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Methodologies in the evaluation of forage mass in tree legumes

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ABSTRACT: To choose the method of forage mass estimation (FM), consider the plant species, required accuracy and available technology. In this sense, the objective was to evaluate the methods of determination of direct FM and comparative visual performance with five and 10 patterns, in the trees Gliricidia (*Gliricidia sepium* Jacq.) and Sabiá (*Mimosa caesalpiniifolia* Benth.) At heights up to 1,5 m above the soil and whole plant (1.65 to 1.90 m for Gliricidia and from 3.63 to 5.03 m for Sabiá, with averages of 1.80 and 4.24 m, respectively), using the plant as a unit sample. The evaluations were performed every 28 days for one year, 2012 to 2013. The trees were cultivated in silvopastoral system with brachiaria, under continuous stocking of cattle with initial weight of ± 175 kg. The methods analyzed by regression in the collection cycles and annually and compared by the 5% F test. At the evaluated times it is possible to estimate the FM production by the indirect method, with no differences in the number of standards. The average annual FM of 118.547 kg in 2,250 plants of Gliricidia ha^{-1}, slightly varying between heights. At Sabiá the annual average FM was 398.241 and 702.281 kg in 2,250 ha^{-1} plants, at heights of up to 1.5 m above the ground and whole plant, respectively. The use of the plant as a sample unit, allowed high determination coefficients above 0.800 in the annual analyzes, for the indirect method.

Key words: comparative visual income; direct method; forage production

Metodologias de avaliação de massa de forragem em leguminosas arbóreas

RESUMO: Para escolha do método de estimativa de massa de forragem (MF) deve-se considerar a espécie vegetal, precisão requerida e tecnologia disponíveis. Neste sentido, objetivou-se avaliar os métodos de determinação de MF direto e rendimento visual comparativo com cinco e 10 padrões, nas arbóreas Gliricídia (*Gliricidia sepium* Jacq.) e Sabiá (*Mimosa caesalpiniifolia* Benth.) nas alturas até 1,5 m acima do solo e planta inteira (1,65 a 1,90 m para Gliricídia e de 3,63 a 5,03 m para Sabiá, com médias de 1,80 e 4,24 m, respectivamente), utilizando-se a planta como unidade amostral. As avaliações realizadas a cada 28 dias por um ano, 2012 a 2013. As árvores eram cultivadas em sistema silvipastoril com braquiária, sob lotação continua de bovinos com peso inicial de ±175 kg. Os métodos analisados por regressão nos ciclos de coleta e anualmente e comparados pelo teste F a 5%. Nas alturas avaliadas é possível estimar a produção de MF pelo método indireto, não havendo diferenças quanto ao número de padrões. A MF média anual de 118,547 kg em 2.250 plantas de Gliricídia ha^{-1}, pouco variando entre as alturas. Na Sabiá a MF média anual foi de 398,241 e 702,281 kg em 2.250 plantas ha^{-1}, nas alturas de até 1,5 m acima do solo e planta inteira, respectivamente. A utilização da planta como unidade amostral, possibilitou altos coeficientes de determinação acima de 0,800 nas análises anuais, para o método indireto.

Palavras-chave: rendimento visual comparativo; método direto; produção de forragem

Introduction

The use of tree species in agricultural systems provides advantages such as elevation of organic matter in the soil, reduction of erosive processes, improvement of thermal comfort conditions for animals and supply of products to be used as a source of income complementary to the producer (Solorio et al., 2016; Esperschuetz et al., 2017). Besides increasing the nutritional quality of the pasture and possibly reducing nitrogen fertilization costs due to the nitrogen input from symbiosis, diazotrophic bacteria, and leguminous plants, when these are used (Apolinário et al., 2016).

The knowledge of forage mass production (FM) in tree plants, their variation during the year and spatial distribution of forage biomass is essential for decisions related to pasture management (Esquivel-Mimenza et al., 2013). However, the reduced studies evaluating and/or comparing methodologies for the determination of FM in trees is based on the fact that these analyzes are more laborious compared to herbaceous plants due to the height and structure of the plant, the diversity of existing species and the absence of precise evaluation methods.

The direct or the destructive method is among the methods of estimating FM, considered the most accurate, requires the cutting, drying and weighing of forage obtained in a known area (Haydock & Shaw, 1975). This method is of little practical feasibility in large and heterogeneous sample areas, due to the long evaluation time, work and labor, which induces the insufficient number of samples, which may not represent the area to be analyzed, reducing the experimental accuracy (Zanine et al., 2006).

Other methods have been studied to improve the determination of MF so the factors such as time and labor can be optimized while maintaining a satisfactory degree of reliability (Liu et al., 2015). Also, the indirect or double-sampling method is used, which requires a direct cut, but in a smaller number of samples, besides correlating other variables such as the assignment of a note to its estimates (Cóser et al., 2002).

The practicality of the indirect method allows the evaluation of large areas, providing greater precision of the evaluation. However, there is a need to determine the number of standard samples that understands all the variability in the pasture without removing an excessive amount of forage (Zanine et al., 2006). These measurements are necessary for the observer as training for the future estimates (Arruda et al., 2011), and validation of the sampling method, mainly in forages of cespitose growth (Cóser et al., 2003).

Among the indirect methods, the comparative visual performance (RVC), developed by Haydock & Shaw (1975), can be used for FM evaluations of arboreal-shrub species (Oliveira et al., 2015), requiring a direct estimate of mass availability kg ha^{-1}) with continuous scaling values from one to five, allowing high note-weight correlations by inexperienced observers (Zanine et al., 2006).

However, the availability of techniques for estimating FM in tree plants is still rudimentary. For this choice, the plant community, study objective, available time and technology must be considered besides the precision required (Trotter et al., 2010). In this sense, the objective of this study was to evaluate the methods of determination of FM, direct and RVC in tree legumes, Gliricidia (*Gliricidia sepium Jacq.)* And Sabiá (*Mimosa caesalpiniifolia Benth.)* at two heights in the arboreal stratum, using the plant as the sample unit.

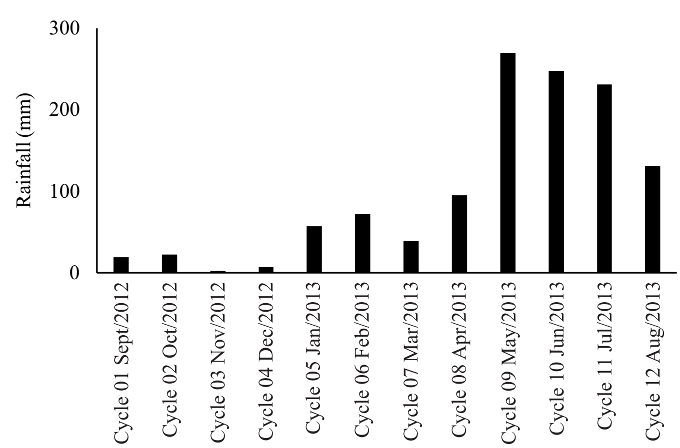
Materials and Methods

The evaluations were carried out at the Itambé Experimental Station, belonging to the Agronomic Institute of Pernambuco, located in the physiographic microregion of the northern forest of the state at 7°24'37" S and 35°06'46" O, at 189 m altitude and average temperature 25 °C (CPRH, 2003).

FM estimates were performed every 28 days for a one-year period, with Cycle 01 occurring in September 2012, with plants presenting one year and eight months old. The accumulated rainfall during the experimental period was 1,192.0 mm, the precipitation per collection cycle expressed in Figure 1 (IPA, 2016).

The experimental area consisted of pastures in the silvopastoral system, *Brachiaria decumbens* Stapf. and Gliricidia and *Brachiaria decumbens* Stapf. and Sabiá, arranged in a randomized block design, with three replicates. Both consortia under stocking continue with adjustments of the forage supply of 3.0 kg of dry matter of B. decumbens per kg^{-1} of animal live weight. The animals present in the pastures were males of the Girolando breeds with the initial mean live weight of approximately 175 kg.

Each experimental unit was a 1.0 ha picket, with the implantation occurring in January 2011. The legumes in the area were in double rows spaced 15.0 m between rows, 1.0 m between rows, 0.5 m between plants of each line, making up a population of 2,500 plants ha^{-1}, in 14 double rows. For the calculations of FM per hectare, 10% of plant mortality



Source: Instituto Agronômico de Pernambuco.

Figure 1. Rainfall between September/2012 and August/2013 of the municipality of Itambé, Pernambuco.

was considered, based on the number of plants per picket per hectare, the as average value between pickets. The average areas occupied by tree crowns were 1,465.0 m² in Gliricídia and 3,879.0 m² in Sabiá. For this estimate, how much the crowns of the legumes advanced in the 15.0 m of a cultivar of the brachiaria was considered, as recommended by Tonini & Arco-Verde (2005).

The evaluations were performed through the direct method and the RVC according to Haydock & Shaw (1975), at two plant heights, up to 1.5 m above the ground and whole plant, with Gliricidia heights varying from 1.7 to 2, 1 m for the beginning and end of the experimental period, respectively, and mean height between the cycles of 1.80 m. For Sabiá, plant heights varied from 3.6 to 5.0 m during the experimental period, with an average of 4.24 m. It is worth mentioning that the height up to 1.5 m above the ground was established considering the browsing of the animals, after previous ethological observation, as recommended by Santana et al. (2011) and Oliveira et al. (2015).

In the direct method, there were 10 plants per picket peeled for each height and evaluation cycle, emphasizing the non-discharge of terminal shoots with diameters of less than 5.0 mm. The choice of plants for defoliation occurred considering the production patterns, after a visual analysis of the 12 central double rows per picket. The first and last rows were discarded to avoid the border effect, as well as the first plants at the intersections of the pickets and one plant per row, was chosen. Five levels of production were collected, from lowest to highest production, two plants per level.

To estimate FM production by the RVC method the standard plants used were those collected in the direct method of mass estimation. The five FM levels observed received scores from 1 to 5, with level 1 representing the plant with the lowest FM production and level 5 the plant with the highest FM. Level 3 was intermediate at levels 1 and 5. A similar procedure occurred in levels 2 and 4.

In the methodology with 10 standard reference samples, two standard plants were used per note. In the methodology of five standard samples, a standard plant was used per note. After the selection of standard plants, previous training of the observer, and subsequent defoliation and weighing of the material, grades are assigned to 50 plants per picket, covering the entire cultivation area and the entire length of the lines, except the final rows and initials, and the first plants at the intersections of the pickets, avoiding the border effect. The FM collected after weighing were conducted to the forced circulation air oven at 55 °C for 72 hours, then weighed for determination of the dry matter.

The methods of evaluation were analyzed by regression to verify if there was a relationship between the masses obtained by the direct method "x" and indirect method "y" with five and 10 standard reference samples, at both heights and plants evaluated by a cycle of collection and annually, considering the three evaluation pickets. For comparison of dry forage masses obtained by the direct method and RVC with five and 10 standard samples per collection cycle, a 5% probability of error test was used. The analyses were performed in the statistical package Statistical Analysis System (SAS).

Results and Discussion

A significant proportion of forage mass variation can be explained by the RVC method in the two plant species, heights and numbers of standard plants analyzed, possibly due to the homogeneous characteristics of the tree vegetation during the experimental period (Table 1 and 2). The homogeneity occurred due to the implantation of the Gliricidia and Sabiá seedlings in the experimental areas occur simultaneously and the animal stocking is adjusted based on the forage supply of 3.0 kg of dry matter of B. decumbens per kg^{-1} of animal live weight, not considering the consumption of the legume, and reducing possible modifications in the architecture of the plant.

The coefficients of determination (R^2) presented an increasing behavior with the collection cycles (Tables 1 and 2), evidencing the training of the evaluator, very important in the recommendation and validation of the sampling method (Lopes et al., 2000). Zanine et al. (2006) pointed out the observer as the main agent for the accuracy of the RVC method, where not altering it during the experiment provides an increase in the accuracy of the evaluations.

According to Thomson (1986), R^2 above 0.75 are considered satisfactory for the use of indirect methods of evaluating FM in intercropped pastures of ryegrass and white clover in New Zealand. In this way, it ratifies the use of RVC method for evaluations of the legumes Gliricídia and Sabiá with ten or five samples of standard plants. However, it is noted that the values of the significance of R^2 in the Sabiá plants in both numbers of standards and heights evaluated are higher than those of Gliricidia (Tables 1 and 2). Possibly, due to the acceptance of the animals, the Glirite has provided modifications in the architecture and height of the vegetable, hindering to establish the evaluation standards.

Despite the high values of R^2 observed in Sabiá's FM evaluations, differences were found between the estimates of FM obtained by the direct and RVC methods, at both heights and number of standards (Table 2), where the RVC method tended to overestimate the FM, increasing from 24.5 to 32.0% for plant height up to 1.5 m above the ground, and from 6.6 to 12.6% in whole plant evaluations. Although the indirect method allows approximate values of FM to the direct method, more attention is needed for calibration at each sampling, so the generated equations are more accurate and allow reliable estimates to be obtained (Cóser et al., 2003).

The regression analyses with all the evaluations, on an annual basis, showed that the linear equation provided greater significance in plant species, heights and numbers of standard plants evaluated, with high R^2 and lower coefficients of variation (CV), (Table 3), emphasizing the possibility of reliable results for determination of FM using the RVC method

Table 1. Estimated dry mass of forage (kg in 2,250 plants ha^{-1}) of Gliricidia (*Gliricidia sepium* Jacq.) At a height of up to 1,5 m above the ground and whole plant by direct methods and visual performance comparative with five and 10 standard samples.

Up to 1,5 m above ground						
Cycles	Month and year cycles	Direct method (kg in 2,250 plants ha^{-1})	Comparative visual performance method (kg in 2,250 plants ha^{1})			
			Five patterns	R^2 (standard deviation)	Ten patterns	R^2 (standard deviation)
1	Sept/2012	51.570	57.104	0.656 (±0.117)	52.468	0.626 (±0.049)
2	Oct/2012	52.821	51.231	0.647 (±0.070)	52.323	0.657 (±0.034)
3	Nov/2012	57.525	57.865	0.783 (±0.087)	57.350	0.669 (±0.061)
4	Dec/2012	49.725	53.941	0.713 (±0.030)	51.524	0.796 (±0.059)
5	Jan/2013	65.325	67.770	0.604 (±0.020)	67.729	0.682 (±0.086)
6	Feb/2013	104.981	108.118	0.704 (±0.077)	113.118	0.894 (±0.011)
7	Mar/2013	140.310	135.428	0.786 (±0.026)	140.210	0.808 (±0.022)
8	Apr/2013	176.344	185.298	0.733 (±0.105)	184.828	0.808 (±0.029)
9	May/2013	258.936	267.455	0.857 (±0.022)	264.564	0.763 (±0.038)
10	Jun/2013	272.809	281.808	0.871 (±0.083)	282.097	0.851 (±0.021)
11	Jul/2013	92.288	68.885	0.782 (±0.134)	80.296	0.701 (±0.064)
12	Aug/2013	93.863	79.669	0.724 (±0.085)	78.587	0.738 (±0.063)

Whole plant							
Cycles	Month and year cycles	Direct method (kg in 2,250 plants ha^{-1})	Comparative visual performance method (kg in 2,250 plants ha^{1})				
			Five patterns	R^2 (standard deviation)	Ten patterns	R^2 (standard deviation)	AP
1	Sept/2012	75.806	79.816	0.721 (±0.100)	79.414	0.512 (± 0.014)	1.68
2	Oct/2012	76.800	88.772	0.704 (±0.088)	82.007	0.626 (± 0.174)	1.65
3	Nov/2012	66.688	68.209	0.612 (±0.059)	69.872	0.643(± 0.144)	1.73
4	Dec/2012	56.576	55.248	0.723 (±0.059)	59.809	0.749 (± 0.166)	1.84
5	Jan/2013	76.800	87.655	0.689 (±0.020)	88.603	0.761 (± 0.217)	1.84
6	Feb/2013	86.269	89.269	0.710 (±0.018)	88.787	0.705 (± 0.083)	1.83
7	Mar/2013	181.204	186.497	0.754 (±0.058)	199.299	0.719 (± 0.077)	1.88
8	Apr/2013	174.206	181.024	0.803 (±0.136)	168.739	0.814 (± 0.235)	1.86
9	May/2013	195.038	199.428	0.832 (±0.059)	191.461	0.912 (± 0.013)	1.88
10	Jun/2013	211.144	227.034	0.841 (±0.051)	230.876	0.813 (± 0.148)	1.90
11	Jul/2013	98.588	86.589	0.712 (±0.039)	89.054	0.705 (± 0.124)	1.76
12	Aug/2013	100.144	93.642	0.885 (±0.046)	88.894	0.721 (± 0.058)	1.78

R^2 - Average determination coefficient per collection cycle; AP - Average plant height per collection cycle (m); Averages in the row followed by "*" are different to ($p < 0.05$) by the F test.

with five standards for the Gliricidia and Sabiá plants, with evaluations of up to 1,5 m height and whole plant, contributed to the less physical removal of vegetation, greater agility of the plants measurements and evaluation.

Although the indirect methods of determination of FM give satisfactory results for the species of erect growth, cespitose in grasses and shrub-arboreal in legumes, not always are obtained good results in arboreal plants, due mainly to the difficulties in obtaining the correct coverage of the soil by the plant species (Lopes et al., 2000). The dimensions and formats of the frames and the number of samples interfere with the accuracy of the method used to evaluate FM (Penati et al., 2005).

The plant was used as a sample unit to overcome this obstacle, which possibly favored greater accuracy in the assignment of notes after the collection of the standards and consequently higher values of R^2, a fact that is possible thanks to the homogeneity of the evaluated tree vegetation, besides the uniformity of the plants as to the growth and development phase. However, the use of the arboreal plant as a sample unit for the evaluation of FM in environments with heterogeneous vegetation, such as the Caatinga, will probably bring lower values of R^2.

The plants Gliricídia and Sabiá presented dry herbage production (kg in 2,250 plants ha^{-1}), different from the results observed by Silva et al. (2014) in plants with 54 months under different planting densities, 400, 600, 800, 1000 and 1200 plants ha^{-1}. In the evaluated Gliricidia the browsing probably compromised the height of the plant and reduced the leaf biomass above 1.5 m of the soil (Table 1), differing from the literature, which expose the low acceptance of the Gliricidia, although this legume presents high nutritional value (Syahniar et al., 2012; Castrejón-Pineda et al., 2015). Different from the observed in Sabiá, where the low acceptance by the animals favored the vegetal growth, consequently bigger foliar biomasses in height unavailable to the animal (Table 2).

The leaves that were not accessed by the animals when falling in the soil became part of the litter, promoting an increase in the organic matter content of the soil, a low carbon-nitrogen ratio, besides the contribution of other nutrients to the soil, constituting an important means of recycling of nutrients and improving the long-term productivity of the pastures (Mello et al., 2014, Castrejón-Pineda et al., 2015, Apolinário et al., 2016).

Table 2. Estimated forage dry mass (kg in 2,250 plants ha^{-1}) of Sabiá (*Mimosa caesalpiniifolia* Benth.) At a height of up to 1.5 m above the ground and whole plant by direct methods and visual performance comparing with five and 10 standard samples.

Up to 1,5 m above ground							
Cycles	Month and year cycles	Direct method (kg in 2,250 plants ha^{-1})	Compara ve visual performance method (kg in 2,250 plants ha^{1})				
			Five pa erns	R^2 (standard devia on)	Ten pa erns	R^2 (standard devia on)	
1	Sept/2012	173.888	174.474	0.649 (± 0.110)	174.156	0.722 (± 0.044)	
2	Oct/2012	178.369	178.522	0.723 (± 0.135)	177.424	0.715 (± 0.091)	
3	Nov/2012	117.204	126.307	0.544 (± 0.092)	125.607	0.600 (± 0.074)	
4	Dec/2012	93.832	93.094	0.734 (± 0.074)	91.378	0.707 (± 0.029)	
5	Jan/2013	171.853	192.602	0.686 (± 0.060)	191.425	0.707 (± 0.087)	
6	Feb/2013	211.500	239.205	0.811 (± 0.047)	236.818	0.836 (± 0.031)	
7	Mar/2013	440.276	588.550*	0.783 (± 0.109)	573.155*	0.943 (± 0.040)	
8	Apr/2013	542.100	555.336	0.768 (± 0.024)	609.731	0.893 (± 0.041)	
9	May/2013	604.763	684.306	0.809 (± 0.068)	677.768	0.829 (± 0.072)	
10	Jun/2013	625.050	778.127*	0.796 (± 0.048)	743.199*	0.881 (± 0.045)	
11	Jul/2013	605.963	689.987	0.949 (± 0.039)	689.909	0.877 (± 0.097)	
12	Aug/2013	607.734	688.663	0.831 (± 0.107)	684.422	0.815 (± 0.071)	
Whole plant							
Cycles	Month and year cycles	Direct method (kg in 2,250 plants ha^{-1})	Compara ve visual performance method (kg in 2,250 plants ha^{1})				
			Five pa erns	R^2 (standard devia on)	Ten pa erns	R^2 (standard devia on)	AP
1	Sept/2012	378.113	384.708	0.613 (± 0.066)	389.630	0.616 (± 0.052)	3.63
2	Oct/2012	380.269	376.840	0.598 (± 0.098)	383.245	0.647 (± 0.151)	3.86
3	Nov/2012	221.823	228.668	0.657 (± 0.097)	224.052	0.690 (± 0.168)	3.87
4	Dec/2012	207.289	225.517	0.658 (± 0.143)	213.234	0.711 (± 0.086)	3.92
5	Jan/2013	374.550	358.265	0.695 (± 0.072)	371.509	0.701 (± 0.069)	3.99
6	Feb/2013	370.425	378.233	0.707 (± 0.107)	377.906	0.828 (± 0.068)	4.13
7	Mar/2013	959.018	968.962	0.818 (± 0.023)	1014.488	0.827 (± 0.060)	4.27
8	Apr/2013	1008.113	1064.724	0.807 (± 0.045)	1135.632*	0.929 (± 0.027)	4.31
9	May/2013	1027.800	1069.201	0.839 (± 0.025)	1050.366	0.794 (± 0.008)	4.53
10	Jun/2013	1026.731	1153.493*	0.801 (± 0.048)	1123.079*	0.805 (± 0.057)	4.63
11	Jul/2013	1054.763	1172.031*	0.885 (± 0.040)	1166.730*	0.827 (± 0.053)	4.77
12	Aug/2013	1095.389	1179.430*	0.942 (± 0.014)	1167.892*	0.803 (± 0.039)	5.03

R^2 - Average determination coefficient per collection cycle; AP - Average plant height per collection cycle (m); Averages in the row followed by "*" are different to ($p < 0.05$) by the F test.

Table 3. Linear regression equation between the methods for determining direct forage mass "x" and comparative visual performance "y" with five and ten standard samples from the annual evaluation (interval between 28-day evaluation) of Gliricidia (*Gliricidia sepium* Jacq.) and Sabiá (*Mimosa caesalpiniifolia* Benth.) up to 1,5 m above the ground and whole plant.

Plant species	Number of standards	Evalua on height	Equa on	R^2	CV (%)
Gliricidia sepium Jacq.	Five samples	Up to 1,5 m above ground	y = 7.1966 + 0.9432x	0.9091	9.13
		Whole plant	y = 4.2643 + 0.9341x	0.9074	7.52
	Ten samples	Up to 1,5 m above ground	y = 4.8949 + 0.9527x	0.9078	8.17
		Whole plant	y = 0.4124 + 0.9768x	0.9327	6.99
Mimosa caesalpiniifolia Benth.	Five samples	Up to 1,5 m above ground	y = 20.230 + 0.8537x	0.8757	7.69
		Whole plant	y = 28.189 + 0.9147x	0.8624	4.93
	Ten samples	Up to 1,5 m above ground	y = 17.321 + 0.8371x	0.9030	11.17
		Whole plant	y = 35.432 + 0.8911x	0.8903	6.27

R^2 - Average determination coefficient per collection cycle; CV - Coefficient of variation.

In both evaluated plant species, the highest values of forage dry matter occurred with the beginning of the first rains, Cycle 6 (Tables 1 and 2). It should be noted that the production variation found in Sabiá occurs due to the phase of the plant cycle. Considered to be early deciduous, the Sabiá tends to lose its leaves at the beginning of the dry period, regrowth and reach full vegetation at the beginning of the rains, flora, and fruit in the middle of the rainy season (Freire et al., 2010).

In the literature evaluated, the FM of arboreal plants using the direct and RVC method are found, such as the work of Silva et al. (2017) estimating the dry matter yield of G. sepium Jacq. up to 1.1 m above the soil by the direct method, observed the production of 3,490 kg ha^{-1}. The study by Santana et al. (2011), evaluating forage dry matter production per hectare in the arboreal-shrub stratum of the Caatinga during the rainy season, using RVC methodology with iron squares measuring 1 m^2 (1 × 1 m) for plant observation herbaceous and 4 m^2 (2 × 2 m) for shrubs, verified a decrease of 89.2% in forage dry matter production between March and June of 2003.

However, the availability of techniques for estimating FM in tree plants is still rudimentary, the evaluation is complex due to the characteristics that make up the whole system, so the correct choice of the method of evaluation by the researcher becomes a primary requirement to obtain a high degree of experimental accuracy with reduced execution difficulty (Zanine et al., 2006).

Conclusions

The choice of five evaluation standards for the visual performance method allowed the mass evaluation of the tree legumes Gliricídia and Sabiá, with high values of coefficient of determination contributed for the less physical removal of the vegetation and the greater agility of the measurements;

The use of the plant as a sample unit allows high determination coefficients for the indirect method of forage mass estimation, comparative visual performance.

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Literature Cited

Apolinário, V.X.O.; Dubeux Junior, J.C.B.; Lira, M.A.; Ferreira, R.L.C.; Mello, A.C.L. de; Coelho, C.D.L.; Muir, J.P.; Sampaio, E.V.S.B. Decomposition of arboreal legume fractions in a silvopastoral system. Crop Science, v.1, n.3, p.1-24, 2016. https://doi:10.2135/cropsci2015.09.0588.

Arruda, D.S.R.; Canto, M.W. de; Jobim, C.C.; Carvalho, P.C.F. Métodos de avaliação de massa de forragem em pastagens de capim-estrela submetidas a intensidades de pastejo. Ciência Rural, v.41, n.11, p.1-6, 2011. https://doi.org/10.1590/S0103-84782011005000141.

Castrejón-Pineda, F.A.; Martínez-Pérez, P.; Corona, L.; Cerdán, J.L.V.; Mendoza, G.D. Partial substituion of soybean meal by *Gliricidia sepium* or *Glirizum aulmifolia* leaves in the rations of growing lambs. Tropical Animal Health and Production, v.48, n.1, p.932-934, 2015. https://doi.org/10.1007s11250-015-0932-2.

Companhia Pernambucana do Meio Ambiente - CPRH. Diagnóstico socioambiental do litoral norte de Pernambuco. Recife: - CPRH, 2003. 214p.

Cóser, A.C.; Martins, C.E.; Carvalho, C.A.B. de; Gerônimo O.J.; Freitas, V.P.; Salvati, J.A. Avaliação de metodologias para a estimativa da disponibilidade de forragem em pastagem de capim-elefante. Ciência e Agrotecnologia, v.26, n.3, p.589-597, 2002. https://www.editora.ufla.br/index.php/component/phocadownload/category/47-volume -26-numero-3?download=823:vol26numero3. 11 Mar. 2017.

Cóser, A.C.; Martins, C.E.; Deresz, F.; Freitas, A.F. de; Paciullo, D.S.C.; Salvati, J.A.; Schimidt, L.T. Métodos para estimar a forragem consumível em pastagem de capim-elefante. Pesquisa Agropecuária Brasileira, v.38, n.7, p.875-879, 2003. https://doi.org/10.1590/S0100-204X2003000700012.

Esperschuetz, J.; Balaine, N.; Clough, T.; Bulman, S.; Dickinson, N.M.; Horswell, J.; Robinson, B.H. The potential of *L. scoparium*, *K. robusta*and *P. radiata*tomitigate N losses in silvopastural systems. Environmental Pollution, v.225, n.1, p.12-19, 2017. http://doi.org/10.2016/j.envpol.2017.03.042.

Esquivel-Mimenza, H.; Ibrahim, M.; Harvey, C.A. Benjamin, T.; Sinclair, F.L. Standing herbage biomass under different tree species dispersed in pastures of cattle farms. Tropical and Subtropical Agroecosystems, v.16, n.2, p.277-288, 2013. http://www.revista.ccba.uady.mx/ojs/index.php/TSA/article/view/1679/829. 22 Mar. 2017.

Freire J.L.; Dubeux Junior, J.C.B.; Lira, M.A.; Ferreira, R.L.C.; Santos, M.V.F. dos; Freitas, E.V. de. Deposição e composição química de serrapilheira em um bosque de sabiá. Revista Brasileira de Zootecnia, v.39, n.8, p.1650-1658, 2010. https://doi.org/10.1590/S1516-35982010000800005.

Haydock, K. P.; Shaw, N. H. The comparative yield method for estimating dry matter yield for pasture. Astralian Journal of Experimental Agriculture and Animal Husbandry, v.15, n.76, p.663-670, 1975. https://doi.org/10.1071/EA9750663.

Instituto Agronômico de Pernambuco - IPA. Índices pluviométricos. http://www.ipa.br/indice_pluv.php#calendario_indices. 9 Abr. 2017.

Liu, Z.; Chen, R.; Conção Y.; Han, C.; Yang, Y. Estimation of above ground biomass for alpine shrubs in the upper reaches of the Heihe River Basin, Northwestern China. Evironmental Earth Sciences, v.73, n.1, p.5513-5521, 2015. http://doi.org/10.1007/s12665-014-3805-5.

Lopes, R.S.; Fonseca, D.M.; Cóser, A.C.; Nascimento Júnior, D. do; Martins, C.E.; Obeid, J.A. Avaliação de métodos para estimativa da disponibilidade de forragem em pastagens de capim-elefante. Revista Brasileira de Zootecnia, v.29, n.1, p.40-47, 2000. https://doi.org/10.1590/S1516-35982000000100006.

Mello, A.C.L. de; Costa, S.B.M.; Dubeux Junior, J.C.B.; Santos, M.V.F. dos; Apolinário, V.X.O. Tenório Filho, F.; Meireles, M.S.; Pereira, C.G. Pasture characteristics and animal performance in a silvopastoral system with *Brachiaria decumbens*, *Gliricidia sepium* and *Mimosa caesalpiniifolia*. Tropical grasslands, v.02, n. 1, p.85-87, 2014. http://www.tropicalgrasslands.info/index.php/tgft/article/view/172/118. 03 Abr. 2017.

Oliveira, O.F.; Santos, M.V.F. dos; Cunha, M.V. Da; Mello, A.C.L. de; Lira, M.A.; Barros, G.F.N.P. de. Características quantitativas e qualitativas de Caatinga raleada sob pastejo de ovinos, Serra Talhada (PE). Revista Caatinga, v.28, n.3, p.223-229, 2015. https://doi.org/10.1590/1983-21252015v28n325rc.

Penati, M.A.; Corsi, M.; Lima, C.G. De; Martha Junior, G.B.; Dias, C.T.S. Número de amostras e relação dimensão: formato da moldura de amostragem para determinação da massa de forragem de gramíneas cespitosas. Revista Brasileira de Zootecnia, v.34, n.1, p. 36-43, 2005. https://doi.org/10.1590/S1516-35982005000100005.

Santana, D.F.Y.; Lima M.A.; Santos, M.V.F. dos; Ferreira, M.F.; Silva, M.J.A.; Marques, K.A.; Mello, A.C.L. de; Santos, D.C. dos. Características da Caatinga e da dieta de novilhos fistulados, na época chuvosa, no semiárido de Pernambuco. Revista Brasileira de Zootecnia, v.40, n.1, p.69-78, 2011. https://doi.org/10.1590/S1516-35982011000100010.

Silva, P.S.L.; Paiva, H.N. de; Oliveira, V.R. de; Siqueira, P.L.O.F.; Soares, E.B.; Monteiro, A.L.; Tavella, L.B. Biomass of tree species as a response to planting density and interspecific competition. Revista Árvore, v.38, n. 2, p.319-329, 2014. https://doi.org/10.1590/S0100-67622014000200012.

Silva, S.F.; Carneiro, M.S.S.; Edvan, R.L.; Pereira, E.S.; Morais Neto, L.B.; Pinto, A.P.; Camilo, D.A. Agronomic characteristics and chemical composition of Gliricidia sepium grown under different residual heights in different seasons. Ciencia e Investigación Agraria, v.44, n.1, p.35-42, 2017. https://doi.org/10.7764/rcia.v44i1.1579.

Solorio, F.J.; Basu, S.K.; Sarabia, L.; Ayala, A.; Ramírez, L.; Aguilar, C.; Erales, J.A.; Ku, J.C.; Wright, J. The potencial of silvopastoral systems for milk and meat organic production in the tropics. Organic Farming for Sustainable Agriculture, v.9, n.1, p.169-183, 2016. https://doi.org/10.1007/978-3-319-26803-3.

Syahniar, T.M.; Antari, R.; Pamungkas, D.; Marsetyo, D.E.; Mayberry, D.E.; Poppi, D.P. The level of tree legumes required to meet the maintenance energy requirements of Ongole (Bos indicus) cows fed rice straw in Indonesia. Animal Production Science, v.57, n.7, p.641-646, 2012. https://doi.org/10.1071/AN11280.

Thomson, N. A. Techniques available for assessing pasture. Dairy Farming Annual, v.38, n.2, p.113-121, 1986.

Tonini, H.; Arco-Verde, M.F. Morfologia da copa para avaliar o espaço vital de quatro espécies nativas da Amazônia. Pesquisa Agropecuária Brasileira, v.40, n.7, p.633-638, 2005. https://doi.org/10.1590/S0100-204X2005000700002.

Trotter, M.G.; Cordeiro, D.W.; Donald, G.E.; Schneider, D.A. Evaluating an active optical sensor for quantifying and mapping green herbage mass and growth in a perennial. Crop & Pasture Science, v.61, n.5, p.389-398, 2010. https://doi.org/10.1071/CP10019.

Zanine, A.M.; Santos, E.M.; Ferreira, D.J. Principales métodos de evaluación de pasturas. Revista Eletrônica de Veterinária REDVET, v.7, n.11, p.1-13, 2006. http://www.veterinaria.org/revistas/redvet/n111106.html. 11 Mar. 2017.