Sorghum cutting and grazing for hay production

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ABSTRACT

Sorghum hybrids (*Sorghum bicolor* cv. Bicolor) with Sudan grass (*Sorghum bicolor* cv. Sudanense) have been gaining increasing importance in feeding herds, due to their resistance to drought, great speed of establishment and growth, high capacity for tillering and regrowth after cutting or grazing (which allows successive uses), good nutritional value and great capacity for dry matter production. For the crossing of the species, a strain of Sudan grass (Sorghum sudanense (Piper) Stapf.) is used as a male and, as a female, a strain of grain sorghum (Sorghum bicolor (L.) Moench. Thus, the use of hay from sorghum for cutting and grazing is one of the alternatives to the problem of seasonality of forage plants, allowing the surplus produced, or in exclusive cultivation areas, to be stored and used in animal feed in times of scarcity. The objective of this work was to carry out a review of the narrative literature on sorghum, cutting and grazing for hay production.

Keywords: Haygrass, Composition, Sudan.

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INTRODUCTION

The main limitations for roughage production in Brazil are related to climatic seasonality, with higher production in the summer, due to higher precipitation and high temperatures, and lower production in the winter, due to unfavorable conditions that reduce plant growth and forage digestibility. To maintain animal productivity during periods of scarcity and lower nutritional value of forage, it is crucial to adopt conservation strategies, such as the production of silage, pre-dried, and hay, which ensure the availability of roughage feed throughout the year (FAEP/SENAR-PR, 2020).

Among the species of the genus *Sorghum*, there are cultivars adapted for green use (grazing and cutting), silage and haymaking. Sorghum varieties and hybrids, which have suitable characteristics for silage production and for use in the cutting regime, are generally not recommended for hay production, as they have thick stalks and do not support direct grazing. The cultivars of Sudan grass (*Sorghum bicolor* cv. Sudanense) are suitable for grazing and for the cutting regime, and can produce good quality hay, since they have thin stalks, providing rapid dehydration (Rodrigues, 2000). Sudanese sorghum, also known as Sudanese sorghum or Sudanese grass, is an early-cycle plant that can be harvested every 40 to 50 days. It has medium size, high nutritional value, vigorous tillering, high regrowth power, tolerance to salinity and main aptitude for hay production, it is also suitable for grazing because it can withstand animal trampling well. In addition, it can also be used for silage in due course. (Menezes et al., 2019; Tabosa, 2020).

In this sense, sorghum hybrids (*Sorghum bicolor* cv. Bicolor) with Sudan grass (*Sorghum bicolor* cv. Sudanense) have been gaining increasing importance in feeding herds, as they are resistant to drought, have a high speed of establishment and growth, a high capacity for tillering and regrowth after cutting or grazing (which allows successive uses), good nutritional value and a large capacity for dry matter production (Tomich, 2006).

In the hay production process, forage conservation occurs through dehydration. To properly preserve forage as hay, it is essential to quickly stop plant respiration and protein degradation after harvest. Haymaking involves changes in the structure and chemical composition of the plant due to the removal of water. Understanding these changes is crucial to apply good practices in the production, conservation, and feeding of ruminants, especially to ensure the availability of food during critical periods of the year (FAEP/SENAR-PR, 2020). Therefore, the use of thin-stemmed cultivars is indicated and higher planting density and early harvest are recommended.

Thus, the use of hay from sorghum for cutting and grazing is one of the alternatives to the problem of seasonality of forage plants, allowing the surplus produced, or in exclusive cultivation areas, to be stored and used in animal feed in times of scarcity. The objective of this work was to carry out a review of the narrative literature on the importance of welfare in dairy cattle farming.

ORIGIN AND CHARACTERIZATION OF CUT/GRAZING SORGHUM

The probable origin of sorghum is on the African continent, although there is evidence to suggest the possibility of two independent regions of dispersion: Africa and India. Not being native to the Western Hemisphere, sorghum was introduced more recently to the Americas.

In Brazil, its cultivation is rapidly becoming popular, and the country is already the fifth largest producer in the world, according to recent data from Conab. The 2022/2023 harvest was estimated at approximately 3.528 million tons, reflecting a significant increase in production, whose average productivity was around 2,815 kg/ha (Conab, 2023).

Due to its high resilience to water stress, sorghum has become a crucial crop for arid and semi-arid regions due to its water-use efficiency and its ability to produce biomass in adverse conditions, which favors its expansion in Brazil and other regions with a similar climate (Asadi, Eshghizadeh, 2021).

There are currently three main types of sorghum cultivated: forage sorghum, which produces a higher amount of dry matter compared to grain sorghum, has thick stems, and is widely used in silage production (Rezende et al., 2020; Ribeiro et al., 2017); grain sorghum, which has a moderate productive potential and can be used for pasture, hay production or silage (Ribeiro et al., 2017); and hybrid sorghum with sudangrass, which has thin stems, high tillering capacity, and rapid regeneration after grazing (Bath, 2019).

Forage sorghum for cutting and/or grazing comes from crosses of species of the genus *"Sorghum",* in which a strain of Sudan grass (*Sorghum bicolor* cv. Sudanense) and as a female a grain sorghum strain (*Sorghum bicolor* cv. Bicolor). The hybrid resulting from this cross is a plant of fast vegetative growth, abundant tillering and easy establishment. It has good resistance to water deprivation, presenting great rusticity and little demand regarding soil quality, in addition to ease of management for cutting or direct grazing, good nutritional value and high forage production (Rodrigues, 2000).

Tomich *et al*. (2006) highlighted the high protein content and high digestibility of this forage, being a roughage option of high nutritional value for the period of scarcity of pastures, making sorghum for cutting/grazing a high quality food source for cattle.

HAY PRODUCTION AND CONSERVATION

The forages available in the pastures, during the dry period, do not contain in quantity and quality all the essential nutrients to fully meet the requirements of the grazing animals. Thus, it is of paramount importance to produce high-quality forage for the production of hay of high nutritional value during the summer, resulting in efficient use of this forage resource to overcome the quantitative and qualitative deficiencies observed during the dry season (Reis *et al*., 2001).

To produce high-quality hay, certain conditions must be observed: good quality forage must be harvested and dried with a minimum of nutrient losses. The basic principle of haymaking is the conservation of the nutritional value of the forage through rapid dehydration, since the respiratory activity of the plants, as well as that of the microorganisms, is paralyzed. Thus, hay quality is associated with factors related to the plants that will be hayed, the climatic conditions occurring during drying and the storage system employed (Reis *et al*., 2001).

The climate is the main limiting factor in hay production and plays a fundamental role in the process. Temperature, relative humidity (RH), wind speed and solar radiation significantly influence the speed of forage dehydration, thus interfering with hay quality (Evangelista, Lima, 2019).

The water content at cutting for haymaking is about 60 to 75 % for grasses, while the ideal cutting time would be the one in which the forage would be more suitable for haymaking, from a qualitative and quantitative point of view. Therefore, this time cannot be defined only in terms of growth or pre-fixed cut dates, but rather in periods of crop rest, local conditions of the environment and economic aspects. It is therefore worth emphasizing that the quality of the forage at the time of cutting is of primary importance in the quality of the hay (VILELA, 2009).

Forage dehydration is directly related to the loss of nutrients and, consequently, to the nutritional value of the hay. In this phase, a large amount of water evaporates and should be carried out in the shortest possible time (Evangelista. Lima, 2019). The initial drying stage is fast, because in this phase the stomata remain open and the vapor pressure deficit between the forage and the air is high and the water loss can reach 1 g g-1 of DM hour-1 (Reis *et al*., 2001).

In the first two hours the forage loses water until it reaches 60% moisture, then the loss becomes slow. And for adequate dehydration of the forage to occur, the relative humidity of the air must be a maximum of 65%, otherwise there will not be a sufficient gradient for the evaporation of water from the plant to the environment. It is also necessary that the cut material be turned over every two hours to accelerate this loss of water (Evangelista, Lima, 2019).

During the forage drying process, when the humidity is between 60 and 65%, water loss occurs slowly until it reaches about 45%, at which point the stomata close and water loss starts to occur through the leaf cuticle. From there, moisture continues to decrease through cell plasmolysis until it reaches the optimal level for hay, between 15 and 20%. At the end of dehydration, the forage, despite reduced metabolism, becomes vulnerable to environmental damage such as rewetting, leaching and leaf fall. This phase continues until the forage reaches adequate water content that should not exceed 18 - 20% (Evangelista, Lima, 2019).

Hay is one of the most versatile forage conservation systems, since, as long as it is properly protected during storage, it has the following advantages: it can be stored for long periods with small changes in nutritive value, a large number of forage species can be used in the process, hay can be produced and used on a large and small scale, it can be harvested, stored and fed to animals manually or in a fully mechanized process, and can meet the nutritional requirements of different categories of animals (Reis *et al*., 2001).

Thus, it is essential to properly store hay to preserve its quality. The place must be dry, ventilated and protected from sunlight. Bales should be stacked on pallets, allowing air circulation to prevent fermentation and nutritional loss. Regular inspections are necessary to detect excessive moisture or mold. Special constructions are not required, but the environment must guarantee good conservation conditions (Evangelista, Lima, 2019).

FACTORS THAT INTERFERE WITH THE NUTRITIVE VALUE OF HAY

The nutritive value of hay is the result of the interrelationships that occur between numerous factors, the most important of which are those related to plants, processing in the field and storage conditions. Changes in nutritive value occur as a result of the genetic diversity of plants and interactions with the environment and management (Reis *et al*., 2001).

The leaf is the most nutritious and digestible part of the plant, preferred by animals. A high leaf:stem ratio increases the nutritive value and softness of hay. Forages with more leaves dehydrate faster, reducing the risk of losses due to rain. Thin, soft stems also indicate good quality hay. Therefore, a well-produced hay must have soft stems and a high number of leaves, resulting in a soft and good quality product (Evangelista, Lima, 2019).

It is worth noting that the physical appearance of a hay, even if it seems appropriate, should never be a sole requirement for the decision on the quality or classification of that hay. Thus, a bromatological analysis performed with correct and meaningful sampling protocols can show its nutritional value. Analyses such as crude protein, neutral detergent insoluble fiber, acid detergent insoluble fiber, fibrous fraction-bound nitrogen and mineral concentration must be performed in order to maintain quality control of the food purchased or produced (Domingues, 2009).

According to Reis *et al*. (2001), in addition to these aspects, it is important to report that soil fertility influences the production and nutritive value of forage plants, allowing plants to absorb chemical elements essential to animals and increase the production of high-quality forage by stimulating growth.

However, Lascano *et al*. (2001) reported that the effect of nutrients on the soil has been shown to be of little relevance on forage quality, but with a notable effect on total production and yield of different forage species. The exceptions would be nitrogen, whose effect on crude protein levels is considerable, and the contribution of sulfur and calcium in soils deficient in these minerals, which can improve digestibility and tissue composition. Reis *et al*. (2001) add that, in addition to nitrogen and calcium, phosphorus, potassium and microelements are necessary to ensure high forage yields and maintain the persistence of desirable plants in the stand for long periods. The periodic evaluation of soil fertility helps to determine the amounts of correctives and fertilizers to be applied, ensuring the economic return on investment.

Lascano *et al*. (2001) identified several environmental factors (droughts, high temperatures, flooding, shading and mineral deficiencies) with a marked influence on the quality of forage and hay produced from it. They concluded that temperature has the most intense effect on the digestibility of forages, due to its effect on the decrease in the leaf/stem ratio, increasing the less digestible fractions.

The stage of development at the time of cutting has a great influence on the quality of the forage. With growth, changes occur, which result in an increase in the levels of structural compounds, such as cellulose, hemicellulose and lignin; at the same time, a decrease in cell content. In addition to these changes, it is important to note that the decrease in the leaf/stem ratio results in changes in the structure of the plants. Thus, it is expected that older plants will have a lower content of potentially digestible nutrients (Reis *et al*., 2001).

In hay production, several losses can occur throughout the process that begin immediately after cutting, with inevitable biochemical changes, such as respiration and oxidation, occurring during drying. Removing water quickly helps minimize these losses. Other losses include leaching, loss of leaves due to handling, failure to collect, improper storage, high humidity that maintains cellular respiration, and the development of microorganisms. Inadequate production practices can also increase these losses (Evangelista, Lima, 2019).

According to Reis *et al*. (2001), on average, 2.5% of nitrogen (N) is lost due to excessive temperature increase and/or interference by microorganisms. In addition, these conditions promote non-enzymatic reactions, such as Maillard reactions, which result in the loss of carbohydrates and digestible proteins. These reactions often cause darkening of the forage and an unpleasant odor, reducing its palatability.

Losses of minerals such as phosphorus and calcium can occur in small amounts, however prolonged exposure in the field can alter these values. The occurrence of leaching, leaf breakage and other indirect physical processes can lead to the loss of minerals, notably potassium (Reis *et al*., 2001).

It is important to consider that during drying and as a result of respiratory activity (which results in a decrease in soluble carbohydrate contents), the concentrations of crude protein, neutral detergent fiber, acid detergent fiber, and lignin, which are not affected by respiration, may increase proportionally, since the results are expressed as a percentage of dry matter (Reis *et al*., 2001).

The main reason for the use of hay in animal feed is to provide energy for maintenance, milk and meat production, work and other functions during dry periods. Hay also provides protein, vitamins and minerals to maintain proper body condition to achieve adequate production levels.

FINAL CONSIDERATIONS

Hay production from sorghum is a strategic alternative to mitigate the effects of seasonality on forage supply, especially in regions where climate variability affects the availability of quality pasture throughout the year. Sudanese sorghum, due to its resilient and nutritional characteristics, proves to be an excellent option for hay production as a roughage feed alternative for ruminants during periods of scarcity.

The use of appropriate techniques in the harvesting and storage of hay is essential to preserve nutritional quality and ensure that hay can meet the requirements of the animals, providing the necessary nutrients to maintain milk and meat production.

Therefore, sorghum hay offers an efficient solution for production systems facing challenges related to climatic seasonality. The adoption of appropriate hay management and conservation practices will allow producers to ensure the availability of quality feed throughout the year, promoting the stability of animal production and food security.

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