International Journal of Agriculture and Environmental Research

ISSN: 2455-6939

Volume: 11, Issue: 06 "November-December 2025"

MANAGEMENT AND CONSERVATION OF DANIELLIA OLIVERI AGROFORESTRY PARKLANDS IN THE SUDANO-SAHELIAN ZONE OF CAMEROON

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DOI: https://doi.org/10.51193/IJAER.2025.11604

Received: 29 Sep. 2025 / Accepted: 07 Oct. 2025 / Published: 24 Nov. 2025

ABSTRACT

In Northern-Cameroon, as in other semi-arid zones of Africa, farmers have historically cleared wooded savannas to create cultivated landscapes. These human-made, multi-tiered systems are known as agroforestry parklands. Despite their agricultural importance, they have not been the subject of comprehensive scientific study concerning their sustainable management and conservation, even as they undergo significant agricultural transformation. Although related studies exist, to our knowledge, none have specifically focused on the role of indigenous knowledge in the sustainable management and conservation of *Daniellia oliveri* agroforestry parklands. This study aims to analyze the indigenous knowledge that facilitates the sustainable management of these parklands. A methodological approach based on farmer surveys was employed in the Bénoué and Mayo-Rey divisions. Data were collected using semi-structured questionnaires administered to a total of 504 farm operators managing *D. oliveri* parklands, with 252 operators selected from each division. The results indicate that the management of *D. oliveri* parklands is guided by traditional practices such as pruning (94.58%) and bushfire control (46.42%). Soil fertility is maintained through the application of organic fertilizers (50.79%) and crop rotation (27.94%). A floristic inventory revealed a regeneration rate of 59.79%. Seedling density varied from 14 stems per hectare in actively cultivated parks to 53 stems per hectare in

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fallow parklands. Agricultural yields ranged from 1.6 t/ha for *Oryza sativa* to 11.11 t/ha for *Zea mays*. The findings demonstrate that indigenous knowledge provides an effective foundation for the sustainable management and conservation of *Daniellia oliveri* agroforestry parklands.

Keywords: Agroforestry parkland, *Daniellia oliveri*, Sustainable management, Sudano-sahelian, Cameroon.

1. INTRODUCTION

The global demographic boom and the consequent intensification of rural land use have precipitated a critical reduction in land availability (Mahamadou *et al*., 2024). This scarcity has fundamentally altered patterns of natural resource management (Mamah *et al*., 2019). In light of the demonstrated limitations of conventional, input-intensive agriculture, a growing body of research has highlighted the multifaceted and essential roles played by agroforestry systems (Mapongmetsem, 2024). Agroforestry is defined as "a land use system in which perennial woody plants are deliberately maintained in association with crops and/or livestock in a dispersed spatial arrangement, and where both ecological and economic interactions exist between the woody plants and the other components of the system" (Boffa, 2000). These systems are of crucial importance for food security, traditional medicine, and the maintenance and restoration of soil fertility (Mapongmetsem *et al.,* 2022). This research was conducted within *Daniellia oliveri* agroforestry parklands in the Sudan-Sahelian zone of Cameroon. These parklands provide local operators with products for food, pharmacopoeia, energy, and service wood, constituting vital sources of income for rural and urban populations alike (Dangai *et al*., 2020; Dodorom *et al*., 2023). From an ecological perspective, they contribute significantly to climate change adaptation and mitigation through carbon sequestration, as well as the protection and enhancement of soil fertility (Avoutchou *et al*., 2022). However, these agricultural production systems are experiencing progressive degradation (Njoya *et al*.,2022). Primary constraints include fuelwood extraction, timber harvesting, the collection of medicinal products, bush fires, overgrazing, shifting cultivation employing slash-and-burn techniques, and prolonged drought (Dodorom, 2024). Furthermore, these systems face challenges such as weak natural regeneration and the slow growth rates of key, high-value agroforestry species (Dona, 2018). Consequently, the capacity of *D. oliveri* parklands to provide essential ecosystem services to operators is increasingly compromised. Therefore, it is imperative to evaluate the indigenous management strategies implemented for their conservation. While previous studies have analyzed farmer perceptions of climate change and adaptive measures in the Sudan-Sahelian zone of Cameroon, a significant research gap remains (Koguia *et al*., 2021). To our knowledge, no study has specifically focused on the agroforestry parklands of *D. oliveri*, despite their role as sites of significant agricultural transformation. It is within this context that the present study was initiated, with the primary objective of cataloging the indigenous knowledge

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that contributes to the sustainable management and conservation of *Daniellia oliveri* agroforestry parklands.

2. MATERIALS AND METHODS

2.1. Study Area

The study was conducted in the sudan-sahelian zone of Cameroon, a region with a predominantly rural population (MINAT, 2010). The specific site is geographically located at approximately 9°17’59.54” N latitude and 13°23’54.13” E longitude, with an average altitude of 249 meters above sea level [15] (Fig:1). The area is characterized by a tropical climate, featuring a prolonged dry season and a short rainy season (Letouzey, 1968). It is among the zones most severely affected by agricultural land degradation, a consequence of land scarcity, overexploitation, and the compounded effects of climate change (Peltier, 2007). Primary crops include *Zea mays*, *Arachis hypogaea*, *Gossypium hirsutum*, and *Oryza sativa* (IRAD, 2008). The vegetation consists of residual, sparse wooded savannas and open forests (Letouzey, 1968).

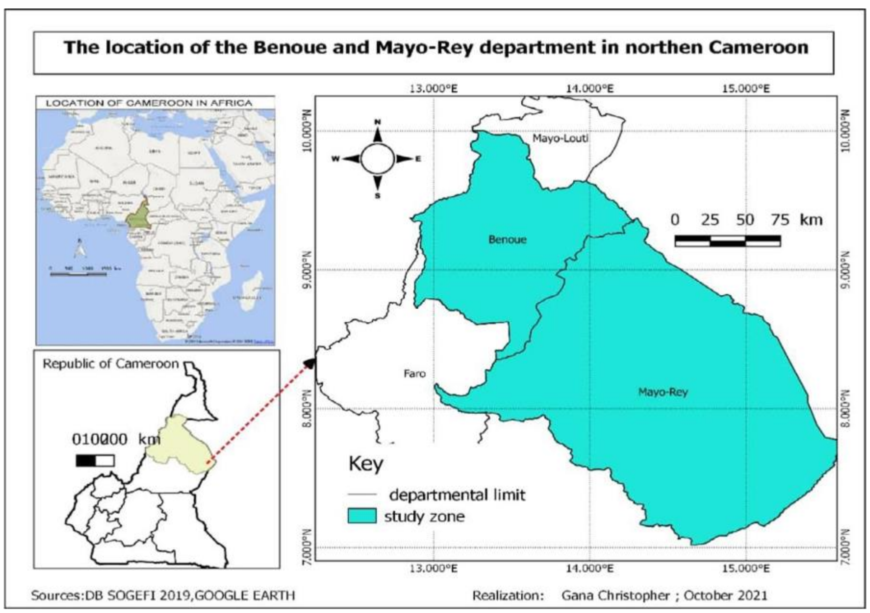

Figure 1: Map of study zone

2.2. Sampling and data collection

The unit of analysis for this study was the individual farming operation, as this is the level at which critical decisions regarding land-use management and conservation techniques are made. The research was conducted in the Bénoué and Mayo-Rey departments. A participatory and iterative scientific approach was employed at each site (Hamawa, 2015). The methodology consisted of two

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phases. **Preliminary investigation:** The preliminary phase facilitated contact with key resource persons, **identified potential challenges in administering the questionnaire**, and enabled the **refinement** of the survey instrument. This phase also served to finalize the selection of study sites (Houehanou *et al*., 2016). Data Collection: he main data collection method utilized individual semi-structured interviews, conducted with a previously developed questionnaire (Njoya *et al*., 2022**)**. This approach was chosen to capitalize on and clarify local knowledge and skills related to the sustainable management of *Daniellia oliveri* agroforestry parklands. Respondents were selected if they were over 15 years of age, based on the premise that younger individuals would possess less relevant experiential knowledge (Houehanou *et al*., 2016). The interviews focused on management practices and the assessment of agricultural yields within the parklands. A total of 504 operators were surveyed, with 252 randomly selected from each department.

2.3. Assessment of regeneration

A floristic inventory was conducted across 144 quadrats, each measuring 100 m x 100 m. Within these quadrats, all individuals of any species with a height of less than 5 m and a diameter at breast height (DBH) of less than 10 cm were classified as regeneration (Ngom *et al*., 2013). To differentiate between seedlings and root sprouts, the root system was excavated; seedlings were identified by the presence of a taproot system, while shoots developed directly from roots. The renewal rate (TR) was calculated as follows (Poupon, 1980):

TR = (Total number of young plants/Total population size) *100. The specific importance of regeneration (ISR) for a species was determined using the ratio (Akpo et Grouzis, 1996): **ISR = (Number of young plants of a species /Total number of young plants counted) * 100**

2.4. Estimation of agricultural yield

Agricultural yield was estimated using the square yield method. Within each 100 m × 100 m plot, ten 5 m × 5 m (25 m²) squares were randomly selected, and all produce within each square was harvested. The harvested seeds were dried and weighed, and the mean yield from all measured squares was calculated and extrapolated to a per-hectare basis. Seed weights, recorded in kilograms, were then converted to tons.

2.5. Data analysis

The collected data were analyzed using descriptive statistics. All analyses were performed using SPSS software.

3. RESULTS

3.1. Local conservation practices of agroforestry parklands of *Daniellia oliveri*

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The percentage of conservation techniques in *Daniellia oliveri* agroforestry parklands ranged from 11.53% for assisted natural regeneration in Bénoué to 94.58% for pruning in Mayo-Rey (Table 1).

Table 1: Local practices for the conservation of agroforestry parklands of *Daniellia oliveri*

Zones	Practice of agroforestry parkland conservation (%)			
	Assisted natural regeneration	**Pruning**	**Fight against bush fires**	**Reforestation**
MRAP	17,31	52,41	13,17	17,11
BAP	11,53	42,17	33,25	13,05
Total	28,84	94,58	46,42	30,16

BAP = Bénoué Agroforestry parklands of *Daniellia oliveri*; **MRAP** = Mayo-Rey Agroforestry parklands of *Daniellia oliveri*

3.2. Soil fertility improvement practices

The percentage of soil fertility improvement techniques in *Daniellia oliveri* agroforestry parklands ranged from 4.59% for land fallowing in Bénoué to 54.35% for the use of organic fertilizers in Mayo-Rey. On average, soil fertility improvement practices varied from 8.09% for land fallowing to 50.79% for the use of organic fertilizers (Table 2).

Table 2: Endogenous practices for improving soil fertility

Fertility conservation practices of parklands	Respondents (%)		
	BAP	MRAP	Total
Use of organic fertilizers	47,23	54,35	50,79
Crop rotation	24,54	31,34	27,94
Association of crops with trees	16,65	9,72	13,19
Leave the field fallow	4,59	11,58	8,09

BAP = Bénoué Agroforestry parklands of *Daniellia oliveri*; MRAP = Mayo-ReyAgroforestry parklands of *Daniellia oliveri*

3.3. Density of regeneration in agroforestry parklands of *Daniellia oliveri*

Regarding the number of seedlings obtained, values ranged from 17 individuals per hectare in fallow parklands of Bénoué to 39 individuals per hectare in cultivated parklands of Mayo-Rey (Figure 1).

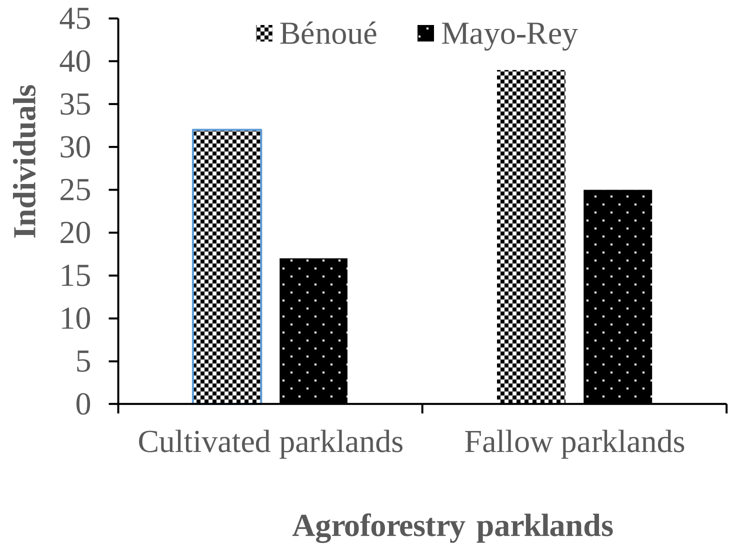

Figure 2: Number of young plants resulting from regenerations in agroforestry parklands

The overall regeneration rate of agroforestry parklands was 59.79%. Species regeneration capacity was higher in cultivated parklands of Mayo-Rey (32.85%) than in Bénoué (26.94%) (Figure 2).

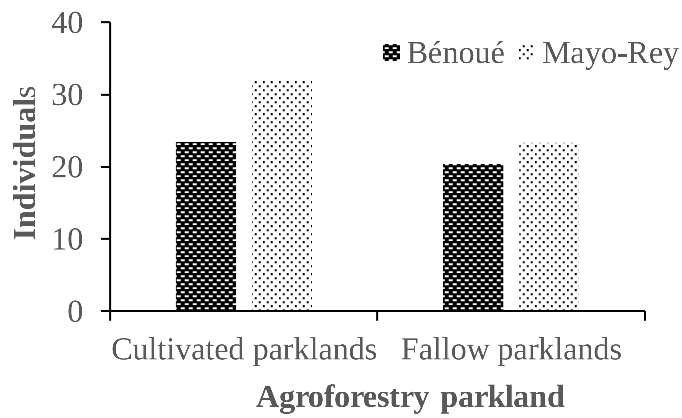

Figure 3: Rate of young plants from seedlings in agroforestry parklands

The specific importance of regeneration was observed in 37 species. The species with strong regeneration capacity in the agroforestry parklands of *Daniellia oliveri* are: *D. oliveri* (57.76%), *Bombax costatum* (27.05%), and *Detarium microcarpum* (17.92%). In the agroforestry parklands of Bénoué and Mayo-Rey, *Daniellia oliveri* accounts for 83.61% and 31.94% respectively, followed by *Bombqx costatum* (52.43%) in the agroforestry parklands of Bénoué and *Detaruim microcarpum* (22.56%) in the agroforestry parklands of Mayo-Rey (Table 3).

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Table 3: Regeneration rate based on agroforestry parklands

Species	Agroforestry parklands				
	Bénoué		Mayo-Rey		
	Cultivated parklands	Fallow parklands	Cultivated parklands	Fallow parklands	Average
Acacia polyacantha	3,34	0,00	0,00	0,00	0,83
Faidherbia albida	0,00	0,00	2,55	0,00	0,63
Acacia nilotica	2,37	0,00	0,00	0,00	0,59
Acacia seyal	0,00	0,00	1,66	0,00	0,41
Adansonia digitata	7,86	0,00	0,00	0,00	1,96
Afzelia africana	0,00	0,00	0,00	0,85	0,21
Anogeissus leiocarpa	9,88	27,74	6,65	0,00	11,07
Annona senegalensis	4,57	0,00	7,12	9,81	5,37
Azadirachta indica	5,50	0,00	0,00	0,00	1,37
Balanites aegyptiaca	17,69	32,45	0,00	0,00	12,53
Bombax costatum	41,27	63,58	3,37	0,00	27,05
Burkea africana	0,00	0,00	0,00	1,17	0,29
Combretum molle	0,00	0,00	0,00	5,54	1,38
Daniellia oliveri	85,38	81,84	36,32	27,56	57,76
Detarium microcarpum	0,00	26,64	24,1	21,02	17,98
Lophira lanceolata	0,00	0,00	10,45	1,52	3,09
Parkia biglobosa	36,37	0,00	0,00	0,00	9,09
Piliostigma thonningii	0,00	23,38	0,00	0,00	5,84
Prosopis africana	0,00	0,00	1,17	10,4	2,89
Sarcocephalus latifolius	0,00	0,00	0,00	6,93	1,73
Sclerocarya birrea	0,00	0,00	0,00	7,25	1,81
Securidaca longepedunculata	0,00	0,00	0,00	7,89	1,97
Tamarindus indica	0,00	44,33	0,00	0,00	11,08
Vitellaria paradoxa	19,05	0,00	0,00	0,00	4,76
Ziziphus mauritiana	0,00	0,00	6,56	0,00	1,64

3.4. Main modes of natural regeneration in agroforestry parklands

The density of natural regeneration (wildlings) exhibited significant variation based on land use, ranging from 14 stems per hectare in cultivated parklands to 53 stems per hectare in fallow parklands. Regeneration via seed germination was observed across 37 species. *Daniellia oliveri* demonstrated a high density of germinated individuals, with an overall average of 47 stems/ha, varying between divisions: 25 stems/ha in Bénoué and 32 stems/ha in Mayo-Rey. In addition to *D.*

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oliveri, *Bombax costatum* was also well-represented, with an overall density of 18 stems/ha, higher in Bénoué (12 stems/ha) than in Mayo-Rey. The proportion of natural regeneration was significantly greater in fallow parklands (65.31%) than in cultivated parklands (34.69%). Regarding regeneration through suckering, densities ranged from 9 individuals/ha in fallow parklands of Mayo-Rey to 18 individuals/ha in cultivated parklands of Bénoué, observed in 25 species across the agroforestry parklands (Table 4).

Table 4: Natural regeneration density by planting

Species	Agroforestry parklands				
	Bénoué		Mayo-Rey		
	Cultivated parklands	Fallow parklands	Cultivated parklands	Fallow Parklands	Total
Acacia polyacantha	8	0	0	0	8
Faidherbia albida	0	0	103	0	103
Acacia nilotica	5	0	0	0	5
Acacia seyal	0	0	98	0	98
Adansonia digitata	11	0	0	0	11
Anogeissus leiocarpa	18	102	0	0	120
Annona senegalensis	23	0	0	341	364
Azadirachta indica	7	0	0	0	7
Balanites aegyptiaca	18	127	0	0	145
Bombax costatum	69	231	0	96	396
Burkea africana	0	0	55	109	164
Combretum collinum	0	0	38	0	38
Combretum molle	0	0	0	190	190
Combretum glutinosum	0	0	43	0	43
Daniellia oliveri	214	307	305	462	1288
Detarium microcarpum	0	112	59	253	424
Guiera senegalensis	0	0	56	0	56
Lophira lanceolata	0	0	34	0	34
Parkia biglobosa	62	0	0	0	62
Piliostigma thonningii	0	100	0	0	100
Prosopis africana	0	0	44	0	44
Pterocarpus erinaceus	0	0	149	0	149
Sarcocephalus latifolius	0	0	0	147	147
Sclerocarya birrea	0	0	0	172	172
Securidaca longepedunculata	0	0	0	152	152
Tamarindus indica	0	124	0	0	124

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Vitellaria paradoxa	68	0	0	0	68
Vitex doniana	0	0	69	0	69
Ziziphus mauritiana	0	0	51	0	51
Total	503	1103	1104	1922	4632

Across all agroforestry parklands, 384 suckers of *Daniellia oliveri* were recorded, including 230 in Bénoué and 154 in Mayo-Rey. This was followed by *Bombax costatum*, with 289 suckers/ha, comprising 141 in Bénoué and 148 in Mayo-Rey. Suckering accounted for 34.01% of regeneration in cultivated parklands compared to 26.99% in fallow parklands (Table 5).

Table 5: Modes de régénération naturelle par drageonnage

Espèces	Agroforestry parklands				
	Bénoué		Mayo-Rey		
	Cultivated parklands	Fallow Parklands	Cultivated parklands	Fallow Parklands	Total
Anogeissus leiocarpa	17	38	0	0	55
Azadirachta indica	26	0	0	0	26
Balanites aegyptiaca	87	44	0	0	131
Bombax costatum	159	76	0	72	307
Burkea africana	0	0	0	5	5
Daniellia oliveri	226	101	293	109	729
Detarium microcarpum	0	32	42	18	92
Lophira lanceolata	0	0	37	32	69
Parkia biglobosa	100	0	0	0	100
Sclerocarya birrea	0	0	0	19	19
Securidaca longepedunculata	0	0	0	31	31
Tamarindus indica	0	44	0	0	44
Ziziphus mauritiana	0	0	34	0	34
Total	652	335	406	286	1679

Stump sprouts represented the third mode of regeneration observed in agroforestry parklands, with numbers ranging from 461 in fallow parklands of Bénoué to 2,344 in cultivated parklands of Mayo-Rey (Table 6).

Table 6: Natural regeneration modes by rejection

Espèces	Agroforestry parklands				
	Bénoué		Mayo-Rey		
	Cultivated parklands	Fallow Parklands	Cultivated parklands	Fallow Parklands	Total
Acacia polyacantha	43	0	0	0	43
Fadherbia albida	0	0	60	0	60
Acacia nilotica	34	0	0	0	34
Acacia seyal	0	0	39	0	39
Afzelia africana	0	0	0	8	8
Anogeissus leiocarpa	91	33	156	0	280
Annona senegalensis	0	0	167	92	259
Azadirachta indica	3	0	0	0	3
Balanites aegyptiaca	19	36	0	0	55
Bombax costatum	78	92	79	0	249
Burkea africana	0	0	0	11	11
Combretum molle	0	0	0	52	52
Daniellia oliveri	201	110	875	352	1538
Detarium microcarpum	0	32	569	197	798
Lophira lanceolata	0	0	245	18	263
Parkia biglobosa	214	0	0	0	214
Piliostigma thonningii	0	66	0	0	66
Sarcocephalus latifolius	0	0	0	65	65
Sclerocarya birrea	0	0	0	68	68
Securidaca longepedunculata	0	0	0	74	74
Tamarindus indica	0	92	0	0	92
Vitellaria paradoxa	136	0	0	0	136
Ziziphus mauritiana	0	0	154	0	154
Total	819	461	2344	937	4561

3.5. Agricultural yield of the last 5 years of *Daniellia oliveri* agroforestry parklands (t/ha)

Figure 3 presents the agricultural yields over the last five years in *Daniellia oliveri* agroforestry parklands in the Sudanian-Sahelian zone of Cameroon. Yields ranged from 1.6 t/ha for *Oryza sativa* to 11.11 t/ha for *Zea mays*.

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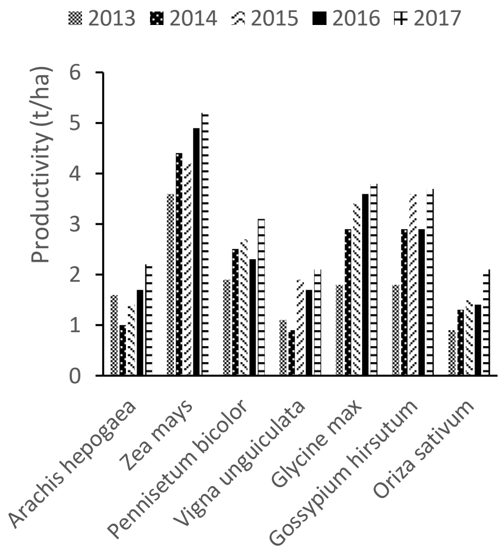

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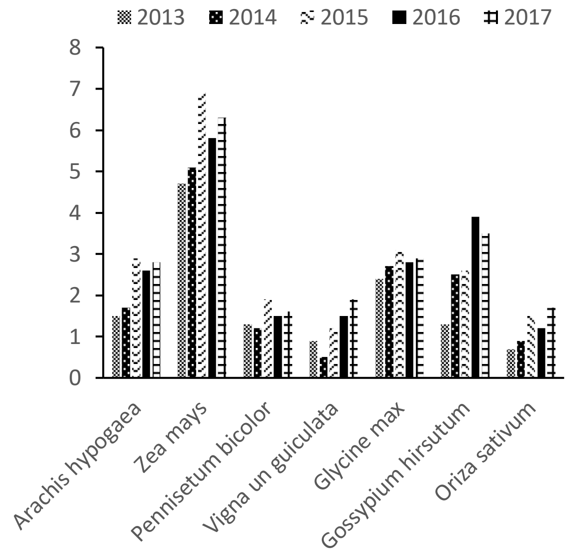

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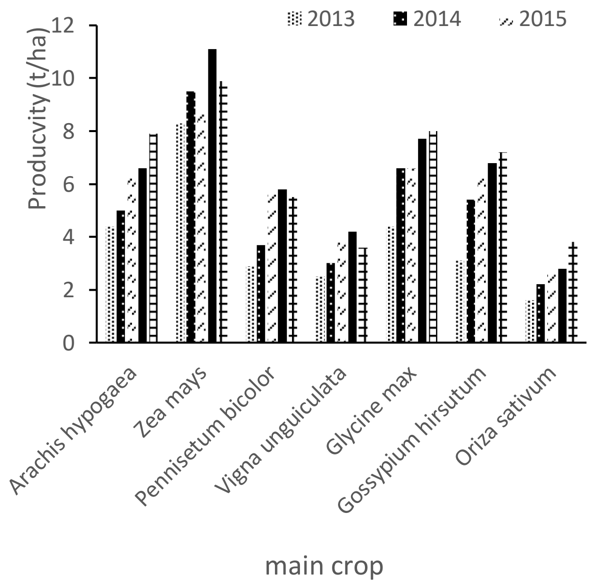

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Figure 4: Agricultural production of *Daniellia oliveri* agroforestry parklands (a = Bénoué, b = Mayo-Rey and c = Global)

Figure 4 presents the different crops under tree cover of *Daniellia oliveri* in the Sudanese-Sahelian zone of Cameroon.

Arachis hypogaea ***under tree cover***

Glycine max ***under tree cover***

Zea mays **under tree cover**

Pennisetum **bicolor under tree cover**

Figure 5: Different crops under tree cover

4. DISCUSSION

4.1. Local practices for the conservation of *Daniellia oliveri* agroforestry parklands

Management practices in *Daniellia oliveri* agroforestry parklands varied between the two study sites. Operators employed multiple and diverse silvicultural and agricultural techniques for tree maintenance. The current physiognomy of these parklands is a direct result of sustained operator efforts toward preservation, consistent with Sène (1994), who emphasized the importance of pruning for understory crops in Senegal's peanut basin. Local populations have developed effective methods for species preservation and dissemination, including allowing natural regeneration in fields and enriching parklands with exotic species. Nearly all interviewed farmers (96.36%) reported practicing assisted natural regeneration, combating bushfires, and engaging in reforestation through community nurseries. Notably, the prohibition of wood exploitation within

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these parklands is self-enforced by the farmers. To optimize agricultural production, operators prune *D. oliveri* and other species when their canopies become overly cumbersome for understory crops. Standing or fallen dead wood is left to decompose to fertilize the soil, though it is also used as fuelwood. Cultivated areas expand with each agricultural campaign. Plowing is preferred over burning to prepare land, as it avoids the destruction of young plants and mature trees, a practice consistent with Gbesso *et al*. (2017) in Benin, who described plowing as a superior technique for species conservation. Land expansion is primarily driven by decreased yields from plot overexploitation, exacerbated by climate change effects such as delayed rains and severe drought.

4.2. Soil Fertility Improvement Practices

The proportion of farmers actively improving soil fertility differed significantly, ranging from 4.59% in Bénoué to 54.35% in Mayo-Rey. Cost-effective practices commonly employed include the application of organic fertilizers and the retention of crop residues for in-situ decomposition. In some systems, such as *Borassus aethiopum* parklands in Cameroon, targeted livestock grazing is practiced to enhance fertility (Mamah *et al*.,2019). Soil fertility is a major concern for farmers, who often use specific woody species as indicators of fertile land. They report that *Daniellia oliveri* agroforestry parklands generally maintain their own fertility, primarily through the decomposition of tree leaf litter. Some farmers apply compost, which serves as a substrate for chemical fertilizers and improves water infiltration. Crop rotation is another widely used strategy, with plots left fallow for two to five years depending on the farmer's approach, to improve soil texture and quality for future yields, a practice also documented by Gbesso *et al*. (2014) in Benin. Alternatively, some farmers graze cattle in their parklands to utilize manure as a natural fertilizer. This finding contrasts with Tabi (2017), who reported that populations in *Vitellaria paradoxa* parklands used both chemical and organic fertilizers. The establishment of *D. oliveri* agroforestry parklands are perceived to have improved local microclimatic conditions. Farmers reported that trees play a significant role in mitigating heat, providing cooler air, and contributing to more timely rainfall. These observations suggest that *D. oliveri* parklands contribute to improved precipitation patterns and microclimatic conditions in the study sites. Given the diverse roles and benefits of these agroforestry systems, a detailed study of regeneration types in *D. oliveri* parklands is warranted.

4.3. Density of regeneration in *Daniellia oliveri* agroforestry parklands

Stand regeneration within the agroforestry parklands was assessed by measuring the density of young plants. Regeneration rates varied significantly across different areas and land-use types. Seedling density ranged from 5 individuals per hectare in fallow parklands of Bénoué to 39 individuals per hectare in cultivated parklands of Mayo-Rey.The low regeneration observed in fallow areas can be attributed to the systematic harvesting of fruits from woody plants, which reduces the available seed bank for germination. Furthermore, young shoots are subject to grazing

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by animals (Ouedraogo, 2009). These factors, combined with the high frequency of late-season bushfires in fallow lands, inhibit the development of young plants, thereby compromising natural regeneration. In contrast, cultivated parklands are better protected, and operators actively preserve young seedlings to ensure the replacement of aging trees. Species demonstrating high germination rates included *Daniellia oliveri* (286 individuals/ha) and *Bombax costatum* (206 individuals/ha). These results indicate that species from the Fabaceae family exhibit robust regeneration, a finding consistent with Sarr *et al*. (2014) in an agropastoral area of Senegal and Moussa *et al*. (2015), who reported the dominance of Caesalpiniaceae (a subfamily of Fabaceae) in parklands with *Faidherbia albida* and *Prosopis africana* in Niger.Regeneration occurs through three primary mechanisms: seeding, root suckering, and sprouting. Certain species exhibit strong regenerative capacity despite seed coat dormancy. Land-use systems particularly favor species capable of sprouting, producing root suckers, or regenerating from the soil seed bank (Bellefontaine *et al*.,2003). In the parklands agroforestry of Bénoué and Mayo-Rey, *D. oliveri* accounted for 83.61% and 31.94% of regeneration, respectively. In Bénoué, it was followed by B. costatum (52.43%), while in Mayo-Rey, Detarium microcarpum (22.56%) was the second most dominant species. This contrasts with findings by Laminou *et al*. (2017) in Niger, who reported the clear dominance of *Guiera senegalensis*, *Combretum micranthum*, and *Piliostigma reticulatum*.The weakest regeneration was observed for species such as *Prosopis africana* and *Combretum molle*, aligning with observations by Niang-Diop (2010) in the Fathala forest of Senegal, where young *Prosopis africana* plants were nearly absent a phenomenon attributed by Tybirk (1991) to seed coat impermeability.Overall, the regeneration index was higher in cultivated agroforestry parklands. These results are consistent with Jiagho (2018), who documented low vegetation regeneration rates at the edge of Waza National Park. According to that author, low regeneration may result from environmental factors such as reduced rainfall, climate degradation, overexploitation, overgrazing, and flooding, which are particularly relevant to fallow parklands. Further supporting this, Mahamoud *et al*. (2008) also reported low regeneration rates (below 50%) in community forests within Senegal's Sudano-Sahelian zone. The regeneration patterns observed in this study can be broadly explained by the Sudano-Sahelian characteristics of the *D. oliveri* agroforestry parklands, given the similar climatic and edaphic conditions across the two study sites.

4.4. Main modes of natural regeneration in agroforestry parklands

Natural regeneration is a fundamental process for understanding the dynamics of woody vegetation, occurring either through vegetative means or natural seeding. Young individuals originating from seeds and root suckers often exhibit highly similar morphology, making them difficult to distinguish in the field without excavating the root system. The density of seedlings germinated from seeds varied significantly by land use, ranging from 14 stems per hectare in cultivated parklands to 53 stems per hectare in fallow areas. As noted by Ngom (2008), natural

ISSN: 2455-6939

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seeding is often facilitated by animals that disperse seeds through their droppings, a phenomenon observed across 37 species. *Daniellia oliveri* demonstrated a high germination rate, with an overall density of 47 stems/ha, varying geographically from 25 stems/ha in Bénoué to 32 stems/ha in Mayo-Rey, indicating successful colonization of parklands in both departments. Bombax costatum was also well-represented (18 stems/ha overall), with a higher density in Bénoué (12 stems/ha). In contrast, species such as *Acacia sieberiana* and *Boswellia dalzielii* exhibited very low germination rates across all sites, likely due to high local demand for their pods and seeds, which reduces the available seed bank. This observation aligns with Niang-Diop *et al*. (2010), who identified factors such as seed coat dormancy and seed infestation as key limitations to germination in natural ecosystems. The percentage of natural seedlings increased from cultivated to fallow parklands, with higher seed availability in fallow areas leading to greater regeneration through seeding. Specific regeneration rates varied considerably among species, and abandoned fallows undergoing regeneration can evolve into savanna ecosystems in the absence of human disturbance, a process often accompanied by sprouting (Fawa *et al*., 2015). Regarding vegetative regeneration, the density of root suckers ranged from 9 individuals/ha in fallow parklands of Mayo-Rey to 18 individuals/ha in cultivated parklands of Bénoué. This mode of regeneration was observed in 25 species. The capacity for suckering appears to be genotype-specific, influenced by the unequal distribution of nutrient reserves within different parts of the plant. Furthermore, species employ diverse regeneration strategies that vary spatiotemporally and are dependent on ontogeny (Bellefontaine et Monteuuis, 2002). Overall, 23 species utilized root suckering as a multiplication strategy, making it a prominent regeneration mechanism across the parklands. According to Mapongmetsem *et al*. (2011), felling or disturbance triggers a sap influx from the roots, stimulating adventitious buds to develop into shoots. It can be hypothesized that taller cut stumps receive more light and consequently exhibit more vigorous sprouting. By ensuring its reproduction, a plant species secures a role that is significant not only environmentally but also socio-economically. In this vein, Mapongmetsem (2017) emphasizes that methods for producing trees and shrubs of high socioeconomic value often occur naturally within agroforestry parklands, representing a considerable advantage for valuable species. A well-functioning agroforestry parkland ecosystem supports robust crop and tree production, enhances biodiversity conservation, and reduces exploitation pressure on natural forests.

4.5. Agricultural yield of the last 5 years from *Daniellia oliveri* agroforestry parklands

The primary crops cultivated within *Daniellia oliveri* agroforestry parklands include *Zea mays, Arachis hypogaea*, *Gossypium hirsutum, Glycine max, Pennisetum glaucum* (corrected from P. bicolor), *Oryza sativa*, and *Vigna unguiculata*. A common management practice is the pruning of *D. oliveri* at the beginning of the growing season to mitigate excessive shading of understory crops. This finding aligns with Sène (1994), who emphasized the importance of pruning agroforestry

ISSN: 2455-6939

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species to enhance crop performance in Senegal's peanut basin. Soil fertility is maintained primarily through the decomposition of leaf litter and domestic waste, supplemented by the application of animal manure. Similar fertility management practices have been documented by Sabai *et al*. (2014) in Benin. Coupled with farmer responses on species conservation, these observations indicate that the integration of *D. oliveri* into the agrarian system is both a deliberate choice by landholders and a practice inherited from ancestral knowledge. *Zea mays* consistently demonstrates significant yield across sites and years, with productivity influenced by soil fertility, rainfall patterns, and the application of indigenous knowledge. This corroborates findings by Sapkota *et al*. (2010) in Nigeria, which confirmed the impact of rainfall variability on crop yields. Leguminous species (Fabaceae), including Arachis hypogaea, Glycine max, and Vigna unguiculata, contribute to soil fertility enhancement through biological nitrogen fixation. These results are consistent with Mahamane (1997) in Niger, where farmers reported increasingly proficient management of parkland production over time. Production from *D. oliveri* parklands is primarily destined for household consumption. Surplus production is commercialized in local and regional markets, generating income used to purchase non-cultivated goods, soap, oil, and meat, as well as to cover educational expenses and healthcare costs. The significant socio-economic value of products derived from these agroforestry systems underscores the need for agricultural extension services to promote awareness among operators regarding the multiple benefits of parklands, including advocacy for the development and implementation of endogenous strategies for climate change mitigation and adaptation.

5. CONCLUSION

Agriculture within *Daniellia oliveri* agroforestry parklands demonstrates significantly improved outcomes, contributing to the gradual disappearance of fallow periods in traditional rotation systems. The coexistence of trees and crops, when effectively managed by operators, exhibits synergistic rather than conflicting effects. These parklands serve multifunctional roles aimed at protection, conservation, and the restoration of soil fertility, alongside biodiversity conservation. A notable socio-legal observation is that rural populations often associate tree ownership with land ownership, leading to provisions that recognize private ownership of both planted and preserved trees. The findings of this study indicate that future research must address multiple fronts. Particularly, there is a need to quantitatively confirm that tree-crop interactions in these systems yield net positive effects. Such evidence-based techniques will constitute essential tools for facilitating dialogue with farmers regarding sustainable land use management. Future research directions include assessing the contribution of *D. oliveri* to soil fertility through detailed physicochemical analyses and establishing community nurseries to promote the expansion of these agroforestry systems. Based on our findings, we recommend the following actions: **Develop synergistic partnerships** among stakeholders to provide training and assistance to operators for improved tree management in agroforestry parklands ; **Promote specific adaptation techniques** such as live hedges, windbreaks, and bunds to mitigate the effects of climate change ; **Establish training centers** to educate agricultural operators on proper tree pruning, plantation, and protection techniques within their land use systems ; **Raise awareness among farmers** regarding best practices including assisted natural regeneration, early bushfire management, and litter composting methods and **Develop a management charter** in collaboration with landowners that formalizes guidelines for tree protection and emphasizes the importance of tree planting initiatives.

ACKNOWLEDGEMENTS

The authors extend their thanks and gratefulness to the authorities of the Sudano-sahelian zone who facilitated the access to the Benoue and Mayo-Rey agroforestry parklands. A sincere thank you is extended to the inhabitants for their hospitality and their involment in the conduct of this work, including the reviewers for their constructive critics and comments.

REFERENCES

[1]. Akpo L, E, Grouzis M. 1996. Influence du couvert sur la régénération de quelques espèces ligneuses sahéliennes (Nord-Sénégal, Afrique occidentale). *Webbia*, 50 (2) : 247-263

[2]. Avoutchou M, Avana-Tientcheu M L, Dongock Nguemo D, Mapongmestem P M. 2022. Potentiel écologique et ethnobotanique des parcs agroforestiers à *Borassus aethiopum* Mart. (Arecaceae) dans la Région de Mayo-Kebbi Est (Tchad). *Rev Écosystèmes et Paysages* (Togo), 2 (1) : 140-155

[3]. Bellefontaine R, Monteuuis O. 2002. Le drageonnage des arbres hors forêt : un moyen pour revégétaliser partiellement les zones arides et semi-arides sahéliennes. In Multiplication végétative des ligneux forestiers, fruitiers et ornementaux. *Verger M*. (edi). CIRAD-INRD: Monpellier. pp; 135-148

[4]. Bellefontaine R, Sabir M, Kokou K, Guinko S, Saadou M, Ichaou A, Hatem C, Bationo B A, Karim S, Logbo J. 2003. Revégétalisation, une quatrième voie : la propagation végétative naturelle. XIIè Congrès Forestier Mondial (Montréal), Actes du XIIè congrès, FAO Rome (Italie), 272 p.

[5]. Boffa J M. 2000. Les parcs agroforestiers en Afrique subsaharienne. Cahier FAO Conservation, 34, FAO, Rome, 230p.

[6]. Dangai Y, Hamawa Y, Oumarou Z H, Fawa G, Mamah M, Mapongmetsem P M. 2020. Caractérisation biophysique et floristique des parcs agroforestiers à *Daniellia oliveri* dans la zone soudano-sahélienne du Cameroun. *International Journal of Applied Research*, 6(9) :398-409

[7]. Dodorom T W, Fawa G, Hamawa Y, Oumarou H Z, Dangai Y, Ibrahima A,

Mapongmetsem P M. 2023. Characterization and Carbon Sequestration Potential of Sahelian Agroforestry Parklands of Chad. *Science Development*, 4(1) : 1-11

[8]. Dodorom T W. 2024. Dynamique des parcs agroforestiers et atténuations des changements climatiques au Tchad. Thèse de Doctorat / Ph. D, Université de Ngaoundéré. 135

[9]. Dona A. 2018. Savoirs endogènes, gestion de la biodiversité et des stocks de carbone dans les systèmes d'utilisation des terres dans la région de Tandjilé–Est du Tchad. Thèse de Doctorat/Ph. D, Université de Ngaoundéré, 135p

[10]. Fawa G, Mapongmetsem P M, Noubissie T J B, Bellefontaine R. 2015. Multiplication végétative d'une espèce locale d'intérêt socio- économique au Cameroun : *Ximenia americana* L. *VertigO- la Revue électronique en sciences de l'environnement*, 15483. 21

[11]. Gbesso F L, Nassi M K, Gbesso F H G, Akoegninou A. 2017. Utilisation sociale de Borassus aethiopum Mart et ses habitats dans les communes de Savè et Glazoué au Benin. *International Journal of Biological and Chemical Sciences*, 11(4) : 1512- 1522

[12]. Gbesso F L, Yedomonhan H, Tente B, Akoegninou A. 2014. Distribution géographique des populations de *Borassus aethiopum* Mart (Arecaceae) et caractérisation phytoécologique de leurs habitats dans la zone soudano-guinéenne du Benin, *Journal of Applied Biosciences*, 74 : 6099–6111

[13]. Hamawa Y. 2015. Etude ethnobotanique et écologique de *Vepris heteropylla* (Engl) Letouzey dans la zone soudano-sahélienne du Cameroun : Thèse de doctorat PhD, Université de Ngaoundéré, 213p

[14]. Houehanou D T. Assogbadjo E, Chadare F J, Zanvo S, Sinsin B. 2016. Approches méthodologiques synthétisées des études d'ethnobotanique quantitative en milieu tropical. *Annales des Sciences Agronomiques du Bénin*, 20 : 187-205

[15]. IRAD. 2008. Appuis au programme mondial de recherche et de vulgarisation agricole. 2008 ; 45p

[16]. Jiagho E. R. 2018. Flore et végétation ligneuse à la périphérie du parc national de Waza (Cameroun) : Dynamiques et implications pour une meilleure gestion. Thèse de Doctorat et Doctorat PhD en géographie. Université du Maine. 363p

[17]. Koguia N W, Nonga N F, Madi A, Lebois A, Mabah T G L. 2021. Perception of climatic change and farmers's decision to adapt in the Sudano-sahelian zone in Cameroon. *J JHSSS*. 3(10) :22-33.

[18]. Laminou O M, Bachir O G, Morou B, Saley K, Mahamane A. 2017. État de la végétation ligneuse au Sahel : Cas de Guidan Roumdji au sahel central du Niger. *Journal of Animal &Plant Sciences*. 31(3) : 5033-5049.

[19]. Letouzey R. 1968. Phytogéographie du Cameroun. Edition Lechevalier. 518

[20]. Mahamadou S, Saley M B, Kouame K J, Ambouta K J M. Mohamadou A, Mamadou I. Mahamadou B I. 2024. Perceptions des effets de changements climatiques des paysans à

ISSN: 2455-6939
Volume: 11, Issue: 06 "November-December 2025"

l'échelle du bassin versant de Karey Gorou (Sud-Ouest du Niger) : comparaison entre les données observées et les données d'enquêtes. *Journal of Research in Agriculture and Animal Science Volume*. 11 (10): 01-17

[21]. Mahamane A.1997. Structure, fonctionnement et dynamique des parcs agroforestiers dans l'Ouest du Niger. Thèse de Doctorat 3ième cycle. Université d'Ouagadougou. 213p

[22]. Mahamoud M C, Lô M, Bassène E, Akpo L E. 2008. Caractéristiques de la flore et de la végétation ligneuses des forêts communautaires de la zone soudano-sahélienne au Sénégal. *Journal des Sciences et Technologies*. 6(2) : 72– 85

[23]. Mamah M, Baye-Niwah C, Hamawa Y, Dangai Y, Oumarou Z H, Abdoulaye H, Mal A, Fawa G, Mapongmetsem P M. 2019. *Borassus aethiopum* mart. Agroforestry parklands and climate change mitigation in Cameroon. *International Journa l of Agriculture and Environmental Research*. 5 (4) : 436-455.

[24]. Mapongmetsem P M, Baye-Niwah C, Froumsia M, Kossebe C F, Hamawa Y. 2011. Agroforests potentials in the improvement of Livelihoods and food security in the Guinean Highland Savannahs. *International Journal of Social Forestry*. 4 (2) :162-178

[25]. Mapongmetsem P M. 2017. Domestication et culture des espèces locales d'intérêt économique au Cameroun. Doctoriale, Leçon inaugurale. Université de Ngaoundéré. 44 p

[26]. Mapongmetsem P M. 2021. Multistratas et développement durable. Com. Journée Internationale de Biodiversité. Laboratoire de Biodiversité et Développement Durable. Ngaoundéré, Cameroun. 15p.

[27]. Mapongmetsem P M. 2022. Agroforesterie et développement économique au Cameroun (A propos de la résilience de l'agriculture tropicale aux changements globaux). In Akam A, Kouam S P. (éd.). Pour le libéralisme communautaire de P. Biya. pp. 2022 ; 710-731

[28]. MINAT. 2010. Enquête agricole au Cameroun. Manuel d'instruction aux agents recenseurs, forme. 2010 ; 45

[29]. Moussa M, Larwanon M, Mahamane S. 2015. Caractérisation des peuplements ligneux des parcs à *Faidherbia albida* (Del) A. Chev. et à *Prosopis africana* (Guill., Perrot et Rich.) Taub. Du Centre- Sud Nigerien. *Journal of Applied Biosciences*. 94 : 8890- 8906

[30]. Ngom D, Fall T, Sarr O, Diatta S, Akpo E L.2013. Caractéristiques écologiques du peuplement ligneux de la réserve de biosphère du Ferlo (Nord Sénégal). *Journal of Applied Biosciences*. 2013 ; 65 : 5008-5023

[31]. Ngom D. 208. Définition d'indicateurs de gestion durable des ressources sylvo-pastorales au Sénégal, Thèse de Doctorat en Biologie végétale, Option : Écologie, FST, UCAD. 148 p

[32]. Niang- Diop F, Sambou B, Lykke A M. 2010. Contraintes à la régénération naturelle de *Prosopus africana* : facteur affectant la germination des graines. *Internationale Journal of Biological and Chemical Science*. 4(5) :1693-1705

[33]. Niang-Diop F, Sambou B, Lykke A M. 2010. Contraintes de régénération naturelle de *Prosopis africana* : facteurs affectant la germination des graines. *Intertional Journal of Biological and Chemical Science*. 4(5) : 1693-1705

[34]. Njoya M H, Matavel C E, Msangi A H, Wouapi N H A. Lorh, Sieber S. 2022. Vulnérabilité au changement climatique et réponse adaptatives des petits exploitants agricoles dans la région semiaride de l'Extrême-Nord du Cameroun. *Discov. Sustain*. 3(1) :1-13

[35]. Ouedraogo O. 2009. Phytosociologie, dynamique et productivité de la végétation des parcs nationaux d'Arly (Sud-Est du burkina-Faso). Thèse de doctorat de l'université d'Ouagadougou. 188 p.

[36]. Peltier R, Forkong C N, Ntoupka M, Manley R J, Morillon V. 2007. Evaluation du stock de carbone et de productivité en bois d'un parc agroforestiers à Karité du Nord-Cameroun. *Bois et foret des tropique*. 294(4) :39-50

[37]. Poupon H. 1980. Structure et dynamique de la strate ligneuse d'une steppe sahélienne au nord du Sénégal. ORSTOM éd. (Études & Thèses). 307 p.

[38]. Sabai K., Dagbenonkin G D, Agbangba Codjo E, de Souza J F, Kpagbin G, Azontondé A, Ogouwalé E, Tinté B, Sinsin B. 2014. Perceptions locales de la manifestation des changements climatiques et mesures d'adaptation dans la gestion de la fertilité des sols dans la commune de Binikoara au Nord- Benin. *Journal of applied Biosciences*. 82: 7418-7435

[39]. Sapkota S, Paudel M N, Thakur N S, Nepali M B Neupane. 2010. Effect of climate change on rice production: a case of six vdcs in jumla district. *Nepal Journal of Science and Technology*. 11 : 57-62.

[40]. Sarr O, Ngom D, Ngaryo F T, Diatta S, Akpo L E. 2014. État de la végétation ligneuse dans trois unités d'utilisation des terres d'une zone agropastorale au Sénégal (Région de Kaffrine). *Intertional Journal of Biological and Chemical Science*. 8 (6) : 2669-2684

[41]. Sène A. 1994. Etude socio-economique des systemes à parc dans le bassin arachidier: cas de Sterculia setigeraet de *Cordyla pinnata*. Mémoire de confirmation. Direction des recherches sur les ressources forestières. 86p.

[42]. Tabi T J. 2017. Diversité floristique et stock de carbone des parcs agroforestiers à *Vitellariat parodoxa* Graetner. F. (Sapotacae) de l'arrondissement de Lagdo (Bénoué-Cameroun). Master en Biologie des Organisme Végétaux ; Université de Ngaoundéré. 61p

[43]. Tybirk K. 1991. Régénération des légumineuses ligneuses du Sahel., University of Aarhus, Botanical Institute, AAU Reports. N° 28, 86 p

