Characterisation of livestock production systems and potential for enhancing productivity through improved feeding in Nyanza district, southern Rwanda

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Summary

The Feed Assessment Tool (FEAST) was applied to characterize the production systems mainly related to feed interventions in Rwotso Cell of Nyanza district in southern Rwanda. The assessment was carried out using semi-structured focus group discussion (FGD) with 16 farmers (8 female, 8 male), followed by an individual questionnaire interview conducted with a subset of nine farmers representing different land size categories (small, medium and large-scale farms). The feeding practice that dominates in Rwotso village is zero-grazing system. Insufficient fodder/pasture for animals during the dry season was identified by farmers as a key challenge. This has been correlated with lack of knowledge/skills on pasture/forage establishment, management, utilization and conservation.

The following possible interventions were proposed to alleviate feed shortage in the village:

i. maximizing forage production in all niches by introducing suitable forages and raising awareness of farmers on forage production through training;

ii. encouraging farmers who have plenty of land to produce more forage for sale; and

iii. promoting the use of conserved forages through trainings and field demonstrations.

1. Introduction

Livestock production plays a significant role in the livelihoods of households in rural areas of Rwanda. However, feed availability is a major constraint to livestock production in the country. This is mainly due to high population density that creates land scarcity. For Nyanza district, where most of the population lives on agriculture and livestock keeping on a very limited land area, milk production remains low though the government has put much effort in providing improved cattle breeds for milk production through Girinka program.

FEAST is a systematic approach to assess local feed resource availability and use. It offers a systematic and rapid means to assess feed resources at site level with a view of developing a site-specific intervention strategy to improve and optimize feed supply, utilization and animal production through technical or organizational interventions. FEAST differs from conventional feed assessment approaches that focus on the feeds, their nutritive value and ways to improve it. FEAST broadens this assessment to account for the importance of livestock in local livelihood;, the relative importance of feed problems locally; and the local context related to labour, input availability, credit, seasonality and markets. (Mengistu et al. 2014).

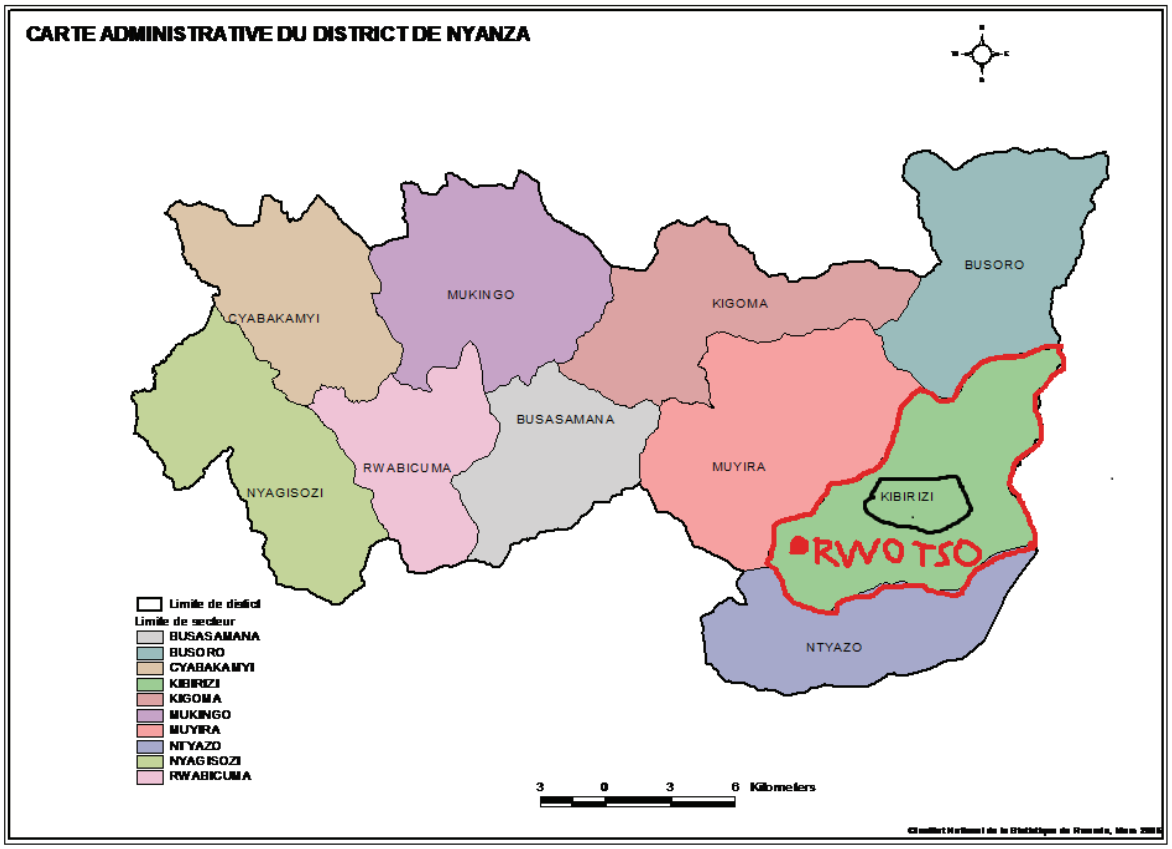
FEAST was employed in Rwotso Cell, Kibirizi Sector of Nyanza district in the southern province of Rwanda, in order to identify and develop appropriate feed interventions for the site. The study was conducted in cooperation with farmers affiliated to the Rwanda Dairy Development Project (RDDP).

2. Methodology

2.1 Description of survey district

The survey was carried out in Nyanza district (Figure 1). The district covers an area of 671 km^2 with a population of 323,719 inhabitants. The population density is 481.5 per km^2 (NISR 2014).

Figure 1: Map of Nyanza district



Rwotso site in Nyanza district has abundant rain in the months of April and November, with the main rainy months beginning from February to end of May; and the dry season from June–September. Agricultural activities are conducted during three seasons throughout the year. The first rainy season starts in September and ends in December. The second rainy season starts in February and ends in June. The dry season corresponds to the months of July, August and early September in the marshlands. Cultivated crops include common beans, maize, banana, cassava and sorghum. The main livestock species kept are cattle, goats and poultry. Cattle are mainly fed on a cut-and-carry system where Napier grass is used as a cultivated forage. The average land size owned by the farmers of Rwotso cell ranges between less than 0.5–8 ha, with more than 70% of the farmers owning around 0.5 ha.

2.1 Data collection

FEAST, a systematic approach developed by Duncan et al. (2015) was used to assess local feed resource availability and propose a site-specific intervention strategy to improve and optimize feed supply to livestock. The assessment was conducted in February 2019. It was carried out through a semi-structured focus group discussion (FGD) with 16 farmers (eight female, 8 male), followed by an individual questionnaire interview conducted with a subset of nine farmers representing different land size categories (small, medium and large-scale farms). The geographic coordinates (longitude, latitude and elevation) of the site were taken and recorded using GPS. The information provided by farmers from the focus group was summarized and the data from the individual interviews were processed through the FEAST software https://www.ilri.org/feast. The following are the findings of the assessment and conclusions for further action.

3. Results

3.1 Land holding

The typical household in Rwotso area is composed of approximately nine members (range 3–12). Farmland size is variable with the average land holding estimated to be 0.75 ha per household. Depending on the land holding size, farmers were classified into three land size classes—small, medium and large (Table 1).

The majority of farmers (70%) own farmlands less than 1 ha, whereas only 10% are considered to belong to the category of large farmers with land exceeding 3 ha. Farmers also reported a decreasing land holding size per family, which is probably attributed to an increased land fragmentation due to a larger family size.

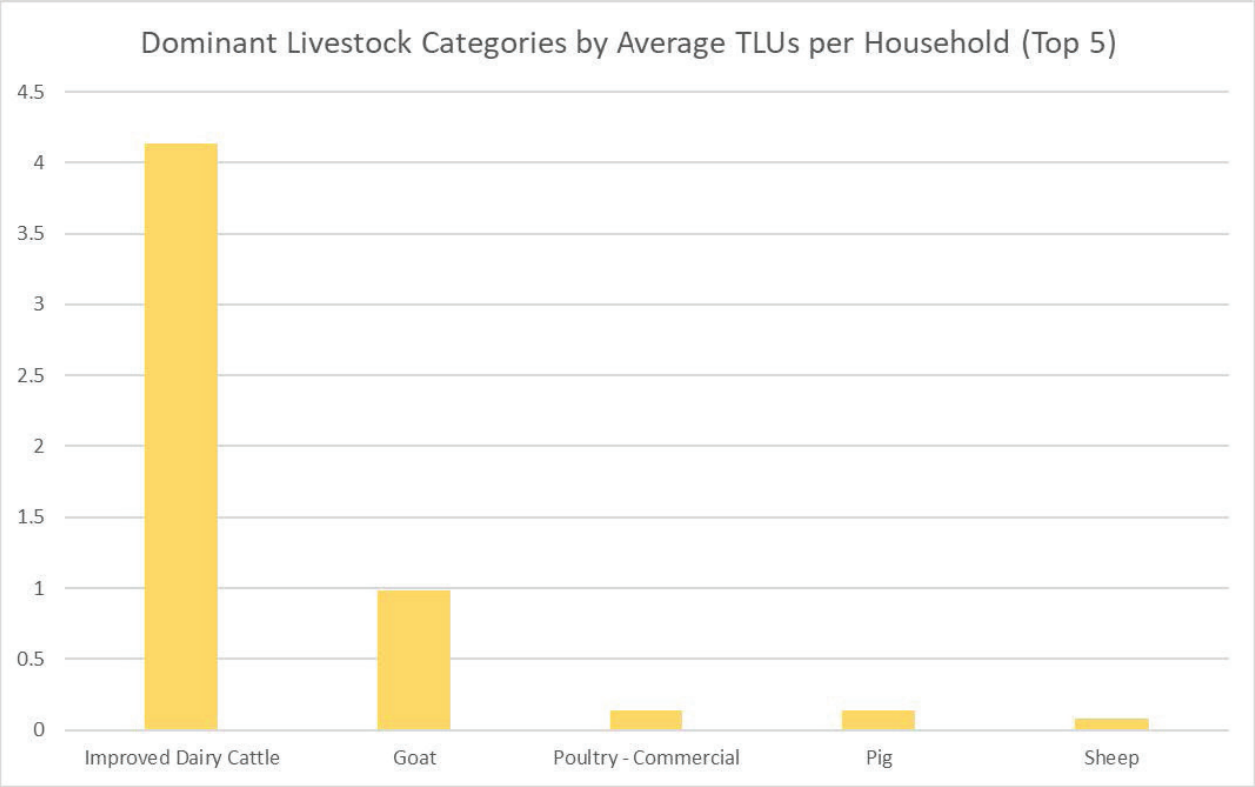
Table 1: Proportion of households who own different land sizes in Nyanza district

Category of farmers	Range of land size	% of households that fall into that category
Landless	0	0
Small farmers	0.5–1.0	70
Medium farmers	1.0–3.0	20
Large farmers	> 3.0	10

3.2 Livestock production system

The farming system in Kibilizi (Rwotso Sector) is a mixed crop-livestock production system. The farmers grow a variety of food crops and raise a variety of livestock species both as a source of food and for income generation. Figure 2 shows livestock holdings on TLU basis. Improved dairy cattle are the most important species followed by goats.

Figure 2: Dominant livestock categories by TLU per household



3.3 Livestock holdings per household by farm size

On average, most households have two to three milking cows. In addition, sheep, goats, pigs and poultry are also raised by farmers for quick sale when funds are required for household expenditure.

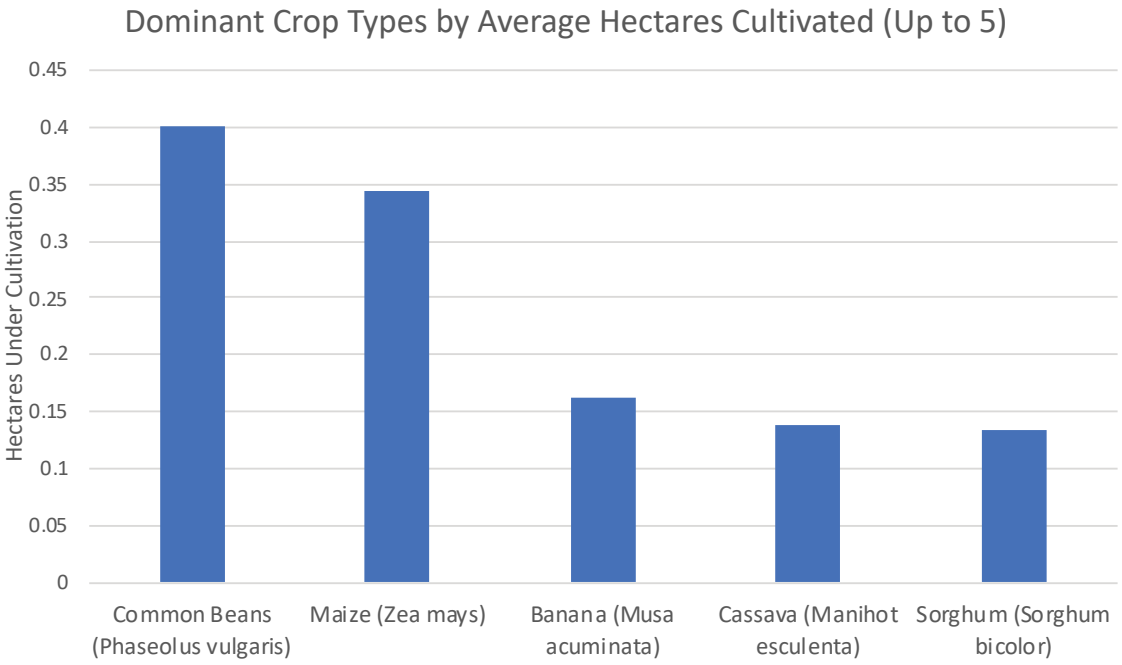
Many small farmers keep 3–4 goats. However, large farmers can keep a larger number of goats. Sheep are kept mainly by large-scale farmers for commercial reasons. Indigenous chickens are kept by households to meet household meat, egg and cash needs, whereas commercial chickens are kept only by large-scale farmers for purpose of income generation.

Cattle are kept not only for milk and cash income from animal sales, but also for manure. Each household also raises a variety of other livestock species for various purposes. Improved dairy cattle are mostly local Ankole cows crossed with Friesian or Jersey breeds. They are kept by approximately 86% of all households. Even if the traditional Ankole cattle are still present on many farms, their number is declining due to poor milk production. Farmers tend to keep improved breeds which give higher milk yields and hence cash income to the households.

3.4 Crop production system

Farmers reported that they grow a variety of food crops dominated in terms of area under cultivation by common beans (*Phaseolus vulgaris)* and maize (*Zea mays*). Those two crops are followed by bananas (*Musa acuminate*), cassava (*Manihot esculenta*), sorghum (*Sorghum bicolor*) and groundnuts (*Arachis hypogaea*). Crops are grown primarily as sources of household food, and secondarily for income generation. The average area of land used for production of food crops is shown in Figure 3.

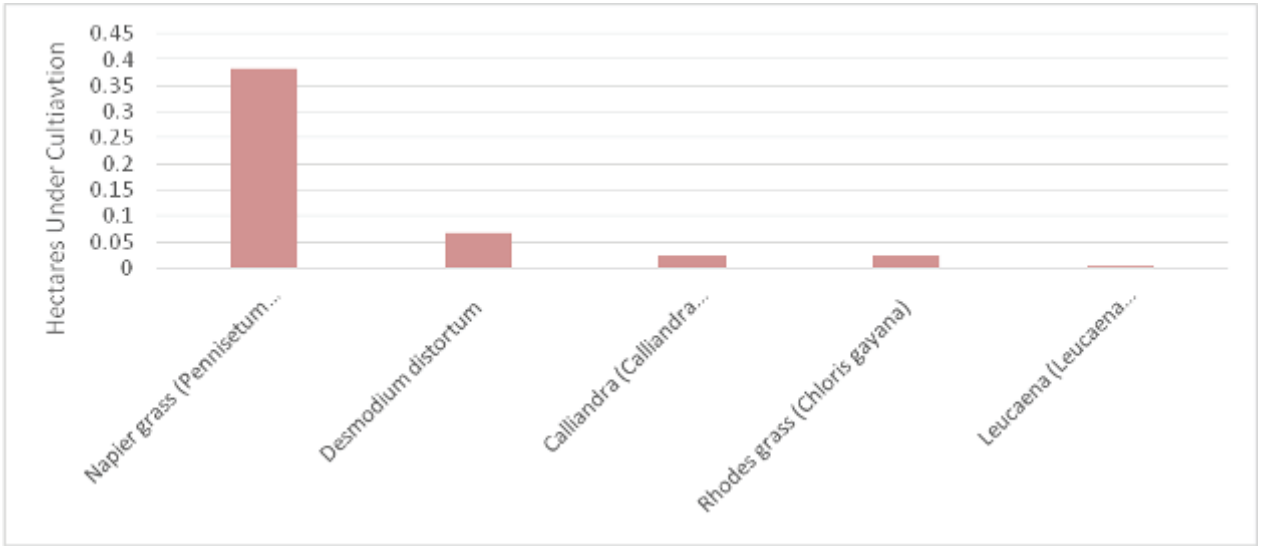
Figure 3: Dominant crop types by average hectares cultivated



3.5 Forage crop production

A variety of forage crops are grown by farmers in Nyanza district. The most common cultivated fodder is Napier grass (*Pennisetum purpureum*) and, to a lesser extent, *Desmodium intortum*. The average area of land used for fodder crops is shown in Figure 4. However, as discussed in section 3.7, the contribution in terms of dry matter, metabolisable energy and crude protein of such cultivated fodder remains disproportionately low.

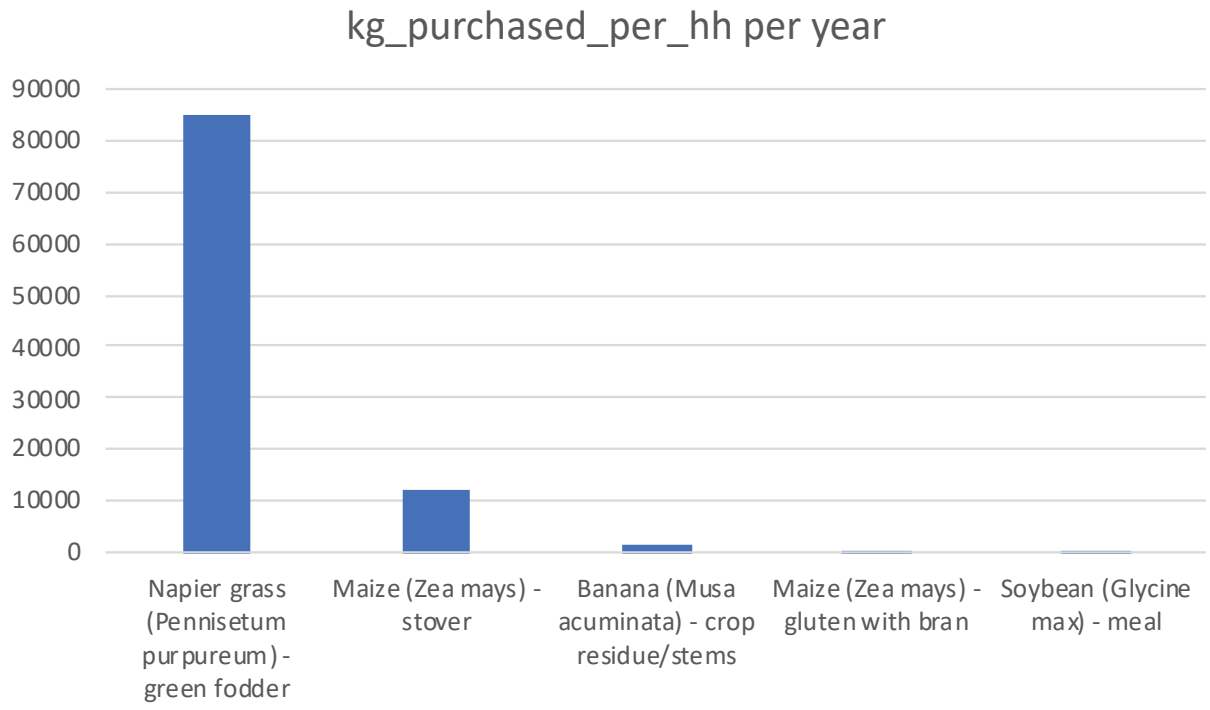
Figure 4: Dominant fodder crops by average hectares cultivated (up to 5)



3.6 Purchased feeds

Maize stover is a commonly purchased feed type by smallholder framers in Rwotso village. This may be related with the fact that maize is one of the most important crops cultivated in the area. The second most purchased fodder crop is Napier grass, followed by Banana pseudo stems. Maize bran, soybean meal and cotton seed cake are negligible in terms of purchased feeds for livestock feeding (Figure 5).

Figure 5: Dominant purchased feed types by kg purchased



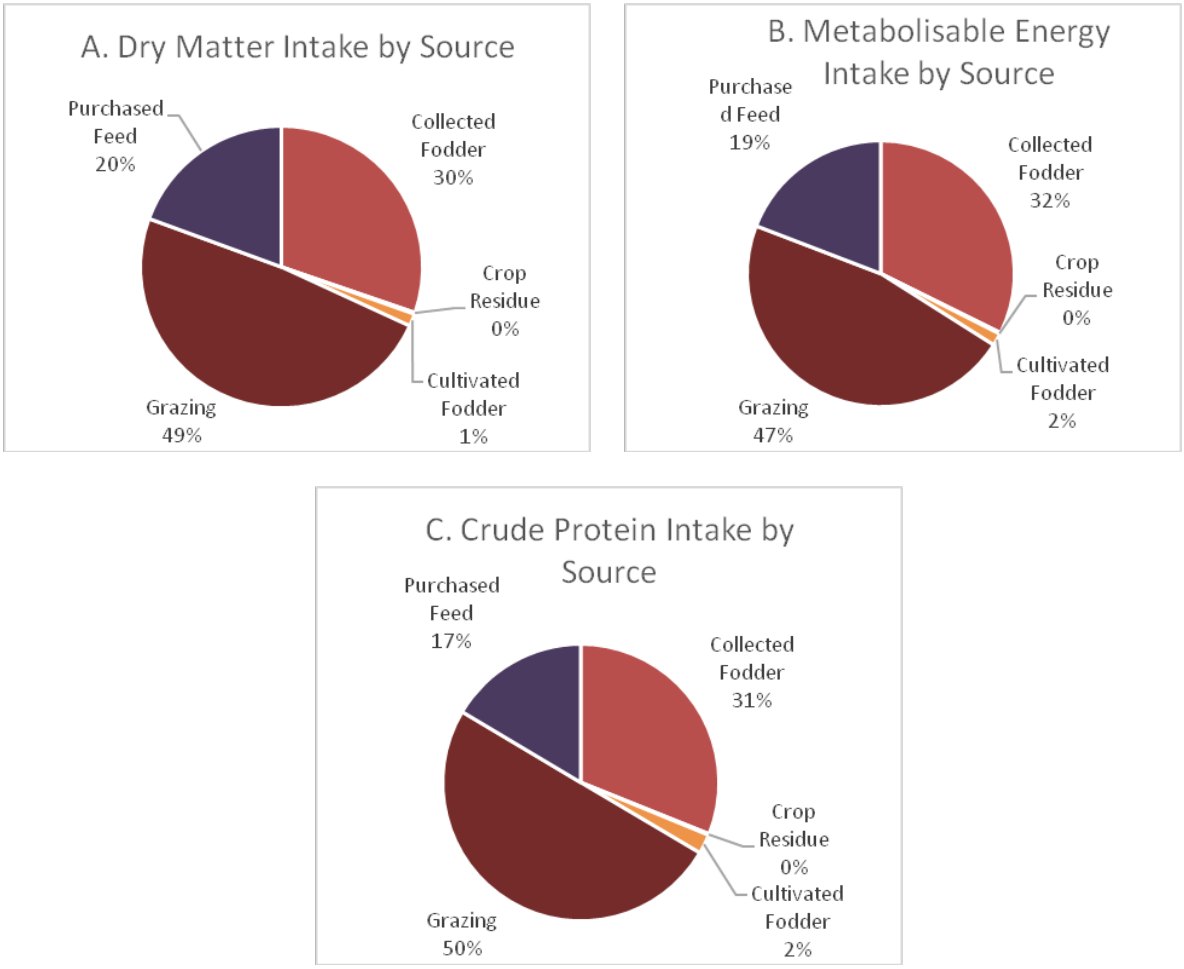
3.7 Contribution of feeds to dietary requirements

Green forages harvested from roadsides, weeds, cut fodder crops, tree leaves, together with natural grazing contribute the largest proportion of the feed base. Natural grazing is the highest (49%) contributor to the dry matter (DM) intake of animals in the area (Figure 6A). Collected fodder is the second feed resource contributing almost 30% of the diet's DM. Cultivated fodder crops contribute only 2% of the DM, suggesting lack of cultivated fodder component in the system.

In terms of metabolizable energy (ME), grazing contributes about 47% of the ME of the feeds consumed by livestock (Figure 6B). The second important contributor to the ME of livestock feed is collected fodder (32%). About 19% of the ME is contributed by feeds purchased from the market.

Grazing also plays an important role in supporting existing smallholder livestock with critically needed crude protein (CP) supplies. About half of the CP supply available to livestock in Rwotso is derived from grazing (Figure 6C). Collected fodder and purchased feeds each contribute about 31% and 17%, respectively.

Figure 6: Contribution of feeds to total dietary requirements in Nyanza district (A): dry matter (DM); (B): metabolizable energy (ME) and (C): crude protein (CP)

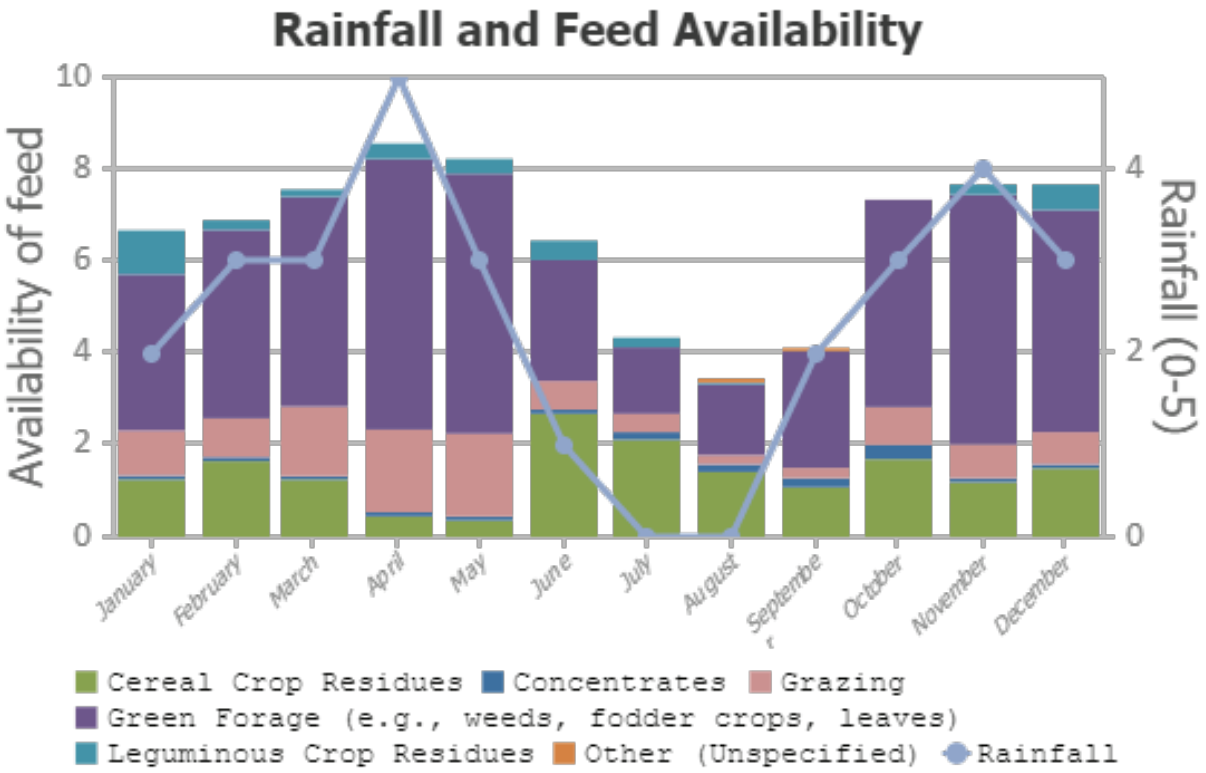


A considerable proportion of forage is produced on terraces and on the bunds of ditches built for erosion control. For the farmers who do not have animals, this fodder is sold to livestock farmers to increase their revenues. This opportunity highlights a possibility to promote fodder production on these niches to increase the level of fodder production in the area.

3.8 Major feed resources available throughout the year

In terms of supply of feed resources, green forages are the most abundant throughout the year (Figure 7). The five most commonly available and used feed resources are green forages (roadside weeds, cut fodder crops and tree leaves), cereal crop residues, leguminous crop residues, grazing and concentrates. However, the contribution of grazing is considerably reduced during the dry season beginning from mid-June to September. Major fodder crops are grown during the rainy season from October–January and February–June. Farmers also feed small amounts of concentrates throughout the year, mainly from July–October, which corresponds to the months of forage shortage. The system appears to be devoid of herbaceous legumes and leguminous crop residues throughout the year. This constitutes one of the major problems faced by farmers in the district. The integration of such leguminous feeds into the existing system will certainly serve as cheap alternative source of protein for livestock.

Figure 7: Feed resources available in Rwotso throughout the year in relation to rainfall pattern

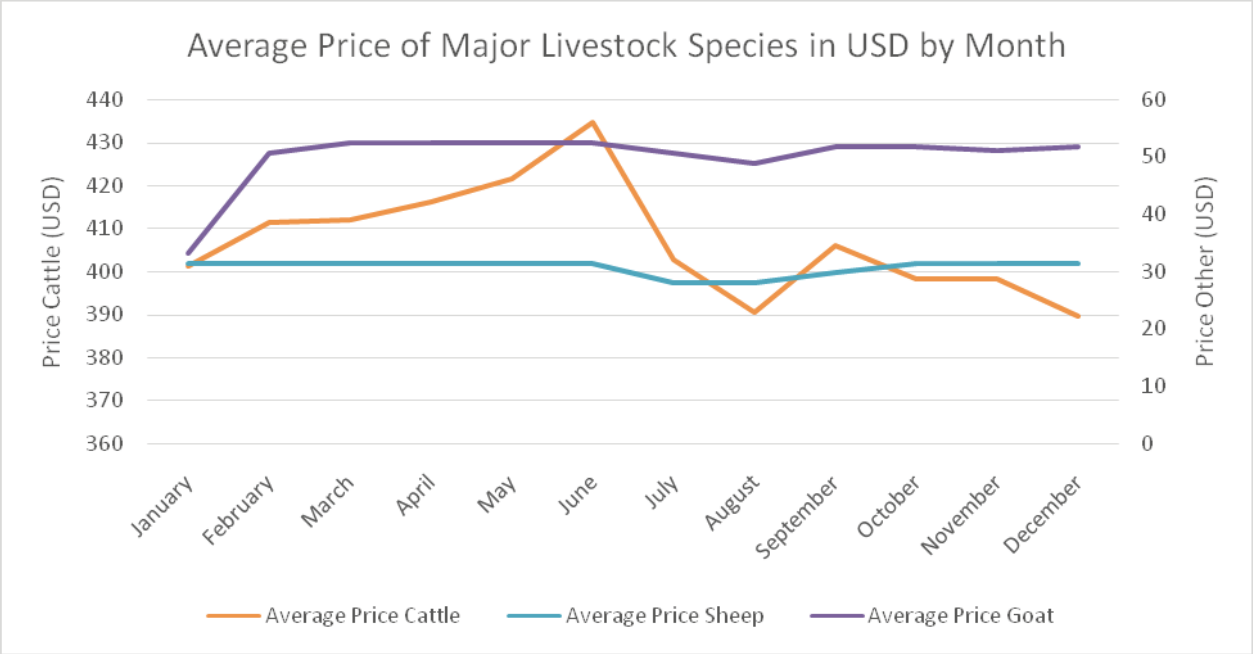


Concentrates constitute a minor fraction of the livestock ration, and if used, are reserved for improved breeds (Friesian) especially during the dry season when there is a drastic shortage of feeds. Concentrates formulated at the farm level are composed mostly of maize bran. Farmers also reported that they can buy a supplementary concentrate (dairy meal) but at a relatively expensive price of RWF230 (USD0.2) per kg.

3.9 The price of different major livestock species

Figure 8 shows the monthly variation in the price of cattle. Prices tend to rise during the early dry season (May–June). Farmers attribute this price inflation to an increase in fodder production in the wet season that leads to improved body condition of animals. It can be observed that the price of cattle falls considerably towards the end of the year. This is due to a large number of animals brought to the market in this period of the year as many households need to secure school fees for their children. The increased supply of cattle observed during this period is also closely associated with Christmas and New Year when meat consumption increases. This means that the price of cattle tends to fall due to a larger offer on the market. The price of sheep and goats, compared to cattle, is relatively constant throughout the year in the area. This is because the market demand for such animals is uniformly spread throughout the year.

Figure 8: The average price of different major livestock species (in USD by month) on farm in the area

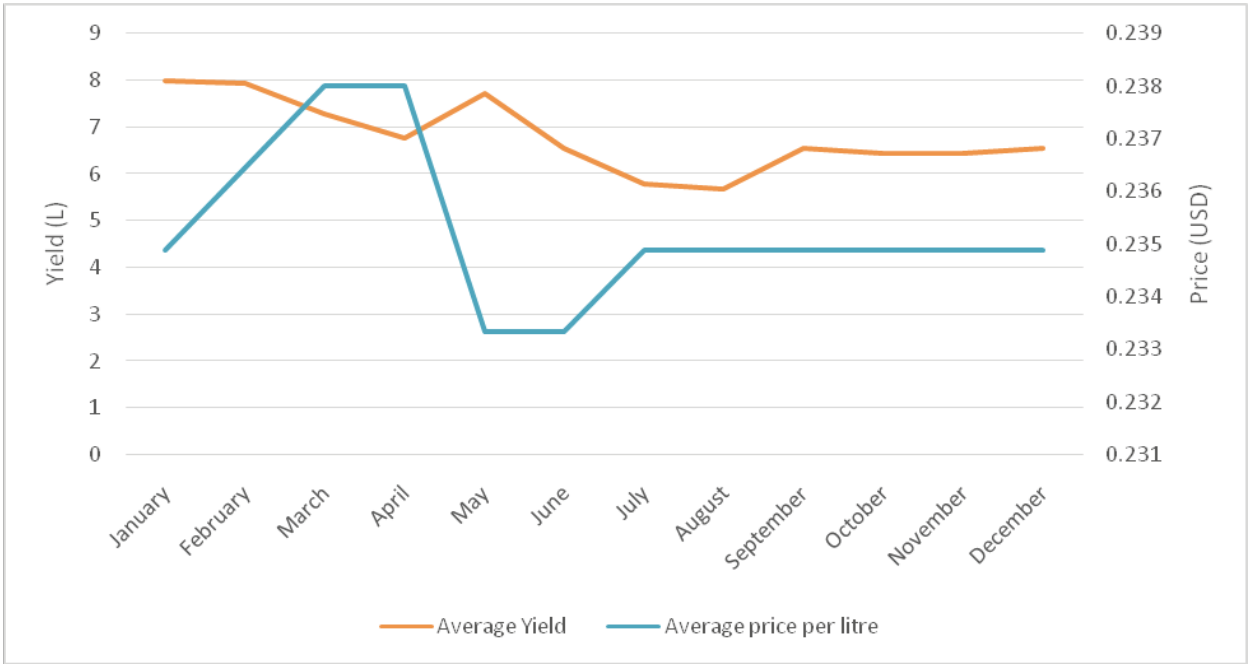


3.10 Daily milk yield

The average milk production per cow per day is 2.5 litres. As illustrated in Figure 9, the average daily milk yield goes down from January–March and starts to increase from Apri–May. From June–August, the daily milk yield goes down considerably with a slight increase in September and becomes constant up to December. This fluctuation follows the rainfall pattern and forage production with more rainfall observed in the months of April, May, September, October, November and December. During these periods, the forage availability is at high level, which increases the milk yield. Hence, milk price goes down because of high amount of milk on the market.

Wide monthly variations are observed in the price of milk. There are some months when the price depends on the milk yield, whereby the price is reduced when milk supply is high. However, smallholder dairy farmers in Rwotso appear to be little affected by price fluctuations as most are members of dairy organizations with milk collection centres (MCC). Generally, prices tend to increase from January–April and fall May–June. Smallholder dairy farmers sell their milk to the MCCs or in the local market centres for an average of RWF170 (USD0.19) per litre throughout the year.

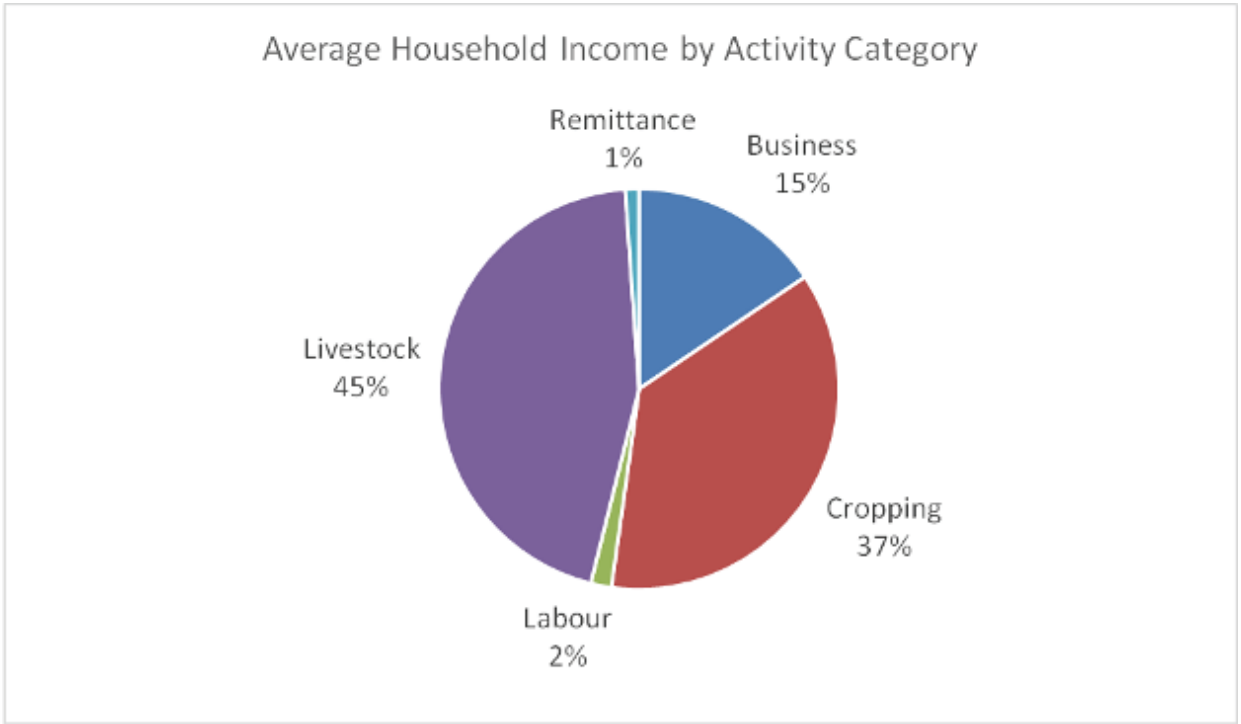
Figure 9: Average daily milk (litre) vs average price received per litre (USD)



3.11 Household income

Figure 10 shows that most household income comes from livestock and cropping. Livestock contribute 45% of household income while crops contribute about 37%. Off-farm activities like business, labor and remittances contribute limited income, totaling 18% of the household income.

Figure 10: Average household income sources by activity category



The reason behind this distribution is that agriculture in this area serves as a subsistence activity, while milk is a main source of cash income through selling of milk via the MCCs. Another factor underlying the high proportion of income from milk in the total household income is the constant price of milk per litre offered by MCCs. This is beneficial to smallholder dairy farmers as it helps them to earn money on a regular basis through milk selling.

3.12 Labour availability and cost

Though the difference is not high, the average daily labor paid for women is better (USD1.5/day) than men (USD1.3/day). This slight difference in favor of women is due to the number and types of jobs done by women on farms. Weeding, postharvest handling of crops and spreading of manure on cultivated land are considered to be women's work, whereas harvesting is done by both men and women. Activities related to livestock keeping and livestock production (except milking and selling of large animal) are performed by women. When it is time to transport manure to the field, it is a heavy job and men are more involved than women. In general, most of the activities on the farm are performed by women.

4. Major problems, contributing factors and possible interventions

Table 2 summarizes the key interventions with regards to mitigating raised problems that are hindering the livestock production system in Rwotso Cell. The planting of grasses for cut-and-carry systems in special niches appears to be the highest priority intervention in order to solve the problem of shortage of feeds. However, in order to supply energy in the animal diets, concentrates and other energy-rich supplements such as molasses should be introduced (or increased) as part of the diet.

Table 2: Major constraints for Rwotso site contributing factors and possible interventions

Major constraints	Contributing factors	Suggested strategies
Feed scarcity especially during the dry season	• Lack of forage seeds • Lack of knowledge • Lack of land • Limited labor availability • Very limited amount of cultivated fodder produced during the rainy season	• Forage seed multiplication • Farmer trainings • Encouraging those who have large land size to produce more forage for sale • Maximize forage production in all niches • Improving forage fields management
Underutilized crop residues	• Lack of awareness	• Promoting the use of crop residues through trainings and demonstration • Promoting farmer to farmer learning
Lack of irrigation system for fodder production	• Less attention given to fodder production	• Rainwater harvesting • Supporting small scale irrigation schemes
Limited use of concentrates	• Less priority given to concentrates • Low purchase capacity • Lack of access to buy concentrates	• Encouraging feed processing plants and concentrate selling in proximate areas
No feed conservation strategies put in place	• Low forage production • Limited skills in forage conservation	• Increasing forage production • Trainings on forage conservation techniques (silage and haymaking, etc.)

Feeding is one of the major constraints to livestock production, especially during the dry season when there is a shortage of forage. The feeding practice adopted by most farmers does not consider the inclusion of adequate nutrients to cover the maintenance requirements and a certain level of milk production. There is also no forage conservation. The use of agricultural by-products is very limited and only used when farmers face shortage of forage. In the dry season, feeding of livestock is heavily constrained by both poor quality and insufficient quantity of forage. This means that the level of milk production decreases considerably and dairy cows lose condition and weight.

Forage cultivation could be one of the solutions to mitigate this problem. However, land shortage is a critical hindrance to the cultivation of forage on farm. The very limited income of farmers in the area limits the purchase of inputs, especially concentrates, to supplement forage and achieve a higher level of animal production. Financial services are also not available because of the requirement for collateral. Farmers are requested to provide guarantees when they have no assets. They rely only on self-help savings groups in case they need financial support.

5. Major interventions proposed by the farmers during farmers' group discussion

Intervention 1. Maximization of forage production in all niches by introducing suitable forages and raising awareness of the farmers on forage production through trainings

The objective of this intervention is to help farmers increase their on-farm feed production capacity through the introduction of adapted forage species/varieties. As land is limited and mainly used for crop cultivation, the strategy will be to integrate forages on arable lands in such a way that the crop and forage cultivation complement each other. Forage growing niches, including alongside feeder roads, terraces and ditches on arable lands, farmland boundaries, the surroundings of the marshlands, forests and public areas will be targeted. In order to obtain quality seeds of forages, selected forage seed multipliers could be supported, and the produced seeds distributed to farmers through subsidized sales. The MCCs could be used as the selling point to facilitate easy access to forage seeds by farmers.

The types of forages will include high yielding grasses, herbaceous legumes and fodder trees. While grasses will be planted on terraces and along boundary lines, the herbaceous legumes will be planted underneath perennial crops such as banana, whereby they provide forage but also prevent the loss of water by limiting evapo-transpiration from the soil. In addition, fodder trees will be integrated into the cropping system, both in public and private lands, to serve multiple functions in addition to providing high-quality year-round feed.

The intervention will be started by selecting potential farmers who would be willing to allocate land to test the proposed technologies, followed by farmer sensitization/awareness creation and sourcing planting materials/seeds/seedlings. A series of on-farm trainings will be conducted involving land preparation and seeding, forage and seedling management, proper harvesting and use of cultivated forages, conservation and ration optimization using locally available feeds and cultivated forages. Data collection protocols will be developed to monitor survival and yield performance of planted forages, farmers perceptions/evaluations, level of input in terms of labor (fertilizer) and increases in yield of milk due to the new intervention. Government institutions, nongovernment organizations, farmer cooperatives and farmer field schools could be used to conduct farmer trainings.

Intervention 2. Encouraging farmers who have large land size to produce more forage for sale

Forage production could be used not only by livestock keeping farmers, but also by other interested farmers as a business. In this way, forage produced could be sold to livestock farmers who face feed shortages but have sufficient financial resources to purchase feed. To make this happen, the forage sellers need to have enough land for forage

production and the required equipment for forage mowing, baling and stacking. They also need to have strong skills in marketing of their business in order to make it known by the buyers. Government institutions like RAB could provide technical support, while financial institutions could provide loans and trainings.

The most important requirement for this business is land for forage production. This can be obtained by buying, renting or free of charge from the local government, as this activity is relevant in solving the problems linked to feed availability in livestock feeding.

As this business is labour demanding, it will at the same time provide employment to several citizens in need and consequently boost the local economy. In addition, other business opportunities will be created including transportation of feeds and market intermediaries.

Intervention 3. Promoting the use of conserved forages through trainings and field demonstrations

Forage conservation during the rainy season is a key element to allow the intensification of dairy farming in the region. The objective of this intervention is to equip farmers with the necessary skills to properly conserve feed for use during times of scarcity. The intervention also aims to promote fodder market and feed transaction in the form of hay. Although there is feed scarcity during the dry season in this district, the climate is conducive for rainfed/ irrigated forage production on targeted niches. This intervention, therefore, addresses how the available potential can be exploited adequately. The intervention will involve training and skill development among farmers about haymaking and baling for commercial or local consumption, silage making for on-farm feeding, crop residue conservation and processing. For this intervention, groups of farmers will be selected. The farmer groups will be those who would be interested in testing conservation practices for own livestock feeding and for commercial purpose. In the latter case, the farmers will be those who can allocate enough land for forage production. Training modules and manuals will be developed for each of the feed conservation technologies. The necessary training equipment and materials will be purchased for demonstration and training of farmers. Training programs will be developed and offered on various aspects of conservation practices. In this respect, the on-going RDDP collaboration with RAB will be exploited to provide the training to the Livestock Farmer Field School (LFFS) facilitators. Other stakeholders who are working around the feed and fodder value chain will be engaged in the delivery of the training. Data collection protocols will be developed and used to monitor the impact of the different trainings on the level of awareness of farmers and adoption of conservation practices.

6. Conclusion and Recommendations

6.1 Conclusion

The farming system in Rwotso Cell of Nyanza district in southern Rwanda is primarily dominated by subsistence-based crop-livestock mixed farming system.

- Feed scarcity, especially in the dry season, is a major constraint with very limited amount of cultivated fodder produced during the rainy season.
- There is no irrigation system for fodder production.
- No feed conservation strategies are in place.
- Crop residues are available during crop harvesting periods but underused because farmers do not have the skills required to process crop residues for livestock feeding.
- The limited use of concentrates in animal feeding contributes to the poor energy status of animals.

6.2 Recommendations

- Farmers need to introduce appropriate fodder conservation options when excess green fodder is produced during rainy seasons to ensure availability of adequate feed throughout the year.
- It is necessary to introduce suitable cultivated forages into the system.
- It is also recommended to implement small scale irrigation schemes to support enhanced fodder production.
- More efforts should be put in supplementing the diets of animals with energy-rich by-products like cereal bran, molasses and other concentrates.
- Overall, farmers are concerned with low milk price offered by the MCCs; this is a disincentive for farmers to invest in better feeding to produce more milk. In addition, incentives for supplying quality milk to the collection centers is not put in place.

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Annexes

FEAST key interventions for Rwotso site, Nyanza district. Scores out of 20 are derived from the intervention ranking analysis of FEAST

Key interventions	Mitigate core constraint	Relevance to commodity	Relevance to farm system	Match context attributes	Production impact
Grasses or cut and carry systems (cut from cultivated fodder field under rainfed)	20	20	20	15	20
Short duration/annual fodder crops (e.g. oats, maize, sorghum and vetch)	20	20	20	13	20
Irrigated fodder production (grasses, maize and sorghum)	19	20	20	13	20
Supplementation with energy-rich supplements, e.g. molasses	14	20	20	14	20
Supplementation using protein by-products, e.g. from meat, blood and bone, fish, legume leaf meal, biofuel co-products, oil seed, poultry litter, etc.	14	20	20	12	20

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