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Importance of feedlot in pasture management systems for the Brazilian semi-arid region

Importância do confinamento em sistemas de manejo de pastagens para região semiárida brasileira

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ABSTRACT

In the semi-arid region's ecosystem, animal production is influenced by spatial and interannual variation in forage supply, both in quantitative and qualitative terms. Knowledge of the effect of animal trampling on vegetation and soil attributes is crucial for an improvement animal production. Understanding how the physical attributes of soils and forage plants respond to intense grazing pressures can explain the main causes of degradation in natural pastures, especially when grazing occurs during the dry season of the year. Animal trampling induces changes in these attributes and in plants, particularly when the stocking rate is not respected and when it occurs at a time when the plant-soil system is weakened, leading to soil compaction. Seasonality in forage production imposes severe restrictions on forage supply and nutrient availability in production systems. Feed shortages during the dry season are one of the main problems producers faces. Therefore, pasture management strategies in semi-arid regions must be adopted to maintain animal production during this period, without harming the forage plant and soil.

KEYWORDS: Pasture degradation. Feed strategies. Impact of grazing. Forage supply.

RESUMO

No ecossistema da região semiárida a produção animal é influenciada pela variação espacial e interanual da oferta de forragem, tanto em termos quantitativos como qualitativos. O conhecimento do efeito do pisoteio animal nos atributos da vegetação e do solo é de grande importância para que haja uma melhoria na produção animal. O entendimento de como os atributos físicos dos solos e a planta forrageira responde a intensas pressões de pastejo podem explicar as principais causas de degradação das pastagens naturais, notadamente quando se realiza pastejo na época seca do ano. O pisoteio animal ocasiona mudanças nesses atributos e nas plantas, principalmente quando a taxa de lotação não é respeitada e quando essa é feita em momento em que o sistema planta-solo está fragilizado, o que pode levar a compactação do solo. A estacionalidade na produção de forragem impõem severas restrições no suprimento de forragens e na disponibilidade de nutrientes nos sistemas de produção. A escassez de alimentos durante a época seca é um dos principais problemas que os produtores enfrentam. Portanto, estratégias no manejo do pasto em regiões semiáridas devem ser adotadas para que a produção animal possa ser mantida nesse período, sem prejudicar a planta forrageira e o solo.

PALAVRAS-CHAVE: Degradação da pastagem. Estratégias alimentares. Impacto do pastejo. Oferta de forragem.

INTRODUCTION

Feed scarcity during the dry season is one of the main problems producers face. Semi-arid and 9arid regions represent around 55% of the world's areas, totaling approximately 2/3 of the earth's surface. Semi-arid regions are characterized by an aridity index (ratio between total annual precipitation and potential evapotranspiration) ranging from 0.20 to 0.50. Soils in these regions have often been degraded by historical land use, resulting in low soil organic carbon content and poor soil structure. Intense human activity in these regions has threatened these soils, favoring greater erosion and degradation (GARCIA-FRANCO et al. 2018).

The Brazilian Semiarid covers an area of around 1.0 million km², corresponding to 64.2% of the northeastern territory, extending across the region's nine states and part of the State of Minas Gerais and Espirito Santo. Being one of the semi-arid areas with the highest population density on the planet (ARAÚJO FILHO 2013).

Given its classification as a region with adverse climate conditions, the area may incur losses in the development of livestock activities, leading to nutritional deficiencies. Low productivity can be attributed to shortcomings in feed, health, and reproductive management (LOUSADA JÚNIOR et al. 2006). This low productivity is mainly due to the irregular availability of feed in quantity and quality, caused by poor rainfall distribution, making animals vulnerable to the seasonality of forage production (GONZAGA NETO et al. 2001).

In the semi-arid region, pasture management has been neglected, which has negative consequences. Typically, the stocking rates used are high, which results in poor animal performance and accelerates soil and pasture degradation. The high stocking rate puts great pressure on pastures and soil, due to excessive trampling. This can lead to compaction during the rainy season and disintegration during the dry season, resulting in negative effects on the chemical, physical and biological properties of the soil, in addition to causing changes in the floristic composition in the region.

According to FERNANDES et al. (2015), the majority of areas occupied by cultivated pastures in the semi-arid region are due to the removal of native vegetation, favoring the establishment of these pastures. For these authors, the areas occupied by pastures grew by 17.2% when compared to 2003, while the Caatinga areas decreased by 18.6%. The removal of native vegetation, coupled with prolonged drought periods, results in soil degradation, diminishing its productive potential.

Productivity in natural pastures must be very well understood in different regions and management conditions. Livestock activity is of great importance for semi-arid regions, however, ruminant farming has been developed in soil and climate conditions that are unfavorable for its success. In order to better utilize the potential of the semi-arid region in a sustainable and economically viable manner, it is necessary to understand that nature must be respected, which determines the time and way in which activities must be carried out (ANDRADE et al. 2010).

Due to an irregularity in the distribution of rainfall and, consequently, a seasonality in forage production, production will not achieve satisfactory results, requiring the search for alternatives that aim to overcome the problem of food shortage during the lean season and thus contribute to maintain and/or increase production in the region (CAVALCANTI et al. 2011). Among the alternatives, the following stand out: the use of feedlot, waste from agro-industry and agricultural activity and the conservation of forage through hay and silage in animal feed (NASCIMENTO et al. 2013).

Thus, the objective of this review is to highlight the importance of feedlot during the dry season of the year in Brazilian semi-arid region, demonstrating alternatives for keeping the animal confined during the critical period, as a way of preserving pasture and soil, in addition to improving the animal's comfort.

Characterization of brazilian semi-arid region

The Brazilian semi-arid region is characterized by a hot and dry climate, with two well-defined seasons, dry and rainy, with average rainfall of 800 mm per year. However, most of the rainfall occurs over three to four months, leading the region to present a negative water balance index in most months of the year, with average temperatures around 28 °C, without many seasonal variations. (ARAÚJO 2011). Temperature, solar radiation and nutrient inputs in semi-arid ecosystems vary little throughout the year, however, precipitation occurs in discontinuous and short-lived events. The semi-arid region of Brazil shares similar climatic conditions with other regions globally that experience significant agricultural production. This prompts us to consider that the production stagnation observed in much of the Brazilian semi-arid region may be attributed to other factors (ARAÚJO FILHO 2013).

The predominant biome in the semi-arid region is the Caatinga, covering around 80% of the geographic area of this region. The term caatinga is a denomination of indigenous origin (Caa-tinga: white forest or caa-inig: dry forest). The only genuinely Brazilian biome, it presents a great biodiversity, being distributed in its different strata (tree, shrub and herbaceous), with the vast majority of species being considered deciduous in the dry season. An estimated 932 species have been recorded in the region, with 380 being endemic (ARAÚJO FILHO 2013). However. the list of species in the caatinga remains incomplete due to the lack of studies in the region.

The predominant soils in the region are classified as oxisols, neosols, argisols and planosols (ARAÚJO FILHO 2013). Regarding chemical characteristics, the soils are considered adequate. However, they present physical restrictions, including shallow depth, irregular drainage, and acidic pH (PEREIRA FILHO et al. 2006).

Eight types of vegetation formations have been described in the Caatinga: arborescent caatinga, arborescent caatinga with open shrub substrate, closed arborescent caatinga, open arborescent caatinga with bromeliaceae and cactus substrate, dense shrub caatinga, open shrub caatinga typical of shallow soils with rocky outcrops, savannah caatinga formed by the Seridó and Sertanejo plateaus and savannah caatinga with rocky outcrops. Variations, both in botanical composition and vegetation density, may be linked to local edaphoclimatic conditions or the phase of secondary succession in the caatinga.

The main predominant economic activity of the regions encompassing this climate is livestock farming, mainly the raising of ruminants, as with the inconsistency of rainfall there is difficulty in the development of agricultural activities (SANTOS 2013). Productivity of ruminant in the semi-arid region is primarily influenced by irregular forage supply, both within and between years. The main food for ruminants is pasture, with a predominance of natural pastures in relation to cultivated pastures.

The natural species that stand out most in animal nutrition are: catingueira

(Caesalpinia pyramidalis), sabiá (Mimosa caesalpiniifolia), maniçoba (Manihot glaziovii), angico (Anadenanthera macrocarpa), rompe gibão (Pithecelobium avaremotemo), catingueira rasteira (Caesalpinia microphylla), juazeiro (Zyzyphus joazeiro), favela (Cnidoscolus phyllacanthus), jurema preta (Mimosa tenuiflora), feijão bravo (Phaseolus firmulus), canafístula (Senna espectabilis), marizeiro (Geoffrae spinosa), mororó (Bauhinia sp.), engorda-magro (Desmodium sp), pau ferro (Caesalpinia ferrea), mata pasto (senna sp) marmelada de cavalo (Desmodium sp), camaratuba (Cratylia mollis), and the urinárias (Zornia sp). Also noteworthy are the forage cactus: facheiro (Cereus squamosus) and mandacaru (Cereus jamacaru) (DRUMOND et al. 2004).

In cultivated pastures, most species originate from Africa, mainly grass species adapted to the semi-arid region such as: Gramão (Cynodon dactylon), Urochloa (Urochloa mosambicensis), Buffel (Cenchrus ciliares), panasco grass (Aristida setifolia), massai grass (Megathyrsus maximus), pangola grass (Digitaria decumbens), and Andropogon (Andropogon gayanus). In flooded areas the most used species are: Brachiaria humidicola, B. arrecta, B. mutica, Ecinocloa polystachya e E. pyramidalis. On land that can retain moisture for longer during the dry season, it is recommended to use elephant grass (Pennisetum purpureum) for cutting or sugar cane (Saccharum officinarum). Few legumes are cultivated, with emphasis on species from the genera Prosopis, Stylosanthes, Macroptilium, Desmanthus and Leucaena, which improve the quality of the animals' diet, especially in the dry season, in addition to helping with biological nitrogen fixation (CÂNDIDO et al. 2005).

Characterization of animal production in brazilian semi-arid region

Natural vegetation is rich in forage species in the tree, shrub and herbaceous stratum, however, they are often exploited in an extractive way, leading to a rapid decrease in these species. More than 70% of the species in this biome participate in the diet of domestic ruminants, while grasses and herbaceous dicotyledons, during the rainy season, account for more than 80% of the diet.

The bioproduction in the caatinga is estimated to be around 4.0 tons/hectare/year. However, there are significant variations depending on the seasons, location, and type of caatinga (ARAÚJO FILHO & CRISPIM 2002, ARAÚJO FILHO 2013). These factors also influence the variation in forage floristic composition. Animal performance depends on the production of dry matter, as well as quantitative and qualitative factors produced by pasture, animal consumption, and the animal's own characteristics. Therefore, we can see the relevance of vegetation as a producer of dry matter for the formation of the final product.

Understanding dry matter production is crucial for determining the animal load per area. Additionally, knowledge of the chemical composition and digestibility of the forage in the animals' diet is essential, as they serve as indicators of the production process. The assessment of forage potential in different semiarid areas shows that there are large differences in relation to forage yield. The native pastures in these areas need to be monitored, as they present changes in floristic and botanical composition, due to climatic effects and grazing animals (ANDRADE et al. 2006).

Most of the forage during the rainy season comes from the herbaceous stratum, with a low contribution from tree and shrub foliage. As the dry season approaches, the foliage of deciduous woody species becomes the main source of food for animals, making it necessary to know the nutritional value of this forage. As the dry season begins, much of the foliage falls, becoming a source of forage for the animals (PARENTE & PARENTE 2010).

According to ARAÚJO FILHO et al. (2002), at most, only 10% of the production of leaf biomass is actually consumed, that is, of the 4,000 kg/ha/year of biomass, only 400 kg/ha actually constitutes the forage consumed. This means that, although the production of grazable biomass is high for a native pasture in a semiarid region, the inaccessibility in the rainy season and the low quality in the dry season negatively impact its consumption.

Under these conditions, the expected weight gain for cattle is 275.5 g/head/day during the rainy season, with losses of up to 155.7 g/head/day during the dry season. Goats can gain up to 36.1 g/head/day during the rainy season and 14.9 g/head/day during the dry season, while sheep can gain around 44,0 g/head/day during the rainy season and 18.2 g/head/day during the dry season (ARAÚJO FILHO et al. 2002).

In an attempt to improve animal performance in native pasture areas, ARAÚJO FILHO (1992) suggested adopting techniques Caatinga managements (thinning, lowering and enriching). For more information about these techniques, we recommend reading ARAÚJO FILHO (2013).

When evaluating the performance of sheep on thinned pasture, OLIVEIRA et al. (2015) reported an average daily gain of 51 g/animal/day during the rainy season and 32 g/animal/day in the dry season. SANTANA et al. (2010) reported an average weight gain of 393 and 431 g/animal/day for Guzerá and Girolando cattle grazing Caatinga enriched with Cenchrus ciliares and Urochloa mosambiecensis in the rainy season. In a study carried out in Paraíba, PESSOA et al. (2022) reported an average weight gain of 58.92 /animal/day for goats grazing Caatinga enriched with Urochloa trichopus.

Impact on the plant after grazing in the dry season

To increase livestock production in the semi-arid region, a reassessment of the environment where the activity is carried out is necessary. Livestock farming is a predominant economic activity in the semi-arid region, largely developed extensively (SILVA et al. 2018). The utilization of semi-extensive and extensive systems contributes to environmental changes due to the high stocking rate, surpassing the support capacity limits. In the medium term, this exerts strong pressure on the floristic composition of the vegetation. The animal species, intensity and frequency of grazing, method of seizure, deposition of feces and urine, are factors that interfere with the regrowth of forage plants and can cause changes in the persistence, productivity, and botanical composition of the canopy (PEDREIRA et al. 2001).

A better understanding of animal interference is necessary, as the consequences of herbivory in ecosystems depend on the abundance of herbivores and their movement. Grazing intensity is a crucial factor to consider, as in some situations, it can lead to soil compaction, damaging the germination of several species (PARENTE & PARENTE 2010). Grazing affects leaf area, light interception, photosynthetic rates, and the ability to produce new leaves. Plant growth is determined by the amount of carbon fixed per day, a process dependent on the energy intercepted through incident solar radiation and the existing leaf area (NABINGER 1996).

Defoliation caused by grazing can trigger several factors that can harm regrowth and development after grazing. One of the first effects that can be observed after defoliation is the instantaneous reduction in photosynthesis, which can spread quickly throughout the plant when defoliation is severe. The reduction in photosynthesis is not always equal to the leaf area lost, as there is a different contribution between leaves of different ages (BRISKE & RICHARDS 1995). Defoliation caused by grazing influences foliage architecture and reproductive parts, causing plants to become shorter, more compact and in a horizontal position. This horizontal structure becomes more prominent when animals graze more frequently in specific sites than in others. Although the horizontal structure is less well known than the vertical structure, it affects patterns of animal selection and the processes that govern the functioning of the pastoral ecosystem. In natural pastures, this behavior is quite visible when using different grazing intensities (CARVALHO et al. 2007).

With increasing grazing intensity or decreasing grazing height, the likelihood of removing meristematic tissue increases, promoting the emergence of lateral tillers (HEADY & CHILD 1994). Tillers originating from lateral buds have a lower rate of stem elongation, causing less elevation of their apical meristem (SANTOS et al. 2014). For lateral tillers to develop, there must be lateral buds in the basal tillers and for them to develop, the apical dominance of the basal tiller must be broken, which happens when the apical meristem is eliminated. It is worth noting that lateral and basal tillers will always exist, and this combination is beneficial for the plant, since basal tillers have a high weight and favor the distribution of light, while lateral tillers show rapid recovery after grazing and a high proportion of leaves (SANTOS 1995).

Intense grazing can affect the root system, resulting in an almost complete stoppage of root growth, accompanied by reduced root respiration and resulting in reduced nutrient absorption after defoliation. The intensity of defoliation is proportional to the reduction in root respiration and nutrient absorption.

Animals need plants for food and plants depend on animals for seed dispersal and nutrient recycling. In response to grazing, plants develop defense mechanisms and animals use strategies to circumvent these mechanisms (SANTOS et al. 2011a). For BRISKE (1996), the resistance of plants to grazing may be due to their escape or tolerance mechanism, where the escape mechanism reduces the possibility of the plant being grazed and the tolerance mechanism facilitates growth after grazing.

When the plant has high concentrations of lignin, animals increase grazing time in an attempt to overcome the low digestibility of the forage, thereby extending retention time. Ruminants have developed the ability to extract more slowly degradable cell wall polysaccharides, resulting in greater gastrointestinal retention and limited forage consumption (SANTOS et al. 2011a).

In systems considered to be in a non-equilibrium state, the primary challenge is to increase forage availability. Each species forming a pasture plays a crucial role in the ecosystem. Therefore, in studies on animal performance, it is essential to include information about vegetation to enhance the analysis and interpretation of the animal-plant relationship. Quantifying this relationship is highly relevant for understanding animal production (PARENTE & PARENTE 2010).

Following conservation standards and maintaining a balance between forage supply and demand would prevent significant effects on vegetation from grazing by any animal species. From the perspective of animal feeding, varying grazing pressures result in different levels of forage supply.

Animal exploitation over the years causes harmful effects on vegetation, being related to inadequate management of livestock and vegetation (PEREIRA FILHO et al. 1997). The use of inappropriate species associated with high stocking rates, where the grazing season and the distribution of the herd on the pasture are disregarded may be factors to be considered in the cause of these effects. The plant's response is affected by the animal species depending on the grazing habit, which differs depending on the size of the mouth, the anatomy of the lips and the method of capturing the forage.

Impact on the soil after dry season grazing

In soil management systems involving animals, changes in the physical, chemical, and biological characteristics of the soil can occur, influencing the growth and development of the root system (SILVA et al. 2000). The intensity of these changes depends on the management applied in the grazing area. This can vary based on factors such as texture, organic matter content, soil moisture content (TREIN et al. 1991), plant biomass on the soil, plant species, grazing intensity and duration, and animal category (CORREA & REICHARDT 1995).

Soil characteristics are modified according to management and management intensity. Changes in the physical properties of the soil caused by animals in intensive systems have been the subject of many discussions, however the available information that evaluates their effects is limited when it comes to the semi-arid region. In this region, the use of semi-extensive or extensive systems becomes a contributing factor to environmental change. This is due to the high-capacity rate, often exceeding their support capacity limits, exerting significant pressure on the soil through excessive trampling, leading to soil degradation and potentially contributing to desertification (PARENTE & MAIA 2011).

In natural pastures, the main factor causing the decline in productivity is the high stocking rate, with animal overload due to the availability of forage supply, causing damage to the physical properties of the soil. Another factor is the use of inadequate grazing systems, which do not respect the development of forage species (PARENTE & MAIA 2011).

Animal trampling can cause, with greater or lesser intensity, changes in soil properties. This depends on the intensity and frequency of grazing, as the animals exert pressure on the soil that is greater than the pressure applied by agricultural equipment. Other factors that condition the degradation of soil physical attributes are the growth habit of forage crops and soil texture (LUZ & HERLING 2004).

Studies evaluating the effects of trampling on soil physical characteristics quantify density and other properties affected by compaction, including resistance to penetration, water retention, and infiltration (IMHOFF et al. 2000). External factors such as the intensity and frequency of pressure exerted, and internal factors such as physical properties, affect the soil's response to compaction (DEFOSSEZ & RICHARD 2002).

Compaction caused by animal trampling contributes to a reduction in pasture productivity and longevity (IMHOFF et al. 2000, COSTA et al. 2010). Considerable losses in forage production, loss of carrying capacity and reduction in animal productivity can be caused by unfavorable soil physical conditions for plant growth (LEÃO et al. 2004). Since soil compaction is an important inhibitor of the development of roots and, consequently, of the aerial part of plants, as it influences the relationship between air, water and temperature, which influence germination, emergence and sprouting, in addition to affecting root growth (CANALLI & ROLOFF 1997).

The pressure exerted by animals' hooves on the soil compromises the physical quality of the surface layer of the soil, as there is an increase in soil density and a reduction in porosity (GIAROLA et al. 2007). The increase in the animal stocking rate in pastures that have low productivity, resulting in increased grazing pressure, compromises the physical quality of the soil, as there is a greater animal load on the soil, regardless of the production system (LANZANOVA et al. 2007).

For achieving and sustaining high productivity, the physical attributes of the soil must favor root system growth (PARENTE & MAIA 2011). Thus, soils should have ample pore space for water and gas movement, along with favorable resistance to root penetration and development. The compromise of these properties is one of the main factors that degrade pastures and considerably reduce their longevity.

Inadequate pasture management during grazing can lead to soil impoverishment, primarily through water erosion caused by reduced surface coverage. Soils can become poorer due to the extraction of nutrients by animals when feeding on forage, although much of it returns to the soil through waste, contributing to nutrient cycling (BERTOL et al. 1998).

High grazing pressures can cause changes in the physical conditions of the soil, making it difficult for plant roots to grow. Compaction tends to reduce the density and macro porosity of the soil and, consequently, there is an increase in resistance to the growth of the root system. According to FLORES et al. (2007), soil management systems that include animal grazing can cause changes in the physical, chemical and biological characteristics of the soil, affecting root growth.

Soil compaction caused by sheep grazing is limited to the first 5.0 cm of soil, which indicates that compaction was more intense where the pasture received greater trampling (GREENWOOD et al. 1998). CERVELATI et al. (2011) reported that in the dry season, where trampling is very damaging, compaction can reach up to 11 cm in depth. In a study on sheep trampling in intercropped pasture, PEREIRA JÚNIOR (2006) observed an increase in density and a reduction in porosity in the surface layer of the soil. These changes can compromise water and air storage, crucial factors for plant growth and development.

In their evaluation of the impact of various sheep grazing pressures on the physical and mechanical properties of the soil and their interactions, ZHAO et al. (2007) reported that grazing led to a reduction in soil water content and carbon stock. NEATH et al. (1990) suggested that in pasture management, selective regimes can be used that maintain the soil surface in conditions to withstand the compaction forces caused by grazing, avoiding changes in soil density and resistance to root penetration.

Impact on the animal after grazing in the dry season

The challenge of pasture production systems is the use of technological alternatives that are capable of increasing productivity and quality of the final product, with low environmental impact. For this to be possible, enhancing animal performance and optimizing forage resources are the main objectives of management strategies that can be adopted (REIS et al. 2012).

In the semi-arid region, forage production is seasonal, resulting in times of food scarcity for ruminants. Livestock farming in the region suffers a strong impact due to these seasonal variations in pasture, as it is difficult to adjust the feed supply with demand, resulting in malnutrition of the animals and, consequently, a reduction in the productive performance and productivity of the herds (SANTOS et al. 2004).

The decrease in both quantity and quality of forage available for ruminant animals results in low animal production because their nutritional requirements are not met (EUCLIDES et al. 1998). When there is a reduction in forage availability, there is a limitation in the rate of food intake by the animal, increasing grazing time. While the animal can increase grazing time to compensate for the low intake rate, this compensation may be incomplete, leading to a progressive reduction in consumption (SANTOS et al. 2004).

When the intake rate is critically low, grazing time becomes limited by the reduced availability of energy for this process and the animal may go into starvation. In other words, as the animal engages in grazing and rumination, dry matter consumption is limited by the animal's ability to select food. The time spent grazing determines the amount of forage ingested, the energy spent on forage capture and animal performance (ZANINE et al. 2006). During severe food shortages, the animal prefers not to graze because the energy expenditure to search for food would be very high. Consequently, the animal expends little energy on grazing, resulting in energy loss instead of gain (QUADROS 2006).

ANDRADE et al. (2007) found weight gain of 77 g/day in sheep finished in native caatinga enriched with buffel grass, without concentrated supplementation. CARVALHO JÚNIOR (2008) observed weight gain of 103 g/day in F1 Boer x SRD (No Defined Breed) goats finished in thinned caatinga. CARVALHO JÚNIOR et al. (2011) evaluating the performance of F1 crossbred goats (Boer x SRD) finished in thinned caatinga and subjected to different levels of supplementation 0.0; 0.5; 1.0; and 1.5% of body weight (BW) achieved a gain of 151 g/day and DMI of 953.36 (g/day) for animals supplemented with 1.5% of body weight. PESSOA et al. (2022) reported goats grazing on native pasture enriched with Urochloa grass and deferred showed an average daily weight gain of 53.52 g/day.

Strategies to confine the animal in the dry season of the year

Due to the prolonged dry season that affects the semi-arid region, feedlot appears to be a highly recommended practice, allowing the herd's nutritional conditions to be improved. Feedlot has allowed an increase in animal weight gain, a reduction in slaughter age, a higher enjoyment rate, better quality carcasses and greater capital turnover, in addition to reducing soil compaction, reducing the risks of degradation (FRESCURA et al. 2005, MEDEIROS et al. 2008).

The prolonged dry season in the semi-arid region makes feedlot a recommended practice to face food shortages, allowing the stocking rate to increase and improve the herd's nutrition. The semi-arid region is characterized by low and poorly distributed rainfall, resulting in water deficit and high evapotranspiration. This leads to a reduction in forage production and quality during drought, since precipitation has a direct relationship with production. Therefore, producers seek strategies to meet the feed needs of their herds during periods of food scarcity. Therefore, feedlot appears as a viable alternative in the semi-arid region, allowing to overcome the challenges of the dry season and guarantee adequate feeding conditions for the herd, contributing to the productivity and sustainability of livestock in the region (NASCIMENTO et al. 2013, VALE & AZEVEDO 2013).

While the use of feedlot has been encouraged, achieving economically compensative weight gain in this practice requires a diet with sufficient levels of protein and energy, typically achieved through the use of concentrates (MEDEIROS et al. 2008). However, the practice of using concentrates is more adopted by producers with higher levels of investment, for this reason an alternative is to finish animals in feedlot, aiming to increase animal production (POLI et al. 2008). Conventional concentrated feeds, based on corn and soybeans, used in this system are decisive in increasing feedlot costs (XENOFONTE et al. 2009). Therefore, when adopting this system, producers must consider various aspects of their property, including diet, management, health, and economic factors (SILVA et al. 2010).

In the feedlot system, the use of creep feeding, consisting of supplementary feeding in selective feeders during the breeding phase which only the offspring has access to the food, has been shown to be effective in reducing the slaughter age of lambs (GARCIA et al. 2003). GÓES et al. (2008) concluded that the greatest weight gain was obtained when calves received creep feeding.

Despite being the most economical method for feeding livestock, native pasture exhibits seasonality in forage production, impacting animal production, particularly during the dry season (MORAIS & VASCONCELOS 2007). Utilizing by-products from the fruit agroindustry and residues from agricultural production holds significant potential for animal feed, serving as crucial resources during the dry period, either due to ease of acquisition or large-scale production (NOGUEIRA et al. 2010). Other strategies that can be used in feedlot, and which have been gaining prominence, is the use of agricultural and agro-industrial residues and by-products that may be viable depending on their availability in the region (DANTAS FILHO et al. 2007, CAVALCANTI et al. 2011, NASCIMENTO et al. 2013). These strategies can improve animal productivity in the semiarid region.

The use of these new alternatives can bring benefits to the formulation of diets for ruminants, ensuring greater food availability and greater production efficiency. Post-harvest losses of agricultural crops are estimated at around 20 to 50% and processing can generate around 40% of waste, which has great potential for use in animal feed. The use of agroindustry byproducts in animal feed serves as an alternative source of nutrients for use during periods of food shortage, constituting a source of fiber for animals (ROGÉRIO 2005).

LOUSADA JÚNIOR et al. (2006), studying the dry matter consumption of different fruit by-products, observed higher dry matter consumption in passion fruit and melon residue. These same authors concluded that the by-product of passion fruit and melon have good nutritional value and can be used to feed ruminants. For PARENTE et al. (2009), cashew bagasse and the residue from passion fruit can be used in feed formulation. In other words, the by-product of fruit growing has great potential for animal feed.

Among the different alternatives, forage conservation has been gaining more and more space in the food management adopted by producers in the semi-arid region. It can be said that hay and silage production are viable alternatives for conserving forage, aiming to meet the animals' food needs in the dry season (NASCIMENTO et al. 2013).

The use of preserved forage has been gaining attention from producers in some countries such as the United States, Australia and England, where hay is the main source of preserved roughage. The use of silage in Brazil has shown significant growth among producers who adopt the use of forage conservation techniques (PEREIRA et al. 2006).

The Brazilian semi-arid region contains many forage species that can be explored and have potential to produce silage and hay, replacing conventional crops such as corn, which can make this practice more expensive throughout the entire harvesting process until conservation, and can be characterized as a risk crop in dry regions. When included in the animal diet, it can contribute to improving the productive performance of animals throughout the year. (NASCIMENTO et al. 2013). Among the conserved species with potential for forage production are elephant grass, sugar cane, sorghum (Sorghum bicolor and Sorghum sudanense), millet (Pennisetum glaucum), buffel grass, Massai grass, tifton grass 85 (Cynodon spp. cv. Tifton 85), coast-cross grass (Cynodon dactylon), among others.

When evaluating the performance of sheep receiving different sources of conserved roughage: 38% of millet silage) and 62% concentrate (corn, soybean meal and urea); inclusion of 20% of agave mucilage silage to replace millet silage; inclusion of 20% of agave mucilage silage associated with agave powder as an additive to replace millet silage; inclusion of 20% of agave mucilage hay to replace millet silage), SANTOS et al. (2011b) reported that average weight gain and feed conversion were not influenced, with average values of 196.4 g/day and 5.2, respectively.

When studying the inclusion of by-products from agroindustry (pineapple and cashew) in elephant grass silage, FERREIRA et al. (2009) reported that these by-products can be included in elephant grass silage as they improve sheep performance. RABELO et al. (2013) reported that sugarcane silage treated with calcium oxide and sodium chloride does not influence the weight gain of sheep, but improves the performance of these animals when compared to untreated silage.

Among the native species of the Caatinga, some have been studied for the production of feed conserved in the form of hay or silage, such as the species Ziziphus joazeiro (BARROS et al. 1991), Capparis flexuosa (BARRETO 2005), Mimosa hostilis (PEREIRA FILHO et al. 2003), Senna obtusifolia (NASCIMENTO et al. 2006).

CONCLUSION

The low production rates in the semi-arid region are a result of the low availability of forage in the dry season, which reflects the low support capacity. Production efficiency in this region depends on feeding strategies that can meet the objectives of the breeding systems, and it is important to pay attention to the availability of forage, especially native species, throughout the year.

Intensive grazing harms plants, soil and animal performance. Feedlot during the dry period proves beneficial for the animal, the plant, and the soil, as grazing during this period can alter the animal/plant/soil relationship. Therefore, it is necessary to use tools that can reduce the forage deficit for animals during the scarcity period, thus improving productivity in the region. Feed supplementation and roughage conserved practices are recommended practices in animal production systems in the semi-arid region, since these systems have as their main characteristic the uneven distribution of biomass throughout the year.

AUTHOR CONTRIBUTIONS

Conceptualization, methodology, and formal analysis**, Francisco Gleyson da Silveira Alves, Shirlenne Ferreira Silva, Francisca Debora da Silva Ferreira and Ricardo Loiola Edvan;** investigation**, Francisco Gleyson da Silveira Alves, Sávio Levy Sousa Alves, Alexsandro Ferreira Lopes and Amanda Monteiro da Silva;** resources and data curation**, Francisco Gleyson da Silveira Alves and Ricardo Loiola Edvan**; writing-original draft preparation**, Francisco Gleyson da Silveira Alves, Shirlenne Ferreira Silva, Francisca Debora da Silva Ferreira, Sávio Levy Sousa Alves, Alexsandro Ferreira Lopes and Amanda Monteiro da Silva**; writing-review and editing**, Shirlenne Ferreira Silva and Ricardo Loiola Edvan**; supervision, **Ricardo Loiola Edvan**. All authors have read and agreed to the published version of the manuscript.

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The authors declare no conflict of interest.

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