



*Improved productivity through crop-livestock
interventions in Eastern DR Congo and Burundi (CLiP)*

Assessment of livestock feed resources and potential feed options in the farming systems of Eastern DR Congo and Burundi

CLiP Working Paper No. 1

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Summary

In the Democratic Republic of Congo (DRC) and Burundi, farmers commonly practice mixed crop-livestock farming, but the emphasis on livestock production is low due to many constraints including feed scarcity, especially during the dry season. To address the livestock feeding issue, this study aimed at assessing the current status of livestock feeding and identifying potential feed interventions that would fit with the existing crop-livestock context.

The survey used the Feed Assessment Tool (FEAST) approach (Duncan et al., 2012 updated by ILRI, 2015) in two sites in DRC (Miti and Kamanyola) and two sites in Burundi (Giheta and Cibitoke). The tool consists of two main parts; the first is a focus group discussion (FGD) aimed at providing an overview of the farming system with particular emphasis on aspects of livestock feeds while the second is an individual farmer interview (IFI) that collects quantitative data from households. The Intervention Ranking Analysis within FEAST uses FEAST data to prioritize potential feed interventions.

Results from the focus group discussions and individual farmer interviews indicated that small and medium – scale farmers are dominant in both DRC and Burundi and rely on less than 1 ha of land each. The dominant crops are banana, cassava, maize, beans, rice and sweet potatoes, and together these provide only 20 – 30% of their residues to feed livestock. The dominant livestock species are local dual-purpose cattle, dairy cattle, pigs and goats, and production is often constrained by scarcity of good forages and pasturelands, livestock diseases, limited knowledge on appropriate crop-livestock practices, limited access to credit and lack of improved livestock breeds. Grazing and naturally collected green fodder are the most important sources of feed for livestock and provide substantial biomass, while cultivated forages and purchased feedstuffs are important protein sources.

Interventions such as introduction of improved forage species and feeding systems, control of livestock diseases, capacity building of farmers in improved crop-livestock production practices, are needed to increase crop-livestock production.

1. Introduction

In Sub-Saharan Africa (SSA), mixed crop-livestock systems are the dominant farming system (Herrero et al. 2010). Most households use crop-livestock integrated farming to overcome food and income problems where land access is restricted (Garrity et al. 2012). In the Great Lakes Region of SSA, the livestock sector is facing a range of constraints related to population growth (Battistin et al. 2009) and the scarcity of collectable fodder (Maass et al. 2012; Mutimura et al. 2013).

In the Democratic Republic of Congo, for instance, livestock production is an integral part of the farming system where food crops are produced for subsistence and livestock are raised to provide mainly meat and other secondary outputs like milk, hide/skin, and manure in smallholder systems (Maass et al. 2013). Likewise, in Burundi, the agricultural sector remains the engine for the country's economic growth and there is a strong focus on agricultural intensification in small scale farms (Niragira 2016). In both countries, farmers generally favor small livestock because they are less demanding than cattle (Maass et al., 2013; Jenicek and Grofora 2015) but can provide inputs for crop production. Crops, on the other hand, provide residues to maintain livestock production (Powell et al. 2004). However, this integration is often constrained by limited livestock feed resources, most scarce in the dry season, pushing farmers to leave animals to range freely leading to increasing conflicts between farmers and significantly reduced productivity of both crops and livestock (Cox 2012; Maass et al. 2012). In rural areas, farmers face multiple challenges in livestock production, among which feed quality and availability, competition between humans and animals for cereal and legume products, and limited knowledge on appropriate utilization of existing feed resources, are the most cited (Mutua et al. 2012; Niragira et al. 2013; Bacigale et al. 2014). Market-sourced feed concentrates are not always available in animal production areas or are too expensive for most farmers (Msangi et al. 2014).

There is therefore a need to assess locally available feed resources to inform livestock actors and guide interventions to overcome issues. However, the existing literature deals with livestock feeding issues without considering the broader farming system to allow selection of appropriate interventions.

This working paper describes the challenges and opportunities in livestock feeding in relation to crop-livestock production systems of eastern DRC and Burundi. Specifically, it aims to:

- 1) Identify problems and opportunities associated with crop-livestock production

- 2) Describe existing feed resources, their nutritional importance as well as their availability throughout the year
- 3) Highlight interventions that can potentially improve livestock feeding within the existing farming system.

2. Methodology

2.1. Study area

The study was conducted in South Kivu (eastern DRC) and Burundi where two contrasting agroecological zones (high and low altitude) were investigated. The *groupement* of Miti (DRC) and the *colline* of Giheta (Burundi) were selected as high-altitude zones, while the *groupement* of Kamanyola (DRC) and the *colline* of Cibitoke (Burundi) were in the low altitude zone (Table 1). The main selection criteria were accessibility, security and existence of livestock as part of farming activities.

The Table 1. Geographical locations and demography of the FEAST meeting points in DRC and Burundi

Country	Sites	Altitude (m, asl.)	Latitude	Longitude	No. Households	HH Size
DR Congo	Miti	1583	02°21.574' S	28°47.81' E	4,738	8
	Kamanyola	973	02°44.228' S	29°00.07' E	10,814	6
Burundi	Giheta	1593	03°21.881' S	29°51.08' E	1,113	8
	Cibitoke	936	02°56.094' S	29°12.69' E	938	5

2.2. Selection of participants

Across the sites, farmer groups were selected according to the following criteria:

- Respondent must be mixed crop-livestock farmer with a good knowledge of the livestock production systems in the area
- Farmers selected randomly i.e. every listed farmer has an equal chance of being selected
- Equal/ reasonable representation of male and female
- Selection of farmers based on distribution of the hamlets within the particular village.

A key informant, who usually was a farmer leader cooperating with local officials was in charge of contacting farmers who fulfil the selection criteria. For the meetings, 14 to 16 randomly selected farmers, representing 3 wealth classes based on land holdings, were invited from the pool of farmers contacted by the key informants. Small-, medium- or large-scale farmers were defined according to local criteria in each village.

2.3. Identification of issues and opportunities surrounding crop-livestock production

The FEAST (Feed Assessment Tool) procedure was applied as described by Duncan et al. (2012) and ILRI (2015). The tool was translated into French and all interactions with respondents were done in either Swahili (in Sud-Kivu) or Kirundi (in Burundi). After a visit to the sites to collect primary information, two main sessions were followed under the FEAST exercise respecting gender and youth participation. The first one involved focus group discussions (FGD) with local farmers to gather general information on the farming system with particular emphasis on aspects of livestock feeds, whereas the second session focused on individual farmer interviews (IFI) aimed at collecting data specific to each household (ILRI, 2015). After the FGD, 9 farmers, representing each of the three farmer categories were selected in each site for interview.

From the FGDs and IFIs, key elements of the farming system were characterized focusing on:

- Land holding by households
- Livestock holding by households
- Dominant crops and use of crop residues
- Main problems relating to crop-livestock production and potential solutions

2.4. Feeds and feeding systems

Data from FGDs and IFIs revealed the contribution of feed resources in livestock feeding in relation to seasonality and site-specifics and highlighted the factors constraining livestock production in Sud-Kivu and Burundi.

For seasonal feed availability, feed supply was assessed by assigning to each month a score out of 10 using pebbles, to indicated how much overall feed was available in that month. A score of 10 meant there was abundant feed and a score of zero meant there was none.

Afterwards, the feeds provided to livestock each month were determined by indicating how much of the nutritional requirements of the livestock herd was supplied from different sources – the total for each month had to add up to 10.

Rainfall was estimated by farmers using scores from 0 to 5 whereby 0 means no rain was observed during a certain month and 5 represented the month with the heaviest rains.

2.5. Potential interventions to improve livestock feeding

After the FEAST exercise, the Intervention Ranking Analysis component of FEAST was applied to prioritize possible interventions based on survey responses. Interventions were selected from a range of around 30 possible generic feed interventions that had previously been identified and catalogued in the FEAST software.

The interventions are ranked on scale of 0 – 20 based on 5 key factors:

- The ability of the intervention to mitigate core constraints: overall feed scarcity, feed quality, seasonal scarcity
- Relevance to commodity: how suitable the intervention is for the main livestock commodity under consideration - dairy cattle, beef cattle, goats, pigs, etc.
- Relevance to farming system e.g. mixed intensive, agro-pastoral, pastoral, landless
- The ability of the intervention to match the local context – land availability, labor availability, skills of farmers, availability of inputs etc.
- Production impact: some interventions have greater effects than others.

2.6. Statistical data analysis

The collected data were first examined using descriptive statistics, such as cross-tabulation, bar charts and pie charts. To aggregate numbers of individual livestock species into the Tropical Livestock Unit (TLU), conversion factors were used (0.7 for cattle; 0.2 for pigs; 0.1 for sheep and goats, 0.01 for chicken, fowls, ducks and rabbits; and 0.005 for covies) (Chianu *et al.* 2007).

Data for cultivated crops, crop residues, availability of livestock feed resources and contribution of feed sources to livestock diet were subjected to simple analysis within the FEAST data application which allowed generation of standardized bar plots and graphs.

3. Results

3.1. Issues and opportunities related to crop-livestock production

This section presents the farm size, livestock holding, dominant crops and use of crop residues as well as the problems and possible solutions to livestock production in the study areas. The four villages investigated have different characteristics (Table 3), and they show considerable differences in their practices as far as agriculture and livestock are concerned.

3.1.1. Land holding

Land holding was defined as land that farmers can access for cropping activities. Overall, most of the households in the 4 sites are categorized as small or medium farmers (Table 2). However, this situation varies from one site to another in each country. For DRC, small scale farmers are dominant in Miti while in Kamanyola, medium and large-scale farmers are dominant based on their land holdings. For Burundi, medium-scale farmers are dominant in both Giheta and Cibitoke sites.

Table 2: Land size by households

Country	Variables	Category of farmers			
		Landless	Small scale	Medium scale	Large scale
DRC	<i>Classes* (ha)</i>	0	<0.25	0.25-1	>1
	Miti (%)	5	65	25	5
	Kamanyola (%)	5	10	45	40
	Mean (%)	5	38.75	38.75	17.5
Burundi	<i>Classes* (ha)</i>	0	<0.5	0.5 - 1	>1
	Giheta (%)	0	20	60	20
	Cibitoke (%)	0	25	40	35
	Mean (%)	0	22.5	50	27.5

*Landholding categories were defined by farmers themselves as part of the FEAST process (Duncan et al. 2012; ILRI 2015).

3.1.2. Dominant crops and use of crop residues

Cropping plays a very significant role in both DRC and Burundi. However, population pressure in high altitude zones like Miti and Giheta allows very small average cropping areas of arable crops per household (Tables 3 & 4).

For DRC, the major crops grown in the Miti site are, in decreasing order of importance, beans, banana, maize, cassava, soybean and sweet potato. In Kamanyola, areas were larger, and the major crops include banana, maize, cassava, soybean and tomato (Table 3).

Table 3. Dominant crops and use of crop residues in DRC

Sites	Crops*	Average area (ha)	Average farm yield (kg)	Use of crop residues (%)			
				Feeding	Burnt	Mulch	Sold
Miti	Beans	0.044	207.2	20	10	65	5
	Maize	0.032	202.2	40	5	50	5
	Banana	0.031	338.5	35	5	45	15
	Cassava	0.029	450.7	5	0	80	15
	Cabbage	0.023	200.0	75	0	15	10
	Soybean	0.017	258.3	30	20	40	10
	Sweet potato	0.016	415.3	60	0	25	15
Kamanyola	Banana	1.364	1,967.4	25	10	55	10
	Maize	0.730	1,523.0	70	0	30	0
	Cassava	0.581	1,609.9	20	5	65	10
	Soybean	0.444	185.0	5	20	55	20
	Tomato	0.130	270.0	50	0	35	15

*Crops are ordered by area

For Burundi, the major crops in the Giheta site include maize, rice, banana, cassava, beans, onion, sweet potato and peas. In the Cibitoke site, the major crops are maize, cassava, banana, sweet potato, beans and soybean (Table 4).

Table 4. Dominant crops and use of crop residues in Burundi

Sites	Crops	Average area (ha)	Average farm yield (kg)	Use of crop residues (%)			
				Feeding	Burnt	Mulch	Sold
Giheta	Maize	0.25	661.4	20	10	55	15
	Rice	0.25	209.4	15	10	45	30
	Banana	0.24	858.2	20	5	30	45
	Cassava	0.23	598.2	30	5	40	25
	Beans	0.19	127.3	25	20	5	50
	Onion	0.18	450.3	10	5	40	45
	Pea	0.15	32.3	15	5	50	30
Cibitoke	Maize	0.54	1,317.8	15	5	65	15
	Cassava	0.54	947.3	15	10	60	15
	Sorghum	0.51	740.4	10	10	45	35
	Banana	0.43	1,417.9	20	10	55	15
	Beans	0.32	124.1	15	5	65	15
	Sweet potato	0.30	412.8	15	10	55	20
	Sweet potato	0.15	51.4	35	0	50	15
	Soybean	0.11	53.5	20	15	45	20

3.1.2. Livestock holdings and livestock system

Livestock holdings are presented in Tropical Livestock Units (TLU) whereby one TLU is equivalent to one cow of 250 kg live-weight (Ghirotti, 1993).

In DRC, local dual-purpose cattle appear to be dominant livestock species kept in Miti and Kamanyola sites, and pigs and goats are also important in the livestock system. Interestingly in Miti site, farmers report that dairy cattle are on the increase due to their high milk production that encourages larger farmers to raise them using a stall-feeding system.

In Burundi, pigs and goats are the most dominant species in the Giheta site while improved dairy cattle and local dual-purpose cattle are the most dominant types in the Cibitoke site (Figure 1).

In DRC, there is little difference between the Miti and Kamanyola sites in the purposes for raising the livestock species (Table 5). The common purposes for both sites are milk, meat, savings and sales for income, among others. However, the importance and levels of the mentioned purposes vary between the sites depending on the specific role of the livestock species and production system practiced. In the Kamanyola site, for instance, cattle are kept under an extensive rearing system and transhumance is

practiced. Hence, farmers do not rely heavily on their manure production. The same observation is made on goats that are always allowed to roam freely and mostly kept for sales. Kamanyola is therefore still at a very low level of crop and livestock integration.

In Burundi, in both the Giheta and Cibitoke sites most animals are either kept under zero-grazing or on a semi-zero-grazing production system. Therefore, raising for manure production is a very important element commonly mentioned by FEAST participants (Table 6). Improved cattle breeds are mostly kept for milk production and the milk is sold for income generation. Medium-sized animals, such goats and pigs, are mainly kept to be sold while small livestock (local poultry, rabbit and cavies) are mostly used for household consumption and for sales to generate money for the smallholder farmers.

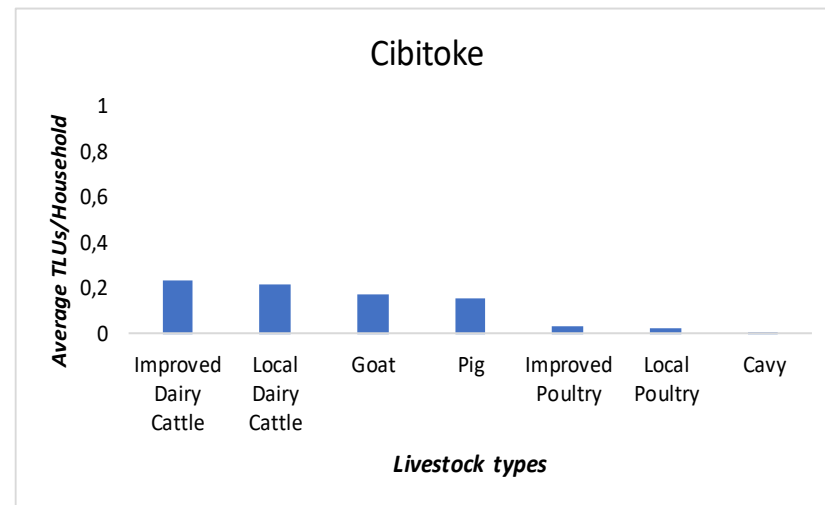
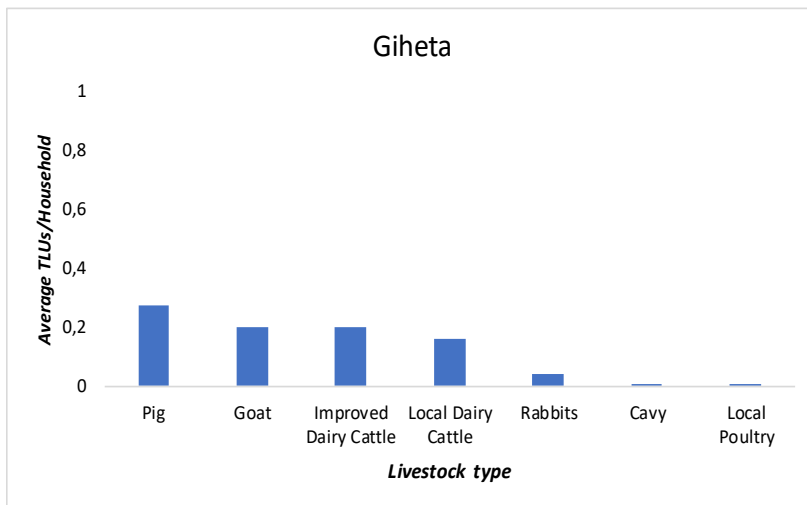
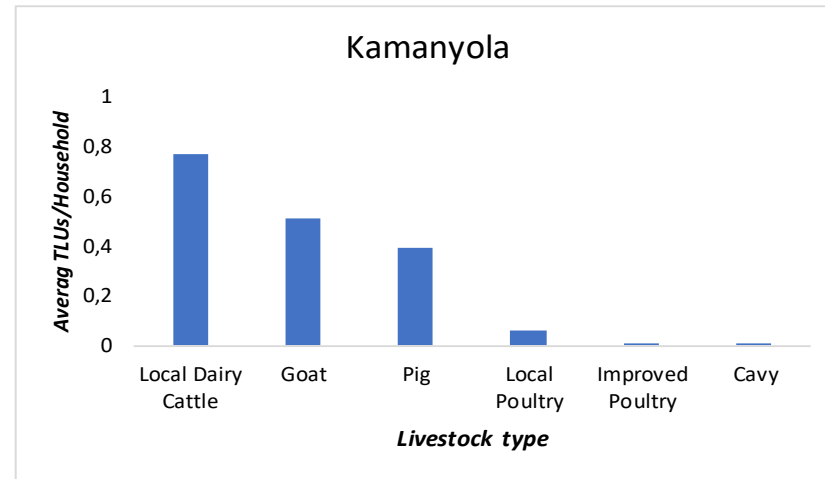
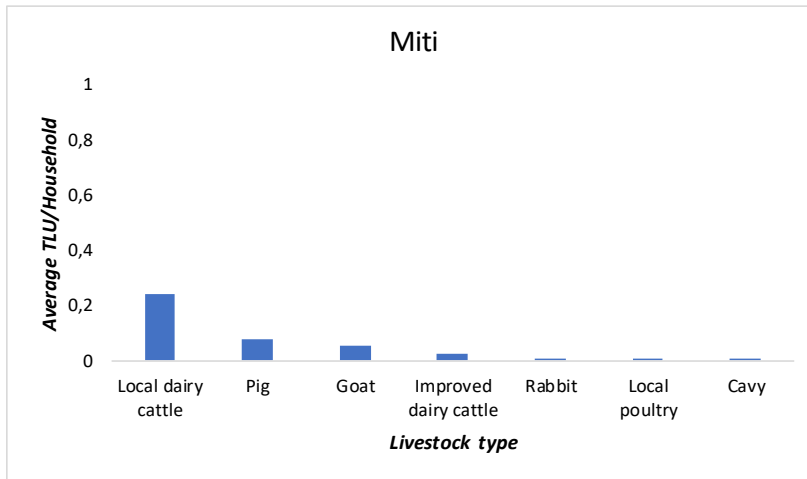


Figure 1. Average livestock holding in Tropical Livestock Unit (TLU) per household in the study sites

Table 5: Livestock species, breeds and their uses in two sites of Sud-Kivu, DR Congo

Sites	Species	Breed	Uses (in order of importance)
Miti	Cattle	Local	Sales for income > Savings > Manure > Dowry > Milk
		Improved	Milk > Manure > Sales for income
	Goats	Local	Sales for income > dowry > Manure > meat.
	Pigs	Local	Sales of piglets for income > manure > savings.
	Chicken	Local	Meat > sales for income > manure
		Improved	Sales of eggs > sales of animal (for income) > meat > manure
	Rabbit	Local	Sales for income > manure > meat
Cavies	Local	Meat > manure > giving	
Kamanyola	Cattle	Local	Sales for income
		Improved	Milk production
	Goats	Local	Sales for income
	Pigs	Local	Sales of piglets
	Poultry	Local	Sales for income > Meat
		Improved	Eggs > Meat > Manure
	Rabbit	Local	Meat > sales for income
Cavies	Local	Eat > Sales > Manure > Blood for treating anaemia	

Table 6: Livestock species, breeds and their uses in two sites of Burundi

Site	Species	Breed	Uses (in order of importance)
Giheta	Cattle	Local	Manure > Milk > Sales for income > Other
		Improved	Milk > Manure > Sales for income
	Goats	Local	Manure > Sales for income > Meat
	Pigs	Local & Improved	Manure > Sales for income > Meat
	Poultry	Local	Manure > Meat > sales for income
		Improved	Sales of eggs > Manure > Sales of animal (for income) > Meat
	Rabbit	Local	Manure > Meat > Sales for income
Cavies	Local	Manure > Meat > Sales for income	
Cibitoke	Cattle	Local	Sales for income > Manure > Milk > Meat
		Improved	Milk > Manure > Sales for income
	Goats	Local	Sales for income > Manure > Meat
	Pigs	Local	Sales for income > Manure
	Poultry	Local	Sales for income > Meat > Manure
		Improved	Sales for income (Animal) > Sale of Eggs > Manure > Meat
Cavies	Local	Manure > Meat > Sales for income	

3.1.3. Problems and potential solutions to crop-livestock production

During the FGD sessions, farmers were asked to mention problems related to livestock production within their areas. Also, farmers suggested solutions for each of the key problems identified. Several problems were pointed out, of which five dominant problems emerged following application of a pair-wise comparison of the problems (Tables 7 & 8).

For DRC, the problems of scarcity of good forages and pasturelands, livestock diseases and lack of veterinary assistance, limited knowledge on appropriate crop-livestock practices and limited access to credit appeared as the most prominent issues constraining crop-livestock production in both Miti and Kamanyola sites even though their ranking differed from one site to another (Table 7). In Kamanyola where animals are either on transhumance or on free-grazing system, the issue of livestock feeding is not perceived to be very pertinent. In the other sites where most farmers have small areas of land and depend on semi-zero-grazing or zero-grazing systems, the problem of livestock feeding is listed among the most critical.

Table 7. Major problems and potential solutions for DRC

Identified problems	Ranking		Potential solutions
	Miti	Kamanyola	
Scarcity of pasture lands and improved forage species	1	4	Forage cultivation by farmers Learn conservation technics Stall-feed the animals
Livestock diseases/Lack of veterinary services	2	3	Capacity building of existing vet technicians Increase availability of vet labs and vet pharmacies Improve hygiene control by farmers
Less knowledge on improved crop-livestock practices	3	1	Training of farmers on good crop-livestock practices Gather farmers into cooperatives
Insecurity	4	-	Increase involvement of the government and the army
Theft	5	5	Keep animals under zero-grazing Involve the government to end impunity
No access to credit	-	2	Create microcredit institutions Farmers' cooperatives

For Burundi, the most important challenges identified in descending order of importance were inadequate knowledge of livestock husbandry, lack of fodder in the dry season and shortage of pasture lands, lack of means to purchase concentrate feeds (especially for pig farmers). Livestock disease issues and the lack of improved livestock breeds were also listed among others (Table 8).

Table 8. Major problems and potential solutions for Burundi

Identified problems	Ranking		Potential solutions
	Gitega	Cibitoke	
Less knowledge in livestock husbandry	1	3	Train farmers on good livestock husbandry and feeding
			Capacity building of local technicians
			Establishment of retail outlets for concentrate feeds
Lack of fodder in dry season and shortage of pasture lands	2	2	Cultivate improved forage species
			Conserve and feed crop residues to animals
Lack of means to purchase concentrate feeds	3	1	Alleviate conditions to access credit
			Creation of farmers' cooperatives
			Connect farmers to processing plants
Livestock diseases	4	4	Multiply selling points of vet products
			Regular vaccination
			Capacity building of local CAHWs
Lack of improved livestock breeds	5	5	Restock the community by improved animals
			Artificial Insemination

To mitigate issues related to livestock production, farmers in both DRC and Burundi suggested the need to enhance their capacity in livestock husbandry, domestication and conservation of improved forage species, connection to veterinary services, connection to markets and restocking the communities with improved animal breeds (Tables 7 & 8).

3.2. Feeds and feeding systems

3.2.1. Fodder crops

In both DRC and Burundi, improved cattle and pigs are stall-fed with improved forage legumes and grasses that are cut and carried by farmers. Feed is often supplemented with purchased concentrates such as maize bran, rice bran, palm kernel cake, molasses or minerals. In Kamanyola, where most farmers are less concerned about livestock feeding pressure because their animals are on free range or on transhumance, only small areas of land are dedicated to cultivating forage crops such as *Pennisetum purpureum* and

Leucaena leucocephala. In Miti (DRC), Giheta and Cibitoke (Burundi) sites, goat rearing is common; goats are reared by tethering in farmsteads or along roadsides, and they are sometimes fed on cultivated forages.

In the Miti and Giheta sites, many farmers expressed their wish to cultivate improved forages, but they are limited by land availability.

In the DRC sites, the most dominant fodder crops are *P. purpureum*, *Pennisetum clandestinum*, *Trypsacum andersonii* and a little *Mucuna pruriens* as a supplemental forage legume. In the Burundi sites, the most frequently cultivated forage grass species are *P. purpureum*, *T. andersonii* and *Setaria sphacelata* and the forage legume species are *Calliandra calothyrsus*, *M. pruriens*, and *L. leucocephala* (Figure 2).

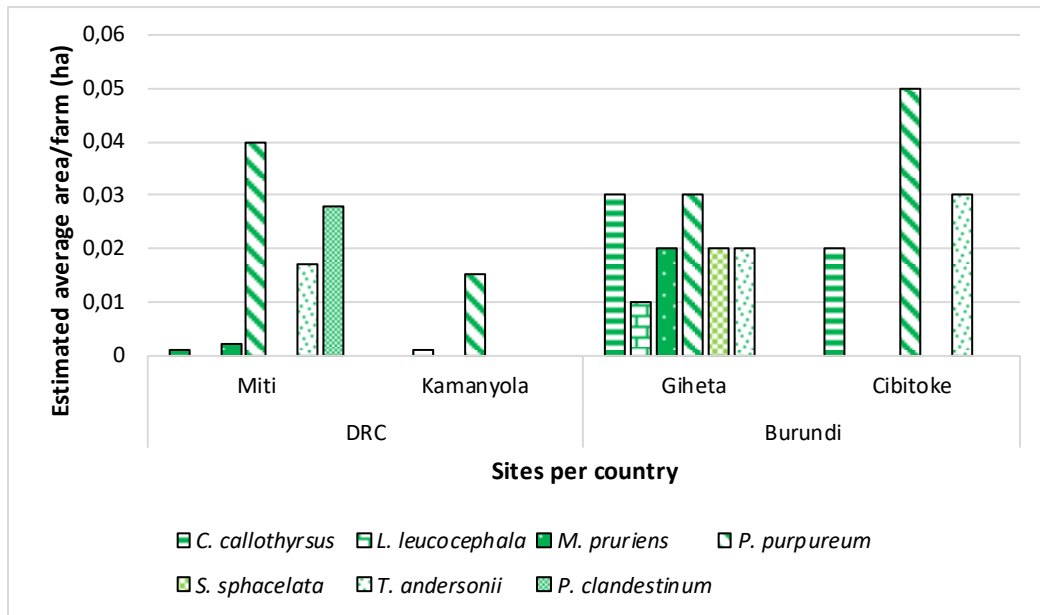


Figure 2: Area allocated to forage crops in DRC (Miti and Kamanyola) and Burundi (Giheta and Cibitoke)

3.2.2. Feeds and feed availability

The major feed types available in Miti and Kamanyola (DRC) and in Giheta and Cibitoke (Burundi) are presented in Figure 3.

In all the four sites across countries, feed availability is generally related to rainfall patterns where abundant feed is observed from November to April before the dry season comes (Figure 3). Grazing or green fodder (naturally occurring or forage crops) are plentiful during the wet season from September to January and from April to May. However, there is inadequate supply of this feed type during the dry (June

to August) and short rainy seasons (February to March). During the dry season and short rainy seasons – corresponding to harvesting time, grazing of natural grasses is complemented with crop residues (maize stover, cassava peels or legume residues) and purchased concentrates.

Specifically, in Miti and Kamanyola sites (DRC), throughout the year grazing is the main source of feed for ruminants while green forages are mostly collected for pigs, cavies and rabbits. However, in Giheta and Cibitoke sites (Burundi), there seems to be a minor difference between the two sites mainly due to the difference in rearing system depending on land availability and cropping system. In Cibitoke, mostly dairy cattle, pigs and improved breeds of other animals are kept under a strict zero-grazing system while in the Giheta site almost all the animals are kept under that system due to the dominance of communal grazing lands. Therefore, in Giheta, green fodder (naturally occurring fodder and cultivated fodder) is the type of feed most fed to animals, followed by crop residues, purchased concentrates and grazing. In Cibitoke, grazing and gathering green fodder are both importance feed sources in animal diets throughout the year and concentrates are also purchased as supplements.

During the feed scarcity period and in order to supplement existing feedstuffs, farmers often purchase other feeds. Figure 4 presents the dominant feedstuffs that farmers purchase during a typical year. Across all the sites, the following feeds are purchased:

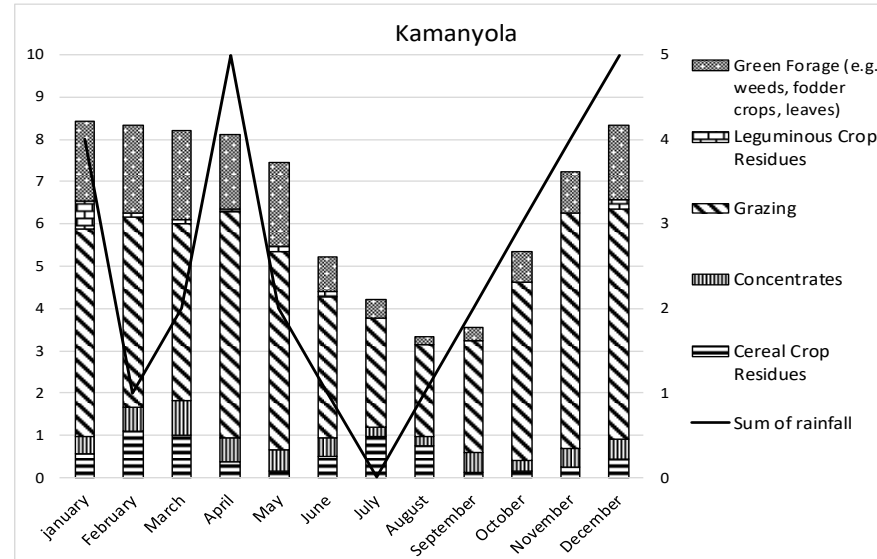
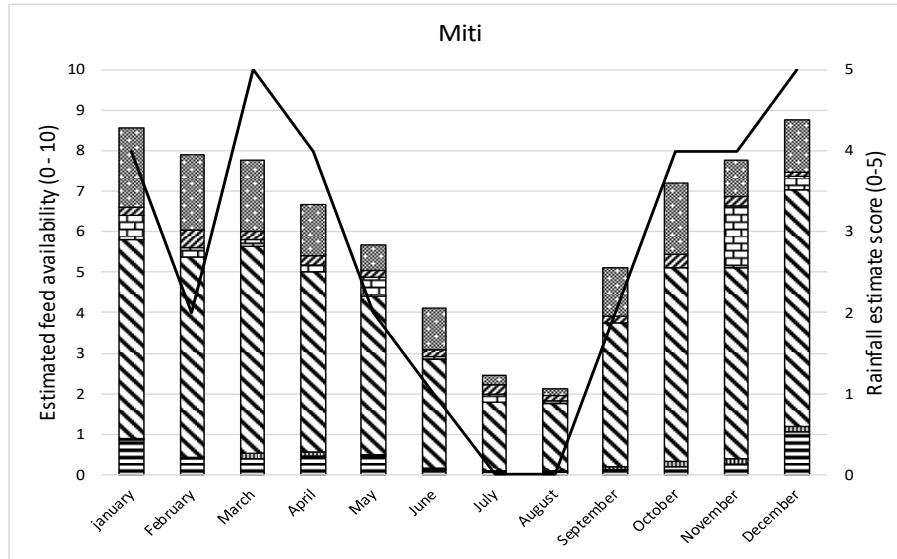
- To supplement energy: maize bran and rice are the most common. Rice bran is not found in Miti which is not a rice production zone. Molasses is purchased by farmers in both Giheta and Cibitoke. Considerable quantities of Napier grass (*P. purpureum*) and some crop residues are purchased by farmers in Giheta to feed the ruminants kept under zero-grazing.
- To supplement for protein: soybean meal and the palm kernel cake are the most common feedstuffs that are purchased by farmers despite their high cost. In Kamanyola, fish meal is used as a supplement for poultry while cattle whey (lactoserum) is often added to pig diets.
- The mineral supplements are often mineral blocks or salt.

Country

High altitude

Low altitude

DRC



Burundi

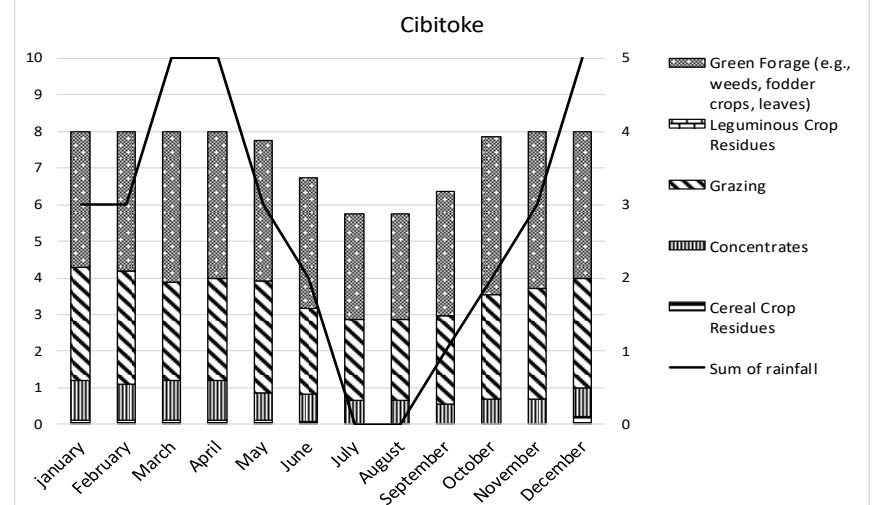
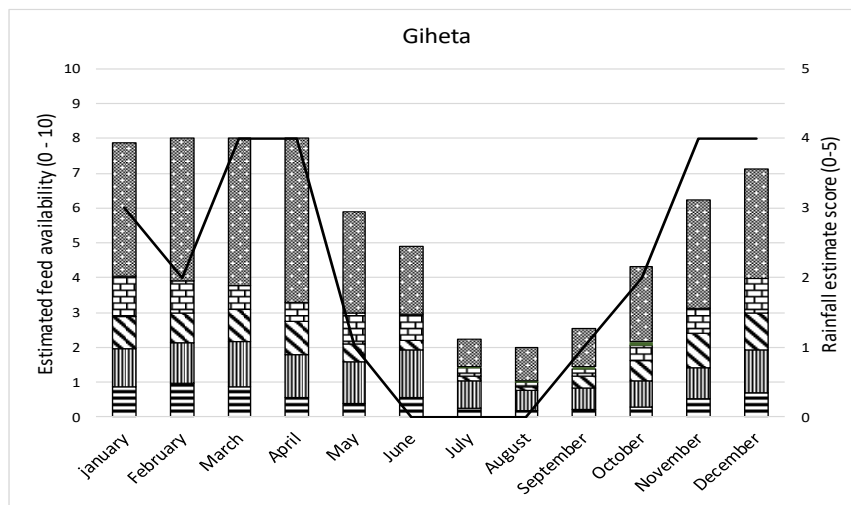


Figure 3. Feed resource availability throughout the year assessed by FEAST method in DRC (Miti & Kamanyola) and in Burundi (Giheta & Cibitoke)

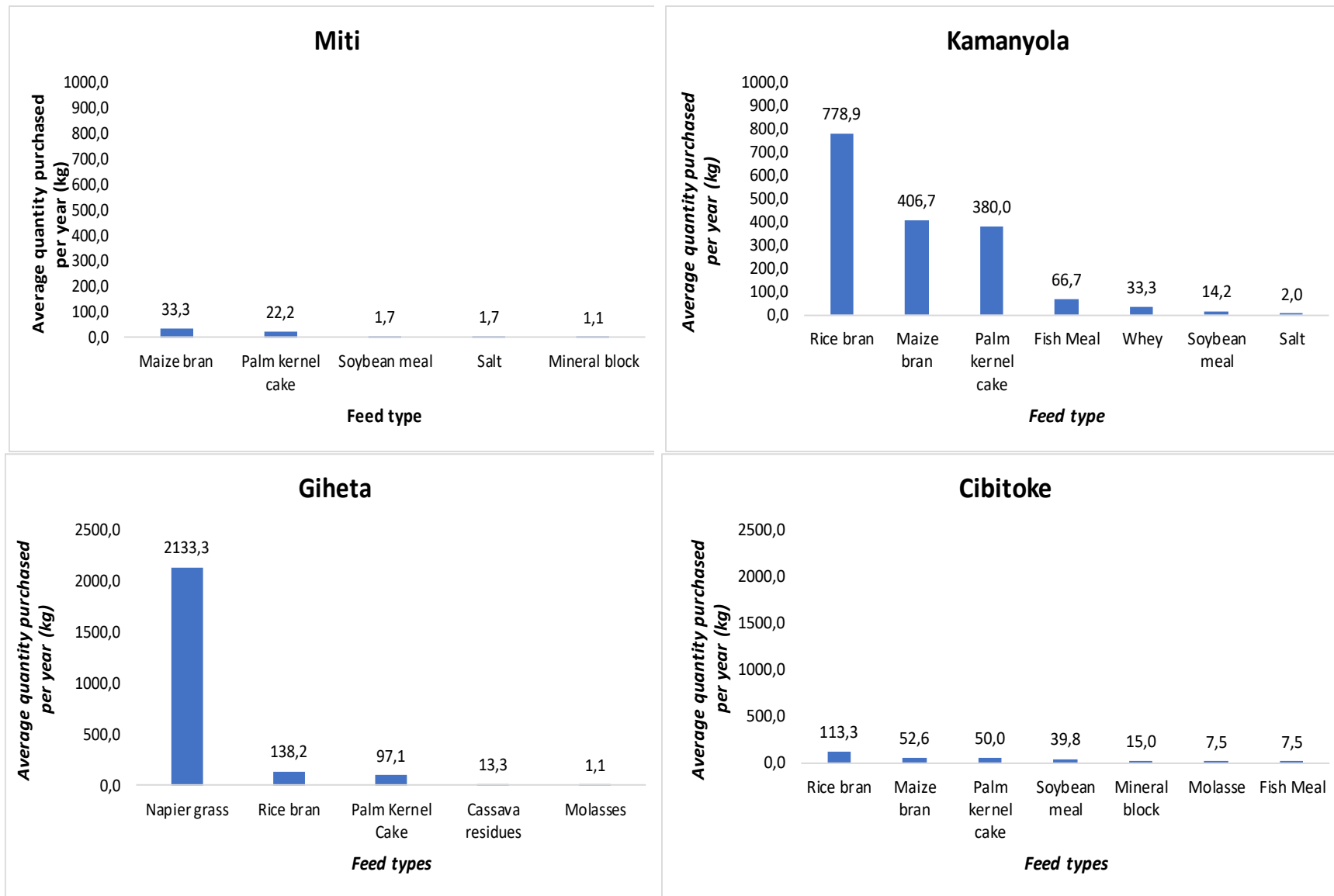


Figure 4. Quantity of feed purchased over a 12-month period in DRC (Miti & Kamanyola) and in Burundi (Giheta & Cibitoke)

3.2.3. Nutrient contribution to the livestock diets

in the DRC sites, grazing contributes the largest proportion of dry matter available to animals (58 – 68% DM), metabolizable energy (56 – 65% ME) and the crude protein (44 – 54% CP).

- In Miti, collected green fodder along the roadsides or around the homesteads contributes 19% DM, 21% ME and 14% CP, while cultivated forages contribute at 16% DM, 16% ME and 36% CP.
- In Kamanyola, purchased feeds constitute the second most important feed source to contribute the largest proportion of nutrient to the animal diets (18% DM, 22% ME and 36% CP). Crop residues and collected fodder are less represented in the livestock feeding plan (Figure 5). Even though quite a lot of Napier grass is cultivated in Kamanyola, farmers do not perceive it as a real contributor to livestock feeding as it is mostly sold to dairy farmers coming from Rwanda.

In the Burundi sites, there is a difference between the two sites:

- In Cibitoke, cultivated forages contribute with highest proportion to the livestock diets in terms of dry matter content (60%), metabolizable energy (61%) and crude protein (67%). This is followed by collected fodder (20% DM, 21% ME and 16% CP) and grazing (14% DM, 13% ME and 11% CP).
- In Giheta, collected green fodder makes the biggest share with 64% DM, 64% ME and 59%CP; followed by cultivated forages (21% DM, 22% ME and 25% CP) and grazing (10% DM, 9% ME and 9% CP) (Figure 6).

The above results indicate that in both the DRC and Burundi sites, grazing and collected fodder are mainly an energy source while cultivated fodder and purchased feeds are important sources of protein to animals.

This suggests that improving grazing areas with high protein cultivated forages would improve the CP availability to grazing animals, while for animals on zero-grazing, inclusion of cultivated forage species and purchased feed ingredients with relatively high CP content would help also improve the overall protein content of the diets.

Sites

Miti

Kamanyola

DM by Source

ME by Source

CP by Source

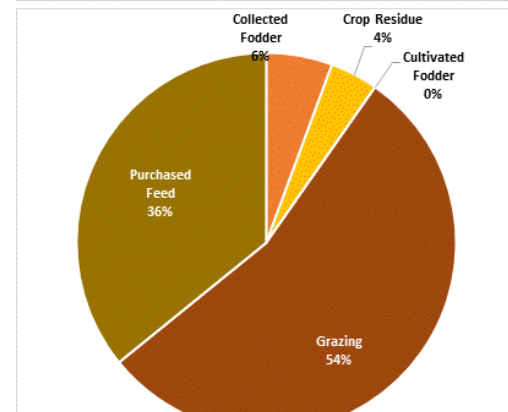
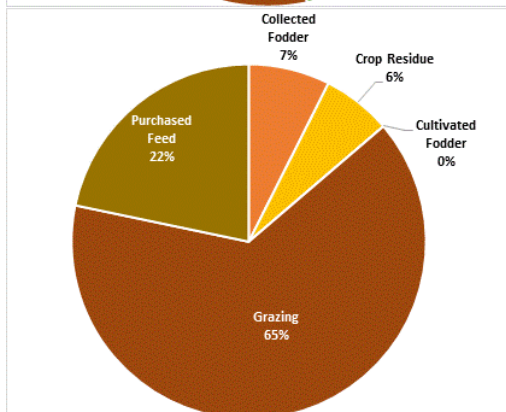
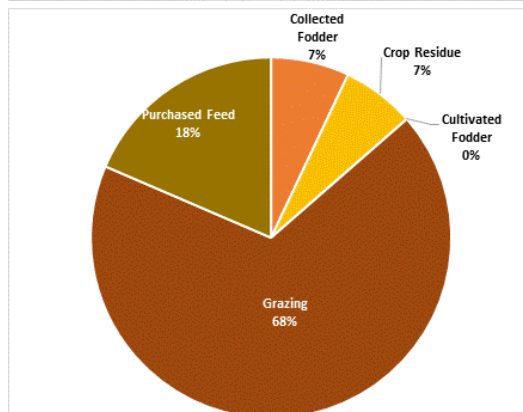
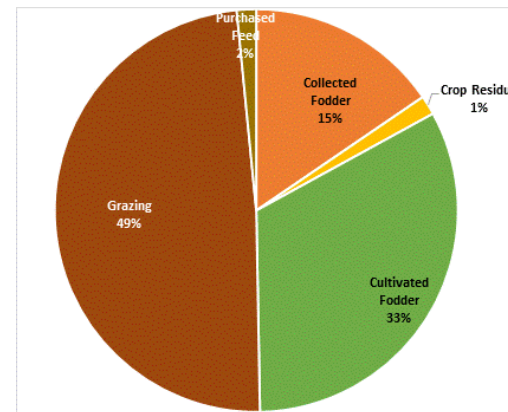
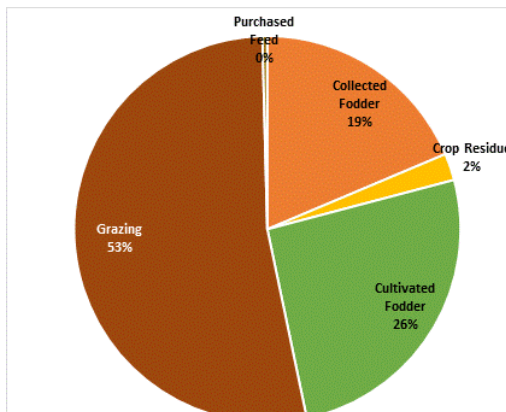
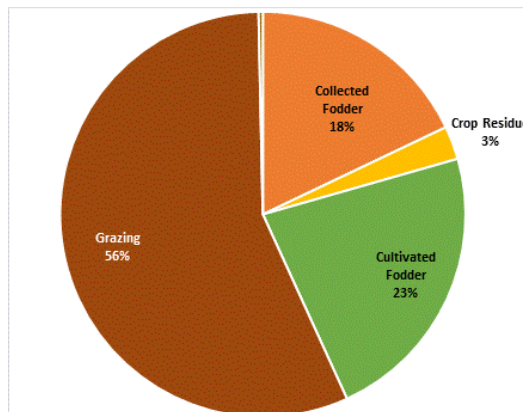


Figure 5. Contributions of various feed sources to the dietary requirements in Miti and Kamanyola sites, Eastern DRC

Sites

Cibitoke

Giheta

DM by Source

ME by Source

CP by Source

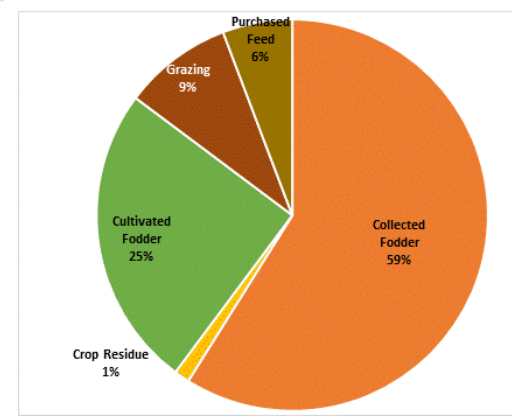
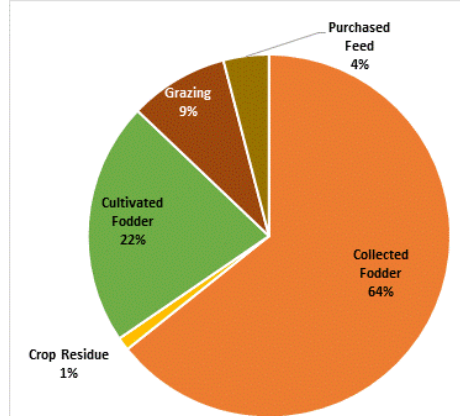
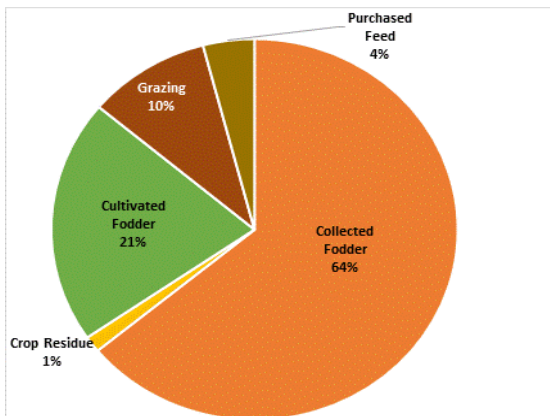
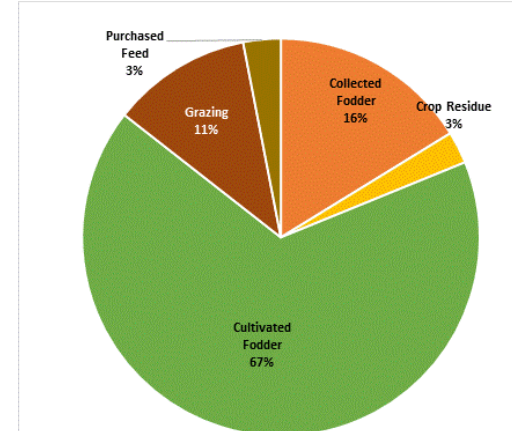
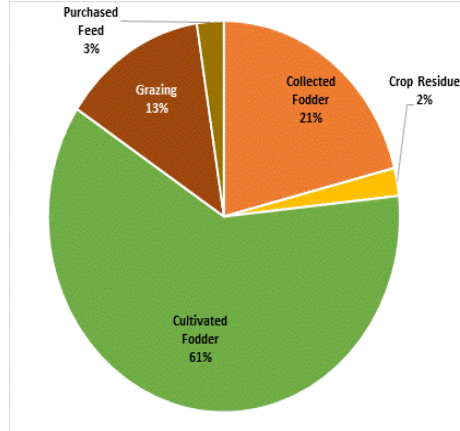
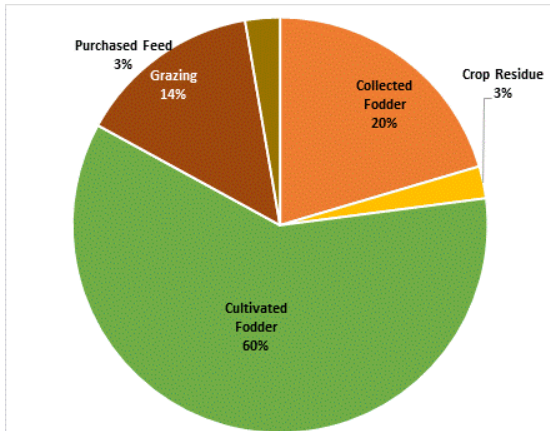


Figure 6. Contributions of various feed sources to the livestock dietary requirements in Giheta and Cibitoke sites, Burundi

3.3. Suggested interventions for livestock feeding

The core feed issues are presented in Table 9 for each site. In DRC, both Miti and Kamanyola site are constrained by poor availability of input delivery, knowledge/skills, cash and credit, energy/protein shortage and land for fodder cultivation, but also the problem of feed scarcity during dry and growing seasons.

On the other hand, Giheta and Cibitoke sites in Burundi are commonly constrained by poor availability of labor and land for fodder cultivation, problems of energy/protein shortage, quantity of feed and scarcity of feed in growing season. Giheta is also constrained by poor availability of cash/credit, while Cibitoke is apparently constrained by low availability of input delivery, knowledge/skill as well as problems related to scarcity of feed during dry season.

Table 9. Core feed contexts in FEAST sites

Key attributes	Score (Out of 4) in DRC		Score (Out of 4) in Burundi		Meaning of the scores
	Miti	Kamanyola	Giheta	Cibitoke	
Availability of cash/credit	2	1	1	3	4 = Best
Availability of input delivery	1	1	3	1	4 = Best
Availability of knowledge/Skill	1	2	3	2	4 = Best
Availability of labor	4	4	1	1	4 = Best
Availability of land for fodder cultivation	2	3	2	2	4 = Best
Availability of water in growing season	3	3	4	4	4 = Best
Is energy/protein shortage a problem?	3	3	3	3	0 = No, 4 = Serious
Is quantity of feed a problem?	3	3	3	2	0 = No, 4 = Serious
Is scarcity of feed in dry season a problem?	2	1	3	2	0 = No, 4 = Serious
Is scarcity of feed in growing season a problem?	2	2	2	3	0 = No, 4 = Serious

Considering the above described feed contexts in integrated crop-livestock systems, Tables 10 and 11 suggest appropriate feeding interventions that could be promising candidates to alleviate livestock production issues in DRC and Burundi, respectively.

In DRC, the following interventions are suggested:

- In the Miti site, rehabilitation of communal grazing land is suggested for cattle or goats that are under grazing systems. Farmers are also suggested to grow tall grasses in row

or in intensively managed plots to be regularly cut, chopped and fed to herbivores fresh or ensiled. Grass species used in such systems include *Panicum maximum* (Guinea grass), *Pennisetum purpureum* (Napier grass), *P. pedicellatum* (Desho grass), *Brachiaria hybrids* (Mulato), *Brachiaria brizantha* (brizantha), *Chloris gayana* (Rhodes grass), *Paspalum atratum* (atratum), *Tripsacum laxum* (Guatemala grass) and *Axonopus scoparius* (Imperial grass). Supplement the livestock diets with energy-rich supplements (e.g. molasses) and protein by-products (such as meat, blood, fish, legume leaf meals, biofuel coproducts, oil seed, poultry litter, etc.) is also requested to farmers in order to improve livestock production. Marshy areas can be exploited for forage cropping or other niches ready for irrigation to overcome the dry-season feeding issues and therefore ensure year-round livestock production.

Table 10. Intervention ranking for DRC

Site	Potential interventions	Score ranking factors					Mean
		MCC	RtoC	RtoFS	MCA	Prol	
Miti	Rehabilitation of communal/degraded grazing land.	16	20	15	14	20	17.0
	Grasses for cut & Carry	20	5	15	15	20	15.0
	Energy-rich supplements	16	10	10	17	20	14.6
	Protein byproducts	16	10	10	16	20	14.4
	Irrigated fodder production	20	10	10	12	20	14.4
Kamanyola	Energy-rich supplements	15	15	20	18	20	17.6
	Protein byproducts	15	10	20	17	20	16.4
	Cereal byproducts	12	10	20	18	20	16.0
	Commercial balanced feed	17	5	20	17	20	15.8
	Brewers' wastes	14	10	20	19	15	15.6

MCC=Ability to mitigate core constraints; RtoC= Relevance to the commodity; RtoFS = Relevance to the Farming system; MCA = Ability to match the context attributes; Prol = Production impact

- In Kamanyola, inclusion of concentrates that can supply energy and protein are suggested in livestock diets. Cereal byproducts (such as maize bran, rice bran, etc.) can be fed to animals along with commercial balanced feed and locally made brewers' wastes can help to mitigate the existing cattle transhumance while increasing productivity.

For Burundi, the following interventions are suggested:

- In Giheta, farmers are encouraged to supplement livestock diets with energy-rich feedstuffs (e.g. molasses), protein by-products (e.g. from meat, blood and bone, fish, legume leaf meal,

biofuel co-products, oil seed, poultry litter etc.), cereal byproducts (rice bran, maize, wheat, etc.). Use of commercial balanced compounded feeds (e.g. dairy meal) and distillers or brewers' waste (local and industrial) are also recommended as a way to overcome the livestock feeding issues.

- In Cibitoke, forage domestication is recommended. Cultivating forage grasses for cut-and-carry, short duration fodder crops and irrigated fodders are strongly suggested to fit in the existing crop-livestock system. Forages can be fed fresh or made into hay or silage. Maize and sorghum need to be chopped before feeding. Growing fodder crops such as fodder oats for cool season feed supply or sorghum/maize for dry season feed supply (hay/silage) is a major strategy to overcome feed scarcity at particular times of the year. Furthermore, livestock diets need to be supplemented with energy-based feedstuffs.

Table 11. Intervention ranking for Burundi

Site	Potential interventions	Score ranking factors					Mean
		MCC	RtoC	RtoFS	MCA	Prol	
Giheta	Energy-rich supplements	16	20	20	15	20	18,2
	Protein byproducts	16	20	20	14	20	18,0
	Cereal byproducts	14	20	20	15	20	17,8
	Commercial balanced feed	18	20	20	14	20	18,4
	Brewers' wastes	14	20	20	17	15	17,2
Cibitoke	Grasses for cut & Carry	20	20	20	13	20	18,6
	Energy-rich supplements	18	20	20	16	20	18,8
	Short-duration fodder crops	20	20	20	12	20	18,4
	Protein byproducts	18	20	20	14	20	18,4
	Irrigated fodder production	19	20	20	11	20	18,0

MCC=Ability to mitigate core constraints; RtoC= Relevance to the commodity; RtoFS = Relevance to the Farming system; MCA = Ability to match the context attributes; Prol = Production impact

4. Conclusions

From the results of this study, the following conclusions can be derived:

- 1) The farming system in both DRC and Burundi is characterized by mixed crop-livestock production system although crop-livestock is still at low level of integration, especially in Kamanyola where cattle are still reared under transhumance and most animals are allowed to free graze during the dry season. Small and medium-size farmers make up 75% of the farmers with Kamanyola and Cibitoke (low-altitude) and these sites have higher land availability than Miti and Giheta (high-altitude). A medium farmer has between 0.25 – 1 ha (DRC) or 0.5 – 1 ha (Burundi).

- 2) Banana, maize, beans and rice are the most important crops for DRC sites but only about 30% of their residues is used in livestock feeding. In Burundi, the dominant crops (maize, rice, banana, cassava, beans and sweet potatoes) provide about 20% of their residues to feed livestock.
- 3) In DRC, local dual-purpose cattle appear to be the dominant livestock species in terms of TLUs in Miti and Kamanyola and pigs and goats are also important. In Burundi, however, pigs and goats are dominant in Giheta while improved dairy and local dual-purpose cattle are the most important in Cibitoke. Generally, crop-livestock production in both countries is constrained by scarcity of good forages and pasturelands, livestock diseases, limited knowledge on appropriate crop-livestock practices, limited access to credits and lack of improved livestock breeds.
- 4) Feed availability strongly follows the rainfall pattern, and, despite the very low livestock holdings, it never reaches 100% during the year. Grazing and naturally occurring fodder were the main sources of feed for livestock but during the dry season and harvesting periods, crop residues and purchased concentrates act as supplements to the livestock diets. However, grazing and the collected green forages were found to act mainly as an energy source rather than supplying protein, while cultivated forages and purchased feedstuffs are important protein sources.
- 5) To overcome the livestock feeding issues in both DRC and Burundi, forage domestication (forage grasses for cut-and-carry, irrigated forages and short-term forage crops) and supplementing the livestock diets with protein- and energy-enriched byproducts were suggested as best-bet feed interventions to be tested to fit into the farmers' practices.

References

- Bacigale, S.B., Paul, B.K., Muhimuzi, F.L., Mapenzi, N., Peters, M. and Maass, B.L. 2014. Characterizing feeds and feed availability in Sud-Kivu province, DR Congo. *Tropical Grasslands – Forrajes Tropicales* 2 :9 – 11.
- Battistin, F., Garip, J.A. and Maletta, H. 2009. Rapport d'analyse et lignes d'action pour la création d'emploi et le redressement économique locale au Sud-Kivu (RDC). *International Labor Office, ILO International Programme on Crisis Response and Reconstruction*, Geneva, Switzerland. <http://goo.gl/zeH33p>.
- Chianu, J.N., Tsujii, H. and Manyong, V.M. 2007. Crop-livestock interaction in the savannas of Nigeria: Nature and determinants of farmer decision to use manure for soil fertility maintenance. *Journal of Food, Agriculture and Environment* 5(2): 295 – 301.
- Cox, T.P. 2012. 'Farming in the battlefield: the meanings of war, cattle, and soil in South-Kivu, Democratic Republic of the Congo'. *Disasters* 36(2): 233 – 248.
- Duncan, A., York, L., Lukuyu, B., Samaddar, A. and Stür, W. 2012. Feed Assessment Tool (FEAST): A systematic method for assessing local feed resource availability and use with a view to design intervention strategies aimed at optimizing feed utilization (www.ilri.org/feast).
- Garrity, D., Dixon, J. and Boffa, J.M. 2012. Understanding African farming systems: Science and Policy implication. Invite paper, *Food Security in Africa: bridging research into practice*. 29-30 November 2012, Sydney, Australia.
- Ghirotti, M. 1993. Rapid appraisal benefiting from the experiences and perspectives of livestock owners. *World Animal Review* 77: 26 – 37.
- Herrero, M., Thornton, P.K., Notenbaert, A.M., Wood, S., Msangi, S. et al. 2010. Smart investments in sustainable food production: revisiting mixed crop – livestock systems. *Science* 327: 822 – 825.
- ILRI, 2015. Feed Assessment Tool (FEAST) focus group discussion guide, version December 2015. Nairobi. www.ilri.org/feast.
- Jenicek, V. and Grofora, S. 2015. Least developed countries – the case of Burundi. *Agricultural Economics – Czech* 61(5): 234 – 247.

Maass, B.L., Chiuri, W.L., Zozo, R., Katunga, M.D., Metre, T.K. and Birachi, E. 2013. Using the 'livestock ladder' as a means for poor crop – livestock farmers to exit poverty in Sud-Kivu province, Eastern DR Congo. In: Vanlauwe, B., van Asten, P. and Blomme, G. (eds.), *Agro-Ecological Intensification of Agricultural Systems in the African Highlands*. London, UK: Earthscan-Routledge: 145 – 155.

Maass, B.L., Katunga, M.D., Chiuri, W.L., Gassner, A. and Peters, M. 2012. Challenges and opportunities for smallholder livestock production in post-conflict South Kivu, eastern DR Congo. *Tropical Animal Health and Production* 44(6): 1221 – 1232.

Msangi, S., Enahore, D., Herrero, M., Magnan, N., Havlik, P. et al. 2014. Integrating livestock feeds and production systems into agricultural multi-market models: the example of IMPACT. *Food Policy* 49: 365 – 377.

Mutimura, M., Lussa, A.B., Mutabazi, J., Myambi, C.B., Cyameshi, R.A. and Ebong, C., 2013. Status of animal feed resources in Rwanda. *Tropical Grasslands – Forrajes Tropicales* 1: 109 – 110.

Mutua, F.K., Dewey, C., Arimi, S., Ogara, W., Levy, M. and Schelling, E. 2012. A description of local pig feeding systems in village smallholder farms of Western Kenya. *Tropical Animal Health and Production* 44: 1157 – 1162.

Niragira, S. 2016. Understanding smallholder farming systems for food security in Burundi. *Ghent University. Faculty of Bioscience Engineering, Ghent, Belgium*. (Available from <http://hdl.handle.net/1854/LU-8165916>). (Accessed 14 October 2018).

Niragira, S., D'Haese, M., Buysse, J., Desiere, S., Ndimubandi, J. and D'Haese, L. 2013. Options and impact of crop production specialization on small-scale farms in the north of Burundi. Invited paper, *4th International Conference of the African Association of Agricultural Economists*, 22 – 25 September 2013, Hammamet, Tunisia.

Powell, J.M., Pearson, R.A. and Hiernaux, P.H. 2004. Crop – livestock interactions in the West African drylands. *Agronomy Journal* 96: 469 – 483.