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Research article

Floristic composition of ibecetane cattle multiplication ranch rangeland

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Abstract

The floristic composition and pastoral value of the Ibecetane cattle multiplication ranch center in the Niger Republic were investigated in 2022. The rangeland consisted of three soil-geomorphological units. 4 parallel transect lines of 6 km length crossing the landscape units in the East-west direction at 500 +m width from each other were set on the rangeland. Along each transect plot, samples of 50 × 50 m area were demarcated and, 30 quadrats of 1m² were randomly assigned per sampling unit and the herbaceous layer was harvested. Results indicated that 45 herbaceous species with a 3.22 diversity value comprising 23 grasses and 22 legumes belonging to 37 families were identified. Two groups can be distinguished, one group with a soil coverage higher than 10% and including *Cenchrus biflorus* (35.6%), *Tribulus terrestris* (11.9%) and *Dactyloctenium aegyptium* (11.2%), while the other group had less than 10% soil coverage percentage. Distribution analysis of the herbaceous species indicated that the dominant species was C. *biflorus* 36.9% followed by *Dactyloctenium aegyptium* (11.6%), *Alysicarpus ovalifolius* (9.9%) and *Tribulus terrestris* (12.3%). *Cenchrus and Tribulus terrestris* pastures were dominant on shallow limon-clays soils with 3.47 and 0.68 diversity and equitability indexes against and on sandy soil with 1.99 and 0.48, respectively. The C *biflorus* and *D. aegyptium* pasture present on mixt or mixt soil type had a frequency of 35.3 and 11.8% with a diversity and equitability value of 2.93 and 0.60, respectively. Overall, the pasture is of good quality and management is required to restore the lost perennials.

Keywords: Diversity, Equitability, Herbaceous, Ibecetane, Pasture

Introduction

Animal husbandry is the primary activity of 87% of the population in Niger Republic (Ministère de l'Elevage et de Industries Animales (MEIA, 2012). The husbandry systems are nomadic, transhumant, and agro-pastoral, representing 16, 18, and 66% of the animal population, respectively. Livestock feed derived from the enclave and pastoral land (protected by law N° 61005 of 27th May 1961). Despite the large size of the livestock, the large grazing land set above the agricultural zone (above 350 mm rainfall) and livestock routes facilitating the mobility of herders, natural pastures face many challenges, both human and environmental, which often lead to conflict between farmers and pastoralists (Bonnet, 2012). The challenges are demographic pressure on pastoral land and livestock corridors or routes to facilitate mobility, encroachment of misappropriation practices for the development of private ranches (Mary and Bonnet, 2006) and overgrazing (Blench and Marriage, 1999).

Climate change, or changes in rainfall and temperature patterns, desertification, and drought, directly affect the production of agricultural crops as well as forages and livestock (Birendra and Ashisan, 2016). The consequences include severe loss of vegetation cover, above-ground plant productivity, and soil erosion, elimination of soil seed bank, and shift in species composition and density of palatable species replaced by unpalatable or less palatable species (Ahmad *et al*., 2012; Hiernaux, 1996). These resulted in less availability of forage for the animals in the last 10 years as shown by the annual evaluation pastoral campaign (MEIA, 2018).

The herbaceous carpet constitutes the main source of livestock feed in the Sahel in general and Tahoua in particular. The recurrent frequency of drought in the area and the importance of animal population required continuous monitoring and evaluation of the primary sources of feed for animals. Therefore, understanding the overall fodder balance, including potential biomass

production, pastoral value, pasture quality and diversity, and carrying capacity, is of great importance for the effective management of the pastoral zone and decision-making. This study seeks to characterize the grassland resources of Tahoua, focusing on the floristic composition, pastoral value and carrying capacity.

Materials and Methods

***Study area*:** The Secondary Livestock Multiplication or Breeding Centre of Ibecetane (SLMCI) is located between 5.78° and 6.04° East longitude and 15.26° and 15.52° North latitude in the middle of the pastoral zone at an altitude of 547 m. The center was created in 1975, after the big drought of 1972-1973 the country faced, during which the Niger Republic lost 47% of its cattle population, 36% of its sheep herd, 15% for goat and donkey, 12% equine and 17% camels, but its activities fully began in 1976 (Zangui Ibrahima, 1986). The SLMCI ranch has a perimeter of 84.5 km and an area of 42,065 ha._The climate is a Sahelo-Saharan type with irregular and often low rainfall poorly distributed over time and space. The year is divided into three distinct seasons, namely a dry and cold season (November-February), a dry and hot season (March-May) and a rainy season (June-October). As for temperatures, they fluctuate and vary from 17°C in the cold period to more than 40°C in the dry season. The average rainfall recorded in the year 2018 was 318.6 mm. The soil-geomorphology of the center is composed of a succession of dunes and depressions or lowlands running East-West connected by variable slopes from the relief. Thus, three main types of soil are encountered and include sandy and sandy-loamy soils at the level of dune formations, clay to clay-loamy soils in the valleys and lowlands and lastly glacis and rocky soils on the slopes of the hills (CRD, 2016).

***Vegetation survey*:** Vegetation assessment was conducted using Daget and Poissonet (1971) method, also known as intercept point method. The sampling consisted of setting transects set in the east-west by crossing the three types of geomorphological units. A total of 4 parallel transects, each 6 km long and 500 m apart, were laid. Along each transect, 50 m x 50 m plots, i.e., 2500 m^2 and 200 m apart, were placed. A total of 105 plots were set and all the plants were counted for each species in all. Plant samples were collected, dried and analyzed using a conventional method (A). Collected samples from both sites were identified using the plant lexicon of the Niger plant. Descriptive statistics were used to analyze the data and the parameters investigated include:

Specific frequency (Fsi) of (i) = cumulative sum of contacts of the species on the reading line.

The specific contribution: Csi (%) = (Fsi/ΣFsi) *100, where Fsi is equal to a specific frequency of the species representing a sum of contacts of the species on the reading line; ΣFsi is the sum of contact of all species and Csi the specific contribution of specie i.

Species diversity: Shannon-Weiner diversity and Peilou (E) measured the diversity and regularity within the community of an ecosystem. The Shannon-Weiner diversity index (H) is based on information theory. It is expressed in bits, the extreme value being between 0.5 (very low density) and 4.5 (high density). It is associated with the equity index or regularity index, which is more rigorous than the diversity index (Devineau *et al.,* 1984). The regularity index varies between 0 and 1. It tends toward 0 when almost all the population belongs to a single species and toward 1 when each species is represented by the same number of individuals (Saidou *et al.,* 2010).

The regularity index varies between 0 and 1. It tends toward 0 when almost all the population belongs to a single species and towards 1 when each species is represented by the same number of individuals (Saidou *et al*., 2010). The formulae used to calculate these indices are: H=-Σpi log2 (pi), where pi=ni/N = population of the individual in the total sample that belongs to species i, ni = number of individuals of species i, N is the total number of individuals in the pathway, log2 = logarithm base2 and H= Shannon diversity index expressed in bits; E=H/Hmax with Hmax equal to log2 (ni/N)/ ΣFsi..

***Statistical analysis*:** Descriptive statistics and plotting were conducted on Excel 2013.

Results and Discussion

Floristic richness and composition: About 45 species were identified on the rangeland, among which 14 were common to all soil units (31.1%), 22 species (48.9%) were found either in one unit while 9 species (20%) were common to two soils (Table 1). The botanical family of plant species identified can be grouped into three main groups (Table 1). Three botanical families can be distinguished. The first group of 15 families is represented by one genus except the Amaranthaceae and Convolvulaceae families, each represented by two and three species. A second group of 6 families, among which the Capparidaceae, Cucurbitaceae, Euphorbiaceae, Fabaceae, Molluginaceae and Malvaceae, with 2 genera each and a third group of 1 family only (Poaceae) with 10 genres and 14 species. The relative frequency of the first group is lower than 3%, whereas those of the second group range between 4 and 7%. The Poaceae family is the most representative, with 10 genera and 14 species.

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with 10 genera and 14 species and constituted 31% of the inventoried species, followed by the Malvaceae (2 genera and 3 species and represent nearly 7% of the inventoried species.

22 legume plant species belonging to 16 families were identified on the rangeland. Out of this total, the Malvaceae family was dominant with 13.64%, followed by Fabaceae, Euphorbiaceae, Cucurbutaceae, and Molluginoceae family with 9.09%. 23 grass plant species belonging to 7 families were also identified with the dominance of the Poaceae family (56%). All the grass and legume species are annual plant species.

The analysis of the floristic composition revealed that the Poaceae family is the most represented, followed by the Fabaceae/Malvaceae families. The high frequency of the Poaceae family in all the pasture types could be attributed to its high tillering possibility and a higher rate of regrowth after grazing. These findings were in line with the findings of César (1991), who stated that Poaceae family species were the most commonly found, followed by those of legumes. The floristic composition results of the range were also similar to those obtained by Ngom *et al*. (2012) in the Ferlo biosphere reserve (Northern Senegal), and Soumana (2011) in the rangelands of the Zinder region. However, the number of species inventoried in our study was lower compared to those obtained by (Diallo *et al*., 2009) and could be explained by the difference in rainfall pattern and soil characteristics of the area.

Regarding the abundance of species found or species richness, the results indicated that the rangeland had an important diversity and richness of herbaceous plant resources. The herbaceous flora identified was lower than the findings of Alhassane *et al*. (2017), who listed 134 herbaceous species in the natural range of the Maradi region. Ngom *et al.* (2012) reported a grassland flora rich in 120 species divided into 69 genera belonging to 23 botanical families of varying importance in the Ferlo biosphere reserve. Saïdou *et al*. (2010) identified 57 herbaceous species in the Sahelian Experimental Station of Toukounous; Soumana (2011) also reported 252 species in rangelands in the Zinder region, and Guisse *et al*. (2011) listed 62 species in the Dahra area (Ferlo). Although the previous results found higher number of plant species in their study sites, our finding exceeded those reported by Rabiou *et al.* (2017) with 40 herbaceous species identified on protected follows in the Sahelian zone of Banizoumbou; Manzo *et al.* (2017) reported 38 herbaceous species divided into 25 genera and 13 families in the dune zone of south-eastern Niger (case of Mainésoroa), Salou (2016) listed 43 species in the Secondary Livestock Multiplication Center of Fako (Nord-Dakoro/Niger); Rabiou (2017) obtained 23 species from pastoral developments in the Department of Abalak in Niger, Kumawat *et al*. (2022) identified 31 species in 4 ha rangeland of Rajasthan, 33 plant species were identified during the study area in Turkey (Muhammed and Erdal, 2023), Ngom *et al*. (2012) reported 69 genera and 23 families in the ferlo and Rakotoarimanana and Grouzis (2008) reported 27 herbaceous species in the south-western savannah of Madagascar. The difference between these Sahelian sites could be due to overexploitation and poor management of plant resources as indicated by Salou (2016) and Alhassane *et al*. (2017) and might be related to the number of plots surveyed, the abundance of water points in the study areas whose surroundings might be colonized by various species and finally the rainfall of the area.

Table 1. Family distribution of rangeland species

Family	Genera	Absolute frequency (%)	Relative frequency (%)
Poaceae	10	14	31,11
Capparidaceae	2	2	4,44
Fabaceae	2	2	4,44
Cucurbitaceae	2	2	4,44
Cyperaceae	1	1	2,22
Pedaliaceae	1	1	2,22
Rubiaceae	1	1	2,22
Zygophyllaceae	1	1	2,22
Tiliaceae	1	1	2,22
Malvaceae	2	3	6,67
Convolvulaceae	1	3	6,67
Amaranthaceae	1	2	4,44
Asteraceae	1	1	2,22
Aizoaceae	1	1	2,22
Scrophulariaceae	1	1	2,22
Euphorbiaceae	2	2	4,44
Caesalpiniaceae	1	1	2,22
Portulacaceae	1	1	2,22
Caryophyllaceae	1	1	2,22
Molluginaceae	2	2	4,44
Rosaceae	1	1	2,22
Asclepiadaceae	1	1	2,22
Total	37	45	100,00
Confidence interval (%)		0.95	

***Soil herbage and species distribution based on soil types*:** Table 2 indicated that 10156 species (specific frequency) were identified on three types of soils encountered on the rangeland. Six species had a specific contribution of 79.7% out of which C. *biflorus* (36.9%). *T. terrestris* (12.3%), *D. aegyptium* (11.6%), A. *ovalifolius* (9.9%), *E. tremula* (5.2%) and A. *mutabilis* (3.9%). The remaining

Table 2. Herbaceous vegetation composition and average soil herbage of Tahoua rangeland

Family	Genera	Species	Fs	Cs	R (%)	Is	Vr = Cs x Is
Poaceae	10	*Cenchrus biflorus*	3743	36.86	35.65	3	110.57
		Brachiaria xantholeuca	139	1.37	1.32	3	4.11
		Brachiaria ramosa	201	1.98	1.91	3	5.94
		Ctenium elegans	363	3.57	3.46	1	3.57
		Aristida adscensionis	1	0.01	0.01	2	0.02
		Cynodon dactylon	15	0.15	0.14	1	0.15
		Paspalidium geminatum	52	0.51	0.5	0	0
		Eleusine indica	3	0.03	0.03	1	0.03
		Aristida mutabilis	398	3.92	3.79	3	11.76
		Eragrostis tremula	525	5.17	5	3	15.51
		Brachiari alata	238	2.34	2.27	3	7.03
		Pennisetum pedicellatum	1	0.01	0.01	3	0.03
		Dactyloctenium aegyptium	1177	11.59	11.21	3	34.77
		Cencrhus preurii	217	2.14	2.07	3	6.41
Capparidaceae	2	*Gynandropsis gynandra*	294	2.89	2.8	1	2.89
		Cleome paradoxa	1	0.01	0.01	0	0
Fabaceae	2	*Zornia glochidiata*	38	0.37	0.36	3	1.12
		Alysicarpus ovalifolius	1000	9.85	9.52	3	29.54
Cucurbitaceae	2	*Citrullus lanatus*	1	0.01	0.01	2	0.02
		Cucumis melo	35	0.34	0.33	1	0.34
Cyperaceae	1	*Cyperus rotundus*	181	1.78	1.72	2	3.56
Pedaliaceae	1	*Ceratotheca sesamoides*	3	0.03	0.03	1	0.03
Rubiaceae	1	*Mitracarpus villosus*	67	0.66	0.64	0	0
Zygophyllaceae	1	*Tribulus terrestris*	1253	12.34	11.93	2	24.68
Tiliaceae	1	*Corchorus tridens*	3	0.03	0.03	1	0.03
Malvaceae	2	*Sida cordifolia*	1	0.01	0.01	0	0
		Sida ovata	5	0.05	0.05	0	0
		Hibiscus micranthus	2	0.02	0.02	1	0.02
Convolvulaceae	1	*Ipomoea aquatica*	1	0.01	0.01	1	0.01
		Ipomoea vagans	2	0.02	0.02	2	0.04
		Ipomoea aitonii	1	0.01	0.01	1	0.01
Amaranthaceae	1	*Amaranthus viridis*	11	0.11	0.1	0	0
		Amaranthus graecizans	1	0.01	0.01	0	0
Asteraceae	1	*Centaurea perrottettii*	49	0.48	0.47	1	0.48
Aizoaceae	1	*Limeum viscosum*	37	0.36	0.35	0	0
Scrophulariaceae	1	*Striga hermonthica*	3	0.03	0.03	0	0
Euphorbiaceae	2	*Euphorbia hirta*	5	0.05	0.05	0	0
		Phyllanthus pentandrus	1	0.01	0.01	0	0
Caesalpiniaceae	1	*Cassia italica*	4	0.04	0.04	0	0
Portulacaceae	1	*Portulaca oleracea*	12	0.12	0.11	0	0

Family	Genera	Species	Fs	Cs	R (%)	Is	Vr = Cs x Is
Caryophyllaceae	1	*Polycarpaea spp*	7	0.07	0.07	0	0
Molluginaceae	2	*Mollugo nudicaulis*	41	0.4	0.39	0	0
		Gisekia pharnacioides	20	0.2	0.19	1	0.2
Rosaceae	1	*Neurada procumbens*	3	0.03	0.03	0	0
Asclepiadaceae	1	*Leptadenia hastata*	1	0.01	0.01	2	0.02
Total	37		10 156	100	96.72	57	262.88

SF: Specific frequency; SC: Specific contribution; R: Abundant or covering percentage; SI: Specific index; Rv: Relative value

species had a specific contribution of less than 4%. Apart from *T. terrestris*, which had an average quality index, all the dominant five (5) species had a good quality index, and this implies that the pasture of rangeland is of good quality.

The global coverage estimate of the dominant species was 77.1%. Three types of soils were identified on the rangeland and, including sandy soils, shallow limestone-clay soils and mixt soil types or in between dune and shallow zones. The species with good pastoral values (3 mark) were dominant on the three geographical soil types, contributing nearly to 86.2% on the sandy soil, 62.8% on shallow limon-clays soil and 82.4% on mixt soil type.

The landscape of the zone probably favors the availability of water and is certainly the reason why most of the plant species identified had a good pastoral value of 87.6% as shown by the rangeland pasture species composition. The global plant soil herbage of the rangeland was 96.7% and was 92% for sandy soil, 90.8% for mixt soil types and 82.2% on shallow limon-clays soil with a standard deviation of 8%. Only one species had a percent herbage-specific coverage greater than 10% on all three geomorphological units. This was C. *biflorus*, with 19.2% on shallow limon-clay soils. 35.3% on mixt soil types and 52.5% on sandy or dune soils.

Indices (dominance, species diversity, species richness): Two types of pastures were identified based on the floristic composition list and abundant dominant species. These were dominated by *C. biflorus* and *T. terrestris* pasture, *C. biflorus* and *D. aegyptium dominated types*. (i)The *C. biflorus* and *T. terrestris* characteristics of two vegetation units and pasture from shallow limo-clay soil where the proportion of dominant species was weak (six dominant species out of 35 identified (17.1%). Diversity and equitability indexes were 3.47 and 0.68, respectively (Table 3). The value of the equitability in the shallow zone denoted a regular spatial distribution or species. The diversity index indicated a great floristic diversity on shallow soils. (ii) The sandy soil pasture was composed of 18 species. Here, the Shannon diversity index was 1.99 bits and the equitability index of 0.48. These values indicated a diversity of herbage coverage and an abundance of species.

The C *biflorus* and *D. aegyptium* pasture of mixt soil type. In this unit *C. biflorus, and D. aegyptium*, had the highest respective frequencies of 35.3% and 11.8%. The diversity index was 2.93 bits and that of equitability was 0.60. In this pasture type, the dominance of the species group was more pronounced than in the previous pasture type. The specific contribution of 8% for legume was observed on shallow limon-clay soil, while other families were present on all the pasture unit types. They constituted 15.5% of species on mixt soils. 33.5% of species were found on shallow soil and 6.2% on sandy soil. The annual grass dominance could be considered as a pressure index since animals exert a selective consumption of phytomass, which favors the less consumed species to dominate.

The pasture species identified could be regrouped into three family groups, namely the annual grasses, legumes, and other families (Fig 1).

Table 3. Specific richness and index according to landscape unit

Indices	Sandy soil	Shallow limon-clay soil	Mixt soil	Total sample
Total sample	35	35	35	105
Specific richness	18	35	29	45
Shannon	1.99	3.47	2.93	3.22
Equitability	0.48	0.68	0.60	0.59

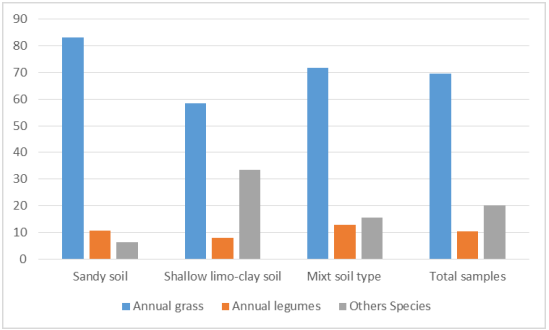

Fig 1. Specific contribution of a family group on vegetation unit (%)

The variation in the specific diversity depends on the pasture units. Thus, the specific richness of shallow or lowland soils was higher than that of the mixt and dune soils. These results corroborated the findings of Toko Imorou (2013), who obtained higher specific richness values on ranges present along the rivers and the bottom of the slopes. However, natural constraints such as high-pressure bad management practices would directly influence the richness and diversity of fodder and plants by causing soil degradation and a reduction or even disappearance of herbaceous plants (Salou, 2016).

***Pastoral value*:** Species with average pastoral value with mark 2 were mostly found on shallow limon-clay soils, while those with low pastoral value were mostly encountered on the mixt soil types. The average pastoral value of species to the global quality index varied between 9.4% in mixt soil and 24.5% in shallow limon-clay soils. Plants with low pastoral value and with no pastoral value contribution were less. The pastoral value also varied in all the different geomorphological units and was 92.0, 82.2 and 90.8%, respectively, on sandy soil, shallow soil and mix soil types.

The pastoral value was higher on dune plots (92%) than on mixt soils and lowlands soils, with 90.8% and 82%, respectively. The grasses group showed the highest pastoral value in dune soils (83.2%), while the legumes group remained higher in mixt soils with a pastoral value of 12.7%. This variation could be explained by the nature of the soil (César, 1994). The gross pastoral values of the three soil types were consistent with those indicated by Bakhoum (2013) for the pastures of the northern Sudanese zones. The gross pastoral value varied from 82.2% to 92.0% according to the soil type. On the scale of vegetation units, it was 87.6% and could therefore be considered very high. Higher pastoral value is strongly dependent on the composition and the specific contribution present in the range. These results showed that the rangelands could be considered good pastures because they had a gross pastoral value greater than 65%, which was the threshold value set by Daget and Godron (1995; cited by Bakhoum, 2013).

Conclusion

The present work focused on the study of the herbaceous vegetation pastoral zone of Tahoua. The floristic inventory has identified 45 species, divided into 37 genera and 22 families. The most important families are Poaceae (10 genera), Malvaceae (2 genera), Molluginaceae (2 genera), Euphorbiaceae (2 genera), Cucurbitaceae (2 genera), and Capparidaceae (2 genera).

The production of the grassland is estimated on average at 1.19 t DM per hectare with a net pastoral value of 84.8%. Depending on the geomorphological units, it has been shown that it is the flora of the lowlands and that of the mixt soils (or transition zone between the lowlands and the dune soils) that are the most diversified in vegetation. However, the pastoral value varies little according to the grazing unit. On dune soils, the floristic richness is less important. Rainfall associated with ecological conditions determines the establishment of herbaceous vegetation. Despite the very heavy exploitation during the hot, dry season (March to May), the pastoral zone seems to meet the demand for animals. Due to the high frequency of fire outbreaks consuming many hectares of fodder, higher forage production needs to be protected from fire, whereas bare areas need soil and water conservation techniques to restore land degradation.

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