

Assessment of existing and potential feed resources to improve livestock productivity in the dryland areas of Burkina Faso



ILRI PROJECT REPORT



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International Livestock Research Institute (ILRI)

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Summary

Evaluation of existing and potential feed resources was conducted in Orodora district in the Southern region of Burkina Faso using Feed Assessment Tool (FEAST). The assessment was carried out through focus group discussions and individual interviews. Two villages, Mahon and Sayaga, which are about 25 and 40 km from Orodara town, respectively were selected for the study. The study sites were characterized by mixed crop-livestock production systems. Seventy-percent of cropping activities were focused on fruit tree cultivation while food crop production accounted for the rest. Livestock species (predominantly local breeds) in the area included cattle (dairy and draught), sheep, goat, pig, poultry and donkey which are kept for different purposes. The main source of household income is crop production while livestock production contributed 35% and 45% to the household income in Mahon and Sayaga, respectively. Constraints to livestock production in these areas included shortage of water in the dry season for animals, insufficient quantity and quality of feed in the late dry season of the year and high cost of veterinary drugs and services. Other constraints were low technical knowledge of fodder production and conservation, and lack of credit facilities. To mitigate these constraints farmers suggested an integrated approach to improve livestock production through (i) Construction of small reservoir to provide water for human and animal consumption, (ii) training on the integration of forage legume into both tree and arable cropping, and efficient utilization of available feed resources and (iii) establishment of a veterinary service and drug centre in the village.

Introduction

Livestock sector is the second most important source of income in Burkina Faso and its contribution to the country's GDP is currently estimated at 15% (Nianogo and Thomas, 2004). Nineteen percent of Burkina Faso's export products are from livestock production (MRA, 2004). The population of ruminant livestock species of Burkina Faso is estimated to be 8.7, 11.4 and 7.3 million heads of cattle, goats and sheep, respectively (FAOSTAT, 2008) and the annual growth rate was reported to be 4.7%, 3.3% and 2.3% for goats, sheep and cattle, respectively (MRA, 2004). Most of these animals are found in the arid and semi-arid part of the country. However, the livestock numbers are growing faster in the sub-humid zone (Lead, 2005), as a result of the recent pattern of transhumance in West Africa in which pastoralists and their livestock transited from the more arid Sahelian region in the north to the more humid Sudano-Guinean regions in the south (Ayantunde, *et al.*, 2014). The extensive production system using low inputs is common in the country (MRA, 2004), while the "mixed system" in which crop and livestock production are jointly practiced is the most dominant in the sub-humid zone (Seré and Steinfeld, 1996).

Nutrition of cattle, sheep and goats in the agro-pastoral systems of the Sahelian and Sudanian-Savanna zones of West Africa is essentially based on the exploitation of naturally occurring herbaceous and ligneous plant species, and crop residues. Qualitative and quantitative forage shortage, particularly in the dry season, is the major constraint in these farming systems (Breman and de Ridder, 1991). During periods of feed shortage (the dry season), livestock owners often use agricultural by-products such as cereal (maize, millet, sorghum, wheat) bran, cotton seed cake in the cotton producing zone, cowpea hay and groundnut haulm to supplement animal feed. Herders and others pastoral groups sometimes cut down branches from various tree species such as *Acacia* spp., *Balanites aegyptiaca*, *Pterocarpus lucens*, *Boscia angustifolia* to feed their animals during the dry season (Gautier, *et al.*, 2005).

Pastures in Burkina Faso are subject to seasonal variability. Generally, there is good availability of forages in terms of quantity as well as quality in the rainy season which lasts for about 6 months (May–October) in the sub-humid zone. This is followed by another 6 months of dry season (November - April) when there is a rapid decline in forage resources in both quantity and quality. This has been considered as the major limitation to meeting the nutrient requirements of grazing livestock for most of the year (Kavana *et al.*, 2007). With this constraint, animals that rely on natural pastures as basal diet cannot perform at high level without feed supplementation with concentrate which may be expensive for low income farmers (Mohammed-Saleem, 1990).

In order to identify the best-bet solution to feed constraint in this area, more information on existing and potential feed resources is needed to enhance feed production and supply, and consequently improve livestock productivity. The objective of this study was to evaluate existing and potential feed resources in the study sites to guide feed-related interventions to improve livestock productivity in the dryland areas of Burkina Faso.

Map of Burkina Faso showing the study site



Materials and methods

Description of study site

The study sites are located in Orodara district in the southern part of Burkina Faso within latitude 11.3167° N and longitude 4.5667° W. Orodara district is in the South Sudan agro ecological zone of Burkina Faso with one rainy season per year and annual total rainfall ranging from about 900 to 1200 mm. Using the soil classification system of the Food and Agriculture Organization of the United Nations (FAO 2001), this area is a mixture of Ferrasols/Oxisols, Luvisols/Alfisols, Ferralitic Arenosols, and Arenic Gleysols/Cambisols. Organic carbon (C) content is 0.34–1.44% and total nitrogen (N) content is 0.02–0.12%. Available phosphorus (P) (Bray I) is 2.0–7.4 mg/kg soil, except for bottom valley soils where these values tend to be higher (FAO 2001). The main textural classes are loamy sand, sandy loam, loam, sandy clay loam, clay, and silty clay loam. These characteristics impose some limitations on crop production including restriction of plant rooting systems, high runoff, and low retention of water and nutrients (FAO, 2001). Mixed crop-livestock system is the dominant agricultural production system in the study site. The dominant crops grown in the study site include cotton, yams and cereals (sorghum, millet and maize). In addition, fruit trees such as mango, citrus and cashew are widely cultivated in the study area. Livestock are owned and managed under traditional production systems which are characterized by low productivity in terms of milk and meat. Mahon and Sayaga communities which are about 25 and 40 km from Orodara town respectively were selected for the study.

Methodologies

Evaluation of existing and potential feed resources was conducted using Feed Assessment Tool (FEAST) developed by ILRI (Duncan *et al.*, 2012). FEAST is a systematic method to assess local feed resource availability and use. It helps in the design of intervention strategies aiming to optimize feed utilization and animal production. It comprises Participatory Rural Appraisal (PRA) using semi-structured questionnaire in a focus group discussion and individual interviews to collect both qualitative and quantity data.

Implementation of the survey

Twenty six farmers which comprised 18 men and 8 women in Mahon and 20 farmers (15 men and 5 women) in Sayaga were selected as representatives of the community to participate in group discussions using the participatory rural appraisal (PRA) approach to provide an overview of the farming systems and to identify constraints and opportunities for improving livestock production in the 2 study communities. For the individual interview, twelve farmers were then selected representing 3 wealth categories within the community namely average, above average and below average in terms of land area owned and number of livestock possessed by the household. Four farmers from each wealth category were individually interviewed to collect quantitative and qualitative data on feed resources in the community. Samples of available feed resources offered to animal were collected and analyzed for nitrogen and ash content, fibre components (NDF, ADF and ADL) and *in vitro* organic matter digestibility.

Data analysis

The quantitative data collected from individual key informant farmers were entered into the FEAST excel template (www.ilri.org/feast) and analyzed. Results are presented in tables and figures in the report.

Results and discussion

Overview of the farming system

From the results of the survey, farming systems in both Mahon and Sayaga can be described as mixed crop-livestock production with fruit trees dominating the cropping systems. The major crops grown in both areas were maize, millet, sorghum, groundnut and cowpea which were mainly grown during the raining season. Other crops such as cabbage, carrots and other vegetables are planted in the dry season both for consumption and income.

Farmers in both Mahon and Sayaga described two distinct cropping seasons based on the rainfall patterns and the time of crop harvest. The long rainfall season locally called ‘Gnigboke’ extends from May to October, while the dry season ‘Gnigbeke’ is from November to April (Table 1)

Table 1. Names of the cropping seasons that occur in Mahon and Sayaga

Name of season	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Long Rain (<i>Gnigboke</i>)					█							
Dry season (<i>Gnigbeke</i>)	█											█

Crop production in Mahon and Sayaga was dominated by fruit tree crop. Farmers confirmed that 70% of their cropping activities were focused on fruit tree cultivation while food crop production accounted for the rest. The fruit tree crops were mango (which is 60% of the production), orange and cashew. Both fruit trees and arable crop production were rain-fed. According to Badini *et al.*, (1997), 75% of the crop production in Burkina Faso which is the main source of food and income for the majority of people is rainfed. Maize was the dominant arable crop in both Mahon and Sayaga followed by sorghum (Figure 1 and 2). However, rice was considered as one of the dominant arable crops in Mahon due to the presence of lowland areas which could support rice cultivation.

Figure 1. Average area (ha) per household of dominant arable crops in Mahon.

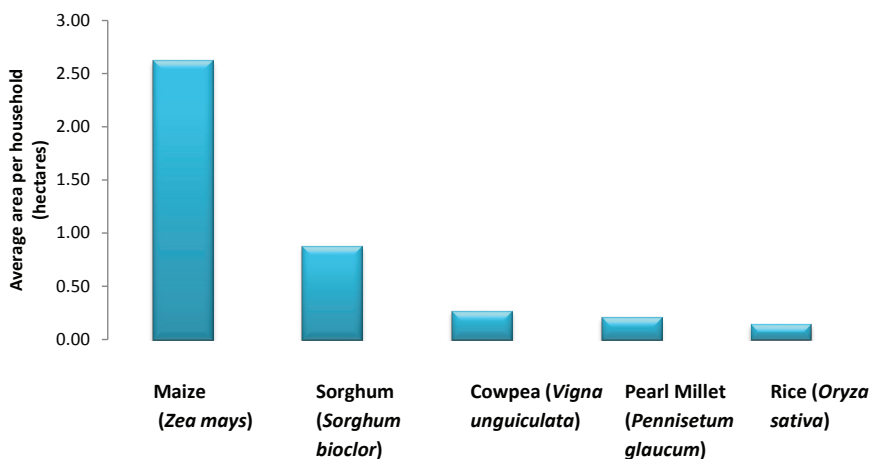
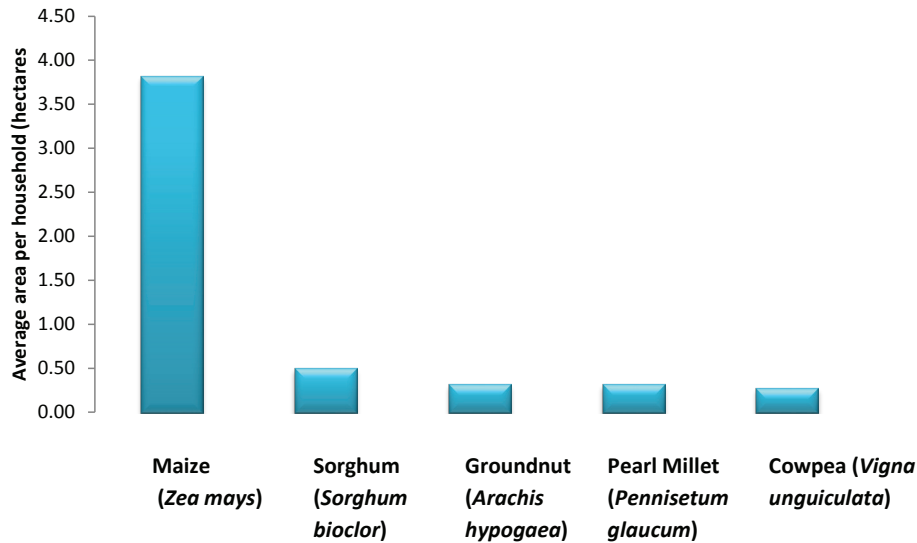


Figure 2. Average area (ha) per household of dominant arable crops in Sayaga.



Both household and hired labours for agricultural activities are available all year round in Mahon and Sayaga. Household members serve as labour force for certain farm activity such as fertilizer application. However, since most household members have their own farms to cultivate and may not always be available and adequate to undertake farm activities such as weeding and harvest, hired labours are therefore required at such times. In Mahon, there is an organized labour group where farmers can go and hire for the cropping activities. The cost of hiring group labour ranged from 10,000 to 25,000 CFA per day (21 to 53 USD as at the time of the study) which sometimes consisted of 15 to 20 men per group. A male farm labourer is hired for an average of 1500 CFA per day (3 USD) while female labourer could be less than 1000 CFA per day (2 USD) depending on the nature of work. Women are mostly needed during harvest and post-harvest operations. However in Sayaga, labour cost does not depend on the nature of farm activities.

Availability of irrigation facility is a great constraint to crop production in the study sites due to the absence of perennial rivers. The only dam available is about 4 km to Mahon making it difficult to practice irrigation and this limits the productive ability of farmers in the dry season and animals often trekked long distance in search of water. Farming at this time of the year (dry season) in Mahon is also limited to vegetables, carrots, cabbage and tomatoes which are planted on small areas in lowland where the soil water is still available in sufficient amount to grow such crops. However, farmers reported that due to erratic rainfall pattern, there is reduction in the level of the water tables in the lowlands in the last 2 years as a result of low rainfall. There are no low land areas in Sayaga, therefore cropping activities were limited to the raining season.

Access to credit was described by the farmers as another constraint to agricultural production in the study areas. Although there is a local credit bank for farmers owned by the government (Caisse populaire), access to credit is quite difficult. Kuwornu (2012) reported similar situation from a study conducted in Ghana. The main bottle neck as noted by the farmers in the study areas is the long process of applying and receiving the credit. Farmers reported that it could take about 8 months before it is released. Sometimes, the loan is released after farming activities had ended for the cropping season. Apart from the problem of timing, farmers don't have the required collateral needed as guarantee to access credit. Another issue with access to credit according to the farmers interviewed was that available credit is mostly given for crop production for the purchase of farm inputs like fertilizer and improved seeds, and to pay hired labour which implies that it is difficult to access credit for livestock production. According to the respondents, there is no credit facility available for the farmers in Sayaga for both crop and animal production, although famers in the area were willing to organize their own cooperative if they could be trained on how to establish and run it.

Inputs such as fertilizers, improved seeds and tractor services are not readily available according to the respondents. Farmers also reported that some input such as fertilizer and seed are sometimes of low quality. At present, farmers in Mahon set up a community seed store where each farmer contributes his own grain seed which they later share during planting. Farmers in Sayaga reported that most agricultural inputs are not available in local markets, fertilizer prices were reported to be too high while other inputs are in short supply compared to Mahon. This could be attributed to the far distance of Sayaga to the major town in the region.

According to the farmers interviewed, an average of 8 % of the people in every household migrated from Mahon to the cities and towns in search of better paid jobs. These groups of people are mostly youth and middle aged population. Few of them return to the village during the festive periods or at the end of each year. Migration out of Sayaga is quite high as about 25 % of people from each household had moved out to cities and towns in search of better livelihood opportunities. Higher migration in Sayaga could be attributed to its remoteness. Deshingka (2010) reported higher incidence of migration among chronically poor people living in remote villages.

Household characteristics, land holding and land use pattern

Mahon is made up of approximately 180 households with an average of 20 to 25 people in each household. The average land holding in the study sites was between 5 to 10 hectares for different wealth categories (Figure 3). The results indicated that the majority of the farming households are smallholders with land sizes less than 5 hectares. Few households classified as medium and large farmers had few household size. The farmers remarked that in the past, farm lands were jointly owned and cultivated by every member of the family; but recently, the lands were divided within the family to every member. As a result of land fragmentation, arable land is in short supply as the family size continues to increase and there is no more fallow practice in the communities. This fragmentation of limited farmland leads to shorter fallow periods and in some cases continuous cultivation (Bezuayehu *et al* 2002). Continuous cropping significantly of the same land affects soil physical and chemical properties by increasing soil bulk density and reducing both macroporosity and macro-aggregates, resulting in less water and nutrient availability (Qin *et al.*, 2007). Consequently, crop yields become unstable and tend to decline, especially in low rainfall years (Sainju *et al.*, 2009). The 2% landless farmers in Mahon were the Fulani (pastoralist) migrants whose major livelihood strategy is animal production and do not have right to own land in the community.

Sayaga consist of about 110 household with the average family size of 16 people per household. The farm land varied among the households but average farm size was about 5 hectares. Majority of the households fell into the category of smallholder farmers with 1 to 5 ha of land (Figure 4), followed by the medium land holding and large land holding farmers. Namubiru-Mwaura and Place (2013) reported average size of 3 ha and above as land owned by smallholder farmers in West Africa countries namely Burkina Faso, Mali, and Niger. There was no landless farmer in Sayaga (Figure 4).

Figure 3. Average land area per household in Mahon.

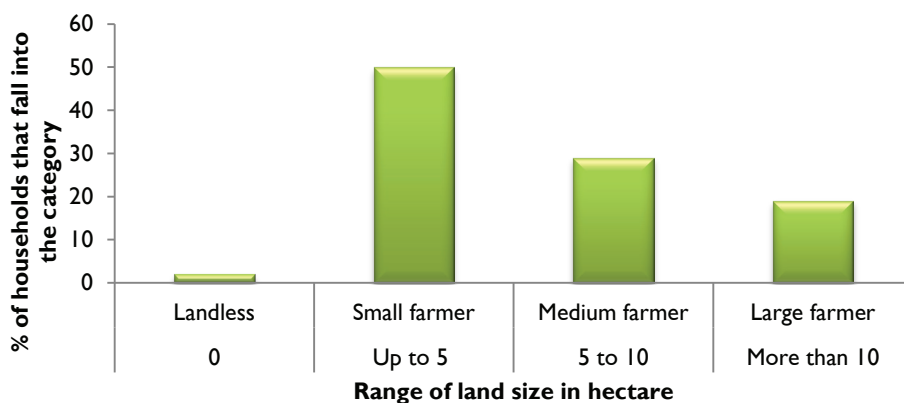
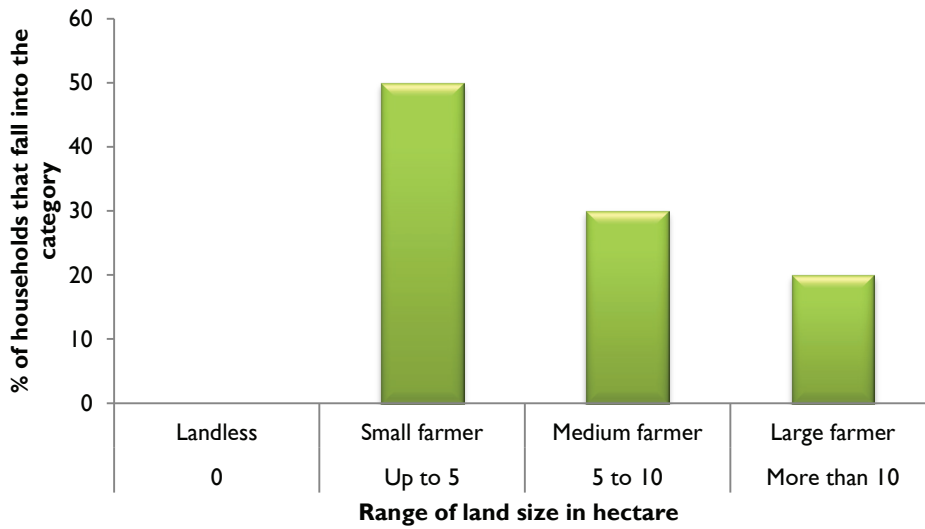


Figure 4. Average land area per household in Sayaga.

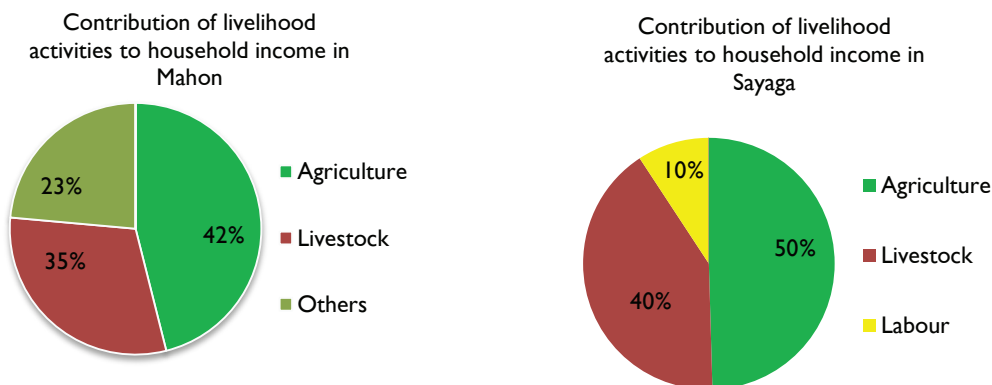


Major sources of household income

As presented in Figure 5, the main contributors to household income were crop farming, livestock production and other occasional businesses. Basically, income generated from crop production including fruit trees and arable crops were the main contribution to household income in the study sites. Livestock production also contributed 35% and 45% to the household income in Mahon and Sayaga, respectively. This comes from sales of milk and live animals in general. This confirmed the report of Mabe *et al.*, (2010) that livestock contributes a large proportion of the income of smallholder farmers in sub-Saharan Africa.

The farmers' responses showed that non-farm businesses were also important sources of income in Mahon and Sayaga. The direct agricultural income of the poor is not enough to sustain their livelihoods, either because of landlessness or because the land they own or lease is insufficient. Furthermore, wage employment in agriculture is highly seasonal, therefore the poor farmer value non-farm sources as means of earning additional income (IFAD, 2002). Household income derived from other sources such as off-farm businesses was higher in Mahon than in Sayaga. The distance and poor access road to nearby town may be responsible for this.

Figure 5. Contribution of livelihood activities to household income in Mahon and Sayaga.



Livestock assets, roles and management

Livestock form an integral part of agriculture and almost every farming household keep ruminants and/or indigenous chicken and different livestock species were kept for various purposes. Livestock species in the area included cattle (dairy and draught), sheep, goat, pig, poultry and donkey. There were no improved breed of cattle or other animals in both Sayaga and Mahon.

The results of our study indicated that cattle are the dominant livestock species in the areas (Figure 6 and 7). Farmers reported that approximately 70% and 65% of the households keep local dairy cows and draught cattle with an average number of six and four per household, respectively. Generally, cattle are kept for the purpose of draft power, manure, milk and cash income. According to farmers, draft cattle are the most important animals because of their use for cultivating cropland cultivation, crop threshing and straw transportation. Peeling and Holden (2004) had stated that cattle in the communal areas have multiple uses that include acting as a source of draught power, transport, milk, manure and savings among others

About 90% of the households owned sheep with the average number of eleven per household. They are mostly used as source of cash and meat. From the survey, every household in Mahon reared at least 10 local chickens. These chickens are sold as need arises, and are also slaughtered for consumption during festivals or ceremonies but occasionally for food.

Although the number of donkey per household is very few, about 80% of the households in Mahon have at least one donkey. The primary purpose is for transportation of goods, crop harvests, people and fetching of water.

Figure 6. Average livestock holdings per household dominant species (TLU) in Mahon.

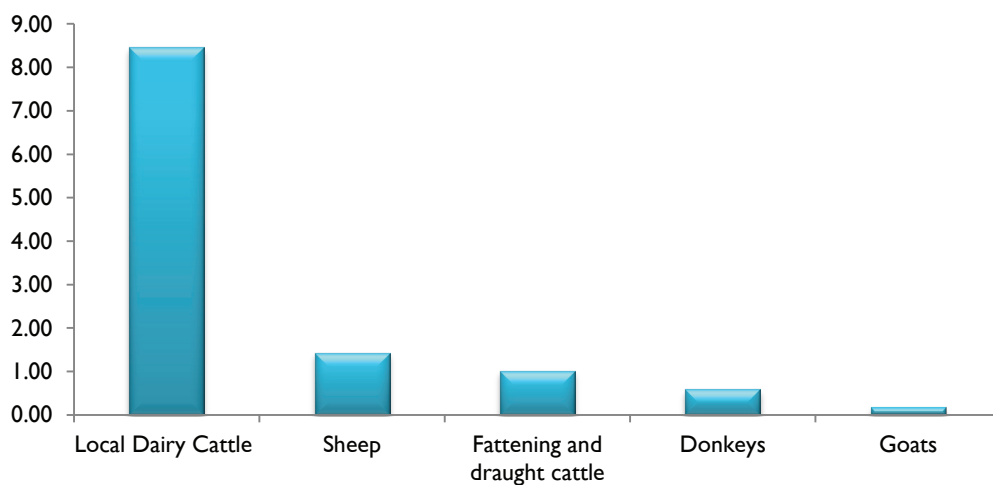
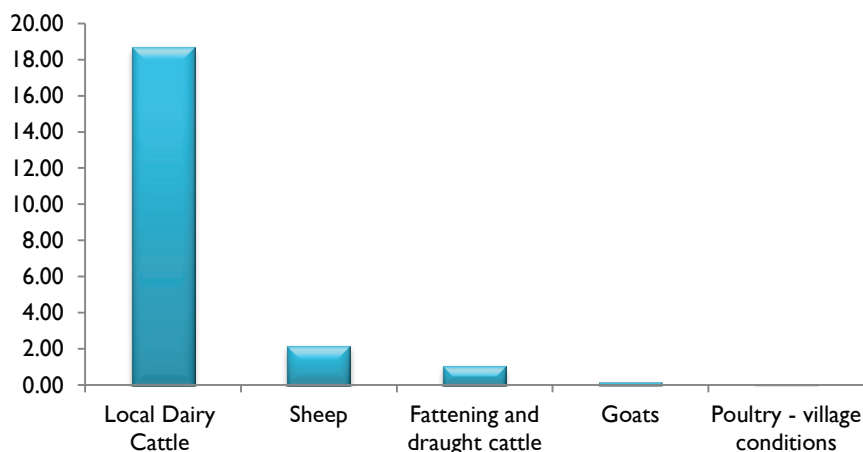


Figure 7. Average livestock holdings per household dominant species (TLU) in Sayaga.



In both study sites, different housing and feeding management practices were used for different livestock species and different classes of animals. Cattle and donkeys were housed in the shed made of wooden poles and thatched roof. Due to their vulnerability to diseases, sheep and goats are provided better housing near the homestead during the raining season to protect them from diseases. During the rainy season, lactating cows are also housed in the shed and they are often released for grazing. No housing system is practiced for pigs and poultry.

The primary feeding practice in the study areas was open grazing. Herding was done when the number of animals is about ten and above. When the number of animal is few, in particular one or two, they are usually tethered. Generally, farmers tethered their animals and feed them with crop residues. Occasionally, concentrate is offered during the dry season when there are limited feed resources.

During the raining season, which is also the cropping time, open grazing is almost restricted to keep the animal from damaging crops. However, animals are allowed to graze near the homestead.

According to the farmers, residues from cereals (maize, sorghum and millet) are chopped before feeding and sometimes salt is sprinkled to add taste to some dry residues. One particular farmer in Mahon had practiced urea treatment and noticed a remarkable improvement in his animal performance over time. However, he discontinued for the fear of urea toxicity as a result of inappropriate dosage and financial constraint. Urea treatment of crop residues was not practiced in Sayaga due to cost. The farmers were aware of the potentials of such treatment to increase feed intake and animal performance, yet the costs of procuring it discouraged its use. Results from another study in Zimbabwe revealed that labour availability, training, access to urea fertilizer and markets, and extension services are the main factors affecting adoption of urea treatment of maize stover technology (Mudzengi *et al.*, 2014). Fodder production was not common in the study areas. Poor access to seeds, the problem of land rights and scarcity of land had been identified as major obstacles to adoption of fodder production in Burkina Faso (Kagone, 2006). However, one of the respondents in Mahon reported planting about 0.06 hectares of *Mucuna pruriens* over a period of 2 years and occasionally planted fodder maize but could no longer continue because of shortage of land and inability to harvest and conserve the seed of *Mucuna*.

Veterinary services were available to the farmers in both villages but not easily accessible. The veterinary clinic is located at about 8km from Mahon and 15km from Sayaga. The distance and the cost of transportation which is about 1500 FCFA make the service difficult to access. Farmers reported that about 2000 FCFA is spent to bring the veterinarian to Mahon for general treatments. In Sayaga, veterinary officers seldom visit the village but the farmers often invited them when it becomes inevitable which costs about 5000 FCFA due to long distance. Farmers described different symptoms of diseased condition in cattle such as fever, weakness and loss of appetite. Others are lameness and mange which cost 400 FCFA per cow to treat. The farmers also reported a disease condition in their cattle, whereby the animals are eating stones, sticks or plastic bags. Based on the symptoms described by farmer, this condition may probably be allotrophagia, although no clinical diagnosis was carried out. Allotrophagia had been reported as a diet-related disease of depraved or perverted appetite, whereby the animals start eating objects that they normally do not eat (Anderson, 1994; Akgul *et al.*, 2000). This condition is probably due to mineral deficiency in the available feeds resources, natural pasture and crop residues, in the study sites.

Artificial Insemination (AI) services were not available in the study sites. The practice is not common in the area according to the respondents. Uncontrolled mating with existing local bulls is the common practice in both study communities. In Sayaga, 20% of the farmers recalled being aware of AI but have never seen it practiced. However, they are willing to adopt AI if they can be trained and have access to it.

Major livestock feed resources and seasonal availability

The major feed resources were natural pasture and crop residues (Figure 8 and 9). Naturally occurring green fodder materials such as weeds from cropping areas, roadsides and naturally occurring grasses also served as sources of feeds particularly at the onset of rains. However, its availability was generally low in November to April to June which is the period of dry season. Crop residues become available in October after the crop harvest while availability of green forage declines. This may contribute to the increase in the quantity of commercially formulated ration purchased by the farmers as the dry season prolongs.

Since the majority of the cultivated land area is allocated to cereal crops production, crop residues become the major feed resources during the dry season. In Sayaga, cereal crop residues (maize and sorghum stovers) and legumes (groundnut and cowpea haulms) formed parts of available feed resources (Figure 9). The collected residues are stacked in piles near homesteads and animals were given small quantities in the morning and evening. The result showed that the quantity of collected crop residues used as livestock feed was higher in Sayaga than in Mahon. According to farmers, greater percentages of the crop residues were left on the field. These are also grazed along with naturally occurring forages which made grazing a major feeding method in both study sites.

The result also showed that farmers in Mahon use commercially formulated ration as feed resource throughout the year while in Sayaga, farmers fed commercially formulated ration during the dry season till the onset of rains (Figure 8 and 9).

Figure 8. Available feed resources in Mahon.

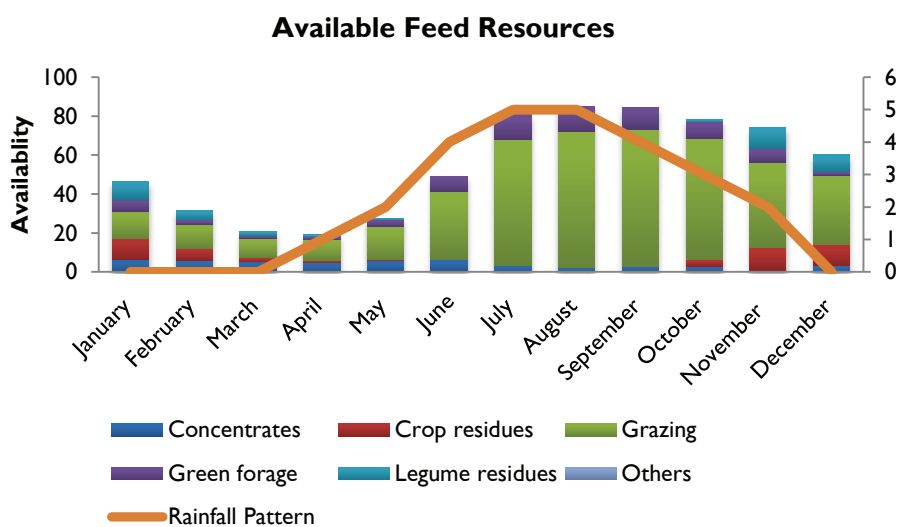
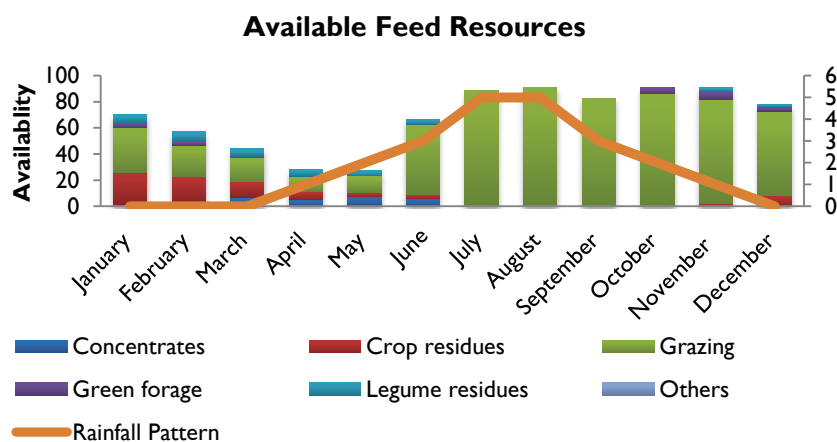


Figure 9. Available feed resources in Sayaga.



The type, quantity and prices of purchased feed resources at the time of the study as described by the farmers were presented in Table 2. All the farmers interviewed in Mahon purchased supplementary feeds in the last 12 months. The available purchased feeds as reported by the farmers were maize bran, cotton seed cake, cowpea hay, *Parkia biglobosa* (pulp) leaves and commercially mixed ration (Table 2). *Parkia biglobosa* is one of the dominant tree crops in study sites. The seed is used in making a local condiment. Ninety percent of the respondents purchased significant amounts of *Parkia biglobosa* pulp which was one of the wastes from its processing for making the local condiment. The pulp was mixed with chopped straw and fed to animals. This feed resource was the cheapest as at the time of the study and this may influence its choice and the quantity purchased. From the results, a total of 500 kg of *Parkia biglobosa* pulp was recorded as purchased by four of the respondents in Mahon at different intervals between May 2013 and April 2014. Maize bran, *Parkia biglobosa* (pulp) were commonly purchased in both sites, however, the quantity of each purchased feed was higher in Sayaga than in Mahon. Farmers in Sayaga depend on livestock production more than in Mahon as shown in the income generation from livestock. This may influence their decision for more purchased feed especially during feed shortage. There were slight variations in the prices of commercially mixed ration and *Parkia biglobosa* pulp in both study sites.

Out of all the respondents in Mahon, 10% purchased cotton seed cake once in the last 12 months and no farmer in Sayaga purchased cotton seed cake which costs 500 FCFA per kilogram as at the time of the study. The quantity and frequency of purchased feed in both sites may be due to poor accessibility and the management practices in both Mahon and Sayaga. This suggests the need to improve the utilization of the available feed resources and to identify other potential feed resources and strengthening their use.

Table 2. Quantity, prices and frequency of purchased feed in Mahon and Sayaga over the past 12 months

Purchased feed	Number of farmers	Prices* (FCFA/kg)	Quantity purchased (kg)	Mahon		Sayaga	
				Number of farmers	Prices* (FCFA/kg)	Quantity purchased (kg)	Number of farmers
Commercially mixed ration	6	220.00	375	4	200.00	1250	
Cotton (<i>Gossypium</i> sp.) - seed cake	1	500.00	25	-	-	-	
Cowpea – hay	1	100.00	25	-	-	-	
Maize - bran	4	120.00	225	3	120.00	750	
<i>Parkia biglobosa</i> (pulp)	4	50.00	500	6	50.00	2625	
Total (kg)			990			4625	

*Prices as at the time of the survey.

Table 3. Potential feed resource, feed processing methods and farmers' constraints in utilization

Potential Feed resources	Reason for not using the resource	How to strengthening the use of the feed resources
<i>Mucuna pruriens</i>	Knowledge gap is the major problem. Some of the farmers observed that when it was introduced to the village some years back, its potential to add to feed quality and quantity was great. But they lacked the agronomic knowledge since it is an annual forage legume that should be planted yearly from the harvested seed.	Seed supply and knowledge of its annual propagation
<i>Leuceana leucocephala</i>	Farmers reported that lack of knowledge. One farmer watched it on the television once when he visited a relative in the city. Sharing with others, they are longing to know how to get access to the planting materials.	Supply of planting materials and training on how to be used properly.
Fodder maize and Forage grass	Lack of information and seed supply. The farmers remarked that they rarely see the extension service who will put them through and initiate any useful practice which they will then follow after	Strengthening the capacity of the extension service. Adequate supply of the seed of fodder maize
Methods of improving existing feed resources		
Conserved crop residues	Lack of information and proper training on how to conserve the quality of crop residues	Since maize is a major crop in the area and maize straw is of low nutritive value, convenient and affordable methods of improving maize straw quality should be sought.
Urea treatment of crop residues	Farmers reported that lack of knowledge was the predisposing factor for not exploiting the potential of urea treatment. The fear of losing the animal if the urea was not apply in the right quantity	Awareness and training of farmers on the use of urea

Grazing which include the natural pasture and crop residues left on the field, contributed the largest proportion to livestock diets in terms of dry matter (DM), metabolizable energy (ME) and crude protein (CP) in the study sites followed by the naturally occurring green fodders which collected for livestock feeding (Figures 10, 11 and 12). While the percentage contribution of purchased feed to the DM, ME and CP in Mahon is less than 10%, purchased feed contributed 4%, 18% and 8% of DM, ME and CP, respectively to the livestock total diet in Sayaga. This implies that farmers in Sayaga depend more on purchased feed than in Mahon.

Trends in the contribution of collected crop residues to livestock feed were similar in both study sites. The percentage contribution of collected crop residues to the diets on the basis of DM, ME and CP was less than 3%. It was noted that this percentage (3%) only accounted for the few collected quantity of crop residues. Farmers usually leave larger percentage of crop residues on the farm for animal to graze which might have been mixed up or considered as grazing during the interview. Generally, crop residues in both areas are mainly composed of cereals as the dominant crops. The feeding value of cereal stovers are very low while haulms of leguminous crop are very high owing to higher protein content (Carangal and Calub 1987) but the quantities generated in these areas are generally low. This is owing to the fact that legumes are not largely cultivated in the area. . The quality of the collected crop residues become very low especially during the dry periods due to poor storage practices as residues are stockpiled on rafters outside where they are subjected to unfavorable weather and consequently, the quality diminishes. Delayed

harvesting can also lead to greater loss of leaves and leaf sheaths, the most digestible parts of cereal straws with a consequent reduction in nutritive value (Williams *et al.*, 1997).

Cultivated fodder, although not commonly practiced in Mahon, contribute about 1% of DM, ME and CP to the total diet of the existing feed resource. Although its contribution may be limited, it thus implies that cultivated pasture especially forage legume could improve the quality of livestock feed resources if integrated into arable cropping. In contrast, no farmer in Sayaga cultivates fodder.

Figure 10. Contribution of various feed sources to the DM content of total diet in Mahon.

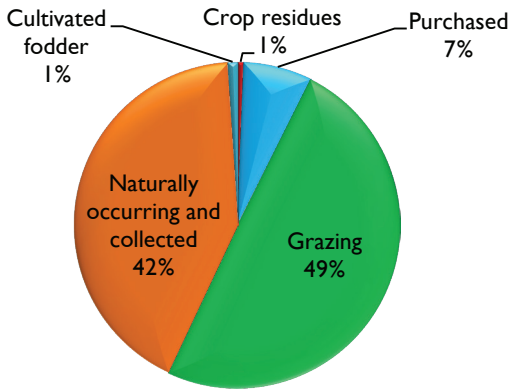


Figure 11. Contribution of various feed sources to the ME content of total diet in Mahon.

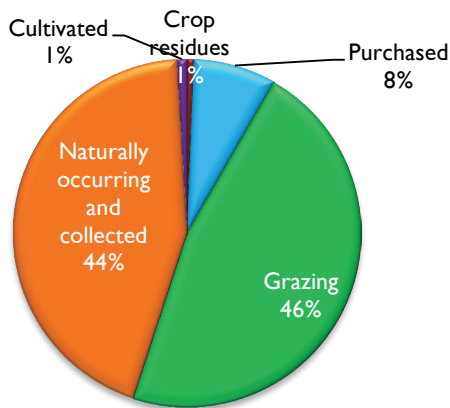


Figure 12. Contribution of various feed sources to the CP content of total diet in Mahon.

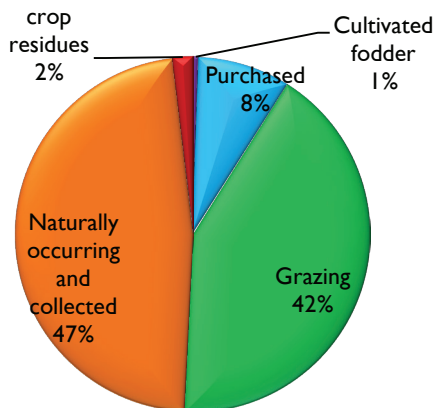


Figure 13. Contribution of various feed sources to the DM content of total diet in Sayaga.

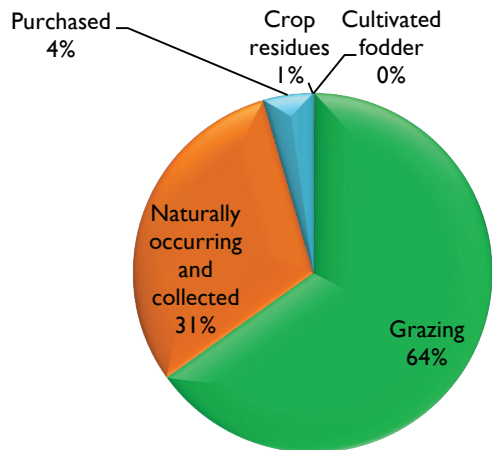


Figure 14. Contribution of various feed sources to the ME content of total diet in Sayaga.

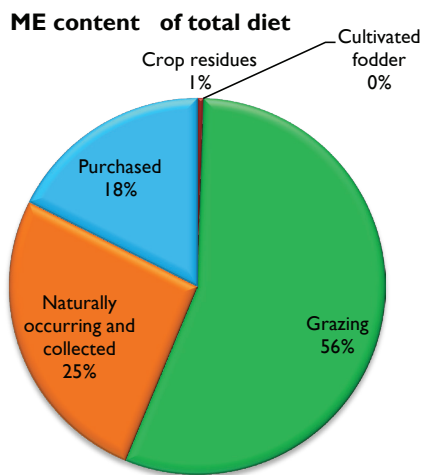
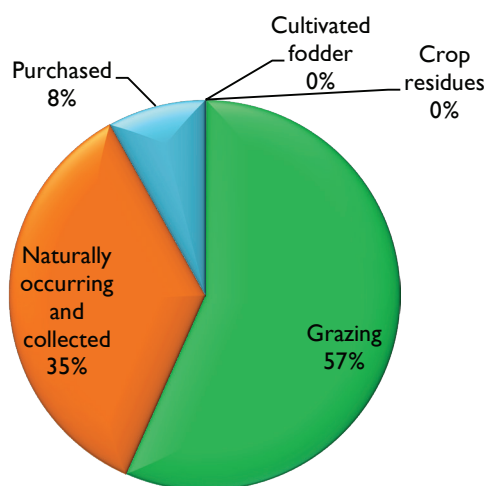


Figure 15. Contribution of various feed sources to the CP content of total diet in Sayaga.



Farmers' feed quality assessment indicators

In both Mahon and Sayaga, all the farmers interviewed confirmed the use of physical parameters to determine feed quality given to the animals. All the farmers considered sick animals and pregnant female in that order as the priority animals that should be given quality feeds before other animals. Farmers reported that quality feeds are needed by sick animals for early recovery and for foetal development in pregnant females. Colouration, texture, odour, leaf to stem ratio, moistness, age at harvest and animal behaviour were listed as farmers' quality assessment indicators of livestock feed in both sites (Table 4).

Table 4. Farmers' indicators of feed quality assessment

Parameters	Description
Colouration	Dark green colouration showed better quality than yellowish green. For cereal crop residues, no specific colour was mentioned, however, farmers noted that green colouration of cowpea and groundnut crop residues indicated good quality.
Texture	Farmers reported that coarse texture of maize gluten with bran due to the presence of crushed grains are of higher quality than the powdery maize gluten with bran. Coarse texture of the stem sorghum residues with the presence of the sheath indicated higher quality than smooth texture. Soft and tender plant fraction and crop residues were considered high quality than the tough samples.
Odour	Farmers described an offensive odour (pungent and rancid smell) in commercially formulated ration as poor quality while a pleasant smell of fresh coconut indicated high quality.
Leaf to stem ratio	Farmers considered high leaf to stem ratio as high quality feed for both fresh pasture and crop residues.
Moistness	From farmers' perspective, high moisture content indicated high quality. Some farmer reported that when animals take moist feed, their water intake will be reduced and this help to them manage the limited water source available because water supply was a major constraint.
Age at harvest	Farmers reported that younger plants are of higher quality than older plants.
Animal behaviour	Animals exhibited certain behaviour that indicated the quality of a feed. Wagging of tails when the food is served, competition for the feed, high intake rate and no left over are indicators of high quality as described by the farmers

Berhanu *et al* (2009) also confirmed the use of visual observation and smell by farmers in Ethiopia to assess the quality of agro-industrial by-products. In terms of colour as indicator, feeds generally have their own typical appearance, which the farmers are familiar with. Deviation from the typical appearance or colour may have implication on quality. In another report from Ethiopia, farmers assessed black colouration of sorghum stover as poor quality and greenish colour hay good quality legume hay. (Berhanu *et al* 2009).

As reported by the famers, coarse maize bran indicated high quality. Ground feeds with a large percentage of fine particles (<0.5 mm) are clearly less well accepted by cattle than coarse ground feeds (Morand-Fehr *et al.*, 1994). The preference for coarse particles may be due to greater ease of prehension. Toughness of plant materials has been found to be as a result of increase in cell wall content particularly lignin which causes a decrease in relative crude protein content, reduced intake and digestibility (Kidunda *et al* 1990; Seyoum *et al* 1998).

In terms of leaf to stem ratio, leafiness in herbaceous plants has been associated with forage quality. This is because there is usually a positive correlation between leaf percentage in a given plant species and protein, mineral composition and dry matter digestibility (Norton 1981). Studies of the voluntary intake of sheep and cattle fed

separated leaf and stem fractions of a range of tropical grasses have also indicated that leaf is eaten in much larger quantities than stem due to a shorter time the leaf is retained in the reticulo-rumen (Minson 1980).

Farmers' perceived high moisture content relative to dryness as indicator for high feed quality as it reduces water intake by animals. Water intake (from all sources) had been reported to be related to the intake of dry matter (Forbes, 1985). The more moisture supplied in the feed, the lower the need for drinking water. Studies have also shown that the nutritive quality of forages varies as they grow towards maturity which agrees with farmers' assessment (Bilal et al. 2001)

According to the farmers, animal behaviour had been the major indicator for feed quality assessment over many generations. Kalio et al., (2006) confirmed the utilization of any feed resource have been influenced by the animals' preference and acceptability of the feed, which is related to the animal's behavioral pattern. Similarly, the extent of preference and acceptability of a feed is one of the principal things to note when determining the best feed stuff (Ganskopp et al., 1997). Calves show more eating behaviour and less idle standing, licking object and drinking behaviour when served preferred diet (Mustafa et al. 2009)

In both study sites, farmers identified some potential feed resources and feed processing methods that they heard about but are not currently practiced. They also mentioned few ways to strengthening the use of such resources.

Constraints to livestock production and proposed solutions

The livestock production constraints were identified in order of importance and farmers suggested solutions (Table 5). Shortage of water was described by the farmers as the first constrain in both communities. Inadequate quantity and quality feed throughout the year ranked next to shortage of water.

Table 5. Major problems identified by the farmers facing livestock production in Mahon and Sayaga and suggested solutions

Problems in order of importance	Problems identified	Proposed solution by the farmers
1	Shortage of water in the dry season for animals	Construction of small dam for the animal Provision of water storage facilities in the village
2	Inadequate quantity and quality feed throughout the year.	Training and skill acquisition on how to improve the quality available feeds especially crop residues Training on how to formulate animal feed ration using available feed resources. Provision of forage legume and grass seed for cultivation
3	High cost of veterinary Drugs and services	Training on proper storage methods for crop residues Establishment of a veterinary service and drug centre in the village
4	Poor performance of their local breeds	Introduction of improved breed for cross breeding programme that can improve the genetic capacity of the local breed.
5	Poor housing provision	Provision of concrete and ventilated and protective housing for the animals. This will also facilitate the collection and utilization of animal dungs as manure

The followings are potential interventions for both Mahon and Sayaga derived from farmers' proposed solutions and existing opportunities

1. Farmers reported that lack of information on other feed resources was the predisposing factor for not exploiting the potential of the livestock sector to the fullest. Hence, training on ration formulation based on the locally available feed resources, fodder production, feed conservation and processing would be instrumental to enhance knowledge base and attitude/behaviour change of the farmers and livestock extension workers.
2. Improving the utilization of crop residue
 - a. Large quantities of crop residues are produced from cereals. However, only few are collected and properly used as animal feeds throughout the season due to poor storage facilities and strategies. Conservation of crop residues should be encouraged. Farmers need to be trained on how to conserve crop residues in a rain proof, well-ventilated barn to retain the quality of the crop residues throughout the period of storage.
 - b. Crop residue treatment and crop residue-based rations. In both villages, cattle showed symptoms of allotrophagia, a condition arising from mineral deficiency. On-farm training on ration formulation using cereals and legumes crop residues will increase the quality of livestock feed in the areas. Farmers could also be trained on the making of multinutrient feed block using local resources to improve animal feed intake.
3. Land was reported as one of the limiting factors inhibiting expansion of agricultural activities in the areas. Therefore planting of forages legumes tree as fodder bank around the homestead and backyard as forage production is recommended. The legume trees are multipurpose and can provide feed, fuel, serve as live fences and shade. Backyard production of fodder trees is not land or labour demanding.
4. Integrated crop farming with shade-tolerant forage grass and legumes planted in tree plantation. This practice encourages the effective utilization of same land resources where the tree biomass helps to enrich the soil and the animal dungs as well. Planting of fodder shrubs and tree as edge rows in arable crop land in form of alley-cropping will also restores nitrogen to the top layer of soil so that farmers can use the same piece of land year after year to grow their forage crops.
5. General health management and diseases prevention are the most important factors that affect ruminant production in the tropical environments. Losses because of ill health and diseases have not been quantified in the economic terms. Therefore, intervention must include proper animal healthcare. Provision of a veterinary center around these two villages is required.
6. Better management of the existing water resources, collecting rain water for dry periods, utilizing the existing limited water sources by making water reservoirs or ponds. Extracting the ground water with the assistance of government and non-government organizations.

Conclusion and recommendations

The farming system in both Mahon and Sayaga is characterised by mixed crop-livestock production system with fruit trees as major crops. Majority of the farmers are smallholder farmer cultivating less than 5 hectares of land. Cattle are the most important livestock in these areas and are predominantly local breed. Agricultural practices in both areas is characterised majorly by fruit trees cultivation and then arable crops. This contributes significantly to household's income generation. Livestock rearing contributes next crop farming and other activities are different kinds of businesses which includes farm labour and trading. In general, proximity to an urban center tends to put Mahon ahead of Sayaga in terms of access to information on livestock feed resources, agricultural inputs and markets opportunity.

Livestock production in these areas depends mostly on grazing of natural pastures. Crop residues, though available, had less contribution to the livestock diet in terms of DM, ME and CP, particularly when critically needed between March and April. This is as a result of poor storage facilities and continuous cropping on same land which affect the quality of the crop and residue. Although inadequate quantity and quality feed throughout the year was a problem facing livestock production in both Mahon and Sayaga, farmers viewed that shortage of water in the dry season for animals is the main constraint to livestock production in the areas.

It is important to address the improvement of utilization of crop residues since it is available in both study sites and encourage forage production to improve livestock productivity and farmers livelihood.

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