestock into Farming Systems

The implications of the recent changes for the integration of livestock into mixed farming systems and for specific livestock production related issues, as well as some of the new opportunities that are arising in this climate of change, are examined in further detail below.

Draught animals

In most EAH countries, the use of animal traction was introduced only in the late 19th or early 20th century. Generally, the use of work animals is on the increase in these areas, although their use is often restricted as a result of the size of holdings and the lack of feed resources. Use of dairy cows (multipurpose) and donkeys (which have specific advantages from a gender point of view) is increasing, however. Unfortunately, the implementation of programmes to stimulate their use is often hampered through the lack of appropriate complementary technologies and an enabling environment because most policy-makers still view the use of work animals as a retrograde step.

Ethiopia is very much the exception to the rule in the EAH. Pairs of oxen have been used for cultivation for thousands of years and currently an estimated 8 million oxen cultivate about 80 % of the soils. The use of oxen is said to be essential to cultivate the heavy soils. Ethiopia also has the largest population of donkeys on the continent (about 6 million) which are mainly used for pack transport and play a key role in marketing. Unfortunately, the use of oxen is generally rather inefficient. The animals are used for six to eight weeks per year only and require a large follower herd to ensure their continued availability, which causes severe pressure on land and the available feed resources. Programmes to promote the use of single ox traction or the use of dairy cows for traction have had little influence because of the lack of complementary technologies and infrastructure and the fact that livestock are still one of the most secure investments in the country (Gryseels et al. 1986; Gryseels 1988; Panin and Brocken 1992; Winrock 1992; Wilson 1995).

In other countries in the world, decreasing farm sizes, and reduced availability and access to common property resources have led to the development of alternative strategies. In parts of Bolivia, for example, farmers who do not have enough resources to maintain a pair of draught animals throughout the year buy a young pair of oxen at the start of the cultivation season. These animals are used for work for the duration of the cultivation period, during which time the farmers take advantage of the relative abundance of feed resources. At the end of the working period the animals are sold (Dijkman et al. 1999a, 1999b). In this way the farmers not only reduce their dependence on the hiring of tractor services or work animals from other farmers – methods that frequently reduce the timeliness of planting and are often prohibitively expensive – they also optimise the generation of income from their work animal and feed resource sub-systems. Although the quality of the work produced by these young animals may not be comparable to that of more experienced pairs of work animals, soil preparation techniques and cultivation systems are such that this reportedly has little effect on crop production. One potentially negative effect is that the practice often depends on importing animals from other parts of the country, which could potentially result in the establishment of exotic pathogens and vectors. As yet, no systems like this have been observed in the EAH.

Diversification of use

In many smallholder farming systems, the activities carried out by the different types of draught animals are often well-defined. Frequently, however, there are opportunities to increase the efficiency of use of the draught animals by diversifying the tasks that they are used for and thus reducing the idle time.

In various different cultivation systems across the developing world, all field operations apart from primary cultivation, which uses oxen, are carried out by hand.

However, there are many possibilities for employing equines (single or paired) in systems where they are available, for example in tasks like inter-row weeding (see, for example, Betker 1993; Emhardt 1994). Similarly, oxen (single or paired) could be used for secondary cultivation purposes, equines for primary cultivation on light soils, or combinations of different species, as necessity determines. Unfortunately, the implements needed for these types of operations are often not available. However, in many areas it would be possible to evaluate, adapt, and manufacture low-cost implements that have proved successful in other countries. One of the main stumbling blocks, often mentioned, to the spread of these types of technologies is the established cultural prejudice against the employment of animals for activities that deviate from the norm. However, recent evidence from southern Africa, where farmers started employing donkeys for primary cultivation purposes following the loss of their oxen in recent droughts, and Bolivia where the use of equines for activities other than pack transport is rapidly increasing, would suggest that this is dictated more by requirements than by cultural taboos (Sims et al. 1998, 1999).

Nutrition

As a result of the large variety in environments, the systems of animal nutrition are very diverse and often of different importance. Feeding systems range from the grazing of a large number of mixed herds on natural pasture, as in Ethiopia, through tethering of cattle and small ruminants in certain parts of the Tanzanian, Burundian, and Rwandan highlands, to zero-grazing dairy systems (mainly for high-grade dairy cattle but also for goats) in Kenya, Tanzania, and other EAH countries.

Apart from different systems of feeding, there is also a large diversity in the importance of the various feed resources. Nevertheless, in almost all crop-livestock systems, crop by-products continue to be of great importance. Grown forages are also still of major importance in many, particularly market-oriented, systems, although it is likely that with further increases in population their importance will decrease. In some areas in Kenya, for example, the application of maize food/feed systems and the use of concentrates and other bought feeds in market-oriented dairy systems is on the increase. Increased market orientation often provides farmers with the cash resources to buy additional feed resources, although this is dependent on a proper functioning of the markets and availability.

Nevertheless, natural grasses and grazing are still of major importance in many crop-livestock systems. The herding systems employed in Ethiopia were mentioned before, but even in zero-grazing systems, cut roadside grasses and other natural vegetation still constitute a major part of the animals' diets. Tethering is often practised in very densely cultivated and populated areas as animals cannot be allowed to roam around.

Bought fodder is becoming more and more important particularly in market-oriented crop-livestock systems (concentrates and forage). In some areas in Kenya, for example, some farmers have started growing Napier grass as a cash crop. The relative importance of the trade in feed and fodder, however, is very dependent on an enabling infrastructure and policy environment.

The various trends discussed are also having a significant impact on the feeding systems employed. Increases in cropped area and/or the intensification of cropping, can reduce access to grazing areas and the availability of feed and fodder. In general, however, it also leads to the production of more crop by-products and residues (provided the crops grown produce residues that can be used by animals). The change may, however, shift scarcity problems from the dry to the wet season.

(Tothill 1988; Shem 1994; Wilson 1995; Akyeampong and Dzowela 1996; Drechsel et al. 1996)

Integrating food and feed systems

When we discuss feed shortages for ruminant animals, the first 'solution' we tend to think of is to plant more and better. This may indeed be the appropriate solution in some cases. However, competition for land to grow crops for human consumption may restrict the possibilities available. Although many elegant systems have been designed for cultivating fodder in association with other crops, thus far their success has been limited. Nevertheless, opportunities may still exist within the current cropping systems to optimise the biomass available to animals without jeopardising crop production.

Weeding is a time-consuming chore in the majority of cropping systems. The weeds we're trying to remove, however, are often the forage used in natural pasture or on fallow land. What are the possibilities for using this production of biomass better? One route would be to investigate the influence of these weeds on total crop production during the different stages of crop growth. It may be possible to devise systems in which weeds are managed to optimise both feed and food production from the available land. Some farmers in Ethiopia and Bolivia, for example, have developed an integrated food/feed system in which they allow certain weed species to flourish alongside the cereal crop to increase biomass production, forage palatability, digestibility, and nutritional value, thus addressing several priority problems simultaneously. It would be useful to compare efficiency and total production in this type of integrated system with systems in which forage and human food crops are cultivated separately in monocultures. Clearly many different permutations of the strategies mentioned can be imagined, but these depend on the cropping systems currently in use.

Soil fertility

One of the most important aspects of the integration of animals into cropping systems is the production of manure. In many parts of the EAH, supply of chemical fertilisers is still difficult, especially where the infrastructure is poor or when chemical fertilisers are beyond the financial means of farmers. Equally, many soils in the EAH are poor in organic matter and the cropping results obtained on these soils with organic manure are often much better than those with chemical fertiliser. Improvement of the physical properties of soil through the application of organic manure is also said to reduce soil erosion. Even where chemical fertilisers are used, combination with organic manure can result in synergistic effects, making both more effective. Thus, in many systems, livestock are the 'tool' that allows intensification through the importation of nutrients and the acceleration of nutrient cycling. In some places, however, the lack of trees and other energy sources leads to the use of manure for fuel (for household use and sale). On some farms in Ethiopia as much as 1/3 of cash income is derived from the sale of fuel cakes. Biogas systems, are gaining popularity in some highland areas of Nepal. Although this system enables the manure to be used both as fuel and as fertiliser, it does not have the income-generating aspect.

Unfortunately, significant amounts of nutrients are often lost as a result of the collection and storage methods used for manure, and the lack of urine collection. In general, 40-60% of the N excreted by animals is contained in urine (Powell and Ikpe 1992). Urine must be conserved for nutrient collection to be optimised. In systems where animals graze, this may be impossible to achieve. Although the grazing land benefits from the deposited urine, an estimated 50% of the N in urine voided onto pasture is lost through ammonia volatilisation. Much of the N contained in faeces dropped on pasture is lost by a similar route (Watson and Lapins 1969). It is therefore important to minimise exposure of livestock excreta destined for fertiliser use to the effects of climate (Tanner et al. 1995). Minimising nutrient losses through the promotion of effective recycling is a key issue in maintaining the sustainability of smallholder mixed farming systems. There is much research underway in this area and several more efficient systems are currently being tested and implemented. One interesting point is that improvement of animal nutrition often has a direct effect on the nutrient composition of the manure, and thus benefits both the crop and the livestock systems.

The method used to collect manure obviously depends on the husbandry system employed. Under zero-grazing systems, collection of both manure and urine is relatively easy, although many systems are rather inefficient in both collection and subsequent storage. If animals are herded, considerable labour is needed to collect the manure. If animals graze fallow land, the deposition of manure and urine will still benefit the soil, although there are problems with the spatial allocation of the nutrients. In most herding systems animals are penned at night, which facilitates the collection of manure, although most of the urine will be lost. In some tethering systems, e.g., in Rwanda, the droppings of small ruminants are carefully collected for composting or direct use as manure.

(Powell et al. 1995; Drechsel et al. 1996; Hawassi et al. 1998; Lekasi et al. 1998; Thorne and Cadish 1998; Thorne et al. 1998)

Changing systems

In the past, cropping has been sustained by the transfer of organic soil nutrients from forest and grazing land via the fodder/bedding–animal–manure/compost (FAM) pathway. This pathway not only obliges farmers to keep large numbers of animals, it also requires access to a significant acreage of grazing and/or forest land to maintain the arable land (e.g., Wyatt-Smith 1982; Pandey and Singh 1984). While access to, and quality of, grazing and forest resources have declined, alternative options such as the use of costly inorganic fertilisers have not been available to poorer farmers. Under these circumstances, the most promising option for targeting the needs of the poorest farmers would appear to lie in reducing the nutrient losses associated with inefficient organic matter management practices. Recent studies (e.g., Pilbeam et al. 2000) have indicated that these can be highly significant, with the FAM pathway potentially responsible for more than 70% of all N losses from the system. Thus, in many areas, the role of the livestock component in regulating nutrient flows via the FAM pathway is pivotal for the sustainability of the system as a whole.

Strategic studies conducted in Kenya on the impact of livestock and manure/compost management on nutrient flows suggest that, for highly integrated systems, these factors must be taken into account if efficient nutrient management is to be used to enhance soil fertility. Key findings of this research include observations that small changes in the type and quantity of feed supplements can result in large differences in the extent of net N mineralisation following incorporation of manure (Delve 1998; Lekasi et al. 1998; Thorne and Cadish 1998; Thorne et al. 1998). Further research is needed, however, to examine specifically the scope for managing livestock to create more effective linkages between off-farm nutrient resources and arable land, given the scenario of changing access to and availability of common property nutrient resources.

Income Generation

Apart from their integration in, and aid to the farming system, livestock also have many direct income-generating and capital accumulation functions. This can vary from livestock being the main cash crop, as in smallholder dairy systems, to the occasional chicken or goat sold to cover sporadic or emergency expenses. Livestock are potentially the most dynamic part of the rural economy. They can provide a steady stream of food and revenues, help to raise whole farm productivity and are often the only secure means of asset accumulation and an effective strategy for risk aversion at smallholder level. The range and amount of products sold depend on the different systems; they can vary from meat to manure, eggs to fibre, and milk to work. Although these products are very important, in many systems the contribution of livestock to the maintenance of the system (in all its forms) often constitutes the main (indirect) cash generating influence.

Changes in Use, Type, Species and Management

The changes in demography and markets, and the intensification of land use, has had a major influence on the use, type, species, and management of animals in some areas of the EAH. Some of the main examples are listed below.

From cattle to small ruminants — Significant reductions in landholdings and increased land fragmentation (in countries such as Rwanda and Burundi) are leading to a significant reduction in the number of cattle kept, as households cannot feed the animals anymore. As a result, farmers are changing from large to small ruminants. This trend is actively encouraged by the extension services and government agencies in these countries.

From local to high-grade animals — In countries such as Kenya and Tanzania where market-oriented smallholder dairy production has really taken off, the more traditional systems and animals used for dairy production are being exchanged for stall-fed exotic breeds to take full advantage of the existing market opportunities. In some areas of countries like Ethiopia, Tanzania, and Kenya, the same is happening in dairy goat enterprises.

From grazing to pens — Changes are taking place in feeding and management systems as a result of many factors connected to the recent trends, for example increases in the area under crops, reduction of access to common resources, ease of collecting manure and urine, efficient use of the available feed resources, health considerations, and investment in animal resources.

From mix to specialisation — Increased market and income-generating opportunities, and the need to improve the efficiency of use of the available feed and labour resources, have led to significant changes from, for example, mixed species' holdings to specialised dairy or small-scale fattening enterprises.

From self-grown to bought — Rather than spending scarce resources on raising replacement animals, many farmers opt to buy animals if and when they need them.

A similar trend can be observed in the acquisition of feed, particularly, in zero-grazing systems where herd sizes are largely independent of farm size. High stocking rates can be sustained by buying in fodder and concentrates, and these imported nutrient resources also contribute to sustaining the nutrient extraction rates from the soil that result from the intensive cropping in these systems.

From animals to no animals — Although this scenario is currently based on some anecdotal evidence from the Enset systems in Southern Ethiopia, it is likely that as farm sizes decrease, a situation can be reached in which no animals can be maintained on the farm. The eventual consequences for household survival, considering the importance of the animal component for the maintenance of the system as a whole, can only be hypothesised at present.

(Wilson 1995; Wilson et al. 1995; de Haan et al. 1997; Smith et al. 1997; Steinfeld et al. 1997; Nell 1998)

Key Policy Issues

National and international policies can have a major impact on production systems, market opportunities such as in dairy farming, processing, and affiliated supply services. In general, the new policies in the EAH lean towards increased market orientation, privatisation or dismantling of state-owned interests in production and distribution, and liberalisation of markets and trade, and they have an increased emphasis on issues of poverty alleviation and social needs. Nevertheless, there are still major problems in the availability and accessibility of credit, and even where credit is available the amount is normally only just enough to buy animals but not for the additional inputs required. In addition, in many of the EAH countries, policies have been only partially implemented. This leads to market distortions and disincentives. In particular, when farmers are not paid export parity prices for products, subsidies may be required on inputs to stimulate production. There are also significant constraints still to services focusing on rural areas as a result of the continuing preoccupation with the needs of the urban elite. Extension services are in most cases still massively understaffed, and the staff poorly trained and without the appropriate information and technologies that farmers require. In some countries (Kenya and Tanzania) the provision of veterinary and reproductive services is increasingly being taken over by the private sector. However, many of these privatised services will require additional support until the systems are fully developed.

(Assefa and Agrawal 1990; Kebede 1992; Umali et al. 1992; Swallow 1994; Mudinu 1996; Ade Freeman et al. 1998).

Role of Gender

Although it is widely known that women and children carry the main responsibility for many livestock, still only marginal attention is being paid to their specific needs and requirements in research and development programmes and the provision of services. More attention should also be paid to the effects that increasing population pressure has within and between households on access to natural resources. Particularly since women often control livestock resources, differential access to resources could have serious negative effects on production. Moreover, radical changes to livestock production systems leading to cut-and-carry feeding and the collection of manure are likely to cause significant increases in workloads for women and children in these areas. Even though all poor people experience a lack of services and opportunities for human development, a lack of a voice in decision-making, and social subordination and exclusion, in all or nearly all cases women and girls suffer from them to a greater degree than men.

Although the donor community's concerns have had some effect, gender appreciation in the provision of and access to services like credit and extension, or gender representation in research and development work, often remains tokenism. This is probably best illustrated by an example. The recently published agriculture modernisation plan in Uganda calls for the expenditure of US$120 million on improved and decentralised research and extension services. However, even though most farmers are women, little emphasis is given to gender issues and the number of female extension workers remains minimal.

(Pankhurst 1992; Mekuria 1994; Peacock et al. 1994; FAO 1998; LID 1999)

From Key Constraints to Sustainable Solutions

It is clear from the preceding discussion that there are still major problems in the EAH with respect to infrastructure and marketing, and access to information, services, and inputs. However, the changes in policies towards increased market orientation and reduction of government control and subsidies are resulting in significant improvement in the situation. Although these changes are in many cases slow, it is encouraging to see the improvements in service provision and marketing and these trends should be actively encouraged.

There continue to be large problems in many areas related to the maintenance and sustainability of the natural resource base, but the shift of government institutions away from a solely urban focus holds promise for the future.

Although much research has been carried out in the past decades, a large part was performed in isolation and without paying due attention to the external driving forces that have caused, and are causing, significant changes in the existing farming systems. Any new initiatives, therefore, will have to look beyond the conventional. Although the new possibilities and opportunities that may emerge might sometimes seem far-fetched, one has to realise that the changes driven by population increase and environmental modifications are inevitable. Luckily, many research organisations have shifted their research agenda to a more client and poverty-oriented focus, with due respect being paid to the forces of change. In some cases this has already led to the diffusion of appropriate technologies. A number of practical examples of sustainable technologies that can sustain large numbers of people, and which are already widely used, have been highlighted in this paper.

Notwithstanding the present positive developments, it is still imperative that the efficiency and production of the current systems be dramatically improved to fulfil the needs of the coming years. The potential needs are highlighted by what has been called 'The Livestock Revolution' in a study which predicts that by 2020 each person in the developing world is likely to demand some 29 kg of meat and 63 kg of milk on average per year, up from 21 kg and 41 kg, respectively, in 1993 (Delgado et al. 1999). Achieving this will not only require changes to be made in the training that future researchers and development workers around the world receive, but also that we can develop a clear understanding of the external forces of change to enable us to approach the problems in a dynamic, integrated, and systems-oriented manner. Exciting new opportunities are developing for sustainable livestock production from these changes in macro-economics and consumption patterns, some of which are already being exploited successfully. Dairy farming (both cattle and goats) has been discussed at length in this paper, but there are other opportunities too for smallholder livestock producers like small-scale fattening of small ruminants and cattle to supply the increasing urban meat market. Likewise, even though increases in poultry production have been confined primarily to large-scale commercial enterprises, there is a new market developing for local eggs and poultry, as many people don't like the 'improved' eggs and the soft meat from commercial poultry.

Many problems have been experienced in delivering the results of research to front-line extension staff in a comprehensible and useable form. Without the effective implementation of this link, it is difficult to see how extension services (public, cooperative, and private) can promote improved management and new strategies amongst their client farmers in a way that is flexible enough to meet the individual needs and that accounts for the dynamics of smallholder systems. Paper-based extension literature (in tabular or other formats) is not easily assimilated by extension staff, who are not generally experts in the particular subject matter. Although some new approaches are currently being tested (Thorne 1998), these new methods still rely heavily on frequent contact between extension systems, that are often poorly functioning, and farmers. Deficiencies in this process may mean that these approaches will not always be sufficiently responsive to changing seasons, resource endowments, local markets, and production objectives, compromising the extent to which farmers can base their management decisions on these and other factors. There is, therefore, a need to generate information in a form that reduces the complexity of the interaction between extension services and farmers and that allows the farmer to take a more active part in the evaluation of alternative strategies.

Smallholder farmers in the EAH have clearly demonstrated that, given the right environment and support, they can respond positively to change.

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