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Integration of the Quality of Herbaceous Phytomasses in the Estimation of the Load Capacity of Pastures in Central Senegal

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Abstract— *The objectives of this study are, on the one hand, to carry out a qualitative assessment of pastures in central Senegal and, on the other hand, to test a method for quantitative and qualitative evaluation of herbaceous pastures. The method used is that of the stratified sampling line associated with the Braun Blanquet approach. The selected evaluation parameters are the amount of phytomass, pastoral value and carrying capacity. Phytomass-based prioritization shows that the amount of forage produced per site follows a growing gradient from north to south. The same trend is observed in the classification of pastures based on load capacity. The parameters studied show that the quantity and quality of pastures appear to be influenced by rainfall and soil conditions. The northernmost sites have the lowest load capacities ranging from 0.02 to 0.18 UBT/Ha. The southernmost sites have the highest load capacities ranging from 0.20 to 0.43 UBT/Ha. The results show that the method used is applicable without risk of increasing field work or increasing financial and material resources. In addition, it allows for quantitative and qualitative evaluation of pastures.*

I. INTRODUCTION

Senegal is a country where livestock production is largely based on pastoral and agropastoral husbandry (Sy et al., 2011; Minel, 2009). One of the main keys to the success of these livestock systems is the availability of pastoral resources in quantity and quality. According to estimates by Pagot (1985), more than 90% of the energy consumed by cattle in the extensive system comes from grazing. From this point of view, it becomes imperative for the state authorities and other structures that evolve in the subthe livestock sector to have access to reliable information on the state and evolution of pastoral resources in order to have effective decision support tools.

These needs for access to this pastoral information have been well expressed by the Ministry of Livestock and Animal Productions (MEPA) in its National Programme for the Development of Livestock (PNDE). In line 2 of the strategic axis 2 of the PNDE, entitled “Improvement of routes and access to concentrated feed”, the Ministère de l'Elevage et des Productions Animales (MEPA) wishes to carry out the following activities in the field of pasture:

- an inventory of pastoral resources,
- Monitoring and evaluation of pastures
- improvement of pastures through the introduction of appropriate forage species.

These activities of monitoring and evaluation of pastoral resources by the estimation of crop production are carried out by the CSE through an agreement that binds it with the State of Senegal since 1987. The methodology used by the CSE for the evaluation of crop production is essentially based on the use of remote sensing vegetation index data, which are calibrated by phytomass measurements at Ground Control Sites (SCS). The result allows to define the map of crop production that takes into account the woody and herbaceous fraction of pastures. However, this method remains purely quantitative and does not include the qualitative aspect of the herbaceous and woody fraction of the phytomass for the calculation of the load capacity of the pasture.

Indeed, the calculation of the load capacity, following the methodology hitherto in progress at the CSE, is based on the production of raw phytomass that does not take into account the qualitative aspect. The calculation of this parameter has evolved and now uses the qualified phytomass that allows the integration of the qualitative aspect (Akpo et Grouzis, 2000), then by Ngom (2012). This qualified phytomasse is the product of raw phytomasse and pastoral value (Baumer, 1997). The pastoral value is obtained by combining the floristic composition and the indices of specific qualities according to the formula of Baumer of 1997. However, in Senegal, specific quality indices are not available for the woody fraction of pastures (Akpo and Grouzis, 2000). In view of this situation, the study is limited solely to assessing the quality of the herbaceous fraction of pastures.

For this reason, the Ecological Monitoring Centre (CSE), in collaboration with the National Institute of Agronomy of Tunisia (INAT), has entitled it “Integration of Herbaceous Phytomasse Quality into the Estimation of the Load Capacity of the Paturages in the Centre of Senegal”.

To better understand the subject, the work began first with a bibliographical synthesis that describes on the one hand the evolution of methods and formulas for calculating the parameters Pastoral Value (VP) and Load Capacity (CC) and

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presents the results of research carried out in Senegal. The study is further oriented in defining the methodology and the material used. It ends with the presentation and discussion of the results obtained.

II. Materials and Methods

2.1. Materials

The study is conducted at eight CSE ground control sites, namely C2L5, C2L6, C2L7, C2L8, C3L5, C3L6, C3L7 and C3L8.

These sites are located in three major ecogeographical areas of Senegal (Figure 4).

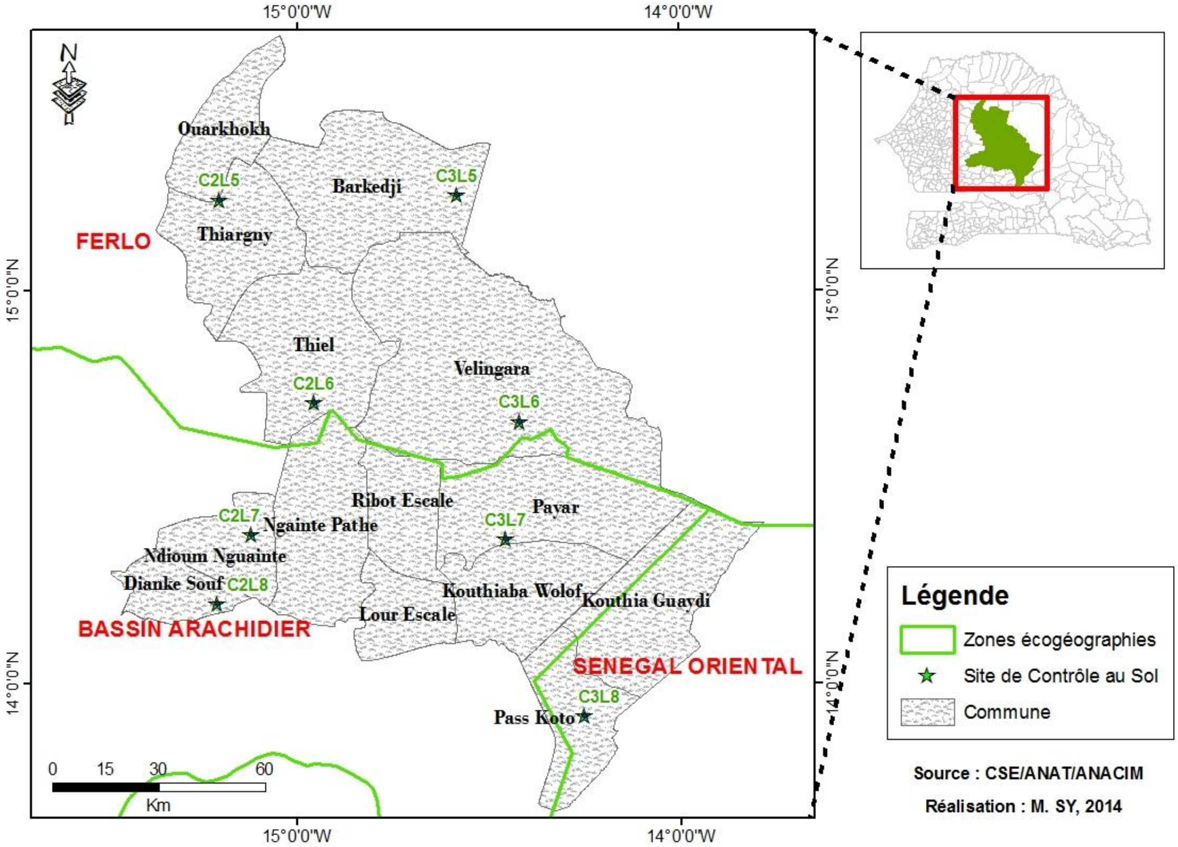

Figure 1: Geographical location of ground control sites (SCS)

- Site C2L5 is located in the Ferlo. It is 8 km southeast of Khogué Tobéne coming from Linguère or 8 km northeast of Thiargny coming from the South. It is located in the 400 mm isohyet zone. The soil is of a low-leaching ferruginous type and the relief is marked by low-grade dunes (CSE, 2013).
- Site C2L6 was established in 1988 at the Doli Ranch on the Dioridi 2 plot. It is located in the sandy Ferlo. It is located in 400 mm isohetes. The soil is a low-leaching tropical ferrous type of soil, while the terrain is relatively flat with some micro-depressions (CSE 2013).
- Site C2L7, located on the 600 mm isohyet according to the 1981-2010 standard, is in Ndioum Guent in the sylvo-pastoral reserve of Sine Saloum. It is 7 km east of Ndioum Guent going towards Boyguel-Loumbol and passing through Touba Fall. The soil is scrubbed tropical ferruginous while the terrain is relatively flat.
- Site C2L8 located in the classified forest of Delbi near Malem Hodar, where average annual rainfall according to 1981-2010 normal is 600 mm. The soil rests on a ferruginous shell.
- Site C3L5 located on the 400 mm isohyet according to 1981-2010 normal and in the zone of ferruginous Ferlo. The first landmarks are located 59 and 62 km from Linguère, south of the Linguère-Ourossogui road. The relief is a plateau and the soil is of a low-leaching ferruginous type resting on gravel material. It is between Barkédji, Velingara and Ranerou.
- Site C3L6 is located on the 500 mm isohyet according to 1981-2010 standard. This site is near the large Ngonor pond. It is 26 km north of Payar going towards Bem-Bem and passing through Darou Rakhmane. The soil is of a slightly leached iron type and the terrain relatively flat.
- Site C3L7, also located on the 600 mm isohyet according to the 1981-2010 standard is Payar, in the classified forest of Panal. The soil is poorly developed on a gravelonary plateau.
- C3L8 located in the forest of Paniates at almost 5 kilometers from Malem Niani located within a Sudanian zone with rainfall normally 700 mm. The site is also not far from

Koussanar, Ndiayenne Bamba and Ida Mouride. The soil is tropical leached on a gravelly plateau.

2.2. Methodology

The methodology adopted for this study is based in part on the method used by the CSE. It combines the stratified sampling line method with the Braun Blanquet (BB) approach. The BB approach is based on a visual assessment of the degree of importance of the different species in the floristic procession. It allows for a percentage to be allocated to each species that indicates its degree of importance. This approach is coupled with the stratified sampling line method to be able to determine the phytomass and calculate specific contributions and pastoral values.

2.2.1. Evaluation of grassland production

The methodology applied is based on the combination of the stratified sampling line method and the Braun Blanquet approach. Indeed, on the 1 km long transect, a stratification is carried out according to different levels of production of the herbaceous stratum. The transect starts from a fixed landmark and its orientation is determined using a compass.

On the transect, each square meter is rated by a production level ranging from 0 to 3 (Table 1).

TABLE 1: Scale of production levels of the herbaceous phytomass

Rating	Level of production
0	bare soil,
1	relatively low output on the SCS,
2	average output on SCS,
3	relatively high output on SCS

Then, 1 square metre panels are randomly selected from each transect of each site. A floristic inventory is carried out on each selected square meter. Unlike the CSE method, a comprehensive floristic inventory is carried out on each placard. In addition, each registered species is associated with a percentage that specifies its degree of importance. After the inventory, each square metre taken as a sample is cut and weighed on the field.

A part of the green matter taken from these plots is transported to the oven after re-sampling (Photos 06, 07, 08 and 09) for each production level in order to obtain the dry matter rate. The output obtained is weighted by the relative frequency of each stratum.

On the one hand, these quantitative data will be used to calculate the phytomass of grassland at the level of each stratum. The sum of phytomasses from different strata will yield total grassland phytomass (CSE, 2013).

On the other hand, the floristic inventory and the precision of the degrees of importance of each species will allow to know the specific richness, the floristic composition and the specific contributions. These specific contributions combined with specific quality indices allow the calculation of pastoral values and the deduction of load capacities.

2.2.2. Data processing

Data processing revolves around the calculation of pastoral value and carrying capacity. These indicators were chosen to assess the quality of pastures because of their simplicity, speed and accuracy. Indeed, according to Pechanec and Pickford (1937), an effective evaluation method must meet three fundamental criteria: speed, accuracy and flexibility. However, one of the reasons for the notion of pastoral value is its simplicity of use.

2.2.3. Calculation of the pastoral value

The pastoral value is calculated on the basis of specific contributions and indices of specific qualities (Isi) (Akpo, 2002).

Indeed, the specific quality index reflects the zootechnical interest. Its determination is based on palatability (or palatability), productivity (kg DM/ha/day), bromatological value and digestibility of the forage species. According to Akpo (2002), this quality criterion for herbaceous species on grazing land in the Sahelian zone is based on a rating scale of 0 to 3, that is on a scale of four classes (0, 1, 2 and 3) as follows:

- the plants of good pastoral value (BVP) are those whose Isi is equal to 3;
- the plants of medium pastoral value (MVP) are those with an Isi equal to 2;
- the plants of low pastoral value (FVP) are those with an Isi equal to 1;
- the plants without pastoral value (SVP) are those with Isi equal to 0.

The relative pastoral value is calculated by multiplying the species' specific contribution (Csi) by the corresponding quality index (Isi).

The gross pastoral value is obtained by adding up the relative pastoral values and then expressing them as a percentage (%).

The net pastoral value (NPV) or overall quality index (IGQ), is between 0 and 100% and is obtained by the formula of Baumer (1997).

Vpn = IGQ = RGV x 1/3 ΣCsi x Isi (Equation n°1)

Vpn : Net Pastoral Value
IGQ: specific quality index
RGV: global vegetation cover
Csi: Specific contribution
Isi: Specific quality index

The IGQ or net pastoral value is applied to the herbaceous phytomass produced to obtain « qualified » forage production (Boudet, 1983).

Pfq (kg/ha) = P (kg/ha) x Vpn (Equation n°2)

Pfq: Qualified Forage Production
P: Biomass production
Vpn : Net Pastoral Value

This production of qualified forage (Pfq) will be used to determine the theoretical load capacities of pastures using the Baumer 1997 formula.

$$CC\ (UBT/Ha) = \frac{ki\ x\ Pfq}{6{,}25\ Kg\ de\ MS\ x\ UBT/J\ x\ Njss}$$

(Equation n°3)

CC: load capacity
Pfq: Qualified Forage Production
DM: Dry matter
UBT: Tropical livestock unit
Njss: Number of dry season days
Ki: 1/3

The load capacity is calculated based on the qualified forage produced and for an essential dry season use of nine months.

III. Results And Discussions

3.1. Results

3.1.1. The phytomass

The analysis in figure 2 shows that phytomass production is higher at the C3L8 and C2L8 sites located respectively in eastern Senegal and at Saloum in the 600 and 700 mm isohyetes. These productions are of the order of 3268.98 kg/ha for C3L8 and 2523.70 Kg/Ha for C2L8.

Phytomass production is relatively average at the C3L7 and C2L7 sites located in the 600 mm Saloum isohyetes. Production levels are 1838.09 kg/ha for C3L7 and 1697.26 kg/ha for C2L7.

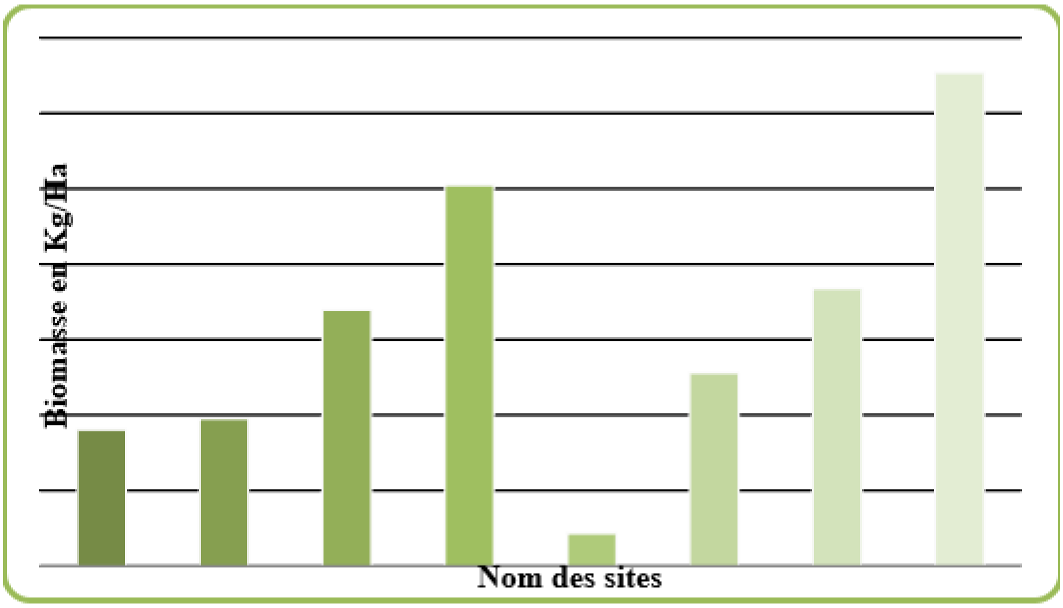

Figure 2: Production of Phytomassic grassland in the SCS of central Senegal in 2014

Sites C3L6, C2L6 and C2L5 located respectively in the Saloum and in the sandy Ferlo in the 500 mm isohyetes recorded relatively low phytomass productions. The quantities produced are 1279.05 kg/ha for C3L6, 976.09 kg/ha for C2L6 and 901.75 kg/ha for C2L5.

The C3L5 site in the ferruginous Ferlo produced the lowest amount of phytomass at about 215.35 Kg/Ha.

3.1.2. The pastoral value

This indicator (pastoral value) is one of the bases for classifying sites following their quality. Table 2 summarizes the results of its calculation at each site level in each ecogeographical area.

TABLE 2: Classification of the SCS in central Senegal according to their pastoral value

SCS	Net Pastoral Value (IGQ)	ZEG
C2L8	73.94	Groundnut basin
C3L8	67.2	Eastern Senegal
C2L5	66.85	Ferlo
C3L6	64.71	Ferlo
C2L6	63.24	Ferlo
C3L7	54.01	Groundnut basin
C2L7	53.4	Groundnut basin
C3L5	52.93	Ferlo

The first analysis of this table shows that the classification of sites follows the following order: C2L8, C3L8, C2L5, C3L6, C2L6, C3L7, C2L7 and C3L5. The pastures with the best pastoral values have been scattered between the Peanut Basin, eastern Senegal and a little in the Ferlo. The pastoral values follow some order in different ecogeographical areas.

3.1.3. The load capacity

The results of the load capacity calculations for the centre sites are summarized in Figure 3.

The analysis of Figure 3 and Table 3 shows that the sites located in the 600 and 700 mm isohyetes to the south, more precisely in eastern Senegal (C3L8 in the Malem Niani) and the Saloum (C2L8 in the Delbi near Malem Hodar) have the best load capacities with values of 0.43 UBT/Ha and 0.37 UBT/Ha respectively.

The load capacities of sites in 500 and 600 mm are second. These are mainly sites C2L7, C3L7 and C3L6 with values of 0.20 UBT/Ha, 0.18 UBT/Ha and 0.16 UBT/Ha respectively.

Sites C2L5 and C2L6 in 400 mm isohyetes take the third place and have load capacities of around 0.12 UBT/Ha.

Site C3L5, which is located in 400 mm isohyetes, has the lowest load capacity. Its load capacity value is 0.02 UBT/Ha.

The analysis in Table 3 shows that the loading capacity of sites follows an increasing gradient from north to south. Indeed, it follows the same direction as the rainfall gradient which is increasing from north to south.

3.2. Discussion

3.2.1. Discussion of site value calculation results

The evolution of phytomassity over time was also studied. Information is summarized in Figure 4.

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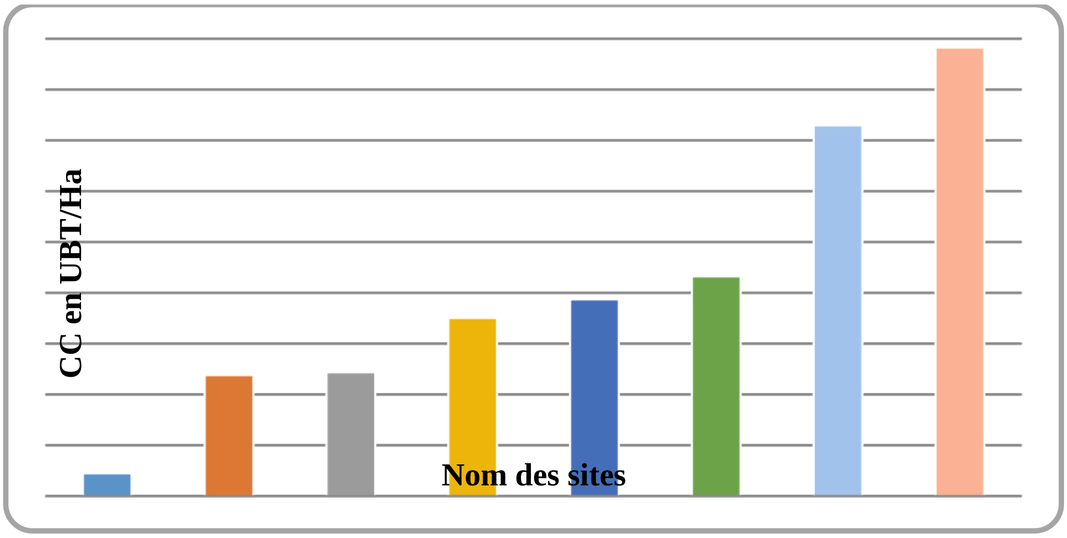

Figure 3: Load capacity of the SCS of central Senegal in 2014

TABLE 3: Classification of SCS and ZEG by load capacity

SCS	Load capacity UBT/Ha	ZEG	Isohyetes in mm
C3L8	0,43	Eastern Senegal	700
C2L8	0,37	Groundnut basin	600
C3L7	0,2	Groundnut basin	600
C2L7	0,18	Groundnut basin	600
C3L6	0,16	Ferlo	500
C2L5	0,12	Ferlo	400
C2L6	0,12	Ferlo	400
C3L5	0,02	Ferlo	400

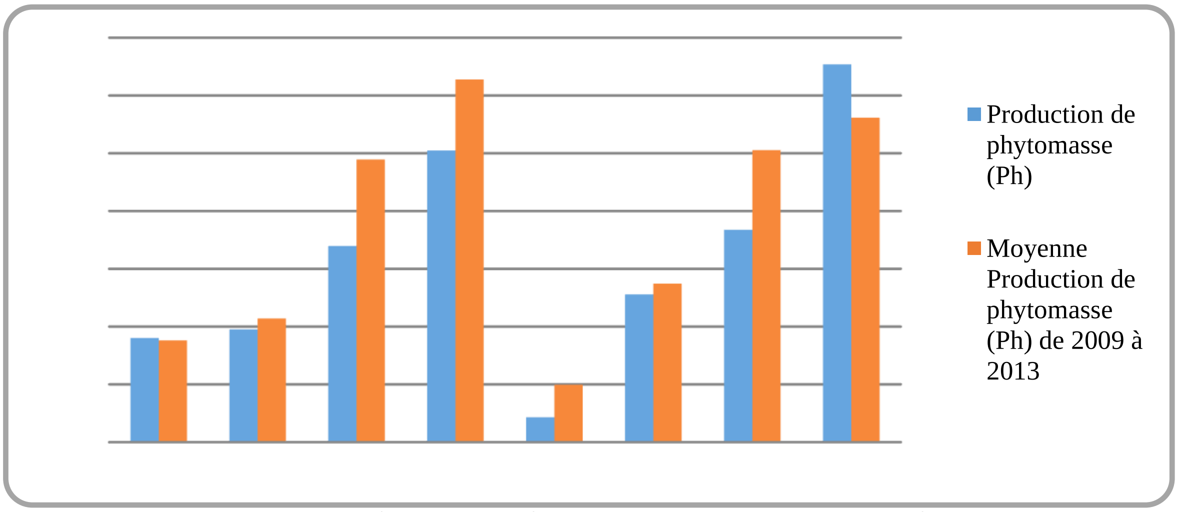

Figure 4: Comparative study of the production of phytomass grassland (in kg/ ha in the SCS of central Senegal

The analysis in Figure 7 shows a relative decline in phytomass production at the level of the majority of sites in the centre over the years. In 2014, only the C3L8 site located in eastern Senegal has a production above the average of the last five years.

This being said, the production levels of phytomassic grassland on most central sites (Ferlo and Saloum) tend to decrease over the years. This phenomenon could be explained by the drops in rainfall following climatic disturbances that are increasing over the years (Personal communication: Bamba DIOP).

In summary, a classification based solely on the amount of phytomass produced shows that pastures follow the following hierarchy: C3L8, C2L8, C3L7, C2L7, C3L6, C2L6, C2L5 and C3L5. According to the phytomass criterion, the best pastures are observed in eastern Senegal, followed by those of Saloum and Ferlo.

These differences in production could be explained by the soil-climatic differences at the level of the agroecological zones hosting the different sites.

Following the gradien of the isohytes, the observation is that the wettest areas produce more phytomass. Therefore, an increase in phytomass production is observed from north to south. And this observation is in perfect agreement with some research results according to which there is a positive correlation between rainfall and phytomass production.

3.2.2. Discussion of the results of the Site Pastoral Value calculation

The first analysis of this figure shows that the classification of sites follows the following order: C2L8, C3L8, C2L5, C3L6, C2L6, C3L7, C2L7 and C3L5.

The analysis of figure 8 also shows that the best pastoral value (73.94%) is obtained on the C2L8 site. Indeed, this is explained by its specific richness (20 herbaceous species) and its good floristic composition. Assessment of the correct composition could be made by the different forage categories that make up the site's forage spectrum (Figure 5).

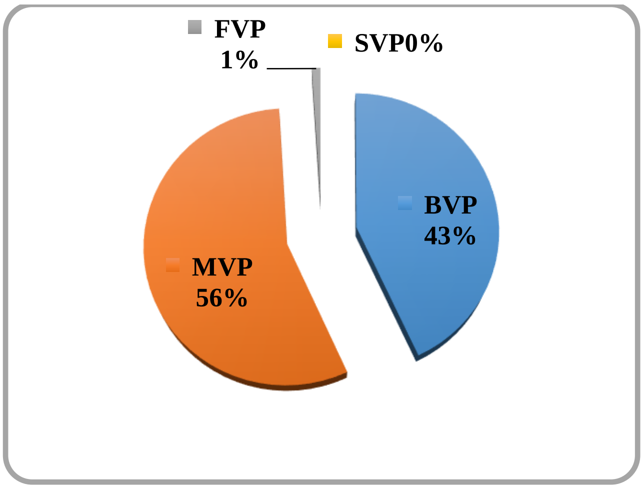

Figure 5: Level of contribution of different feed categories to the formation of pastoral value of the C2L8 site

The analysis of Figure 5 shows that the better pastoral quality of the C2L8 site comes from the fact that its floristic composition consists of 43% of species at BVP and 56% of species at MVP. This being said, most of the species that make up the herbaceous carpet have more or less good productivity, palatable, digestible and good nutritional value. This less interesting quality of the pastures of this site could be explained by its ecogeographical situation which offers a good rainfall (isohyete of 600 mm) and fairly rich soils.

In terms of quality, the C2L8 site is followed by the C3L8 and C2L5 sites which have pastoral values of 67.20% and 66.85%, respectively. This relatively interesting quality of pasture is due to the fact that the herbaceous floral spectra of both sites are made up mainly of good and medium pastoralist species (Figures 6 and 7).

Indeed, the C3L8 site consists of 63% species of BVP and 19% species of MVP (Figure 6). The C2L5 site is composed of 35% BVP species and 58% MVP species (Figure 7).

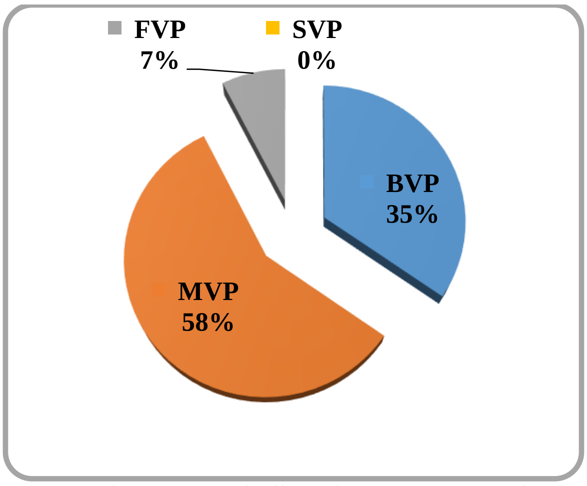

Figure 6: Level of contribution of different feed categories to the formation of pastoral value of C2L5 site

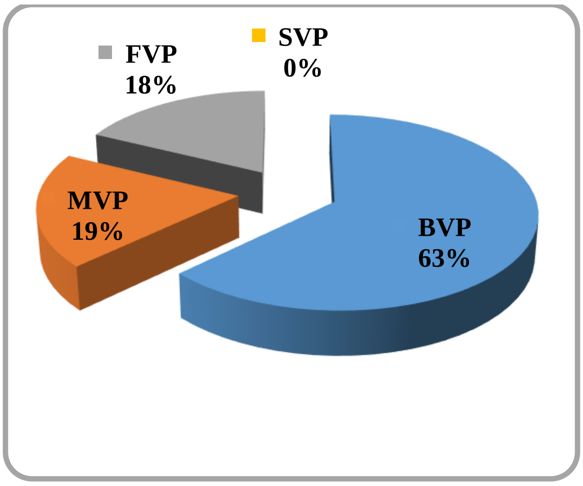

Figure 7: Level of contribution of different feed categories to the formation of pastoral value of C3L8 site

3% on the generation of IGQ. In other words, the site C3L8 is dominated by species at BVP while C2L5 is richer in MVP species.

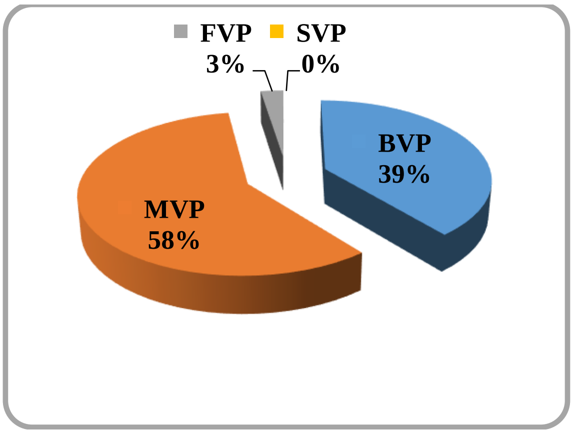

Figure 8: Level of contribution of different feed categories on the formation of the pastoral value of the C3L6 site

Sites C3L6 and C2L6 have more or less similar pastoral values and follow C2L5 in quality. Sites C3L6 and C2L6 have

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pastoral values of 63.24% and 64.71%, respectively. The more or less interesting values of these IGQ are explained by the low levels of contribution of species with low and without pastoral value at the level of floristic processions of both sites (Figure 9 and 10).

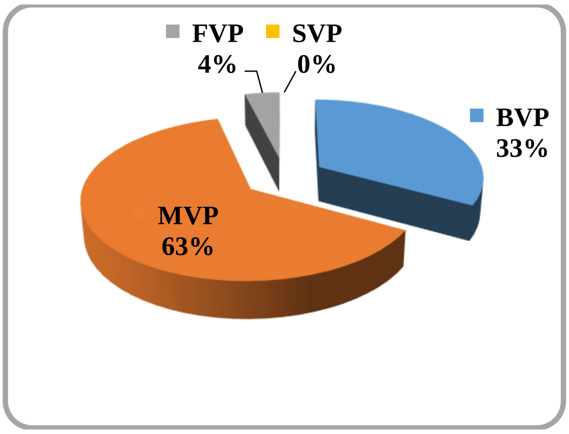

Figure 9: Level of contribution of different feed categories on the formation of the pastoral value of the C2L6 site

The analysis in Figures 9 and 10 shows a low proportion of species at FVP and a good contribution of species at MVP at C2L6 and C3L6 sites. Both sites are dominated mainly by MVP species.

Sites C3L5, C2L7 and C3L7 have the lowest relative qualities with respective pastoral values of 52.93%, 53.04% and 54.01%.

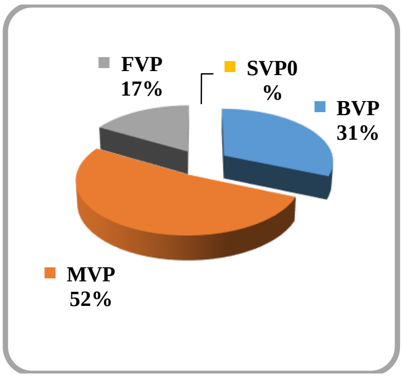

Figure 10: Level of contribution of different feed categories on the formation of the pastoral value of the C3L5 site

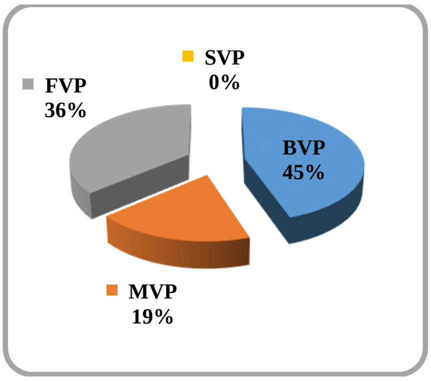

Figure 11: Level of contribution of different feed categories to the formation of pastoral value of C3L7 site

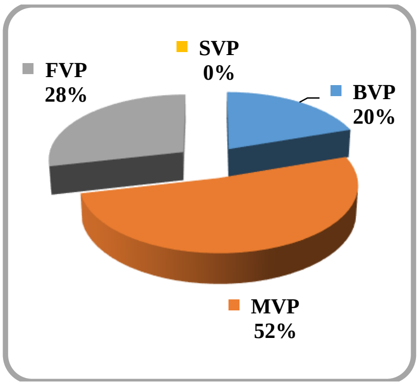

Figure 12: Level of contribution of different feed categories on the formation of the pastoral value of the C2L7 site

The relative weakness of the pastoral values of these sites is explained in large part by the higher or lower contribution levels of species to FVP on the IGQ.

For C3L5, the weakness of the IGQ is also explained by its high proportion in soil. Its plant recovery rate is the lowest on all sites. This could be explained by the fact that its soil is hard (ferruginous soil) and its rainfall is relatively low (Isohyète 400 mm).

The low quality of C3L7 grazing is explained by the high proportion of species with FVP (Figure 12).

3.2.3. Discussion of site load capacity calculation results

The analysis in Table 3 shows that load capacities follow an increasing gradient from north to south. This could be explained not only by the fact that rainfall is more interesting in the south but also because the soils are also better and there is less bare soil.

In conclusion, the ranking of sites according to load capacity gives the following results: C3L8, C2L8, C2L7, C3L7, C3L6, C2L6, C2L5 and C3L5.

The values of load capacities do not show a big difference from those found by Akpo in Ferlo in 2012, by Assarki in 2000, in an ecosystem in Mali and by Tiendrebeogo and Sorg (1997), in the classified forest of Gonsé in Burkina Faso.

IV. Conclusion and Recommendations

In summary, the results of the study show first that the method resulting from the combination of the stratified sampling line and the Braun Blanquet approach is well feasible and applicable in the field. Its application has not caused any increase in the field work and does not require other additional financial resources. On the contrary, it enriches monitoring and evaluation with pastoral information, allowing for the calculation of pastoral values and capacities.

Secondly, the results of the study show that a characterization and classification of pastures based solely on quantitative parameters (phytomass) or qualitative parameters (pastoral values) suggest many shortcomings.

They also show that a study and prioritization based on parameters integrating quantitative and qualitative aspects such as load capacity seems closer to reality.

The sites with the lowest load capacities are C3L5, C2L5, C2L6, C3L6 and C2L7 located further north. The sites with the highest levels of load capacity in central Senegal are C3L8, C2L8 and C3L7 located further south.

It is important to note that the study had a number of limitations. The first is the non-inclusion of the wood fraction in the calculation of pastoral value. Secondly, there is no translation of the biomass obtained in terms of livestock product (meat and milk).

Finally, there is no definition of hazardous pastures that deserves special attention.

To go beyond the first limit of this study, this work should be continued later to integrate the woody fraction in the calculation of pasture value by trying to find specific quality indices for each woody.

To exceed the second limit, bromatological analyses will have to be performed at least once in order to determine a relationship between the qualified phytomass and the forage and protein values of the sites.

This will make it possible to translate the qualified phytomass into meat and milk, which is of more zootechnical interest.

To overcome the third limit, it will be necessary to work in collaboration with the MEPA Study and Planning Cell in order to know the theoretical and real loads. This could help identify and prevent areas that may be overgrazed.

REFERENCE

[1] Aidoud, A. 1989. Contribution to the study of grazing ecosystems (Hautes plaines Algéro-Oranaises). PhD, USTHB, Alger

[2] Akpo L.E., D. Masse, and M. Grouzis, 2002: Duration of fallow land and pastoral value of herbaceous vegetation in the Sudanese zone in Senegal.

[3] Akpo L.E., Grouzis M., 2000. The value of grazing in the Southern region: the case of the Sahelian grasslands of northern Senegal. Tropicultura, 18 pages

[4] Assarki H. 2000. Pastoral management: Evaluation of forage potential in the rural commune of Madiama. Katibougou IPR/IFRA end-of-cycle submission; Mali Rep.: p. 70.

[5] Barral H, Benefice E, Boudet G, Denis JP, De Wispeleare G, Diaté I, Diaw OT, Dieye K, Doutre MP, Meyer JF, Noel J, Parent G, Piot J, Valentin C, Valenza J, and Vassiliades G. 1983. Livestock production systems in Senegal in the Ferlo region. Synthesis of studies of a multidisciplinary research team. ACC/RIZAT (LAT), GERDAT-Orstom, p. 172.

[6] Baumer M. 1997. Agroforestry for animal production. Technical Centre for Agricultural and Rural Cooperation – International Centre for Agroforestry Research; 384.

[7] Boudet G. 1983. Grazing and livestock in the Sahel. Technical notes MAB/UNESCO ; 29-33. Carriére M, Toutain B. 1995. Use of grazing land for livestock and interactions with the environment: assessment tools and indicators. CIRADEMVT, p.92.

[8] Braun-Blanquet J. 1932. Plant Sociology. The Study of Plant Communities. English translated and edited by Fuller GD, Conard HS. Hafner Press: New York, 439 p.

[9] CSE, 2013. Method of assessing pastures.

[10] CRBT, 1978. Phytoecological and pastoral report on the high plains of the Saida wilaya. CRBT, Algiers

[11] Daget, Ph. and Poissonet, 1990. Notion of Pastoral Value. Benchmarks No3.

[12] Daget, Ph. and Poissonet, P. 1965. Expression of the forage value of the Margeride grasslands. Doc No. 20, CNRS-CEPE, Montpellier.

[13] De Vries, D.M.et al. 1942. Een Waardering van grasland of grond van de plantkindige samenstelling. Landbouwk. Tigdschr. Wageningen:

[14] Delpech, 1960. Criteria and judgment of the agronomic value of grasslands. Ann Agro., (212): 5-41.

[15] Diouf A, 2005: Inventory of sites, tools and results of ecological/environmental monitoring in Senegal. 24-page report.

[16] Ellenberg, H. 1952. Landwirfschafiliche planzen zoologie. Bandii. Wiesen und Werden, Stuttgart.

[17] Ellenberg, H. 1962. Landwirfschafiliche planzen zoologie. Bandii. Wiesen und Werden, Stuttgart.

[18] Hirche, A. 1965. On the notion of pastoral value. Parcours demain. num. Spec. Sémin. Intern. Tabarka.

[19] Klapp, E. 1954. Wiesen und Werden. Paul Pathy. Berlin

[20] Loiseau, P. and Sebillote, M. 1972. Study and mapping of pastures in eastern Morocco. Notice of pastoral map at 1/100.000. 3 Vol. MARA/ERES/SCET/ Coopération Paris.

[21] Michele Nori, Michael Taylor, Alessandra Sensi, 2008. Pastoral rights, ways of life and adaptation to climate change. Pub. 33 p.

[22] Ngom D., Akpo al, 2012. Pastoral quality of grassland resources in the Ferlo Biosphere Reserve (Northern Senegal)

[23] Pechanec J.F., Pickford G.D., 1937. A comparison of some methods used in determinating percentage use of fat range. Res., 54: 753-765

[24] Rwabahungu M., 2001. Tenurial reforms in West and Central Africa: legislation, conflicts and social movements. Krishna B. Ghimire and Moore B., 2001.

[25] Swift J.J., 1996. Desertification: narratives, winners and losers. In: Leach M. and Mearns R. (Eds.), 1996a. James Currey pubbl., Oxford

[26] Tiendrebeogo JP, Sorg JP. 1997. Study of the loading capacity of the classified forest of Gonsé. MEE/SG/DGEF, p.24.

[27] Weachter, P. 1982. Study of the relationship between domestic animals and vegetation in the steppes of southern Tunisia. Pastoral implications. Thesis Doct., Ingen., USTL, Montpellier