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Full Length Research Paper

Herbage yield, species diversity and quality of native grazing land vegetation under sub humid climatic conditions of Western Ethiopia

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This survey was undertaken in Mendi district of West Wollega Zone and aimed to identify frequently occurring species, and variation of study sites in terms of herbage dry matter (DM) yield and quality traits. Five sites were sampled to determine botanical composition, herbage yield, species diversity, crude protein (CP), neutral detergent fibre (NDF) and *in vitro* organic matter digestibility (IVOMD). Overall, 20 species were identified (19 were herbaceous species and one was a dwarf perennial shrub). Out of the 19 species, eight were perennial graminoid, one was annual graminoid and the rest were annual non-graminoid species. *Hyparrhenia rufa*, *Pennisetum polystachyon* and *Brachiaria humidicola* were observed to be dominant. Location significantly (P<0.05) affected herbage yield, while intra-location transect position did not (P>0.05). Mean herbage DM yield values ranged between 0.86±0.39 kg m^{-2} and for *Guyo Tayiba* site to 3.40±0.39 kg $m^{-2}$for *Idoro Tobara* site. Species richness ranged from 3±0.67 to 4±0.67, but between- and within-location values did not vary significantly (P>0.05). Between-and with-in location differences were not significant (P>0.05) for diversity. Evenness ranged from 1.21±0.54 to 2.26±0.54. The mean CP, NDF and IVOMD were 6.17±1.27%, 75.89% and 48.44%, respectively. Based on values of species diversity, yield and quality, the studied grassland was found to be poor.

Key words: Evenness; species richness; Shannon diversity index; herbage quality.

INTRODUCTION

Livestock production is an important economic activity in mixed crop-livestock and pastoral production systems in East Africa region in general and Ethiopia in particular. The productivity of the sector across the region is constrained by several technical factors, among which feed scarcity in quality and quantity is the major one. Natural pasture grazing is a vital land use system that provides the bulk of feed for livestock production in Ethiopia (Daniel, 1987; Lulseged, 1987). The primary productive capacity and pasture quality of native grasslands is, however, low and this is partly attributed to overgrazing. Over years, the grazing pressure has steadily increased across the entire country and it has become a severe environmental concern at present.

Some previous grassland studies in Ethiopia have generated information regarding the performance of grassland vegetation under certain circumstances. Past research themes mainly focused on evaluation of the impacts of grazing pressure on attributes of grassland vegetation (Abebe *et al,* 2006; Ayana *et al,* 2010) mainly under arid or semiarid conditions. However, the status of grassland vegetation parameters under certain situations cannot be generalized across ecological regions as impacts could vary depending for example on site productivity (Curtin, 2002) or the prevailing grazing management systems (Shankar and Singh, 1996; McIntire *et al,* 2003).

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Table 1. Soil PH, organic carbon and total nitrogen of the study locations (n = 2)

Site	PH	Organic carbon	Total nitrogen
Site 1	5.00	3.40	0.29
Site 2	5.50	3.41	0.19
Site 3	5.10	3.52	0.23
Site 4	5.47	2.56	0.23
Site 5	5.42	1.78	0.37
Mean	5.29	3.33	0.26

To improve the condition of grasslands by putting suitable rehabilitation options in place, understanding their prevailing status and factors influencing their functions under various environmental circumstances is very important. This information is also useful as it serves as baseline evidence against which the success of future rehabilitation efforts will be evaluated. The objective of the present study was to assess the prevailing status of sub humid native grazing lands under continuous grazing in sub humid area of western Ethiopia. The study particularly assessed the frequency of prevailing species and herbage yield, species diversity and certain quality traits of herbaceous vegetation as influenced by location.

MATERIALS AND METHODS

Location

The study was conducted in Menasibu district of West Wollega zone of Oromia Regional State, Ethiopia during the first two weeks of October 2010. This time was preferred for two reasons: first, it is the end of rainy season in the area during which grassland vegetation accumulate substantial amount of herbage and second, it is the time when most grassland species flower during the same period and their identification can be performed without much difficulty. The specific study site falls within the western sub humid highlands of the country and has an elevation that ranges from about 1600 to over 1800 masl. The landscape varies from gently undulating plains and plateaus to rolling plateaus of wider valley bottoms. The climate of the area is mild hot with mean annual rainfall varying from 1200-2000 mm and the dominant soils belong to dystric Nitosols series (Gauchan *et al*, 1998). The mean PH, organic carbon and total nitrogen contents of soil samples of the study locations, based on two soil samples per location, taken at a depth of 120 cm during the present grassland study are given in Table 1.

Sampling procedures

Five grassland sites located in five villages of Menasibu district hereafter to be referred to as; *Buke Hena* (Site 1), *Buke Sachi* (Site 2), *Darge Tobara* (Site 3), *Guyo Tayiba* (Site 4) and *Idoro Tobara* (Site 5), located within 20 Km radius of Mendi town, main administration town of the district, were systematically selected for this study. In each village, representative sampling locations were selected in collaboration with the local community and village level agricultural development workers.

Three 50 m long transects were placed at three slope positions at each study location. A metal frame quadrat of 1m×1m with short legs welded to its corners was placed at every 10 meters starting from one end, making 5 samples per transect and 15 1m2 quadrat samples per site. The transect positions within location were selected to represent upper, medium and lower positions. For identification of herbaceous species, an experienced staff familiar with the common herbaceous species in the area was included in the study team. A collection of voucher specimen developed from previous similar grassland inventory studies in other similar areas, and illustrative plant identification guides were also used. Species that could not be identified during the sampling process were pressed, mounted in a scrapbook and identified later.

Herbaceous vegetation within the quadrats was then manually clipped and sorted in to the different species to determine the biomass dry weight of each after finally drying it in an oven to constant weight. For each quadrat, species richness (as number of species encountered) and; Shannon's diversity ($H' = -\sum [pi \times lnpi]$) and evenness ($HE' = [H'/lnS]$) indices were calculated, where 'S' is the number of species and 'pi' being the relative biomass dry weight of each species.

For nutritive value analysis, a total of five samples (one composite sample per location) were maintained. These were ground to pass through a 1mm screen and analyzed for DM and ash by the methods of the A.O.A.C (1995). Nitrogen was determined by the micro-Kjeldahl method and CP was calculated as N×6.25. The NDF was determined according to Van Soest and Robertson (1985) and the IVOMD was determined by the methods of Tilley and Terry (1963) as modified by Van Soest and Robertson (1985).

Statistical analysis

Descriptive statistical methods were used for summarizing data on frequency of occurrence of species and nutrient contents of the feed samples. For herbage yield, species richness, diversity and evenness, the total variation was partitioned into that associated with location and transects position within location using the GLM procedure (SAS, 2002). Tukey's test was employed for separating significant treatment differences ($P<0.05$).

RESULTS AND DISCUSSION

Frequency of species occurrence, biomass yield and diversity

Overall, 20 species were identified in the present d survey, out of which 19 were herbaceous species and one was a dwarf perennial shrub. Out of the 19 herbaceous species, eight were perennial graminoid, one was annual graminoid and the rest were annual non-graminoid species.

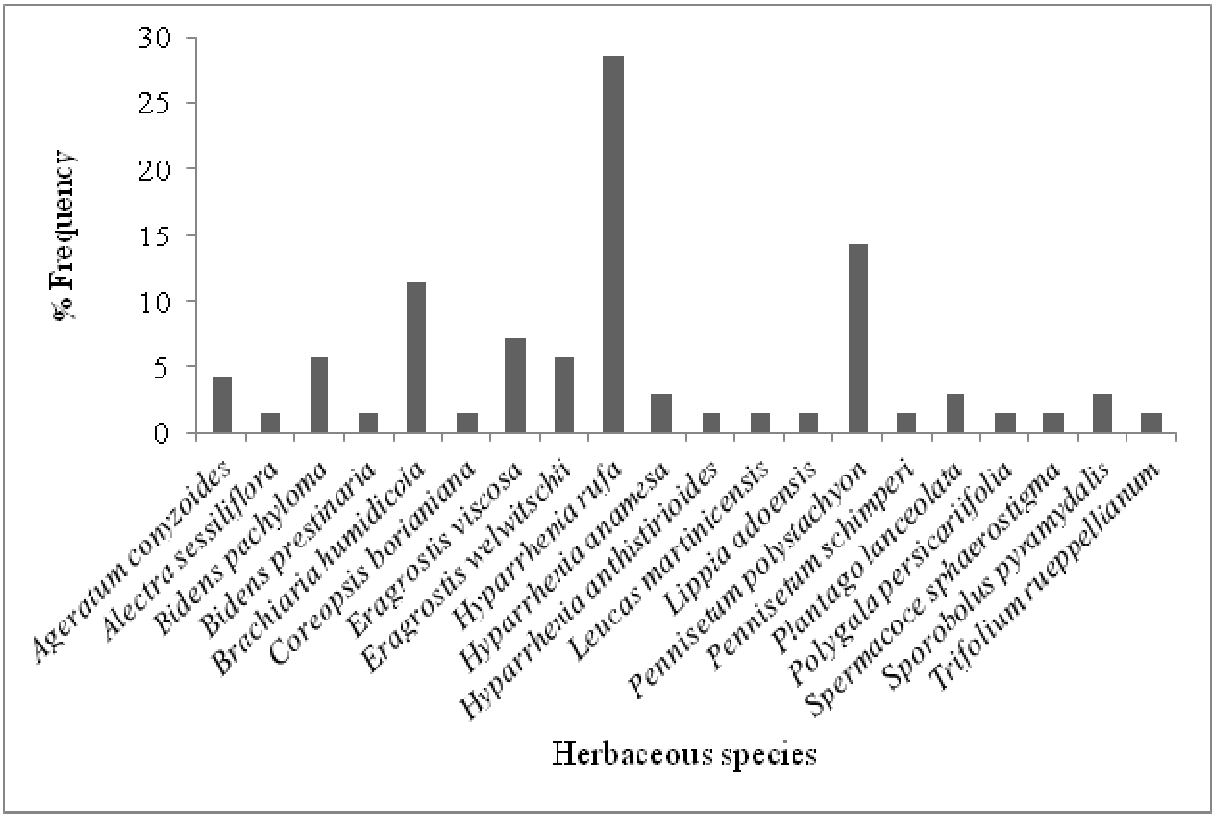

Figure 1. Species identified and their frequency of occurrence (n = 70) in the study area

The relative frequency of each species is presented in Figure 1. Accordingly, three perennial grass species*; Hyparrhenia rufa, Pennisetum polystachyon* and *Brachiaria humidicola*, with respective percentage values of 28.57, 14.29 and 11.43 were observed to be dominant. Among the grass species, *Brachiaria humidicola* was the most preferred species by grazing livestock. It was also reported to perform fine on acid soils and resist termite attacks, the two important factors hindering productivity of native grasslands in the study area.

Least square means for DM yield, species richness, and Shannon diversity and evenness indices for locations and intra-location transect positions are presented in Table 2. Differences in herbage DM yield between locations was significant (P<0.05) with higher yield for Site 5 followed by Site 3, and lowest mean DM yield was recorded for Guyo Tayiba (0.86±0.39). The effect of intra-location transect position was not significant (P>0.05) for herbage yield, but numerically higher value was recorded for the upper transect position.

The effect of location and transect position was not significant (P>0.05) for species richness. Species richness was relatively high at Site 3 followed by Site 1 and Site 4. Numerically lowest number of species was recorded for Site 2 and Site 5. Likewise, mean species richness value was high at the lower transect position, the remaining ones having equivalent number of species.

Similarly, the effect of location and transect position was not significant (P>0.05) for Shannon diversity index (H'). Shannon diversity was observed to be high at Site 1, followed by Site 5. Moderately high diversity value was observed at the middle transect position, with values of the upper and lower transect positions being similar. For evenness index, the effect of both factors was not significant (P>0.05); and relatively better evenness values were recorded for Site 1, followed by Site 2 and Site 5, values being equal for the latter two. Generally, the five locations had a consistently similar ranking order for diversity and evenness indices with Site 1 > Site 2 > Site 5 > Site 3 > Site 4.

The study indicated that the area and herbage production capacity of grazing lands in the study area is low which is apparently caused, among others, by encroachment of crop production, overgrazing and high termite infestation level. This concurs with reports of an earlier agro-ecosystem analysis (Gauchan *et al*, 1998) undertaken in the same district. The superior frequency and aggressivity of giant Hyparrehenia species could in

Table 2. Herbage DM yield (mean±s.e.m; kg m^{-2}), species richness, diversity and evenness as affected by sampling location and intra-location transect positions

Sources of Variation	DM Yield	Species richness	Diversity index	Evenness index
Sites				
Site 1	1.63[ab] ±0.39	3.33 ±0.67	2.84 ±0.84	2.26 ±0.54
Site 2	1.40[b]±0.39	3.00 ±0.67	1.24 ±0.84	1.21 ±0.54
Site 3	2.03[ab] ±0.39	4.00 ±0.67	1.22 ±0.84	0.88 ±0.54
Site 4	0.86[b] ±0.39	3.33 ±0.67	0.94 ±0.84	0.77 ±0.54
Site 5	3.40[a] ±0.39	3.00 ±0.67	1.33 ±0.84	1.12 ±0.54
Slope positions				
Upper	2.46 ±0.31	3.20 ±0.51	1.21 ±0.65	1.51±0.41
Middle	1.44 ±0.31	3.20 ±0.51	2.12 ±0.65	1.65±0.41
Lower	1.70 ±0.31	3.60 ±0.51	1.21 ±0.65	0.94 ±0.41

[a,b] Location means followed by different letters vary significantly ($P<0.05$)

part be attributed to good site condition mainly high rainfall and temperature that the area experiences.

Herbage yield values in the present study are comparable to previous reports from highland native grassland sites of Ethiopia (Zinash and Seyoum, 1991). The relatively higher DM yield at Site 5 could be attributed to the slightly better total soil N at this location as compared to the other sites as shown in Table 1. The values of species richness at various locations in this study is lower than reports for enclosed sites of semiarid environment in southern Ethiopia (Ayana *et al*, 2010a); and values of species richness at Site 3 is similar to those reported for grazed semiarid grassland sites (*Ayana et al*, 2010b). The study demonstrated some locations with relatively high species richness to have low diversity, for example that of Site 4 and Site 3. This agrees with the view that species richness explains diversity partially (Brian *et al*, 2005), but contradicts with the one that considers species richness to be a proxy for diversity (Gatson, 1998, Tilman and Lehman, 2002). The diversity index values obtained in this study are comparable to those values reported for semiarid grasslands in southern Ethiopia (Ayana *et al*, 2010). Though species richness was relatively high at Site 4 and Site 3, species evenness values were found to be low at the same. This can be related to dominance of few species contributing the most to biomass harvested. Accordingly, *Hyparrhenia rufa* and *Pennisetum polystachyon* were dominant at Site 4; while *Brachiaria humidicola* and *Hyparrhenia anamesa* were overriding at the latter.

Herbage nutritive value

Descriptive statistics for certain herbage quality traits is given in Table 3. Accordingly, the mean ash and OM contents of herbage samples were 7.02±1.27 and 92.98±1.27%, respectively. The CP concentration ranged from 5.03 to 8.07 with a mean of 6.17%. The mean IVOMD value was 48.44% and that of NDF being 75.89%.

The mean herbage CP in the present study is lower than previously reported values (12.1%) for natural pasture herbage harvested during the wet season while it is higher (3.2%) than that of the dry season (Zinash and Seyoum, 1991). According to Leng (1990), forages with respective CP and digestibility values lower than 8 and 55% are categorized under low quality forages. Similarly, Adugna and Said (1994) have pointed out that CP contents less than 7.5% inhibit intake, digestibility and proper utilization of feed DM. Thus, in terms of CP and digestibility values, herbage evaluated in the present study fall under the category of forages of low quality. The NDF value of 76% in this study is beyond a threshold level (60%) that decreases voluntary feed intake, increased rumination time and decreased efficiency of conversion of metabolizable energy to net energy. The observed herbage quality attributes as a whole indicate that the studied grasslands are poor in supplying herbage of required quality suggesting the need for protein and energy supplementation to enhance the performance of animals grazing these pastures.

Conclusion

Overall, 20 species were identified, out of which three grass species; *Hyparrhenia rufa*, *Pennisetum polystachyon* and *Brachiaria humidicola*, were dominant. Location significantly affected herbage yield, while intra-location transect position had no effect. Between-and with-in location differences were not significant for diversity. The herbage quality attributes generally indicate that the vegetation is poor in supplying herbage of required quality suggesting the need for protein and

Table 3. Mean ± standard deviation (SD); minimum and maximum values (%DM) of the various forage quality traits averaged over the sampling locations (n = 5)

Quality traits	Mean ± SD	Minimum	Maximum
Ash	7.02±1.27	5.85	9.12
OM	92.98±1.27	90.88	94.15
CP	6.17±1.27	5.03	8.07
NDF	75.89±2.24	72.72	77.78
IVOMD	48.44±3.81	42.89	52.95

CP = crude protein; IVOMD = in vitro organic matter digestibility; NDF = neutral detergent fibre

energy supplementation to enhance the performance of animals grazing these pastures.

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