# Evaluation of Botanical Composition of Kashin-Dila Rangeland in Mallam-Madori Local Government Area, Jigawa State, Nigeria

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## Abstract

*One of the most important aspects in grassland science is the characterization of vegetation in terms of its botanical composition. Botanical composition of rangeland is important because individual species may differ in feeding value, content of harmful substances and their reaction to environmental and management factors. This study was therefore conducted to identify, classify and assess the botanical composition of forages growing in Kashin-dila rangeland of Mallam-Madori Local Government Area, Jigawa State. The rangeland that covers 564.2 ha was stratified into two distinctive vegetation (grassland and shrub land) areas, where a plot of 1 ha was marked and replicated ten times (10 ha) in the first stratum and five times in the second, making a total of 15 sample plots and 150 sample points when a quadrat of 1m x 1m was thrown ten times in each plot. The collected forages were categorized into herbaceous and woody forages. Thirty herbaceous forages were identified and classified, belonging to 14 families with poaceae as the most frequent. Nineteen of these forages were annuals and the remaining 11 were perennials. Ten of the forages were classified as grasses based on forage type, 3 sedges, 5 legumes, and 12 forbs. Among the 30 herbaceous forages, 10 were decreasers, 11 increasers, and 9 invaders. Twelve woody forages were identified and also classified as in the latter. The woody forages belong to 8 families. Fabaceae was the most frequent family. The botanical composition of poaceae was 23.81% covering 9.17% of the vegetation cover, cyperaceae with 7.14% covering only 0.005%, fabaceae with 21.43% spread over 47.47% while other families were 47.62% covering 43.36% of the total vegetation cover of the rangeland. The botanical composition of the rangeland was good, having good number of perennials, moderate decreasers and low invaders were also good potentials for the rangeland.*

**Keywords:** Botanical composition, Classification, Forages, Identification, Kashin-dila rangeland.

## Évaluation de la composition botanique des pâturages de Kashin-Dila dans la zone d'administration locale de Mallam-Madori, État de Jigawa, Nigéria

## Résumé

*La connaissance de la composition botanique est essentielle en science des prairies pour caractériser la végétation. Elle revêt une importance capitale car la valeur alimentaire, la présence de substances nocives et la réponse aux facteurs environnementaux et de gestion varient selon les espèces. Cette étude visait à identifier, classer et évaluer la composition botanique des fourrages du pâturage de Kashin-Dila, situé dans la zone d'administration locale de Mallam-Madori, État de Jigawa, au Nigeria. Le pâturage d'une superficie de 564,2 hectares a été stratifié en deux zones distinctes de végétation (prairies et arbustales). Une parcelle d'un hectare a été délimitée et répétée dix fois (10 ha) dans la première strate et cinq fois dans la seconde, totalisant ainsi 15 parcelles d'échantillon et 150 points d'échantillon (quadrant de 1m x*

*1m lancé dix fois par parcelle). Les fourrages récoltés ont été classés en fourrages herbacés et ligneux. Trente fourrages herbacés appartenant à 14 familles ont été identifiés et classés, les Poaceae étant les plus abondantes. Dix-neuf étaient des annuelles et les onze restantes, des vivaces. Dix ont été classés comme graminées, trois comme carex, cinq comme légumineuses et douze comme plantes dicotylédones. Parmi les 30 fourrages herbacés, dix étaient des espèces en régression, onze en progression et neuf envahissantes. Douze fourrages ligneux ont également été identifiés et classés selon ce critère. Ces derniers appartiennent à huit familles, les Fabaceae étant les plus fréquentes. La composition botanique était la suivante : 23,81 % pour les Poaceae (couvert végétal de 9,17 %), 7,14 % pour les Cyperaceae (couvert végétal de 0,005 %), 21,43 % pour les Fabaceae (couvert végétal de 47,47 %) et 47,62 % pour les autres familles (couvert végétal de 43,36 %). La composition botanique du pâturage s'est avérée satisfaisante, avec une proportion intéressante de plantes vivaces, un nombre modéré d'espèces en régression et un faible nombre d'espèces envahissantes, indiquant un bon potentiel pour le pâturage.*

**Mots-clés** : Composition botanique, classification, fourrages, identification, pâturages de Kashin-Dila.

**Running title:** Assessment of forage biomass yield in Kashin-dila Rangeland

## Introduction

Livestock is one of the fastest growing agricultural sub-sectors as it forms 33% of the agricultural gross domestic product (GDP) in the developing countries and is rapidly increasing demand for livestock products (Thornton, 2010). Natural rangelands provide feed to a large number of livestock and are considered one of the cheapest sources of forages for grazing animals (Ismail *et al.,* 2014).

Plant communities in rangelands are formed as a result of lengthy processes with the combined effects of soil, topography and climatic factors which make the vegetation of each rangeland unique (Cinar *et al.,* 2020). Plant communities respond differently to grazing, and plant distribution and composition can be used to assess rangeland quality. Ecologically, forage species can be divided into different groups as decreasers, increasers and invaders, based on their succession and response to grazing intensity and preference by grazing animals (Tefera *et al.,* 2007; Ruvuga *et al.,* 2021).

Forage species life forms (ratio of annual to perennial forages) can also be used to assess the conditions of rangelands. Perennial forage species are usually preferred, due to their persistence, productivity and year-round availability, whereas annuals have large specific leaf area but thinner leaves than perennials, and also have low biomass and a short life cycle, making them less suitable for grazing (Pfeiffer *et al*., 2019).

The botanical composition of rangeland is important because individual species may differ in feeding value, content of harmful substances and their reaction to environmental and management factors (Becker, 2011). Measurement of botanical composition may be in terms of the yield of the species components, the frequency of occurrence of different species, the number of plants present, or the area covered by different species (Alkemade *et al.,* 2013). Measurement of yield has direct relevance on animal production, because it describes the feed available, while the other measures have only indirect relevance to animal production; because the relations between yield and frequency, number or area will differ between species, their role is mainly to describe and quantify the population of plants in the pasture (Babalik and Kilic, 2015). Classical plant succession theory has postulated that, in the absence of disturbing factors, there is a directional change in botanical composition to a "climax" stage in the vegetation. Besides botanical changes due to such

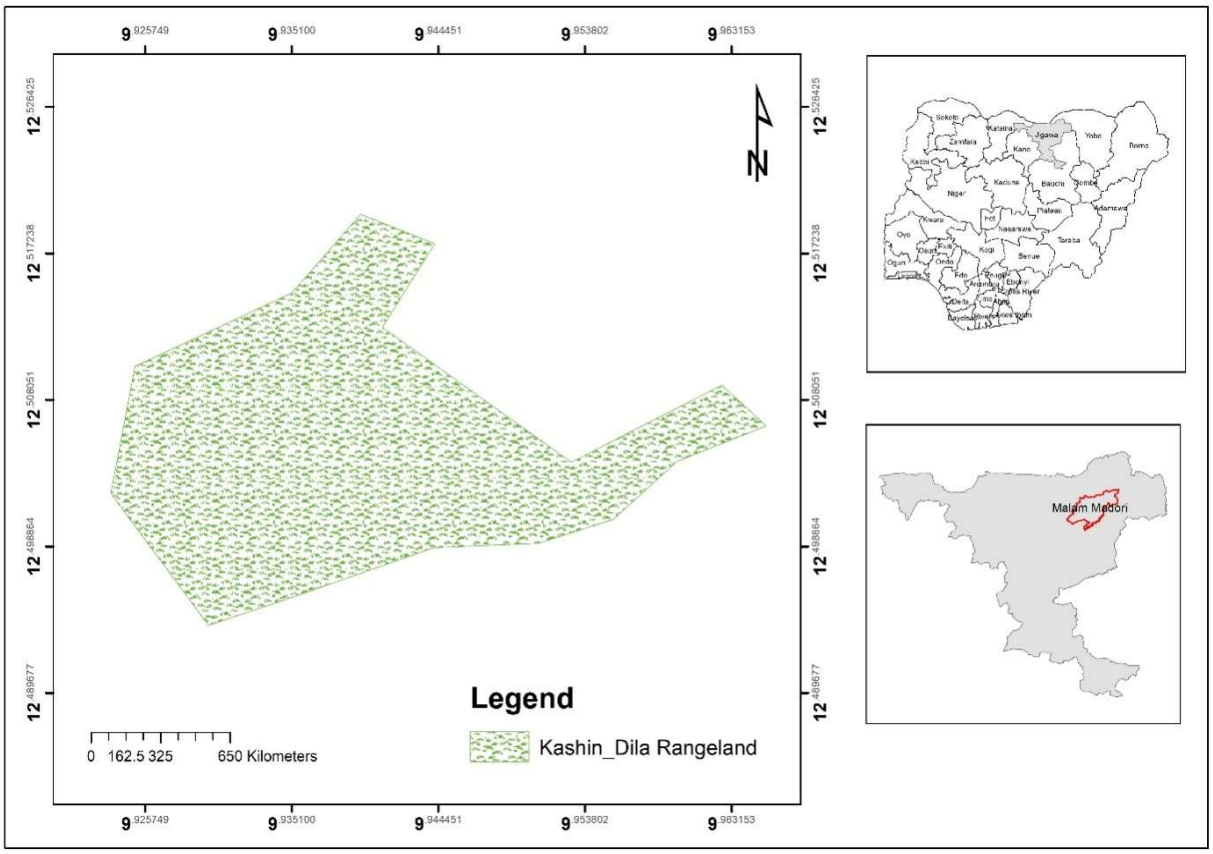
successional trends, vegetation also changes according to the way it is treated (Di Virgilio *et al.,* 2019). Rangeland has traditionally been assessed based on its species composition and basal cover, quantified in terms of a veld condition score (Becker, 2011; Cinar *et al.,* 2020). The other aspect of botanical composition/species composition is a means of correcting faulty managerial applications by using the change in botanical composition as an index of rangeland degradation (Desalew, 2008; Bailey *et al.,* 2019). This happens when undesirable species increase at the expense of desirable species.

Characterization of vegetation in terms of its botanical composition is one of the most important aspects in grassland science. The botanical composition reflects the site, conditions and management factors, which their changes have impacts on yield and forage quality (Peratoner and Potsch, 2019). Changes in the botanical composition over time provide relevant hints about the impact of environment and management on vegetation. As most of rangeland vegetation are perennial or even permanent, vegetation dynamics enable to identify medium and long-term effects. For this reason, the description of the botanical composition of pasture and rangeland is essential and is therefore an indispensable part of monitoring and analysis both in field trials and field surveys (Peratoner and Potsch, 2019).

Pasture and rangeland can be classified based on forage type as; woody forages or browses, which are trees and shrubs, and herbaceous forages; consisting of grasses, legumes and forbs. Therefore, pasture and rangelands are made up of single or mixture of grasses, sedges, legumes, forbs and browses, and can be classified as such (Ogbu and Ilo, 2021). Classification of the forages can also be done based on family, life form, preferences, etc. (Babalik and Kilic, 2015; Bala *et al.,* 2020; Mosisa *et al.,* 2021; Ruvuga *et al.,* 2021). To determine the grazing capacity of a rangeland, it is crucial to have an understanding of the forage species present in the rangeland (Godari *et al.,* 2013). Thus, identification, classification and understanding the botanical composition as well as spatial and temporal changes in forage quality in the rangeland is essential for livestock farmers (Peratoner and Pötsch, 2019).

**Materials and methods**

The study was conducted at Kashin-dila rangeland of Mallam-Madori Local Government Area of Jigawa State, Nigeria. The area is located close to Kashin-dila village, along Hadejia-Mallam-Madori road 9km and 12km away from Mallam-Madori and Hadejia towns, respectively. The average altitude of the rangeland is 356m above sea level and the total area covers 564.2 hectares on latitude $12^0 30^{'} 22$"N and longitude $9^0 56'53$"E. The annual rainfall ranges between 200 - 600mm with relative humidity of 75 % during the rainy season and a mean annual temperature of $28^0$C. Cattle, sheep and goat are usually the most important animals grazing in the area by Fulani pastoralists (BirdLife International, 2021; Field Survey, 2023; Muhammad *et al*., 2023).




**Botanical composition and vegetation cover**

The rangeland comprised of two distinctive vegetation areas; an area predominantly covered with grasses (grassland) and an area predominantly covered with shrubs (shrub land). The rangeland was stratified into these two areas where sample plot of one hectare was identified and marked ten times (10 ha) in the first stratum (grassland) and five times in the second stratum (shrub land), making a total of fifteen sample plots and one hundred and fifty (150) sample points when a quadrat was thrown ten times in each plot (Muhyadin, 2021; Ruvuga *et al.,* 2021). The forages in the rangeland were categorized into two groups; herbaceous forage species group consisting of grasses, sedges, legumes and forbs, and browse/woody forage species group consisting of trees and shrubs (Ogbu and Ilo, 2021). On monthly bases from July to November, 2023 herbaceous forage species composition were randomly sampled using 1 m x 1 m open ended quadrat from each replication plot. Within each quadrat, samples of the herbaceous forage species were identified and scored in percentage (%) relative to their proportion within the quadrat and categorized into grasses, sedges, legumes and forbs, while v*egetation cover and forage distribution for browse/woody forages were measured fortnightly, using the line intercept method (Godínez-Alvarez et al., 2009). A 50 m tape measure was used as the sampling unit. The measuring tape was laid starting from the sampling point on the transect line and the linear distance of tape measure that intercepted shrubs, tree canopy and bare ground were recorded. Tree density was estimated once, at the beginning of the study period, using the point-centred quarter (PCQ) by Bryant et al. (2004) method. In this method, a steel cross was thrown randomly from the individual sampling point, the nearest tree was identified and distance from center of the*

*cross to the identified tree was measured using 50 m tape measures in all four directions of the cross* (Babalik and Kilic, 2015; Ruvuga *et al.,* 2021). To help in identifying the collected species, representative plants with flowering head and other vegetative parts from each species were collected, coded and dried in presses. Following drying, the specimens were mounted. Some common species were identified right in the field using common names, while botanical names were later identified using Blench (2007).

**Statistical analysis**

Data collected was analysed using Microsoft Excel and simple descriptive statistics was employed to represent the results of botanical composition of the rangeland.

**Results and discussion**

***Herbaceous forage species***

Thirty (30) herbaceous forage species were identified in the study area and classified based on family, life form, forage type, preference, and utilizations by animals as shown in Table 1 (ICAR, 2011; Mosisa *et al.,* 2021; Ogbu and Ilo, 2021; Ruvuga *et al.,* 2021). The 30 herbaceous forage species found belong to 14 families. The families with the most species were poaceae with 10 species, fabaceae with 5 species, cyperaceae with 3 species, acanthaceae with 2 species and 10 other families with one specie each (Figure 1). Nineteen (19) of these forages were annuals and the remaining eleven (11) of them were perennials. Ten (10) of the forages were classified as grasses based on forage type, three (3) were grass-like herbs (sedges), five (5) were legumes and twelve (12) forbs. Among the total of 30 herbaceous forage species, ten (10) were found to be decreasers, eleven (11) of them increasers and nine (9) of them were invaders. The forage composition of the rangeland was good, as it triples the eleven (11) species reported by Bala *et al.* (2020) when they evaluated the species richness and distribution patterns of forages on a rangeland in Mando, Kaduna State, Nigeria. It also exceeds the twenty (20) species reported by Mosisa *et al.* (2021) when they evaluated three areas (protected, private rangelands and ranch) in August, 2017 as well as nineteen (19) species reported by Ruvuga *et al.* (2021) when they do their rangeland evaluations on Miombo woodland, Tanzania in 2012 Having small number of perennial plants (37%) in the rangeland is negative in terms of the rangeland quality (Babalik and Kilic, 2015). The low amount of decreasers (33%) and with almost equal number of invaders (30%) are also poor potentials for the rangeland though, Babalik and Kilic (2015) reported a lower amount of decreasers (6%) and high amount of invaders (80%) which depict a threat for the rangeland's future.

***Browse/woody forage species***

Twelve (12) browse/woody forage species were identified in the study area and were also classified based on family, life form, forage type, preference and utilizations by animals as shown in Table 2 (ICAR, 2011; Mosisa *et al.,* 2021; Ogbu and Ilo, 2021; Ruvuga *et al.,* 2021). The 12 forage species found belong to 8 families. Fabaceae with 4 species was the most frequent family of the browse plants recorded, 2 species of combretaceae and 6 other families with one specie each (Figure 2). The forages were all perennials (with 6 trees and 6 shrubs), out of which only three (3) were found to be decreasers, eight (8) increasers and only one (1) of them was invader species. The browse plants composition of the rangeland can also be compared with the eleven (11) forage species reported by Bala *et al.* (2020) and twenty (20) and nineteen (19) species reported by Mosisa *et al.* (2021) and Ruvuga *et al.* (2021). Having large number of perennial plants in the rangeland is positive in terms of the rangeland quality (Babalik and Kilic, 2015). The low amount of decreasers (25%) and low amount of invaders (8%) are also good potentials for the

rangeland when compared with Babalik and Kilic (2015) who reported lower amount of decreasers (6%) and very high amount of invaders (80%) which threatens the continuity and future of the rangelands.

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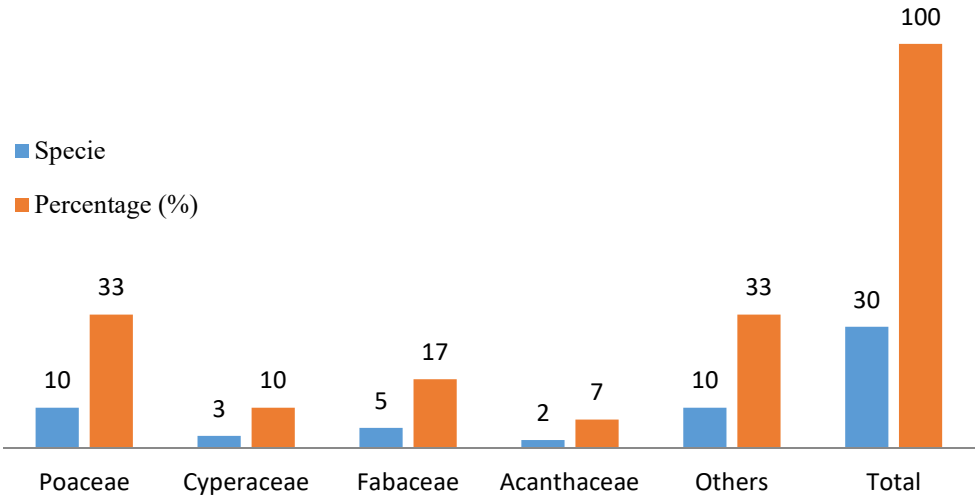


**Fig. 1 Classification of herbaceous forages based on family**

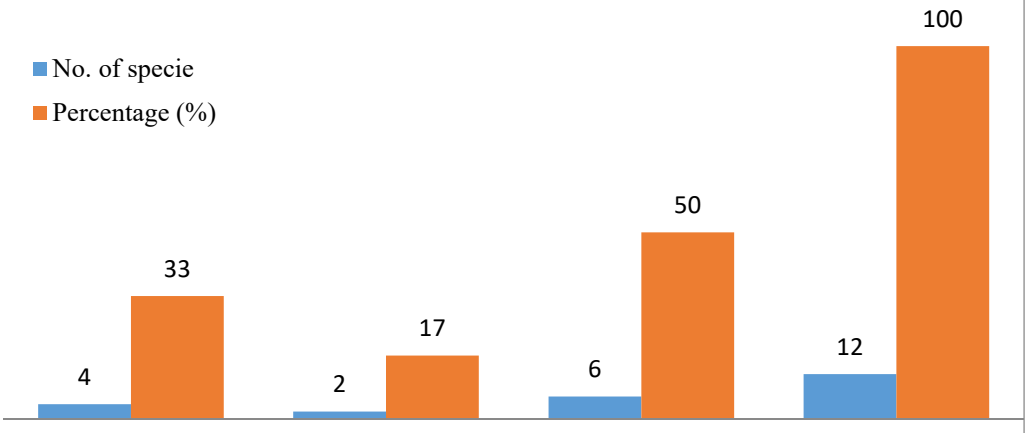


**Fig. 2 Classification of browse/woody forages based on family**

**Table 1. Identification and classification of herbaceous forages based on family, life form, forage type and preference**

| Forages | Common name | Local name | Family | Life form | Forage type | Forage category | Species occurrence | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Grassland | Shrub land |
| *Axonopus compressus* | Carpet grass | Carpet grass | Poaceae | Perennial | G | ↓ | P | C |
| *Imperata cylindrical* | Cogon grass | Komayya | Poaceae | Perennial | G | ↓ | P | P |
| *Cenchrus biflorus* | Indian Sandbur | Karangiya | Poaceae | Annual | G | ↑ | C | C |
| *Cenchrus ciliaris* | Buffel grass | Karangiya | Poaceae | Perennial | G | ↓ | P | - |
| *Pennisetum pedicellatum* | Kyasuwa | Kyasuwa | Poaceae | Annual | G | ↓ | C | P |
| *Digitaria velutina* | Velvet fingergrass | Harkiya | Poaceae | Annual | G | ↓ | C | P |
| *Eragrostis ciliaris* | Gophertail love grass | Komayya | Poaceae | Annual | G | ↓ | C | P |
| *Eragrostis tremula* | Love grass | Tsintsiya | Poaceae | Annual | G | ↓ | C | P |
| *Cynodon dactylon* | Bermuda grass | Kiri-kiri | Poaceae | Perennial | G | ↓ | C | C |
| *Dactyloctenium aegyptium* | Crowfoot grass | Gude-gude | Poaceae | Annual | G | ↓ | C | P |
| *Cyperus rotundus* | Nutsedge/ Nutgrass | Aya-aya | Cyperaceae | Perennial | S | ↑ | C | P |
| *Cyperus esculentus* | Yellow Nutsedge | Jiji | Cyperaceae | Annual | S | ↑ | C | C |
| *Kyllinga brevifolia* | Spikesedge | Gemun kwado | Cyperaceae | Perennial | S | ↑ | C | C |
| *Crotalaria retusa* | Rattle weed | Gyadar awaki | Fabaceae | Annual | L | ↓ | C | - |
| *Alysicarpus vaginalis* | Alyce clover | Gadagi | Fabaceae | Annual | L | ↑ | C | - |
| *Zornia glochidiata* | Zornia | Dankadafi | Fabaceae | Annual | L | ↑ | C | P |
| *Senna obtusifolia* | Sickle pod | Tafasa | Fabaceae | Annual | L | * | D | C |
| *Senna occidentalis* | Coffee senna | Mazanfari | Fabaceae | Perennial | L | * | C | P |
| *Hygrophila auriculata* | Marsh barbell | Kayar rakumi | Acanthaceae | Perennial | F | ↑ | - | P |
| *Monechma ciliatum* | Black mahlab | Alkamar Tururuwa | Acanthaceae | Annual | F | ↑ | C | - |
| *Calotropis procera* | Sodom apple | Tumfafiya | Apocynaceae | Perennial | F | * | P | P |
| *Momordica balsamina* | Balsam apple | Garafuni | Cucurbitaceae | Annual | F | * | C | - |
| *Leptadenia hastate* | Leptadenia | Yadiya | Asclepiadaceae | Perennial | F | * | C | C |
| *Sphaeranthus angustifolius* | Hura | Hura | Asteraceae | Annual | F | ↑ | C | C |
| *Tribulus terrestris* | Puncture vine | Tsidau | Zygophyllaceae | Annual | F | * | C | P |
| *Mitracarpus villosus* | Girdlepod | Goga masu | Rubiaceae | Annual | F | * | C | - |
| *Amaranthus viridis* | Slender amaranth | Zaki banza | Amaranthaceae | Annual | F | ↑ | C | P |
| *Ipomoea eriocarpa* | Morning glory | Yaryadi | Convolvulaceae | Annual | F | ↑ | C | - |
| *Waltheria indica* | Sleepy morning | Hankufa | Malvaceae | Annual | F | * | - | C |
| *Datura metel* | Thorn apple | Zakami | Solanaceae | Perennial | F | * | P | - |

*G* = Grass, S = Sedge, L = Legume, F = Forb, ↓ = Decreaser, ↑ = Increaser, * = Invader, *D* = Dominant (>20%), *C* = Common (5-20%), *P* = Present (<5%), - = Not present (0%)

**Table 2. Identification and classification of browse/woody forages based on family, life form, forage type and preference**

| Forages | Common name | Local name | Family | Life form | Forage type | Forage category | Species occurrence | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Grassland | Shrub land |
| *Guiera senegalensis* | Sabara | Sabara | Combretaceae | Perennial | S | ↑ | P | D |
| *Vachellia nilotica* | Gum arabic tree | Bagaruwa | Fabaceae | Perennial | S | * | P | P |
| *Vachellia sieberiana* | White thorn tree | Farar kaya | Fabaceae | Perennial | S | ↑ | P | C |
| *Tamarindus indica* | Tamarind | Tsamiya | Fabaceae | Perennial | T | ↑ | P | P |
| *Piliostigma thonningii* | Monkey biscuit | Kargo | Fabaceae | Perennial | S | ↓ | P | C |
| *Azadirachta indica* | Neem | Darbejiya | Meliaceae | Perennial | T | ↑ | C | P |
| *Balanites aegyptiaca* | Desert date | Aduwa | Zygophyllaceae | Perennial | T | ↑ | P | P |
| *Diospyros mespiliformis* | Ebony tree | Kanya | Ebenaceae | Perennial | T | ↑ | P | C |
| *Anogeissus leiocarpa* | African birch | Marke | Combretaceae | Perennial | T | ↑ | - | P |
| *Adansonia digitate* | Baobab | Kuka | Malvaceae | Perennial | T | ↓ | P | P |
| *Ziziphus mauritiana* | Jujube tree | Magarya | Rhamnaceae | Perennial | S | ↓ | P | C |
| *Annona senegalensis* | African custard-apple | Gwandar jeji | Annonaceae | Perennial | S | ↑ | - | P |

S = Shrub, T = Tree, ↓ = Decreaser, ↑ = Increaser, * = Invader, *D* = Dominant (>20%), *C* = Common (5-20%), *P* = Present (<5%), - = Not present (0%).

***Botanical composition of forage species in the rangeland***

The forage species in the study area were categorized by family into four groups: Poaceae family, Fabaceae family, Cyperaceae family and plant types from other families and their botanical compositions with respect to the number of species as well as the area covered were given in table 3 and figure 3. The botanical composition of the poaceae family was found to be 23.81% covering 9.17% of the vegetation cover of the rangeland area, cyperaceae with 7.14% covering only 0.005%, the composition of fabaceae was 21.43% spread over 47.47% of the rangeland vegetation while forages from other families were 47.62% covering 43.36% of the total vegetation cover of the rangeland. The botanical composition of the forage species in the study can be compared with both the general average percentage of 47.95% poaceae, 23.37% fabaceae and 28.68 % other families reported by Babalik and Kilic (2015). Babalik (2008) and Mosisa *et al.* (2021) also found similar results in their respective studies.

**Table 3. Botanical composition of forage species in the rangeland**

| S/N | Category | Number of specie | Percentage (%) | Area covered (%) |
|---|---|---|---|---|
| 1 | Poaceae | 10 | 23.81 | 9.168 |
| 2 | Cyperaceae | 3 | 7.14 | 0.005 |
| 3 | Fabaceae | 9 | 21.43 | 47.465 |
| 4 | Others | 20 | 47.62 | 43.362 |
| | Total | 42 | 100 | 100 |

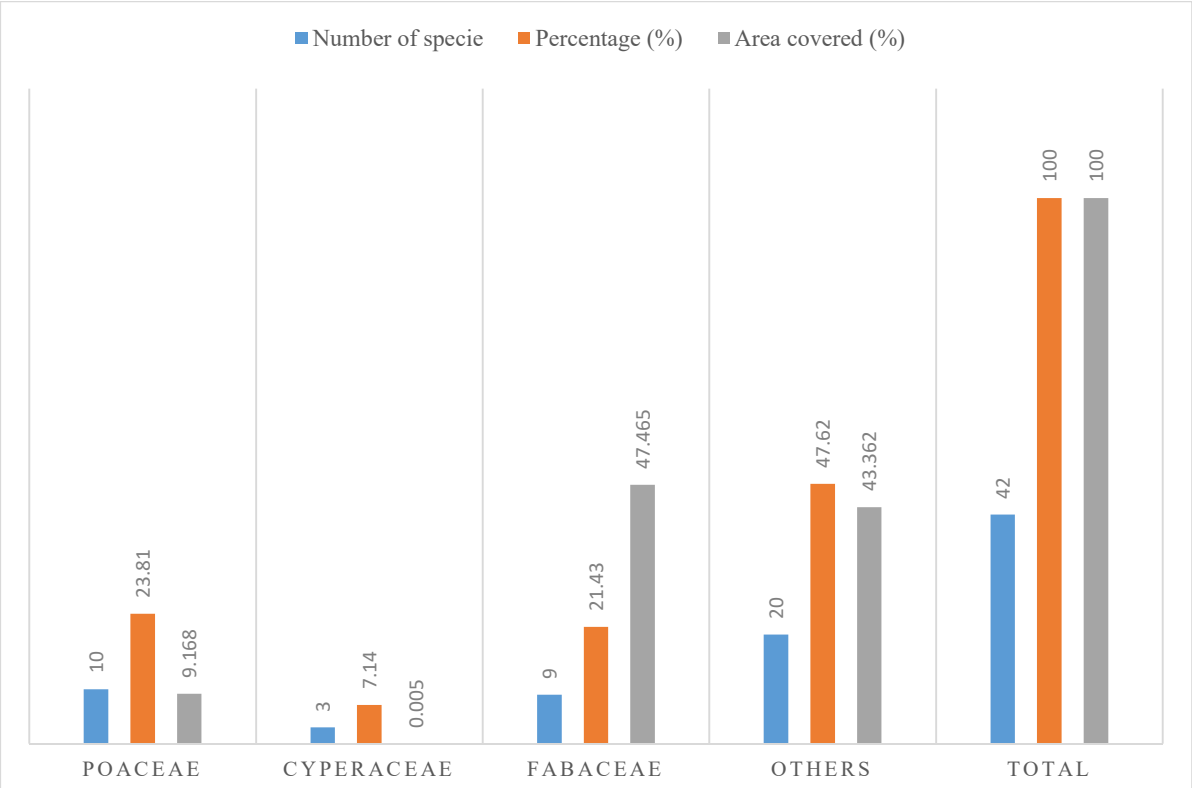


**Fig. 3 Botanical composition of the rangeland**

**Conclusion and recommendation**

The forage composition of the rangeland was good, having good number of perennial plants in the rangeland is also positive in terms of the rangeland quality. The moderate amount of decreasers and low amount of invaders are also good potentials for the rangeland, as very high amount of invaders depicts a threat for the rangeland's future. Further research on range condition as well as nutritional quality of the forages in the rangeland is recommended.

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