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Pastoral Value and Carrying Capacity of Pastures in a Context of Socio-Environmental Changes in Ouassa-Pehunco in Benin

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Abstract: The objective of this study is to determine the pastoral value and the carrying capacity of pastures in agropastoral areas in the Commune of Ouassa-Péhunco in Benin. The method consisted in making phytosociological and linear surveys and cutting biomass. The results showed that 4 pastures with 236 species including 91 woody and 145 herbaceous species divided into 177 genera and 69 families are identified and listed. Phanerophytes and therophytes are the most represented biological types. The pastoral values are generally appreciable on all four (04) pastures. The productivity of grasses varies between 4.16 to 4.79 tDM/ha and that of legumes and others between 4.38 to 4.69 tDM/ha. This situation shows the availability of fodder during the rainy season and the carrying capacity at the end of the rainy season is very high; which explains why this environment is always favorable to the installation of breeders. The pastoral value in all the pastures is on average 71.23% with a brushing rate of 13.22%. Productivity at the end of the rainy season is on average 4.52 ± 0.87 tDM/ha in all pastures, 4.52 ± 0.94 tDM/ha in grasses and 4.53 ± 0. 81 tMS/ha in legumes and others. The carrying capacity in all the pastures is estimated on average at 0.66 ± 0.16 TLU/ha in legumes and others and at 0.66 ± 0.17 TLU/ha in grasses. The state of flora and vegetation is extremely dynamic and sensitive to changes, in particular changes in land use. Vegetation fires, grazing, slash and burn agriculture and erratic rainfall constitute. The dominant forms of disturbance of the structure and physiognomy of vegetation within landscapes.

Key words: Pastoral Value · Carrying Capacity · Pastures · Fodder · Ouassa-Péhunco and Benin

INTRODUCTION

In sub-Saharan Africa, most plant and animal production comes directly from rural areas where natural resources (water, vegetation and land) are found. With high climatic variability and population growth, estimated at 3.5% in the Sahelian zone, these resources are subject to intense exploitation which leads to often irreversible ecological imbalances [1].

In Benin, livestock and agriculture are the key sectors of the national economy. Benin's livestock system is dominated by ruminants. It is still marked by its extensive character, strongly dependent on natural vegetation. Agriculture contributes an average of 32.7% to the Gross Domestic Product (GDP) and provides about 70% of jobs [2]. These agricultural and pastoral activities affect the natural ecosystems of the different regions of the country. For Djènontin [3], the plant environment is subject to permanent pressures linked to various activities (agriculture, logging and livestock farming) whose consequences take on a catastrophic appearance, especially for fragile ecosystems. According to Akpo *et al.* [4], thenatural ecosystems are subject to severe degradation due to agro-pastoral activities. For Thiam [5], the trend towards sedentarization thanks to modern hydraulic works has had the effect of accelerating the growth of cattle herds and the installation of agricultural areas. Cattle breeding in the North of Benin

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is thus confronted with the reduction of fodder supply in time and space. In the municipalities of northern Benin, biodiversity is plagued by deforestation, wildfires, poaching, disappearance, the introduction of invasive alien species and overgrazing [6, 7]. The densification of human occupation and the gradual increase in pastoral charges leave in some areas very little leeway for the future of this extensive system. The deterioration of agro-pastoral production potential in view of the increase in land pressure is one of these multiple problems [8]. The spatio-temporal distribution of pastoral resources explains the extensive nature of cattle breeding. This results in increased competition in the exploitation of resources, leading to conflict situations with serious consequences [9, 10]. The state of flora and vegetation is extremely dynamic and sensitive to changes, particularly changes in land use. The dominant forms of disturbance of the structure and physiognomy of vegetation within landscapes are wildfires, grazing, slash and burn agriculture and irregular rainfall [11-14].

Natural resources experience variations (quantity and quality) and severe constraints linked to rainfall deficits which hinder the proper development of plants. They are still abundant in Ouassa-Péhunco and there are many behaviors harmful to their good management. Economic activities, population growth, the constraints of the natural environment are all elements that interact with each other and constitute a threat to the environment of the said Commune [15]. Added to this is the lack of rainfall coupled with the ever-increasing human needs for arable land, leading to a reduction in the surface area of grazed areas and often even their degradation [16]. This study aims to determine the pastoral value and carrying capacity of pastures in agropastoral areas in the Commune of Ouassa-Péhunco in Benin. This study makes it possible to understand the various ecological aspects linked to agriculture in general and to the extensive breeding of cattle in particular.

MATERIALS AND METHODS

Geographical Framework of the Study: The essential elements of this part are, among others, the geographical location, the biophysical and socio-demographic characteristics and the economic activities.

Geographical Location: The Municipality of Ouassa-Péhunco is located in the northern region of Benin more precisely in the Department of Atacora. It is located between 10°03' and 10°45' north latitude then 1°45' and 2°15' east longitude and is limited to the north by the Commune of Kérou, to the south by the Department of Donga, to to the east by the Department of Borgou and to the west by the Commune of Kouandé (Figure 1). It has three (03) Arrondissements including thirty-five (35) administrative villages with an area estimated at more than 1956 km^2.

Equipment Used for Carrying out Linear Surveys and Biomass Cuts: The equipment used for carrying out the linear readings (10 m x 10 m) consists of:

- Two (02) stakes of 1.5 m each to stretch the ribbon;
- A 50 m long tape for the census of plant species;
- A 1.5 m long rod for the census of plant species;
- A hammer to drive in and fix the stakes;
- General inventory sheets for plant species.

The equipment used for setting up the plots (1 m x 1 m) of the biomass cuts consists of:

- A gardener's pruner for cutting plant material;
- A4 productivity envelopes for taking samples for the laboratory;
- A 200 g ± 2 g load cell; 1000 g ± 10 g and 20 kg ± 100 g for sample weighing;
- A precision electronic scale to weigh the oven-dried samples.

It was also a question of the application of data collection methods and the palatability of species.

Data Collection Methods: The linear surveys were carried out using the method of aligned quadrat points [17]. They are carried out on fixed lines 5 m long chosen and installed inside homogeneous squares of 10 m x 10 m. A 1.5 m wooden rod is moved perpendicular to the ground, along this string, which is each time lowered to the ground. All herbaceous species that are in contact with the wood stem are then recorded. Several species are therefore recorded at the same reading point, but each species is counted only once. On the other hand, if no species touches the stem, we note the presence of bare soil (empty). Finally, at the level of each plot, 3 survey lines were installed and the recording of species is made at intervals of 10 cm from the tape stretched over the herbaceous vegetation. A total of 104 plots have been installed and a census of 150 points is carried out at the level of each homogeneous plot.

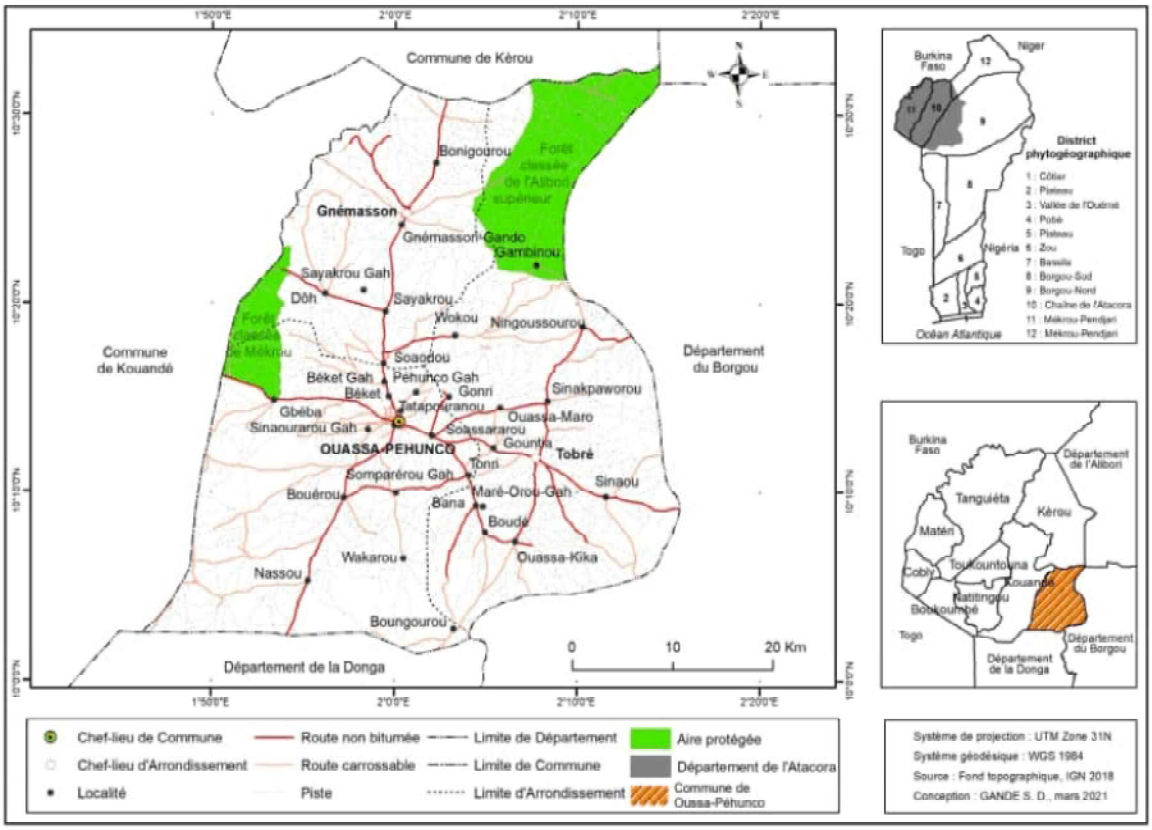

Fig. 1: Geographical location of the Municipality of Ouassa-Péhunco

Species Palatability: Species palatability is a very important parameter in assessing the pastoral value of pastures. It is determined by direct observation of grazing animals or by information from breeders on condition that they specify the period of consumption and the type of pasture where the plant is consumed [18].

The palatability of a species depends on the area, the period, the animal species, the availability of other species and the phenological stage [19]. The quality index reflects the spontaneity of the animal to sample a given species. It varies in time and space. To this end, species with very little palatability in the rainy season may well be palatable during the dry season when fodder is scarce [20]. Similarly, depending on the agro-ecological environment, the level of harvesting of a species may vary.

Finally, the palatability of species is expressed qualitatively or quantitatively through specific quality figures or indices and according to a rating scale [21]. It varies from 0 to 4 namely:

- 0: for species disdained by animals or species refused;
- 1: for mediocre species;
- 2: for species with average palatability;
- 3: for species with good palatability;
- 4: for species with very good palatability.

Line Survey Data: These data made it possible to determine the characteristics of the different pastures studied.

Determination of Pastures: Pasture characteristics are determined from linear surveys. The following parameters defined by Daget and Godron [22] were calculated for this purpose:

Species Specific Frequency (FSi) is the number of contact points where the species was encountered.

Centesimal Frequency (FC) is equal to the ratio (in %) of the FSi to the number (N) of sample points.

$$FC = \frac{FSi}{N} \times 100$$

When the number of points is very high, HR represents the recovery [23].

Specific contribution of the species (CSi) is a value making it possible to evaluate the contribution of the species to the constitution of the vegetation cover. It is defined by the ratio to the sum of the FSi of all the species.

$$CSi = \frac{FSi}{\sum_{i=1}^{n} FSi} \times 100$$

Fsi = Specific frequency of species i representing the sum of contacts of this species on the read line;
ΣFsi = Sum of contacts of all species and
Csi = Specific contribution of species i.

Daget and Poissonet [24] showed that the CSi can be considered with a certain approximation, as a relative expression of the biomass.

Daget and Poissonet [17], there is a very close linear relationship between floristic composition and biomass production. These authors called "producing species" all the species whose specific contribution is at least equal to 1%. Among these productive species, a distinction is made between highly productive species with CSi > 4 ± 1, moderately productive species with 1 > CSi < 4 and low-productive species with 1 < CSi < ±1.

Confidence interval or confidence index (CI) or accuracy of measurements indicates the variation in coverage as well as the limit of homogeneity of an observation unit. When CI ≤ 5%, the effect of chance is considered to be eliminated; the centesimal frequency is then equivalent to the overlap [25]. The confidence interval (CI) or confidence index is given by the formula:

$$IC(\%) = \pm 2\frac{\sqrt{n(N-n)}}{N^3}$$

N = Cumulative number of contacts of all species;
n = Cumulative number of contacts of the dominant species.

Data Processing Method: The pastoral value, productivity and carrying capacity of pastures were determined.

Pastoral Value: Pastoral Value (PV) is a concept used to characterize the value of pastures. This value depends on the species present, their specific contributions, their palatability (specific quality index) and the specific richness (number of species encountered on the pasture). For Baumer [26], the pastoral value is an average synthetic index depending on the abundance and nature of the plants that form a pasture. In the southern Sudanian zone, pastoral values of around 50 to 75% are qualified as average to good [27]. For Daget and Godron [22], a good pasture has a pastoral value of over 65%.

Thus, the Net Pastoral Value or Overall Quality Index is determined by the formula;

Vp = 1/4Σ (Csi*Is) ou Vp = 0, 25 (CSi×Isi)

Csi = Specific contribution of species i;
Isi = Specific quality index (palatability index) which reflects the spontaneity of the animal in taking a given species;

The constant 0.25 takes into account the scale of values of the specific quality index which varies from 0 to 4.

It is strongly favored by the availability of pastures in the environment and much more linked to the animal breed exploiting the pastures. The appetite index value system used ranges from 0 to 4 [21] and is as follows:

0: species disdained by the animals or species refused;
1: mediocre species;
2: moderately palatable species;
3: well-palatable species;
4: species very palatable by animals.

Brushing Rate: The brush cover “Te” expresses the level of degradation of a pasture. It is represented by the specific contribution of refusals. Its formula is: Te = 1-(@@@@@@/@@@@).

Fro = Optimal relative frequency by cancellation of the specific frequency of refusals.
Fr = Specific frequency of refusals.

Evaluation of the Participation of Herbaceous Species in Biomass Production: According to Daget and Poissonet [17], there is a very close linear relationship between floristic composition and biomass production. These authors called "producing species" all the species whose specific contribution is at least equal to 1%. Among these producing species, they stand out:

- Very productive species with CSi > 4 +/- 1,
- Low-producing species with 1 < CSi < 4 +/- 1.

This classification was used to assess the key species that contribute to the biomass in order to judge the quality of the pastures, taking into account the behavior of the species under pasture and their fodder value [28].

Pasture Productivity and Carrying Capacity: It is the integral harvest which consists in cutting all the vegetable matter on foot (cut at ground level). The weight of fresh material thus harvested is weighed in the field. The water content of this fresh material is determined on several samples by desiccation (drying) in an oven until a constant weight is obtained. The type of plant formation and the topographic position were decisive in the choice of plots and plots. The herbaceous biomass is harvested in plots of 10 m x 10 m or 100 m^2. Plots of 1 m x 1 m or 1 m^2 were installed inside these plots. The size of 1 m^2 and the square shape of the plots have been used by several authors [21, 29, 30, 31] in order to avoid edge effects and for reasons of ease and speed of establishment of plots in tall herbaceous formations. Thus, the species are cut at ground level using a gardener's pruner in 7 plots of 1 m^2 chosen at random in each plot of 10 m x 10 m.

A total of 35 plots of biomass cuts were installed on all the sites at the flowering-fruiting stage. The phytomass cut for this purpose is sorted by plot and divided into two batches (grasses, legumes and others). The weight of fresh materials is weighed in the field using a spring balance. A 100g sample of each category was placed in A4 field productivity envelopes and returned to the processing base for determination of pasture productivity and carrying capacity.

The evaluation of the cattle load ecologically accepted by the pastures was carried out according to the method used by Boudet [32]. He defines carrying capacity as “the amount of cattle that the pasture can support without deteriorating, the cattle having to remain in good condition or even gain weight or produce milk while on the pasture”.

Thus, the load capacity (Cc) is calculated from the following formula:

ki = {k1, k2} with k1 = 1/3 for savanna pastures; k2 = 1/2 for fallow pastures due to their high susceptibility to degradation. And 6.25 = Consumption of UBT in Kg of DM/day; TLU = Tropical Livestock Unit.

The quantity of qualified fodder (useful biomass) (Q) is obtained by multiplying the production harvested by the value of this synthetic index of pastoral quality [33].

$$Cc(UBT/ha/an) = \frac{Production(kg\frac{MS}{ha})xki}{6{,}25\left(\frac{kgMS}{UBT}\right)x\ dure'e\ d'utilisation}$$

$$DTE(UBT/ha) = \frac{1}{CC\ annuelle\ (UBT/ha)}$$

Q (kg MS/ha) = P * Vp

P = Total gross production in kilogram of dry matter per hectare,
Vp = Net pastoral value and MS = matière sèche.

$$Ta = \frac{S2 - S1}{S1x(t2 - t1)}x100$$

S1 = Area of a vegetation unit at date t1;
S2 = Area of the same vegetation unit at date t2 and
t = Number of years between t1 and t2.

RESULTS

Determination of Pastoral Value: The specific contact contribution and the specific quality indices make it possible to determine the pastoral values ??of the different pastures of the Commune.

P1 Pasture with Piliostigma Thonningii and Eleusine Indica in Shrubby and Fallow Savannas: This pasture is present in shrubby savannahs and fallow land on two topographic facets (lower slopes, slopes) on soils with a sandy-loamy and sandy-clayey texture. It is often disturbed by agricultural and pastoral activities.

Specific Contribution and Floristic Diversity: The inventory of this distributed pasture allowed the identification of 75 species in 64 genera and 33 families. Poaceae and Leguminosae dominate the flora. These families are the most represented with 24 species divided into 18 genera.

In total, 7 highly productive species were reported in this pasture, namely Pennisetum polystachion with 13.25% CSi andropogon tectorum with 12.95% CSi, Tephrosia bracteolata with 9.05% CSi, Sporobolus pyramidalis with 7, 14% CSi, Paspalum conjugatum with 5.90% CSi, Loudetia arundinacea with 4.62% CSi and Andropogon gayanus with 4.4% CSi. The rate of highly palatable species in this pasture is 38.55% CSi, well palatable is 38.53% CSi, 43.06% CSi for moderately palatable species. The cover of herbaceous vegetation is

on average 53.95% with an average specific contribution of 1.33%. The Shannon index values of herbaceous (H) is 3.29 bits and the Pielou evenness (E) is 0.76. These values express a high diversity and regular spatial distribution of individuals per species.

Pastoral Value and Brushing of the Pasture: Figure 2 presents the specific contribution of species classified by forage categories of pasture to Piliostigma thonningii and Eleusine indica of shrubby savannas and fallows.

From the analysis of Figure 2, it appears that the good grasses are the most abundant with a specific contribution of 41.59%. Medium quality grasses come in second place with 18.52% specific contribution. Fodder legumes, miscellaneous fodder and refusals respectively occupy third, fourth and fifth position with specific contributions of 15.02%, 12.86% and 9.31%. On the other hand, grasses of poor quality represent a low specific contribution in this pasture. It can be deduced that agro-pastoral activities are weak in this pasture. This favors the strong presence of good grasses and medium grasses.

The pastoral value of this pasture is high, ie 75.75% with a low contribution of refusals (9.31%); which corresponds to a brushing rate of 9.31%.

P2 Pasture with Pterocarpus Erinaceus and Tephrosia Bracteolata in Wooded and Fallow Savannas: This pasture is present in wooded savannahs, shrublands and fallow land on a topographic facet (bottom of the slope) on soils with a sandy-gravelly and sandy-loamy texture. This pasture is subject to agricultural and pastoral activities.

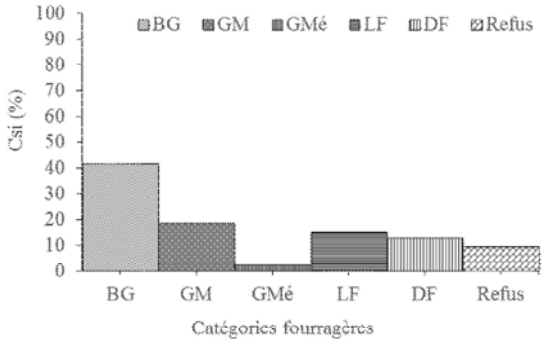

Fig. 2: Forage categories of Piliostigma thonningii and Eleusine indica pasture in shrubby and fallow savannas

Legend: BG: Good grasses; MG: Medium Grasses; PG: Poor grasses; FL: Forage legumes; VFS: Various fodder species

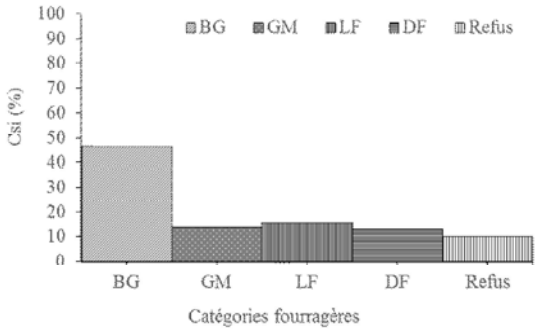

Fig. 3: Forage categories of pasture with Pterocarpus erinaceus and Tephrosia bracteolata in wooded and fallow savannas

Legend: BG: Good grasses; MG: Medium Grasses; FL: Forage legumes; VFS: Various fodder species

Specific Contribution and Floristic Diversity: The inventory of this pasture allowed the identification of 87 species divided into 74 genera and 38 families. Poaceae and Leguminosae dominate the flora. These families are the most represented with 25 species divided into 18 genera.

A total of 7 highly productive species have been identified in this pasture. These were Pennisetum polystachion with 15.17% CSi andropogon tectorum with 13.70% CSi, Tephrosia bracteolata with 12.02% CSi, Paspalum conjugatum with 7.98% CSi, Rottboellia cochinchinensis with 7 .32% CSi andropogon gayanus with 5.99% CSi and Sporobolus pyramidalis with 4.25% CSi. The degree of palatability of this pasture is assessed at 58.93% CSi for highly palatable species, 19.74% CSi for highly palatable species, 5.52% CSi for moderately palatable species and 5.60 % CSi for poor species. The cover of herbaceous vegetation is on average 163.13% with an average specific contribution of 1.15%. The values of the Shannon diversity index of herbaceous (H) is 3.15 bits and the Pielou evenness (E) is 0.70. These values express a high diversity and regular spatial distribution of individuals per species.

Pastoral Value and Brushing of the Pasture: Figure 3 shows the specific contribution of species classified by forage categories of pastureland with Pterocarpus erinaceus and Tephrosia bracteolata of wooded savannas and fallows. It appears from the examination of Figure 3 that the good grasses are the most abundant with a specific contribution of 46.76%. Fodder legumes with 15.89% specific contribution come second. Then the average grasses and the various fodder occupy

respectively the third, fourth and fifth rank with 13.97%, 13.18% and 10.20% of specific contribution. In contrast, low quality grasses have specific contributions of 2.70%. The pastoral value of this pasture is very good, i.e. 78.45% with a low brushing rate (10.20%). This explains a preponderance of species of very good palatability in this pasture.

P3 Pasture with Combretum Collinum and Rottboellia Cochinchinensis in Wooded and Fallow Savannas: This pasture is present in tree and shrub savannahs and fallow land on two topographic facets (bottom of the slope, interfluves) on soils with a sandy-gravelly and sandy-loamy texture. This pasture is disturbed by unsuitable farming practices and frequent trampling by animals.

Specific Contribution and Floristic Diversity: The inventory of this pasture allowed the identification of 116 species divided into 93 genera and 48 families. Poaceae and Leguminosae dominate the flora. These families are the most represented with 40 species divided into 28 genera.

In total, 6 very productive species were identified in this pasture, namely: Andropogon tectorum with 9.56% CSi, Hyparrhenia involucrata with 6.42% CSi, Rottboellia cochinchinensis with 6.34% CSi Andropogon gayanus with 5, 14% CSi, Pennisetum polystachion with 4.80% CSi and Paspalum conjugatum with 4.10% CSi. The degree of palatability of this pasture is assessed at 39.73% CSi for highly productive species, 24.83% CSi for highly palatable species, 8.18% CSi for moderately palatable species and 10.35 % CSi for poor species. The cover of herbaceous vegetation is on average 35.13% with an average specific contribution of 0.86%. The values of the Shannon diversity index of herbaceous (H) is 3.93 bits and the Pielou evenness (E) is 0.82. These values express a high diversity and regular spatial distribution of individuals per species.

Pastoral Value and Brushing of the Pasture: Figure 4 shows the specific contribution of species classified by forage categories of pasture with Combretum collinum and Rottboellia cochinchinensis of wooded and fallow savannas.

It emerges from the examination of Figure 4 that the good grasses are the most abundant in this pasture with a specific contribution of 41.25%. Refusals come in second place with 16.92% specific contribution. Fodder legumes and various fodder occupy respectively 16.08% and 14.62% of specific contribution. The fifth place medium grasses with contributed the height of 11.12% and occupy the last place. The pastoral value in this pasture is high, i.e. 67.18% with a low brushing rate (16.92%). This justifies a preponderance of species of very good palatability in this pasture.

P4 Pasture with Acacia Polyacantha and Eragrostis Ciliaris in Shrubby and Fallow Savannas: This pasture is present in tree and shrub savannas and fallow land on a topographic facet (bottom of the slope) on soils with a sandy-loamy and sandy-gravelly texture. This pasture is often subject to agricultural and pastoral activities whose soils are mostly disturbed by the regular passage of animals.

Specific Contribution and Floristic Diversity: The inventory of this pasture allowed the identification of 169 species divided into 128 genera and 51 families. Poaceae and Leguminosae dominate the flora. These families are the most represented with 58 species divided into 39 genera.

A total of 4 highly productive species were reported in this pasture. These are Hyparrhenia involucrata with 8.22% CSi, Pennisetum polystachion with 6.77% CSi andropogon tectorum with 5.15% CSi and Paspalum conjugatum with 4.62% CSi. The degree of palatability of this pasture is assessed at 30% CSi for highly productive species, 29.82% CSi for highly palatable species, 9.33% CSi for moderately palatable species and 14.41% CSi for mediocre species. The cover of herbaceous vegetation is on average 74.77% in this pasture. The Shannon index values of herbaceous (H) is 4.14 bits and the Pielou evenness (E) is 0.81. These values express a high diversity and a regular spatial distribution of individuals per species.

Pastoral Value and Brushing of the Pasture: Figure 5 presents the specific contribution of species classified by forage categories of Acacia polyacantha and Eragrostis ciliaris pasture in shrubby and fallow savannas.

Examination of Figure 5 shows that the good grasses are the highest in this pasture with a specific contribution of 32.27%. Then come the various fodder crops with a contribution of 26.41%. The forage categories (refusal, medium grasses and forage legumes) have respective specific contributions of 16.45%, 13.91% and 10.34%. In this pasture, we observe that poor grasses are poorly represented. The pastoral value in this pasture is very high, i.e. 63.54% with a low contribution of refusals (16.45%) which corresponds to a brushing rate of 16.45%. This justifies a preponderance of species of good palatability.

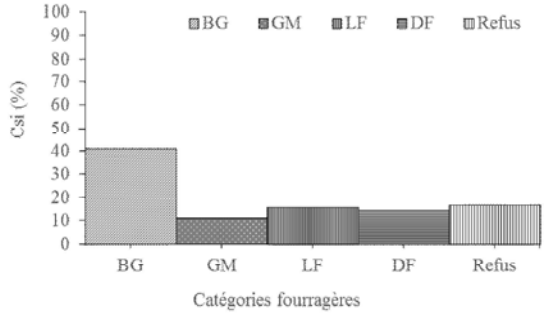

Fig. 4: Fodder categories of pasture with Combretum collinum and Rottboellia cochinchinensis in wooded and fallow savannas

Legend: BG: Good grasses; MG: Medium Grasses; FL: Forage legumes; VFS: Various fodder species

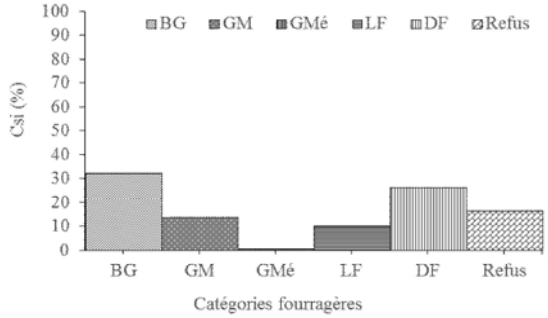

Fig. 5: Forage categories of Acacia polyacantha and Eragrostis ciliaris pasture in shrubby and fallow savannas

Legend: BG: Good grasses; MG: Medium Grasses; PG: Poor grasses; FL: Forage legumes; VFS: Various fodder species

Comparative Analysis of Identified Pastures: The characteristics of the identified pastures are summarized in Table 1 by the values of the Shannon diversity index, the Piélou equitability, the pastoral value and the brushing rate.

Across all pastures, the average value of the Shannon diversity index is 3.63 bits. The highest value of the Shannon index is observed in the P4 pasture while the lowest was noted in the P2 pasture. As for the equitability of Piélou, it varies between 0.70 and 0.82 and remains high in all the pastures (E > 0.50). These values translate a floristic homogeneity of these pastures. With regard to pastoral values, we note that overall they are very good with an average of 71.23%; which proves that there is a low rate of undergrowth in these four (04) pastures. Consequently, these pastures have not experienced strong anthropization or deterioration. Good grasses are the most dominant forage categories in all pastures (Figure 6).

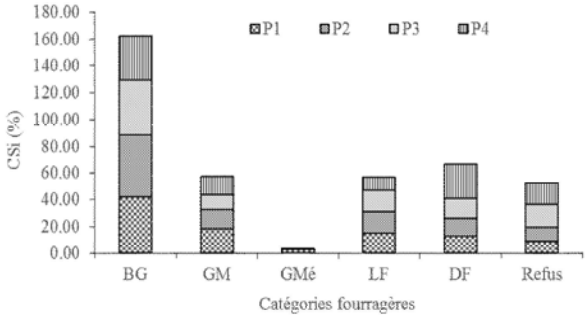

Fig. 6: Forage categories of the pastures studied

Legend: BG: Good grasses; MG: Medium Grasses; PG: Poor grasses; FL: Forage legumes; VFS: Various fodder species

Pasture Productivity and Carrying Capacity: Productivity and carrying capacity of P1 pasture with Piliostigma thonningii and Eleusine indica in shrubby and fallow savannas: The productivity of the P1 pasture with Piliostigma thonningii and Eleusine indica in the shrubby savannas and fallows is 9.26 ± 2.47 tDM/ha. It can support a load capacity of 1.35 ± 0.61 TLU/ha/year, which corresponds to an equivalent soil demand of 2.96 TLU/ha/ year. The amount of qualified fodder is 7014.25 ± 1867.70 kg/DM/ha. Table 2 presents the productivities, the theoretical carrying capacities, the quantities of qualified fodder and the equivalent land demands of the different fodder categories at the peak biomass of pasture P1 with Piliostigma thonningii and Eleusine indica in shrubby savannahs and fallows. From the analysis of this table, it appears that the productivity, the quantity of qualified fodder and the carrying capacity are higher in grasses. While legumes and others have a higher value of equivalent land demand

Productivité et Capacité De Charge du Pâturage P2 À *Pterocarpus erinaceus* et *Tephrosia bracteolata* Des Savanes Arborées et Jachères: La productivité du pâturage P2 à Pterocarpus erinaceus et Tephrosia bracteolatades savanes arborées et jachères est de 9, 43 ± 1, 76 tMS/ha avec une quantité de fourrage qualifié de 7394, 97 ± 1384, 57 Kg/MS/ha. La capacité de charge est de 1, 38 ± 0, 26 UBT/ha/an, ce qui correspond à une demande en terre équivalente de 2, 90 UBT/ ha/an. Le tableau 3 présente les productivités, les capacités de charge théorique, les quantités de fourrage qualifié et les demandes équivalentes en terre des différentes catégories fourragères au pic de biomasse du pâturage à Pterocarpus erinaceus et Tephrosia bracteolatades savanes arborées et jachères.

Table 1: Summary of linear structural and pasture diversity parameters

Pastures	Shannon Diversity Index (Bits)	Fairness of Piélou	Pastoral value (%)	Brushing rate (%)
P1	3, 29	0, 76	75, 75	9, 31
P2	3, 15	0, 7	78, 45	10, 20
P3	3, 93	0, 82	67, 18	16, 92
P4	4, 14	0, 81	63, 54	16, 45
Average	3, 63	0, 77	71, 23	13, 22

Source: Field data processing, 2020

Legend: P1: Pasture with Piliostigma thonningii and Eleusine indica in shrubby and fallow savannas;

P2: Pasture with Pterocarpus erinaceus and Tephrosia bracteolata in wooded and fallow savannas;

P3: Pasture with Combretum collinum and Rottboellia cochinchinensis in wooded and fallow savannas and

P4: Acacia polyacantha and Eragrostis ciliaris pasture in shrubby and fallow savannas.

Table 2: Productivity, quantities of qualified fodder and carrying capacity of the categories of fodder species in pasture P1

Forage categories	P (tMS/ha)	Q (KgMS/ha)	CC (UBT/ha/an)	ELD (UBT/ha/an)
Grasses	4, 79 ± 1, 52	3626, 61 ± 1148, 55	0, 70 ± 0, 33	1, 43
Legumes and others	4, 47 ± 0, 95	3387, 63 ± 719, 15	0, 65 ± 0, 28	1, 53
Average	4, 63 ± 1, 23	3507, 12 ± 933, 85	0, 68 ± 0, 31	1, 48

Legend: P: productivity, Q: Quantity of qualified fodder CC: carrying capacity, ELD: Equivalent Land Demand

Table 3: Productivity, quantities of qualified fodder and carrying capacity of categories of fodder species in P2 pasture

Forage categories	P (tMS/ha)	Q (KgMS/ha)	CC (UBT/ha/an)	ELD (UBT/ha/an)
Grasses	4, 74 ± 0, 83	3714, 94 ± 652, 12	0, 69 ± 0, 12	1, 45
Legumes and others	4, 69 ± 0, 93	3680, 03 ± 732, 45	0, 69 ± 0, 14	1, 46
Average	4, 71 ± 0, 88	3697, 48 ± 692, 28	0, 69 ± 0, 13	1, 45

Legend: P: Productivity, Q: Quantity of qualified fodder CC: carrying capacity, ELD: Equivalent Land Demand

Table 4: Productivity, quantities of qualified fodder and carrying capacity of categories of fodder species in pasture P3

Forage categories	P (tMS/ha)	Q (KgMS/ha)	CC (UBT/ha/an)	ELD (UBT/ha/an)
Grasses	4, 37 ± 0, 90	2933, 08 ± 790, 42	0, 64 ± 0, 13	1, 57
Legumes and others	4, 38 ± 0, 74	2945, 70 ± 707, 81	0, 64 ± 0, 11	1, 56
Average	4, 38 ± 0, 82	2939, 39 ± 749, 11	0, 64 ± 0, 12	1, 56

Legend: P: productivity, Q: Quantity of qualified fodder CC: carrying capacity, ELD: Equivalent Land Demand

L'examen de ce tableau révèle que la productivité et la quantité de fourrage qualifié sont plus élevées dans les graminées. Les capacités de charges et les demandes en terre équivalentes s'équivalent presque dans les deux catégories fourragères.

Productivity and Carrying Capacity of P3 Pasture with Combretum Collinum and Rottboellia Cochinchinensis in Wooded and Fallow Savannas: The overall productivity of the P3 pasture with Combretum collinum and Rottboellia cochinchinensis of tree and fallow savannas is 8.75 ± 1.64 tDM/ha with a carrying capacity of 1.28 ± 0.24 TLU/ha/year. This corresponds to an equivalent land demand of 3.13 TLU/ha/year. The quantity of qualified fodder is 5878.77 ± 1498.22 Kg/DM/ha. Table 4 presents the productivities, the theoretical carrying capacities, the quantities of qualified fodder and the equivalent land demands of the different fodder categories at the peak of biomass of the P3 pasture with Combretum collinum and Rottboellia cochinchinensis of tree savannahs and fallow land. Examination of this table shows that the productivity and the quantity of qualified fodder are high in legumes and others. The carrying capacity and equivalent soil demand are similar in grasses and legumes and others.

Productivity and Carrying Capacity of P4 Pasture with Acacia Polyacantha and *Eragrostis ciliaris* in Shrubby and Fallow Savannas: The overall productivity of the P4 pasture with Acacia polyacantha and Eragrostis ciliaris in the shrubby savannas and fallows is 8.75 ± 1.11 tDM/ha. It can support a load capacity of 1.28 ± 0.16 TLU/ha/year, which corresponds to an equivalent land demand of 3.14 TLU/ha/year. The amount of qualified fodder is 5562.13 ± 1094.45 kg/DM/ha. Table V presents the productivities, the theoretical carrying capacities, the quantities of qualified fodder and the equivalent land demands of the different fodder categories at the peak biomass of pasture P4.

Table 5: Productivity, quantities of qualified fodder and carrying capacity of categories of fodder species in P4 pasture

Forage categories	P (tMS/ha)	Q (KgMS/ha)	CC (UBT/ha/an)	ELD (UBT/ha/an)
Grasses	4, 16 ± 0, 51	2642, 62 ± 509, 39	0, 61 ± 0, 08	1, 65
Legumes and others	4, 59 ± 0, 60	2919, 51 ± 585, 05	0, 67 ± 0, 09	1, 49
Average	4, 38 ± 0, 56	2781, 06 ± 547, 22	0, 64 ± 0, 08	1, 57

Legend: P: productivity, Q: Quantity of qualified fodder CC: carrying capacity, ELD: Equivalent Land Demand

Table 6: Mean value of variation in herbaceous biomass and pasture carrying capacity

Pastures	P (tMS/ha)	CC (UBT/ha/an)
P1	4, 63 ± 1, 23	0, 68 ± 0, 31
P2	4, 71 ± 0, 88	0, 69 ± 0, 13
P3	4, 38 ± 0, 82	0, 64 ± 0, 12
P4	4, 38 ± 0, 56	0, 64 ± 0, 08
Average	18, 09 ± 3, 49	2, 64 ± 0, 64

Source :Field data processing, 2020

Table 7: Summary of productivities, quantities of qualified fodder, carrying capacity and DTE by fodder categories

Pastures	Forage categories	P (tMS/ha)	Q (KgMS/ha)	CC (UBT/ha/an)	ELD (UBT/ha/an)
P1	Grasses	4, 79 ± 1, 52	3626, 61 ± 1148, 55	0, 7 ± 0, 33	1, 43
P2	Grasses	4, 74 ± 0, 83	3714, 94 ± 652, 12	0, 69 ± 0, 12	1, 45
P3	Grasses	4, 37 ± 0, 9	2933, 08 ± 790, 42	0, 64 ± 0, 13	1, 57
P4	Grasses	4, 16 ± 0, 51	2642, 62 ± 509, 39	0, 61 ± 0, 08	1, 65
Average		4, 52 ± 0, 94	3229, 31 ± 775, 12	0, 66 ± 0, 17	1, 53
P1	Legumes and others	4, 47 ± 0, 95	3387, 63 ± 719, 15	0, 65 ± 0, 28	1, 53
P2	Legumes and others	4, 69 ± 0, 93	3680, 03 ± 732, 45	0, 69 ± 0, 14	1, 46
P3	Legumes and others	4, 38 ± 0, 74	2945, 7 ± 707, 81	0, 64 ± 0, 11	1, 56
P4	Legumes and others	4, 59 ± 0, 60	2919, 51 ± 585, 05	0, 67 ± 0, 09	1, 49
Average		4, 53 ± 0, 81	3233, 22 ± 686, 12	0, 66 ± 0, 16	1, 51
General Average		4, 52 ± 0, 87	3231, 27 ± 730, 62	0, 66 ± 0, 16	1, 52

Source: Field data processing, 2020

From the analysis of this Table 5, it appears in legumes and others that the productivity, the quantity of qualified fodder and the carrying capacity are higher. While the equivalent land demand is higher in the grasses of this pasture.

Comparative Analysis of Biomasses and Carrying Capacities of Pastures: The average value of the herbaceous phytomass for all the pastures is 18.09 ± 3.49 tMS/ha and that of the carrying capacity of the pastures is 2.64 ± 0.64 TLU/ha/year. Table 6 presents the mean value of the variation of the herbaceous biomass or phytomass and the carrying capacity. It emerges from the analysis of the said table that the herbaceous phytomass and the carrying capacity vary significantly from one pasture to another. This explains why the carrying capacity and the productivity of the herbaceous layer depend on the climate, the soil, the ligneous cover and the degree of degradation of the flora. The highest phytomass values are obtained in P1 and P2 pastures. While the P3 and P4 pastures obtain the lowest values. These low values observed are explained on the one hand by trampling, heavy use or overloading of pastures during the rainy season and on the other hand by the unsuitable farming practices of farmers.

Summary of Productivities, Quantities of Qualified Fodder, Carrying Capacity and DTE by Category: The summary of productivities, quantities of qualified fodder, carrying capacity and equivalent land demand by fodder category is summarized in Table 7. Analysis of this table reveals that productivity, quantity of qualified forage and carrying capacity are higher in P1 and P2 grass pastures. While legumes and others have a higher value in P3 pasture in equivalent land demand.

DISCUSSION

Pastoral Value and Carrying Capacity of Pastures: The pastoral value in the Commune of Ouassa-Péhunco is on average 71.23%. This very high value is due to a low rate of brushing or refusal in the different pastures [34]. These pastures have not experienced strong anthropization or deterioration. According to Djibril and

Toko Imorou [33] and Fournier [35], in the study of the dynamics of riparian plant formations and carrying capacity around the Dunkassa pastoral hydraulic reservoir in northeastern Benin, the pastoral value around the reservoir of hydraulics is on average 37%. For Zoungrana [27], the pastoral values in the southern Sudanian zone are around 50 to 75%. They are described as average to good pastures. Daget and Godron [22] estimate that a good pasture has a pastoral value greater than 65% and this pastoral value characterizes good vegetation. The value of pastures depends on the importance of agricultural activities. According to Boudet [32], the pastoral value is highly variable; it is linked to several factors which are themselves variable in space and time. Zoungrana [27] estimates that the value of pastures depends essentially on climate, soils and livestock management methods. It also depends, first of all, on the species present, the palatability of which conditions attendance and ingestion. Herbaceous strata provide the bulk of livestock feed, while woody fodder contributes mainly in the dry season and is a recognized and highly valued protein supply, as are crop residues from the fields. The Commune's pastures have an average productivity of 4.52 ± 0.87 tMS/ha with an average annual carrying capacity of 0.66 ± 0.16 TLU/ha/year. This corresponds to an equivalent land demand of 1.52 ha/UBTThe productivity of grasses at peak biomass is 4.52 ± 0.94 tDM/ha with a carrying capacity of 0.66 ± 0.17 TLU/ha/year. For vegetables and others, it is 4.53 ± 0.81 tMS/ha with an annual carrying capacity of 0.66 ± 0.16 TLU/ha/year. The Pterocarpus erinaceus and Tephrosia bracteolata pasture in wooded and fallow savannas has the highest productivity value with 4.71 ± 0.88 tDM/ha and the lowest productivity value is recorded in the Acacia polyacantha and Eragrostis ciliaris pasture in the shrubby savannas and fallows with 4.38 ± 0.56 tDM /Ha. The carrying capacity around the Dunkassa reservoir was estimated at 0.35 TLU/ha/year, which corresponds to an equivalent land demand of 2.87 ha/TLU/year with a productivity of 2.39 tDM/ha [33]. For Boni [30] in the Wari-Maro classified forest, the average carrying capacity is 0.83 TLU/ha/year with an equivalent land demand of 1.2 ha/TLU/year and an average productivity of 3 .2 tDM/ha. According to Boudet [18], the carrying capacity is reduced following the vegetation fires which consume the pastures. In the Sudanian region of Senegal, the carrying capacity varies from 0.91 to 0.93 TLU/ha/year [4]. In the Nazinga savannahs in the Sudanian region, productivity varies between 2 and 12 tDM/ha/year depending on the facies and the topography [35]. In the Vipalogo terroir in Burkina-Faso, the units' theoretical carrying capacities are 0.73 TLU/ha/year [36]. These various results corroborate, the hypothesis H2 according to which the pastoral value and the carrying capacity are relatively weak is verified in this sector.

CONCLUSION

The analysis of the flora and vegetation of the Commune of Ouassa-Péhunco made it possible to inventory 236 species including 91 ligneous species and 145 herbaceous distributed in 69 families and 177 genera in 104 records. Leguminosae and Poaceae are the most represented families. According to the hierarchical classification of phytosociological records based on the presence-absence of species, four (04) types of pastures have been identified. Shannon's diversity index shows that P1 pasture with Piliostigma thonningii and Eleusine indica in shrubby and fallow savannas and P2 pasture with Pterocarpus erinaceus and Tephrosia bracteolata in tree and fallow savannahs are the most diversified, whereas P3 pasture with Combretum collinum and Rottboellia cochinchinensis in wooded and fallow savannahs and the P4 pasture with Acacia polyacantha and Eragrostis ciliaris in shrubby and fallow savannahs are the least diversified. The pastoral values are generally appreciable on all four (04) pastures with an average of 71.23%. The productivity of grasses varies between 4.16 to 4.79 tDM/ha and that of legumes and others varies between 4.38 to 4.69 tDM/ha. This situation shows the availability of fodder during the rainy season. The carrying capacity at the end of the rainy season is very high; which explains why this study environment is always favorable to the installation of breeders.

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