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# Floristic Composition, Biomass Production and Chemical Composition of Major Herbaceous Species in Chifra District of Afar Regional State, Ethiopia

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## Abstract

The objectives of the study were to assess the distribution and composition of grass species, occurrence of bare patches under three grazing areas. The study was undertaken in Chifra district of zone one (Awsi Rasu) of the Afar Regional State. The total herbaceous species recorded in the study district was 35. These were 25 (71%) species of grasses and 10 (29%) non-grass species. The non-grass species comprised 3 species of legumes, 1 species of sedge, and 6 species of other herbaceous plants. Of the grass species, 20% were highly desirable, 24% desirable, 44% less desirable and 12% undesirable. The riversides grazing area had a significantly ($P \leq 0.05$) higher percentage of bare ground than the communal and enclosure areas. Furthermore, the communal grazing areas had a higher ($P \leq 0.05$) percentage of bare ground than enclosure areas. The enclosure areas in the >850-1100 m altitude zone had a significantly ($P \leq 0.05$) higher total herbaceous dry matter biomass, total grass dry matter biomass and total non-grass dry matter biomass than the enclosures in >550-850 m altitude of the study district. The CP content was higher in the composite sample taken from enclosure areas and lowest in river sides grazing areas in both seasons. *Cenchrus cillaris* and *Chryspogon plumolosus* were the best grass species with better nutritive value due to lowest content of ADF and higher content of CP, whereas *Tetrapogon cenchriformis* was a low quality grass relative to the other grass species.

**Keywords:** Communal; Riversides; Enclosure; Herbaceous species; Bare ground; Biomass

## Introduction

The peoples' living in Afar region depend basically on livestock for their upkeep, food and money. But due to the harsh environmental conditions, they practice semi-nomadic pastoralism as a major strategy of exploiting the grazing and browse resources available in the area. The livestock forms an efficient avenue for conversion of forage into meat, milk and other animal products for the people. The primary feed sources for large number of livestock in the region are rangelands composed of indigenous species of grasses, shrubs and fodder trees. Most of these grass species however, are subjected to continuous threat of genetic erosion due to overgrazing, rangeland degradation, invasion and encroachment by undesirable species (like *Prosopis juliflora, Parthenium hysterophorus, Calotropis procera, Tribulis terrestris, Sida ovata, Cryptostegia grandiflora* etc.) and weakening of the indigenous rangeland resource management practices of the pastoralists [1]. These rangelands suffer since some decades from severe degradation due to deep socioeconomic changes as expressed by the appearance of the agro-pastoral society instead of the former pastoral one [2].Traditional grazing system (transhumance and nomadism) which had historically allowed for grazing deferment and control of grazing livestock were abandoned [3].

Rangeland management practices of the study areas are also affected by expansion of crop farming, increased human and livestock populations and desertification making the rangelands to be severely overgrazed and remain bare land without vegetation and general loss of bio-diversity. The degradation of soils and the loss of perennial palatable species, mainly grasses are two of the direct results of recent aggravations from antropic pressure on the arid rangelands. The negative effect of overgrazing is excessive removal of the living parts of the high range value species, which may lead to their extinction [4]. This factor is being more harmful when coupled with the climatic aridity effect.

In the rangeland of the study district, no research work has so far been undertaken regarding, floristic composition, biomass production and chemical composition of the major feed resources and the pastoralists view on constraints that affect their livestock except very few assessments regarding the potential and constraints on the production system [5]. These gaps need to be filled by studying the existing range resource potential of the study area. This in turn helps to pave the way for designing different rangeland interventions to be undertaken in the area. Thus, the main objectives of the study were to assess the distribution and composition of grass species, occurrence of bare patches under three grazing areas, biomass production and chemical composition of major grass species in the study area.

The specific objectives of the study were:

To study the species composition and biomass production of herbaceous species at different grazing areas.

To evaluate the chemical composition of major grass species in the study area.

## Material and Methods

### Study area

The study was undertaken in Chifra district of zone one (Awsi Rasu) of the Afar Regional State. The total land area of the district is about 173,374 ha of which the largest area is rangeland [6]. The average temperature of the area is about 29°C, and the rainfall is bimodal with

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erratic distribution, with the long rainy season (Kerma) is between Mid-June to Mid-September and the short rainy season (Sugum) that occurs between March and April. The average annual rainfall is recorded to be between 400 and 600 mm [6]. The district has an estimated total population of 91,078, of which 50,859 are males and 40,219 are females; 9,132 or 10.02% of its population are urban dwellers and the household numbers are 17,744 [7].

## Sampling procedures

**Site selection and layout:** The rangeland in the study district was stratified based on altitude and grazing areas. Accordingly, the altitude classifications used were > 550-850 m a.s.l and > 850-1,100 m a.s.l. Furthermore, the grazing areas were stratified as communal grazing, riversides and enclosure, which represent the major grazing areas of the pastoral community. The sampling procedure was stratified random sampling technique [8]. The number of sampling range sites from altitudinal range between > 550-850 m a.s.l were 11 from communal grazing, 6 from riversides and 2 from enclosure areas and from the altitudinal range between > 850-1100 m a.s.l., 4 from communal grazing, 2 from riversides and 2 from enclosure areas. The allocation of range site is based on the grazing potential and the availability of rangeland (proportional sampling method). In each range site, a sampling block of 3 km by 1 km was demarcated and further stratified into three sample plots of equal size based on landscape. In enclosure area, the sample block was demarcated either in continuous or in separate manner based on the area of rangeland available in each pastoralists field. Samples from the riverside areas were taken within 400 to 500 m away from the riverside on non-water logged area. Vegetation composition assessment was conducted during the main rainy season of 2008 the time when most of the plants are at their flowering stage.

**Species identification:** In each study plot and/or quadrant, elder pastoralists and knowledgeable people were consulted to identify the local name of each woody and herbaceous plant. Plants were identified in the field and specimens were collected, pressed and dried properly using plant presses and transported to the Herbarium of Haramaya University for further identification and nomenclature. Nomenclature of the plant species followed the Flora of Ethiopia [9,10] and the Flora of Tropical East Africa [11].

**Herbaceous species composition:** Plant species composition of the herbaceous layer at each sample site was determined by using a wheel point apparatus based on the frequency of occurrence of the species and a minimum of 300 point observations were recorded at the interval of 3 m by revolving the wheel-point [12]. At each observation point, the nearest herbaceous species within a radius of 300 mm was recorded. If no herbaceous species occur within the given radius of the point, it was recorded as "bare ground". Bare ground was treated as if it is a plant species and gives an indication of plant density [13], which is also an important additional parameter for recording real changes in rangeland condition [14].

The identified herbaceous species were classified into groups using desirability grouping methods based on the opinion of herdsmen about the herbaceous species, vigor and palatability. Using the desirability method, they were divided into 4 groups, i.e., highly desirable, desirable, less desirable and undesirable. Highly desirable grass species include species that are decreases and perennials with a high palatability, while the desirable grass species are those that increase in abundance with moderate over-utilization, perennials and which are average or high in terms of their palatability. The less desirable species include those species of grasses that increase in abundance with severe over utilization and undesirable species include those grass species which increase in abundance with extremely severe over-grazing. This group includes both perennial and annual species that have low palatability as perceived by the pastoralists. Moreover, the frequency classification was according to the method of Amsalu and Baars [15], such as present (<10%), common (10% and 20%) and dominant (>20%).

**Dry matter determination**

In each of the sample plot, the herbaceous vegetation was harvested at ground level using hand shears from five randomly placed quadrate. Each 1 m × 1 m quadrate was used to assess the dry matter biomass production. The herbaceous species were divided into grasses and non-grasses by hand separation. The grass plants were sorted by species while the non-grass herbaceous were combined as forbs. The samples were oven-dried at 105°C for 24 hr and weighed in order to determine the dry matter content.

**Chemical analysis of natural pasture and grass species**

Chemical analyses were undertaken on three important grasses and three composite samples from different grazing areas i.e., enclosure, riversides and communal. Samples were stratified by season i.e., rainy season (from Mid-June to Mid-September) and dry season (from November to February) and types in order to know the difference in nutrient composition. Three most important grass species were selected based on the pastoralists' ranking of preference and samples of each grass species were taken from five different places and made a composite sample for each grass sample. The sample was collected, air dried, kept in air tight paper bags and moved to Haramaya University Animal Nutrition Laboratory. Samples of each species were milled using a simple laboratory mill to pass through 1mm sieve and oven-dried at 60°C for 72 hr and prepared for further determination of %DM, %Ash, %CP, %NDF, %ADF and %ADL. Dry Matter (DM), ash, nitrogen were determined according to AOAC [16] procedure. The crude protein was estimated by multiplying the N percentage by 6.25. Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), and Acid Detergent Lignin (Lignin) were analyzed following the procedures of Van Soest and Robeson [17].

**Statistical analysis:** The frequency of each herbaceous species, including that of bare ground, was expressed as a percentage of the total number of points. The proportion of the different grass species according to their desirability was calculated using percentage.

The data obtained from the dry matter production were subjected to ANOVA using the GLM procedure of Statistical Analytical System (SAS) [18] computer software. ANOVA was used with the interaction for dry matter biomass to look at the effect of altitudinal level versus grazing areas. Significant differences were detected with $P \leq 0.05$ and means were separated by Duncan's Multiple Range Test (DMRT).

## Result and Discussion

### Herbaceous species composition

The total herbaceous species recorded in the study district was 35. These were 25 (71%) species of grasses and 10 (29%) non-grass species. The non-grass species comprised 3 species of legumes, 1 species of sedge, and 6 species of other herbaceous plants. Of the grass species, 20% were highly desirable, 24% desirable, 44% less desirable and 12% undesirable. Based on the results, more than 50% of the species belong to less desirable and undesirable species which indicates the low grazing value and the deteriorating range condition of the study area.

According to response of the pastoralists, the most important and identified grasses in the study district were *Cenchrus ciliaris, Panicum coloratum, Cynodon dactylon, Chryspogon plumolosus, Brachiaria insculpta, Digitaria milanjana, Tetrapogon cenchriformis and Andropogon canaliculatus*, which are more prefered for livestock production. According to the respondents, these grass species were very important for milk and meat production but now these species are endangered due to overgrazing and inappropriate range management system. The important grass species (decreasers) have been replaced by the less important grass species (increasers) like *Brachiaria dictyneura, Brachiaria eruciformis, Lintonia nutans, Aristida somalenisis, Sporobolus pyramidallis, Eleusine multifolia and Eragrostis teniufolia*. Besides the increaser species, the less palatable weeds and forbs like *Blephris ciliaris, Amaranthus thunbeerii, Achyranthus aspera, Sida ovata and Tragus terrestris* were widely distributed on the grazing area of the study district.

The highly desirable grass species *like Cenchrus pennisetiformis* and *Cymbopogon giganteu*s were only found in the upper altitude (>850-1100 m) of the study district but the less desirable grass species like *L. nutans, E. tenuifolia* and *A. somalenisis* were found in the lower altitude (>550-850 m) while the other highly desirable, desirable and undesirable grass species were found in both altitudes of the study district and the only difference was the frequency of occurrence of each species in both altitudes, for instance *C. ciliaris* was dominantly (24.62%) found in the enclosure area of the upper altitude (>850-1100 m), but commonly (12.8%) found in lower altitude (>550-850 m) and *T. beteronianus* was commonly found along riversides (12.79%) and communal grazing areas (10.2%) in lower altitude (>550-850 m) but in upper altitude (>850-1100 m) only found in communal grazing areas in less proportion (2.44%). The percentages of less desirable and undesirable herbaceous species were higher in lower altitude than upper altitude of the study district. This indicated that vegetation condition in the lower altitude might have been influenced by overgrazing and drought. The degree of grazing strongly affects the structure, composition, quality and productivity of rangeland vegetation [19] and also according to Azaiez et al. [4] overgrazing is the main factor leading to the deterioration of the perennial plant cover and its negative effect is excessive removal of the living parts of the range value species, which may lead to their extinction.

**Communal grazing areas**

The desirable grass species *C. plumolosus* was the only species that dominated in the communal grazing areas of upper and lower altitudes and *C. plumolosus* is tolerant to drought and heavy grazing due to its high regeneration capacity, it is useful in controlling erosion and recovers easily from intense grazing [20]. According to the opinion of the pastoralists, this grass species had a high yield and nutritive quality that increase milk production and live weight gain (fattening) and also used for the purpose of house making. Due to this fact, milk, butter and meat availability were very high. The less desirable grass species, *E. multiflora* and *S. pyramidalis* were commonly found in the communal grazing areas of upper and lower altitudes and also *T. beteronianus* was commonly found in communal grazing areas in lower altitude (>550-850 m) of the study district. The less desirable grass species like *Eragrostis teniufolia, Aristida adoenesis, Aristida somalense* and *Brachiaria* species were abundant in the communal grazing areas (Table 1). This indicated that, the communal grazing areas were invaded by less desirable grass species. According to the study of Amsalu and Baars [21], the presence of *E. multiflora* species in communal grazing areas could be due to the less palatable nature of this grass species.

**Riverside Grazing Areas:** In the riverside grazing areas of the study district, desirable grass species like *Digitaria milanjana* and less desirable grass species like *E. teniufolia* were dominant grass species (Table 1). All the desirable grass species except *D. milanjana* (21.47%) share the lowest percentage (less than 10%) of the herbaceous layer in the riverside grazing areas of upper and lower altitudinal categories. The invader grass species, *T. beteronianus* is commons (10.2%) in the riverside grazing areas of lower altitude (>550-850 m). As indicated by Van oudtshoom (1999) [22], the less desirable grass species increase in the vegetation due to severe overgrazing and they are generally good indicators of a declining range condition. Highly desirable grass species like *C. ciliaris* were totally absent from riverside grazing areas in both altitudes but *C. dactylon* only existed in low proportion (0.41%) in upper altitude (>850-1100 m) along the riverside of the district. This showed a high grazing pressure along the riversides to the extent of affecting the distribution of promising grass species. This is from the fact that, livestock graze the first lush of grass, before seed setting. This may result in poor regeneration capacity of the rangeland either from existing vegetation propagates or soil seed banks. In arid and semi-arid rangelands, heavy and/or continuous grazing affects the species composition negatively, often resulting in the replacement of perennial species by annuals [22].

**Enclosure areas:** In the enclosure areas of the study district, highly desirable grass species such as *C. ciliaris, P. coloratum, C. dactylon, C. giganteus and C. pennisetiformis*; desirable grass specie like *C. plumolosus* were some of the dominant and/or common grass species. Among the highly desirable grass species that were identified only in the upper altitude (> 850-1100 m) of the study district were *C. giganteus* and *C. pennisetiformis*, whereas the remaining highly desirable species found in upper and lower altitudes of the study district but the relative occurrence was higher in the upper altitude (> 850-1100 m). The dominance of perennial grasses may indicated that the herbaceous layer was in good condition [23]. Similar results were reported by Noy-Meir et al. [24] and De-Val and Crawley [25] indicating that in protected areas highly desirable perennial grasses were found to be abundant.

The invader species, *T. beteronianus* was found in lower altitude (>550-1100 m) with low percentage composition of the species (1.24%) than in the other two grazing areas. Most of the grass species found in upper and lower altitude categories such as *C. dactylon*, were tolerant to drought and heavy grazing which was in line with the work of Adane [26] and *C. ciliaris*, a climax species in the arid region [21].

**Bare ground:**In the study district, there was a significant difference ($P \leq 0.05$) among the three grazing areas in their percentage of bare ground. The riversides grazing area had a significantly ($P \leq 0.05$) higher percentage of bare ground than the communal and enclosure areas. Furthermore, the communal grazing areas had a higher ($P \leq 0.05$) percentage of bare ground than enclosure areas. The proportion of bare ground in the enclosure area of upper and lower altitudes was significantly lower ($P \leq 0.05$) than the values in the other two grazing areas. This difference might be happened due to the high grazing pressure in riversides and communal grazing areas which depleted the vegetation cover.

There was a significant difference in percentage bare ground among the communal, riverside as well as enclosure grazing areas of the two altitude zones (Table 2). The percentages of bare ground were significantly ($P \leq 0.05$) lower in grazing areas along the riversides in the > 850-1100 m ($14.0 \pm 0.47$) altitude zone than in the riverside grazing areas found in the >550-850 m altitude ($18.5 \pm 0.27$). The possible

| Species | Cg (use values) | >550-850 m a.s.l | | | >850-1100 m a.s.l | | |
|---|---|---|---|---|---|---|---|
| | | *C* | *R* | *E* | *C* | *R* | *E* |
| *Brachiaria dictyneura* | UD | 2.14 | 12.73 | 1.36 | 1.22 | 10.36 | 0.24 |
| *Brachiaria eruciformis* | UD | 1.86 | 3.21 | 2.65 | 1.36 | 2.04 | - |
| *Cenchrus ciliaris* | HD | 0.15 | - | 12.8 | 1.52 | - | 24.62 |
| *Dactyloctenium aegypticum* | D | - | - | 10.78 | 0.68 | 3.24 | 11.06 |
| *Eleusine multifolia* | LD | 10.36 | 1.42 | 2.2 | 11.24 | 0.18 | - |
| *Eragrostis teniufolia* | LD | 1.55 | 12.4 | 2.5 | 0.88 | 10.48 | 1.28 |
| *Eragrostis cilianensis* | LD | - | 2.38 | 1.5 | - | - | - |
| *Panicum coloratum* | HD | - | - | 12.6 | 0.76 | 0.55 | 15.45 |
| *Chloris prieurii* | LD | 1.21 | 1.19 | - | 1.23 | 1.04 | - |
| *Chrysopogon plumolosus* | D | 21.61 | 2.26 | 10.8 | 20.48 | 1.06 | 10.06 |
| *Sporobolus pyramidallis* | LD | 11.45 | 2.6 | 2.4 | 10.68 | 10.02 | 1.44 |
| *Aristida adoenesis* | LD | 2.64 | - | 3.69 | 0.64 | 1.43 | 0.82 |
| *Cynodon dactylon* | D | - | - | 10.46 | - | 0.41 | 12.83 |
| *Bothriochloa insculpta* | D | 1.12 | 1.54 | 2.9 | 1.64 | 1.23 | 0.25 |
| *Tragus beteronianus* | LD | 12.79 | 10.2 | 1.24 | 2.44 | - | - |
| *Digitaria milanjana* | LD | - | 20.8 | - | - | 28.47 | - |
| *Aristida somalense* | HD | 1.16 | 1.16 | - | - | - | - |
| *Andropogon canaliculatus* | D | 0.15 | 0.45 | 6.3 | - | 1.25 | 1.13 |
| *Tetrapogon cenchriformis* | HD | 0.29 | 0.26 | 8.8 | 1.27 | 4.14 | 0.56 |
| *Lintonia nutans* | LD | - | - | - | 1.6 | - | - |
| *Eragrostis supariba* | D | - | - | 2.3 | 0.29 | - | 0.28 |
| *Cymbopogon giganteus* | D | - | - | - | 1.28 | - | 2.03 |
| *Teterapogon vilosus* | LD | - | - | - | 1.57 | - | 1.45 |
| *Cenchrus pennisetiformis* | LD | - | - | - | - | - | 11.1 |
| *Brachiaria sp.* | HD | 1.16 | 0.57 | 1.48 | 0.84 | 1.15 | - |
| **Sedges** | | | | | | | |
| *Cyperus bulbosus* | HD | - | - | 1.86 | - | - | 2.11 |
| **Legumes** | | | | | | | |
| *Indigofera spinosa* | LD | - | 1.62 | - | 0.62 | 1.04 | 1.23 |
| *Tephrosia vogelii* | HD | 0.74 | - | 0.18 | - | 0.25 | 1.05 |
| *Crotalaria incana* | D | 1.57 | 0.36 | 0.86 | 2.46 | - | - |
| **Others/forbs** | | | | | | | |
| *Blephris ciliaris* | LD | - | 2.45 | - | 0.15 | 1.03 | 0.04 |
| *Ocimum lamifoliu* | HD | 4.21 | - | 0.22 | 11.2 | 10.2 | - |
| *Amaranthus thunbeerii* | LD | 10.8 | 4.38 | 0.12 | - | 0.09 | - |
| *Achyranthus aspera* | LD | - | 2.73 | - | 12.2 | - | - |
| *Sida ovata* | LD | 1.28 | 3.84 | - | 1.14 | - | - |
| *Tribulis terrestris* | LD | 11.7 | 11.4 | - | 10.5 | 10.2 | 1.03 |

**Note:** Cg=Categories; C=Communal grazing areas, R=Riverside grazing areas and E=Enclosure; 2.Use value: - HD=highly desirable; D=Desirable; LD=Less desirable, UD=Undesirable; 3. Relative abundance: - D=Dominant (> 20%); C=Common (10-20%); P=Present (<10% of the total herbaceous plant) and -=absent

**Table 1:** Percentage composition of herbaceous species in different grazing areas of Chifra district in Afar Region.

| Parameter | Lower altitude (>550-850m) | Upper altitude (>850-1100m) |
|---|---|---|
| Bare ground | Enclosure | Enclosure |
| | 9.5 ± 0.21[a] | 5.33 ± 0.21[b] |
| Bare ground | Communal | Communal |
| | 13.5 ± 0.18a | 11.0 ± 0.18b |
| Bare ground | Riversides | Riversides |
| | 18.5 ± 0.27a | 14.0 ± 0.47b |

Means with different letters in a row are significantly different (P<0.05).

**Table 2:** Bare ground proportion (LSM ± SE) in upper and lower altitudes of Chifra district in Afar Region.

reason could be that the grazing areas along the riverside in the upper altitude (>850-1100 m) were far from the pastoralists homestead. Furthermore, the communal and enclosure grazing areas in upper altitude (>850-1100 m) had a significantly ($P \leq 0.05$) lower percentage of bare ground (communal=11.0 ± 0.11; enclosure=5.33 ± 0.15) than those found in the lower altitude (>550-850 m) (communal=13.5 ± 0.31, enclosure=9.5 ± 0.44) (Table 2). The possible reason could be associated with the relatively better rainfall that the grazing areas in the upper altitude (> 850-1100 m) receive which favored for the growth of more herbaceous vegetation which covered the soil. Furthermore, the grazing pressure was relatively lower in the upper altitude than in the lower altitude. The amount and distribution of bare ground is one of the most important contributors to site stability relative to the site potential; therefore, it is a direct indicator of site susceptibility to accelerated wind or water erosion. Percentage bare area could be used as indicator of range deterioration; with reduced herbaceous cover. This finding was in line with the report of Gemedo [27] for Borana rangelands in which the rangeland condition was negatively correlated with bare soil. In upper and lower altitudes of the study district, especially the grazing areas near by the riversides were heavily grazed; the herbaceous layer was severely damaged and was in poor condition for rearing different animal species.

The percentage bare ground in grazing areas of the lower altitude

(>550-850 m) was higher than those found in the upper altitude (>850-1100 m). In the lower altitude, it escalated as high as 20% and in upper altitude (>850-1100 m) up to 16%. A similar finding was also reported by Lisan [28] for range sites around riversides in Shinile and Dembel districts.

## Biomass production

**Riverside grazing areas:** The riverside grazing areas found in the >850-1100 m altitude category of the study district had a significantly ($P \leq 0.05$) higher total herbaceous dry matter biomass, total grass dry matter biomass and total non-grass dry matter biomass than the riverside grazing areas in the >550-850 m altitude category. The total herbaceous dry matter biomass in riverside grazing areas located in the >850-1100 m altitude category of the study district ranged from 331 to 525 kg/ha, while the total grass dry matter biomass and total non-grass dry matter biomass ranged from 268 to 420 kg/ha and 21 to 172 kg/ha, respectively (Table 3).Whereas in the >550-850 m altitude, the total herbaceous dry matter biomass, total grass dry matter biomass and total non-grass dry matter biomass ranged from 206 to 525 kg/ha,190 to 420 kg/ha and 0 to 131 kg/ha (Table 3). The possible reason for such difference was due to continuous grazing pressure by the animals of the pastoralists nearby the riversides and those migrating from other areas during the dry season which resulted in decreased biomass production. The mean total herbaceous dry matter biomass, total grass dry matter biomass and total non-grass dry matter biomass values recorded for the riverside grazing areas of upper and lower altitudes were greater than those reported by Lisan [28] for similar grazing types located in two districts. The possible reason might be due to large number of animals accommodated in the riversides grazing areas of the two districts.

**Communal grazing areas:** There was a significant difference ($P \leq 0.05$) between the communal grazing areas of the two altitude zones in terms of total herbaceous dry matter biomass, total grass dry matter biomass and total non-grass dry matter biomass production (Table 3). Based on the results, the communal grazing lands located in the > 850-1100 m altitude had a significantly ($P \leq 0.05$) higher total herbaceous dry matter biomass, total grass dry matter biomass and total non-grass dry matter biomass production than the communal grazing lands in >550-850 m altitude.

The total herbaceous dry matter biomass, total grass dry matter biomass and total non-grass dry matter biomass in the >850-1100 m altitude ranged from 408 to 617 kg/ha, 221 to 500 kg/ha and 34 to 284 kg/ha, respectively. Whereas in the >550-850 m altitude, the total herbaceous dry matter biomass, total grass dry matter biomass and total non-grass dry matter biomass ranged from 229 to 598 kg/ha, 184 to 420 kg/ha and 0 to 172 kg/ha, respectively (Table 3). Several studies [19] have revealed that high variability of rainfall strongly influences the amount and composition of herbaceous vegetation; especially during shortage of rainfall (drought time) the perennial grasses may die and replaced by annuals and drought resistant forbs.

| Grazing types | Parameters | Upper altitude (>850-1100m) | Lower altitude (>550-850m) |
|---|---|---|---|
| Riversides | Tgb | 343.07 ± 9.37$^a$ | 291.97 ± 6.22$^b$ |
| | Tngb | 112.533 ± 10.65$^a$ | 64.522± 4.94$^b$ |
| | THB | 455.60 ± 12.228$^a$ | 356.49± 7.993$^b$ |
| Communal | Tgb | 374.38± 6.88$^a$ | 296.27± 4.59$^b$ |
| | Tngb | 158.7± 7.52$^a$ | 112.05± 3.65$^b$ |
| | THB | 533.08± 8.65$^a$ | 408.32± 5.90$^b$ |
| Enclosure | Tgb | 748.77 ± 9.73$^a$ | 622.57 ± 10.775$^b$ |
| | Tngb | 374.87 ± 10.647$^a$ | 10.90± 8.557$^b$ |
| | THB | 1123.63 ± 12.228$^a$ | 633.47 ± 13.845$^b$ |

Tgb=Total grass dry matter biomass; Tngb=Total non-grass dry matter biomass; THB=Total Herbaceous dry matter Biomass;
Means with different letters in a row are significantly different at ($P \leq 0.05$)

**Table 3:** Biomass production (LSM and SE) of the three grazing areas of Chifra district in Afar Region district (kg/ha).

**Enclosures:** The enclosure areas in the >850-1100m altitude zone had a significantly ($P \leq 0.05$) higher total herbaceous dry matter biomass, total grass dry matter biomass and total non-grass dry matter biomass than the enclosures in >550-850 m altitude of the study district. This was associated with the higher rainfall and basal cover in the former altitude than the latter. The total herbaceous dry matter biomass, total grass dry matter biomass, and total non-grass dry matter biomass in the enclosure areas of >850-1100 m altitude ranged from 884 to 1,261 kg/ha, 620 to 891 kg/ha and 220 to 478 kg/ha, respectively, whereas, in >550-850 `m altitude they varied from 506 to 813 kg/ha, 484 to 807 kg/ha and 0 to 168 kg/ha, respectively (Table 3). The mean total herbaceous dry matter biomass and total grass dry matter biomass values obtained from the enclosures of upper and lower altitudes (Table 3) was lower than those reported by Admasu [29] with similar altitudes in Hamer and Benna-Tsemay districts. The degree of grazing strongly affects the structure, composition, quality and productivity of rangeland vegetation [19]. This phenomenon is likely to occur where a concentration of large herds of livestock in relatively smaller areas may lead to overgrazing, trampling and hindrance to vegetation regeneration [30].

## Biomass in upper altitude (>850-1100 M) of the study district

The enclosures had a significantly ($P \leq 0.05$) higher biomass of total herbaceous, total grass and total non-grass than the other two grazing areas, and also there was a significant ($P \leq 0.05$) difference between the communal and riverside grazing areas in terms of the mentioned parameters. The total herbaceous biomass value ranged for the enclosures from 884 to1,261 kg/ha; for communal grazing areas from 408 to 617 kg/ha and it ranged from 331 to 525 kg/ha for riverside grazing areas.

The value for the total grass biomass and non-grass biomass in the enclosures ranged from 620 to 891 kg/ha and 220 to 478 kg/ha, respectively, whereas in the communally grazed and riverside grazing areas, the total grass biomass ranged from 221 to 500 kg/ha and 268 to 420 kg/ha, respectively and the non-grass biomass ranged from 34 to 284 kg/ha for communally grazed areas and from 21 to 172 kg/ha for grazing areas along the riverside(Table 3). The main reason for the improvement in biomass production in the enclosure areas over the other grazing areas are already discussed in section 3.3.2 and 3.3.3 and these results are in agreement with the findings of Amsalu and Baars [15] and Admasu [29].

## Biomass in lower altitude (>550-850 m) of the study district

Similar to the case in >850-1100m altitude of the study district, the enclosures had a significantly ($P \leq 0.05$) higher biomass of the different components than the communal and riverside grazing areas. The values for total herbaceous dry matter biomass in enclosure areas, communal and riverside grazing areas varied from 506 to 813 kg/ha, 229 to 598 kg/ha and 206 to 525 kg/ha, respectively. The value for the total grass biomass and non-grass biomass in the enclosures ranged from 484 to 807 kg/ha and 0 to 168 kg/ha, respectively, whereas in the communally grazed and riverside grazing areas, the total grass biomass ranged from 184 to 420 kg/ha and 190 to 420 kg/ha, respectively and the

non-grass biomass ranged from 0 to 172 kg/ha for communally grazing areas and from 0 to 131 kg/ha for grazing areas along the riverside (Table 3). The communally grazing and those grazing areas along the riverside showed a significant difference ($P \leq 0.05$) in parameters considered for the study. The communal grazing areas had a higher value of total herbaceous dry matter biomass, total grass biomass and non-grass biomass than those along the riverside. The main reasons for the differences are already discussed in section 3.3.2. In rangeland ecosystems, fodder production is influenced by climate [31] and degree of degradation [32,33].

## Chemical composition of vegetation in study district

**Composite samples (natural pasture):** The Ash content of enclosure area was higher than the other grazing areas in wet season while the dry season communal grazing area was higher ash content than the other grazing areas. The CP content was higher in enclosure areas and lowest in riversides grazing areas in both seasons. The composite natural pasture sample from the enclosure area had good forage quality with low content of ADF and high content of CP as compared to the rest composite samples. Such differences may be associated with higher composition of palatable legumes found in enclosure areas. In general, the CP content of the enclosure areas in the study district was greater than the minimum level (7%) of crude protein required for optimum functioning of rumen microorganism.

The ADF content of the natural pasture sampled from the different grazing areas ranged from 15.0% in enclosure areas to 30.0% in riversides grazing areas during the wet season while in the dry season it ranged from 46.7% in enclosures to 56.5% in riversides. The lowest ADL content (4.2%) was found in samples taken from communal grazing areas during the wet season while in the dry season, 7.4% in enclosure areas.

In both seasons, the highest ADL content was recorded in samples taken from riversides grazing areas in both seasons (Table 4). During the wet and dry seasons, the lowest NDF content, 42.8% in the wet season and 47.2% in the dry season was found in enclosure areas and the highest 54.8% in the wet season and 66.2% in the dry season found in riversides grazing areas. According to Singh and Oosting [34], a feed with NDF content greater than 65% is categorized as low quality feed that could affect intake and productivity of animals. Accordingly, the natural pasture composite sample taken from riversides grazing areas can be categorized as low quality feeds.

**Grass species:** The DM, CP, NDF, ADF, ADL and ash contents of grass species during the wet and dry seasons are presented in Table 4. During the wet season, the highest DM was found in *Cenchrus ciliaris* while in the dry season in *Chrysopogon plumolosus*. The CP content was higher in *Cenchrus cillaris* and lowest in *Tetrapogon cenchriformis* in both seasons. The lowest NDF content was found in Cenchrus ciliaris and the highest in Chrysopogon plumolosus. The ADF content ranged from 18.9% in *Chrysopogon plumolosus* to 28.9% in *Tetrapogon cenchriformis* during the wet season while in the dry season it ranged from 42.4% in *Cenchrus cillaris* to 53.9% in *Tetrapogon cenchriformis* (Table 4). Those species with higher ADF content may have lower digestibility since digestibility of feeds and ADF content are negatively correlated. Due to this, *Tetrapogon cenchriformis* could have lower digestibility than the other grass species. The lowest ADL content (3.7%) was found in *Cenchrus ciliaris* during the wet season while, in the dry season, 11.1% in *Chrysopogon plumolosus*. The highest ADL was found in *Tetrapogon cenchriformis* in both seasons (Table 4). High CP combined with low NDF and ADF contents are indicators for species with good forage quality [35]. Accordingly, *Cenchrus cillaris* and *Chrysopogon Plumolosus* were the best grass species with better nutritive value due to lowest content of ADF and higher content of CP, whereas *Tetrapogon cenchriformis* was a low quality grass relative to the other grass species.

During the wet and dry seasons, the chemical composition of each grass species were different in terms of NDF, ADF, ADL and CP. Studies on the nutritional quality of semi-arid grassland also indicated that, as the growing season progressed, protein and mineral contents decreased, whereas fiber concentration increased [36]. The mean CP content of grasses declined from 7.63% in the wet season to 4.7% in the dry season. According to Adesogan et al. [37], physiological stage of forage species, time of grazing and species are some of the factors that cause variability in chemical composition of forages. This finding was in line with the result of other studies [36,38,39].

## Conclusion

From this finding, it can be concluded that the range vegetation of the study area, is subjected to continuous threat of genetic erosion and extinction due to overgrazing and rangeland degradation. Vegetation changes over time clearly affect the level of biodiversity, conservation status and productivity of rangelands. The frequency and intensity of utilization has significantly influenced the vegetation structure, composition, quality and productivity. The most important and highly desirable grass species were endangered in most of the grazing areas. Communal and riversides grazing areas were invaded by less desirable and undesirable species which indicates the low grazing value and the deteriorating range condition of the study area.

The composite natural pasture sample from the enclosure area had good forage quality with low content of ADF and high content of CP as compared to the rest composite samples. *Cenchrus cillaris*

| Composite sample | DM (%) | Ash (%) | ADF (%) | ADL (%) | NDF (%) | CP (%) |
|---|---|---|---|---|---|---|
| **Wet season** | | | | | | |
| Riversides | 93.3 | 13.3 | 30.0 | 5.1 | 54.8 | 5.2 |
| Communal | 92.7 | 13.6 | 28.8 | 4.2 | 49.6 | 6.3 |
| Enclosure | 92.8 | 16.2 | 15.0 | 5.0 | 42.8 | 7.2 |
| Mean ± SD | 92.9 ± 0.3 | 14.3 ± 1.6 | 24.6 ± 8.3 | 4.8 ± 0.5 | 49.1 ± 6.03 | 6.2 ± 1.0 |
| **Dry season** | | | | | | |
| Riversides | 93.3 | 15.4 | 56.5 | 22.0 | 66.2 | 3.3 |
| Communal | 91.2 | 14.1 | 50.9 | 20.2 | 50.8 | 3.5 |
| Enclosure | 91.4 | 7.7 | 46.7 | 7.4 | 47.2 | 4.2 |
| Mean ± SD | 92.0 ± 1.1 | 12.4 ± 4.1 | 51.4 ± 4.8 | 16.5 ± 7.9 | 54.7 ± 10 | 3.6 ± 0.4 |

**Table 4:** Chemical composition of natural pasture collected from different grazing areas both in the wet and dry seasons at Chifra district in Afar Region.

and *Chrysopogon plumolosus* were the best grass species with better nutritive value due to lowest content of ADF and higher content of CP, whereas *Tetrapogon cenchriformis* was a low quality grass relative to the other grass species.

Therefore, conservation of endangered and promising grass species by making seed collection and multiplication are crucial for future rangeland restoration purposes and also making enclosure is another option to revive the endangered species. Continuous awareness rising through training is play vital roles in order to enhance the traditional knowledge of the pastoralists and also to know modern rangeland management thereby improve the livelihood of the community.

## References

1. Afar Pastoral and Agro-pastoral Research Institute (APARI) (2005) Rangeland management strategic plane.
2. Action for Integrated Sustainable development Association (2009) Pastoral perceptions and role of traditional institutions in rangeland management and natural resource uses in Dalifaghe District of Afar Region state, Ethiopia.
3. Le Floc'h E, Neffati M, Chaieb M, Floret C, Pontanier R (1999) Rehabilitation experiment at menzel habib, Southern Tunisia. Arid Soil Res. Rehabilitat., 13: 357-368.
4. Azaiez O, Hichem B, Ali B, Mohammed El (2008) Communal rangeland rest in arid area, a tool for facing animal feed costs & drought mitigation: The case of Chenini community, South Tunisia. Journal of Biological Sciences, 8: 822-825.
5. WARC and APARI (2007) Assessment made on the Potential, Constraints, and Opportunity on the Production System of Afar National Regional State; Case Study on selected Woredas of zone 1, 4, and 5.
6. Afar Pastoral, Agricultural and Development Beuro (APADB) (2006) Baseline survey made on the Potential, Constraints, and Opportunity on the Production System of 29 words of Afar National Regional State.
7. Central Statistical Authority (CSA) (2007) Ethiopian Statistical Abstract, Central Statistical Authority, Addis Ababa Ethiopia.
8. ILCA (International Livestock Center for Africa) (1990) Livestock system research manual. No.12, section 1. Working document used in range management. ILCA, Addis Ababa, Ethiopia. Society of range management, Denver, Colorado, USA.
9. Hedberg I, Edwards S (1989) Flora of Ethiopia. The National Herbarium, Addis Ababa, Ethiopia. 3: 660.
10. Hedberg I, Edwards S (1995) Flora of Ethiopia and Eritrea. The National Herbarium, Addis Ababa, Ethiopia. 7: 660.
11. Cufodontis G (1953-1972) Enumeratio Plantaraumaetiopiae. Spermatophyte. Bulletin dela State Botanical Garden of Brusel·les, 1: 23-42.
12. Tidmarsh CEM, Havenga CM (1955) The wheel point method of survey and measurement of semi-open grasslands in Karoo vegetation in South Africa. Mem. Bot.Surv. South. Africa. No 29.
13. Mentis MT (1984) Monitoring in South African grasslands. Pretoria: Council for Scientific and Industrial Research. National scientific Programs Unit (South African National Scientific Programs report no. 91).
14. Danckwerts JE, Teague WR (1989) Veld Management in the Eastern Cape, Pretoria Pasture Research Section, Department of Agriculture and Water supply. Eastern Cape Region.
15. Amsalu S, Baars RMT (2002) Grass composition and rangeland condition of the major grazing areas in the mid rift valley, Ethiopia. African Journal of Range and Forage Science, 19: 161-166.
16. AOAC (1990) Official methods of analysis of the Association of Official Analytical Chemists, 15th edn. Association of official analytical chemists, Washington, Dc.
17. Van Soest PJ (1982) Nutritional ecology of ruminants. O and B books. Inc. Oregon, USA.
18. Statistical Analysis System (SAS) Institute Inc (2001) Applied statistics and the SAS programming language 2nd edition Cary, North Carolina.
19. Herlocker D (1999) Rangeland Resources in Eastern Africa: Their Ecology and Development. GTZ, German Technical Cooperation, Nairobi.
20. Kidane G, PJ Pietese PJ (2006) Impact of grazing around a watering points o soil status of a semi-arid rangeland in Ethiopia. African Journal of Ecology: 45, 72-79.
21. Amsalu S (2000) Herbaceous species composition, dry matter production, and condition of the major grazing areas in the mid rift valley of Ethiopia. An MSc thesis, Presented to the School of Graduate Studies of Alemaya University, Dira dewa Ehiopia, p. 95.
22. Sarmento G (1992) Adaptive strategies of perennial grasses in South Africa savannas, Journal of vegetation Science, 3: 325-336.
23. O'Connor TG, Pickett (1992) The influence of grazing on seed production and seed banks of some African Savanna grasslands. Journal of Applied Ecology, 29: 247-260.
24. Noy-Meir I, Gutman M, Y Kaplan Y (1989) Responses of Mediterranean grassland plants to grazing and protection. J. Ecol., 77: 290-310.
25. De-Val E, MJ Crawley (2005) Are grazing increaser species better tolerators than decreasers? An experimental assessment of defoliation tolerance in eight British grassland species. J. Ecol., 93: 1005-1016.
26. Adane K (2003) Effect of stage of harvesting and fertilizer application on dry matter yield and quality of natural grasslands in the highlands of north Shao, Oromia. An MSc. Thesis Presented to the School of Graduate Studies of Haramaya University. p. 96.
27. Gemedo-Dalle (2004) Vegetation Ecology, Rangeland Condition and Forage Resources Evaluation in the Borana Lowlands, Southern Oromia, Ethiopia. A PhD thesis Presented to Georg-August-university Gottingen, Germany.
28. Lisan T (2007) Woody and Herbaceous species composition and the condition of the rangelands in Shinile zone of Somali regional state, Ethiopia. An MSc Thesis Presented to the School of Graduate Studies of Alemaya University.
29. Admasu T (2006) Pastoralists Perceptions on Range-Livestock Management Practices and Rangeland Assessment in Hamer and Benna-Tsemay Districts of South Omo Zone. An MSc Thesis Presented to the School of Graduate Studies of Haramaya University, Ethiopia.
30. ASAL (1998) Community Level Natural Resource Management Plan for the Central Kajiado Planning Area: The Case of Olobelibel and Oloontulugum. Arid and Semi-Arid Lands Programme, Kajiado.
31. De Queiroz JS (1993) Range degradation in Botswana: Myth or reality? Pastoral Development Network Paper 35b. Overseas Development Administration. London. Dodd J.L., 1994. Desertification and degradation in Sub-Saharan Africa. The role of livestock. Bioscience. 44: 28-34.
32. Mc Naughton SJ, Wallace LL, Coughenour MB (1983) Plant adaptation in an ecosystem context; effects of defoliation, nitrogen and water on growth of an African C4 Sedge. Ecology. 64: 307-318.
33. Schlesinger WH, Reynolds JF, Cunningham Gl, Huenneke LF, Jarrell WM, et al. (1990) Biological feed backs in global desertification. Science. 247: 1043-1048.
34. Singh GP, Oosting SJ (1992) A model for describing the energy value of straws. Indian dairyman XLIV: 322-327.
35. Aregheore EM, Steglar TA, Ng'ambi JW (2007) Nutrient characterization and in vitro digestibility of grass and legume/browse species - based diets for beef cattle in Vanuatu.
36. Pérez Corona ME, Vázquez de Aldana BR, Criado BG, Ciudad AG (1998) Variations in nutritional quality and biomass production of semi-arid grasslands. Journal of Range Management 51: 570-576.
37. Adesogan AT, DI Givens, E Owen (2000). Measuring chemical composition and nutritive value in forages. In: Mannetje L.'t , Jones RM (eds). Field and laboratory methods for grassland and animal production research. CABI Publishing, Wallingford, UK. pp. 263-278.
38. Kirby DR, DM Green, TS Mings (1989). Nutrient composition of selected emergent macrophytes in Northern Prairie wetlands. Journal of Range Management 42: 323-326.
39. Heitschmidt RK, EE Grings MR, Haferkamp, MG Karl (1995). Herbage dynamics on two Northern Great Plains range sites. Journal of Range Management 48: 211-217.