TARABA JOURNAL OF AGRICULTURAL RESEARCH
ISSN: 978-978-923-450-9
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©tajar publication 2020

FLORISTIC DIVERSITY AND FORAGE YIELD IN A NATURAL RANGELAND OF MAMBILLA PLATEAU, NIGERIA

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Received 27th October, 2020 Accepted 15th January, 2021

ABSTRACT

The study was conducted to investigate diversity of flora and forage yield on the Mambilla Plateau, Taraba State, Nigeria. Four (4) rangelands were selected and surveyed. And the results indicated a total of twenty (20) trees species belonging to 13 families of Eucaliptus tereticornis (53.19%), Psidium guajava (10.63%), Mangifera indica (6.38%), Ficus lutea (4.26%), Psychotria peducularis (4.26%), Clausena anisata (2.66%), Erythrophyla (2.66%), Pisum sativa (2.66%), Albizia gummifera (1.60%), Bridelia speciosa (1.60%), Combretum molle (1.60%), Syzigium malaccense (1.60%), Dalbergia latifolia (1.06%), Entada abyssinica (1.06%), Newtonia buchananii (1.06%), Trema orientalis (1.06%), (Polinia vine (1.06%), Anthonotha nolgia (0.53%), Cola verticillata (0.53%) and Nuxia congesta (0.53%). Results also indicate a total of 25 grass/herbs species belonging to 18 families of abundance as Sporobolus Spp (33.09%), Imperata cylindrical (14.18%), Sida acuta (9.81%), Pycnantha (4.72%), Guizotia scabra (4.01%), Diodia virginiana (3.30%), Ageratum conyzoides (3.07%), Vernonia (2.95%), Chromulina (2.48%), Aspilia thouarsii (2.36%), Emilia spp (2.12%), Nephrolepis exaltata (2.12%), leea guineensis (1.77%), Deinbolia spinata (1.65%), Cantium vulgare (1.53%), Vogelii nobilis (1.30), Gazinia spp (1.18%), Lithofragma (1.18%), Piper peltalum (1.18%), Protea spp (1.18%), Rotundifolium (1.18%), , Sonchus spp (1.18%), Madagalensis (1.06%), Cyperus albostriatus (0.94%) and Dioscoria spp (0.35%). Shannon-weigner diversity revealed indices of 3.11 (Ngel-nyaki), 2.84 (Zongon-Ajiya), 2.05 (Lekitaba) and 1.93 as the least in Yerimaru for trees, and 3.90 (Ngel-nyaki), 2.82 (Yerimaru), 2.64 (Zongo-Ajiya) and least was 2.05 (Lekitaba) for grasses. Forage yield showed Ngel-nyaki (3,947.60kg/m^2)> Yerimaru (3,535.30kg/m^2) > Lekitaba (3,195.10kg/m^2) > Zango Ajiya (2,408.60kg/m^2). The rangelands are ecologically rich.

Keywords: Ecology, Rangelands, Flora, Diversity, Forage Yield.

INTRODUCTION

Rangelands are dominated by grasses, forbs, and shrubs probably resulting from its characterized low precipitation, shallow soils, slow nutrient cycling and are efficient at water and nutrient utilization making the environment suitable for ecological balance. Therefore, practices that are appropriate to temperate pastures, such as fertilization and ploughing, are often inappropriate on rangelands. They are very productive, providing sustainable income for ranch communities while protecting valuable natural resources through appropriate grazing strategies (Freidel *et al*., 2000).

Rangelands contribute largely to the socio-economic growth of most countries through provision of habitat and forage for wildlife and livestock, ecological balance to the ecosystem as well as environmental indicator. However, sustainability of a rangeland can only be maintained if it remains at its natural state in terms of flora and fauna in the presence of indigenous soils sustained under favourable weather conditions. However, what is being viewed nowadays as natural rangelands are in most cases secondary succession habitats emerging from human destructions for either agricultural activities, deforestation due to logging or merely an outcome of recurring annual bush fires (Umrani, 1998).

Irrespective of the state of a rangeland, monitoring involving the process of watching, measuring and documenting interactions, conditions and changes on the rangeland is pertinent to pave way for sound management decisions that could enhance its sustainability. However, concerted effort is required from both governmental and non-governmental organizations as well as the rural communities to attain a natural rangeland's equilibrium and sustainability (Umrani, 1998 and Ruyle, 2003).

Almost all over the world rangelands are recognized as significant baseline resource in the livestock industry. This is more so on the continents of Africa, Australia, North America and South America where vast expanses of territory provide habitat and grazing for livestock and wild life. Rangelands are home to some 200 million people in the tropics and support about a billion domestic animals (Heady and Heady, 1982). For all practical purposes, ruminant livestock production in Nigeria is in the hands of pastoralists who own over 90% of the stock holdings. The stocks are mainly reared under transhumance system of grazing over large expanses of rangelands. Under this production system the livestock rely on the natural rangeland forages with little or no supplementation for their nourishment year-round (Heady and Heady, 1982).

The Mambilla Plateau which is the high est peak of Nigerian landscape provides good and favourable conditions for the establishment and development of rangeland resource. It contains vast wild lands with enormous and diverse species of grasses, forbs and herbs that have high potentials for a rangeland. But because of improper understanding of the use and importance of rangelands, these resources are being indiscriminately overexploited. Hence, the need for this study to look into the habitat ecology of rangelands as regards to diversity of plants biomass and associated faunal species (Sommer and Ross, 2011).

MATERIALS AND METHODS

Study Area

The investigation took place on the Mambilla Plateau (figure 1) which at about 1,500 m above sea level is Nigeria's peak. The Mambilla Plateau is located in Taraba State straddling the Cameroonian border (longitude 6°47'43″N and latitude 11°11'58″E). The Mambilla Plateau is the origin of the Taraba River, largest tributary to the Benue River. The Mambilla Plateau demarcates the northern edge of the Cameroonian Highlands and adjoining on the Nigeria side by fragments of montane forests and Africa's Gulf of Guinea forests considered to be a hotspot of biodiversity (Oates *et al.*, 2004; Sommer and Ross, 2011). Heavy downpours from March – mid November are followed by 3 months period with very little or no rainfall. Habitat types include flat grassland, riverine and gallery forest, montane forest and montane grassland. It includes a succession of lowland along the cameroonian border (<825 m), sub-montane (>1,650 m) strata, rising to 2,419 m at Gangirwal, Nigeria's peak.

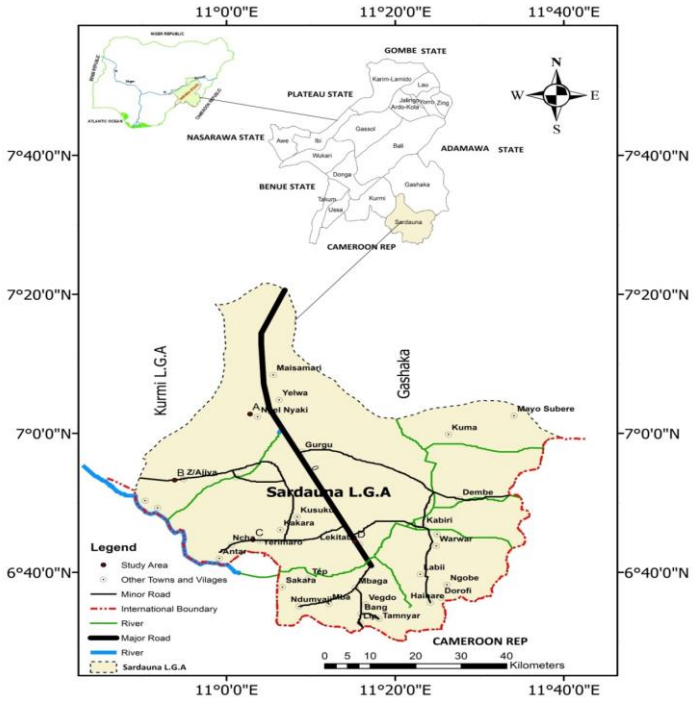

Figure 1: MAP OF SADAUNA LOCAL GOVERNMENT AREA SHOWING THE STUDY SITE

METHODOLOGY

Line transects were used proceeding randomly selected representative sites (a, b, & c) of the Mambilla Plateau. A compass direction was randomly selected and stringed into a 50 meter tap along the directions covering 4 km. Measurements of species occurrences were recorded at every 50 meters increment along the said line. The measurement process was repeated by restringing the line and re-measuring the desired factors and elements. The dominant species were recorded within 20 cm of each toe step.

Initially, a transect location was randomly selected in each site and permanently marked. This includes the use of GPS coordinate and specific distances and directions to obvious landmarks.

Statistical Analysis

The Shannon-Weiner diversity index (H') was used to determine species diversity and abundance of each rangeland, mathematically expressed as:

$$H' = -\sum_{i=1}^{s} \text{pi In pi}$$

Where H' is the species diversity index, s is the number of species, and "pi" is the proportion of individual of each species belonging to the i^{th} species of the total number of individuals. Shannon's Equitability Index (H'E) was used to assess the species evenness, using the formula;

$H'E = H'/H_{max}$

Where H_{max} is defined as lnS

Relative Abundance (RA) was used to determine the percentage of individual taxa or species in a sampling point given as;

$$RA = \frac{No.of\ individual\ taxa}{Total\ No.of\ all\ species}\ X\ 10$$

Forage yield was determined using the pasture height or ruler method, where a ruler will be placed at ground-level in the centre of a randomly thrown quadrat and visually assessing the average height of herbage in the quadrat.

RESULTS

A total of twenty (20) trees species belonging to thirteen (13) families were identified during the study period Table 1 . The families *Cambretaceae* and *Fabaceae* had 3 species each, followed by *Myrtaceae* and *Phyllanthaceae* with 2 species each, while the rest of *Acanthaceae*, *Ancardiaceae*, *Cannabaceae*, *Lycaenidae*, *Moraceae*, *Rubiaceae*, *Sterculaceae* and *Silbaceae* had recorded 1 species each. In terms of abundance, *Eucalyptus tereticornis* recorded 100 individuals (53.19%) as the highest, followed by *Psidium guajava* 20 individuals (10.63%), *Mangifera indica* 12 individuals (6.38%), *Ficus lutea* and *Psychotria peducularis* with 8 individuals (4.26%), *Clausena anisata*, *Erythrophyla* and *Pisum sativa* had 5 individuals each (2.66%), *Albizia gummifera*, *Brigdelia speciosa*, *Combretum molle* and *Syzigium malaccense* recorded 3 individuals each (1.60%), *Dalbergia latifolia*, *Entada abyssinica*, *Newtonia buchananii*, *Polinia vine* and *Trema orientalis* all recorded 2 individuals (1.06%), while *Anthonotha nolgia*, *Cola verticillata* and *Nuxia congesta* recorded 1 individuals each (0.53%).

Table 1: Checklist of Tree Species on the Mambilla Plateau

Family	Scientific name	English name	Species No. (Frequency)	RA
Acanthaceae	*Polinia vine*	Unknown	2	1.06
Anacardiaceae	*Mangifera indica*	Mango	12	6.38
Cannabaceae	*Trema orientalis*	Oriental trema	2	1.06
Combretaceae	*Combretum molle*	Valvet bushwillow	3	1.60
Fabaceae	*Anthonotha nolgia*	Anthonotha	1	0.53
	Dalbergia latifolia	Rosewood	2	1.06
	Entada abyssinica	Unknown	2	1.06
	Albizia gummifera	Peacock flower	3	1.60
	Pisum sativa	Pea	5	2.66
Lycaenidae	*Newtonia buchananii*	Baker	2	1.06
Moraceae	*Ficus lutea*	Giant-leaved	8	4.26
Myrtaceae	*Eucalyptus tereticornis*	Eucalyptus spp	100	53.19
	Psidium gujava	Guava	20	10.63
	Syzygium malaccense	Malay apple	3	1.60
Phyllanthaceae	*Bridelia speciosa*	Bridelia	3	1.60
Rubiaceae	*Erythrophyla*	Musanda linearfolia	5	2.66
	Psychotria peduncularis	Psychotria	8	4.26
Rutaceae	*Clausena anisata*	Clausena	5	2.66
Sterculiaceae	*Cola verticillata*	Cola nut	1	0.53
Stilbaceae	*Nuxia congesta*	Brittle-wood	1	0.53
Total Species			**188**	**99.99**

Sources: (Field work research, 2017) **RA**= Relative Abundance

Table 2 revealed a total of 25 grass/herbs species belonging to 18 families. (*Cantium vulgare*, *Cyperus albostriatus* (0.94%), *Sida acuta* (9.81%), *Imperata cylindrical* (14.18%), *Sporobolus Spp* (33.09%), *Diodia virginiana* (3.30%), *Ageratum conyzoides* (3.07%), *Aspilia thouarsii* (2.36%), *Vernonia* (2.95%), *Gazania spp* (1.18%), *Guizotia scabra* (4.01%), *Sonchus spp* (1.18%), *Chromulina* (2.48%), *Dioscoria spp* (0.35%), *Emilia spp* (2.12%), *Vogelii nobilis* (1.30), *Madagalensis* (1.06%), *Rotundifolium* (1.18%), *Nephrolepis exaltata* (2.12%), *Piper peltalum* (1.18%), *Protea spp* (1.18%), *Pycnantha* (4.72%), *Deinbolia spinata spp* (1.53%), *Lithofragma* (1.18%) and *leea guineensis* (1.77%) belonging to 18 families. *Asteraceae* had the highest species as 6, followed by *Rubiaceae and Poaceae with 2 species each, while the remaining families of Apocynaceae, Chromolinaceae, Cyperaceae, Dioscoriaceae, Fosbergi, Gentiniaceae, Guttiferae, Lamiaceae, Lomariopsidaceae, Malvaceae, Piperaceae, Proteaceae, Sapindaceae Saxifragaceae Vitaceae* with 1 species each.

Table 2: Checklist of Grass/Herbs Species on Mambilla Plateau

Family	Scientific name	English name	Species No. (Frequency)	RA
Apocynaceae	*Pycnantha*	Pleiocarpa Spp	40	4.72
Asteraceae	*Ageratum conyzoides*	Goatweed	26	3.07
	Aspilia thouarsii	Aspilia	20	2.36
	Gazinia spp	Treasure flower	10	1.18
	Guizotia scabra	Sunflecks	34	4.01
	Sonchus spp	Sow thistles	10	1.18
	Vernonia	Ironweed	25	2.95
Chromulinaceae	*Chromulina*	Golden-brown algae	21	2.48
Cyperaceae	*Cyperus albostriatus*	Cyperus Swamp	08	0.94
Dioscoreaceae	*Dioscorea spp*		03	0.35
Fosbergi	*Emilia spp*	Tessel Flower Pualele	18	2.12
Gentiniaceae	*Vogelii nobilis*	Anthocluster	11	1.30
Guttiferae	*Harungana madagascariensis*	Harungana	09	1.06
Lamiaceae	*Rotundifolium*	Platostoma	10	1.18
Lomariopsidaceae	*Nephrolepis exaltata*	Sword fern	18	2.12
Malvaceae	*Sida acuta*	Wire weed	83	9.81
Poaceae	*Imperata cylindrical*	Spear grass	120	14.18
	Sporobolus Spp	Drop seed	280	33.09
Piperaceae	*Piper peltalum*	Pepper	10	1.18
Proteaceae	*Protea spp*	Sugarbush	10	1.18
Rubiaceae	*Diodia virginiana*	Viginia buttonweed	28	3.30
	Canarium vulgare	Pilinut	13	1.53
Sapindaceae	*Deinbollia pinnata*	Unknown	14	1.65
Saxifragaceae	*Lithophragma parviflorum*	Small flower	10	1.18
Vitaceae	*Syzygium guineensis*	Woodland waterberry	15	1.77
		Total	**846**	**99.89**

Sources: (Field work research, 2017). **RA =** Relative Abundance

Table 3 revealed that Ngel-Nyaki had the highest species abundance and evenness (63, 0.75) followed by Zongo-Ajiya (48, 0.64), then Lekitaba (40, 0.56) and the laest was observed in Yerimaru (37, 0.53). Shannon-Weiner diversity indices for trees reveal that Ngel-Nyaki had the highest diversity of 3.11, followed by Zongo-Ajiya 2.84, Lekitaba 2.05 and 1.93 as the least in Yerimaru. While for grasses/herbs category, it revealed that species abundance is of the order Ngel-Nyaki (359) followed by Zongo-Ajiya (203), then Yerimaru (176) and the least was in Lekitaba with 108. Evennes showed that Ngel-Nyaki had the highest (0.66), followed by Yerimaru (0.53), then Zango-Ajiya (0.51) and the least (0.44) was in lekitaba. Shannon-Weiner diversity index showed indices of 3.90 (Ngel-Nyaki) as the highest, followed by 2.82 (Yerimaru), then 2.64 (Zongo-Ajiya) and least was 2.05 (Lekitaba).

Table 3: Diversity Characteristic of Ranged lands

Component	Diversity Parameters	Range lands A	B	C	D
Trees	$H^{'}$	3.11	2.84	1.93	2.05
	E	0.75	0.64	0.53	0.56
	S	63	48	37	40
Grass/herbs					
	$H^{'}$	3.90	2.64	2.82	2.05
	E	0.66	0.51	0.53	0.44
	S	359	203	176	108

Sources: (Field work research, 2017). NB: $H^{'}$ = Diversity index; E = evenness; S = Abundance

Forage yield is the amount of grass or forage a rangeland is capable of producing from a given area of the range, which constitute the primary productivity in the rangelands. Results of this study (Table 4) indicated that Ngel Nyaki with 3,947.6 kg/m^2 is the highest, followed by Yerimaru with 3,535.3 kg/m^2, Lekitaba with 3,195.1 kg/m^2 while Zango-Ajiya which constitutes the least forage yield had 2,408.6 kg/m^2, with percentage forage yield of 30.16%, 27.01%, 24.41% and 18.41% respectively.

Table 4: Average Height and Forage Yield of Rangelands in Four Sites on the Mambilla Plateau

S/No.	Site	Average height (cm)	Forage yield
1	Ngel Nyaki	0.29	3,947.6 kg/m^2
2	Zango Ajiya	0.14	2,408.6 kg/m^2
3	Yerimaru	0. 24	3,535.3 kg/m^2
4	Lekitaba	0.18	3,195.1 kg/m^2

Sources: (Field work research, 2017).

DISCUSSION

Species Abundance and Diversity

The species abundance and diversity in the study area indicates an interspersion of species including grasses, forbs and shrubs with few trees which are the feed resources of natural rangeland in the study area. The most dominant vegetation were determined to be the grasses and forbs (n = 846; 81.81%), while Trees (n = 186; 18.19%) of the vegetation cover. This shows that grasses constitute the majority of the vegetation cover while tree are sparsely distributed at the high altitudes and along riverine areas. This is probably an indication of its mountainous nature and because the grasses and forbs constitute primary element of fodder to livestock and trees as the only supplement when there is no much grasses cover.

Livestock generally prefer to graze or feed on grasses than they do on trees probably because the grasses and forbs are more palatable than the trees, as lignifications which result in high concentration of different chemicals in the trees is much more than in grasses. The findings of this study could also be due to height/altitude of the study area: a situation in which the nutrient contents are probably washed down slopes by heavy rains which makes the available residual nutrient to only support growth of grasses and not trees. It is also likely that overgrazing is responsible for the gradual disappearance of tree species due to total uprooting of seedlings by livestock during grazing which disrupts regeneration. Other climatic conditions of temperature, humidity, light etc. could also have effect on the availability and abundance of different flora encountered in the study area, as all of which have different effects on the diversity and abundance of the different vegetation.

The results of this study concurs with Landsberg, *et al.* (2003) who reported that the ground-layer flora (grasses and forbs) are very much abundant than upper layer species in Australia rangelands, with grasses occurring at about 466m and trees at 134m. Hailu (2016) reported that the grazing management practices have negative effect on the distribution, diversity, biomass and soil attributes of vegetation species in Harishin rangelands of Somalia Regional State of Ethiopia.

The shrubs and trees are rather few and this is not unconnected with the effect of anthropogenic activities like wild fire, agriculture, overgrazing which kill seedlings of the woody species and the high rate of deforestation and illegal mining by the surrounding communities which may in turn result to gully erosion. The trees species observed are in agreement with Aregheore (2005), who listed the dominant tree species in the zone to include *Isoberlinia doka, Parkia biglobosa, Butyrospermum paradoxum* and *Khaya senegalensis* forming the bulk of the scattered woodlands.

The low tree species richness (20 taxa) observed in the study area may be misleading to an understanding of the whole area to be under its natural state, on the contrary to a probable anthropogenic activities over time resulting into the present scenario. This low number of trees may not have been unconnected to human preference in relation to utilization (Barau *et al.*, 2016). As these tree species are used either for firewood, local home construction, timber, furniture, leaves etc. by the locals in the area. Such pressure from human and repeated grazing by livestock may perhaps reduce reproduction potentials that may pave way for non-reproductive cycles resulting into destroying the seedlings due to its flexibility and palatability. It may also be that seed dispersal mechanism are not adequate and could affect or restrict regeneration and growth, hence, affecting abundance. Overgrazing leads to increased bare

ground and washing away of deposited seeds that could probably be encouraged by the steep sloppy terrain of the study area to the detriment of montane forest regeneration hence, the observed scenario.

The result is in line with the findings of Egeru *et al.,* (2015) who acknowledged that low tree species richness of native trees in Karamoja region of Uganda and opined that it could be as a result of poor management due to anthropogenic activities.

The present study revealed that grasses/herbs make the dominant plant species in the study area. The dominant grasses and herbs included *Sporobolus Spp (33.09%), Sida acuta* (9.81%), *Pycnantha (4.72%), Cyperus albostriatus (0.94%), Imperata cylindrical (14.18%), Diodia virginiana (3.30%), Ageratum conyzoides (3.07%). Sporobulus (33.09%)* is a perennial plant. Majority of the dominant grass/herbs species have favourable characteristics which include wind pollination aid by hermaphroditic nature, germination ability under minimal favourable conditions, grows well in most soil types including nutritionally poor soils and PH levels, as well as having tolerance to droughts. Most of these grass/herbs species are perennial in nature and germinate immediately after receiving first rainfall (Verdoodt *et al.,* 2008; Lugusa *et al.,* 2006). Most of these grass/herbs species emerge with decreasing palatable grass/herbs species probably resulting from overgrazing. Hence, their invasion of a vast land may be an indication of poor range conditions as reported by Oluwale *et al.* (2008). Based on the aforementioned findings, it may not be out of place to state that the study area is being faced with the problem of severe grazing in agreement with Du Toit (2010). In other words, the dominant grass/herbs species of the study area are characterised by self-seeding ability, tolerance to drought and high spreading or dispersal capacity in consonance with Machogu (2013).

Forage Yield

Forage yield and production from pasture and rangeland can vary significantly from one to another and year to year which may be linked to precipitation, temperature, available nutrient and plant health (Berger, 2017). The high forage yield (3,947.6kg/m^2) of Ngel-Nyaki as shown by the findings of this study may not be unconnected to the presence and effort of the Ngel-nyaki Montane Forest Project (NMFP). The establishment and maintenance of NMFP over a decade most have contributed immensely on the conservation status of the study site. The outcome of this study may also be an indication on the recovery of some endangered grass species after a decade of grazing restriction in some parts of the study area. Furthermore, the findings of this study may not be far from the well established fact that the presence of researchers in any given area can provide deterrence to anthropogenic activities that may favour the depletion of its resources (Buba *et al.,* 2016).

The finding of this study disagrees with the findings of Khan (2003) who reported a whooping 700kg/ha of forage yield in Pakistan as against the 0.39476kg/ha recorded in Ngel-Nyaki.

Considering the other Rangelands of the Mambilla Plateau, whose biomass yield were lower than that of Ngel-Nyaki but yet high enough to support grazing may be related to high weeds population resulting from the suggested severe grazing of the study area: a situation whereby repeated grazing on palatable plants species may lead to uprooting and killing before flowering and fruiting stages. By so doing, the palatable plants species are wiped out and succeeded by weeds and unpalatable plants, hence, the high biomass yield as shown by this study. Consequently, growth rate of the said plant species are further enhanced by climatic factors and physical conditions of the habitat in comformity with the findings of Egeru *at al.* (2015). The steepy terrain of the study area may also have favourable influence on biomass yield by regulating grazing regimes and trampling with subsequent mild grazing with associated high forage yield (Dasci and Comakli, 2011).

CONCLUSION

This study determines the diversity of flora, forage yield and forage composition on the Mambilla Plateau. The study revealed an interspersion of plants species diversity in the study area and includes grasses, forbs and shrubs with few trees that constitutes feed resources of a

natural rangeland. The most dominant vegetation is grasses and forbs, while Trees are mostly found eucalyptus.

The outcome of the study indicates that the rangelands of the Mambilla Plateau still contain the ecological potentials, for tourism and conservation as well as sustainable resource exploitation such as grazing management. However, these potentials are faced with threats from anthropogenic activities and over exploitation. Despite the lack of grazing management plan, the biomass yield of the study remains high. However, government attitude towards this region has paved the way for indiscriminate exploitation of this rich scenery or in some cases left untapped. In conclusion, if efforts are made available to the natural features of the study area, there will be hope for attaining the best rangelands in Nigeria. Concerted effort from the Government, individuals, and Non-governmental organizations is therefore, required to ensure a stable ecological balance in the region.

ACKNOWLEDGEMENT

We wish to acknowledge our field assistants (Misa Zubairu, Dahiru Zubairu, Thomas Patrick and Idrisa Musa) whose knowledge of the terrain and vegetations were very helpful. And lastly, to all the many individuals, who also assisted in one way or the other and are not mentioned, your contribution will remain greenly fresh in our memories. We will always remain grateful to all of you.

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