Fodder resources used by cattle during the dry season in the subdivisions of Mindif, Maga, and Zina in the Far North Region of Cameroon

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Abstract: Climate change in the Far North region in recent years has considerably impacted pasture productivity, resulting in a significant fodder deficit, particularly during the dry season. This study, conducted in the Mindif, Maga, and Zina subdivisions, aimed to enhance understanding of the forage species consumed by cattle during the dry season. The adopted methodology focused on structured and semi-structured pastoral surveys, an assessment of pasture productivity using the integral harvesting technique, and floristic inventories using the foot-by-foot method for woody plants and the field tour method for herbaceous plants. The results showed that approximately 83.67% of woody plants and 68.63% of herbaceous plants inventoried in pastures were grazed by cattle during the dry season. Grazing values were 42.73% and 46.99% in the dry and cold seasons, particularly in Mindif and Maga, and 34.43%, 44.63%, and 48.57% in Mindif, Maga, and Zina, respectively, in the dry and hot seasons. Pasture productivity and carrying capacity in the dry and cold seasons were 910 kg DM/ha in Mindif and 1,706.5 kg DM/ha in Maga, with respective carrying capacities of 0.53 and 0.76 UBT/ha in the cold season. During the dry and hot season, these values were 128.6, 626.50, and 1128 kg DM/ha at Mindif, Maga, and Zina, respectively, with stocking capacities of 0.09, 0.28, and 0.50 TLU/ha/hot season. Given the importance of pastures, whose sustainability is under threat, it is crucial to develop strategies that preserve biodiversity and ensure food security.

Key-words: Fodder, dry season, cattle, pastures, productivity, herbaceous.

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1. Introduction

Livestock farming supports the local economies of developing countries but remains heavily reliant on the availability of natural vegetation [7]. Despite depletion in both quantity and quality during the dry season, natural pastures provide a diverse range of herbaceous and woody fodder that is rich in nitrogen and energy [71]. For any productive livestock farm, feed is essential for good reproduction, growth, and health [16]. A reduction in herbaceous resources, along with the drying out and death of woody plants, are clear signs of the degradation of natural vegetation [40]. Using natural pastures with poor nutritional value during the dry season does not support intensive animal growth [74]. Moreover, these herbaceous pastures are becoming increasingly scarce due to their high demand among livestock [4]. Additionally, new agricultural frontiers have emerged and expanded rapidly, encroaching on rangeland and negatively impacting the supply of meat and milk for both rural and urban populations [38]. In Africa, cattle rearing is among the main production activities in many regions [48]. In sub-Saharan Africa, for example, cow production accounts for just 7% of the global output, yet the region is home to nearly 17% of the world's cattle herd [32]. In Cameroon, the livestock sector is also a vital part of the national economy, with 75% of the population dependent on agropastoral activities [33]. The cattle herd is estimated to total 10,202,369 animals, most concentrated in the northern regions of Adamaoua, North, and Far North [49]. In the Far North region, cattle farming is a major activity, with an estimated herd of 1,095,472 animals in 2021, according to MINEPIA. As in other regions, the diet of

herbivores in this area primarily relies on natural grazing [47].

The productivity of natural pastures in this area ranges from about 3-4 tonnes of dry matter (DM) per hectare (ha) in regions with less than 1,000 mm of rainfall to 7-8 tonnes DM/ha in areas with more than 1,000 mm of rainfall [12]. Natural pastures consist of herbaceous and woody layers and are vital for land protection, land improvement, and livestock feeding [30].

In recent years, however, climate change has affected rangeland productivity and pastoral mobility practices by reducing both the quantity and quality of fodder resources, degrading the most edible species, promoting invasive species, drying up waterholes and bodies of water, altering mobility strategies, and worsening relations between farmers and herders, which has led to a decline in animal productivity [27].

In response, Cameroon's Ministry of Livestock, Fisheries and Animal Industries (MINEPIA) is encouraging the development of fodder crops, especially during the dry season, with support from its partners through various projects and programmes. Nonetheless, despite these initiatives, fodder crops remain poorly adopted by most livestock farmers, even in the most suitable areas [49]. Moreover, there are relatively few reliable studies documenting the extensive use of vegetation—including grasses, trees, and shrubs—by livestock in arid and semi-arid regions of sub-Saharan Africa, as reported by [63], [36], and [10].

Consequently, it is urgent to inventory the flora in pastures, particularly during the dry season, to identify species of pastoral significance and optimise their utilisation. With this aim, this study was conducted to improve understanding of the forage species consumed by cattle during the dry season in the Far North region and to assess their relation to cattle requirements.

2. Methods

2.1 Location of the study area

This research was carried out in three divisions of the Far North region (Figure 1). These divisions are well known for their livestock and the very high cattle densities during the dry season. The divisions of greatest interest to pastoralists Mindif (Mayo-Kani Division), Maga (Mayo-Danay Division), and Zina (Logone et Chari Division) were targeted.

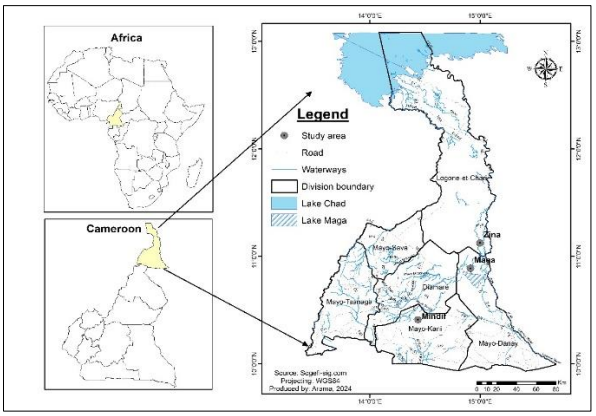


Fig.1: Location map of the study area

The average annual temperature in the Far North is 25.28 °C, with a range from 19.28 °C to 37.7 °C [54]. The dominant wind during the dry season is the Harmattan. Climatic conditions in this region are relatively harsh, with an agricultural season lasting two to three months and minimum relative humidity rarely exceeding 60%. Rainfall is low, averaging around 800 mm annually [72]. The vegetation includes wooded and grassy savannah, forest galleries, steppe, and thorn bush. During the dry season, this vegetation cannot fully perform its functions of protecting the soil, providing grazing land, or serving as a biological reserve [64].

2.2 Sociodemographic and pastoral surveys

The villages to be surveyed in the visited communes were chosen on a reasoned basis, with emphasis placed on accessible villages with high livestock potential and grazing areas where biomass surveys were carried out.
Semi-structured questionnaires were administered to shepherds to characterise the herders, their farms, and the species of forage eaten, as well as the grazing areas visited. A preliminary census of village chiefs identified 130 shepherds in Mindif, 150 in Maga, and 212 in Zina. Based on this census, the number of shepherds to be surveyed was determined by the formula of [8] as follows:

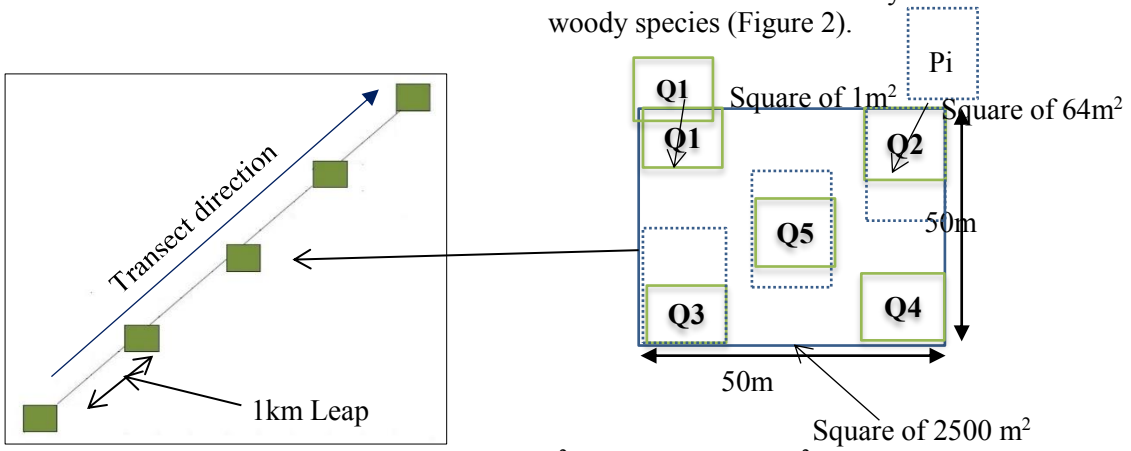
$$n = \frac{(Z\alpha/2)^2\ p(1-p)N}{(Z\alpha/2)^2\ p(1-p) + (N-1)E^2}$$ **Formula (1)**

Where: n = size of the sample to be surveyed; Zα/2 = 1.96 (value corresponding to the 95% confidence threshold); E = chosen margin of error (5%); p = estimated proportion of the population with the characteristic under study; N = total population of shepherds.

Using this formula, the sample sizes obtained per site were 97 at Mindif, 108 at Maga, and 137 at Zina. The palatability of the grazed species was also determined, as was the grazing quality, which was expressed by calculating the pastoral value [3]. Focus groups were used to assign a palatability index of 0–3 to the inventoried herbaceous and woody species on the pastures, where 3 = very palatable species, 2 = moderately palatable species, 1 = not very palatable species, and 0 = not palatable species [26].

2.3 Floristic inventory

In each locality, the grazing areas of interest to the surveyed shepherds were visited. In Mindif, these were the Gagadje, Maodine, Sabongari, and Doyang pastures. In Maga, the Ziam, Maoda, and Kaykay pastures were studied. In Zina, the grazing areas of Shede, Kaziré, Gala, Arainaba, and Lougouma were surveyed. A systematic survey of the vegetation was carried out along a transect measuring 7–10 km, with a 2,500 m² plot established at each kilometre for data collection. The dry matter productivity (i.e., fodder production) of herbaceous species was assessed, as was the floristic inventory of herbaceous and woody species (Figure 2).



(**Q1, 2, 3** and **4**= Square of 1m²; **Pi**= square of 64m²)

Fig. 2: Schematic diagram of the fodder collection and floristic inventory system

The 'foot-to-foot' or 'en plein' method [69] was used for the inventory of woody species. This involved listing and counting all woody species present in the plot.

For herbaceous species, the inventory technique used was the 'field walk' method [50]. This involved counting all species present within an observation area while walking through it in different directions. The minimum area chosen was 64 m², as defined for the herbaceous stratum by [57]. Herbaceous productivity was assessed using the integral harvesting method [21]. This method involves cutting all plant material on a given surface at ground level. The weight of the green matter was measured in the field using a dynamometer scale to assess the quantity of dry matter. To determine the dry matter content, a sample was weighed and then dried in a 105 °C oven.

2.4 Determining the pastoral value

To determine the pastoral value of the pastures, the frequency and specific contribution of the different species were calculated:

- The specific frequency (F_{si}) of a species, which is calculated by summing the presence of each species in each survey [21].

$$F_{si}=ni/N \times 100 \quad \textbf{Formula (2)}$$

Where ni=number of times species i was surveyed, N=total number of individuals sampled.

- The Specific Contribution (C_{si}) of a species, which is the percentage ratio of the F_{si} of this species to the sum of the Fsi of all the species (n) recorded on all the samples [26]. This is a measure of the contribution of species (i) to aerial plant cover. It is obtained by the formula :

$$C_{si}=100\times Fsi/(\sum Fsi) \quad \textbf{Formula (3)}$$

- The Pastoral Value (Vp) is a global index used to evaluate pasture quality [26]. It is expressed as follows:

$$Vp = 0{,}3\sum(Csi \times Isi) \quad \textbf{Formula (4)}$$

The various I_{si} (Specific Quality Index) values for the species inventoried were established using the 0 to 3 rating scale (3= Highly palatable species, 2=Medium palatable species, 1=Lowly palatable species, 0=Unpalatable species).

2.5 Estimation of carrying capacity

For this study, the dry season was divided into two: a cold dry season from November to February and a hot dry season from March to April. The carrying capacity was calculated based on the fodder produced by the herbaceous layer [21].
The carrying capacity (CC) of the different pastures was calculated based on consumable fodder, taking into account the effective consumption of 1/3 of the produced fodder. The following formula was used:

CC (TLU/ha/season) = (K x Quantity of total fodder production (kg DM/ha))/ (6.25 (kgDM/TLU) x duration of use) Formula (5)
K=1/3: Fraction of fodder production consumed (KgDM/ha), duration of use (dry season), DM=Dry Matter

2.6 Evaluation of the degree of similarity and difference between flora

The percentage of species common to two surveys, relative to the species specific to each survey, was expressed by Jaccard's coefficient of similarity (Ij). Plant communities are considered similar if Ij is greater than or equal to 50% [2]. The mathematical expression of the Jaccard index is:
$$\mathbf{Ij = c/(a + b - c)} \quad \textbf{Formula (6)}$$
where: c = number of species common to the two pastures (P1 and P2);
a = number of species in P1.
b = number of species in P2.
To establish the difference between the two surveys, the Hamming distance H was calculated by [25]. It is expressed as: **H = 1- Ij Formula (7)**
The following qualifications were adopted
- Very small floristic difference for $H < 20$.
- Small difference $20 \leq H < 40$.
- Medium difference $40 \leq H < 60$.
- Strong difference $60 \leq H < 80$.
- Very strong difference $80 \leq H$.

3. Results and discussion

3.1 Socio-demographic characteristics of the herders interviewed

The socio-demographic characteristics of the shepherds surveyed in the three communes are presented in Table 1.

Table 1. Socio-demographic characteristics of the shepherds

		Mindif	Maga	Zina	Mean
Sex (%)	Male	100	100	100	100
	Female	0	0	0	0
Age of shepherds (%)	Under 18s	1.23	2.67	2.12	2.01
	18 to 39 years old	45.13	53.22	69.56	55.97
	40 to 60 years old	37.22	30.66	21.75	29.88
	Over 60 years old	16.42	13.45	6.57	12.15
Level of formal education (%)	None	41.22	29.47	44.59	38.43
	Primaire	35.11	32.32	14.03	27.15
	Secondaire	16.13	25.28	16.23	19.21
	Koranic school	7.54	12.94	25.15	15.21
Ethnic group (%)	Peul	49.65	46.84	58.87	51.79
	Mbororo	28.99	16.99	22.56	22.85
	Moundang	4.23	2.03	2.33	2.86
	Arabe choas	9.88	6.07	8.41	8.12
	Mousgoum	2.13	14.33	4.07	6.84
	Other	5.12	13.73	3.76	7.54
Secondary activity (%)	None	10.66	2.68	4.31	5.88
	Farming	57.44	69.33	62.04	62.94
	Breeding	24.53	16.68	17.04	19.42
	Trade	5.66	7.44	10.73	7.94
	Marabou	1.71	3.87	5.89	3.82

In the study area, shepherding is an activity carried out exclusively by men (100%). Very few individuals under the age of 18 are involved in this activity. Among the surveyed shepherds, 55.97% were aged 18–39, and 12.15% were over 60. Although most shepherds do not speak French, 15.21% had attended a Koranic school. Of those surveyed, 38.43% had no formal education, 27.15% had attended primary school, and 19.21% had attended secondary school.

The herders surveyed belong to different ethnic groups. The Peul constitute the largest group (51.79%), followed by the Mbororo (22.85%), the Arabe Choas (8.12%), the Mousgoum (6.84%), and other ethnicities, including the Guiziga, Toupouri, and Massa, which together account for 7.54%. In addition to herding, 62.94% of the surveyed shepherds also engage in farming. Conversely, only 19.42% of herders who own their animals are not involved in farming. Activities such as trading and maraboutism are less common, representing 7.94% and 3.82% respectively.

In the surveyed localities, it became evident that shepherding is performed exclusively by men. This could be attributed to the physically demanding nature of the activity, and traditionally, herders entrust their flocks to men in exchange for payment, who then take care of them and lead them to pasture. [61] A study conducted in north-east Algeria found that, although predominantly male-dominated (76%), twenty-four per cent of herders are female, and they typically remain near their farms, mainly herding small ruminants.

It was also observed that young people under 18 are hardly represented, accounting for only 2% of the population. This may be because herders are prioritising education for young children. [61] In North-East Algeria, the average age of shepherds ranges from 32 to 62.

In addition to age, the relatively high proportion of illiterate shepherds could be explained by the fact that, historically, these local populations did not prioritise education, and most are Muslim.

Regarding ethnic groups, the Peul and the Mbororo, who are key figures in pastoral societies, form the majority (51.79% and 22.85% respectively). These findings align with those of [28], who demonstrated that the activity is dominated by prominent actors within pastoral communities in northern Cameroon. It is believed that the activity's spread to other ethnic groups results from unemployment in rural areas and the lack of income-generating activities. It is also increasingly common for shepherds to engage in farming. They are known to occupy pastoral lands by cultivating crops, which occasionally leads to conflicts among different land users. A study in northern Cameroon [43] reports that, despite their origins as pastoralists, the Mbororo have adopted agricultural practices after becoming sedentary. The presence of herdsmen is also documented in records [18] from the rural community of Téssékré in Ferlo, Senegal; the commune of Djougou in northern Benin; the commune of Dantiandou in Fakara, western Niger; and the commune of Hombori in Gourma, Mali. According to these sources, families in vulnerable situations who have gradually exited the pastoral system and are unable to support themselves through agro-pastoralism are forced to earn a living working for others, especially herding cattle for farmers. A small proportion of herdsmen are heavily involved as intermediaries in livestock trade at specialised markets.

3.2. Breeds of cattle reared

Surveys have shown that the most common breed in the area is the Peul Fulani zebu, accounting for 60.20% of the herd. This is followed by the Mbororo zebu, accounting for 31.21%. Bokolo and Goudali zebus are used to a much lesser extent, accounting for 5.22% and 3.37% of the herd, respectively (Figure 3).

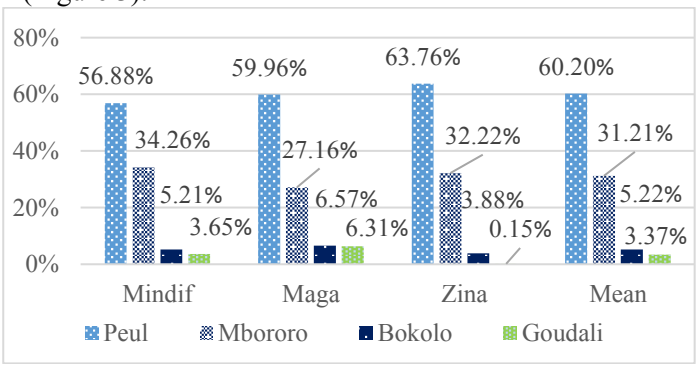


Fig. 3: Distribution of the different breeds of cattle reared in the area

The Fulani Peul zebu and the Mbororo zebu were the most widespread breeds in the area. These breeds are considered the best adapted to the environment, capable of withstanding extreme conditions such as high temperatures, long journeys, water scarcity, and limited grazing opportunities at certain times of the year. However, the presence of less well-adapted breeds, like the Goudali and Bokolo zebu, could be due to farmers' efforts to improve local breeds' performance and increase beef and dairy production. Furthermore, the results obtained by [20] show that Mbororo zebus are predominantly found in the North and Far North regions, where they are most suited. According to [1], over 70% of the cows in Cameroon are produced by the Fulani tribe, which explains this breed's dominance in the area. These findings are also in line with those of [22], who demonstrated that breeds often serve as identity markers for pastoral groups.

3.3 Floristic composition of pasture vegetation

3.3.1 Family diversity and specific contribution of woody species

A total of 50 woody species were inventoried on the pastures visited. These species belong to 19 different botanical families (Table 2).

Table 2. Contributions of woody species observed

Scientific name	Family	Maga			Mindif			Zina		
		Is	Fi	Csi	Is	Fi	Csi	Is	Fi	Csi
Acacia ataxacantha (DC.)	*Fabaceae*	1	0.39	0.69	1	14.91	20.13			
Acacia hockii (De Wild.)	*Fabaceae*	2	0.39	0.69						
Acacia laeta (R.) (Br. ex Benth.)	*Fabaceae*				1	0.29	0.39			
Acacia nilotica (L.) (Willd. ex Delile)	*Fabaceae*	2	0.39	0.69				1	0.33	0.45
Acacia senegal (L.) Willd.	*Fabaceae*	1	4.04	7.11	1	0.29	0.39			
Acacia seyal (Delile.)	*Fabaceae*	1	5.35	9.4	1	1	1.35	1	3.67	5.02
Acacia sieberiana (DC.)	*Fabaceae*	1	4.96	8.72						
Adansonia digitata (Linn.)	*Malvaceae*				1	0.14	0.19			
Annona senegalensis (Pers.)	*Annonaceae*	2	1.04	1.83	0	0.29	0.39	2	2	2.74
Anogeissus leiocarpa (DC.)	*Combretaceae*	2	0.13	0.23	2	3.71	5.01			
Azadirachta indica (A.) Juss.	*Meliaceae*	1	0.52	0.92	1	0.29	0.39			
Balanites aegyptiaca (L.) Delile.	*Zygophyllaceae*	3	1.57	2.75	2	10.29	13.88	1	4.33	5.93
Bauhinia rufescens (Lam.)	*Fabaceae*				2	0.03	0.04			
Borassus Aethiopium (Mart.)	*Arecaceae*	1	1.7	2.98						
Boscia senegalensis (Pers.) Lam.	*Capparaceae*				0	0.14	0.19			
Cadaba farinosa (Forssk.)	*Capparaceae*				0	1.43	1.93			
Calotropis procera (Aiton) W.T.	*Apocynaceae*	1	1.7	2.98	1	1.71	2.31			
Capparis tomentosa (Lam.)	*Capparaceae*				0	2,14	2.89			
Cassia arereh (Delile.)	*Fabaceae*				1	0,43	0.58			
Celtis toka (Forssk.)	*Cannabaceae*							1	0.67	0.91
Combretum aculeatum (Vent.)	*Combretaceae*	1	0.65	1.15	1	2.71	3.66			
Combretum glutinosum (Perr. ex DC.)	*Combretaceae*				1	1.71	2.31			
Combretum collinum (Fresen.)	*Combretaceae*				1	0.71	0.96			
Commiphora africana (A.Rich.) Endl.	*Burseraceae*				1	0.14	0.19			
Commiphora pedunculata (Kotschy & Peyr.)	*Burseraceae*				0	0.14	0.19			
Dalbergia melanoxylon (Guill. & Perr.)	*Fabaceae*				1	1.14	1.54			
Dichrostachys cinerea (L.)	*Fabaceae*				1	0.14	0.19			
Diospyros mespiliformis (Hochst. ex A. Rich.)	*Ebenaceae*				1	0.43	0.58			
Faidherbia albida (Delile) A. Chev.	*Fabaceae*	3	8.87	15.6	3	0.71	0.96	2	12	16.44
Grewia bicolor (Juss.)	*Malvaceae*				1	1.57	2.12			
Grewia mollis (Juss.)	*Tiliaceae*	0	0.13	0.23						
Guiera senegalensis (J.F. Gmel.)	*Combretaceae*				2	20.14	27.19			
Hexalobus monopetalus (A. Rich.)	*Annonaceae*				1	0.86	1.16			
Hyphaene thebaica (L.) Mart.	*Arecaceae*	2	1.17	2.06				1	7.67	10.50
Lannea humilis (Oliv.) Engl.	*Anacardiaceae*	2	0.26	0.46				2	0.67	0.91
Mitragyna inermis (Willd.) K.Schum.	*Fabaceae*							1	6	8.22
Piliostigma reticulatum (DC.) Hochst.	*Fabaceae*	1	15.65	27.52	2	0.43	0.58	2	1	1.37
Pteleopsis suberosa (Engl. & Diels)	*Combretaceae*				0	0.71	0.96			
Pterocarpus lucens (Lepr.)	*Fabaceae*							3	1.67	2.28
Sclerocarya birrea (A. Rich.) Hochst.	*Anacardiaceae*	2	0.26	0.46	2	0.14	0.19			
Senna singueana (Delile) Lock	*Fabaceae*				0	1	1.35			
Sterculia setigera (Del.)	*Malvaceae*	1	0.13	0.23						
Stereospermum kunthianum (Cham.)	*Bignoniaceae*							1	0.33	0.45
Strychnos spinosa (Lam.)	*Loganiaceae*	1	0.13	0.23						
Tamarindus indica (L.)	*Fabaceae*				1	0.14	0.19	1	2.67	3.65
Terminalia laxiflora (Engl. & Diels)	*Combretaceae*							0	0.33	0.46
Vitex doniana (Sweet.)	*Lamiaceae*				1	0.57	0.78			
Ziziphus mauritiana (Lam.)	*Rhamnaceae*	2	7.17	12.61	2	3.43	4.64	1	29.67	40.64
Ziziphus spina-christi (Linn.) Desf.	*Rhamnaceae*	1	0.26	0.46	1	0.14	0.19			
Overall total			**56.86**	**100**		**74.05**	**100**		**73.01**	**100**

Fi=specific frequency, Csi=Specific contribution, Is=Quality index (3=Very palatable species, 2=Average palatability, 1=Low palatability, 0=Not palatable species)

A total of 12 plant families, represented by 23 species, were encountered on the Maga pastures. The species making the highest contributions were *P. reticulatum* (DC.) Hochst. (28.10%), *F. albida* (Delile) A. Chev. (15.93%), *A. senegal* (L.) Wild. (12.96%), and *A. seyal* (Del.) Baill. (9.6%). In Mindif, 14 plant families were inventoried, represented by 35 species. The species with the greatest specific contributions were *G. senegalensis* (J.F.) Gmel (27.19%), *A. ataxacantha* DC (20.13%), *B. aegyptiaca* (L.) Delile (13.88%), and *Z. mauritiana* Lam (4.63%). In the Zina pastures, nine plant families, represented by 15 species, were recorded. The dominant species in these pastures were *Z. mauritiana* (40.64%), *F. albida* (16.44%), *H. thebaica* (10.50%), and *M. inermis* (8.22%). A broadly similar taxonomic distribution was observed by [68] in the natural savannah zone of Moutourwa in Cameroon's Far North region. Their results showed that the most abundant families were *Caesalpiniaceae* (34.41%), *Annonaceae* (14.23%), *Combretaceae* (9.41%), and *Mimosaceae* (7.78%). Furthermore, despite the diversity of woody species recorded in the different grazing areas, Zina has a low species count (16). This could be due to the presence of yaérés, which flood at the end of the rainy season and prevent woody seeds from germinating. These results align with those obtained by [55] regarding the herbaceous vegetation of wetlands in northern Cameroon. They demonstrated that the woody layer is typically diminished in areas prone to long-term flooding. The number of species recorded is close to the 38 species identified in the agrosystems on the outskirts of Maroua town by [17]. [39] Identified 52 woody species belonging to 21 families in the grassy, shrubby, and tree savannah zones on the outskirts of Waza National Park. Additionally, a study conducted by [29] in the Laf area of Extreme North Cameroon, examining four land use types (crops, fallow land, wooded savannah, and shrub savannah), identified a total of 20 families and 46 woody plant species. These results illustrate the diversity of woody flora in the area's pastures. [58] Described pastures in the Minidif region as dominated by various trees and shrubs, including *Acacia sp*., *Commiphora Africana* (A. Rich.) Engl., and *S. birrea*. Potentially invasive woody plant species include *P. reticulatum* [9], *A. ataxacantha* [53], *D. cinerea* [9], [58], and *Z. mauritiana*, which typically colonises disturbed areas such as fallow land [9]. *C. aculeatum*, a species highly valued by livestock, is known to be sensitive to grazing. According to [41], grazing on young Combretaceae compromises their survival. Conversely, woody plants such as *A. leiocarpa* and *S. birrea* are less affected by grazing [11]; [51]. Overgrazing causes the disappearance of woody species such as *V. donania* and *A. leiocarpus*. [15] Observed the disappearance of these valuable species following intense grazing in the Sudanian pastoral zone of Niassa, Burkina Faso. *G. senegalensis*, on the other hand, is an indicator of overgrazing according to [6]; however, its strong presence mainly highlights the impact of human activities on these usually infertile uplands. The differences observed within the same agro-ecological zone could result from anthropogenic pressure, such as deforestation and excessive firewood harvesting, as well as animal pressure like overgrazing, trampling, and erosion. These factors, along with climatic variability (normal, deficit, and surplus rainfall years), have been observed in recent years. 3.3.2. Diversity of herbaceous families and species in the dry and cold season The floristic inventory of the herbaceous stratum in the Maga, Mindif, and Zina pastures includes 14 families and 52 species belonging to the following families: *Caesalpiniaceae*, *Commelinaceae*, *Acanthaceae*, *Asparagaceae*, *Asteraceae*, *Convolvulaceae*, *Cyperaceae*, *Euphorbiaceae*, *Fabaceae*, *Lamiaceae*, *Phyllanthaceae*, *Poaceae*, *Rubiaceae*, and *Tiliaceae* (table 3).

Table 3. Contribution and pastoral value of grasses

Scientific name	Family	Maga				Mindif				Zina			
		Is	Fi	C_{si}	Vp	Is	Fi	Csi	Vp	Is	Fi	C_{si}	Vp
Alysicarpus vaginalis (L.) DC.	*Fabaceae*					1	0.67	3.26	1.08				
Andropogon Gayanus (Kunth var.)	*Poaceae*					2	0.18	0.89	0.59				
Andropogon sp	*Poaceae*									2	0.31	1.36	0.9
Aristida adscensionis (L.)	*Poaceae*					2	1.36	6.67	4.4				
Asparagus africanus (Lam.)	*Asparagaceae*					0	0.27	1.33	0				
Aspilia bussei (O.Hoffm. & Muschl.)	*Asteraceae*					0	0.27	1.33	0				
Brachiaria lata (Schumach.) C.E.Hubb.	*Poaceae*					2	0.73	3.56	2.35				
Brachiaria sp	*Poaceae*	2	1.67	15.9	10.49					2	2	8.72	5.75
Cassia mimosoidus (L.)	*Caesalpiniaceae*					0	0.48	2.37	0				
Cassia obtusifolia (L.)	*Fabaceae*	0	0.33	3.18	0	0	1.06	5.19	0				
Cenchrus biflorus (Roxb.)	*Poaceae*	3	0.04	0.35	0.35								
Commelina benghalensis (L.)	*Commelinaceae*	2	0.07	0.71	0.47	1	0.09	0.44	0.15				
Commelina erecta (L.)	*Commelinoideae*	2	0.26	2.47	1.63					2	0.13	0.54	0.36
Corchorus tridens (L.)	*Tiliaceae*	0	0.11	1.06	0	0	0.64	3.11	0				
Cortaderia sp	*Poaceae*	2	0.26	2.47	1.63								
Crotalaria retusa (L.)	*Fabaceae*	2	0.11	1.06	0.7	2	0.73	3.56	2.35				
Cyperus rotundus (L.)	*Cyperaceae*	0	0.07	0.71	0	0	0.73	3.56	0				
Cyperus difformis (L.)	*Cyperaceae*	0	0,26	2.47	0					0	0.56	2.45	0
Dactyloctenium aegyptium (L.) Willd.	*Poaceae*									3	0.75	3.27	3.24
Digitaria sanguinalis (L.) Scop.	*Poaceae*	2	0.07	0.71	0.47	2	0.27	1.33	0.88				
Echinochloa colona (L.) Link.	*Poaceae*	3	0.48	4.59	4.55	2	0.09	0.44	0.29				
Echinochloa sp	*Poaceae*									2	4.19	18.26	12.05
Eleusine indica (L.)	*Poaceae*					1	0.09	0.44	0.15				
Eragrostis barteri (C.E. Hubb.)	*Poaceae*									3	0.75	3.27	3.24
Eragrostis pilosa (L.) P. Beauv.	*Poaceae*	3	0.67	6.36	6.3	3	1.94	9.48	9.39				
Euphorbia hirta (L.)	*Euphorbiaceae*					0	0.09	0.44	0				
Hygrophila auriculata (DC.)	*Acanthaceae*	1	0.41	3.89	1.28	2	0.27	1.33	0.88	2	1.44	6.27	4.14
Hyparrhenia rufa (Nees) Stapf.	*Poaceae*					2	0.45	2.22	1.47	1	2.63	11.44	3.78
Ingigofera hirsuta (L.)	*Fabaceae*	0	0.19	1.77	0	0	0.36	1.78	0				
Ipomea eriocarpa (R. Br.)	*Convolvulaceae*					1	0.09	0.44	0.15				
Leucas marticensis (Jacq.) R. Br.	*Lamiaceae*	0	0.04	0.35	0	0	0.09	0.44	0				
Loudetia kagerensis (K.Schum.) C.E.Hubb.	*Poaceae*					2	0.58	2.81	1.86	2	1	4.36	2.88
Merremia tridentata (L.) Hallier f.	*Convolvulaceae*	0	0.04	0.35	0								
Mitracarpus villosus (Sw.) DC.	*Rubiaceae*	0	0.41	3.89	0	0	0.7	3.41	0				
Monechma ciliatum (Jacq.) Milne-Redh.	*Acanthaceae*	0	0.04	0.35	0	0	0.55	2.67	0				

Oryza longistaminata (A.) (Chev. & Roehr.)	*Poaceae*									1	0.69	3	0.99
Pannicum laxum (Sw.)	*Poaceae*	2	0.33	3.18	2.1					2	0.69	3	1.98
Paspalum laxum (Lam.)	*Poaceae*					2	0.09	0.44	0.29				
Pennisetum polystachyon (L.) Schult.	*Poaceae*					2	0.91	4.44	2.93				
Pennisetum pedicellatum (Trin.)	*Poaceae*	2	0.22	2.12	1.4	2	1.21	5.93	3.91				
Pennisetum sp	*Poaceae*									2	1.13	4.9	3.24
Phragmites communis (Trin.)	*Poaceae*									1	1.31	5.72	1.89
Phyllanthus amarus (Schumach. & Thonn.)	*Phyllanthaceae*	0	0.3	2.83	0								
Rootboellia exaltata (L.)	*Poaceae*					1	1.3	6.37	2.1				
Schoenefeldia gracilis (Kunth.)	*Poaceae*					2	0.39	1.93	1.27				
Senna occidentalis (L.) Link.	*Fabaceae*	0	0.44	4.24	0								
Setaria sphaceleta (Stapf. & Hubb.)	*Poaceae*	2	0.04	0.35	0.23	1	2.88	14.07	4.64				
Spermacoce stachydea (DC.)	*Rubiaceae*					0	0.55	2.69	0				
Vertivera nigratana (Benth.) Stapf.	*Poaceae*	1	0.78	7.42	2.45					1	3	13.08	4.32
Zizania palustris (L.)	*Poaceae*	1	2.22	21.2	7					1	1.56	6.82	2.25
Zornia glochidiata (Rchb. ex DC.)	*Fabaceae*	3	0.63	6.01	5.95	3	0.33	1.63	1.61				
Overall total			**10.49**	**100**	**47**		**20.44**	**100**	**42.74**		**22.95**	**100**	**52.18**

Fi= Specific frequency, Csi= Specific contribution, Vp= Pastoral value, Is= Quality index (3= Very palatable, 2= Moderately palatable, 1= Not very palatable, 0= Not palatable)

A total of 27 species from 11 families were identified in the Maga pastures. The *Poaceae* family was the most common, with 11 species, followed by *Fabaceae* with five, *Cyperaceae* with two, and *Acanthaceae* with two. The other families *Commelinaceae*, *Commelinoideae*, *Convolvulaceae*, *Lamiaceae*, *Phyllanthaceae*, Rubiaceae, and Tiliaceae—each had one species. The most prevalent species were *Z. palustris* L., *Brachiaria sp*., *V. nigratana* (Benth.) Stapf., and *E. pilosa* (L.) P. Beauv., contributing 21.20%, 15.90%, 7.42%, and 6.36%, respectively.

A herbaceous inventory in the Mindif grazing areas identified 33 species across 14 families. The most represented were *Poaceae* (15 species), *Fabaceae* (5), *Acanthaceae* (2), and *Rubiaceae* (2), while the other families *Caesalpiniaceae*, *Commelinaceae*, *Asteraceae*, *Asparagaceae*, *Convolvulaceae*, *Cyperaceae*, *Euphorbiaceae*, *Lamiaceae*, and *Tiliaceae* each contributed one species. The species with the highest relative abundance were *S. sphaceleta* (Stapf.) Hubb. (13.81%), *E. pilosa* (L.) P. Beauv. (9.30%), *A. adscensionis* L. (6.54%), and *R. exaltata* L. (6.25%).

The inventory of Zina pastures yielded 17 species within four families. *Poaceae* was the dominant family, with 14 species, followed by *Acanthaceae*, *Commelinoideae*, and *Cyperaceae*, each with one species. Notably, *Echinochloa sp*. (18.26%) and *V. nigritana* (Benth.) Stapf. (13.08%), *H. rufa* (Nees) Stapf. (11.44%), and *Brachiaria sp*. (8.72%) had the highest relative contributions.

These findings differ markedly from the 80 species across 18 families recorded by [42] in the Dièma council, located in the northern Sudanian zone of Mali, where *Poaceae*, *Fabaceae*, and *Convolvulaceae* predominated. The number of species recorded is also lower than the 71 herbaceous species from 66 genera and 21 families identified by [13] in the Mayo-Danay department. Conversely, these results align more closely with those of [56], who documented 57 species in Dosso, Niger, a semi-arid Sahelian region.

The floristic composition showed *Poaceae* to be dominant across all sites. These results highlight the diversity of herbaceous flora in the area's pastures. Previously, [58] described Mindif pastures as dominated by species like *H. rufa*, *A. gayanus*, *Pennisetum sp*., and *Acacia sp*., though current observations differ, likely due to poor pasture management and over-exploitation of fodder resources during the rainy season when animals are withdrawn.

Several authors have noted the invasive nature of particular species in these pastures, especially herbaceous types such as *A. gayanus* and *H. rufa* [58]; [60].

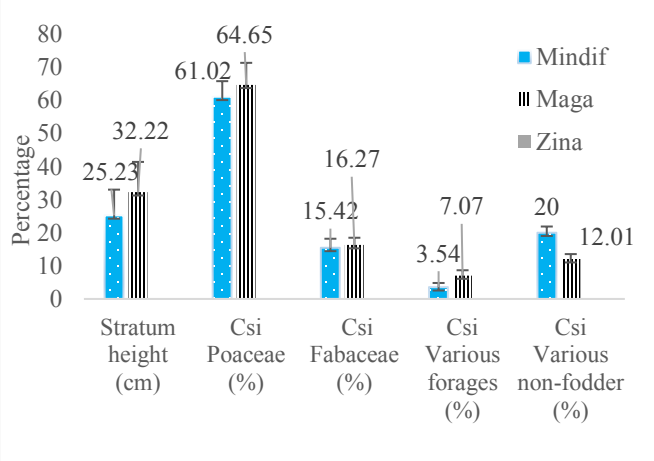
Some of these species are highly vulnerable to intense grazing pressure. For instance, *Panicum* [70], which was not seen on Mindif pastures, and *Brachiaria sp*., which needs a period of vegetative rest [43]. Overgrazing can eliminate some species, including *A. gayanus* [23]; [65] and *H. rufa* [31], as these cannot withstand continuous grazing. Their rarity signifies advanced ecological degradation. Additionally, [24]; [15] observed the disappearance of species like *V. nigritana* and *P. pedicellatum* in the Sudanian pastoral zone of Niassa in Burkina Faso. Although Mindif hosts a rich flora, the presence of woody plants such as *C. glutinosum* and *G. senegalensis* might signal the outset of colonisation by xerophilous, hardy species, which are indicators of grazing imbalance [14]. According to local farmers, *C. tomentosa* is not particularly popular among cattle, but it does seem to boost their appetite and water intake.

Furthermore, [73] identified certain species such as *S. pyramidalis* and *S. sphacelata*, which are believed to result from poor pastoral management or overgrazing, as seen in the Adamaoua region. He also noted species resistant to overgrazing, like *Brachiaria brizantha* (Hochst. ex A. Rich.) and *E. indica*, which have especially been observed in the Mindif area.

3.3.2.1. Specific contribution of herbaceous species families

The contribution of grasses was particularly significant in all the surveyed grazing areas.

Figure 4 shows that the highest values were 61.02% and 64.65% for the Mindif and Maga pastures, respectively.



(Csi=Specific contribution, cm=centimetre, %=percentage)

Fig. 4: Specific contribution of pasture species

The contribution of *Poaceae* is particularly high in the Mindif and Maga regions. This exceeds the value of 42.2% reported by [46]. That study attributed this figure to the 26.02% contribution of non-fodder species in the studied rangelands of north-eastern Benin. Moreover, these findings align with those of [21], who described rangelands as predominantly dominated by *Poaceae*. [3] also showed that the Sudano-Sahelian savannah herbaceous vegetation was characterised by strong annual grass dominance.

3.3.2.2 Pastoral value of pastures

The pastoral values of the pastures in Mindif and Maga are below 50%. These values vary depending on the species groups comprising the pastures (Figure 5). *Poaceae* contributed the most to the overall pastoral value of the visited pastures (36.52% and 36.96%), followed by *Fabaceae* with around 5.04% and 6.65%. Other herbaceous species groups make only minor contributions to the total pastoral value.

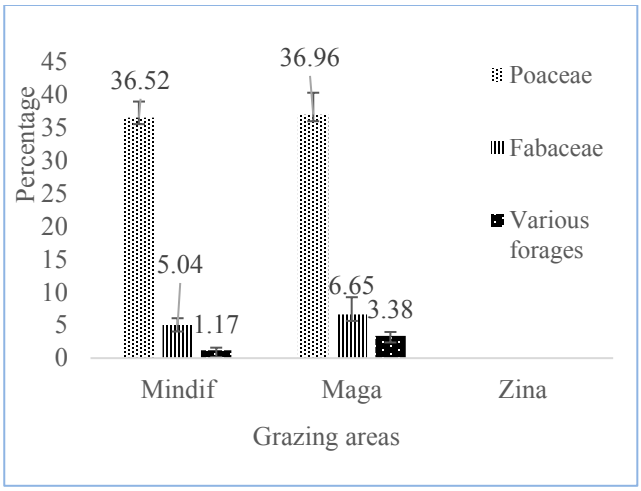


Figure 5: Pastoral value of different pasture groups

The pastoral values recorded across various zones are generally not very high. In contrast, [67] concluded that the values in the Guinean-Sudanese region of Benin were generally favourable, with most above or close to 50%. The combined values were 42.73% for Mindif and 46.99% for Maga, likely reflecting the species present and their palatability to cattle. [73], who studied vegetation in the Adamaoua region, found that the pastoral values were 46% and 47% for vegetation subjected to overgrazing; 56%, 58%, and 60% for minimally disturbed vegetation; and 52% for fallow land. These figures are similar to those obtained for vegetation units affected by overgrazing.

3.3.2.3 Fodder productivity and carrying capacity

The data on variations in forage productivity among different species in the visited pastures are shown in Table 4.

The highest dry matter yield by grasses during the dry, cold season was recorded in Maga pastures (1,706.50 ± 147.10 kg DM/ha), while the lowest was in Mindif (910 ± 50.62 kg DM/ha). The average stocking rate from November to February was 0.53 TLU/ha/CDS at Mindif and 0.76 TLU/ha/CDS at Maga. It should be noted that livestock could not graze in the Zina area during this period due to flooding, so no data on grass productivity or capacity could be gathered there. The Zina pastures flooded during this period, precluding data collection.

Table 4. Productivity and load capacities during the dry and cold periods

Dry and cold season (November-February)	Herbaceous productivity Kg DM/ha	CC in TLU/ha/CDS
Mindif	910±50.62	0.53
Maga	1706.50±147.10	0.76
Zina	-	-

(CC= Carrying Capacity, DM= Dry Matter, ha=hectare, TLU= Tropical Livestock Unit, CDS= Cold Dry Season)

Carrying capacities during the hot and cold seasons are relatively low, yet higher than the 0.20–0.24 TLU/ha/year range reported by [5] in West African Sahelian pastoral zones (Niger and Benin). Similarly, [62] reported values ranging from 0.45 to 1.63 TLU/ha/year in the Sudanian zone of Burkina Faso. Values akin to this study's (0.40 TLU/ha/year) were observed by [37] in a restricted grazing area at the Sayam secondary livestock multiplication centre in Diffa, Niger. These assessments consider plant dry matter production (fodder) at the end of the active vegetation period [45]. In this region, altered rainfall patterns mean the end of the rainy season varies from late September to mid-October. Consequently, fodder yields harvested in November tend to be lower than the 2.5–4 tDM/ha noted by [58] in the Mindif region. This reduction in fodder production likely results from the continuous pressure of animals on these pastures over time. A similar value of 643.6 kg DM/ha was reported by [56] in Niger.

3.3.3 Diversity of herbaceous families and species in the dry and hot season

A floristic survey of the Maga, Mindif, and Zina pastures identified 21 species belonging to the *Poaceae* and *Acanthaceae* families.

Nine species of *Poaceae* and one *Acanthaceae* species were recorded in Maga (Table 5). The most abundant species included *Z. palustris* L. (36.14%), *Brachiaria sp*. (27.11%), *V. nigratana* (Benth.) Stapf. (12.65%), and *P. pedicellatum* (Trin.) Baill. (6.63%).

Four herbaceous species were identified in Mindif: five *Poaceae* species and one *Acanthaceae*. The dominant species were *S. sphaceleta* (Stapf.) Hubb. (45.67%), *A. adscensionis* (L.) (21.63%), *P. pedicellatum* Trin. (19.23%), and *S. gracilis* Kunth (6.25%).

In Zina, 14 species were documented, including 13 of *Poaceae* and one of *Acanthaceae*. The most prevalent were *Echinochloa* sp. (22.41%), V. *nigritana* (Benth.) Stapf. (16.05%), *H. rufa* (Nees) Stapf. (14.05%), and *Z. palustris* L. (7.36%).

Table 5. Specific contribution and pastoral value of herbaceous species inventoried in the dry and hot season

Scientific name	Family	Maga				Mindif				Zina			
		Is	Fi	Csi	Vp	Is	Fi	Csi	Vp	Is	Fi	Csi	Vp
Andropogon gayanus (Kunth.)	*Poaceae*					1	0.18	2.88	0.95				
Andropogon sp	*Poaceae*									1	0.31	1.67	0.55
Aristida adscensionis (L.)	*Poaceae*					1	1.36	21.63	7.14				
Brachiaria sp	*Poaceae*	2	5	27.11	17.89					1	0.38	2.01	0.66
Cortaderia sp	*Poaceae*	1	0.78	4.22	1.39								
Dactyloctenium aegyptium (L.) Willd.	*Poaceae*									2	0.75	4.01	2.65
Echinochloa colona (L.) Link.	*Poaceae*	2	0.33	1.81	1.19								
Echinochloa sp	*Poaceae*									2	4.19	22.41	14.79
Eragrostis barteri (C.E. Hubb.)	*Poaceae*									2	1.19	6.35	4.19
Eragrostis pilosa (L.) P. Beauv.	*Poaceae*	2	0.44	2.41	1.59								
Hygrophila auriculata (DC.)	*Acanthaceae*	1	0.67	3.61	1.19	2	0.27	4.33	2.86	2	0.56	3.01	1.99
Hyparrhenia rufa (Nees) Stapf.	*Poaceae*									1	2.63	14.05	4.64
Loudetia kagerensis (K.Schum.) C.E.Hubb.	*Poaceae*									2	1	5.35	3.53
Oryza longistaminata (A.) (Chev. & Roehr.)	*Poaceae*									1	1.38	7.36	2.43
Pannicum laxum (Sw.)	*Poaceae*	1	1	5.42	1.79					2	0.69	3.68	2.43
Pennisetum pedicellatum (Trin.)	*Poaceae*	2	1.22	6.63	4.37	1	1.21	19.23	6.35				
Pennisetum sp	*Poaceae*									1	0.81	4.35	1.43
Phragmites communis (Trin.)	*Poaceae*									2	0.44	2.34	1.55
Schoenefeldia gracilis (Kunth.)	*Poaceae*					1	0.39	6.25	2.06				
Setaria sphaceleta (Stapf. & Hubb.)	*Poaceae*					1	2.88	45.67	15.07				
Vertivera nigratana (Benth.) Stapf.	*Poaceae*	1	2.33	12.65	4.17					1	3	16.05	5.3
Zizania palustris L.	*Poaceae*	1	6.67	36.14	11.93					1	1.38	7.36	2.43
Overall total		**13**	**18.44**	**100**	**45.51**	**7**	**6.29**	**99.99**	**34.43**	**21**	**18.71**	**100**	**48.57**

Fi= Specific frequency, Csi= Specific contribution, Vp= Pastoral value, Is= Quality index (3= Very palatable, 2= Moderately palatable, 1= Not very palatable, 0= Not palatable)

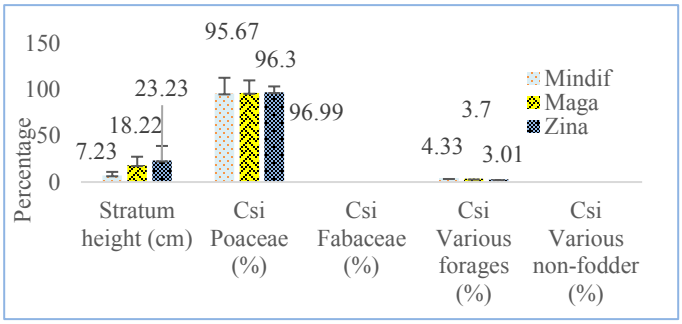
The herbaceous species encountered during this period are mostly perennials. These plants tend to be tufted and have persistent buds, enabling them to regenerate after bushfires. The herbaceous plants found in these areas belong to two plant families: *Poaceae* and *Acanthaceae*. Similar results were obtained by [13] in the savannah ecosystems of the Sudano-Sahelian zone of Cameroon (Mayo-Danay), where *Poaceae*, *Fabaceae*, and *Asteraceae* were identified as the most prevalent families.

The distribution of perennial species is linked to pastures with high fodder productivity. These species play an important role in fodder production on pastures, which are often maintained by fire during the dry season in the Yaéré zone. [35], In the Sudanian zone of Burkina Faso, a test area revealed that perennial grasses dominated rock formations and open wooded savannahs.

These results align with those from a South Sudanian area in western Burkina Faso [19], which states that when pastoral pressure was low, the soil was almost entirely covered by perennial grasses. This applies to the Zina pastures and part of Maga, which are rarely used during the rainy season due to flooding.

3.3.3.1 Specific contribution of herbaceous species families

The contribution of grasses was very high in all the surveyed pastures. The highest values obtained were 95.67% and 96.99%, respectively, at the Mindif and Zina pastures (Figure 6).



Csi= Specific contribution, cm=centimetre, %=percentage)

Fig. 6: Specific contribution of pasture species families

3.3.3.2. Pastoral value of pastures

The pastoral values obtained for the pastures are all below 50 (Figure 7). The Poaceae family contributed the most to the total pastoral value of the visited pastures (31.57% to 46.58%), followed by various other forage species.

The total pastoral values were 34.43%, 44.63%, and 48.57% for Mindif, Maga, and Zina pastures, respectively.

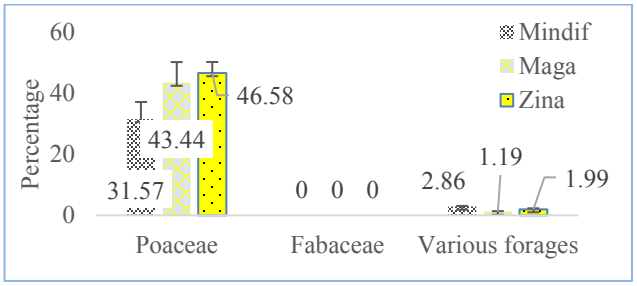


Fig.7: Pastoral value of the different groups making up the pastures

3.3.3.3 Fodder productivity and carrying capacity

Table 6 presents the results regarding the variation in forage productivity among the different species found in the visited pastures.

The maximum amount of fodder produced during the hot and dry season was obtained on the Zina pastures (1,128 ± 161.13 kg DM/ha). The lowest fodder production was on the Mindif pastures (128.6 ± 10.38 kg DM/ha). The average carrying capacities in TLU/ha/HDS were 0.09, 0.28, and 0.50 for the Mindif, Maga, and Zina pastures, respectively.

Table 6. Productivity and load capacities in dry and hot periods

Dry and cold season	Herbaceous productivity Kg DM/ha	CC in TLU/ha/HDS
Mindif	128.6±10.38	0.09
Maga	626.50±49.98	0.28
Zina	1128±161.13	0.50

(CC=carrying capacity, DM=Dry Matter, TLU=Tropical livestock Unit, HDS= Hot Dry Season)

The fodder production and carrying capacity values observed during the period were very low, likely due to the relief and flood-prone nature of the pastures in the Zina and Maga zones, as well as the overexploitation of the Mindif pastures. Fodder production values at Mindif are close to 150.44 and 109.34 kg of dry matter per hectare, resulting in a carrying capacity of 0.101 and 0.089 livestock units (TLU) per hectare per year. These figures were obtained by [66] at Déréki and Tombitere in the Niger Sahel. During the flood periods in November and December, the fodder produced during the rainy season is quickly destroyed by water through processes such as rotting and fermentation. However,

the remaining amount provides an important fodder stock for animals that stay in the plain during March, April, and May. Similar results regarding herbaceous cover were observed by [34] in the Logone floodplain, which showed low coverage in April and May (the hot, dry season) and a decrease in coverage between November and December (during flood periods).

3.3.4 Degree of community and differences between flora

The results in Tables 7 and 8 show that the values of Jaccard's coefficient of similarity (Ij) for the different pastures compared in pairs are all below 50%. Consequently, the different plant communities in the surveyed pastures are not similar.

Table 7. Degree of community and differences between the herbaceous layers

Compared pastures	Herbaceous Ij	Hamming dist.	Floristic difference
Mindif & Zina	0.12	0.88	Very strong
Maga & Mindif	0.40	0.60	Strong
Zina & Maga	0.26	0.74	Strong

It can be seen that the difference in floristic composition of the herbaceous layer of the Mindif pasture compared with that of Zina is very strong, while the difference between the Maga and Mindif pastures is strong, as is that between Zina and Maga.

Regarding woody plants, the floristic difference between the pastures compared in pairs was significant (Table 8).

Table 8. Degree of community and differences between woody flora

Compared pastures	Ligneous Ij	Hamming dist.	Floristic difference
Mindif & Zina	0.26	0.74	Strong
Maga & Mindif	0.32	0.68	Strong
Zina & Maga	0.40	0.60	Strong

The differences in floristic composition between pastures in the area and the lack of similarity observed are likely related to relief, soil type, and the flooded nature of Zina pastures and part of Maga pastures. These results demonstrate the variation in floristic composition between the pastures visited during the season. These findings align with those of [39] in the Sudano-Sahelian zone of Cameroon, who demonstrated that the three landscape units encountered in Waza National Park and its peripheral zone (grassy savannah, shrub savannah, and tree savannah) exhibit distinct flora and vegetation characteristics. [52], The Sudano-Sahelian zone showed that Hamming distances between various plant formations varied unevenly.

4. Conclusion

The vulnerability of pastoral populations, intensified by climatic hazards that affect pastures and livestock, particularly during the dry season, poses a major obstacle to developing livestock farming, especially in Cameroon's Far North region, where the dry season can last up to nine months. This study, carried out in the Mindif, Maga and Zina subdivisions, aimed to improve understanding of the forage species consumed by cattle during the dry season in the Far North. The results showed that all herdsmen encountered in the area were male. Peul zebus are the most widely distributed breed. In Mindif, 80% of the herbs found are consumed during the dry and cold season, compared to 87.9% in Maga. Conversely, all herbaceous plants available during the dry and hot seasons are consumed. Pastoral values are 42.73% and 46.99% in the dry and cold season, especially in Mindif and Maga. In the dry and hot season, they are 34.43%, 44.63%, and 48.57% in Mindif, Maga, and Zina. Productivity and carrying capacity during the dry and cold season were 910 kg DM/ha in Mindif and 1,706.5 kg DM/ha in Maga, with respective carrying capacities of 0.53 and 0.76 TLU/ha/CDS. Values during the dry and hot season were 128.6 kg DM/ha, 626.5 kg DM/ha, and 1,128 kg DM/ha in Mindif, Maga, and Zina, respectively, with respective carrying capacities of 0.09, 0.28, and 0.50 TLU/ha/HDS. The flora of the three pastures visited differs when compared pairwise. The floristic richness of the herbaceous layer was greater. However, restoring the plant cover with the most palatable perennial grass species could significantly improve the pastoral value of the pastures, reduce disease, and increase livestock numbers.

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