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AGRICULTURAL RESEARCH FOR FOOD SECURITY AND SUSTAINABLE LIVELIHOOD

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Chapter 15

OVERCOMING THE CHALLENGES OF SMALL RUMINANT FEEDING IN THE TROPICS: AN OPPORTUNITY TO SUSTAINABLE LIVELIHOODS

L. K. Adjorlolo, T. Adogla-Bessa and E. C. Timpong-Jones

Introduction

Small ruminant production is a key component of animal production in West Africa. Apart from chickens, small ruminants are considered by Ghanaian farmers to be the next most important animals they keep (MoFA, 2004). Currently, sheep and goat populations are estimated to be 4.02 million and 5.44 million respectively (MoFA, 2013) with as much as 55.2% and 34.1% of rural households keeping goats and sheep respectively (GSS, 2000). Meat from sheep and goats are highly acceptable sources of protein across the sub-region. Unlike pork, there are few taboos associated with mutton or goat meat (chevon). In fact, goat meat is considered a delicacy in most parts of Ghana. Another factor responsible for small ruminant production being an important component of the farming systems of West Africa is the low cost of establishment and production compared with cattle or pigs (Wilson and Azeb, 1989). This is largely because sheep and goats are smaller and so, easier to acquire. Usually they do not require elaborate housing and they feed mainly on materials such as grass which humans do not eat. Thus, small ruminants are often preferred by resource-poor farmers, especially those engaged in the low input systems.

In most parts of Ghana, small ruminants are kept by people who grow crops as their primary occupation (Ntifo-Siaw and Ghartey, 1988). Flock sizes are small; usually less than 20 heads per household (Adjorlolo *et al.*, 2007; Timpong-Jones *et al.*, 2011) as is the case in most parts of West Africa (Otchere, 1986). These probably have contributed to the perception that small ruminant keepers do not raise their animals as a business. However, recent reports indicate that most farmers keep small ruminants for income (Adjorlolo *et al.*,

2007; Naandam and Turkson, 2010), as a store of wealth and means of diversifying their livelihoods. It has been reported that about 54% of rural households in Ghana kept livestock for the purposes of ensuring income security and as a store of wealth whereas 40% kept them as a means of raising money for domestic exigencies such as school fees and hospital bills (MOFA/DFID, 2002). The Ghana government recognises the immense role livestock can play in alleviating poverty and enhancing rural livelihoods. Thus, in a livestock development policy document, a target was set to work towards increasing sheep and goat populations by 500% and 1,300%, respectively between 2004 and 2015 with the aim of reducing poverty among food crop farmers from the then level of 59% to 30% by 2015 (MOFA, 2004).

In spite of the important roles small ruminants play in poverty alleviation and enhancement of rural livelihoods, there are major challenges to the production of small ruminants in Ghana including inadequate feeding in particular. In addition to the seasonal feed shortages which are mostly due to the dry seasons, urbanisation is gradually becoming another major challenge. Urbanisation and population growth are creating an increasing demand for food. To respond to this, more land which hitherto was used for grazing animals is being put under crops, thus pushing animal production to marginal lands. This paper looks at how these events affect feed availability to ruminant livestock, coping strategies of farmers and some technologies available for adoption to help mitigate the effects of dwindling grazing lands in most parts of Ghana.

Feeding within the context of farming system

The farming systems of West Africa, with respect to livestock, may be classified as sole livestock and crop–livestock systems. The sole livestock class has two sub-systems, namely, rangeland-based and landless whereas the crop–livestock class has three sub-systems, namely, annual crop–livestock, tree–crop–livestock and irrigated/flooded cropland–livestock (Fernández-Rivera *et al.*, 2004). The sole livestock systems usually have cattle and in peri-urban areas, pigs, as the major species kept. In most parts of rural Ghana, the annual

crop-livestock farming systems are often practiced. Early literature suggested that small ruminants in these systems were often left to fend for themselves by scavenging around villages and feeding on household organic waste. Most common household waste fed in southern Ghana is cassava peels (Adjorlolo *et al.*, 2007 and Timpong-Jones *et al.*, 2011). Plantain and yam peels are also used to feed small ruminants. These animals are usually in small flocks of up to 10 per household (Asafo-Adjei and Dantankwa, 2003). In rural areas, cut forage is often fed as a supplement. Common forages fed include indigenous species such as *Securinega virosa, Zanthoxylum xanthoxyloides, Flacourtia flavescens* (Timpong-Jonese *et al.*, 2012) and exotic species such as *Leucaena leucocephala* and *Gliricidia sepium* (Abdulrazak *et al.*, 1996). This is generally true in southern Ghana where crop farms are usually far from the settlements. However, in areas where compound farming is practiced, as is common in northern Ghana, free roaming of small ruminants is often not allowed. Animals are allowed to graze around the homestead only when the compound farms are not cropped. Otherwise they are tethered to graze or fed cut forage (Karbo and Agyare, 2002). Feeding is not planned and often inadequate. On institutional farms, it is common to find animals fed on established pastures and supplemented when necessary (Figures 15.1 and 15.2).

Figure 15.1: Sheep grazing in a paddock with cultivated pasture at LIPREC

Figure 15.2: Goats in a paddock at LIPREC supplemented with silage in the dry season

Africa ruminants loss significant amount of weight gained in the rainy season. For instance Rose-Innes (1977) gave weight losses of 11% of body weight in cattle during the dry season in Ghana whiles Bourzart (1985) reported 20–30% live weight losses in sheep in Burkina Faso. A study conducted between 1981 and 1982 on Red Sokoto (Mardi) goats in Nigeria showed an average weight loss of 18% between December and May (Alaku and Moruppa, 1983). An estimate by Otchere (1986) gave weight losses of about 15% for sheep in the Accra Plains of Ghana during the dry season. In addition to weight losses, another effect of the dry season on ruminants is decline in reproductive performance as reported by Rutagwenda *et al.* (1985) on work done in Kenya. This effect was largely attributed to lower conception and higher abortion rates during the dry season.

Efforts towards solving the dry season feeding problems in Ghana have focussed on three main approaches, namely, strategies to improve the quality of crop residues which are abundant during the dry season; supplementation to improve the utilisation of available fodder; and conservation of fodder available in the rainy season for dry season feeding. Studies at the Livestock and Poultry research Centre (LIPREC) of the University of Ghana and elsewhere have yielded several useful results as outlined below.

Use of crop residues as feed

Fibrous crop residues are highly lignified materials which are generated in abundance during the early dry season upon harvesting of crops. Feeding of crop residues to ruminants is not new in Ghana. In densely populated areas of Northern Ghana, crop residues such as baled rice straw, cassava peels, cotton seed and pigeon pea residues are sold for animal feeding (Karbo and Agyare, 2002). However, most of them are not optimally used due to lack of treatment to improve their quality. Crop residues such as maize stovers and rice straws can be chopped to improve prehension by small ruminants (Figure 15.3). In addition to chopping, crop residues may be treated with alkalis such as sodium hydroxide, ammonia or urea. Ensiling crop residues with urea has yielded several successes.

This method involves dissolving, urea 5-7.5 kg of 50 litres of water and mixing the solution with 100 kg of chopped rice straw and keeping the materials sealed in silos for more than 14 days (LIPREC method). Ensiling of rice straw with urea increased crude protein level by 124%, digestibility of neutral detergent fibre by 32% and improved voluntary feed intake by 38% (Amaning-Kwarteng *et al.*, 2010). The improvement in the digestibility of fibre is largely due to the hydrolysis of the lignin-cellulose bonds in the straw by urea, thus making available the cellulose component for rumen microbial degradation. These have culminated in increased growth of lambs from 10.7 g/d to 72.9 g/d (Amaning-Kwarteng *et al.*, 2010).

Figure 15.3: Maize stovers being chopped prior to chemical treatment

Other studies have looked at the potential benefits of using fungi to degrade fibrous crop residues and feeding the fungi degraded material to ruminants. This is based on the principle that fungi possess enzyme systems that are capable of hydrolysing lignin. Thus, fungi which are capable of degrading lignin without degrading too much structural carbohydrates will give rise to residues with higher digestibility in ruminants. One group of such fungi is the white rot fungi, some of which preferentially degrade lignin. For instance, *Pleurotus ostreatus* was found to selectively degrade lignin whereas *Phanerochaete chrysosporium* did not show selectivity (Kerem *et al.*, 1992). Fungal treatments leading to lignin loss of up to 47% has been reported (Tripathi *et al.*, 2008). Some of the most studied species are *Phanerochaete chrysosporium, Coprinus fimeterius* and *Pleurotus ostreatus.* For a list of some of the fungal species studied and the substrates used worldwide see Adjorlolo and Yeboah (2011). In Ghana, however, not much has been done in this area. The little work done involved the use of *P. ostreatus* (oyster mushroom) to treat rice straw. One of the major challenges with fungal treatment has been its application on large scale for commercial animal feeding.

Studies on supplementation have generally looked at ways of improving the rumen environment in a way as to enhance the utilisation of the fibrous crop residues by the animal. One aspect of this work involved the use of forage legumes and browses while the other aspect involved the use of formulated multi-nutrient supplements. Although there are several forage legumes that are palatable to small ruminants, more attention has been given to those species that have already been incorporated into the farming systems, mainly as cover crops and green manure crops. The use of these forage crops for animal feeding is therefore more likely to be acceptable to farmers. Several forage legumes have been studied as green manure in Ghana (Barnes, 1996; 1999; Birteeb *et al.*, 2011). These forage crops have helped improve soil fertility and increased crop yields. Some of these legumes such as *Mucuna pruriens, Lablab purpureus* and *Puereria phaseoloides* have been used as feed supplements for small ruminants (Nsahlai and Umunna, 1996; Adjorlolo *et al.*, 2001; 2004). By supplying critical nutrients often lacking in fibrous feeds, they enhance feed utilisation and thereby improve animal performance.

The use of cut browse plants as supplements has also given encouraging results. This approach to feeding small ruminants is a common practice among small ruminant farmers (Oppong- Anane, 2001). Some of the browse species studied in Ghana are shown in Table 15.1.

Multi-nutrient supplements in ruminant feeding have involved using formulated feeds that are intended to supply all the critical nutrients needed by the rumen microbes for efficient degradation of feed. In Ghana and most parts of the tropics, urea-molasses-mineral block (UMMB) supplementation has received a lot of attention. Supplementation with UMMB ensures adequate levels of nitrogen (from urea) and soluble carbohydrates (from the molasses) in the rumen. Considering that nitrogen and soluble carbohydrates are the most limiting nutrients in dry season feeds, their supply in adequate amounts in the rumen helps overcome a major limitation to dry season feeding of small ruminants. Several formulations of UMMB have been tried at LIPREC (Egyir *et al.*, 2010) with promising results in terms of improvements in animal performance. Unfortunately, the collapse of the sugar factories has made molasses, which is the major ingredient, unavailable in Ghana. Studies on UMMB have therefore been truncated.

Table 15.1: Some browse species studied as supplements in small ruminant research in Ghana

Browse species	Common names
Albizzia lebbek	East Indian walnut, Woman's tongue
Baphia nitida	Cam wood, Adwuna (Twi)
Blighia sapida	Akee
Cajanus cajan	Pigeon pea
Delonis regia	Flamboyant tree
Ficus exasperata	Sand paper tree
Ficus polita	-
Gliricidia simplicifolia	Gliricidia
Grewia carpinifolia	Ntabuna (Twi)
Kahya senegalensis	Senegal mahogany
Leucaenal leucocephala	Leucaena, White lead tree
Millettia thonningii	Milletia, Osantew (Twi)
Moringa oleifera	Horse radish tree, Never die tree
Securinega virosa	White berry bush, Chinese waterberry
Spondias mombin	Ashanti plum, Hog plum

Feed conservation

Forages may be conserved by sun-drying into hay or ensiling. Forage growth during the rainy season often exceeds the consumption capacity of the animals in most parts of Ghana. Thus, harvesting excess forages and conserving for dry season feeding may help ensure year-round feed availability. Although forage conservation methods are well known, they are not commonly practiced by small ruminant farmers in Ghana. However, some forms of feed conservation practices occur in some parts of the country. In Northern Ghana, some farmers harvest crop residues such as dried groundnut tops and cowpea vines and store for dry season feeding. In

Figure 15.4: Production of sorghum and maize for silage at LIPREC

Southern Ghana, it not uncommon to see farmers, drying cassava and plantain peels and bagging them for future feeding. On institutional farms, hay production and silage making for feeding ruminants are sometimes practiced.

Production of sorghum and maize for silage making at the Livestock and Poultry Research Centre (LIPREC) of the University of Ghana (Figure 15.4) has proved effective in ensuring good dry season feeding of ruminants.

Emerging challenges to small ruminant feeding

Urbanisation and the pressure on grazing lands

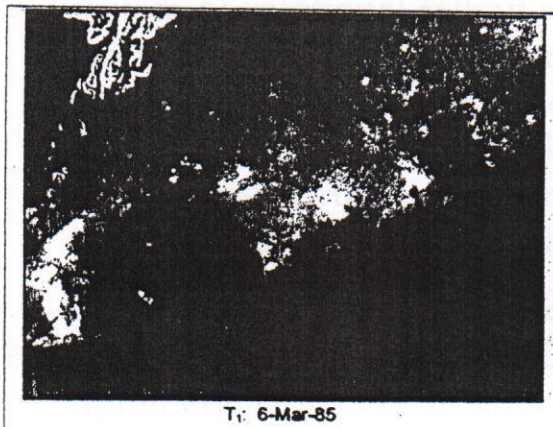
Urbanisation, which is the transition of rural communities into urban settlements, is usually distinct from growth of cities and towns (urban growth). However, for the purpose of this discussion, urbanisation is used to imply both phenomena since both are occurring concurrently, in Africa and have similar impact on animal production.

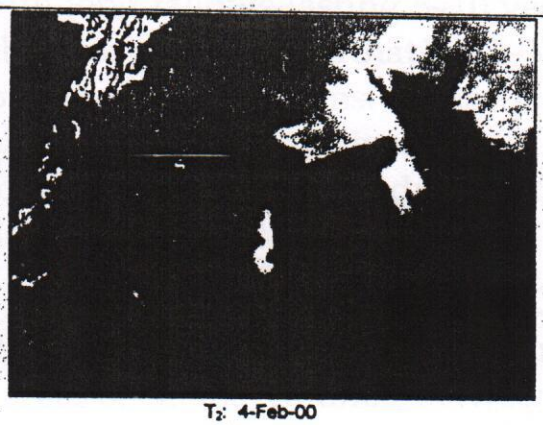
Although urbanisation is a global phenomenon, it seems to be occurring at a faster rate in the developing world (Yadav *et al.*, 2011). Songsore (2010) using data from the Housing and Population Census by the Ghana Statistical Service showed that the number of urban settlements in Ghana grew from 41 in 1948 to 364 in 2000. During the same period, urban population increased by 1,350% from the 1948 figure of 570,597 to 8,278,636 by year 2000. The urban population in Ghana has grown further by 51.5% since 2000 to 12,545,229 in 2010, consituting about 50.9% of the total population (GSS, 2012). This is a result of both population increases and rural-urban migration. If the current trend continues, it is expected that by 2030, about 58% of Ghanaians will be living in urban areas (Farvacque-Vitkovic *et al.*, 2008). The impact of this on animal production is in two fold. Firstly, more land, hitherto used for farming, will be taken for construction of houses, roads and other infrastructural projects to serve the needs of the increasing urban population. According to Oteng-Ababio and Agyeman (2012) cities in Ghana have spread out faster than they have grown in population. This is causing

movement of the boundaries of cities into rural space (Farvacque-Vitkovic *et al.*, 2008) and is affecting farming, especially in peri-urban areas. Angel *et al.* (2005) showed that the built-up area in Accra Metropolis has increased from 133 square kilometres in 1985 to 344 square kilometres in 2000 (Figure 15.5). Expansion of Ghana's cities is occurring not only in Accra, the capital, but also in other cities such as Kumasi, Takoradi and Tamale (Farvacque-Vitkovic *et al.*, 2008).

Increasing crop acreages and the pressure on grazing lands

Another major impact of rapid urbanisation and general population growth is that more agricultural lands are being put under crops to produce food to feed the urban dwellers at the expense of livestock production. Table 15.2 shows a sharp rise in staple crop production especially from 1990 to 2010. This will necessarily require that more land be put under crops. Available data from the Ministry of Food and Agriculture (MOFA) indicate that between 2005 and 2010, acreages under maize, rice and yam increased by 15.6%, 19.9% and 15.2% respectively (MOFA, 2013).





0 5 10 15 20 km

1:350,000

Water

Excessive slope

Built-up area

N

Measure	T_1	T_2	Annual % Change
Population	1,882,990	2,789,380	2.67%
Built-Up Area (sq km)	133.35	344.26	6.56%
Average Density (persons / sq km)	14,120.39	8,102.64	-3.66%
Built-Up Area per Person (sq m)	70.82	123.42	3.79%
Average Slope of Built-Up Area (%)	3.11	3.11	0.01%
Maximum Slope of Built-Up Area (%)	12.28	12.28	0.00%
The Buildable Perimeter (%)	0.71	0.73	0.15%
The Contiguity Index	0.69	0.80	1.01%
The Compactness Index	0.68	0.61	-0.75%
Per Capita Gross Domestic Product	$1,325.50	$1,836.23	2.21%

Figure 15.5: Comparison of the expansion of Accra between 1985 to 2000
Source: Angel et al.(2005)

Table 15.2: Production of some staple in Ghana (MT) from 1980 to 2010

	1980	1990	2010
Cassava	1,857,600	2,717,000	13,504,100
Yams	650,000	877,000	5,960,490
Plantains	734,000	799,000	3,537,730
Maize	382,000	552,600	1,871,700
Total	3,623,600	4,945,600	24,874,020

Source: FAO, 2012

Data showing a direct relationship between increasing crop acreages and decreasing land available for ruminant production may be lacking. However, considering that agricultural land is limited, rapid increases in land used for crop production, coupled with expansion of urban areas unto agricultural lands will have a direct impact on other agricultural activities such as ruminant production. In northern Ghana, Karbo and Agyare (2002) have reported that as a result of increased population pressure, the prevalent farming system of rotational fallow with long fallows lasting 5–10 years or more has given way to shorter bush or grass fallows that last 2–3 years and in some cases, continuous cropping systems. Consequently, fallow lands that are usually used for grazing livestock in most parts of the northern zone are being lost to crop production due to the increasing need to feed the growing population.

Considering that only 57.6% of the total cultivable land in Ghana was cultivated as at 2010 (MOFA, 2013), a crisis situation may not be imminent. However, in some areas of Ghana, conflicts between crop farmers and livestock keepers attest to a growing land use contest. Areas that were previously not cropped and used for grazing of livestock are now being used for crop production. The recent conflicts between *Fulani* herdsmen and sedentary crop farmers may well be a direct effect of expansion of cropping into grazing reserves.

Extension of cropping activities into areas once reserved for livestock production has often brought several conflicts. It is often assumed that once an area is put under crops, livestock keepers will stay away from such areas and send their animals elsewhere. In several cases, this does not happen. Animals are continually grazed

in the same areas that were once considered communal rangelands in spite of cropping activities there. Thus conflicts have resulted from animals foraging on economic crops leading to losses to the crop farmers. Retaliatory actions by the crop farmers have often led to unpleasant situations. Most of the widely reported conflict cases involve cattle herdsmen. However, almost on a daily basis, conflicts with small ruminant farmers occur. Unlike the Fulani herdsmen who are perceived as foreigners and so can be evicted from the communities, the small ruminant farmers are usually indigenes of the various communities. Conflicts involving small ruminant keepers have therefore been handled in a somewhat better manner.

Adaptation to the pressure on grazing lands

Confinement of small ruminants and the implications for feeding

Efforts to adapt to the current challenges of land use and to prevent communal conflicts have led to several areas in Ghana passing by-laws to restrict free roaming of livestock. Some small ruminant keepers, especially those in urban and peri-urban areas, have responded to this by confining their animals. In some rural areas several farmers either confine their animals during a part of the day when the animals cannot be herded, or during parts of the year when there are cropping activities (Adjorlolo *et al.*, 2007). However, all-year cropping in areas where irrigation facilities are available is leading to all-year confinement of small ruminants. Feeding and management of small ruminants in confinement is therefore an emerging challenge in several areas of the country. Confined small ruminants are often malnourished and have the tendency of being inbred.

In southern Ghana, feed resources abound throughout the year. Several crop residues such as cereal straws and cassava tops are abundant. Agro-industrial by-products such as cassava peels from *gari* processing factories, wheat bran, pito mash, maize bran, and brewers spent malt are also generally available. Currently, the use of fruit wastes from fruit processing factories is also being studied at LIPREC. However, for animals in confinement, the challenge is

how to utilise these resources in ways that will meet the animals' nutritional requirements in a cost effective manner. More research attention therefore needs to be given to the nutrition of small ruminant in confinement.

Conclusion

Small ruminant production is an important component of the farming systems of Ghana and the entire West African Region. In a region where crop production is often the primary occupation, small ruminant production is mainly a means of ensuring income security and diversifying livelihoods. However, adequate feeding of small ruminants has been a challenge. Seasonal inadequate grazing opportunity has been a major constraint to the growth of the industry. Gradual loss of grazing lands to urbanisation and crop production also constitute an emerging threat to the industry. The multi-pronged approaches to solving the challenges of small ruminant feeding have yielded several useful results. However, research efforts need to continue and new research agenda developed to address the emerging challenges.

Recommendations

Some key research thrusts that need to be developed to address the emerging small ruminant feeding constraints include the following;

1. Development of crop-livestock integration strategies to optimise land use and minimise waste.
2. Development of feeding packages for confined animals especially in urban and peri-urban areas.
3. Improvement in productivity of stock to justify extra expenditure on feeding.
4. Identification of more feed resources from crop production, processing and marketing activities.
5. Development of strategies to optimise the use of non-conventional feed resources.

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