Tropical and Subtropical Agroecosystems

EFFECTS OF FARMING SYSTEMS ON FLORISTIC COMPOSITION, YIELD AND NUTRIENT CONTENT OF FORAGES AT THE NATURAL PASTURE OF ASSOSA ZONE (WESTERN ETHIOPIA)

[EFECTOS DE LOS SISTEMAS DE CULTIVO SOBRE LA COMPOSICIÓN FLORÍSTICA, RENDIMIENTO Y CONTENIDO DE NUTRIENTES DE LOS FORRAJES EN PASTURAS NATURALES EN LA ZONA DE ASSOSA (OESTE DE ETIOPÍA)]

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SUMMARY

Forage species of the natural pasture of Assosa Zone of Benshangule-Gumuz (Western Ethiopia) were identified and their chemical composition and *in vitro* dry matter digestibility (IVDMD) determined. Data were collected from two farming systems (shifting cultivation: SC and permanent farming system: PFS) and two grazing types (communal grazing land: CGL, riverside grazing land: RSGL). A total of 18 grasses, 2 legumes, sedge, 2 forbs and 17 trees/shrubs were identified from the natural pasture of both farming systems. *Hyparrhenia rufa* had significantly lower NDF and *Eleusine floccifolia* and *Pennisetum catabasis* had significantly lower ADF than those of other grasses. IVDMD of *E. floccifolia* and *P. catabasis* were significantly higher than that of *Chloris pycnothrix, H. rudis, H. rufa, H. collina1, H. collina2* and *Sporobolus pyramidalis*. Crude protein (CP) content of *E. floccifolia* was significantly higher than that of other species except *H. hirta*. The DM and CP contents of *Bauhinia farea* were the highest (P<0.05) among browse species. Grasses such as *C. pychnotrix, H. collina, Digitaria abyssinica, H. hirta, H. rudis* and *S. pyramidalis* were dominant in the study area. Herbaceous biomass production of the CGL in SC was 2,495 kg/ha and that of the RSGL in PFS was 1,244 kg/ha. Continuous overstocking of RSGL decreased the proportion of desirable forage species and encouraged invasion with unpalatable species such as *S. pyramidalis* and *H. collina.* It is suggested to study the nutritive value of dominant species, distribution and conservation of highly palatable species and designs for appropriate management interventions.

Abbreviations: ADF, acid detergent fibre; CP, crude protein; DM, dry matter; IVDMD, *in vitro* dry matter digestibility; N, nitrogen; NDF, neutral detergent fibre; OM, organic matter

Key words: Digestibility; species composition; farming system; nutritive value

RESUMEN

Las especies forrajeras de la pradera de la zona de Assosa en Benshangule-Gumuz (Oeste de Etiopia) fueron identificadas y se determinó su composición química y digestibilidad *in vitro* de la materia seca (DIVMS). Se colectó información de dos sistemas de producción: cultivo rotacional (SC) y sistema permanente (PFS). De igual manera se evaluaron dos sistemas de pastoreo: áreas comunales de pastoreo (CGL) y áreas de pastoreo en rivera de río (RSGL). Se identificaron 18 especies de pastos, 2 leguminosas, 2 herbáceas y 17 arbustivas/arbóreas en la pradera nativa de ambos sistemas de producción. *Hyparrhenia rufa* tuvo el menor contenido de FDN y *Eleusine floccifolia* y *Pennisetum catabasis* tuvieron los menores contenidos de FDA en comparación con los pastos restantes. La DIVMS de *E. floccifolia* y *P. catabasis* fue mayor en comparación con *Chloris pycnothrix, H. rudis, H. rufa, H. collina1, H. collina* y *Sporobolus pyramidalis.* El contenido de proteína cruda (PC) de *E. floccifolia* fue mayor en comparación con las especies restantes a excepción de *H. hirta*. Los contenidos de MS y PC de *Bauhinia farea* fueron los mayores entre las especies de arbustos. Los pastos tales como *C. pychnotrix, H. collina, Digitaria abyssinica, H. hirta, H. rudis* y *S. pyramidalis* fueron dominantes en el área de estudio. La producción de biomasa de las herbáceas en CGL en SC fue de 2495 kg/ha mientras que en RSGL en PFS fue de 1244 kg /ha. El sobrepastoreo continuo de RSGL redujo la proporción de especies

forrajeras deseables y favoreció la invasión de especies poco palatables como *S. pyramidalis* y *H. collina*. Se sugiere estudiar el valor nutritivo de las especies dominantes, la distribución y conservación de las especies más palatables y diseñar estrategias de intervención y manejo apropiadas.

Palabras claves: Digestibilidad; composición de especies; sistemas de producción; valor nutritivo

INTRODUCTION

Livestock in Sub-Saharan Africa are dependent primarily on native grasslands and crop residues. Browse and grass species of communal grazing lands of sub-Saharan Africa are important sources of feed for smallholder ruminant production systems (Dicko and Sikena, 1991). Native feed resources in Benshangul – Gumuz Region of western Ethiopia contribute over 75% of the total feed supplies (BoARD, 2006). Natural pasture comprises the largest feed resource in Ethiopia, but estimates of its contribution vary. Mengistu (1998) estimated that 80-85% of the livestock feed comes from natural pasture. Trees and shrubs play a significant role in arid areas where moisture is inadequate (Eshete, 2002). Grazing is the predominant form of ruminant feeding in most part of the crop-livestock farming areas in Ethiopia (Eshete, 2002). However, Keftassa (1988) reported that crop residues contribute half (40 to 50%) of the livestock feed.

Continuous grazing and stall-feeding with crop residues are common in the highlands of Ethiopia (Ahmed, 2006). Overgrazing reduces ground cover, forage quality and productivity and changes are induced in the dominant growth forms of herbaceous plants as tall perennial bunch grasses which are replaced by annual grass and forbs (Herlocker, 1999). Terefe (2006), Mengistu (2006) and Kassahun (2006) reported that overgrazing might have been the main factor for the decline in the composition and diversity of plant species over a long period of time. Highly desirable grass species were gradually replaced by less desirable and unpalatable species as a result of increased grazing pressure (Crawley, 1986).

Bulo *et al*. (1985) found that IVDMD of leaf and edible stem of 12 shrubs or tree legumes varied from 36.0 to 63.4% and 34.5 to 58.2%, respectively. Mean herbaceous DMY obtained from communal grazing lands for south Omo and north Shoa, Ethiopia, were 244±27 kg/ha and 1264±6 kg/ha, respectively (Terefe, 2006; Ahmed, 2006). Roadside cotton based grazing land in north Gondar had a DMY of 2342 kg/ha (Mengistie, 2006).

Heavy grazing changes species composition, reduces productivity and increases erosion; proper grazing management aids recruitment and persistence of desirable species; poor management hastens the demise of preferred species and ultimately leads to their replacement by other species (Ahmed, 2006).

The productivity of these feed resources is triggered by population expansion and over exploitation. In communal rangelands high stocking rates, few rest periods, frequent close grazing and fire are factors that debilitate rangelands (Gammon, 1984) and controlling these factors are important principles of rangeland management. Identifying the existing forage species of the natural pasture and their nutritive value is the primary task in designing and implementing appropriate management interventions such as livestock feeding strategy. This study was therefore conducted to identify the species composition and measure the nutrient content and digestibility of dominant forage species in Assosa zone in Benishagul-Gumuz region, western Ethiopia.

MATERIALS AND METHODS

Study area

Assosa zone is located in Benishagul-Gumuz region, western Ethiopia. It is located approximately 680 km west of the capital, Addis Ababa. The average annual rainfall of the area is 1316 mm. The rainfall is uni-modal and occurs usually between April and October. The minimum and maximum mean annual temperatures of the zone are 16.7^{o}C and 27.9^{o}C. March and May are the hottest months (31^{o}C).

Shifting cultivation (SC) and permanent farming systems (PFS) are the two types of farming systems in the study zone. Farming systems could be defined as a population that has broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate (FAO, 2001; Doppler, 2002). Shifting cultivation is an agricultural system in which plots of land are cultivated temporarily, and then abandoned (Dumond, 1961). This system often involves clearing of a piece of land followed by several years of farming until the soil looses fertility. Once the land becomes inadequate for crop production, it is left to be reclaimed by natural vegetation, and a previously cultivated field will be cleared of the natural vegetation and planted in crops again. Permanent farming system is an integration of

crop-livestock production where oxen based crop production is dominant (AsARC, 2006) and crop and livestock production practices are interdependent, where cropping provides animals with crop residues and aftermath and animals provide draught power for ploughing and manure for fertilizing the crop land (Nyssen *et al*., 2008). It is also described by continuous use of farm land without fallow due to increasing scarcity of land for extensive farming (Tittonell *et al*., 2005). The majority of the indigenous communities, Berta people are engaged in SC and settlers in PFS.

Communal grazing land (CGL) is a natural pasture subjected to common use or unrestricted access. Riverside grazing land is an area in the range of 600 m on both sides of main rivers. It is part of CGL and is generally mis-managed because it is a common watering place in the area where large number of animals are concentrated especially during the dry season.

Assosa has approximately 81,939 cattle, 73,181 goats, 10,231 sheep, 14,089 donkeys, 40, 3153 poultry, 29 horses and 59,695 beehives (CSA, 2005). It has 35.6% of the livestock population in the region. The major crops grown in the area are sorghum (*Sorghum virgatum*), maize (*Zea mays*), soybean (*Glycine max*), finger millet (*Eleusine coracana*) and ground nut (*Arachis villosulicarpa*). The minor crops produced include Teff (*Eragrostis tef*), haricot bean (*Phaseolus vulgaris*), hot pepper (*Capisicum frutescens*), sweet potato (*Ipomoea batatas*), banana (*Musa paradisiaca*) and coffee (*Coffea arabica*).

Forage sampling for chemical analysis, *in vitro* DM digestibility determination and species identification

Forage samples were collected, from three sites from each of the communally owned and riverside grazing lands. On the whole, 24 composite sampling units (3 quadrates per composite sample unit) for herbaceous and 24 composite sampling units (3 quadrates per composite sample unit) for woody vegetations were employed. The sampling plots were selected randomly and were 30 - 90 ha and 5 - 10 km apart. For sampling of the herbaceous species, a 0.5 m x 0.5 m and for the woody vegetation a 5 m x 5 m quadrates were used. Samples of grasses and leaves of browse were collected at the end of the long rainy season (mid-November) when browse and grass species were at full vegetative stage. Browse leaves and twigs were hand plucked and grasses were cut at approximately 5 cm above the ground. Herbaceous species were identified in the field and the local names of each species were recorded. Grass and browse species were identified using the reference on the Flora of Ethiopia (Hedberg and Edwards, 1989) and of the Flora of Tropical East Africa (Cufodontis, 1953-1972). The herbaceous species were cut at 5 cm above ground, weighed immediately and transferred into properly labelled and ventilated paper bags and fastened at the top. The samples were kept under shade until sampling for the day was completed. The samples in each of the paper bags were hand separated into different species and then weighed. They were then partially sun-dried. Finally, the harvested materials were transported to a laboratory where they were oven dried at 50^0C for 48 h. Samples were ground with Wiley mill (1mm sieve) and stored in airtight containers until they were chemically analyzed.

Determination of relative abundance, longevity, distribution and classes of forage

At each sampling site the grass species composition was assessed from randomly harvested six quadrates of 0.25 m^2 and then rated on the scale of 1 to 10 points. In each of the quadrates grass covers were considered and relative abundance (p=present, c=common, d=dominant, -=not available) determined. Then the grass species were divided according to the succession theory (Dyksterhuis, 1949; Tainton, 1999) into desirable that are likely to decline with heavy grazing pressure (decreasers), intermediate likely to increase with heavy grazing pressure (increasers) and undesirable species likely to invade under heavy grazing pressure (invaders). Classification of grasses into decreasers, increasers and invaders was done by interviewing the local community using a structured questionnaire and cross checking the information from literature.

The percent species composition was determined based on dry-weight-rank method for herbaceous species (ILCA, 1990) and on density basis for woody species. The density of woody species was enumerated from six 25 m^2 quadrates. Only live woody plants irrespective of whether they were single stemmed or multiple stemmed were counted and recorded to estimate the woody vegetation density in the area of 25 m^2 quadrates (Kuchar, 1995). Woody species covers were considered and relative abundance (p, c, d, -) determined. The desirability and palatability of woody species were also recorded based on the discussion with the livestock owners and also supported by literature (Azene *et al*., 1993)

Dry matter yield (DMY) of herbaceous species was determined by cutting the forages within 0.25 m^2 quadrate at 5 cm above the ground. After weighing the fresh sample (g), its DM content was determined by drying it at 105^0C and converted to g DM/0.25 m^2. The DMY (kg/ha) was then calculated by multiplying the DMY in 0.25 m^2 with 40.

Chemical analysis

Feed samples were analyzed for DM, nitrogen and ash using the method of AOAC (1990). Nitrogen was determined by micro-Kjeldhal method. Then crude protein (CP) was calculated as N x 6.25. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were analyzed according to Van Soest *et al.* (1991). The method of Tilley and Terry (1963) as modified by Van Soest and Robertson (1985) was used to determine *in-vitro* DM digestibility (IVDMD). IVDMD was determined in Holeta Agricultural Research Center. Rumen liquor was collected from three fistulated Boran-Fresian crossbred steers kept under maintenance ration. Rumen liquor was taken in the morning before animals were offered with feed and water (concentrate offer was restricted to 24 h before taking rumen liquor). Animals were fed with native grass hay (about 6% CP) and 2 kg of concentrate out of wheat bran and noug cake (*Guzotia abyssinica*). Samples were run in duplicates; 500 mg of each sample was incubated with 30 ml of rumen liquor in 100 ml test tube with a screw cap top in duplicates and incubated in water bath at 39°C for a period of 48 h for microbial digestion and 48 h for enzyme digestion after application of acid pepsin solution. The IVDMD at 48 h was corrected using Leucerne hay of known *in vitro* value (ruminal DM disappearance) in each batch of incubation as a standard. Drying of samples was done at 105°C. IVDMD was estimated as:

IVDMD (%) = sample DM- (corrected residual DM-DM in the blank)/sample DM*100.

Statistical Analysis

The DMY of composite samples from three quadrates of each sampling plot were sorted by farming systems and grazing types and considered as experimental units for data analysis in a factorial randomized complete block design. For the woody vegetation, a quadrate from each sampling plot was considered as an experimental unit for data analysis. The parameters were subjected to ANOVA, using the GLM procedure of SPSS (Version 13) computer software package (SPSS, 2003). Means were tested for significance using Least Significance Difference and differences were declared significant at $P<0.05$.

RESULTS AND DISCUSSION

Floristic composition in Assosa Zone

The authors found 23 herbaceous species. Of the 23 herbaceous species recorded from both farming systems, most of them were grasses (18), a few legumes (2 species), one sedge and two forbs. About 9 % of grasses were highly desirable, 62 % desirable and 29 % less desirable (Table 1). Desirability of each species was recorded based on the response obtained from livestock owners. According to the respondents, highly desirable species were highly preferred by the animals whereas less desirable species were less preferred. Highly desirable species were highly palatable and preferred by livestock (Hoveland, 1996). The reduction in the proportion of highly desirable species might be due to their gradual disappearance through overuse and disturbance by livestock and human beings. Shifting cultivation (SC) does not favor the growth of highly palatable species and allows their replacement by the less palatable ones; and overgrazing which is prominent in permanent farming system (PFS) would eliminate highly palatable species first and give way to the less palatable ones, both situations are causes of the decline of palatable species. Excessive and protracted overuse of land paves the way for invaders or undesirable plants to dominate the area. Respondents indicated that the invader plants were absent in the original vegetation state, but as grazing pressure advanced their rangelands were dominated by invader plants which agrees with the report of Gartner (1976).

Of 18 herbaceous species identified in SC, 15 were grasses, 2 legumes and 1 sedge (Table 1). Even though the proportion of grass species appeared to be higher than legumes and sedges in SC, their desirability/palatability was low; as there were very few highly desirable, but large numbers of desirable grasses. *Chloris prieurieuri, Cynodon dactylon, Cyperus pulchellus Hyparrhenia collina,* and *Pennisetum catabasis* were common species; *Digitaria abyssinica* and *H. hirta* were dominant in the communal grazing areas of SC. *P. catabasis* was the common grass species, while *D. abyssinica, H. collina* and *H. hirta* were dominant in riversides. The communal grazing areas have a relatively higher percentage of highly desirable and desirable grass species than the riverside grazing areas. Large numbers of livestock graze around riversides during the dry season because rivers are used as a source of water for livestock and this has increased grazing pressure (Kassahun, 2006; Terefe, 2006; Abate, 2007).

Of the 13 herbaceous species recorded from PFS (Table 1), 7 were desirable. Out of the 18 herbaceous species recorded in the communal grazing areas, 15 of them were grasses, 2 legumes and 1 sedge. About half of the grasses were desirable. Out of 10 species of grasses recorded in riverside grazing areas, nearly half of them were less desirable. The less desirable species were *Chloris pycnothrix* and *Sporobolus pyramidalis* and the desirable were *Eragrostis barrelieri* and *Hyparrhenia collina*. In communal grazing areas, the proportions of desirable and less desirable grass species were equal. The relatively high percentage of highly desirable grass species (decreasers) in the

communal grazing areas than in riverside grazing areas suggests that the highly desirable species were gradually replaced by less desirable and unpalatable species as a result of increased grazing pressure which agrees with Crawley (1986).

Table 1. Relative abundance of grass species under different grazing types and farming systems of Assosa Zone, Ethiopia

Species	Longevity	Class	SC		PFS	
			CG	RS	CG	RS
Aristida adscensionis	Perennial	DS	P	-	-	-
Brachiaria humidicola	Perennial	DS	P	P	-	-
Cenchrus ciliaris	Perennial	DS	-	P	-	P
Chloris prieurieuri	Annual	DS	C	-	P	-
Chloris pycnothrix	Annual	LD	-	-	D	D
Cida ovate	Annual	DS	P	-	P	-
Crotalaria spinosa	Annual	DS	-	P	-	P
Cynodon dactylon	Perennial	HD	C	-	C	-
Cyperus pulchellus	Perennial	DS	C	P	-	-
Digitaria abyssinica	Perennial	DS	D	D	-	-
Eleusine floccifolia	Perennial	HD	-	-	P	P
Eragrostis barrelieri	Perennial	DS	P	P	-	-
Hyparrhenia collina	Perennial	DS	D	D	C	C
Hyparrhenia hirta	Perennial	DS	D	D	-	-
Hyparrhenia rudis	Perennial	Ds	-	-	D	D
Hyparrhenia rufa	Perennial	DS	-	-	C	C
Indigofer spinosa	Annual	DS	P	-	-	P
Pennisetum catabasis	Perennial	HD	C	C	P	C
Rhychelytrum repens	Annual	LD	P	-	-	-
Sporobolus pyramidalis	Perennial	LD	-	-	D	D

HD = highly desirable; DS = Desirable; LD = Less desirable; CG = Communal grazing; RS = Riverside; SC: Shifting cultivation; PFS: permanent farming system P= present (> 1% and < 5% of DM); C = Common (>5% and <20% of DM), D = Dominant (>20% of DM); - = not available

Woody species composition

In the present study 17 woody species were found. Of the 17 woody species identified from both farming systems 53% were highly desirable, 23% desirable and 22% less desirable. *Oxytenantheria abyssinica* and *Acacia seyal* were more palatable and made up the largest proportions of the highly desirable (HD) species (Table 2).

Acacia seyal, O. abyssinica, Cordiana africana, Coreopsis baraniana, Grewia ferruginea, Rhus natalensis and *R. retinorrhoea* were common and dominant species in SC, but *O. abyssinica* (bamboo) was the most dominant species in riverside and communal grazing lands of both farming systems which can be utilized as source of livestock feed, human food (fleshy shoot), fuel, construction and income generation for the rural people.

During group discussions, the key informants from shifting cultivation described *O. abyssinica* (lowland bamboo) as multipurpose tree that they utilize for fuel, construction, house furniture, cultural music instrument (Zumbara), livestock feed and could be grazed freely and fed as cut and carry. Moreover, they also utilized it as a source of human food (fleshy shoot) and at the time of the study *O. abyssinica* was one of the most important fodder trees in the zone. These findings strengthen earlier reports that woody species are important source of food, fodder, fuel wood, medicine, fiber and gums (Herlocker *et al.*, 1999; Mengistu, 2006).

Table 2. The relative abundance of woody species under different grazing types in the two farming systems of Assosa Zone

Species	Class	SC		PFS	
		CG	RS	CG	RS
Acacia peri	DS	-	-	-	P
Acacia seyal	HD	C	C	-	-
Oxytenantheria abyssinica	DS	D	D	D	D
Bauhinia farea	LD	-	-	C	C
Cordial africana	LD	C	P	-	-
Coreopsis baraniana	DS	C	C	-	-
Deinbollia kilimandscharica	DS	P	P	P	P
Grewia ferruginea	HD	C	C	C	C
Lannea schimperi	DS	-	-	C	C
Maytenus ovatus	LD	P	P	-	-
Maytenus senegalensis	UD	-	-	P	P
Piliostigma thonningii	LD	P	-	P	P
Rhus natalensis	HD	C	C	C	C
Rhus retinorrhoea	LD	C	P	P	P
Securinega virosa	LD	P	C	C	P
Syzygium guineese	LD	P	P	P	P
Vernonia auriculifera	LD	P	C	P	C

HD = highly desirable; DS = desirable; LD = less desirable; CG = communal grazing; RS = riverside; SC= shifting cultivation; PFS= permanent farming system; P= present (>1% and <5% density); C= common (> 5 % and < 20 % density); D= dominant (> 20 % density)

The highly desirable and desirable species were about 75% of the total 14 woody species identified from SC (Table 2), may be due to frequent availability of *O. abyssinica* that excaudate the highly desirable species and favored browsers than grazers. *O. abyssinica* was dominant species whereas *Acacia seyal, Cordia africana, Coreopsis baraniana, Grewia ferruginea, Rhus natalensis, R. retinorrhoea, Securinega viros* and *Coreopsis baraniana* were common but less dominant/dense species in communal grazing lands of the SC. In riverside grazing land *O. abyssinica* was the dominant species while *Acacia seyal, G. ferruginea* and *R. natalensis* were common species.

About 25% of the 13 woody species identified from PFS were less desirable and undesirable, the remaining 75% were either highly desirable or desirable (Table 2). *Bauhinia farea, G. ferruginea* and *R. natalensis* were common where as *O. abyssinica* was dominant in communal grazing lands. In riverside grazing lands, *G. ferruginea* and *R. natalensis* were common species but *O. abyssinica* was the most frequently available species (Table 2).

Biomass Production in Assosa Zone

Communal grazing land

The communal grazing lands of SC produced significantly higher dry matter yield (DMY) from herbs, grasses and legumes with higher basal cover than that of communal grazing lands of PFS. However, differences in DMY of forbs and sedge between the two farming systems were not significant. The mean total herbaceous DMY obtained for the communal grazing areas of both farming systems (Table 3) were higher than those reported of the same grazing types in south Omo Zone by Terefe (2006) (244 ± 26 kg/ha) and in North Shoa Zone by Ahmed (2006) (1264 ± 6 kg/ha); whereas it was lower than those reported for cotton based farming system (3584 ± 403) and sesame based farming system (5008 ± 664) of North Gonder Zone (Mengistie, 2008). The possible reason for these differences could be related to differences in grazing pressure between the two farming systems. Variation in DMY might have been the impact of edaphic conditions, livestock grazing pressure/intensity, grazing and climatic variables.

In both farming systems the main forage sources are grasses followed by legumes and others representing 78% of the total production in SC while 74% in PFS of CGL. Since the climatic conditions of both farming systems are almost similar, the possible reason for these differences could be related to the presence of high population pressure in PFS resulting in intensive cropping and excessive grazing pressure by domestic animals. The major causes of changes in rangelands are excessive grazing by domestic and wild animals, cultivating for crop and intensive collection of firewood, foods and building materials.

In the PFS the rapid human population growth forced the use of communal grazing land for crop production and intensified the grazing pressure on the remaining part of it (Mengistu, 2004) and the resultant overgrazing caused land degradation. High soil erosion, which is the result of land degradation, has compounding effect of overstocking, overgrazing and over-utilization of range vegetation (Kassahun, 2006). It has also been reported that as a result of shrinkage of grazing land, land degradation and intensive grazing pressure, desirable forage species were gradually disappearing (Crawley, 1986).

Riverside grazing areas

Similar to communal grazing areas, riverside grazing areas of SC showed a significantly higher total herbaceous DMY than the riverside grazing areas of PFS. This was associated with the higher basal cover in SC than PFS.

The riverside grazing areas of both farming systems did not show a significant difference on total legume DMY (Table 4). The total herbaceous and grass DMY recorded for the two farming systems were much higher than those reported by Terefe (2006) for similar grazing types located in different altitudes, whereas it was much lower than those reported by Mengistie (2008) of different farming systems of North Gonder.

Table 3. Dry matter yield (kg DM/ha, Mean ± SE) of the natural pasture of communal grazing lands of the two farming systems of Assosa Zone.

Components	Farming System		
	Shifting cultivation	Permanent farming	SEM
Grasses	1891±132a	1251±118b	31
Legumes	399 ± 48a	218 ± 28b	23
Other herbs	205 ± 22a	216 ± 114a	2
Total	2495 ± 202a	1684 ± 259b	37

Means with the same letter in a row are not significantly different at P<0.05; SEM=standard error mean

Chemical composition and in vitro dry matter digestibility of major livestock feed resources of Assosa Zone

Grasses

The chemical composition and *in vitro* dry matter digestibility (IVDMD) of different grass species of the two farming systems are shown in Table 5. Of the nine grass species *Digitaria abyssinica* and *Hyparrhenia hirta* were common in SC, whereas *Sporobolus pyramidalis, Pennisetum catabasis, Eleusine floccifolia, Chloris pycnotrix, Hyparrhenia rudi* and *Hyparrhenia rufa* in PFS, and *Hyparrhenia collina* in both farming systems. The DM contents of *S. pyramidalis* and *H. collina2* (from PFS*)* were higher (P<0.05) than those of *Chloris pycnothrix, E. floccifolia, H. rudis, H. rufa, H. collina1, H. hirta,* and *P. catabasis.* The NDF contents of *H.rufa* was significantly lower than those of other grasses while the ADF contents of *E. floccifolia* and *P. catabasis* were significantly lower than those of other grasses. The IVDMD of *E. floccifolia* and *P. catabasis* were higher than those of *C. pycnothrix, H. rudis, H. rufa, H. collina1, H. collina2* and *S. pyramidalis* whereas, CP content of *E. floccifolia* was higher (P<0.05) than those of other species except *H. hirta*. Less desirable species such as C. pycnotrix and *S. pyramidalis* showed less IVDMD while highly desirable species (*P.catabasis* and *E.floccifolia*) showed higher IVDMD (Table 5). The higher digestibility of highly desirable species justifies why these species are more preferred by animals than less desirable species. Differences in nutrient content between species and within a genus could be associated with their inherent nature. This could be related to morphological and anatomical differences within a genus and also to differences in the contents of lignin, cellulose and hemi-cellulose.

Table 4. Dry matter yield (kg DM/ha, mean ± SE) of the natural pasture of riverside grazing areas of the two farming systems of Assosa Zone

Components	Farming system		
	Shifting cultivation	Permanent farming	SEM
Grasses	1651±130a	884±120b	38
Legumes	415 ± 48a	330 ± 34a	16
Others herbs	332 ± 24a	168 ± 114b	35
Total	2397± 202a	1382 ± 267b	49

Means with the same letter in a row are not significantly different at P<0.05; SEM=standard error mean

Browse species

The chemical composition and IVDMD of different browse species of the two farming systems is shown in Table 6. There were differences in nutrient contents between the five major species namely, *Acacia seyal* from SC; *Bauhinia farea* and *Rhus natalensis* from PFS and *Grewia ferruginea* and *Oxytenantheria abyssinica* from both farming systems. The DM and CP contents of *B. farea* were higher (P<0.05) than those of other species. The OM content of *B. farea* was significantly higher than that of *O. abyssinica, A. seyal* and *R. natalensis*. The NDF, ADF, Ash and IVDMD contents of *B. farea* were lower (P<0.05) than those of *A. seyal*, *O. abyssinica* and *R. natalensis*. Desirable species such as *O. abyssinica* and highly desirable species *A. seyal* showed higher digestibility while less desirable species *B. farea* showed less digestibility (Table 6). Differences in IVDMD between species and within genus could be associated with contents of lignin, cellulose and hemicelulose and the inherent nature of the species.

Table 5. The chemical composition (g/100 g) and *in vitro* dry matter digestibility of different grass species in the two farming systems of Assosa zone

Species	DM	Ash	CP	NDF	ADF	Hemi-cellulose	IVDMD
C. pycnothrix	94d	12cde	8bcd	75bc	40de	35b	45bc
D. abyssinica	96ab	14a	7bcd	76a	42cde	35b	49ab
E. floccifolia	93d	13abc	9a	77a	36f	41a	52a
H. rudis	96bc	13bc	5ef	75bc	43bc	31bcd	46bc
H. rufa	95bc	13cd	5ef	72e	40e	33bc	42cd
H. collina1	96bc	13bc	6def	74cd	43bcd	31bcd	40d
H. collina2	97a	120de	4f	76ab	48a	28d	33e
H. hirta	95bc	14ab	7abc	76ab	46ab	30cd	48ab
P. catabasis	95c	14ab	6cde	73de	40e	33bc	52a
S. pyramidalis	97a	12e	6def	75bc	44bc	31bcd	34e
SEM	0.3	0.2	0.3	0.3	0.8	0.8	1.5

Means with different letters within a column are significantly different at P<0.05; SEM=standard error mean

Table 6. Chemical composition (g/100 g) of different browse species in the Assosa zone

Species	DM	OM	Ash	CP	NDF	ADF	Hemi-cellulose	IVDMD
A. seyal	95bc	91bc	9ab	16c	34ab	29a	5d	65ab
O. abyssinica1	95b	91bc	9ab	17b	36b	28ab	5d	65ab
O. abyssinica2	94d	90c	10a	14d	33a	29a	7a	66a
B. farea	95a	92a	8c	19a	30c	26c	4e	64c
G. ferruginea1	95bc	91ab	9b	16c	33b	28ab	5cd	65b
G. ferruginea2	95bc	91ab	9bc	14d	33b	27bc	6bc	64bc
R. natalensis	95cd	91bc	9ab	15d	34ab	28ab	6bc	65ab
SEM	0.03	0.1	0.1	0.5	0.5	0.3	0.3	0.2

Means with different letters in a column are significantly different at P<0.05; SEM=standard error mean

CONCLUSIONS

A study was conducted on species identification, distribution, palatability/desirability, chemical composition and digestibility of forages of Assosa Zone of Benshangul-Gumuz Region of Western Ethiopia. Seventeen woody and 23 herbaceous (18 grasses and 5 non-grass) species were identified. In shifting cultivation 14 woody and 18 herbaceous plant species were recorded. Of the woody species, 53% were highly desirable, 23% desirable and 22% less desirable. Among the grass species, 15% were highly desirable, 83% desirable and 1% less desirable. In permanent farming system 13 woody plants and 16 herbaceous species were documented. Of the woody plant species 46% were highly desirable, 29% desirable, 21% less desirable and 3% undesirable. Only 7% of the herbaceous species were highly desirable, 53% desirable and 46% less desirable. Among the dominant grass species, *Eleusine floccifica* and *Pennisetum catabasis* showed highest *in vitro* DM digestibility. Less desirable species such as *C. pycnotrix* and *S. pyramidalis* showed less IVDMD while highly desirable species *P. catabasis and E. floccifolia* showed higher IVDMD. It is suggested to determine nutritive value of dominant and palatable forage species, distribution of highly palatable species during the dry and rainy seasons of the year and appropriate natural pasture management techniques through further studies.

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