METHODS FOR ESTIMATING FORAGE MASS IN PASTURES

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Abstract

A large part of farm properties have low levels of productivity, therefore estimate the herbage mass is essential for the proper planning, moreover, properly quantify the forage mass will provide appropriate information on the fertilization of forage produced or loss levels, which are important factors in determining the production system. This literature review covered the most used evaluation methods.

Keywords: herbage, forage, method

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INTRODUCTION

In Brazil, pasture areas correspond to approximately 159 million hectares, that is, they represent the second largest land use modality in the national scenario, surpassed only by native forest areas. However, when we consider only anthropized systems, planted pasture areas are the most abundant ecosystems (Censo Agropecuário, 2019). The vast extent of pasture areas reflects its relevance as a food base in the ruminant production systems in the country (SANTANA et al., 2010).

However, despite the importance of pastures to make animal production sustainable, the problem of degradation in these areas is a chronic adversity that affects about 50% of planted pastures (Dias – Filho, 2011), with an environmental burden, economic and social in the milk and meat production chain. The degradation of pastures involves different causes, the overgrazing caused by the excess of animals, one of the most determinant in this aspect. This imbalance between the supply and demand of pasture occurs due to the lack of food planning for the herd, mainly because it is not a recurrent management technique to measure the amount of forage throughout the year.
Therefore, the search for quick, accurate and low-cost methodological solutions to estimate the forage mass in pasture areas will guide the appropriate management of the forage plants that are used in livestock production systems, therefore the adjustment of the pasture support capacity depends monitoring the supply of bulky food.

MATERIALS AND METHODS

The articles used in the compilation of data as a reference for this review were acquired from the Google Scholar platform. In this search, the keywords “estimating forage mass” were used in the specific period from 2000 to 2020 classified by relevance to compose the database. In addition, articles involving the methodologies used to estimate pasture biomass based on ruler, disk meter and remote sensing were used as research criteria, as they are the most used techniques in the scope of research and extension.

RESULTS AND DISCUSSION

The methods used to estimate the forage mass are divided into "Direct Techniques" and "Indirect Techniques". Another classification of the methods used to estimate the forage mass are: "Destructive" and "Non-Destructive". (Hodgson et al., 2000). According to Barnett (1974) and Mannetje (1987), the direct method is based on cutting and removing forage from a sample area (wooden frame, metal or other materials of known area and of square, rectangular or circular shape) or area total being evaluated, followed by weighing the fresh sample and drying at 65ºC, weighing the dry sample, and estimating the forage mass. This methodology is considered standard because it is more accurate and precise when compared to indirect methods. However, it is not recommended for large areas because it requires a considerable number of samples to represent the forage mass of the entire area, in addition to a reasonable amount of labor and equipment, making the operation laborious, in addition to destroying part of the area. pasture collected for sampling.

The indirect methods used to estimate the forage mass are based on indirect sampling that adopt techniques that must be calibrated according to real values of forage mass evaluated by direct (destructive) sampling. Indirect methods allow a better spatial representation of the sampled area, as it is viable that many values of forage mass are estimated in the evaluated area. This is only possible if each "reading" of forage mass can be done quickly and non-destructively. Thus, it becomes important to identify vegetation characteristics that are highly correlated with forage mass, and that can be measured quickly and easily (CUNHA, 2002).

Indirect method to estimate pasture biomass

Remote sensing method

The remote sensing method refers to the joint use of sensors and equipment for acquisition (satellites, aircraft and drones), processing and analysis of the electromagnetic energy reflected or emitted by the targets (Janssen, 2001). One of the indexes most used in studies on vegetation is the Normalized Difference Vegetation Index (NDVI), proposed by Rouse et al. (1973), which relates the reflectance of vegetation to the red and near infrared wavelengths. The use of images to estimate pasture biomass is promising due to the spatial and temporal scope of the data, but it requires specialized labor and involves a higher cost than other techniques.

Uncompressed height method (ruler)

The uncompressed height method is based on the height of the canopy, which is assessed as the distance between the highest leaf curvature at the sampling point and the soil, or also on the extended height of individual tillers (FRAME, 1981). Like the other indirect methods, the uncompressed height of the canopy is calibrated as an indicator of forage mass by measuring the height of the forage canopy with a ruler or specialized equipment in various points of the pasture in isolation and/or with acetate sheet. The average height is used in the calibration equation to estimate the area's forage mass, as there is a high correlation between canopy biomass and plant height (PEDREIRA, 2002; FRAME, 1981). This technique is the most used in research evaluations and field practices because it is low cost and easy to operate, but it can be of low precision and not feasible in large areas or difficult to access.

Compressed height method (disk meter)

This methodology is based on the principle that the density of plants is correlated with their height (PEDREIRA, 2002). It is worth mentioning that both the forage mass, as well as the responses of forage plants and animals under grazing, have a high correlation with the population of tillers or the height of leaf strata in the forage canopy (FRAME, 1981). Measurements are taken with the disk meter ("disk meter") or rising plate ("rising plate meter"). The disk is an acrylic or aluminum plate that moves freely through a graduated column. The measurement is made with compression of the forage, and the area of the disk usually ranges from 0.2 to 1.0 m² (FRAME, 1981). As for the weight, the extreme values can be harmful, since excessively light disks will respond only in height, whereas very heavy discs will respond very little to density and height, promoting the crushing of forage plants (PEDREIRA, 2002). This methodology has low cost and operational ease, however it is limited to areas of flat relief or of little declivity, because the inclination of the stick compromises the evaluations.

The data compiled in the review showed variable precision (determination coefficient - R^2: 0.38 to 0.93) in the estimation of pasture biomass in an indirect way (Table 1). The higher values of R^2 show better adjustment of the equations for the estimates, as observed by MITCHELL & LARGE (1983) and GONZALES et al. (1990), which obtained values of 0.91 and 0.90, respectively.

The different methods used have particular mathematical models for estimating biomass, which may reflect the plant species and the methodology. Furthermore, the inconsistency in R2 values demonstrates that the techniques are equivalent in terms of precision, so the criterion for choosing the indirect method must be based on other aspects such as operational ease, area size and costs.

Table 1: Forage species and their calibration equations of the different method for the determination of herbage mass

Species	Method	Model	R^2	Author
Cynodon spp.	disk meter	$Y = 1226{,}64 + 170{,}97x$	0,64	Arruda et al. (2011)
Cynodon spp.	disk meter	$y = 3570 + 120x$	0,54	Silva & Cunha (2003)
Cynodon spp.	disk meter	$y = 3055 + 165x$	0,73	Silva & Cunha (2003)
Brachiaria brizantha	disk meter	$y = 1048.7 + 70.3x$	0,91	Braga et al. (2009)
Axonopus catharinensis	disk meter	$y = 86{,}9x + 231{,}0$	0,73	Dufloth et al. (2015)
Cynodon spp.	ruler	$Y = 987{,}02+191{,}95x$	0,56	Arruda et al. (2011)
Brachiaria brizantha	ruler	$y = 507.4 + 105.1x$	0,93	Braga et al. (2009)
Pennisetum purpureum	ruler	$y = 1692.5 + 1843.9x$	0,58	Cóser et al. (1999)
Cynodon spp.	ruler	$y = 3080 + 195x$	0,60	Silva & Cunha (2003)
Axonopus catharinensis	ruler	$y = 108{,}5x + 735{,}4$	0,57	Dufloth et al. (2015)
Pennisetum purpureum	remote sensing	$y = 0{,}043e^{[illegible]}$	0,69	Rahetlah et al. (2014)
Native pasture	remote sensing	$y = -7E - 10x^2 + 3E - 5x + 0{,}2925$	0,38	Serrano et al. (2018)
Native pasture	remote sensing	$y = 5032.5x - 1130.5$	0,46	Liang et al. (2016)
Festuca arundinacea	remote sensing	$y = 0{,}20\ln(x) - 0{,}94$	0,56	Schaefer & Lamb (2016)
Panicum maximum	remote sensing	$y = -234{,}96 + 87{,}92X$	0,74	Batistoti et al. (2019)

*RS: remote sensing

CONSIDERATIONS

The choice of a particular method must take into account the forage species, pasture variability, labor, training, in addition to the availability of resources for the acquisition of equipment necessary for execution. Therefore, the best sampling method will be one that represents the real conditions of the pasture well. The quantification of the variations that occur in the pasture is an arduous task, however if conducted according to the established scientific criteria, as well as analyzed and interpreted from the biological patterns of the plant, and using statistical models, the results will be acceptable. However, these methods must generate accurate and exact information to be used by producers and researchers in their decision-making regarding pasture management.

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