

Original Research Article

## An Assessment of the Diversity of Indigenous Forage Plant Species of the Dry Season in Dry lands of North Western Ethiopia: Implication for their Conservation and Sustainable Use

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**Abstract:** This study was done to assess the diversity of indigenous forage plants of the dry season in *Combretum-Terminalia* woodlands of Guba District, North West of Ethiopia. A total of 69 species of plants were identified and of which all are consumed as a feed resource by the local animal breeds during dry season. The diversity (H) values of the forage plant species ranged between 0.65 to 1.67 across the plots sampled. The similarities (J) between the plots in terms of species composition of all forage species were 0.56 and 0.94. The evenness (E) values of all forage species were in between 0.78 and 0.86 across the sampled plots. The densities of all forage species, including seedlings, were 1216 stems ha<sup>-1</sup>. In the study area *Combretum colinum*, *Lonchocarpus laxiflorus*, *Terminalia laxiflora*, *Acacia polyacantha* and *Ziziphus mucronata* were the five relatively abundant forage species. The Importance Value Index (IVI) values of all the forage species ranged between 0.31 (*Strychnos innocua*) and 81.67 (*Combretum colinum*). Particularly local goat breeds of the study area were known to feed on various plant resources than other breeds. Moreover, Bigariya local cattle breeds were also known to feed on various similar plant resources hence adapted to harsh environmental condition known in western Ethiopia. Pounded barks of *Cordia Africana* and roots of *Securidaca longepedunculata* is used in treatment of diarrhoea and common cold cases of goats. Moreover the sheath of *Hypheneae thebiaca* is used to treat the eye disease of Goats, sheep and cattle.

**Keywords:** Bigariya cattle, density, diversity, evenness, frequency, Importance Value Index.

### INTRODUCTION

Rangelands are defined as those areas of the world, which by reasons of physical limitation, low and erratic precipitation, rough topography, poor drainage, or cold temperatures are unsuited for cultivation and which are a source of forage for free ranging native and domestic animals, as well as a source of wood products, water and wildlife [1]. Of these, extensive livestock production is the major land use on rangelands with large areas of land required per head of livestock [2]. Accordingly, the condition of the rangelands which Trollope *et al.*, [3] defined; the state of health of the rangeland in terms of its ecological status, resistance to soil erosion and potential for producing forage for sustained optimum livestock production must be investigated. Furthermore, rangeland condition is a function of all plant forms (trees, grasses and shrubs) that occur in it [4]. Rangeland condition cannot, therefore, be simply indexed according to its usefulness for a single priority land use. As with grassland, the composition and structure of each of the other components vary, which adds an extra and complicating dimension to rangeland assessment. In addition, the rangeland is frequently used by pastoralists who own different animal types (browsers and grazers). Assessment techniques need to consider the different vegetation components for the proper utilization of the available rangeland resources. Until recent times, research on rangeland dynamics has historically focused on the effects of various management practices on forage production and animal response, with little attention given to the impact of grazing on the condition of the soil. Since animal production is directly related to rangeland condition, rangeland degradation will result in a lower income [5].

In Western Ethiopia, semi-pastoralists of different ethnic groups are found predominately in Benishangul-Gumuz Regional State (BGRS) which are primarily dependent on natural range based livestock production. Even though the study areas have a vast area of rangeland, there was no research study undertaken to assess the condition of the rangelands and take appropriate management interventions in relation to livestock production. Accordingly, the objective of this study was to assess the forage resource diversity and condition of the grazing by livestock in the mentioned study district.

## MATERIALS AND METHODS

### Description of the study area

The study was conducted in one district (Guba) which was purposely selected from Benishangul-Gumuz Regional State western Ethiopia. Benishangul-Gumuz Regional State. Guba Woreda is one of the 20 woredas in the Benishangul-Gumuz Region of Ethiopia. It is located 894km northwest of Addis Ababa and about 220km northeast of Assosa, the capital city of Benishangul-Gumuz Regional State. The district is geographically located at '11° 16' 0" N latitude and 35° 17' 0" E longitude. It is a part of the Metekel Zone, Guba is bordered by the Abay River on the south which separates it from the Kamashi Zone, Sudan on the west, Amhara Region on the north, Dangur on the east, and on the southeast by the Beles River, which separates it from Wenbera [6].

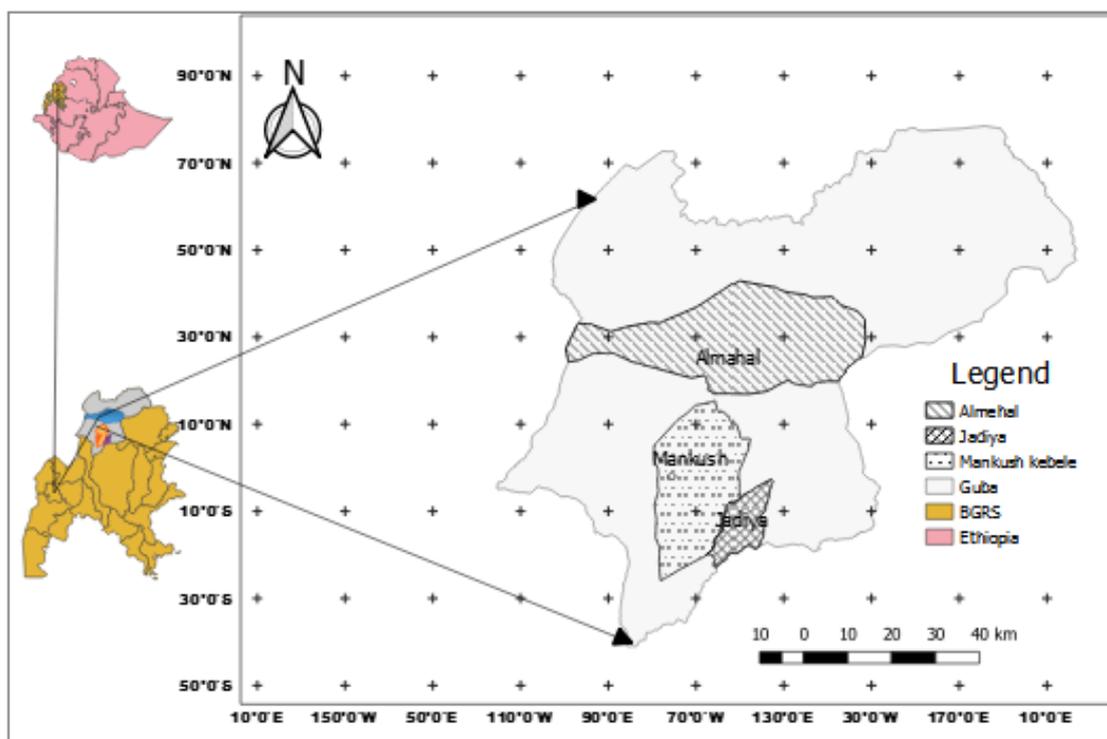


Fig-1: Map of the study area

## STUDY METHODOLOGY

Formal surveys were conducted in Guba district in 2020 dry seasons, as part of the diagnostic first phase. "The potential of crop residues and natural vegetation as ruminant feeds during the dry season in Guba district of Benishangul Gumuz Regional State". The district is in the semi-humid zone. A total of 100 (20 m x 20 m) sample plots were laid along the transect lines, following the procedures described by Kent and Coker [7]. In each plot, the identity, number of individuals, diameter at breast height (DBH) and height of all woody species having a height above 1.5 m were recorded.

A total of 30 structured questionnaires were developed and used. Only the crop/livestock farmers from the selected kebeles were interviewed. The respondent was the household head. Information from the questionnaire, related to utilization of trees and shrubs and other natural vegetation, were coded and summarized using a SPSS calculator. Before social survey field assessment was done to identify the overall vegetation type and feed materials by the live stocks on field. A total of 12 sample plots were taken to visualize and represent the vegetation of the area.

### Forage Preference by Livestock

Direct observation of animals using feeding minutes (Bjugstad *et al.*, 1970) was adopted to assess forage preference by timing the animal as they feed. Moreover, cattle owners were interviewed to rank the mostly preferred species by their livestock's.

### Statistical Analyses

Diversity of all woody species was determined using the Shannon – Wiener Diversity Index (H) and evenness (E) [7]. Jaccard's Similarity Coefficient ( $S_j$ ) was used to compute similarity in woody species composition of the area. The indices were computed using the following formulas:

$$H = - \sum_{i=1}^s P_i \ln p_i$$

Where H = Shannon – Wiener diversity index and  $P_i$  = the proportion of individuals found in the  $i^{\text{th}}$  species;

$$E = \frac{H}{H_{\max}} = \frac{H}{\ln s'}$$

Where E = evenness,  $H_{\max}$  is the maximum level of diversity possible within a given population, which equals  $\ln$  (number of species); and

$$J = \frac{C}{A + B + C}$$

Where J = Jaccard's similarity coefficient, C = the number of species common to both sites, A = the number of species present in one of the sites to be compared and B is the number of species present in the other site.

Density was calculated by converting the total number of individuals of each species to equivalent numbers per hectare (absolute density), and as the percentage of the absolute density of each species divided by the total stem number of all species  $\text{ha}^{-1}$  (relative density). Frequency distribution of each species was determined from the number of plots in which the species was recorded (absolute frequency) [7], and as a percentage (relative frequency) by dividing the absolute frequency of the species by the sum of the absolute frequencies of all the species. The absolute dominance of woody species with DBH 2.5 cm was determined from summing the basal area (BA) of all individuals of a species. Relative dominance was calculated as the percentage of the BA of a species divided by the total BA of all species.

The relative ecological importance of each woody species, commonly referred to as Important Value Index (IVI), was determined by summing its relative frequency, relative density and relative dominance [7].

The population structures woody vegetation and that of forage woody species was assessed from the frequency distribution of diameters based on histograms constructed by grouping all individuals of each woody species into the following successive diameter classes: 1 = 0 – 10, 2 = 10– 20, 3 = 20– 30, 4 = 30– 40 and 5 > 40 cm [8-11]. The data were analyzed using Biodiversity Professional Software version 8.2.

Plant identification was carried out mostly in the field, and for those species, which could not be identified in the field, herbarium voucher specimens were prepared, transported to and identified in the Ethiopian Biodiversity Institute Herbarium. Plant nomenclature in this article follows the published volumes of Flora of Ethiopia, and Flora of Ethiopia and Eritrea [12-15].

## RESULTS AND DISCUSSION

### Species Richness

As it was observed on field survey that the woodland vegetation of Guba district is characterized by small to moderately sized trees, herbs, grasses and sedges. The ground cover is dominated by herbaceous geophytes at the beginning of rainy season (May and June). Towards the end of rainy season (September to November) tall strata perennial grasses become dominant. A total of 69 plant species were recorded in the study area of which all are consumed as a feed resource by the local breeds during dry season (Table-1).

**Table-1: List of some common plant species encountered in Guba district**

| No | Local Name (Gumuzigna) | Botanical Name                     | Family          |
|----|------------------------|------------------------------------|-----------------|
| 1  | Achiquwa               | <i>Leonotis nepetifolia</i>        | Lamiaceae       |
| 2  | Amberta                | <i>Andropogon schirensis</i>       | Poaceae         |
| 3  | Adegila                | <i>Streospermum kunthianum</i>     | Bigniniaceae    |
| 4  | Anderkukuwa            | <i>Strychnose spinosa</i>          | Loganiaceae     |
| 5  | Hanguga/Hangua         | <i>Ziziphus abyssinica</i>         | Rhamnaceae      |
| 6  | Siya/Gaba              | <i>Ziziphus mucronata</i>          | Rhamnaceae      |
| 7  | Antsiqina Guanja       | <i>Cissus cornifolia</i>           | Vitaceae        |
| 8  | Antutiya               | <i>Solanum alatum</i>              | Solanaceae      |
| 9  | Babegoha/Bogoha        | <i>Terminalia macroptera</i>       | Combretaceae    |
| 10 | Babenga                | <i>Hyphaene thebiaca</i>           | Arecaceae       |
| 11 | Bambeluwa              | <i>Entada africana</i>             | Fabaceae        |
| 12 | Bambuta                | <i>Annona senegalensis</i>         | Annonaceae      |
| 13 | Banja                  | <i>Cordia africana</i>             | Boraginaceae    |
| 14 | Banshezegona           | <i>Wissadula rostrata</i>          | Malvaceae       |
| 15 | Bebdaja                | <i>Tragia doryodes</i>             | Euphorbiaceae   |
| 16 | Bewa                   | <i>Lonchocarpus laxiflorus</i>     | Fabaceae        |
| 17 | Begiya                 | <i>Strychnos innocua</i>           | Loganiaceae     |
| 18 | Bora                   | <i>Terminalia laxiflora</i>        | Combretaceae    |
| 19 | Bembeda                | <i>Maytenus senegalensis</i>       | Celastraceae    |
| 20 | Bidiguwa               | <i>Hyparrhenia anthistirioides</i> | Poaceae         |
| 21 | Biilga                 | <i>Lannea welweschii</i>           | Anacardiaceae   |
| 22 | Yempite                | <i>Lannea fruticosa</i>            | Anacardiaceae   |
| 23 | Mamusa                 | <i>Cymbopogon caesus</i>           | Poaceae         |
| 24 | Chaya                  | <i>Pterocarpus lucens</i>          | Fabaceae        |
| 25 | Dijiha                 | <i>Breonadia salicina</i>          | Rubiaceae       |
| 26 | Diwa                   | <i>Syzygium guineense</i>          | Myrtaceae       |
| 27 | Dhoga                  | <i>Tamarindus indica</i>           | Fabaceae        |
| 28 | Mecha                  | <i>Piliostigma thonningii</i>      | Fabaceae        |
| 29 | Fuqa                   | <i>Ficus sycomorus</i>             | Moraceae        |
| 30 | Eboba                  | <i>Rottboellia cochinchinensis</i> | Poaceae         |
| 31 | Asiya                  | <i>Ficus lutea</i>                 | Moraceae        |
| 32 | Bambichowa             | <i>Asparagus flagellaris</i>       | Asparagaceae    |
| 33 | Engifa                 | <i>Combretum collinum</i>          | Combretaceae    |
| 34 | Elta/Enta              | <i>Oxytenanthera abyssinica</i>    | Poaceae         |
| 35 | Ephuwa                 | <i>Sterculia africana</i>          | Sterculiaceae   |
| 36 | Etissayaquwa           | <i>Pennisetum thumbergii</i>       | Poaceae         |
| 37 | Gideya                 | <i>Grewia velutina</i>             | Tiliaceae       |
| 38 | Goha                   | <i>Phoenix reclinata</i>           | Aracaceae       |
| 39 | Golgola                | <i>Boswellia papyrifera</i>        | Bursaceae       |
| 40 | Hesiniya               | <i>Hyparrhenia filipendula</i>     | Poaceae         |
| 41 | Heya                   | <i>Ximenia americana</i>           | Olacaceae       |
| 42 | Jiggnewiya             | <i>Clerodendrum alatum</i>         | Verbanaceae     |
| 43 | Jipiwa/Chamda          | <i>Combretum hartmanianum</i>      | Combretaceae    |
| 44 | Liffa                  | <i>Luffa cylindrica</i>            | Cucurbitaceae   |
| 45 | Machanchiga            | <i>Lagenaria siceraria</i>         | Cucurbitaceae   |
| 46 | Meela                  | <i>Acacia seyal</i>                | Fabaceae        |
| 47 | Mejira                 | <i>Trigonella foenum-graecum</i>   | Fabaceae        |
| 48 | Meetsiya               | <i>Tristemma mauritianum</i>       | Melastomataceae |
| 49 | Piwe                   | <i>Crossopteryx febrifuga</i>      | Rubiaceae       |
| 50 | Qota                   | <i>Balanitis aegyptiaca</i>        | Balanitaceae    |
| 51 | Quatsirqa              | <i>Acacia hecatophylla</i>         | Fabaceae        |
| 52 | Sasiqida               | <i>Cynodon nlemfuensis</i>         | Poaceae         |
| 53 | Sipe                   | <i>Acacia polyacantha</i>          | Fabaceae        |
| 54 | Siqida/Si-Eda          | <i>Securidaca longepedunculata</i> | Polygalaceae    |
| 55 | Songah                 | <i>Ziziphus mauritiana</i>         | Rhamnaceae      |
| 56 | Tisheza                | <i>Vitex doniana</i>               | Verbanaceae     |
| 57 | Dimquri                | <i>Ipomoea eriocarpa</i>           | Convolvulaceae  |
| 58 | Tara/Geret             | <i>Acacia senegal</i>              | Fabaceae        |
| 59 | Mureb                  | <i>Pennisetum unisetum</i>         | Poaceae         |
| 60 | Kota                   | <i>Gardenia ternifolia</i>         | Rubiaceae       |
| 61 | Weela                  | <i>Dicrostachus cinerea</i>        | Fabaceae        |
| 62 | Weela                  | <i>Flueggea virosa</i>             | Euphorbiaceae   |
| 63 | Sigah                  | <i>Anogeissus leiocarpa</i>        | Combretaceae    |
| 64 | Insiya                 | <i>Ficus vasta</i>                 | Moraceae        |
| 65 | Duruba                 | <i>Dalbergia melanoxylon</i>       | Fabaceae        |
| 66 |                        | <i>Saspania spp</i>                | Fabaceae        |
| 67 | Dadiha                 | <i>Acanthus polystachyus</i>       | Acanthaceae     |
| 68 | Ansisiwa               | <i>Albizia malacophylla</i>        | Fabaceae        |
| 69 | Unkown                 | <i>Vernonia purpurea</i>           | Asteraceae      |

**Diversity of forage plant species of the drier season in the study area**

The diversity (H) values of the forage plant species ranged between 0.65 to 1.67 across the plots sampled. The similarities (J) between the plots in terms of species composition of all forage species were 0.56 and 0.94. The evenness (E) values of all forage species were in between 0.78 and 0.86 across the sampled plots (Table-2). The numbers of forage plant species recorded at the study sites are comparable to those reported from Gambella, southwestern Ethiopia [16] and Yabello, southern Ethiopia [17].

**Table-2: List of forage plant species encountered in the study area with their IVI values**

| Botanical Name                  | Family        | DE | RDE   | D<br>O | RDO   | F<br>R | RF<br>R | IVI   |
|---------------------------------|---------------|----|-------|--------|-------|--------|---------|-------|
| <i>Acacia polyacantha</i>       | Fabaceae      | 45 | 13.21 | 7.24   | 39.02 | 59     | 10.01   | 62.24 |
| <i>Acacia seyal</i>             | Fabaceae      | 78 | 20.85 | 1.02   | 15.79 | 80     | 17.2    | 53.84 |
| <i>Streospermum kunthianum</i>  | Bigoniaceae   | 7  | 1.65  | 1.05   | 5.96  | 83     | 13.7    | 21.31 |
| <i>Strychnose spinosa</i>       | Loganiaceae   | 62 | 13.04 | 2.4    | 13.6  | 78     | 12.9    | 39.54 |
| <i>Ziziphus abyssinica</i>      | Rhamnaceae    | 70 | 14.21 | 2.13   | 12.1  | 66     | 10.89   | 37.2  |
| <i>Ziziphus mucronata</i>       | Rhamnaceae    | 76 | 6.65  | 1.44   | 8.15  | 49     | 8.09    | 22.89 |
| <i>Cissus cornifolia</i>        | Vitaceae      | 23 | 7.6   | 0.31   | 1.77  | 51     | 8.42    | 17.79 |
| <i>Acacia hecatophylla</i>      | Fabaceae      | 61 | 14.34 | 1.69   | 13.94 | 37     | 13.11   | 41.39 |
| <i>Terminalia macroptera</i>    | Combretaceae  | 50 | 15.5  | 0.21   | 13.19 | 34     | 25.61   | 54.3  |
| <i>Hyphaene thebiaca</i>        | Arecaceae     | 48 | 22.82 | 6.3    | 25.52 | 26     | 14.29   | 62.63 |
| <i>Entada africana</i>          | Fabaceae      | 17 | 11.65 | 0.08   | 0.48  | 14     | 2.31    | 14.44 |
| <i>Annona senegalensis</i>      | Annonaceae    | 26 | 10.05 | 0.18   | 1.01  | 12     | 1.98    | 13.04 |
| <i>Cordia africana</i>          | Boraginaceae  | 1  | 0.11  | 0.49   | 2.78  | 2      | 0.33    | 3.22  |
| <i>Wissadula rostrata</i>       | Malvaceae     | 4  | 0.75  | 0.01   | 0.08  | 10     | 1.65    | 2.48  |
| <i>Tragia doryodes</i>          | Euphorbiaceae | 1  | 0.11  | 0.18   | 1.01  | 2      | 0.33    | 1.45  |
| <i>Lonchocarpus laxiflorus</i>  | Fabaceae      | 89 | 16.05 | 0.03   | 15.62 | 1      | 16.47   | 48.14 |
| <i>Strychnos innocua</i>        | Loganiaceae   | 1  | 0.11  | 0      | 0.03  | 1      | 0.17    | 0.31  |
| <i>Terminalia laxiflora</i>     | Combretaceae  | 76 | 19.65 | 0      | 32.26 | 1      | 25.26   | 77.17 |
| <i>Maytenus senegalensis</i>    | Celastraceae  | 12 | 8.02  | 1.8    | 10.04 | 14     | 11.1    | 29.16 |
| <i>Acacia senegal</i>           | Fabaceae      | 13 | 4.9   | 3.04   | 34.91 | 20     | 10.99   | 50.8  |
| <i>Lannea welweschii</i>        | Anacardiaceae | 62 | 24.21 | 0.64   | 7.37  | 33     | 18.13   | 49.71 |
| <i>Lannea fruticosa</i>         | Anacardiaceae | 50 | 19.69 | 1.07   | 12.23 | 19     | 10.44   | 42.36 |
| <i>Dicrostachys cinerea</i>     | Fabaceae      | 37 | 13.75 | 1.09   | 12.49 | 18     | 19.89   | 46.13 |
| <i>Pterocarpus lucens</i>       | Fabaceae      | 54 | 17.14 | 0.25   | 22.74 | 15     | 14.15   | 54.03 |
| <i>Anogeissus leiocarpa</i>     | Combretaceae  | 30 | 11.67 | 0.2    | 2.34  | 6      | 3.3     | 17.31 |
| <i>Syzygium guineense</i>       | Myrtaceae     | 6  | 2.37  | 0.62   | 7.11  | 11     | 6.04    | 15.52 |
| <i>Tamarindus indica</i>        | Fabaceae      | 9  | 3.46  | 0.37   | 4.25  | 9      | 4.95    | 12.66 |
| <i>Piliostigma thonningii</i>   | Fabaceae      | 5  | 2     | 0.29   | 3.37  | 6      | 3.3     | 8.67  |
| <i>Ficus sycomorus</i>          | Moraceae      | 4  | 1.64  | 0.34   | 3.92  | 5      | 2.72    | 8.28  |
| <i>Flueggea virosa</i>          | Euphorbiaceae | 6  | 2.55  | 0.12   | 1.37  | 7      | 3.85    | 7.77  |
| <i>Ficus lutea</i>              | Moraceae      | 6  | 2.19  | 0.08   | 0.88  | 5      | 2.75    | 5.82  |
| <i>Asparagus flagellaris</i>    | Asparagaceae  | 2  | 0.91  | 0.22   | 2.58  | 4      | 2.2     | 5.69  |
| <i>Combretum collinum</i>       | Combretaceae  | 92 | 21.1  | 0.1    | 38.35 | 4      | 22.22   | 81.67 |
| <i>Oxytenanthera abyssinica</i> | Poaceae       | 4  | 1.45  | 0.1    | 1.15  | 3      | 1.65    | 4.25  |
| <i>Sterculia africana</i>       | Sterculiaceae | 3  | 1.28  | 0.02   | 0.19  | 4      | 2.2     | 3.67  |
| <i>Pennisetum thumbergii</i>    | Poaceae       | 2  | 0.91  | 0.03   | 0.36  | 4      | 2.2     | 3.47  |
| <i>Grewia velutina</i>          | Tiliaceae     | 1  | 0.36  | 0.03   | 0.3   | 2      | 1.1     | 1.76  |
| <i>Phoenix reclinata</i>        | Aracaceae     | 1  | 0.36  | 0.02   | 0.26  | 2      | 1.1     | 1.72  |
| <i>Boswellia papyrifera</i>     | Bursaceae     | 1  | 0.36  | 0.02   | 0.19  | 2      | 1.1     | 1.65  |
| <i>Hyparrhenia filipendula</i>  | Poaceae       | 1  | 0.18  | 0.04   | 0.52  | 1      | 0.55    | 1.25  |
| <i>Ximena americana</i>         | Olacaceae     | 1  | 0.18  | 0.01   | 0.1   | 1      | 0.55    | 0.83  |
| <i>Clerodendrum alatum</i>      | Verbanaceae   | 1  | 0.18  | 0      | 0.02  | 1      | 0.55    | 0.75  |
| <i>Combretum hartmanianum</i>   | Combretaceae  | 76 | 28.35 | 3.8    | 33.25 | 69     | 15      | 76.6  |

Note: DE ¼ absolute density (ha<sup>-2</sup>), RDE ¼ relative density (%), FR ¼ absolute frequency (%), RFR ¼ relative frequency (%), DO ¼ absolute dominance (m<sup>2</sup>), RDO ¼ relative dominance (%) and IVI ¼ Importance Value Index.

**Density, Frequency and Dominance**

The densities of all forage species, including seedlings, were 1216 stems ha<sup>-1</sup> (Tables-2). Few of the species dominated the woody vegetation and exhibited higher frequency values. In the study area *Combretum collinum*, *Lonchocarpus laxiflorus*, *Terminalia laxiflora*, *Acacia polyacantha* and *Ziziphus mucronata* were the five relatively abundant forage species (Table-2). However, *Phoenix reclinata*, *Clerodendrum alatum*, *imena americana* and *Grewia velutina*, were represented with few individuals. At Guba, the majority of the forage species exhibited high density values

(Table-2). However, the species richness values at the current study sites are far lower than those reported from Combretum-Terminalia forests of Anbessa forest of Assosa district [18] and of Wisin woodland of Bullen districts [19].

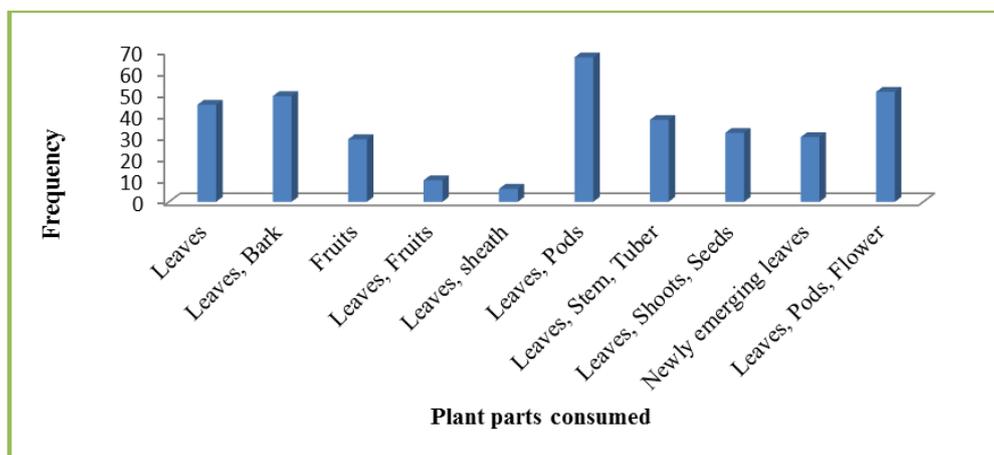
### Importance Value Index

The Importance Value Index (IVI) values of all the forage species ranged between 0.31 (*Strychnos innocua*) and 81.67 (*Combretum colinum*). The most dominant woody species were *Acacia polycanta*, *Hyphaene thebiaca*, *Lonchocarpus laxiflorus*, *Lanea fruticosa*, *Pilostigma thunningii* and *Acacia senegal*. Species with the least values of IVI were *Clerodendrum alatum* and *Ximenia Americana* (Table-2). The forage plant species reported from Guba are among the woody species with relatively high ecological importance, which is clearly reflected in their contribution to the overall IVI of the study sites. Similar results were also reported from Metema districts in Amhara Regional State where woody species contributed 65% and 75% of the total IVI, respectively [17].

### Utilization of plants for livestock feeding

The interviewed farmers (agro-pastoralists) were able to identify which plant species and which vegetative part was favoured by which class of livestock (Table-2). The farmers, however, named these trees and shrubs in their vernacular language (Table-1).

*Acacia hecatophylla*, *Pilostigma thonongii*, *Dicrostachus cinerea* was the most known tree species as indicated by 100 percent of respondents (n = 30). Some farmers collect pods of this tree species and keep them at their homes for the purpose of feeding calves and sick animals which cannot walk long distances in search of feed and water during the dry season. Unfortunately, no grinding or any other physical treatment was reported to be practised for the purpose of improving the nutritive value of the pods. Reasons given to the question as to why they do not grind the pods varied. Some indicated that the work is laborious especially for those with large herds of cattle. However, the majority did not know if this could be of value in feeding practices. During dry season when all the grasses burnt out the fallen dry leaves and pods of the family Fabaceae were known to be consumed with no choices by the local breeds of the area to transit the harsh environment of Guba area (Figure-2). The study indicated that all the local breeds would like to be collectors of the fallen leaves of the drier area which opposes the natural habit of the animals. However, study by Marissa Ames, 2020 indicated that If forage is limited or unavailable due to seasonal conditions, bad weather, or limited pasture space, goats should be fed good hay (free-choice) from a manger or feeder. Hay for goats can be either legume hay (alfalfa or clover) or carbonaceous hay (timothy, brome, orchard grass, mixtures). Legume hay is pricier but has higher nutrition. It's an excellent feed for pregnant or lactating does, and kids. Grass hay is less nutritious and also less expensive, so homesteaders often feed a 50-50 grass-legume mix. All hay should be fine-stemmed, leafy, and green in color. Choose hay meant for horses rather than cows.



**Fig-2: Parts of the forage plants preferred by the local breed during dry season**

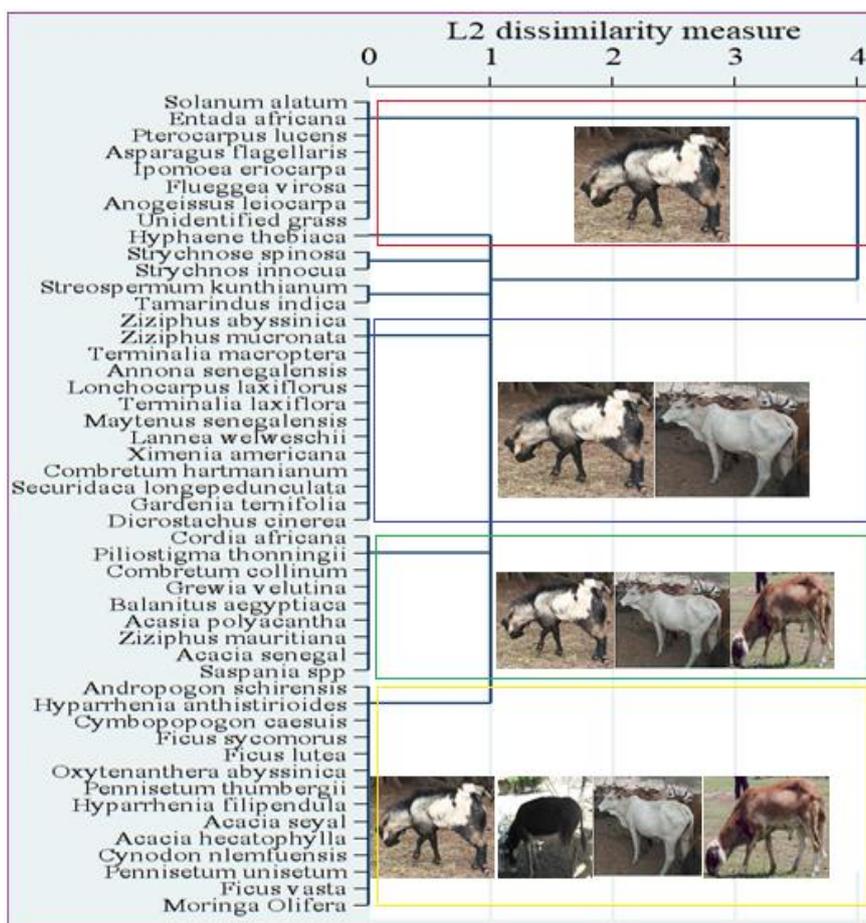
Apart from *Acacia hecatophylla* and *Dichrostachys cinerea* *Anogeissus leiocarpa* was reported to be known and used by all of respondents (n = 30). Its dry leaves were reported to be favoured particularly by small ruminants such as goats.

Other high ranking species were *Lonchocarpus laxiflorus*, *Acacia* species, *Hypheneae thebiaca* and *Ziziphus mucronata* were also mentioned and utilized for livestock feeding.

**Table-3: Knowledge on utilization of some plant species for livestock feeding in Guba district**

| Local Name (Gumuzigna) | Plant species                      | Animal species                   | Favoured plant parts  |
|------------------------|------------------------------------|----------------------------------|-----------------------|
| Amberta                | <i>Andropogon schirensis</i>       | Cattle, Goats, sheep and Donkeys | Leaves                |
| Adegila                | <i>Streospermum kunthianum</i>     | Cattle, Goats, Donkeys           | Leaves, Bark          |
| Anderkukuwa            | <i>Strychnose spinosa</i>          | Donkey, Goats                    | Fruits                |
| Hanguga/Hangua         | <i>Ziziphus abyssinica</i>         | Cattle, Goats                    | Leaves, Fruits        |
| Siya/Gaba              | <i>Ziziphus mucronata</i>          | Cattle, Goats                    | Leaves, Fruits        |
| Antutiya               | <i>Solanum alatum</i>              | Goats                            | Leaves                |
| Babegoha/Bogoha        | <i>Terminalia macroptera</i>       | Cattle, Goats                    | Leaves                |
| Babenga                | <i>Hyphaene thebiaca</i>           | Cattle, Donkeys                  | Leaves, Fruits        |
| Bambeluwa              | <i>Entada africana</i>             | Goats                            | Leaves                |
| Bambuta                | <i>Annona senegalensis</i>         | Cattle, Goats                    | Leaves, Fruits        |
| Banja                  | <i>Cordia africana</i>             | Cattle, Goats, Sheep             | Leaves, Fruits        |
| Bewa                   | <i>Lonchocarpus laxiflorus</i>     | Cattle, Goats                    | Leaves                |
| Begiya                 | <i>Strychnos innocua</i>           | Donkey, Goats                    | Fruits                |
| Bora                   | <i>Terminalia laxiflora</i>        | Cattle, Goats                    | Leaves                |
| Bembeda                | <i>Maytenus senegalensis</i>       | Cattle, Goats                    | Leaves                |
| Bidiguwa               | <i>Hyparrhenia anthistirioides</i> | Cattle, Goats, Sheep, Donkeys    | Leaves, sheath        |
| Bilga                  | <i>Lannea welweschii</i>           | Cattle, Goats                    | Leaves                |
| Mamusa                 | <i>Cymbopogon caesuis</i>          | Cattle, Goats, Sheep, Donkeys    | Leaves                |
| Chaya                  | <i>Pterocarpus lucens</i>          | Goats                            | Leaves                |
| Dhoga                  | <i>Tamarindus indica</i>           | Cattle, Goats, Donkeys           | Leaves, Pods          |
| Mecha                  | <i>Piliostigma thonningii</i>      | Cattle, Goats, Sheep             | Leaves, Pods          |
| Fuga                   | <i>Ficus sycomorus</i>             | Cattle, Goats, Sheep, Donkeys    | Leaves, Fruits        |
| Asiya                  | <i>Ficus lutea</i>                 | Cattle, Goats, Sheep, Donkeys    | Leaves, Fruits        |
| Bambichowa             | <i>Asparagus flagellaris</i>       | Cattle                           | Leaves, Stem, Tuber   |
| Engifa                 | <i>Combretum collinum</i>          | Cattle, Goats, Sheep             | Leaves                |
| Elta/Enta              | <i>Oxytenanthera abyssinica</i>    | Cattle, Goats, Sheep, Donkeys    | Leaves, Shoots, Seeds |
| Etissayaquwa           | <i>Pennisetum thumbergii</i>       | Cattle, Goats, Sheep, Donkeys    | Leaves, Sheath        |
| Gideya                 | <i>Grewia velutina</i>             | Cattle, Goats, Sheep             | Leaves, Fruits        |
| Hesiniya               | <i>Hyparrhenia filipendula</i>     | Cattle, Goats, Sheep, Donkeys    | Leaves, Sheath        |
| Heya                   | <i>Ximenia americana</i>           | Cattle, Goats                    | Newly emerging leaves |
| Jipiwa/Chamda          | <i>Combretum hartmanianum</i>      | Cattle, Goats                    | Leaves                |
| Meela                  | <i>Acacia seyal</i>                | Cattle, Goats, Sheep, Donkeys    | Leaves, Pods, Flower  |
| Qota                   | <i>Balanitis aegyptiaca</i>        | Cattle, Goats, Sheep             | Leaves, Fruits        |
| Quatsirqa              | <i>Acacia hecatophylla</i>         | Cattle, Goats, Sheep, Donkeys    | Leaves, Pods, Flower  |
| Sasiqida               | <i>Cynodon nlemfuensis</i>         | Cattle, Goats, Sheep, Donkeys    | Leaves                |
| Sipe                   | <i>Acacia polyacantha</i>          | Cattle, Goats, Sheep             | Leaves, Pods          |
| Siqida/Si-Eda          | <i>Securidaca longepedunculata</i> | Cattle, Goats                    | Newly emerging leaves |
| Songah                 | <i>Ziziphus mauritiana</i>         | Cattle, Goats, Sheep             | Leaves, Seeds         |
| Dimquri                | <i>Ipomoea eriocarpa</i>           | Cattle                           | Whole part            |
| Tara/Geret             | <i>Acacia senegal</i>              | Cattle, Goats, Sheep             | Leaves, Pods          |
| Mureb                  | <i>Pennisetum unisetum</i>         | Cattle, Goats, Sheep, Donkeys    | Whole part            |
| Kota                   | <i>Gardenia ternifolia</i>         | Cattle, Goats                    | Leaves, Fruit         |
| Weela                  | <i>Dicrostachus cinerea</i>        | Cattle, Goats                    | Leaves, Pods          |
| Weela                  | <i>Flueggea virosa</i>             | Goats                            | Leaves                |
| Sigah                  | <i>Anogeissus leiocarpa</i>        | Goats                            | Leaves                |
| Insiya                 | <i>Ficus vasta</i>                 | Cattle, Goats, Sheep, Donkeys    | Fruits                |
|                        | <i>Saspania spp</i>                | Cattle, Goats, Sheep             | Leaves, Pods          |
| Bufa                   | Unidentified grass                 | Cattle                           | Whole part            |
| Moringa                | <i>Moringa Olifera</i>             | Cattle, Goats, Sheep, Donkeys    | Leaves, Flower, Barks |

The response given by the interviewed farmers on their experiences on utilization of various plants were comparable to observations made by Backlund and Bellskong [20] who closely followed the herds of livestock grazing in selected farms in Metema district, Amhara region.



**Fig-3: Dendrogram showing the classification of forage plant species based on the preferences by local animal breeds. The horizontal axis represents the distance or dissimilarity between clusters and the vertical axis represents the local animal breeds and clusters**

Particularly local goats’ breeds of the study area were known to feed on various feed resources than other breeds. Moreover, Bigariya cattle breeds were also known to feed on various similar plant resources hence adapted to harsh environmental conditions known in western Ethiopia (Figure-3). Similarly the study of Jackson, 2008 stated that “Goats have a huge diversity of other plants to choose from than ones we would normally consider traditional forages like fescue, orchard grass, white and red clover, etc.” To the contrary mixed grazing particularly goats with cattle is not common in other areas of the world this is because “When goats graze first and then the cattle come in, they are doing what we call ‘clean up grazing’ in the pasture. At the end of the first grazing season, it was found that cattle that followed goats weighed on average 30 pounds less than cattle that were grazing with goats all the time [21].”

**Table-1: ANOVA Results**

| Analysis of Variance |            |    |            |      |          |
|----------------------|------------|----|------------|------|----------|
| Source               | SS         | df | MS         | F    | Prob > F |
| Between groups       | 194.417687 | 11 | 17.6743352 | 2.93 | 0.0070   |
| Within groups        | 223.133333 | 37 | 6.03063063 |      |          |
| Total                | 417.55102  | 48 | 8.69897959 |      |          |

As illustrated in Table-4 above, the significance value in testing the reliability of the model for the relationship between the local animal breeds with their sources of feed materials (plant species) was obtained as 0.007 which is less than 0.05 the critical value at 95% significance level. That means most of the local breeds feed differently on different parts of plant materials that are available during dry season in the study area. This statement is similar with the study of Jackson Ky, 2008 [21] stating that “Goats have a huge diversity of other plants to choose from than ones we would normally consider traditional forages like fescue, orchard grass, white and red clover, etc.”

**Veterinary Use of plant species**

Some trees and shrubs are utilized by agro-pastoralists in treatment of animal diseases and disorders. For example, the stem of a mistilto plant "Ewa" is pounded and mixed with water. The material is squeezed out into the

reproductive tract of a cow leaving the mother liquor to induce the expulsion of the retained placenta. On the other hand, pounded barks of *Cordia Africana* and roots of *Securidaca longepedunculata* is used in treatment of diarrhoea and common cold cases of goats. Moreover the sheath of *Hypheneae thebiaca* is used to treat the eye disease of Goats, sheep and cattle

**Table-5: Veterinary use of some trees and shrubs**

| Plant species                      | Animals | Comments   |
|------------------------------------|---------|--|
| <i>Cordia africana</i>             | Goats   | Bark powdered and mixed with water to treat diarrheal diseases                                 |
| <i>Securidaca longepedunculata</i> | Goats   | Chopped and squeezed roots extracts were used to treat respiratory diseases (e.g. common cold) |
| <i>Hyphaene thebiaca</i>           | Cattle  | Chopped sheath of Hyphaene is used to treat eye diseases                                       |
| <i>Euphorbia sp</i>                | Cattle  | Stem pound and mother liquor used (Mistilto) to expel retained placenta                        |

### Treatment of Livestock Products

Some farmers use trees and shrubs to enhance livestock products such as milk. Leafs and Wood from some of the plant species (Table-4) is used to feed the animals specially caws to increase the milk content and even its smoke is believed to increase the shelf life of milk and to impart desirable flavours to the "clotted" and concentrated product. Studies conducted at Sokoine University of Agriculture (SUA) on traditional smoking of milk practised by different tribes in Tanzania show that smoke treatment inhibits growth and activity of mesophilic and thermophilic lactic acid bacteria, although the treated product might not be favoured by everybody tasting the milk [22].

**Table-6: Plant species used as milk enhancer in Guba district**

|                                    |
|------------------------------------|
| <i>Ipomoea eriocarpa</i>           |
| <i>Asparagus flagellaris</i>       |
| <i>Bufa grass</i>                  |
| <i>Hyparrhenia anthistirioides</i> |

### The impact of Seasonal Dynamics and management on the availability of Forage Plant Species

The owners and herders of the study area identified a total of 49 dominant forage species distributed over the seasonal grazing areas (Table-2) and were also able to rank their abundance in the vegetation across seasons. A significant proportion of pastoralists/owners stated that there is a shortage of forage plant species in March, April and May because of late burning which massively distracts the whole part of the plants. Moreover, a decline in wet weight forage quantity is not a problem to Bigariya cattle breed because mostly these breeds are not like other breeds in that they adopted to browse on thorny and longer dominant Acacia species of the area.

Since animals feed resource is not a problem the pastoralists keep their herd of cattle in communal grazing, and herd splitting based on the number of cattle's owned. To the contrary Pastoralist households across East Africa face major livestock losses during dry periods that can cause persistent poverty [22].

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