Scientific Research Publishing

Open Journal of Ecology, 2024, 14, 683-705
https://www.scirp.org/journal/oje
ISSN Online: 2162-1993
ISSN Print: 2162-1985

# Grassland Pasture Composition and Quality in the Communes of Ziguinchor and Kolda, Senegal

**Aly Diallo*, Saboury Ndiaye, Arfang Ousmane Kemo Goudiaby, Yaya Diatta, Mamadou Ndao, Mamadou Diamanka, Gnima Manga**

Department of Agroforestry, Faculty of Science and Technology, Assane Seck University of Ziguinchor, Ziguinchor, Senegal
Email: *aly.diallo@univ-zig.sn

**How to cite this paper:** Diallo, A., Ndiaye, S., Goudiaby, A.O.K., Diatta, Y., Ndao, M., Diamanka, M. and Manga, G. (2024) Grassland Pasture Composition and Quality in the Communes of Ziguinchor and Kolda, Senegal. *Open Journal of Ecology*, **14**, 683-705.
https://doi.org/10.4236/oje.2024.149040

**Received:** August 22, 2024
**Accepted:** September 21, 2024
**Published:** September 24, 2024



## Abstract

In Senegal, natural pasture plays a major role in feeding livestock. During the rainy season, herbaceous plants account for a large proportion of the fodder consumed by ruminants. In Casamance, the composition and quality of these grasses are poorly known and underexploited. In this context, the study aimed to improve the knowledge and valorisation of the herbaceous fodder of the South. Individual interviews were conducted and a questionnaire was sent to farmers living in Ziguinchor and Kolda. A floristic inventory with a phytosociological approach was also carried out. The data collected were processed using Excel and Sphinx software in order to differentiate and classify the herbaceous species eaten by the tail. The majority of respondents were Fulani (55.30%). most of whom ranged in age from 30 to 60. Livestock rearing came second (38.3%) after agriculture (40%) among the principal activities of the people surveyed. The floristic inventory identified 95 species in 68 genera and 22 families. Species of low and medium pastoral value dominate the herbaceous layer. The global rangeland quality index was 48.16% and the brute pastoral value was 54.77%. Thirteen species contributed 54.86% of the pastoral value of the grassland. The floristic composition of community rangelands showed the presence of a varied herbaceous fodder range. The combination of which will help to develop a table of nutritional values for the formation of equilibrated feed rations for farmed livestock.

## Keywords

Fodder, Herbaceous, Pasture, Nutritional Assessment, Livestock

## 1. Introduction

Livestock appear to be the main wealth of the Sahel. In addition to its contribution

to the livelihoods of Sahelians, it represents one of the social values of the region [1]. Indeed, with an estimated annual growth rate of 4%, the demand for livestock products in the Sahel and West Africa is expected to increase significantly by more than 250% by 2025, assuming a 2% growth rate in livestock supply [2]. In Senegal, livestock represents 60% of agricultural households and contributes 4.3% to the country's total gross domestic product [3]. The sector remains highly dependent on the availability of land with natural vegetation. Cattle are the largest group, with 3,464,000 head [3], after sheep, goats, pigs, horses, donkeys and camels, and the poultry sector (industrial and traditional poultry). Livestock is a strategic sector, employing 28.2% of households [4]. Value added in the livestock sector increased by 2.9% in real terms in 2019, after 3.8% in 2018. Furthermore, it should be noted that the weight of livestock farming in the primary sector increased from 23.7% in 2018 to 23.4% in 2019. The share of livestock farming in this Gross Domestic Product (GDP) was 3.4% in 2019, compared with 3.5% in 2018. In nominal terms, the value added generated by the livestock sector stood at FCFA 492 billion in 2019 compared with FCFA 468 billion in 2018. Compared with 2018, the value of dairy imports fell by 6.7% in 2019. In fact, they fell from 43635 billion FCFA in 2018 to 40712 billion FCFA in 2019 [5]. However, their contribution to GDP remains low. In 2013, it was only 4.3% [3]. Livestock is now at the heart of achieving the development objectives of increasing productivity, improving food security and combating poverty [6]. The extensive or low-input system: based on the direct exploitation of natural resources, not linked to agricultural exploitation. It is a system that uses very few agricultural inputs and often limits the use of vaccination. Production is partly for family consumption and partly for sale. This system can also be divided into two subsystems: the pastoral system, which includes a ruminant herd and is used in areas north of the 400 mm isohyle. The agro-pastoral system, which includes 50% of the cattle, is characterised by a certain degree of decentralisation and a somewhat stronger link with agricultural activities [7].

The increase in meat and offal production, which started in 2013, continued in 2019 with an increase of 4.5%. Meat and offal production amounted to 267,358 tonnes in 2019, compared with 255,830 tonnes in 2018. This result is linked to the good performance of meat and offal production from poultry (+10.5%), pigs (+4.9%) and cattle (+4.3%) [5].

Natural pastures in the Sahel play an essential role in livestock nutrition, constituting the basis and often the entire feed resource for ruminants in extensive or even semi-intensive livestock systems [8]. Fodder resources are an important factor in the improvement and development of livestock farming [9] [10] and make a real contribution to the socio-economic development of the country. In southern Senegal, as throughout the Sahel zone, agriculture and livestock production go hand in hand. Traditional livestock rearing is very extensive, using natural feed resources without supplementation, and animals are kept outdoors without special care [11]. Breeding conditions are becoming increasingly difficult under the influence of decreasing rangeland productivity and increasing cultivated areas,

and generally accepted zootechnical standards for the breeds used are not being met [12]. Goats, sheep, pigs and cattle are reared. This type of farming is extensive and generally based on the use of natural pastures dominated by cattle. The general objective of this study was to contribute to a better understanding of grasslands and their use in the municipalities of Ziguinchor and Kolda. More specifically, it aimed to:

- determine the socio-demographic characteristics of the actors in the livestock sector.
- determine the floristic composition of the herbaceous layer.
- assess the forage quality of the grasses eaten by the livestock.

## 2. Materials and Methods

### 2.1. The Study Area

The study was carried out in Upper and Lower Casamance, an area in the south of Senegal. These two zones cover an area of approximately 28350 km$^2$, or 1/7 of Senegal's surface area (Figure 1).

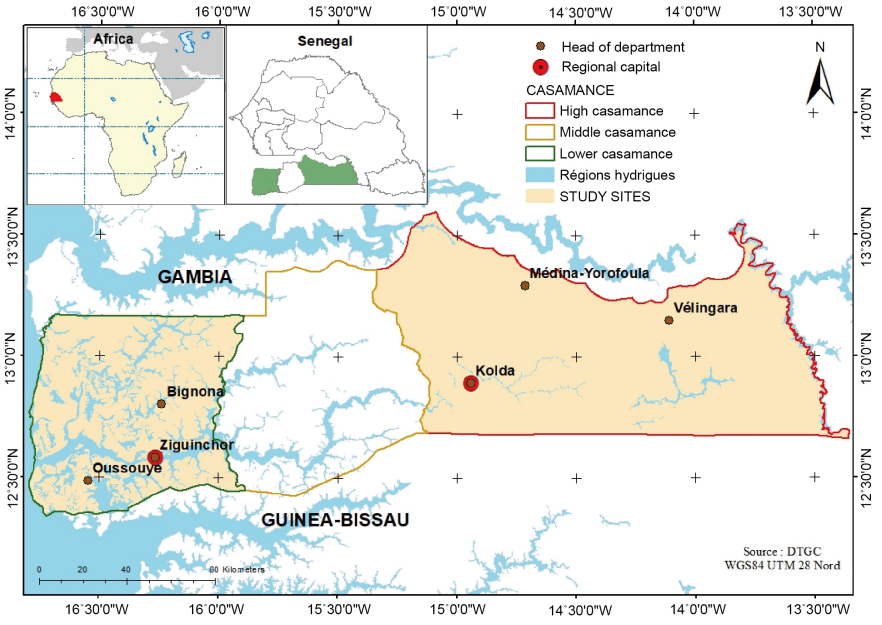


Figure 1. Study area location.

The Ziguinchor region, located in southwestern Senegal at 12˚33'N latitude and 16˚16'W longitude, spans 7,339 km$^2$, accounting for 3.73% of the country's territory. It borders The Gambia to the north, Guinea-Bissau to the south, the Kolda and Sédhiou regions to the east, and the Atlantic Ocean to the west. Ziguinchor experiences a tropical climate with distinct dry (November to May) and rainy (June to October) seasons due to the African monsoon, making it one of Senegal's wettest regions, with annual rainfall between 1300 and 1500 mm. The average annual temperature is around 27˚C, with maximums reaching 37˚C in April and

minimums dropping to 15.5˚C in January. The region's soils are predominantly hydromorphic in valleys and sandy or sandy-clay ferruginous on plateaus, with generally flat terrain [13].

The Kolda region, situated in southern Senegal at 12˚45'N latitude and 15˚30'W longitude, covers 21,011 km$^2$, or 10.68% of the national territory. It borders The Gambia to the north, Guinea and Guinea-Bissau to the south, Tambacounda to the east, and Sédhiou to the west [14]. Kolda has a Sudanian climate with two distinct thermal seasons. The cooler season from July to February sees temperatures range from 20.26˚C to 30.36˚C, while the hotter season from March to June experiences temperatures between 21.26˚C and 35.40˚C. The region receives an average annual rainfall of 1191 mm, with considerable variation. The landscape features sandy-clay sandstones forming plateaus with savannah or open forest, interspersed with valleys containing rice fields and lowland pastures [3].

## 2.2. Methods

### 2.2.1. Herbaceous Surveys

The survey of herbaceous species was conducted in July and August in Ziguinchor, located at 12˚78'33"N latitude and 16˚21'66"W longitude. The Braun-Blanquet phytosociological method was employed, which involves compiling a list of species present within a representative and homogeneous sample of the herbaceous cover. Survey sites were selected based on the homogeneity of the herbaceous vegetation to minimize edge effects [15]. Additionally, all recorded herbaceous plants were identified both in the field and later in the laboratory using references such as the Flora of Senegal [16] and Tropical Weeds [17].

### 2.2.2. Fodder Quality Surveys

An interview guide was developed in collaboration with the heads of the departmental technical services in Ziguinchor, Kolda, and the Kolda Zootechnical Research Centre (ZRC). Using quota sampling, a survey was conducted among livestock farmers to gather relevant data. A structured questionnaire was administered to farmers raising cattle, sheep, goats, and pigs in the two municipalities during the winter season, aiming to collect information on the quality of fodder for each herd and the grasses most consumed by the animals. In total, sixty farmers were interviewed thirty in Ziguinchor and thirty in Kolda.

Some of these farmers were closely monitored as they led their cattle into grazing areas, such as the bush or surrounding regions, to observe the animals' preferences for available grasses and to compare these observations with the farmers' reports. During these monitoring sessions, key activities such as grazing, moving, drinking, resting, and rumination were recorded. The herder also assisted in identifying the herbaceous species most favored by the cattle.

To assess the overall value of the rangelands, two key indicators pastoral value and carrying capacity were employed [18]. Pastoral value, a method for evaluating the forage quality of rangelands [19]-[21], depends on both the specific contribution of species (SCi) and their specific quality index (SQI). The SQI is determined

either by the bromatological values of the plant species found in the analyzed environments or by the scores provided by the farmers, shepherds, herdsmen, and other resource persons interviewed.

#### 2.2.3. Data Processing

They were entered into the Sphinx software and processed using Excel. To assess the diversity and floristic composition of the species in relation to their pastoral value, we sought to determine their cover, frequency and the contribution of each species.

- Herbaceous cover: this was estimated in the field by direct observation and ranged from 10 to 80%.
- Specific frequency of presence (SFP): this corresponds to the percentage of points where the species was encountered and was calculated using the formula in [22].

$$\mathrm{SFPi}(\%) = \frac{\mathrm{ni} \times 100}{\mathrm{N}}$$

ni: number of points where species (i) is present. N: total number of read points.

- Specific contribution (SCi): the percentage ratio between the frequency of this species and the sum of the specific frequencies of the other species [23]. The specific contribution reflects the participation of the species in the spatial occupation of the site. It is expressed by the following formula:

$$\mathrm{SCi}(\%) = \frac{\mathrm{SFPi} \times 100}{\sum \mathrm{SFPi}}$$

- Specific quality index for herbaceous species (Is): this takes into account the plant's season of palatability, the degree of palatability linked to the anatomy and morphology of the leaves and stems, and the fodder value [18] [24] [25]. In the Ferlo-Sahelian ecosystems, the quality index is established on a scale from 0 to 3 [26]-[28], *i.e.* on a scale of four classes (0, 1, 2 and 3) as follows:

- good pastoral value (Gpv): species with a specific index equal to 3;
- medium pastoral value (Mpv): for species with a specific index equal to 2;
- low pastoral value (Lpv): species with a specific index equal to 1;
- no pastoral value (Npv): species with a specific index equal to 0.

- Crude pasture value: calculated by multiplying the specific contributions by the corresponding quality indices. The relative values obtained are summed and expressed as a percentage.

$$\mathrm{Cpv} = \frac{1}{3} \sum \mathrm{SCi} \times \mathrm{SQI}$$

Cpv = Crude pasture value. SCi = Specific Contribution. SQI = Specific Quality Index.

## 3. Results

### 3.1. Study Area Farmers' Socio-Demographic Characteristics

The majority of respondents (86.7%) in both Ziguinchor and Kolda were aged

between 30 and 60 years (Table 1). The remaining age groups, those between 0 and 30 years (5%) and those 60 years and older (8.3%), showed significant differences in representation. The sample was predominantly composed of Peulh (55.7%), Diola (36.7%), Manding (3.3%), Sereres (2.3%), and a small percentage (2%) belonging to other ethnic groups such as Akou, Manjack, and Lebou. The significance of these ethnic groups varied depending on the type of livestock farming practiced.

Table 1. Sociodemographic characteristics of livestock farmers in the two zones.

| Variables | | Intervals or content of corresponding classes | Frequency (%) |
|---|---|---|---|
| **Age** | Young people: under 30 | [0 - 30] | 5% |
| | Adult: between 30 and 60 | [30 - 60] | 86.7% |
| | Old: 60 and over | [60 et plus] | 8.3% |
| **Ethnic groups** | | Peulh | 55.7% |
| | | Diola | 36.70% |
| | | Serere | 2.30% |
| | | Manding | 3.30% |
| | | Others | 2% |
| **Main activities** | | Farming | 40% |
| | | Livestock | 38.3% |
| | | Commerce | 16.7% |
| **Share of cash income from livestock** | | [0 - 25] | 1.7% |
| | | [25 - 50] | 43.3% |
| | | [50 - 75] | 48.3% |
| | | >75 | 6.7% |
| **Role of livestock in household livelihood** | | Very important | 48.3% |
| | | Important | 31.7% |
| | | Moderate | 18.3% |
| | | Low | 1.7% |
| **Membership of an organisation** | | Yes | 46.7% |
| | | No | 59.3% |
| **Other major sources of income** | | Yes | 45.7% |
| | | No | 54.3% |

Agriculture was the primary occupation for 40% of the respondents, closely followed by animal husbandry at 38.3%. Other activities, including trade and various professions (civil servants, mechanics, etc.), accounted for 21.7% of the respondents. The gender distribution among livestock farmers indicated that the majority were men (86.7%), with women making up 13.3%.

In terms of income, the largest proportion of respondents reported earning between 50% - 75% of their monetary income from livestock farming (48.3%), followed by those earning 25% - 50% (43.3%), more than 75% (6.7%), and 0 - 25% (1.7%). Respondents also highlighted the role of livestock in their household livelihoods as very important (48.3%), important (31.7%), medium (18.3%), and low (1.7%).

Membership in farmer organizations was noted among 46.7% of respondents, while 59.3% reported not being affiliated with any such groups. Additionally, 45.7% of the farmers had another significant source of income, whereas 54.3% relied solely on livestock farming.

### 3.2. Farming Systems

Livestock farming was the second most important socio-economic activity in Casamance after agriculture. Livestock include cattle (local breeds, Mathia, Gobra), sheep (local breeds, mixed breeds), goats (local breeds, mixed breeds) and pigs (local breeds, Large White, Landrace). The livestock population was large and diverse (Table 2).

Table 2. Livestock numbers in the two study areas.

| Municipality | Cattle | Sheep | Goats | Pigs | Total |
|---|---|---|---|---|---|
| **Ziguinchor** | 4950 | 1706 | 684 | 1097 | 8437 |
| **Kolda** | 9646 | 11,000 | 1950 | 345 | 22,941 |

Our findings revealed that cattle, sheep, and goat rearing held significant importance among the Peulh, whereas pig farming was predominantly practiced by the Diola and other ethnic groups. Pig rearing, in particular, involved a notable proportion of the Diola community, especially among women. Field observations indicated that the highest animal densities were found in the Kolda community.

Across both zones, traditional extensive and semi-intensive livestock production systems were predominant, accounting for 56.7% of practices (Figure 2). These systems were mainly adopted by the Peulhs and Diolas. However, the Diola community is currently facing several challenges, including the insecurity of pastoral land tenure and the scarcity of fodder. Additionally, 43.3% of the farms were engaged in a combination of extensive, semi-intensive, and intensive animal husbandry.

Among the pastoralists surveyed, 8% of the Fulani did not have cattle in their herds. For those who did rear cattle, 98% of the herds consisted of 0 to 60 head, with only 2% having at least 80 head. Regarding sheep, 20% of the farmers, including both Peulh and Diola, had no sheep at all. Additionally, 72.7% of the flocks had between 0 and 20 sheep, while 27.3% had fewer than 20 head. Goats were present in many of the herds, with 63% of the herds containing between 0 and 20 goats and 36% having fewer than 20 head.

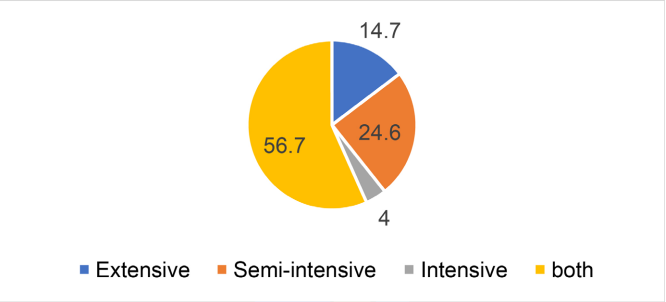


**Figure 2.** Farming systems practised by livestock farmers in the two municipalities.

Pig ownership was predominantly among the Diola and other ethnic groups in both regions. However, some respondents did not rear pigs. Of those who did, 80% had between 0 and 15 pigs, while only 20% had more than 20 pigs. It was observed that some herds included one, two, or three categories of animals, often featuring a mix of local breeds, crossbreeds, or animals produced through artificial insemination (**Figure 3**).

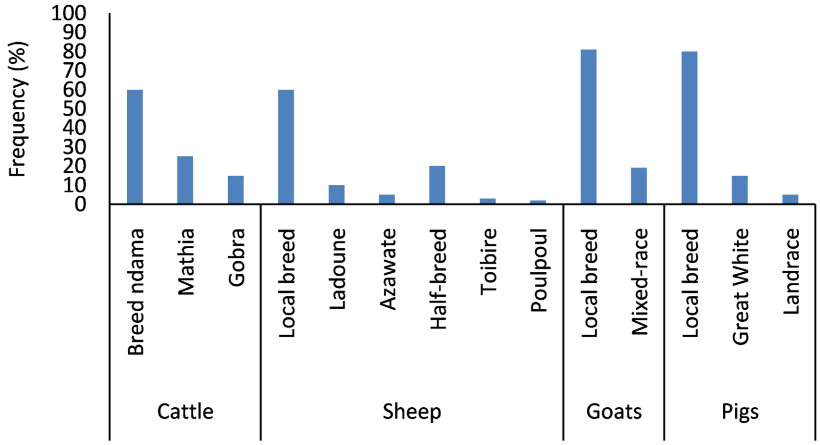


**Figure 3.** Livestock breeds in the two zones.

The herds of the primary ethnic groups surveyed were acquired through various means: inheritance (40.3%), purchase (50.4%), gift (7.3%), and loan (2%) (**Figure 4**). Inheritance was the predominant method for the Peulh, whereas the Diola and other ethnic groups primarily acquired their herds through purchase. During the dry season, herds were typically grazed either within the village or town or in the surrounding forest. In contrast, during the winter, most cattle were moved to more distant grazing areas or open forests.

This revision clarifies the methods of herd acquisition and seasonal grazing patterns, ensuring the information is concise and easy to understand.

Monitoring showed that animals were engaged in activities such as grazing, watering and ruminating. A total of 67% of farmers used this practice, with 64.3% using natural grazing only and 35.7% using supplemental feeding.

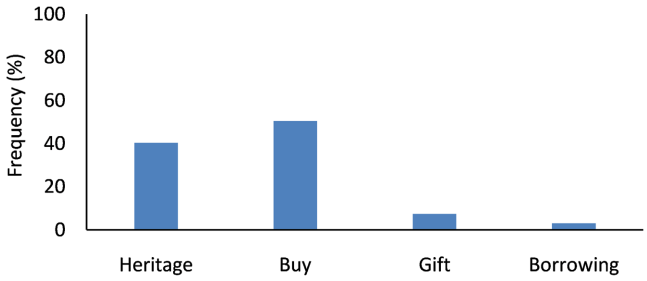


**Figure 4.** Herd acquisition methods in the two regions.

### 3.3. Grassland Composition of Palatable Species in the Area Studied

The survey identified a total of 15 herbaceous forage species palatable to ruminants, categorized into 7 families (Table 3). The *Poaceae* family was the most abundant. Among the 15 species, 9 were notably palatable, with frequencies exceeding 10%. These included: *A. gayanus*, highly cited (equal to 50%); *Aeschynomene indica*, *Eleusine indica*, *Cynodon dactylon*, *Digitaria horizontalis*, *Panicum maximum*, *Pennisetum pedicellatum*, *Dactyloctenium aegyptium* and *Aeschynomene americana.* These species were cited with moderate to high frequency (ranging from 50% to 10%). The remaining 6 species—*Sida rhombifolia*, *Ipomoea tiliacea*, *Andropogon hispidum*, *Hyptis suaveolens*, *Mariscus cylindristachyus*, and *Paspalum scrobiculatum*—were cited less frequently.

**Table 3.** Herbaceous palatable species of the common grazing lands.

| Families | Species | Local names | Frequencies % |
|---|---|---|---|
| ***Poaceae*** | *Andropogon gayanus* | *Egagass* (*D*), *Bouloudé* (*P*) | 50 |
| ***Fabaceae*** | *Aeschynomene indica* | *Biyéye* (*D*), *waba* (*P*) | 30 |
| ***Fabaceae*** | *Aeschynomene americana* | *Biyéye* (*D*), *sabine* (*P*) | 15 |
| ***Poaceae*** | *Pennisetum pedicellatum* | *Pagri diawlé* (*P*) | 45 |
| ***Poaceae*** | *Panicum maximum* | *Erimbaun* (*D*), *Garladé* (*P*) | 40 |
| ***Poaceae*** | *Dactyloctenium aegyptium* | Diadié (P) | 30 |
| ***Poaceae*** | *Cynodon dactylon* | Niamissaye (D) | 41.7 |
| ***Poaceae*** | *Paspalum scrobiculatum* | Essen houte (D) | 6.7 |
| ***Poaceae*** | *Digitaria horizontalis* | Goussah bahkah (D) | 40.7 |
| ***Poaceae*** | *Eleusine indica* | Diadié dathié (P) | 10 |
| ***Asteraceae*** | *Acanthospermum hispidum* | Sibatéhoun (D) | 8.3 |
| ***Lamiaceae*** | *Hyptis suaviolens* | Bouboun siboukh (D), Loubodié (P) | 1.7 |
| ***Cyperaceae*** | *Mariscus cylindristachyus* | Undefined | 7 |
| ***Convolvulaceae*** | *Ipomoea asarifolia* | Tirdé (P) | 7.5 |
| ***Malvaceae*** | *Sida rhombifolia* | Lalélle mbabba (P) | 5 |

NB: D = Diola; P = Peulh.

Among the species observed in the rangelands, three species—*Panicum maximum*, *Ipomoea tiliacea*, and *Aeschynomene americana*—were not included in the list of inventoried species.

### 3.4. Grassland Composition in the Ziguinchor Area

The grassland flora survey revealed 95 species, distributed across 68 genera and 22 botanical families (Table 4). The most common genera were I*pomoea* (7 species), *Cyperus* (4 species), and *Eragrostis* (3 species). Key contributors to the herbaceous cover were *Momordica charantia*, *Cenchrus biflorus*, and *Oplismenus undulatifolius*.

The total herbaceous ground cover was 58.3%. Twelve species exceeded an average cover of 10%, including: *Momordica charantia* (30%), *Cenchrus biflorus* (26%), *Oplismenus undulatifolius* (19%), *Setaria barbata* (17.33%), *Dinebra retroflexa* (17%), *Dactyloctenium aegyptium* (16.49%), *Cyperus squarrosus* (15%), *Ipomoea heterotricha* (15%), *Leucas aspera* (15%), *Digitaria horizontalis* (14.55%), *Setaria pumila* (11.18%), *Dioscorea bulbifera* (11.13%).

Species like *Momordica charantia* (6.92), *Zornia glochidiata* (5.54), *Spermacoce sp* (4.85), and *Aeschynomene indica* (4.15) demonstrated the highest specific contributions, although their relative values were generally low (Table 4).

Table 4. Floristic composition, cover and specific contribution of weeds.

| Families | Genera | Species | Cov% | SFi% | SCi% | SQI | Cpv% |
|---|---|---|---|---|---|---|---|
| ***Acanthaceae*** | *Asystasia* | *Asystasia gangetica* (L.) T. Anderson | 1.54 | 32.5 | 1 | 2 | 2 |
| | *Nelsonia* | *Nelsonia canescens* (Lam.) Spreng. | 2.27 | 27.5 | 0.85 | 2 | 1.69 |
| ***Amaranthaceae*** | *Achyranthes* | Achyranthes aspera L. | 3 | 22.5 | 0.69 | 2 | 1.38 |
| | *Amaranthus* | *Amaranthus viridis* L. | 2 | 2.5 | 0.08 | 3 | 0.23 |
| | *Gomphrena* | *Gomphrena serrata* L. | 1.57 | 17.5 | 0.54 | 2 | 1.08 |
| | | *Gomphrena celosioides* Mart. | 1 | 10 | 0.31 | 3 | 0.92 |
| ***Aristolochiaceae*** | *Aristolochia* | *Aristolochia clematitis* (L.) | 1 | 2.5 | 0.08 | 3 | 0.23 |
| | *Pergularia* | *Pergularia daemia* (Forssk.) Chiov. | 1 | 2.5 | 0.08 | 3 | 0.23 |
| ***Asteraceae*** | *Acanthospermum* | *Acanthospermum hispidum* DC. | 8.33 | 7.5 | 0.23 | 2 | 0.46 |
| | *Helianthus* | *Helianthus divaricatus* (L.) | 1 | 10 | 0.31 | 3 | 0.92 |
| | *Synedrella* | *Synedrella nodiflora* (L.) Gaertn. | 1.33 | 7.5 | 0.23 | 3 | 0.69 |
| | *Verbesina* | *Verbesina encelioides* (Cav.) Benth. & Hook. f. ex A. Gray | 0.3 | 25 | 0.77 | 3 | 2.31 |
| ***Capparaceae*** | *Cleome* | *Cleome coeruleo-rosea* Gilg & Benedict. | 4.44 | 22.5 | 0.69 | 2 | 1.38 |
| | *Gloriosa* | *Gloriosa superba* L. | 5 | 10 | 0.31 | 3 | 0.92 |
| ***Commelinaceae*** | *Commelina* | *Commelina forskalaei* Vahl. | 6.38 | 40 | 1.23 | 1 | 1.23 |
| | | *Commelina benghalensis* L. | 1.26 | 87.5 | 2.69 | 2 | 5.38 |

**Continued**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Convolvulaceae*** | *Ipomoea* | *Ipomoea asarifolia* (Desr.) Roem. & Schult. | 1 | 2.5 | 0.08 | 3 | 0.23 |
| | | *Ipomoea heterotricha* Didr. | 15 | 7.5 | 0.23 | 3 | 0.69 |
| | | *Ipomoea lacunosa* L. | 0.3 | 25 | 0.77 | 3 | 2.31 |
| | | *Ipomoea obscura* (L.) Ker Gawl. | 7.83 | 15 | 0.46 | 3 | 1.38 |
| | | *Ipomoea purpurea* (L.) Roth | 0.5 | 25 | 0.77 | 2 | 1.54 |
| | | *Ipomoea triloba* L. | 2.76 | 62.5 | 1.92 | 1 | 1.92 |
| | | *Ipomoea vagans* Baker | 9.08 | 30 | 0.92 | 1 | 0.92 |
| | *Merremia* | *Merremia aegyptia* (L.) Urb. | 1.69 | 32.5 | 1 | 2 | 2 |
| | | *Merremia kentrocaulos* (C.B.Cl.) Rendle. | 6.2 | 12.5 | 0.38 | 3 | 1.15 |
| | | *Merremia tridentata* (L.) Hallier f. | 5.33 | 7.5 | 0.23 | 2 | 0.46 |
| ***Cucurbitaceae*** | *Momordica* | *Momordica charantia* L. | 30 | 75 | 2.31 | 3 | 6.92 |
| | *Cucumis* | *Cucumis melo Linnaeus* var.*agrestis* Naudin | 1.8 | 50 | 1.54 | 2 | 3.08 |
| ***Cyperaceae*** | *Bulbostylis* | *Bulbostylis capilaris* L. | 2.4 | 37.5 | 1.15 | 1 | 1.15 |
| | *Cyperus* | *Cyperus sphacelatus* Rottb. | 1.07 | 35 | 1.08 | 2 | 2.15 |
| | | *Cyperus compressus* L. | 1 | 2.5 | 0.08 | 3 | 0.23 |
| | | *Cyperus rotundus* L. | 7.26 | 57.5 | 1.77 | 1 | 1.77 |
| | | *Cyperus squarrosus* L. | 15 | 7.5 | 0.23 | 1 | 0.23 |
| | *Kyllinga* | *Kyllinga tenuifolia* Steud. | 0.56 | 22.5 | 0.69 | 2 | 1.38 |
| | *Mariscus* | *Mariscus cylindristachyus* Steud. | 2.32 | 55 | 1.69 | 1 | 1.69 |
| ***Dioscoreaceae*** | *Dioscorea* | *Dioscorea bulbifera* L. | 11.13 | 20 | 0.62 | 1 | 0.62 |
| | *Tacca* | *Tacca leontopetaloides* (L.) Kuntze | 1.11 | 22.5 | 0.69 | 2 | 1.38 |
| ***Euphorbiaceae*** | *Chrozophora* | *Chrozophora senegalensis* (Lam.) Spreng. | 2.78 | 57.5 | 1.77 | 1 | 1.77 |
| | *Croton* | *Croton hirtus* L'Hér. | 5.61 | 95 | 2.92 | 1 | 2.92 |
| | *Euphorbia* | *Euphorbia forskalii* J. Gay | 1.29 | 17.5 | 0.54 | 2 | 1.08 |
| | | *Euphorbia hirta* L. | 2.63 | 40 | 1.23 | 2 | 2.46 |
| ***Fabaceae*** | *Aeschynomene* | *Aeschynomene indica* L. | 1.26 | 67.5 | 2.08 | 2 | 4.15 |
| | *Alysicarpus* | *Alysicarpus ovalifolius* (Schumach.) J. Léonard | 8.7 | 57.5 | 1.77 | 1 | 1.77 |
| | *Crotalaria* | *Crotalaria retusa* L. | 1.38 | 52.5 | 1.62 | 2 | 3.23 |
| | | *Crotalaria senegalensis* (Pers.) Bacle ex DC. | 0.5 | 20 | 0.62 | 2 | 1.23 |
| | *Desmodium* | *Desmodium triflorum* (L.) DC. | 9 | 15 | 0.46 | 2 | 0.92 |

**Continued**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | *Indigofera* | *Indigofera hirsuta* L. | 0.27 | 37.5 | 1.15 | 2 | 2.31 |
| | *Rhynchosia* | *Rhynchosia minima* (L.) DC. | 9.54 | 60 | 1.85 | 1 | 1.85 |
| | *Senna* | *Senna obtusifolia* (L.) H.S. Irwin & Barneby | 7.78 | 100 | 3.08 | 1 | 3.08 |
| | | *Senna mimosoides* L. | 5.2 | 12.5 | 0.38 | 2 | 0.77 |
| | | *Senna occidentalis* (L.) Link | 3.22 | 22.5 | 0.69 | 3 | 2.08 |
| | *Sesbania* | *Sesbania pachycarpa* DC. | 5.31 | 32.5 | 1 | 2 | 2 |
| | *Sida* | *Sida alba* L. | 2.29 | 42.5 | 1.31 | 1 | 1.31 |
| | | *Sida rhombifolia* L. | 4.17 | 45 | 1.38 | 1 | 1.38 |
| | *Tephrosia* | *Tephrosia linearis* (Willd.) Pers. | 3.61 | 45 | 1.38 | 1 | 1.38 |
| | *Zornia* | *Zornia glochidiata* Rchb. ex DC. | 1.22 | 90 | 2.77 | 2 | 5.54 |
| ***Lamiaceae*** | *Hyptis* | *Hyptis suaveolens* (L.) Poit. | 5.03 | 100 | 3.08 | 1 | 3.08 |
| | *Leucas* | *Leucas aspera* (Willd.) Link | 15 | 2.5 | 0.08 | 3 | 0.23 |
| ***Malvaceae*** | *Corchorus* | *Corchorus aestuans* L. | 4.82 | 42.5 | 1.31 | 2 | 2.62 |
| | *Hibiscus* | *Hibiscus asper* Hook. f. | 5 | 52.5 | 1.62 | 2 | 3.23 |
| | *Urena* | *Urena lobata* L. | 5.98 | 100 | 3.08 | 1 | 3.08 |
| ***Nyctaginaceae*** | *Boerhavia* | *Boerhavia diffusa* L. | 3.56 | 22.5 | 0.69 | 2 | 1.38 |
| ***Phyllanthaceae*** | *Phyllanthus* | *Phyllanthus niruri* auct. Afric. | 2 | 5 | 0.15 | 3 | 0.46 |
| | | *Phyllanthus amarus* Schumach. & Thonn. | 6.93 | 100 | 3.08 | 1 | 3.08 |
| ***Poaceae*** | *Dinebra* | *Dinebra retroflexa* (Vahl) Panz. | 17 | 2.5 | 0.08 | 3 | 0.23 |
| | *Andropogon* | *Andropogon gayanus* Kunth | 3.48 | 62.5 | 1.92 | 1 | 1.92 |
| | *Brachiaria* | *Brachiaria lata* (Schumach.) C.E. Hubb. | 7.44 | 62.5 | 1.92 | 1 | 1.92 |
| | | *Brachiaria ramosa* (L.) Stapf | 3.19 | 40 | 1.23 | 1 | 1.23 |
| | | *Brachiaria villosa* (Lam.) A. Camus | 2.14 | 17.5 | 0.54 | 2 | 1.08 |
| | *Chloris* | *Chloris pilosa* Schum. | 1 | 7.5 | 0.23 | 3 | 0.69 |
| | *Cenchrus* | *Cenchrus biflorus* Roxb. | 26 | 2.5 | 0.08 | 2 | 0.15 |
| | *Cynodon* | *Cynodon dactylon* (L.) Pers. | 6.8 | 25 | 0.77 | 1 | 0.77 |
| | *Dactyloctenium* | *Dactyloctenium aegyptium* (L.) Willd. | 16.49 | 92.5 | 2.85 | 1 | 2.85 |
| | *Digitaria* | *Digitaria horizontalis* Willd. | 14.55 | 100 | 3.08 | 1 | 3.08 |
| | *Eleusine* | *Eleusine indica* (L.) Gaertn. | 2.53 | 37.5 | 1.15 | 2 | 2.31 |
| | *Eragrostis* | *Eragrostis aspera* (Jacq.) Nees | 1.6 | 12.5 | 0.38 | 2 | 0.77 |
| | | *Eragrostis ciliaris* (L.) R. Br. | 1.4 | 12.5 | 0.38 | 2 | 0.77 |
| | | *Eragrostis tremula* Hochst. ex Steud. | 0.8 | 12.5 | 0.38 | 2 | 0.77 |

**Continued**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | *Oplismenus* | *Oplismenus undulatifolius* (Ard.) P. Beauv. | 19 | 10 | 0.31 | 1 | 0.31 |
| | *Panicum* | *Panicum subalbidum* Kunth | 0.42 | 47.5 | 1.46 | 2 | 2.92 |
| | | *Panicum pansum* Rendle | 2.67 | 7.5 | 0.23 | 3 | 0.69 |
| | *Paspalum* | *Paspalum scrobiculatum* L. | 1.95 | 50 | 1.54 | 2 | 3.08 |
| ***Poaceae*** | *Pennisetum* | *Pennisetum pedicellatum* Trin. | 8.38 | 32.5 | 1 | 1 | 1 |
| | *Poa* | *Poa annua* L. | 2.86 | 90 | 2.77 | 1 | 2.77 |
| | *Rottboellia* | *Rottboellia cochinchinensis* (Lour.) Clayton | 3.29 | 35 | 1.08 | 2 | 2.15 |
| | *Setaria* | *Setaria barbata* (Lam.) Kunth | 17.33 | 45 | 1.38 | 1 | 1.38 |
| | | *Setaria pumila* (Poir.) Roem. & Schult. | 11.18 | 27.5 | 0.85 | 1 | 0.85 |
| | *Sporobolus* | *Sporobolus pyramidalis* P. Beauv. | 2.67 | 7.5 | 0.23 | 3 | 0.69 |
| ***Rubiaceae*** | *Mitracarpus* | *Mitracarpus villosus* (Sw.) DC. | 8 | 7.5 | 0.23 | 3 | 0.69 |
| | *Spermacoce* | *Spermacoce* sp L. | 4.33 | 52.5 | 1.62 | 3 | 4.85 |
| | | *Spermacoce radiata* (DC.) Sieber ex Hiern | 2 | 2.5 | 0.08 | 3 | 0.23 |
| | | *Spermacoce stachydea* DC. | 2.22 | 45 | 1.38 | 2 | 2.77 |
| ***Solanaceae*** | *Physalis* | *Physalis heterophylla* Nees | 1.67 | 7.5 | 0.23 | 3 | 0.69 |
| ***Sterculiaceae*** | *Waltheria* | *Waltheria indica* L. | 1 | 2.5 | 0.08 | 3 | 0.23 |
| ***Taccaceae*** | *Tacca* | *Tacca involucrata* Schum. & Thonn. | 2.14 | 17.5 | 0.54 | 2 | 1.08 |
| ***Urticaceae*** | *Laportea* | *Laportea aestuans* (L.) Chew | 1 | 7.5 | 0.23 | 3 | 0.69 |
| ***Acanthaceae*** | *Asystasia* | *Asystasia gangetica* (L.) T. Anderson | 1.54 | 32.5 | 1 | 2 | 2 |
| | *Nelsonia* | *Nelsonia canescens* (Lam.) Spreng. | 2.27 | 27.5 | 0.85 | 2 | 1.69 |
| ***Amaranthaceae*** | *Achyranthes* | Achyranthes aspera L. | 3 | 22.5 | 0.69 | 2 | 1.38 |
| | *Amaranthus* | *Amaranthus viridis* L. | 2 | 2.5 | 0.08 | 3 | 0.23 |
| | *Gomphrena* | *Gomphrena serrata* L. | 1.57 | 17.5 | 0.54 | 2 | 1.08 |
| | | *Gomphrena celosioides* Mart. | 1 | 10 | 0.31 | 3 | 0.92 |
| ***Aristolochiaceae*** | *Aristolochia* | *Aristolochia clematitis* L. | 1 | 2.5 | 0.08 | 3 | 0.23 |
| | *Pergularia* | *Pergularia daemia* (Forssk.) Chiov. | 1 | 2.5 | 0.08 | 3 | 0.23 |
| ***Asteraceae*** | *Acanthospermum* | *Acanthospermum hispidum* DC. | 8.33 | 7.5 | 0.23 | 2 | 0.46 |
| | *Helianthus* | *Helianthus divaricatus* L. | 1 | 10 | 0.31 | 3 | 0.92 |
| | *Synedrella* | *Synedrella nodiflora* (L.) Gaertn. | 1.33 | 7.5 | 0.23 | 3 | 0.69 |
| | *Verbesina* | *Verbesina encelioides* (Cav.) Benth. & Hook. f. ex A. Gray | 0.3 | 25 | 0.77 | 3 | 2.31 |

**Continued**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Capparaceae*** | *Cleome* | *Cleome coeruleo-rosea* Gilg & Benedict | 4.44 | 22.5 | 0.69 | 2 | 1.38 |
| | *Gloriosa* | *Gloriosa superba* L | 5 | 10 | 0.31 | 3 | 0.92 |
| ***Commelinaceae*** | *Commelina* | *Commelina forskalaei* Vahl | 6.38 | 40 | 1.23 | 1 | 1.23 |
| | | *Commelina benghalensis* L. | 1.26 | 87.5 | 2.69 | 2 | 5.38 |
| ***Convolvulaceae*** | *Ipomoea* | *Ipomoea asarifolia* (Desr.) Roem. & Schult. | 1 | 2.5 | 0.08 | 3 | 0.23 |
| | | *Ipomoea heterotricha* Didr. | 15 | 7.5 | 0.23 | 3 | 0.69 |
| | | *Ipomoea lacunosa* L. | 0.3 | 25 | 0.77 | 3 | 2.31 |
| | | *Ipomoea obscura* (L.) Ker Gawl. | 7.83 | 15 | 0.46 | 3 | 1.38 |
| | | *Ipomoea purpurea* (L.) Roth | 0.5 | 25 | 0.77 | 2 | 1.54 |
| | | *Ipomoea triloba* L. | 2.76 | 62.5 | 1.92 | 1 | 1.92 |
| | | *Ipomoea vagans* Baker | 9.08 | 30 | 0.92 | 1 | 0.92 |
| | *Merremia* | *Merremia aegyptia* (L.) Urb. | 1.69 | 32.5 | 1 | 2 | 2 |
| | | *Merremia kentrocaulos* (C.B.Cl.) Rendle. | 6.2 | 12.5 | 0.38 | 3 | 1.15 |
| | | *Merremia tridentata* (L.) Hallier f. | 5.33 | 7.5 | 0.23 | 2 | 0.46 |
| ***Cucurbitaceae*** | *Momordica* | *Momordica charantia* L. | 30 | 75 | 2.31 | 3 | 6.92 |
| | *Cucumis* | *Cucumis melo Linnaeus* var.*agrestis* Naudin | 1.8 | 50 | 1.54 | 2 | 3.08 |
| ***Cyperaceae*** | *Bulbostylis* | *Bulbostylis capilaris* (L) | 2.4 | 37.5 | 1.15 | 1 | 1.15 |
| | *Cyperus* | *Cyperus sphacelatus* Rottb. | 1.07 | 35 | 1.08 | 2 | 2.15 |
| | | *Cyperus compressus* L. | 1 | 2.5 | 0.08 | 3 | 0.23 |
| | | *Cyperus rotundus* L. | 7.26 | 57.5 | 1.77 | 1 | 1.77 |
| | | *Cyperus squarrosus* L. | 15 | 7.5 | 0.23 | 1 | 0.23 |
| | *Kyllinga* | *Kyllinga tenuifolia* Steud. | 0.56 | 22.5 | 0.69 | 2 | 1.38 |
| | *Mariscus* | *Mariscus cylindristachyus* Steud. | 2.32 | 55 | 1.69 | 1 | 1.69 |
| ***Dioscoreaceae*** | *Dioscorea* | *Dioscorea bulbifera* L. | 11.13 | 20 | 0.62 | 1 | 0.62 |
| | *Tacca* | *Tacca leontopetaloides* (L.) Kuntze | 1.11 | 22.5 | 0.69 | 2 | 1.38 |
| ***Euphorbiaceae*** | *Chrozophora* | *Chrozophora senegalensis* (Lam.) Spreng. | 2.78 | 57.5 | 1.77 | 1 | 1.77 |
| | *Croton* | *Croton hirtus* L'Hér. | 5.61 | 95 | 2.92 | 1 | 2.92 |
| | *Euphorbia* | *Euphorbia forskalii* J. Gay | 1.29 | 17.5 | 0.54 | 2 | 1.08 |
| | | *Euphorbia hirta* L. | 2.63 | 40 | 1.23 | 2 | 2.46 |

**Continued**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Fabaceae*** | *Aeschynomene* | *Aeschynomene indica* L. | 1.26 | 67.5 | 2.08 | 2 | 4.15 |
| | *Alysicarpus* | *Alysicarpus ovalifolius* (Schumach.) J. Léonard | 8.7 | 57.5 | 1.77 | 1 | 1.77 |
| | *Crotalaria* | *Crotalaria retusa* L. | 1.38 | 52.5 | 1.62 | 2 | 3.23 |
| | | *Crotalaria senegalensis* (Pers.) Bacle ex DC. | 0.5 | 20 | 0.62 | 2 | 1.23 |
| | *Desmodium* | *Desmodium triflorum* (L.) DC. | 9 | 15 | 0.46 | 2 | 0.92 |
| | *Indigofera* | *Indigofera hirsuta* L. | 0.27 | 37.5 | 1.15 | 2 | 2.31 |
| | *Rhynchosia* | *Rhynchosia minima* (L.) DC. | 9.54 | 60 | 1.85 | 1 | 1.85 |
| | *Senna* | *Senna obtusifolia* (L.) H.S. Irwin & Barneby | 7.78 | 100 | 3.08 | 1 | 3.08 |
| | | *Senna mimosoides* L. | 5.2 | 12.5 | 0.38 | 2 | 0.77 |
| | | *Senna occidentalis* (L.) Link | 3.22 | 22.5 | 0.69 | 3 | 2.08 |
| | *Sesbania* | *Sesbania pachycarpa* DC. | 5.31 | 32.5 | 1 | 2 | 2 |
| | *Sida* | *Sida alba* L. | 2.29 | 42.5 | 1.31 | 1 | 1.31 |
| | | *Sida rhombifolia* L. | 4.17 | 45 | 1.38 | 1 | 1.38 |
| | *Tephrosia* | *Tephrosia linearis* (Willd.) Pers. | 3.61 | 45 | 1.38 | 1 | 1.38 |
| | *Zornia* | *Zornia glochidiata* Rchb. ex DC. | 1.22 | 90 | 2.77 | 2 | 5.54 |
| ***Lamiaceae*** | *Hyptis* | *Hyptis suaveolens* (L.) Poit. | 5.03 | 100 | 3.08 | 1 | 3.08 |
| | *Leucas* | *Leucas aspera* (Willd.) Link | 15 | 2.5 | 0.08 | 3 | 0.23 |
| ***Malvaceae*** | *Corchorus* | *Corchorus aestuans* L. | 4.82 | 42.5 | 1.31 | 2 | 2.62 |
| | *Hibiscus* | *Hibiscus asper* Hook. f. | 5 | 52.5 | 1.62 | 2 | 3.23 |
| | *Urena* | *Urena lobata* L. | 5.98 | 100 | 3.08 | 1 | 3.08 |
| ***Nyctaginaceae*** | *Boerhavia* | *Boerhavia diffusa* L. | 3.56 | 22.5 | 0.69 | 2 | 1.38 |
| ***Phyllanthaceae*** | *Phyllanthus* | *Phyllanthus niruri* auct. Afric. | 2 | 5 | 0.15 | 3 | 0.46 |
| | | *Phyllanthus amarus* Schumach. & Thonn. | 6.93 | 100 | 3.08 | 1 | 3.08 |
| ***Poaceae*** | *Dinebra* | *Dinebra retroflexa* (Vahl) Panz. | 17 | 2.5 | 0.08 | 3 | 0.23 |
| | *Andropogon* | *Andropogon gayanus* Kunth | 3.48 | 62.5 | 1.92 | 1 | 1.92 |
| | *Brachiaria* | *Brachiaria lata* (Schumach.) C.E. Hubb. | 7.44 | 62.5 | 1.92 | 1 | 1.92 |
| | | *Brachiaria ramosa* (L.) Stapf | 3.19 | 40 | 1.23 | 1 | 1.23 |
| | | *Brachiaria villosa* (Lam.) A. Camus | 2.14 | 17.5 | 0.54 | 2 | 1.08 |
| | *Chloris* | *Chloris pilosa* Schum. | 1 | 7.5 | 0.23 | 3 | 0.69 |
| | *Cenchrus* | *Cenchrus biflorus* Roxb. | 26 | 2.5 | 0.08 | 2 | 0.15 |

**Continued**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | *Cynodon* | *Cynodon dactylon* (L.) Pers. | 6.8 | 25 | 0.77 | 1 | 0.77 |
| | *Dactyloctenium* | *Dactyloctenium aegyptium* (L.) Willd. | 16.49 | 92.5 | 2.85 | 1 | 2.85 |
| | *Digitaria* | *Digitaria horizontalis* Willd. | 14.55 | 100 | 3.08 | 1 | 3.08 |
| | *Eleusine* | *Eleusine indica* (L.) Gaertn. | 2.53 | 37.5 | 1.15 | 2 | 2.31 |
| | *Eragrostis* | *Eragrostis aspera* (Jacq.) Nees | 1.6 | 12.5 | 0.38 | 2 | 0.77 |
| | | *Eragrostis ciliaris* (L.) R. Br. | 1.4 | 12.5 | 0.38 | 2 | 0.77 |
| | | *Eragrostis tremula* Hochst. ex Steud. | 0.8 | 12.5 | 0.38 | 2 | 0.77 |
| | *Oplismenus* | *Oplismenus undulatifolius* (Ard.) P. Beauv. | 19 | 10 | 0.31 | 1 | 0.31 |
| | *Panicum* | *Panicum subalbidum* Kunth | 0.42 | 47.5 | 1.46 | 2 | 2.92 |
| | | *Panicum pansum* Rendle | 2.67 | 7.5 | 0.23 | 3 | 0.69 |
| | *Paspalum* | *Paspalum scrobiculatum* L. | 1.95 | 50 | 1.54 | 2 | 3.08 |
| | *Pennisetum* | *Pennisetum pedicellatum* Trin. | 8.38 | 32.5 | 1 | 1 | 1 |
| | *Poa* | *Poa annua* L. | 2.86 | 90 | 2.77 | 1 | 2.77 |
| | *Rottboellia* | *Rottboellia cochinchinensis* (Lour.) Clayton | 3.29 | 35 | 1.08 | 2 | 2.15 |
| | *Setaria* | *Setaria barbata* (Lam.) Kunth | 17.33 | 45 | 1.38 | 1 | 1.38 |
| | | *Setaria pumila* (Poir.) Roem. & Schult. | 11.18 | 27.5 | 0.85 | 1 | 0.85 |
| | *Sporobolus* | *Sporobolus pyramidalis* P. Beauv. | 2.67 | 7.5 | 0.23 | 3 | 0.69 |
| ***Rubiaceae*** | *Mitracarpus* | *Mitracarpus villosus* (Sw.) DC. | 8 | 7.5 | 0.23 | 3 | 0.69 |
| | *Spermacoce* | *Spermacoce* sp L. | 4.33 | 52.5 | 1.62 | 3 | 4.85 |
| | | *Spermacoce radiata* (DC.) Sieber ex Hiern | 2 | 2.5 | 0.08 | 3 | 0.23 |
| | | *Spermacoce stachydea* DC. | 2.22 | 45 | 1.38 | 2 | 2.77 |
| ***Solanaceae*** | *Physalis* | *Physalis heterophylla* Nees | 1.67 | 7.5 | 0.23 | 3 | 0.69 |
| ***Sterculiaceae*** | *Waltheria* | *Waltheria indica* L. | 1 | 2.5 | 0.08 | 3 | 0.23 |
| ***Taccaceae*** | *Tacca* | *Tacca involucrata* Schum. & Thonn. | 2.14 | 17.5 | 0.54 | 2 | 1.08 |
| ***Urticaceae*** | *Laportea* | *Laportea aestuans* (L.) Chew | 1 | 7.5 | 0.23 | 3 | 0.69 |

## 3.5. Grassland Production and Quality

### 3.5.1. Pastoral Value

The dietary spectrum analysis (**Figure 5**) revealed that Lpv species were the most significant with a Specific Contribution Index (SCI) of 52.31% and a Specific Quality Index (SQI) of 1. Mpv species followed with a SCI of 37.05% and an SQI of 2. Together, these two categories accounted for 89.36% of the total index values.

In contrast, Npv plants were completely neglected (0% SCI) and Gpv plants had a low overall presence with a SCI of 10% and an SQI of 3.

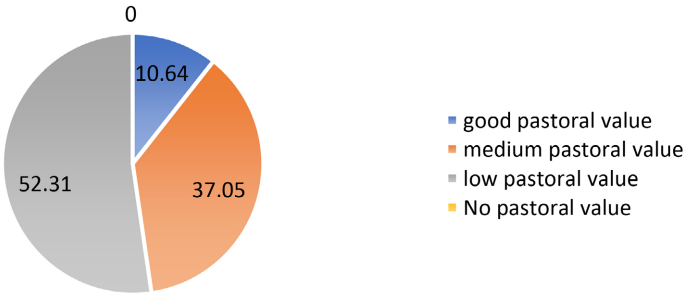


**Figure 5.** Graph of the contribution of meadow species categories to the overall Quality Index.

### 3.5.2. Other Methods of Feeding with Fodder

Surveys revealed that 64.3% of ruminants were fed exclusively on natural pasture during the rainy season, while 35.7% received supplementary fodder for sick, lactating and pregnant animals. Among farmers who practiced fodder collection and conservation, crop residues comprised the majority of stored fodder, averaging 85.4% (**Figure 6**). Natural straw (5.8%), natural tops (6.8%), and cultivated tops (12.8%) were less common compared to cereal stalks (72.6%), which were of fair quality. Fodder plants (1.1%) were grown in small quantities and constituted marginal stocks.

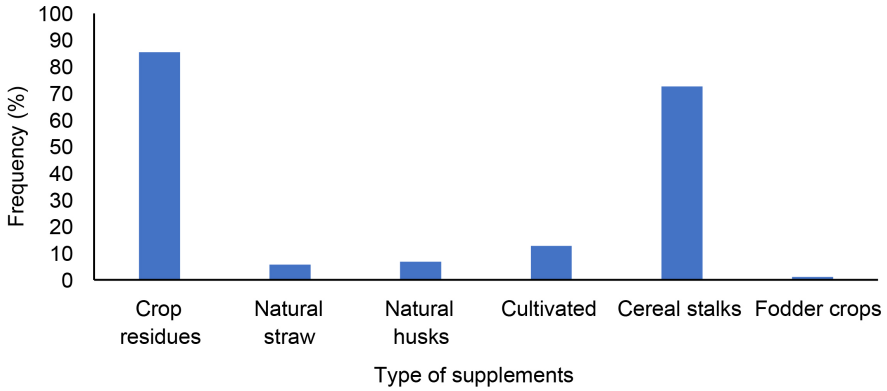


**Figure 6.** Animal supplementation practices.

Farmers cited various reasons for not cultivating fodder crops, including seed issues, lack of knowledge on cultivation techniques, financial constraints, limited time and insufficient land. The quality of stored fodder varied: cereal stalks were fair, legume tops were good and herbaceous fodder was excellent. Notably, *Alysicarpus ovalifolius* and *Dactyloctenium aegyptium* hay, cowpea and peanut tops were well preserved. In contrast, *Zornia glochidiata* tops, which were often cut after losing their leaves, had average quality compared to other preserved legume species.

Forage collection periods varied by category. Natural fodder was collected year-round, with peaks during the main and post-harvest seasons, while crop residues were gathered and conserved immediately after harvest. During the dry season, natural fodder stocks mainly included stems and leaves of herbaceous species.

## 4. Discussion

The findings indicate that the majority of respondents were between 30 and 60 years old. This age group likely possesses extensive knowledge about animal husbandry. which aligns with Adjanohoun's [29] assertion that plant virtues are part of ancestral knowledge passed down through generations. This depth of knowledge underscores the high level of expertise within the studied populations.

The data revealed that the Peulh ethnic group is predominant in the livestock sector, comprising 50% of the respondents. Additionally, agriculture emerged as the most prevalent primary activity among those surveyed. The economic importance of livestock is further highlighted by the fact that 48.3% of respondents reported that between 50 and 75% of their cash income came from livestock, emphasizing its critical role in household livelihoods.

In Casamance, the extensive and semi-intensive livestock systems are well-developed, reflecting the substantial availability of pasture land. This aligns with [30] who noted the significant economic impact of pastoralism in rural households.

The results of the grassland flora survey provide valuable insights into the composition and structure of the herbaceous layer in the study area. With 95 species spread across 68 genera and 22 botanical families, the surveyed area exhibits significant biodiversity, which is essential for the resilience and sustainability of grassland ecosystems. The predominance of certain genera like *Ipomoea*, *Cyperus*, and *Eragrostis* suggests these groups are well-adapted to the local environmental conditions and possibly play crucial roles in the ecosystem.

The key contributors to the herbaceous cover, such as *Momordica charantia*, *Cenchrus biflorus*, and *Oplismenus undulatifolius* indicate species that not only thrive in this environment but also contribute substantially to the ground cover. The total herbaceous ground cover of 58.3% reflects a moderate degree of vegetative cover, which is critical for soil conservation, water retention, and providing forage for grazing animals.

Twelve species exceeded an average cover of 10%, with *Momordica charantia* (30%) and *Cenchrus biflorus* (26%) being particularly dominant. This dominance could be indicative of these species' competitive advantages, such as higher growth rates, better adaptability to local climatic conditions, or effective seed dispersal mechanisms. The presence of species like *Setaria barbata* and *Dinebra retroflexa* with significant coverage further underscores the complexity and diversity of the grassland ecosystem.

The specific contributions of species such as *Momordica charantia* (6.92) and *Zornia glochidiata* (5.54) suggest that these species, while not necessarily dominant

in terms of cover, play unique roles in the ecosystem, potentially offering specialized ecological functions or contributing to the diversity of the forage available to ruminants. The generally low relative values indicate that while these species are present and contribute to the ecosystem, their impact on overall ground cover is limited, perhaps due to specific habitat preferences or competitive interactions with other species.

The herbaceous vegetation in communal pastures was composed of 15 forage grasses consumed by ruminants. This diversity was lower compared to the university and surrounding areas, which may be attributed to variations in soil and climatic conditions affecting flora distribution [31]. The dominance of Poaceae in the pastureland is notable, as these grasses are known for their high regrowth potential [32].

Valued fodder grasses were categorized into highly cited, moderately cited, and poorly cited species. Among them, *A. gayanus* emerged as a highly cited species. According to the study, four forage grasses—*P. pedicellatum*, *A. gayanus*, *A. americana* and *D. aegyptium*—were identified as particularly palatable to ruminants. These findings underscore the importance of these species in forage development programs. Species with a high citation index should be prioritized in extension programs to enhance the effectiveness of forage species promotion.

The combination of these herbaceous species, including both grasses and legumes, has the potential to significantly contribute to the dietary balance of ruminants. The potential benefits of this combination merit further investigation. The Gramineae and Leguminosae families, being the two most important forage families, should be promoted together to provide complementary nutrition for ruminants [33]. Notably, the Gramineae species *A. gayanus* and *P. pedicellatum* are particularly suitable for promotion due to their versatility, including their use in roofing, feeding ruminants, and their ability to adapt to climatic challenges.

Forage grasses were categorized based on their citation frequency: highly cited, moderately cited, and poorly cited. *A. gayanus* was identified as highly cited, and other notable species include *P. pedicellatum*, *A. americana* and *D. aegyptium*. According to [34], legumes like *Z. glochidiata* and *A. indica* contribute significantly to animal performance and can reduce the need for protein supplements. These findings highlight the importance of integrating these species into forage development programs to enhance ruminant diets.

The study also found that the herbaceous pastures had a predominance of species with low pastoral value, as indicated by the pastoral value score (IQS = 1). This finding is consistent with [35], who observed a similar trend in the Maradi region, where high pastoral value species were relatively rare. This scarcity may result from high livestock pressure and insufficient conservation efforts.

Fodder collection and preservation practices were prevalent, with crop residues accounting for the majority of stored fodder. The quality of these stored forages varied, with cereal stalks being of fair quality and legume tops providing better nutritional value. The timing of forage collection also differed by category, with

natural fodder collected year-round and crop residues gathered post-harvest.

Overall, the study underscores the need for targeted forage development programs that promote species with high pastoral value and adaptability. By focusing on integrating valuable grasses and legumes, these programs can improve the dietary balance of ruminants and support sustainable livestock management practices.

## 5. Conclusions

The study highlights the Peulh people's deep expertise in animal husbandry, confirming their status as the predominant ethnic group in the region. The grassland flora survey offers crucial insights into the composition and structure of the herbaceous layer in the study area, documenting 95 species across 68 genera and 22 botanical families. This diversity underscores the ecological resilience and sustainability of the grassland ecosystems in Ziguinchor and Kolda.

Among the identified species, 15 herbaceous fodder plants, belonging to 7 families were found to be particularly palatable to ruminants. The *Poaceae* family was the most prevalent, followed by the Fabaceae family. Key species such as *Andropogon gayanus*, *Pennisetum pedicellatum*, *Aeschynomene americana*, *Aeschynomene indica*, *Eleusine indica*, *Digitaria horizontalis*, *Panicum maximum*, *Dactyloctenium aegyptium* and *Cynodon dactylon* were notably recognized by respondents for their palatability. The Peulh ethnic group demonstrated the highest familiarity with these palatable species.

The floristic composition of the communal grazing lands was analyzed, revealing a diverse range of fodder grasses that can contribute to the development of nutrient tables for formulating balanced rations for domestic ruminants. From a grazing perspective, species with high palatability constitute the largest proportion of the fodder categories and are more concentrated in the better-protected central zones. In contrast, species with low or no palatability are predominantly found in areas with high grazing pressure. The encroachment of less palatable species towards the core area, which is rich in productive species of high pastoral quality, is influenced by heavy grazing. Anthropogenic activities, particularly intense grazing, may lead to the reorganization of the herbaceous layer, as observed in the fire-affected areas where *Euphorbia* now dominates the herbaceous cover.

Future research should focus on understanding how the herbaceous layer responds to abiotic and biotic stresses. Additionally, monitoring the seasonal variability of the herbaceous flora would provide valuable insights into the dynamics of these ecosystems.

## Acknowledgements

The authors of this document would like to express their sincere gratitude to everyone who contributed to this study. Special thanks go to Professor Coly, Head of the Ziguinchor Livestock Department. Mr. Dieng, Head of the Kolda Livestock Department and the entire staff at the Kolda Zootechnical Research Centre (ZRC).

With particular appreciation to Mr. Diatta, a forage crop researcher, for their invaluable support and assistance.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

## References

[1] Dicko, M.S., Djitèye, M.A. and Sangaré, M. (2006) Les systèmes de production animale au Sahel. *Science et Changements Planétaires/Sécheresse*, **17**, 83-97.

[2] Kamuanga, M.J., Somda, J., Sanon, Y. and Kagoné, H. (2008) Livestock and Regional Market in the Sahel and West Africa: Potentials and Challenges. 182 p.

[3] ANSD (2016) Rapport sur la situation économique et sociale du senegal Ed. Elevage. Sénégal, 13 p.

[4] ANSD (2013) Rapport définitif RGPHAE. Rapport, 418 p.

[5] ANSD (2022) Situation économique et sociale du Sénégal Ed. 11 p.

[6] ANSD (2015) Situation économique et sociale régionale (Kolda). Rapport, 99 p.

[7] ISRA (2003) Actes de l'atelier de restitution des résultats du projet PROCORDEL au Sénégal à Dakar: Evaluation de la productivité des bovins métis dans le bassin arachidier. ISRA/ITC, 85 p.

[8] Agonyissa, D. and Sinsin, B.A. (1998) Productivité et capacité de charge des pâturages naturels au Bénin. *Revue d'élevage et de médecine vétérinaire des pays tropicaux*, **51**, 239-246. https://doi.org/10.19182/remvt.9628

[9] Ndiaye, C., Guèye, E.F., Ngom, S., Traoré, E.H. and Akpo, L.E. (2015) Impact de la pluviométrie sur la production de biomasse herbagère en milieu sahélien: Un cas en Région de Matam. Nord du Sénégal. *Livestock Research for Rural Development*, **27**, Article No. 55. http://www.lrrd.org/lrrd27/3/ndia27055.htm

[10] Traore, E., Camara, M., Sall, C., Boye, C., Diarra, E. and Ngom, S. (2016) Note on Available Feed for Livestock in Eastern Senegal and Upper Senegal River Basin. *International Journal of Advanced Research*, **4**, 2123-2128. https://doi.org/10.21474/ijar01/1429

[11] Buldgen, A., Francois, J. and Falla, J. (1995) Seedling Establishment of *Andropogon gayanus var. bisquamulatus* under Dry Conditions. *Tropical Grasslands*, **29**, 248-256.

[12] Buldgen, A., Piraux, M. and Compère, R. (1995) Réhabilitation des terres et synergie agriculture-élevage au sein de systèmes de production modernisés en région sa-hélo-soudanienne sénégalaise. L'homme peut-il refaire ce qu'il a défait? Colloque et congrès Sciences et changements planétaires/Sécheresse. John Libbey Euro-Text, 389-401.

[13] ANSD (2020) Situation économique et sociale Régionale. Ed. 2017-2018. Service régional de la statistique et de la Démographie de Ziguinchor. 130 p.

[14] Faye, S. (2022) Amélioration de la productivité et performance de production du cheptel aviaire en milieu rural dans la région de Kolda. *Revue Marocaine des Sciences Agronomiques et Vétérinaires*, **10**, 85-91.

[15] Mahamane, L. and Mahamane, S. (2005) Biodiversity of Ligneous Species in Semi-Arid to Arid Zones of Southwestern Niger According to Anthropogenic and Natural Factors. *Agriculture, Ecosystems & Environment*, **105**, 267-271. https://doi.org/10.1016/j.agee.2004.03.004

[16] Berhaut, J. (1967) Flore du Sénégal. Edition clairafrique, 2éme édition, Sénégal, 485

p.

[17] Merlier, H. and Montegut, J. (1982) Adventices tropicales. Flore aux stades plantule et adulte de 123 espèces africaines ou pantropicales. Ministère des relations extérieures, 164-167.

[18] Zoungrana, I. (1991) Recherches sur les aires pâturées du Burkina Faso. Thèse, Doc.es Sciences Naturelles de l'Université Bordeaux 3, UFR Aménagement et Ressources Naturelles, 277 p.

[19] César, V., Bellemin-Laponnaz, S., Wadepohl, H. and Gade, L.H. (2005) Designing the "Search Pathway" in the Development of a New Class of Highly Efficient Stereoselective Hydrosilylation Catalysts. *Chemistry—A European Journal*, **11**, 2862-2873. https://doi.org/10.1002/chem.200500132

[20] Daget, P. and Godron, M. (1995) Pastoralisme: Troupeaux. Espaces et sociétés. Hatier/Aupelf, 510 p.

[21] Daget, P. and Poissonet, J. (1971) Une méthode d'analyse phytologique des prairies: Critères d'application. *Annales Agronomiques*, **22**, 5-41.

[22] Ngom, D., Camara, B., Sagna, B. and Gomis, Z.D. (2018) Cortège floristique. Paramètres structuraux et indicateurs d'anthropisation des parcs agroforestiers à Elaeis guineensis Jacq. En Basse Casamance. Sénégal. *Journal of Animal et Plant Science*, **36**, 5919-5932.

[23] Diallo, A., Agbangba, E.C., Thiaw, A. and Guisse, A. (2012) Structure des populations de *Acacia senegal* (L.) Willd dans la zone de Tessékéré (Ferlo nord) Sénégal. *Journal of Applied Biosciences*, **59**, 4297-4306.

[24] Boudet, G. (1978) Manuel sur les pâturages tropicaux et les cultures fourragères. Série Manuels et précis d'élevage. No. 4. IEMV. Ministère de la Cooperation, 258 p.

[25] Kiema, S. (2007) Élevage extensif et conservation de la diversité biologique dans les aires protégées de l'Ouest burkinabé: Arrêt sur leur histoire. Épreuves de la gestion actuelle. État et dynamique de la végétation. Orléans. 657 p.

[26] Akpo, L.E., Masse, D. and Grouzis, M. (2002) Durée de jachère et valeur pastorale de la végétation herbacée en zone soudanienne au Sénégal. *Revue d'élevage et de médecine vétérinaire des pays tropicaux*, **55**, 275-283. https://doi.org/10.19182/remvt.9815

[27] Akpo, L.E. and Grouzis, M. (2000) Valeur pastorale des herbages en région soudanienne. Le cas des parcours sahéliens du Nord-Sénégal. *Tropicultura*, **18**, 1-8.

[28] Barral, H., Bénéfice, E., Boudet, G., Denis, J.P., De Wispelaere, G., Diaite, I., Diaw, O.T., Dieye, K., Doutre, M.P. and Meyer, J.F. (1983) Systèmes de production d'élevage au Sénégal dans la région du Ferlo: Synthèse de fin d'études d'une équipe de recherches pluridisciplinaire. ACC/RIZAT(LAT). GERDAT-Orstom. 172 p.

[29] Adjanohoun, E. (1989) Contribution aux études ethnobotaniques et floristiques en Bénin. Ed. ACCT, 89 p.

[30] Sanou, S. and Aikman, S. (2005) 9. Pastoralist Schools in Mali: Gendered Roles and Curriculum Realities. In: Aikman, S. and Unterhalte, E., Eds., *Beyond Access: Transforming Policy and Practice for Gender Equality in Education*, Oxfam Publishing, 181-195.

[31] Adomou, A.C., Sinsin, B., Der Maesen, V. and Gerardus, L.J. (2006) Phytosociological and Chorological Approaches to Phytogeography: A Meso-Scale Study in Benin. *Systematics and Geography of Plants*, **76**, 155-178. http://www.jstor.org/stable/20649708

[32] Diallo, M., Saleh, M., Bassene, C., Wood, S., Diop, A. and Guisse, A. (2015) Influence de la litière foliaire de cinq espèces végétales tropicales sur la diversité floristique des

herbacées dans la zone du Ferlo (Senegal). *International Journal of Biological and Chemical Sciences*, **9**, 803-814. https://doi.org/10.4314/ijbcs.v9i2.20

[33] Louarn, G., Corre-Hellou, G., Fustec, J., Pelzer, E., Julier, B., Litrico, I., Hinsinger, P. and Lecomte, C. (2010) Déterminants écologiques et physiologiques de la productivité et de la stabilité des associations graminées-légumineuses. *Innovations Agronomiques*, **11**, 79-99.

[34] Baumont, R., Bastien, D., Férard, A., Maxin, G. and Niderkorn, V. (2016) Les intérêts multiples des légumineuses fourragères pour l'alimentation des ruminants. *Fourrages*, **227**, 171-180.

[35] Alhassane, A., Soumana, I., Chaibou, I., Karim, S., Mahamane, A. and Saadou, M. (2018) Productivité, valeur pastorale et capacité de charge des parcours naturels de la région de Maradi, Niger. *International Journal of Biological and Chemical Sciences*, **12**, 1705-1716. https://doi.org/10.4314/ijbcs.v12i4.15