Assessment of existing and potential feed resources to improve livestock productivity in dryland areas of Niger

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Assessment of existing and potential feed resources to improve livestock productivity in dryland areas of Niger

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Summary

Inadequate quantity and quality of feed resources are major factors limiting productivity of livestock systems in the Sahelian zone of West Africa. The possibilities of improving the livestock production systems by assessing potential feed resources and identifying points of intervention was investigated using Feed Assessment Tool (FEAST) in two villages, Milli and Gourdjia in Maradi region of Niger. Results from focus group discussions and individual interviews indicated that mixed crop-livestock production systems are dominant in the study sites. Main livestock feed resources in the study sites were natural pastures, crop residues and agro-industrial byproducts particularly wheat bran. Results further showed that farmers depended on purchased feed which included crop residues, bush hay and cereal brans as major source of feed contributing more to the total diet of the livestock. Farmers were faced with low agricultural productivity due to declining soil fertility, declining grazing area principally due to expansion of cultivated land. Consequently off-farm businesses became a major strategy for sustaining their household. Provision of technical knowledge on how to improve the quality of existing feed resources and health management facilities will enhance productivity.

Introduction

In Niger, a landlocked country in West Africa, crop and livestock production are the mainstay of the national economy, with 35% of the agricultural gross domestic product (GDP) from livestock and thus 12% of the total GDP (Geesing and Djibo, 2006). Agricultural and pastoral activities are carried out in different distinct major agro-ecological zones one of which is the Sudano-Sahelian zone covering the southern part of the country, receiving 600 to 800 mm of rain per year, and being most suitable for agriculture which is mainly rainfed.

Map of Niger

Source: Geesing and Djibo (2006)

Despite the growing pressure on land resources and the associated rise in competition over natural resources, nearly three-quarter of the labour force is employed in subsistence farming and livestock rearing. Livestock, including cattle, sheep, goats, and donkeys, are kept by most farmers to complement crop activities. The ruminants provide manure for crop production and are valued as assets that can be readily liquidated to meet household and farm financial obligations. Nigerien breeds of cattle such as the Azawak or the Kouri rank among the best dairy cows in West Africa. Feed scarcity remains the major obstacle to the development of the livestock sector in Niger and is largely responsible for the poor performance of livestock. To harness the potentials of livestock production in this area, constraints of feed resource should be addressed. To achieve this, it is imperative to understand the feed resource base in the study sites in order to provide site-specific interventions.

The objective of the study is to understand the current status of the farming systems in this area, collect up to date information on feeds resources and feeding strategies in order to guide appropriate research interventions that will improve livestock productivity and related livelihoods.

Materials and methods

Description of study site

This study was carried out in Maradi region of Niger which is one of the seven regions in the country. It is located in the southern part of the central Niger to the east of Tahoua region and west of Zinder region. Maradi is divided into 6 administrative districts namely: Aguie, Dakoro, Guidan Roumdji, Madarounfa, Mayahi, and Tessaoua Departments. Maradi region falls within two agro ecological zones namely Sahelian in the North and sahelo-sudanian in the South with 300 - 600 mm/year of rainfall. The principal cereal crop in this region is pearl millet, which is grown, either as a sole crop or intercropped with cowpea. Where the land quality permits, sorghum and maize are also grown. Cereal production is principally geared toward household consumption, although periodic sales occur when money is needed to meet household obligations. Cowpea and groundnuts are considered as both cash and food crop.

Two villages, Milli and Gourdjia were selected for the study. These two villages are within Aguie administrative district of Maradi region and about 30 km to the border of Nigeria.

Methodologies

Focus group discussions and individual interviews were conducted in the study communities to evaluate existing and potential feed resources using Feed Assessment Tool (FEAST) which was developed by ILRI (Duncan et al., 2012). FEAST comprises Participatory Rural Appraisal (PRA) using semi-structured questionnaire for focus group discussions and individual interviews.

Implementation of the survey

About twenty farmers including women were selected to participate in group discussions using the participatory rural appraisal (PRA) approach to provide an overview of the farming system and to identify constraints and opportunities for improving livestock production in the study sites. For the individual interviews, 12 farmers were selected from those who participated in the group discussions to represent 3 wealth endowment categories namely average, above average and below average in line with wealth ranking by the communities. Four farmers from each category were individually interviewed to collect quantitative information on feed resources and feeding practices. 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 PRA surveys and individual interviews were entered into the FEAST excel template (www.ilri.org/feast) and analyzed. Results are presented in in tables, graphs, Pie and bar charts.

Results and discussion

Overview of the farming system

The results of the survey show that farming system in Milli and Gourdjia is a mixed crop-livestock production. Mixed crop-livestock farming form the dominant farming system in the developing world (Herrero et al., 2010). Particularly the Sahel areas, livestock keeping is a central livelihood element these mixed systems (McIntire et al., 1992). Crop production was rainfed in Milli and Gourdjia and this limited the cropping season to only once in a year. This cropping season, is called Damane which starts from June to October. Farmer also practiced off-season farming from November to January. Farmers reported that the month of May and June were used for land preparation for the planting season (table 1).

Table1. Names the cropping seasons that occur in Milli and Gourdjia

Name of season	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Raining season(*Damane*)												
Cold dry season (off-season farming)												

Crops grown in both sites and average land area cultivated per household were presented in Figures 1 and 2.The major crops grown in the areas were millet, sorghum, cowpea, groundnut and sesame which were intercropped on the same farmland in succession due to shortage of fertile land. Pearl millet was the dominant crop in the area followed by sorghum while cowpea was the dominant leguminous crop in both study sites.

Different authors have clearly underlined the importance of intercropping especially for smallholder farmers in view of its profit maximization, risk minimization against total crop failure, soil conservation and improvement of soil fertility, weed control and yield (Shetty et al., 1995; Mpairwe et al., 2002). The most common associations of crops in this region have been reported by Bationo et al. (2005). Authors found that cereal/cowpea, cereal/groundnut, and cereal/ cereal such as millet/sorghum/maize and millet/sorghum/cowpea are the combination of intercrops in Sudano-Sahelian region of West Africa. In these systems pearl millet is normally sown first and acts as the dominant crop (Bationo et al., 2005)

According to the farmers, during the main cropping season, Pearl millet was planted first and then Sorghum in alternate rows, thereafter cowpea and groundnuts were sown. Pearl millet and Sorghum were the dominant crops in Gourdjia.

Other crops grown in the study site included maize, Bambara nuts, sesame and potatoes. The cold dry season is characterized by dews and fogs with little or no rain. The major crops grown in this period were cabbage, tomato, lettuce, carrot, sweet pepper and onions. These off-season crops grown are mainly used as a means of income generation.

Figure 1: Crops grown in Milli and average area of land cultivated per household.

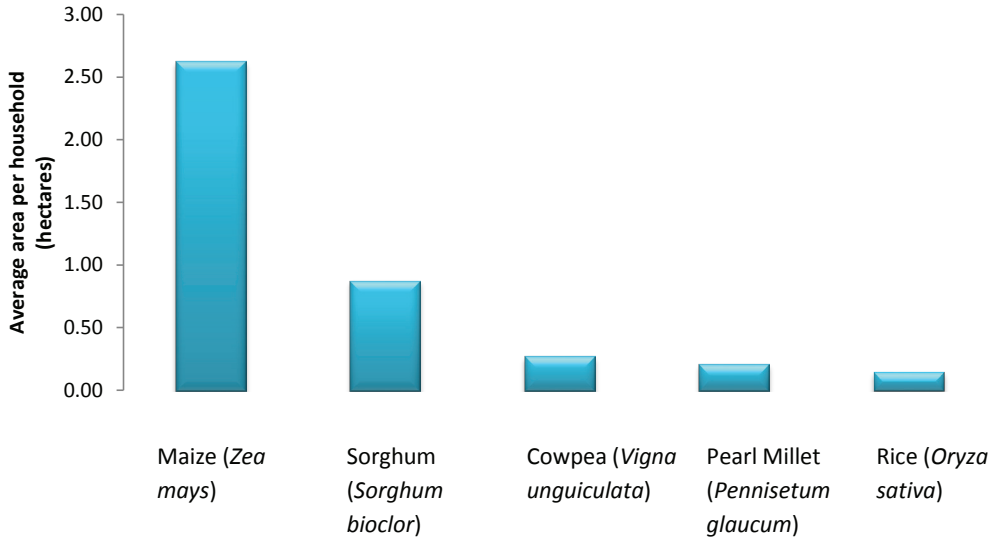
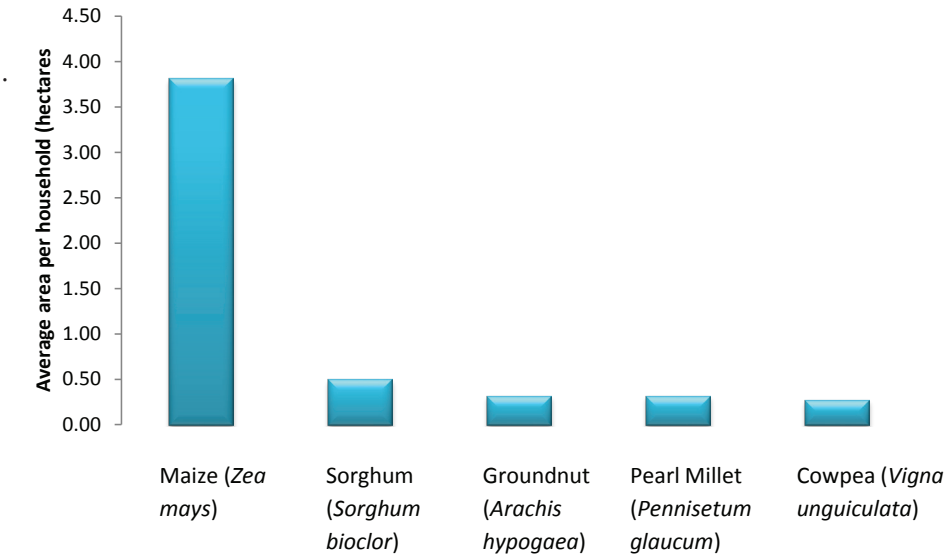


Figure 2: Crops grown in Gourdjia and average area of land cultivated per household.



Since all agricultural activities were land determined, farming is limited by lack of access to fertile land in the study sites. Farmers reported that lands were inherited from their parents and over each generation, the same land areas were shared among increasing number of family members which often resulted in declining available land. Moreover, the limited available land was reported to be low in fertility due to soil degradation resulting from continuous cropping. This major factor was reported to have led to reduction in crop productivity and income generally. It also contributed to low quantity of crop residues as major feed resources and consequently low livestock population. Besides rainfall, soil fertility appears to be more limiting to crop and fodder production in the Sahelian zone (Penning de Vries and Djiteye, 1991). The use of rotation systems, organic and inorganic nutrients combinations and water harvesting technologies and increasing the legume component for better integration of crop-livestock production systems has been suggested to mitigate the problem of soil fertility in the Sahel (Bationo, *et al*., 2005). Identifying alternative nutrient sources, promoting efficient use of existing nutrient resources and settled livestock production for increasing manure production were recommended by Bidjokazo *et al* (2012).

There were no irrigation facilities in Milli. Farmers only practiced traditional irrigation using buckets to water their small area of cabbage and other dry season vegetables.

During the hamattan cropping season in Gourdjia, lowland areas of about 3 hectares were usually cultivated. This is known as fadama farming and 80% of the household in Gourdjia had at least about 0.02 ha. In this area of land there was a minor irrigation facility which comprises of a borehole and water pump (Plate1). These were used to lift water from the borehole supply and distribute water to the area through channels and canals. This initiative was sponsored by the government of Niger. Farmers acknowledged that the fadama farming had contributed to their income especially in dry season. The role of irrigation in poverty reduction had been studied extensively in northern Mali. It increased both household savings and informal social insurance in the form of transfers (Dillon, 2008).

Plate 1: Irrigation system in Gourdjia.

According to the farmers, there was all-year round household labour for farming activities in both sites which was mostly required shortly before and during rainy season for land preparation at 1000 CFA ($2.2) per day for adult equivalent plus lunch.

On average, according to the farmers, about 2 people in a household normally leave the village for cities on yearly basis in search of better employment opportunities or for business. These people return to the village only during the festive period or at the end of each year while some return during the raining season for cropping activities. This leads to seasonal or permanent migration of people especially men to pursue other means of livelihood. In Gourdjia, out-migration is mostly into cities in Nigeria across the border to seek other economic opportunities.

In Gourdjia, farmers described that farming activities such as land preparation, planting, and farm maintenance and herding have suffered greatly as a result of migration. Women and the remaining family members work harder and some even employ farm labourers as a result of out-migration of their family members. However, farmers in Milli viewed that out-migration did not result in decrease in agricultural output. They reported that remittances sent home by out-migrants is use to support agricultural activities by hiring more labourers and increasing agricultural output. Similar response was reported in East Gonja District of Northern Ghana (Batigna, 2004). Nyamieri (2011) also reported that migration was part of an income diversification strategy where remittances are being sent to the farm household to help reduce the risks incurred in both subsistence and agriculture activities in Nyamira district of Kenya.

Farmers noted that besides land, another constraint to agricultural production was lack of access to credit or financial facilities. There was no available credit scheme either by the government or private sector in the community. The farmers therefore established a cooperative society in 2013 where each farmer contributes certain amount and then later can access loan. However, the available cash in the cooperative's account was very low to provide loan to all

the members. Access to financial services by small scale farmers had been reported to have a potential to make a difference in agricultural productivity, food security and poverty reduction (Kalunda, 2014)

Lack of access to agricultural inputs such as fertilizers, improved seeds, tractor services or any other forms of inputs was another major problem in study sites. This is due both to distance to the city and lack of money to purchase the inputs when available. According to the report of Powell et al (1996), lack of access to agricultural inputs is one of the common constraints to crop-livestock systems in the Sahelian region of West Africa.

Household characteristics, land holding and land use pattern

Majority of the households in Milli were in the category of smallholder farmers with 1.5 ha of land on average (Figure 3) while 10% of the households in Milli were landless farmers. Large land holding framers owned more than 3 ha of land. From the results of the surveys, approximately more than half of the farmers in Gourdjia were categorized as small land holder farmers cultivating about 1 ha of land (Figure 4). About 30% of the farmers fell into medium land holder while both landless and large land holding farmers accounted for 10% each in the village. Rainfed mixed cropping system combined with few numbers of animals was the main livelihood strategies of most households in the study site.

Figure 3: Average cultivated land area per household in Milli.

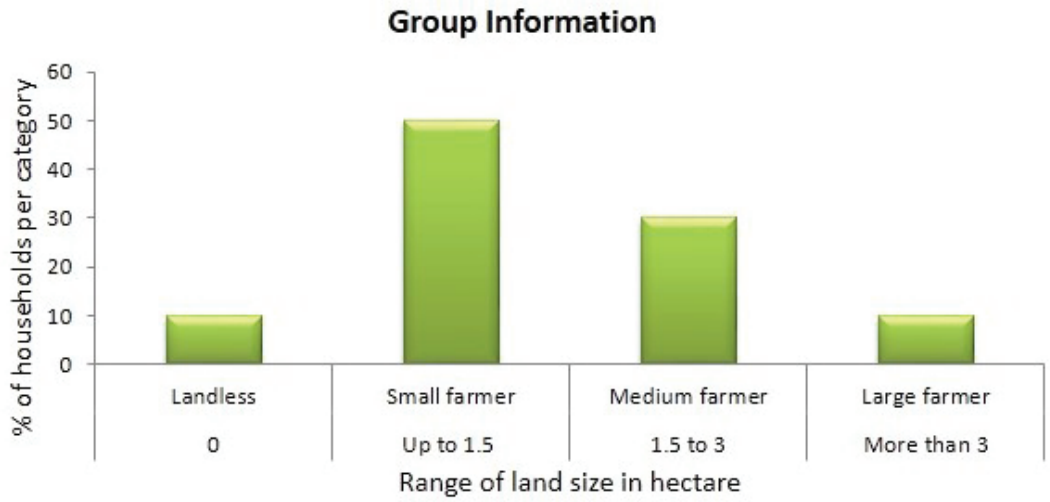
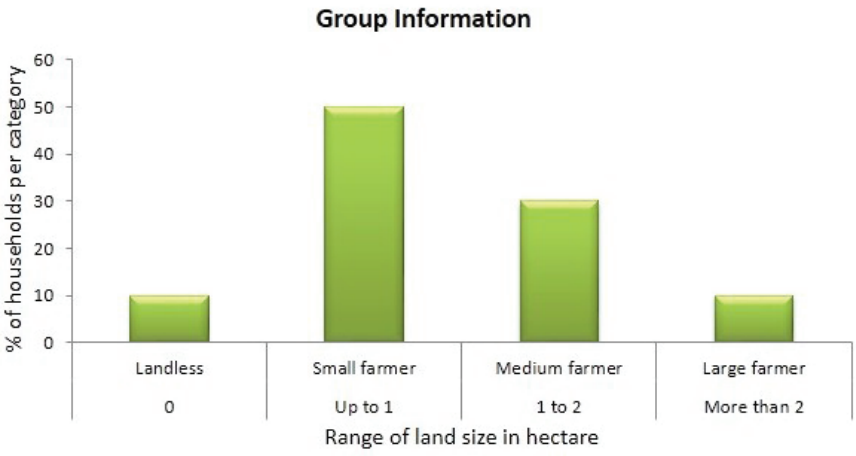


Figure 4: Average cultivated land area per household in Gourdjia.

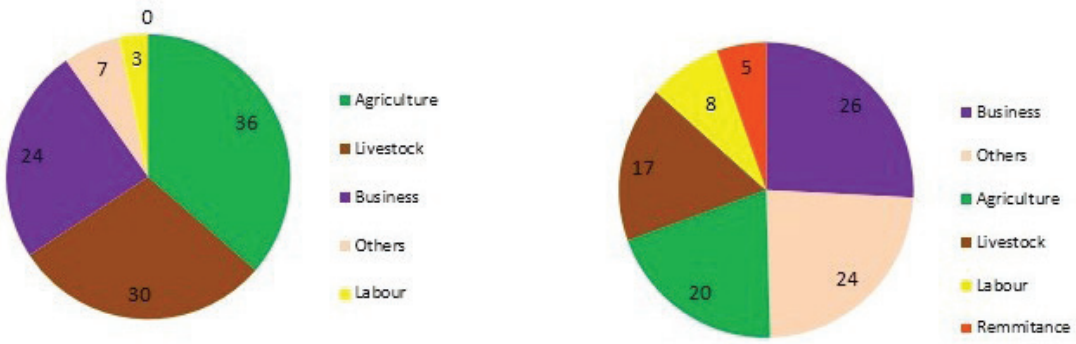


Major sources of household income

Crop production was the main contributor to household income followed by livestock production in Milli. However, other businesses and off-farm labours contributed more to the household income than livestock production (Figure 5). Some of the businesses were trading, hired labour and trade within the country and across border in other places. Due to problem of inadequate land for farming and low number of livestock over the years, farmers in Gourdjia were increasingly engaged in off-farm activities such as trading across the border with Nigeria and migration to urban centres in Niger and Nigeria for jobs. These have formed the major contributor to their livelihood income. Agriculture and livestock contributed 20% and 17% respectively to the farmers' income (Figure 5). From other case study from the sub-humid region of Burkina Faso, livestock rearing accounted for 34% of rural household incomes (Zonon, 2004). Specific problems facing livestock production in the Sahel could be responsible for the low contribution from livestock in the study sites. These problems included: low and variable forage availability and poor quality, water scarcity, low animal production, high mortality rates, low and declining soil fertility (Ayantunde *et al.*, 2008)

In Gourdjia, other business and labour work outside the village contributed 26% and 24% to the household income, respectively which is more than livestock production (Figure 5). In the rural Sahel, livelihoods are not only about cultivation of fields and securing a yield because farm work only takes place during the few months of the rainy season every year. Farmers are involved in all sorts of petty trading, and non -agricultural rural employment is a substantial part of their income and living strategies (Bryceson 1997). From the farmers' responses, engagement in off-farm business increased due to increased population and the pressure on the available and degraded land. Similar increase in the number of off-farm business was reported in Maasailand, Kenya where income diversification and remittances ac¬counted for more than 50% of the rural family's income (Nkedianye *et al.*, 2008).

Figure 5: Contribution of livelihood activities to household income in Milli and Gourdjia (%).



Livestock assets, roles and management

Results of livestock ownership in Milli and Gourdjia as indicated in Table 2 suggested that both dairy and draught cattle were the dominant livestock species with at least one per household. Milk from the dairy cow was mostly sold for income while draught animals are used for farm operations and later fattened to be sold. The farmers noted that after use for traction, animals that have served for some years were fattened and sold. Sheep and goats are kept primarily for income with average of two per household while chickens were also sold as need arises and during festival by very low income farmers that could not afford ram. For religious reasons, pigs are not kept in Milli. Only local breeds of livestock species are kept by the farmers in Milli and Gourdjia.

The contribution of livestock to the poor resource farmers in the Sahel in providing income to the economy of pastoral households, ensuring a means for saving, insurance and legacies was reported by Wane et al. (2009). Their contribution to soil fertility in mixed systems through organic matter transfer in form of manure has been intensively studied and has been reported to result in higher yields in cropland than in production systems without livestock (Manlay et al., 2004).

During the focus group discussion in Milli, farmers reported that the number of animals per household had been reduced. Farmers explained that about 10 years ago, every household in Milli had at least 15 to 20 heads of cattle and other livestock species. However, as the population increased and land area for cultivation reduced, there was pressure on the livestock population in terms of feed availability and sale to generate income for the household. Coupled with this, there was an outbreak of poultry disease and very many household lost their birds.

Table 2: Major livestock species owned per household; their uses, proportion of households own each species and average number of animals in Milli

Livestock species	Use	Percentage of Household that owns the species	Average number of animals per household	Percentage of Household that owns the species	Average number of animals per household
		Milli		Gourdjia	
Local dairy cows	Milk, breeding and manure	35	1	20	2
Draught cattle	Draught and means of transporting manure, crop residues, harvest and a new wife on the wedding day	10	1	30	1
Sheep	Fattened for sale, manure production	40	2	40	3
Goats	Income and food	30	2	30	5
Poultry-village	Income, gifts, festival and ceremonies,	20	3	70	10
Donkeys	Transporting goods and fetching water	3	2	1	1

Majority of the farmers (80%) built sheds made of wooden pole and straws where animals are kept at night. Sheds are also used to shelter the animal after grazing during the day or when it is raining and during the planting when the animals are kept normally indoors.

The livestock management system generally practiced in both Milli and Gourdjia is extensive system. Animals were kept on grazing most of the periods of the year. However, during raining season, farmers reported that all the animals are kept at home in the sheds. This was done to keep the animals from destroying the planted crops and at this time, animals were fed natural pastures and crop residues which were either purchased or from the farmers farm. They also reported that there are local government officers who enforce the law of keeping the animals at home during the cropping season. Owners of strayed animals that damaged crops are made to pay fine.

Keeping the animals in the shed near homestead during the wet season as reported by the farmer was contrary to some previous reports. Thebaud and Batterbury (2001) stated that during the wet season, the common practice in the region is to send the animals on transhumance to pastoral zones in the northern Sahel where the animals remain until harvest of crops in the southern Sahel. However, over time, due to a number of factors such as the drought in the northern Sahel, the seasonal transhumance from southern Sahel is gradually disappearing giving way to the process of sedentarization (Daodu *et al* 2009). According to the survey conducted in Fakara in South-western Niger in 1998 on the practice of wet season transhumance, about 43% of the households managing herds of cattle, sheep and goats did not practice transhumance (Hiernaux and Ayantunde, 2004). From the results on the number of animal per household (Table 2), farmers may not practice transhumance during the cropping season because the number of animals are very few.

Feed resources are not commonly processed in the study sites according to the respondents. According to farmers in Milli, the local extension agents came and trained about 12 farmers in the village on the use of urea treatment of crop residues. However, since the training ended, no one has practiced the method in the village owing to lack of cash to purchase urea and the few number of animals owned. Such training on urea treatment was not reported in Gourdjia as farmers claimed to have never heard of urea treatment.

From the response of the farmers interviewed, major feed resources in both study sites were natural pasture and crop residues. Naturally occurring green fodder species identified included: *Andropogon gayanus, Eragrostic tremula, Pennisetum pedicelatum and Digitaria ciliaris*. These forage grasses were harvested as hay and sold in market along with some crop residues (Plate 2). At harvest, most crop residues were harvested and stockpiled on the farm, on the

animal shed or trees beside the homestead from where they are brought to the animal in the evening after grazing (Plate 3)

Plate 2: Fodder market near Gourdjia.

Plate 3: Means of storing Crop residues in the areas.

Veterinary services were provided in Milli by the regional government. The farmers normally contact Livestock Services whenever there is any need and the veterinarian often responded almost immediately. This service was made available by the government at no cost. However, farmers paid the cost of drugs as the case may arise. This cost varies depending on the nature of the treatment. However, there were no veterinary services either in or near Gourdjia. The veterinary service provided by the government for Milli, only comes to Gourdjia once in a year to vaccinate the animals. This poor veterinary service might have contributed to high animal mortality in the community as described by the farmers and could have discouraged many farmers from investing in livestock production. According to Masikati (2010), the major constraint for cattle production in the smallholder farming systems is the high animal mortality through diseases. Poor farmers have few animals and few reserves on which to survive during lean times and use for recovery, consequently, loss of individual animals has a proportionally greater impact. From farmers' response, artificial insemination (AI) services were not available in the study sites.

Major livestock feed resources and seasonal availability

Figures 6 and 7 showed the composition of feedstuffs available throughout the year in relation to the rainfall patterns in Milli and Gourdjia, respectively. At the peak of rainy season, livestock relied mainly on the available green forage resources which were cut-and-carried to the animals where they were confined to prevent damage of crop farm.

Although there seems to be more forage availability during this time, farmers reported that performance of animals in terms of weight gain was low and this affect the selling price. This reduction in weight gain of grazing ruminants in the wet season, when grazing resources were of the best quality was as a result of under-nutrition due to restricted access to grazing (Ayantunde *et al*., 2008). The authors indicated that the common practice of tethering sedentary cattle in the wet season in the southern Sahel in West Africa reduces forage intake and consequently average daily gain. Other reported cause of the problem of access to pastures in the wet season, especially in agro-pastoral zone in the southern Sahel, is fragmentation of cultivated fields (Turner and Hiernaux, 2002).

From our results, crop residues became the main feed resources at the end of the raining season which also coincided with the harvest period (Figure 6 and 7). Similar result by Fernández-Rivera *et al* (2005) in Fakara, Southwestern Niger showed that the end of growing season for herbage also coincided with peak of availability of millet stover. Moderate to high amounts of millet stover were available in all villages from harvest time to February (middle of the dry season) but the last 3 months (April to June) of dry season were characterised by a remarkable feed scarcity.

Farmers from Milli and Gourdjia also noted that cereal crop residues were more in abundance than legumes. Hence, they were normally fed to the animal first while legumes are fed at critical times when the feeds are scarce or as supplement. In a similar report from The Gambia, farmers fed their livestock mostly with sorghum, millet and maize stover as basal diet while cowpea and groundnut haulms are fed as protein supplement (Russo, 1990). In addition, crop residues are also stored for feeding during in the dry season to selected animals and or sold (Powell *et al*., 1996). As the dry season advances and the cereal residues declined in quantity, legumes residues, concentrate and open grazing formed the major livestock feed resources in the study sites.

Figure 6: Available feed resources in Milli.

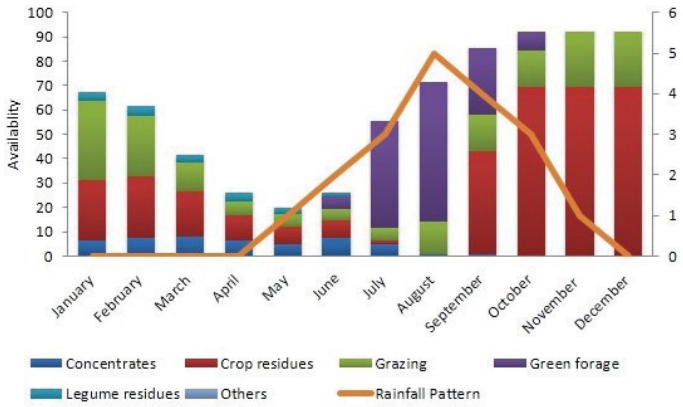
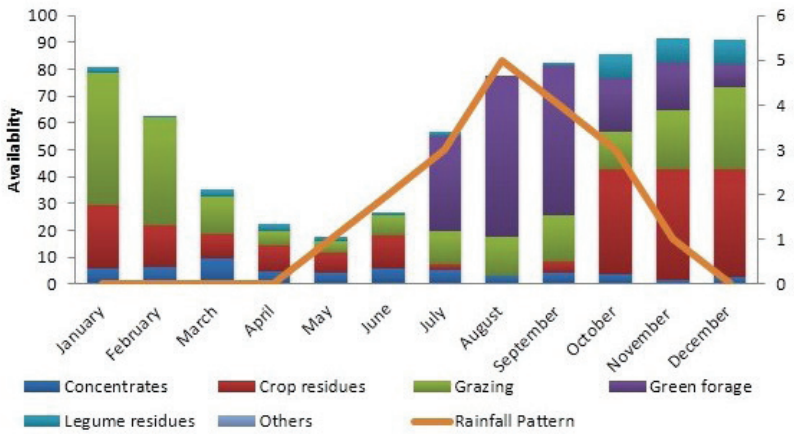


Figure 7: Availability of Feed Resources during the year in Gourdjia.



Some feed resources purchased by farmers in Milli to supplement animals particularly during the cropping season when the animals are kept in the shed included: millet bran, bush hay (*Eragrostic tremula and Andropogon gayanus*), wheat bran, groundnut haulms, cowpea hay and cowpea husk (Table 3). The need for purchased feed was inevitable in the region due to extremely variable and generally low yields of millet and sorghum caused by declining soil fertility and consequently low quantity of crop residues. Many farmers do not produce enough cereals to meet their domestic requirements and residues needed to feed their animals. Reduction in the quantity of available cereal residues per animal has been observed in recent years (FAO 2014). About 58 % of smallholder dairy farmers in Kenya also ranked purchase of fodder from other farmers as the second most important coping strategy against feed shortage in dry season (Njarui *et al*, 2011). Kayouli (1996) also reported that most cereal crop residues are of poor quality with low nitrogen, energy and mineral contents while the edible proportion rarely exceeds one-third of the biomass which necessitates purchase of more feeds.

Purchased feeds available from the feed market in Madaou, a peri-urban village where famers purchase feeds are: Wheat bran, millet bran, and sorghum bran. Others are residues of pearl millet, sorghum, groundnut, cowpea and its husk (Table 3). Bush hays were mainly from *Eragrostic tremula and Andropogon gayanus. Eragrostic tremula* has been reported to be a highly palatable annual forage grass species in south-western part of Niger (Ayantunde *et al*., 2009). According to the authors, herbaceous plants are commonly harvested dry as bush hay in to fatten sheep or to sell at feed market to other livestock farmers. The report of Lamers and Ermhard (1995) also confirmed that fodder weeds such as *Alysicarpus ovalifolius, Commelina forskalaei, Zornia glochidiata and Eragrostis tremula* are traded at rural and urban markets in Niger. They revealed that laboratory analyses of these fodder weeds are two times higher crude protein content than low quality roughages such as millet stover. This may account for the wide used of hay in this region, beside the low price per kilogram.

According to the farmers, large quantities of pearl millet and sorghum bran were produced daily from the household food processing which are used directly to feed animals and often sold at the market. In Milli, wheat bran was purchased more than other available feed stuffs in the feed market (Table 3).The demand for wheat bran was also reported to be generally high throughout the year in feed market in Southern Ethiopia particularly during the fattening period (Berhanu *et al*., 2009). Results showed that bush hay contributed 70 % of the feed purchased in the past 12 months in Gourdjia (Table 3)

Farmers in Milli reported that there was a government grazing reserve about 13.5 km from the village which was established years ago but had been invaded with low quality forage species due to poor management. In addition, a large proportion of the grazing reserve had been turned into farmland. Declining grazing area which is principally due to expansion of cultivated land has been reported as one of the problems facing livestock production in the Sahel region (Ayantunde, 1998). This contributed to the reduction in the available natural pasture and increase in the quantity of feed purchased in the region.

Table 3: Purchased feeds, prices and quantity in Milli and Gourdjia in the past 12 months

Feeds purchased	Quantity (kg)	Number of farmers	Price FCFA/kg	Quantity (kg)	Number of farmers	Price FCFA/kg
	Milli			Gourdjia		
Wheat (*Triticum aestivum*) - bran	2656	10	400.00	2268	11	360.00
Pearl millet (*Pennisetum glaucum*) bran	336	2	80.00	16	1	60.00
Groundnut (*Arachis hypogea*) - crop residue	546	4	100.00	5	1	100.00
Naturally occurring pasture - hay (tropical)	1155	2	30.00	5664	8	20.00
Cowpea (*Vigna unguculata*) husk	184	3	120.00	15	1	150.00
Pearl Millet (*Pennisetum glaucum*) - crop residue	28	2	40.00	220	3	42.00
Sorghum (Sorghum bicolor) bran	-	-	-	64	2	25.00
Sorghum (Sorghum bicolor) - crop residue	-	-	-	3	1	100.00
Grand Total	4905			8225		

Purchased feed accounted for the highest proportion of the livestock diets in Milli and Gourdjia in terms of dry matter (DM), metabolizable energy (ME) and crude protein (CP) (Figures 8 to 13). These purchased feeds are combination of brans, crop residues and *hay of Eragrostic tremula* and *Andropogon gayanus*.

Crop residues contributed next to purchased feeds in terms of DM, ME and CP of livestock diets. Although, in terms quantity and availability during the dry season, crop residue provided the major bulk of feed resources in these sites. However, its contribution to dietary DM and ME and CP was quite low. This probably resulted from the poor quality of the crop residues due to time at harvest, poor storage methods and a generally low nutritional status of cereal straws. Seasonality in supply, low nutrient content, poor digestibility and low voluntary intake by animals are factors limiting the effective utilization of crop residues as animal feed (Tolera et al., 2000). Legume crop residues (cowpeas and groundnut) can serve as supplement to cereal stovers given their relatively high crude protein (about 10% or more) (Tolera *et al*., 2000). However, the quantities of legume crop residues available in these sites are very low (Figure 13).

Figure 8: Contribution of various feed sources to the DM content of total diet in Milli.

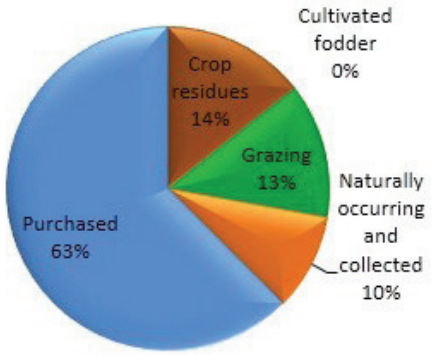


Figure 9: Contribution of various feed sources to the ME content of total diet in Milli.

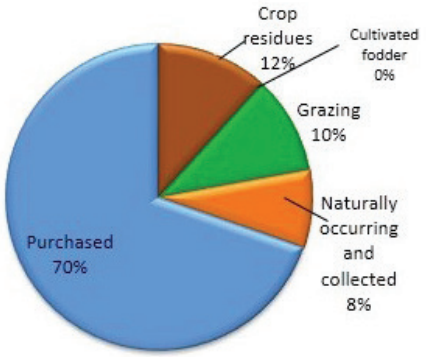


Figure 10: Contribution of various feed sources to the CP content of total diet in Milli.

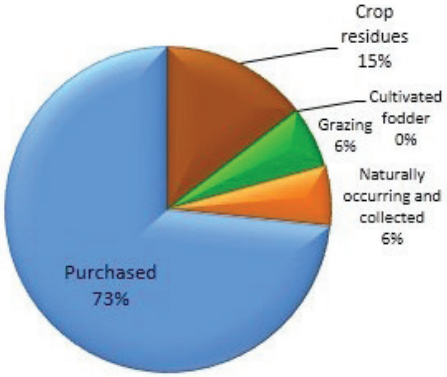


Figure 11: Contribution of various feed sources to the DM content of total diet in Gourdjia.

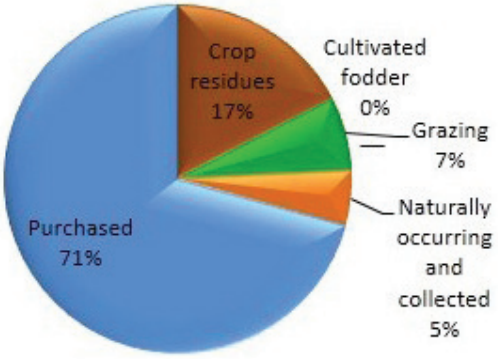


Figure 12: Contribution of various feed sources to the ME content of total diet in Gourdjia.

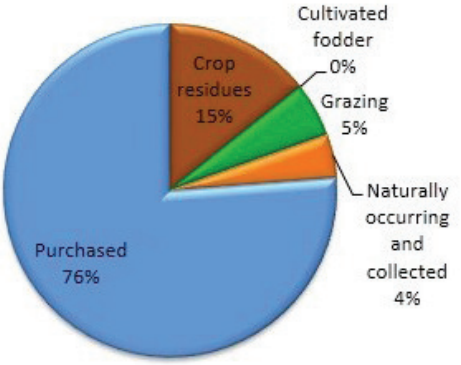
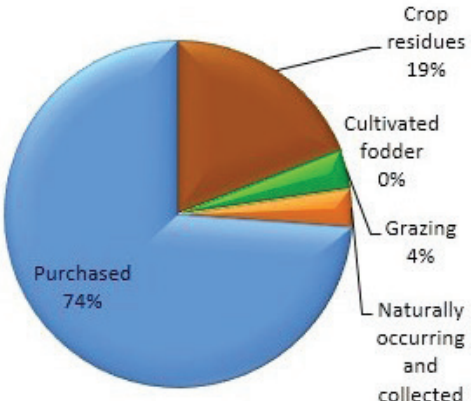


Figure 13: Contribution of various feed sources to the CP content of total diet in Gourdjia.



Farmers' feed quality assessments indicators

Farmers described 5 different physical parameters used in determining feed quality both at the point of purchase or when given to the animals. The physical parameters included: colouration, texture, odour, age at harvest and animal behaviour (Table 4).

Table 4: Farmers' indicators of feed quality assessment

Parameters	Description by the Farmers
Colouration	Green colouration of cowpea and groundnut crop residues indicated good quality while a uniform brown colour of millet bran also indicated quality.
Texture	Farmers described fluffy texture of millet bran as quality while moldy and crusty texture will indicate poor quality.
Odour	According to the farmers, fresh smell odour of millet bran is considered as quality and rancid or decayed smell confirms as poor quality.
Age at harvest	Farmers reported that younger plants are of higher quality than older plants.
Animal behaviour	Eating rate at the beginning of the meal, high intake rate and no left over are indicators of high quality as described by the farmers

From the results, it was cleared that farmers possessed indigenous knowledge concerning the nutritional quality of the feed resources they used. These indicators had been derived empirically from observing the outcomes of feeding different feed resources over the years. In a similar report from Uganda, indigenous criteria used were mostly based on the perceived effects of the feed resources on health, appetite and performance of the animal in question. Hence, a feed resource of good nutritional quality was said to enhance disease resistance, satisfy appetite (animals ingest much of it) and enhance good animal performance (animals gain weight with well-filled bodies and produce more milk during lactation (Lumu, 2013). Furthermore, there is need to assess the relationship between farmers' indigenous knowledge on nutritional quality and the scientific indicators of nutritional quality. However, an observation from Nepal suggested that there is significant complementarity between farmers' assessments of tree fodder feeding values and relative assessments derived from laboratory information (Thorne et al., 1999)

From the interview, farmers described feed resources and/or feed processing methods of they were aware of but are not being used at present. They highlighted reasons for not using such resources or methods and also suggested ways of strengthen the use.

Table 5: Potential feed and processing methods identified by farmers and ways of strengthening their use

Potential Feed resources/ processing methods	Reason for not using the resource	How to strengthening the use of the feed resources
Mixture of *Piliostigma reticulatum* pods and groundnut haulms.	Few farmers reported they have heard of the feed ration made from the *Piliostigma reticulatum* and groundnut haulms but lack the training on how to mix the ration.	More technical information in feeds production, processing and feeding.
Chopped Millet stover mixed with salt	Lack of information, training and the cost of procuring a forage chopper since manual chopping will be laborious and time consuming	Farmers are more keen for knowledge on livestock feed. Farmers requested for training of few selected ones and are willing to contribute to procure a forage chopper if it's available.
Cotton seed cake	According to the farmers, lack of cash and consistent sources of supply hindered the use of cotton seed cake	Establishment of farmers' cooperative association that will be responsible to bulk purchase of cotton seed cake for contributing members
Methods of improving existing feed resources		
Treated crop residues with urea and salt	Farmers acknowledge the potentials of treated crop residues especially the cereals. However, among other reasons for not harnessing the potentials of this method is inadequate cash. They would rather use the cash for other purpose than to buy urea. Other limitations include low quantity of residue turn out from the limited and poor land area.	Organize training sessions and on-farm practical on urea treatment

Constraints to livestock production and proposed solutions

The livestock production constraints were identified in order of importance and farmers suggested solutions are presented in Table 6.

Table 6: Major identified problems facing livestock production in Milli and suggested solutions by farmers

Problems in order of importance	Problems identified	Proposed solution by the farmers
1	High cost of veterinary drugs	Although the veterinary service is free, farmers considered the cost of drug higher than their income. They suggest a subsidy in the price of the drug by the government or low cost drug centre in the village.
2	Absence of credit and loan facilities.	Farmer suggested community credit and loan facilities. They also request for training on the production of marketable farm produce such as local egg production, all year round pepper production with irrigation facilities. This can serve as source of income for them.
3	Shortage of feed in quantity and quality	Provision of grazing areas. Farmers noted that if the existing grazing reserves could be renovated and managed properly, it will encourage them to embark on livestock production again.
4	Shortage of water in the dry season for animals	Construction of bole-holes with storage facilities in the village
5	Animal theft	Provision of good housing for the animals.

Table 7: Major identified problems facing livestock production in Gourdjia and suggested solutions by farmers

Problems in order of importance	Problems identified	Proposed solution by the farmers
1	Poor performance of their local breeds	Introduction of improved breed for cross breeding programme that can improve the genetic potential of the local breed.
2	Shortage of water in the dry season for animals	Construction of bole-holes with storage facilities in the village
3	Shortage of feed in quantity and quality	Provision of grazing areas. Farmers noted that if the existing grazing reserves could be renovated and managed properly, it will encourage them to embark on livestock production again.
4	Lack of veterinary services	Government veterinary service should endeavor to visit the village regularly as they do in Milli which is just 46 km away. They suggest a subsidy in the price of the drugs by the government or low cost drug centre in the village.
5	Inadequate technical knowledge on fodder, feeding management and livestock production.	More technical knowledge in feeds production, processing and feeding through training and tours. Training in livestock improvement related topics is required

Potential interventions derived from farmers proposed solutions and existing opportunities in Milli and Gourdjia

1. Financial constraint is one of the major problems mentioned by farmers in Milli relating to farming and livestock production. Proper training and empowerment on income oriented livestock production such as sheep fattening could be a better way of improving farmers' livelihood and household income.

2. There is a need for regular health treatments of flocks by the veterinary services of the region which will reduce the rate of disease outbreak. These could include preventive strategies through effective disease control and vaccination campaigns.

3. Better management of the existing water resources, collecting rainwater for dry periods such as construction of small reservoirs.

4. Farmers reported that lack of technical knowledge was the predisposing factor for not exploiting the potential of the livestock sector. Hence, training would be instrumental to enhance knowledge base and attitude/behaviour change of the farmers and livestock extension workers.

Conclusion and recommendations

From the results of the study, the farming system in both Mill and Gourdjia is characterised by mixed crop-livestock production system and majority of the farmer are categorized as small land holders. Livestock production depends on natural pasture and crop residues which are both harvested by the farmers or purchased. Animals were kept on grazing most of the periods of the year except during the wet season when cropping activities commenced till harvest. At this period, farmers reported that all the animals are kept at home in the sheds to prevent crop damage. Since the main crops are millet, sorghum, cowpea and groundnuts, crop residues constitute a major source of livestock feed after natural pastures especially during the dry season.

Generally, livestock production in both sites are characterised by very low level of productivity that results from feed related constraints arising from low and variable forage availability and poor quality. Other constraints reported are high mortality rates arising from disease infestation and declining soil fertility. These contribute to the increasing number of agricultural families depending on off-farm incomes and remittances especially in Gourdjia which borders Nigeria and thus encourages cross-border movement.

In other to address the constraints to livestock production as described by the farmers, potential intervention could be providing technical knowledge to improve the existing feed resources and health management facilities using an on-farm experiment approach. The table below identified some potential feed resources that could be exploited for livestock nutrition.

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