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Full Length Research Paper

Effect of farming systems on livestock feed resources and feeding systems in Benishangul-Gumuz region, western Ethiopia

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A study was conducted with the objectives of assessing the livestock feed resources and feeding systems of Assosa Zone of Benishangul-Gumuz Region using group discussions, structured questionnaire and personal observations. The average total family size of the study area was 7.49 of (shifting FS = 9.08; permanent FS = 5.9). Overall, 55% of respondents in the two farming systems were illiterate of which about 43.3 % was found in shifting cultivation where as the rest in permanent farming system. The farm size of households from shifting cultivation (SC) was (6.04 ha) significantly higher ($p<0.05$) than that of (1.26 ha) permanent farming systems (PFS). About 70.8% of respondents from SC get new land by clearing of land without shifting to other places on average within 5.66 years. The number of cows, goats and chicken from SC were significantly higher ($p<0.05$) than that of PFS, while the number of oxen from PFS was significantly higher ($p<0.05$) than SC. Natural pasture and crop residues were the most commonly utilized feed resources. Stubble grazing and browse species also play a significant role during dry season. Among the most commonly used browse species, lowland bamboo (*Oxytenantheria abyssinica*) was the most abundant. The size of natural pasture as well as its quality is declining from time to time mainly due to expansion of farmland and replacement of palatable species by less palatable species like *Sporobolus* pyramidalis and *Hyparrhenia collina* species. About 59.1% of respondents from SC and 37.5% from PFS indicated that expansion of farmland was the main cause of shrinkage of their communal grazing land. Crop residues were also used for construction, fuel and sale. Grazing was the main livestock feeding system in both farming systems. In SC, the first priority was given to weak animals for feeding crop residue, while draught animal take the lead in PFS. Agro-industrial by-products, improved forage crops and hay were less available. In both farming systems, river was the main source of water for livestock. The major livestock production constraints in the study area were disease and parasite followed by shortage of livestock feeds. It is suggested to study the estimated amount of crop residues and contribution of other feeds (grazing lands, forest areas, stubbles and fallow lands) produced in the study area to know the feed balance in relation to livestock population in the area.

Keywords: Feed resources, feeding system, shifting cultivation, permanent farming system

INTRODUCTION

Benishangul-Gumuz Regional State is one of the nine regional states established in 1994 by the new constitution of Ethiopia that created a federal system of governance. According to Benishangul-Gumuz Region Rural Development Coordination Office (2004) about 93.2% of the people's livelihoods in the region depend on agriculture. The agro-ecology of the region is conducive for growing different types of food and cash crops. Different types of livestock are also raised including

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cattle, goat, sheep, donkey and poultry (AsARC, 2006, unpublished).

Though the region is blessed with various potentials and opportunities, it has remained one of the least developed and food insecure regions in the country. The low productivity of both crop and livestock production are the major factors that retard development in the region. Livestock production is constrained by many factors and the return obtained from the sector is very low mainly due to livestock diseases, shortage of feed and water supply during the dry season (AsARC, 2006, unpublished). The problem of feed supply and quality is even more aggravated when indigenous people burn natural pasture during the dry season and the rain delays (AsARC, 2006, unpublished). Low feed supply both in terms of quality and quantity results in retarded reproductive and growth performance of animals (Sisay, 2006).

Inadequate information about livestock feed resource and feeding systems is the main problem in the Assosa zone where this study was undertaken. There is a problem of designing appropriate livestock feeding strategies. Therefore documenting the livestock feed resource and feeding systems of the area is crucial to design appropriate interventions to enhance productivity.

Feed resource assessment in the area helps to design the feeding alternatives during worse season of the year to mitigate the livestock feed shortage in the area. Such studies have not been carried out in Assosa zone. Therefore, this study was conducted to assess the major livestock feed resources and feeding systems in Assosa zone in Benishagul-Gumuz region, western Ethiopia.

MATERIALS AND METHODS

Study area

Assosa zone is located in Benishagul-Gumuz region, Ethiopia. It is located approximately 680 km west of the capital, Addis Ababa. According to National Meteorological Service (NMSA) (2007), the average annual rainfall is 1316 mm with uni-modal type of rainfall that occurs between April and October. Its mean annual temperature ranges between 16.75^{o}c and 27.9^{o}c. March and May are the hottest months (31^{o}c)

There are two types of farming systems used in the study zone, namely SC and PFS. The majority of the indigenous communities, Berta people in Assosa zone practice SC while settlers practice permanent farming.

Assosa zone has 35.6% of the livestock population of the region (CSA, 2005) and has 81,939 cattle, 73,181 goats, 10,231 sheep, 14,089 donkeys, 40, 3153 poultry, 29 horses and 59,695 beehives. Major crops grown in the area are sorghum, maize, soya bean, finger millet and ground nut. Minor crops produced include teff (*Eragrostis tef*), haricot bean, hot pepper, sweet potato, banana and coffee.

Assessment of livestock feed resources and feeding system

Feed resources and feeding systems were assessed by interviewing 60 randomly selected households from each of the farming systems (SC and PFS) using structured questionnaire. Farmers who reared at least one animal and were willing to participate in the survey were selected. The survey was conducted between September and December 2008.

Group discussion was conducted with key informants (elders and leaders) on the issue related to livestock feed resources and feeding systems, such as livestock population, land holding, livestock production constraints, income of household, feed resource, feeding system, water availability, and earlier interventions like improved forage species, feed conservation mechanisms and availability of concentrate feeds in the area.

Statistical Analysis

The statistical analysis was carried out using SPSS, Version 13 computer software package (SPSS, 2003).

RESULTS AND DISCUSSION

Land holding and land use pattern

The average farm size owned per household (hh) in shifting cultivation (SC) was about 6.04 hectares, which was significantly higher ($P<0.01$) than the average farm size (1.26 hectares) owned by permanent farming systems. In both farming communities, every land allocated for livestock including stubble grazing were communal. The average communal pastureland of shifting cultivators and permanent farming communities were 1.63 ha per hh, which was significantly higher ($p<0.01$) than PFS (0.27 ha per hh). Farm size allocation to crop production was 72.2% and to grazing land was 27.04% in SC and 79.02% and 20.98% in PFS, respectively. This implies that a large proportion of farm size was allocated to crop production. The reports of CSA (1995) also confirm that the largest proportion of the land owned by peasant farmers is used for food crop production. The land holding per hh in permanent farming communities were very small compared to the findings of Agajie *et al.* (2001) in the western Shewa of Ethiopia. Out of the total land allocated for cultivation per hh in PFS, 1.83 hectare of land was obtained through rent from nearby shifting cultivators.

The higher landholding of shifting cultivators may be due to expansion of farm land without restriction by clearing of forest either by shifting or without shifting to other places. In addition to this, low population density of the area could have allowed individual farmer's larger

Table 1. Number of livestock owned and cattle herd composition per household in shifting cultivation (SC) and permanent farming system (PFS)

Livestock species	SC (N=60) Mean ± SD	PFS(N=60) Mean ± SD
Cattle	4.7 ± 1.76	5.17± 2.36
Sheep	3.55 ± 2.50	4.27 ± 2.69
Goat	8.32 ± 2.47a	4.65 ± 1.81b
Donkeys	1.44 ± 0.89	1.158 ± 0.50
Chickens	10.77 ± 1.64a	5.58 ± 2.93b
Cattle herd Composition		
Calves	1.49 + 0.7	1.33 + 0.52
Heifers	1.56 + 0.96	1.34 + 0.53
Bull	1.48 + 0.76	1.41 + 0.56
Oxen	1.36 + 0.76b	1.93 + 0.74a
Cow	1.86 + 1.15a	1.47 + 0.65b

Means with different letters within a raw are significantly different (P<0.05); N = number of respondents; SD = standard deviation

landholding. Aryal and Kerkhoff (2007) reported similar observation that shifting cultivators should have large size of land to practice shifting cultivation. It was also indicated that lack of large land size is the main reason for their poverty, because it deprives them of their principal means of production. Kerkhoff and Sharma (2006) also reported that traditional shifting cultivators require and maintain a wide range of natural resources as part of their farming system, by cultivating the steep slopes; growing wide range of crops; collecting wild foods; hunting animals; and fallowing the forests.

Means of getting new land

The cultivable land in SC is replaced by new land at an interval of 5.66 years. This is longer than the two to four years period of cultivation reported in African rain forest (Negi, 1983). According to this survey, 70.8% of farmers get new land by clearing of land without shifting, 11.1% by clearing of land with shifting and 18.1% by fallowing. The larger proportions of farmers practiced SC without moving to other places which indicates that shifting cultivators were fallowing both for long and short periods. This is similar to earlier report (FAO, 1984) that in long fallow period's characteristic of SC, housing may be semi permanent, or farmers may have permanent homes in villages and temporary homes in the fields/rangelands. Shorter fallow periods on the other hand are associated with permanent housing.

Livestock holding

Cattle, sheep, goats, donkeys and poultry were reared by the local community of both farming systems. The number of goats and chickens reared per hh in SC was significantly higher (P<0.05) than that of PFS (Table 1). Low number of chickens and goats in PFS may be due to intensive cultivation of the land and reduced space for scavenging and development of browse vegetation which is a source of feed for chicken and goats, respectively. Variation in size of herd per hh from place to place with the availability of water and grazing lands, prevalence of diseases and parasites as well as the management of the livestock owner have also been reported earlier (Tessema *et al*., 2003).

The livestock holding per hh in the study area was less than the figure reported of North Gindar by Sisay (2006) and of central highlands of Ethiopia by Gryseels (1988). The number of cows per hh in SC was significantly higher (P<0.05) than PFS while in permanent farming system number of oxen per hh was significantly higher (p<0.05) than in SC (Table 1).

The higher number of oxen in PFS than in SC could be related to use of oxen for plaughing of land in PFS and the higher number of cows in SC was due to the presence of enough grazing land per hh for cows and also oxen which are not fully used for plaughing purpose.

Major Livestock production constraints

Livestock production in the study area has primarily been hampered by disease and parasites in both farming systems. This is because of high infestation of tsetse fly that causes trypanosomiasis and cross border movement of cattle from the Sudan also causes the transmission of livestock diseases of economic importance like *blacklegs and pastuerollosis* (Sisay 2006; Agajie *et al*., 2001; Berhanu *et al*., 2007). The second most limiting constraint to production of cattle, small ruminant and

Table 2. Value index of major feed resources calculated from ranking results of respondents from shifting cultivation during wet and dry seasons of Assosa zone

Variables (N=60)	season	Rank 1st	2nd	3rd	4th	Index
Natural pasture	Wet	47	5	8	-	0.31
	Dry	46	11	2	1	0.20
Crop- residue	Wet	1	14	42	3	0.17
	Dry	34	21	5	-	0.19
Browse species	Wet	6	10	24	20	0.15
	Dry	24	16	5	15	0.17
Hay	Wet	1	6	11	42	0.12
	Dry	17	9	10	24	0.13
AIB	Wet	-	5	27	28	0.14
	Dry	18	18	10	14	0.15
Stubble	wet	-	1	12	47	0.10
	dry	32	17	7	4	0.18

N= number of respondents; AIB= Agro-industrial by-product; Index: sum of single feed resource ranked (4*first ranked feed resource) + (3* second ranked feed resource) + (2* third ranked feed resource) + (1* forth ranked feed resource)/Sum of all weighted feed resource mentioned by the respondents

equine is shortage of feed. Shortage of feed in SC may be due to the invasion of the communal grazing land by less palatable species of forages like *Hyparrhenia,* which have bushy nature and hinders development of other species resulting in feed deficit.

There is seasonal fluctuation in the availability of feed. This is in agreement with the findings of Goe (1987) where the most abundant feeds in Sub-Saharan Africa are over mature natural grasses and crop residues, which are limited both in quantity and quality during the dry season resulting in low growth rates. The advancement in growth rate of pasture increases cellulose and lignin content which resulted in low digestibility (Kitaba et al, 2007). This can be aggravated when the indigenous people burns pasture land in dry season with the assumption that this practice kills tsetse flies and improves grass development for the next season. Feed shortage in the area becomes very important in the dry season when pastureland is burnt and rainfall is delayed (AsARC, 2006). In PFS feed shortage is an important constraint, next to diseases and parasites liming cattle, small ruminant and equine production. This might have been caused by the high human population density that demanded more land for crop production leading to a reduction in grazing areas with the resultant overstocking of communal grazing lands. Thus communal grazing lands are not any more productive to supply livestock with adequate quantity of quality forages.

Major livestock feed resources

The ranking in availability of feed resources and preference of farmers to the feed resources during the dry and wet seasons in SC and PFS are shown in Tables 2 and 3.

The main feed resources to livestock in SC were natural pasture, crop residues, stubble grazing and browse species, which agrees with earlier reports (Gambiza, 1996; Alemayehu, 2004; Ayantunde *et al.*, 2005).

Natural pasture as the primary source of feed to animals in SC was ranked first both during the wet and dry seasons (Table 2). Crop residue were ranked 2rd followed by stubble grazing as source of feed during the dry season. Farmers were not engaged in hay making. Quality grass species for hay making were less available. The ranking of natural pasture and crop residues in PFS followed similar trend as in SC (Table 3).

The least in the order of importance as feed resources in the area were stubble grazing and hay during the wet season. This is due to unavailability of stubble grazing in wet season and more use of fresh pasture instead of hay during the wet season. The grazing lands in both farming systems were open and communal grazing were covered with trees and shrubs. About 78.3% of hh in the SC ranked natural pasture as the primary feed resource during the wet season and 76.7% of them ranked it as dry season feed (Table 2). In both farming systems natural pasture was the major livestock feed resources followed by crop residues, which is in agreement with the report of Gambiza (1996).

Condition of the natural pasture and constraints

The size and forage quality of the communal grazing areas of both farming systems are decreasing from time to time. About 59.1% of the cause of reduction in grazing land size in SC and 37.5% in PFS was the expansion of crop production. As a result the feed obtained from grazing lands is inadequate both in terms of quantity and quality throughout the year. The major causes for deterioration of forage quality were over dominance of

Table 3. Value index of major feed resources calculated from ranking results of respondentsfrom permanent farming system in the wet and dry seasons of Assosa zone

Variables (N=60)	Season	Rank				Index
		1st	2nd	3rd	4th	
Natural pasture	Wet	52	2	6	-	0.31
	Dry	40	11	6	3	0.19
Crop- residue	Wet	3	16	16	25	0.16
	Dry	46	10	2	2	0.20
Browse species	Wet	4	8	14	34	0.14
	Dry	15	11	11	23	0.13
Hay	Wet	1	11	15	33	0.14
	Dry	40	10	3	7	0.19
AIB	Wet	5	8	14	33	0.14
	Dry	27	4	4	25	0.14
Stubble	wet	0	1	16	43	0.11
	dry	26	16	7	11	0.16

N = number of respondents; AIB= Agro-industrial by-product; Index: sum of single feed resource ranked (4*first ranked feed resource) + (3* second ranked feed resource) + (2* third ranked feed resource) + (1* forth ranked feed resource)/Sum of all weighted feed resource mentioned by the respondents

Table 4. Value index of preference of crop residues as livestock feed based on ranking by respondents in shifting cultivation and permanent farming systems of Assosa Zone

Variables	Rank				Index
	1st	2nd	3rd	4th	
Shifting cultivation (N=60)					
Maize stover	40	16	3	1	0.28
Sorghum stover	22	22	6	10	0.23
Teff straw	21	22	8	9	0.23
Finger millet	3	8	24	25	0.14
Pulse straw	1	5	10	44	0.11
Permanent farming (N=60)					
Maize stover	17	30	12	1	0.23
Sorghum stover	17	25	10	8	0.21
Teff straw	44	11	2	3	0.27
Finger millet	16	14	24	6	0.19
Pulse straw	1	5	11	43	0.10

Number of respondents; shifting = 60; permanent = 60; Index: sum of single crop residue preference ranked (4*first ranked crop residue preference) + (3* second ranked crop residue preference) + (2* third ranked crop residue preference) + (1* forth ranked crop residue preference)/Sum of all weighted crop residue preference mentioned by the respondents

less palatable species like *Hyparrhenia* in SC and *Sporobolus pyramidalis* in PFS. *Hyparrhenia hirta* was the most abundant species in the communal grazing land of SC and it suppress less competing species like legumes resulting in poor quality forages. In addition, the population growth resulted in high demand of cultivable land per hh to meet food requirement within the limited land that led to cultivation of pasture land and reduced grazing areas (Teferi, 2006). This might have caused loss of palatable forage species due to high grazing pressure. Reduction in pastureland and expansion of farm land were more prominent in SC than PFS.

The communal grazing lands of the study area were covered with trees and shrubs which serve as protein source to livestock. Shifting cultivators use bamboo (*Oxytenanthera abyssinica)* as the main browse species during the dry season when feed is scarce. Among other browse/shrub species were *Rhus natalensis, Bauhinia farea Grewia ferruginea, Acacia seyal a*nd *Deinbollia kilimandscharica.* Browse species are utilized as livestock feed more in SC than in PFS because they are less available in the later.

Preference of crop residues as livestock feeds

In shifting cultivation maize stover was most important livestock feed followed by sorghum stover and teff straw from (Table 4). This was mainly due to the suitability of the area for cereal crops that provide straws and stovers for animals. This is in agreement with the work of Jonah (2004) that reported among crop residues, straws and

stovers are the major feed resources in other developing world, and even more important than cultivated forages due to less competition with cultivable land.

Palatability, quality and leafiness of crop residues were used as the major criteria by respondents to select crop residues as livestock feeds. In PFS teff straw, maize stover and sorghum stover were ranked in decreasing order of importance (Table 4). The least preferred as livestock feed in both farming system was crop residues from pulses because animals refuse to eat it due to rough structure of the residue and lack of adaptation of animals to this type of crop residues.

Socio-economic importance of crop residues

Crop residues were also used for construction, fuel and source of cash income through selling livestock owners. This type of benefit obtained from crop residues results in sustainable interaction between crop and livestock production systems. In both farming systems, the largest proportion of crop residues was used for livestock feeding than for any other uses because of the critical shortage of livestock feed during the dry season. Previous studies (e.g. Tesfaye, 2008) reported that crop-residues have been the main source of livestock feeds especially for ruminant animals during the dry season next to natural pasture. They also serve as a source of fuel, construction and sale (Van Raay and de Leeuw, 1970). In SC, sorghum and maize stovers were used as feed more than other crop residues available in the area. This was probably because of the supply of other feed sources could not meet most of the demand for nutrients and this argument is in agreement with earlier reports (e.g. de Leeuw and Van Rey, 1995). Pulse hualms were the least utilized crop residue as a source of feed and sale.

In the PFS, sorghum stover was used for fuel more than other crop residues while, teff straw was used for livestock feeding. Respondents from this farming system also indicated that the utilization of sorghum stover and maize stover as a source of fuel was due to the scarcity of fire wood in the area. Teff straw was less utilized as a source of fuel because it was the main source of feed during dry season. Therefore, crop residues contribute most of the DM intake especially during the dry season, which is in agreement with the report of Ngongoni *et al*. (2006) that suggested that for the majority of smallholder farmers, crop residues constitute 50-70% of total DM intake, especially during the dry season.

The size of land for crop production and the availability and accessibility of fire wood were major reasons for differences in crop residue utilization between SC and PFS. Teff straw was the first priority as a source of feed in PFS than SC. In both farming systems, crop residues play a significant role as source of livestock feed during the dry season when grass dry out. Similar observations were reported earlier (Reed and Goe, 1989; Seyoum and Zinash, 1995; Solomon, 2004; Tessema, 1984; Mayer, 1983; Urio, 1985).

Agro-industrial by products

About 90% of respondents from SC and 83.3% from permanent farming system respectively, reported that there were no agro-industrial by-products available on local market for their animals partly due to the remoteness of the area. The supplemental feeds available in the area were noug cake and salt but farmers rarely utilize noug cake because it is expensive. is. Due to lack of supplemental feed resources, livestock are fed on natural pasture, browse species and crop residues. A variety of nonconventional traditional feeds of different forms were commonly used. Left over of Enjera and Porridge were supplemented to livestock by more than ½ and 1/3 of the respondents in the SC and by over 1/3 and ¼ of them in PFS.

Stubble grazing

After harvesting the crops, livestock are allowed to graze stubbles of maize, sorghum, teff, and pulses between October and December. The stubbles are accessible to all animals in the community as opposed to the report of Sisay (2006) where stubbles are accessible to livestock owned by individual farmers in central highlands of Ethiopia. The highest proportion of respondents from both farming systems graze animals on aftermath of maize followed by aftermaths of sorghum and pulses. Less number of respondents from SC were grazing animals on aftermath of any of the crops due to the availability of large grazing lands and less amount of aftermath which agrees with the report of Seyoum *et al.* (2001) that the contribution of crop residues and aftermath to the total feed resource base vary from place to place based on intensity of cropping.

Cultivated forage species

Cultivated forage species are not widely produced in the study area. However, attempts were made to improve the supply and quality of traditional forage in a few weredas by the Regional Bureau of Agriculture and Rural Development (BoARD) and Assosa Agricultural Research Center (AsARC). Napier grass, oat, lablab and Sesbania have been introduced earlier (AsARC, 2006, unpublished). Very small proportion (20%) of the hh from PFS but only very small number (3.3%) from SC plant improved forage to alleviate feed shortage during the dry seasons due to weak extension services and limited involvement and devotion of research institutions.

Livestock Feeding Systems

Feeding of livestock in different places differs depending on forage availability, climatic variability of a given location or region to mitigate feed shortage problems during worse conditions, season of the year and type of animal the owner prioritize to feed. Almost all respondents from shifting cultivation herd and feed their animals during the rainy season and 75% of them freely grazing animals during the dry season.

Almost all of the respondents from PFS herd and graze animals during the rainy and dry seasons. Natural pasture was the most commonly utilized feed resource in both farming systems and grazing is the predominant form of ruminant feeding which was in agreement with earlier reports (Getnet, 1999; Yosef, 1999; Getachew, 2000; Solomon, 2004). When natural pasture becomes less available during the dry season, farmers in the study area supplement crop residues for their livestock. Feed shortage in SC is worsened when farmers burn the natural pasture assuming that they can kill tsetse fly and obtain flush grass in the coming season.

In both farming systems bamboo was the most commonly utilized feed resources, fed as supplement to donkeys at night in SC and to oxen in PFS by cut and carry feeding system and agrees with the results of previous studies (Simbaya, 1998; Alemayehu, 2006; Sisay, 2006; Elias, 2007).

Crop residues feeding system

Feeding of crop residues for different class of animals during the dry season vary between the two farming systems depending on the severity of feed shortage and the existing condition of animals. By respondents from shifting cultivation weak animals are given first priority to be fed with crop residues followed by drought animals, while in permanent farming systems the first priority of feeding crop residues is given for drought animals followed by sick animals. Sheep and goats are given the least priority.

Agro-industrial by-ptoduct feeding

Eventhough there are limited accessibilty of agro-industrial by-products in the area, respondents supply agro-industrial by-products to their animals during the dry season to mitigate feed shortage. In SC, lactating cows got the first priority of feeding agro-industrial by-products followed by draught animals . Sisay (2006) reportd that feeding of agro-industrial by-products are prioritized based on the productive potential of animals. In PFS, the first priority of feeding agro-industrial by-product is given to draught animals followed by lactating cows. Farmers purchase agro-industrial by-products to feed oxen and cows during peak time of ploughing and lactation.

Water Resources

The main sources of water in both farming systems during the dry season were rivers, springs and pond. River is about 92% of the water sources to livestock during the dry season in SC while 87% in PFS. Most of the farmers in the two farming systems watered their animals twice a day, only very small number of them water once in a day or two days. The finding here is in congruence with Teshome's (2006) and Tesfaye's (2008) findings. Livestock travel less than 1 km to get to water during dry season in SC compared to1 to 5 km in PFS.

CONCLUSIONS

A study was conducted to assess the livestock feed resource and feeding systems of Assosa Zone, western Ethiopia. The average land holding per household (hh) in shifting cultivation (SC) was significantly higher than that of permanent farming systems (PFS). The number of goats, chicken and cows per hh in SC were significantly higher than that of PFS while the number of oxen in PFS was significantly higher than SC. One of the major livestock production constraints in both farming systems was shortage of feed.

Natural pasture and crop residues were the most commonly utilized feed resource in both farming systems. Although, natural pasture was providing significant amount of feed for the society, nowadays the contribution and also productivity of this feed resource was deteriorating from time to time mainly by expansion of crop production at the expense of grazing land. Crop residues were also used for fuel, construction and source of cash income besides serving as a source of feed. Improved forage species, agro-industrial by-products were less available in the area. Grazing was the main livestock feeding system in both farming systems of the study area. The main sources of water for livestock in both farming systems during the dry season were rivers followed by springs and pond. Further study is suggested to estimate the amount of crop residues produced and contribution of grazing lands, forest areas, stubbles and fallow lands to the feed base of the Zone.

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