Importance of the silvipastoral system on the animal health and welfare of dairy cattle

Importância do sistema silvipastoril na sanidade e bem-estar de vacas leiteiras

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ABSTRACT
Brazil stands out for having one of the largest cattle herds in the world, being the first place in the commercial herd in the whole planet. Within bovine farming, dairy cattle raising stands out for its importance within the national economy because of the representativeness of small family farms, which develop a large part of the national milk production. However, despite the extensive area available for agricultural production, a large part of Brazil is located in the tropical area of the planet. This region is distinguished by high temperatures and high intensity of incident solar radiation. This condition tends to lead the animals to heat stress, thus leading to a decrease in the production of meat, but mainly milk, especially in properties that make use of european breeds. One of the alternatives to overcome the impact of heat stress in tropical regions is to cross european breeds with zebu dairy breeds, as well as seeking measures to reduce the incidence of solar radiation of these animals through integrated systems, such as silvipastoral systems. Thus, this review aims to show that the silvipastoral system is necessary to improve the animal welfare of dairy cattle.

Keywords: silvipastoral system, dairy cattle, heat stress, crossbreeding.

RESUMO
O Brasil se destaca por possuir um dos maiores rebanhos bovinos do mundo, sendo o primeiro colocado no rebanho comercial de todo o planeta. Dentro da bovinocultura, a pecuária leiteira destaca-se por sua importância na economia nacional pela representatividade da pequena propriedade familiar, que desenvolve grande parte da produção nacional de leite. No entanto, apesar da extensa área disponível para a produção agrícola, grande parte do Brasil está localizada na região tropical do planeta. Essa região se destaca pelas altas temperaturas e alta intensidade de radiação solar incidente. Esta condição tende a levar os animais ao estresse calórico, levando assim a uma diminuição na produção de carne, mas principalmente de leite, principalmente em propriedades que fazem uso de raças europeias. Uma das alternativas para superar o impacto do estresse térmico nas regiões tropicais é o cruzamento de raças europeias com raças zebuínas leiteiras, além de buscar medidas para diminuir a incidência de radiação solar desses animais por meio de sistemas integrados, como os sistemas silvipastoris. Assim, esta revisão visa mostrar que o sistema silvipastoril é necessário para melhorar o bem-estar animal da pecuária leiteira.

Palavras-chave: sistema silvipastoril, gado leiteiro, estresse calórico, cruzamento.

1 INTRODUCTION

The profile of the environment where production animals are raised has a relevant effect on the welfare conditions that may affect the productive and reproductive performance of beef and dairy cattle (LEITE DA SILVA et al., 2020). The excellence of the animals' performance will depend on the variation of the environmental temperature, called Thermal Comfort Zone (TCZ), which corresponds to the temperature limit at which the animal maintains hemostasis, without the use of thermoregulatory mechanisms (PEREIRA, 2005).

According to Silanikone (2000), when the environmental temperature exceeds the ZCT the thermolysis mechanisms are reduced and the animal goes into heat stress and this leads to a consequent inactivation of thermoregulatory processes (RODRIGUES et al., 2010). As a response to heat stress, changes in the animal's behavior, body temperature, respiratory rate, as well as changes in the activity of the autonomous nervous system and immunity of the animals will be observed (PARANHOS DA COSTA 2004; GERALDO et al. 2012; MACEDO; ZÚCCARI 2012).

Besides the above-mentioned changes, they also observed a reduction in weight gain, while Geraldo et al. (2012) verified a decrease in food consumption, which also leads to a decrease in reproductive performance as a result of behavioral changes due to heat stress (LIMA et al., 2013). In an attempt to reduce heat stress in animal production environments in tropical climate regions, as well as to reduce the environmental impact of agriculture and livestock, integrated production systems offer real alternatives to overcome the aforementioned impositions, as well as the reduction of climatic and market risks, increasing the sustainability of agricultural production (KINCHEL et al., 2014).

More specifically when the combination between livestock and forestry occurs, Kinchel et al. (2014) defines it as a production system that integrates the livestock component (pasture and animal) and forestry, in consortium. This production system is more directed to areas with difficulty in implementing crops, so it includes only the forestry and livestock components in the same area. Moreover, the use of this type of system has the following benefits: increase soil fertility and conservation, improve thermal comfort of animals, possibility to increase the diversification of biodiversity and also, have a higher production and more quality in forage and animal production (SIERRA et al., 2002; POWER et al., 2003; YAMAMOTO et al., 2007; TUCKER et al., 2008). This system brings among many other benefits a better ambience for animal production, avoiding the mitigating effect of thermal stress in cattle leading to an improvement in productivity as well as milk quality in breeding systems that make use of this type of consortized dairy cow breeding in environments shaded by forestry (KINCHEL et al., 2014; MONEEB et al., 2019; DENIZ et al., 2019; LEITE DA SILVA et al., 2020).

Considering that the current focus is the progress of animal farming productivity without harming the environment, especially when talking about the Pantanal, Cerrado or Amazon biome; Animal Health enters as one of the objectives of iLPF application. Since the improvement of animal welfare by maintaining the environmental temperature within the ZCT makes the animals have a greater immune capacity to promote health (GERALDO et al., 2012).

Thus, this study aims to show that the silvipastoral system is necessary for an improvement in animal welfare of dairy cattle.

2 DAIRY CATTLE FARMING IN BRAZIL

Brazil stands out for having one of the largest cattle herds in the world, being in first place when it comes to commercial herds in the whole planet. Within bovine farming, dairy farming stands out for its importance in the national economy due to the representativeness of small family farms, which develop a large part of the national milk production.

The national dairy production keeps growing over the years. According to the IBGE (BRASIL, 2021), in 2020, the country managed to produce around 35.4 billion liters of milk, which, compared to the previous year, had an increase of 1.5%. Dairy farming, due to its enormous social importance, is one of the most significant activities linked to agribusiness in the country, since it is practiced in more than one million rural properties and, only in primary production, generates more than three million jobs and adds more than six billion reais to the value of national agricultural and livestock production (JUNG; MATTE JUNIOR, 2017).

The terms of productivity (forms of production) and also market (production, consumption and values), are what define this heterogeneity of Brazilian production. The Southeast region stood out in 2019 and 2020 with 12.1 billion liters produced, equivalent to 34.35% of the total national production. The second largest producer in the country, the South region with 12.06 billion liters of milk (34%), followed by the Northeast region

(4.9 billion), Midwest and North, in these regions 4.3 and 2.1 billion were produced, respectively (BRASIL, 2021).

However, despite the extensive area available for agricultural production, much of Brazil is within the tropical area of the planet, with high temperatures and high intensity of incident solar radiation. This condition tends to lead the animals to heat stress, which can generate economic loss, since it directly interferes with milk production, meat production, production physiology, reproduction, calf health and udder health (ABREU, 2011).

The decrease in milk production resulting from increased environmental temperature also depends on other factors such as relative humidity, nutrition, factors related to management and wind speed, and may reach more than 10% in production losses (HEAD, 1989).

These aspects that cause thermal stress directly affect the animal's well-being, which is the result of the state of harmony between the animal and its environment (HURNIK et al., 1995).

2.1 ANIMAL WELFARE

According to Fraser (1999), animal welfare is built by 3 stages, which are: (1) feeling well, in other words, not being subjected to unpleasant states, such as fear and pain, for a long time; (2) having good functioning, that is, having uncompromised health, growth, physiology, and behavior; (3) having a natural life, that is, leading a life that allows the development and use of their natural adaptations.

In 2003, Gröhn et al. observed that there are several critical points for animal welfare. In dairy cattle farming, such as the form of interaction between humans and animals, the management performed, and the equipment used. Moreover, other elements contribute to increase losses and production costs, and also harm animal welfare, such as infectious diseases, infertility, and laminitis (RUSHEN, 2001; BEAUDEAU et al., 2000; BROOM & FRASER, 2007).

Depending on how and where the dairy herd is raised, there are risks of developing some diseases, for example, the probability of a cow developing laminitis and mastitis during lactation is about 32 to 21%, respectively, while the chance of placenta retention or metritis is 15%, when raised in intensive confined systems (GRÖHN et al., 2003). On the other hand, in properties where the confinement breeding system is partial, the animals are housed in a pasture system in the prepartum, rearing or dry period phases, the animals are predisposed to environmental conditions of relief and also the aspect of the soil that interfere in the health of the stratum corneum digitalis (GUIMAR; COSTA, 2018).

Worldwide speaking, dairy cows are managed among a wide range of production systems and in the most different climates. Among this range of systems, it includes fixed stabling, free stabling, bedded stabling, herds in confinement, herds in pastures, it depends on the climatic conditions of the place, property facilities, the management of man with the animal, the topography of the soil, type of pasture, energy, the use or not of machines leaving the system more automated or if it is done manually. And also, how is the market in this area, if there are buyers, the location, if the quality of milk is adequate and meets the needs of buyers, among others (COOK, 2007; PEREIRA, 2009).

Currently, the dairy herd is kept in pasture all year round in countries that are large dairy producers, such as New Zealand, Australia, Argentina and Brazil (RUSHEN et al., 2008). With this, some factors can affect the animals, reducing their level of welfare, such as exposure to climatic extremes, difficulty in accessing drinking water, endo- and ectoparasites, long distances for displacement between the pasture and the milking parlor (COSTA, 2012).

In regions with high temperatures, where the pasture rearing system is used, the animals are directly exposed to sunlight and heat stress directly affects animal welfare, both in productive efficiency and in animal fertility (ROMAN-PONCE et al., 1977; DE RENSIS and SCARAMUZZI, 2003). And in this situation of hot climates, the animals use chemical, physical, biochemical and physiological processes trying to neutralize the negative effects of heat and maintain homeostasis (SILANIKOVE, 2000). To do this, cows use behavioral strategies, such as their position in relation to the sun, and the use of shade and water for immersion (BLACKSHAW and BLACKSHAW, 1994; GLASER, 2003).

According to Blackshaw & Blackshaw (1994), shade is an artifice used by animals to mitigate and reduce the sun's rays and thermal stress, especially in periods of high temperature, high solar radiation and humidity. Thus, integrated production systems offer real alternatives to try to mitigate the situations that heat stress causes, as well as reducing climate and market risks, increasing the sustainability of agricultural production (KINCHEL et al., 2014).

Among the various integrated production systems, the one that has been the most prominent is the crop-livestock-forest integration (iLPF), defined by Kinchel et al. (2012) as the sustainable production of meat, milk, grain, fiber, energy and forest products, among others, in the same area, in intercropping, succession or rotation, seeking synergistic and enhancing effects between the components involved in that agro-ecosystem.

3 ENVIRONMENTAL STRESS CAUSED BY THE SUN

Cattle raising in Brazil is characterized by an extensive system of rearing, in which the animals are raised freely in pasture areas and, therefore, are under the influence of the regional climate. The Brazilian climate is mostly tropical, and with this a large part of the herd is under the direct influence of the sun and can suffer economic, productive, and animal welfare losses as a result of heat stress (OLIVEIRA & FERREIRA, 2011; CARDOSO, 2015; SVERSUTTI & YADA, 2019).

Since the definition of animal welfare by Donald Broom in 1986, heat stress began to be discussed and observed as an important factor to be considered to ensure adequate conditions of comfort, quality of life and reduction of productive losses in herds. This occurs because heat stress generates the need for physiological and behavioral adjustments in animals, in an attempt to adapt to the climate. With this, there is a reduction in pasture intake, growth, and hormonal changes that negatively affect animal production and reproduction (TRATCHER et al., 1974; BROWN-BRANDL et al., 2005; NETO et al., 2019).

When the animal is under heat stress, it may exhibit increased water consumption, modifications in metabolic rate, increased respiratory rate, changes in blood hormone concentration, increased body temperature, increased water loss by evaporation, and reduced feed intake. In contrast, according to Bond et al. (1967), simple shade can reduce the heat stress level of animals by 30% or more (ARMSTRONG, 1994; AZEVEDO et al., 2013).

Reis (1996) confirms that when the animal is under stress, the immune system responds with production and release of high levels of glucocorticoids that, in turn, generate changes in the amount of defense cells in the body, which makes it difficult to face immunogenic challenges, which can facilitate the installation and progression of diseases. Of these glucocorticoid hormones, the most commonly used indicator for dosage in cattle is cortisol, also known as the stress hormone, because it tends to increase its blood concentration in stressful situations (OTTERSBACH et al., 2008; COSTA et al., 2018; CRUZ et al., 2021).

Cortisol has been used to analyze the short-term effects of the management practices used and their effect on animal welfare. Besides the increase in cortisol levels, other effects can be observed on the animal organism, such as: increase in glycemia, stimulation of protein degradation and immunosuppressive effect by inhibiting components of the inflammatory response, altering the leukocyte series (DUKES, 1996, MCFARLANE et al., 1995; BAGATH et al., 2019). In addition, heat exchange generates water loss, decreasing the plasma volume of the blood, which is visible through hematocrit changes (THRALL, 2007).

Heat stress by heat impairs the body's homeostasis maintenance, which hinders the body's ability to remain stable and perform its normal functions. In this way, hormonal alterations act in a negative way on animal reproduction. The bovine female can present from decreased or delayed estrus. In addition, heat stress also impairs embryo viability and development, which is undesirable for reproduction and production, especially dairy (GENDELMAN et al., 2010; FERREIRA et al., 2011; MACEDO et al., 2014; LIMIRO, 2020; COSTA et al., 2019).

High temperatures can affect milk production and quality, this occurs because heat stress requires the body to require energy for the regulation and maintenance of body temperature, so that there is a decrease in the energy available for other physiological mechanisms, such as milk production. With this, besides the decrease in milk volume, there are changes in components, such as proteins, fat, lactose and other solids (VASCONCELOS et al..., 2011; COLLIER et al..., 2012; DOMINGOS et al..., 2013; ROSA, 2019).

To improve the rates and obtain good milk production in cattle, in addition to adequate reproductive, nutritional and sanitary management practices, the environment and the bovine genetics used must be considered as essential factors to ensure productive success. In this way, animals that are less sensitive to environmental heat are essential for locations where the temperature is high. As an example of this, there is the crossbreeding between the Gir and Holstein breeds, which generated crossbred animals with desirable characteristics for dairy production in Brazil (SILVA, 2000; ROSA, 2019; BOMFIM, 2019).

Thus, in addition to genetics adapted to the breeding environment, there are other alternatives and management strategies, such as the use of systems that integrate shading. An example of this is the crop-livestock-forest integration system (ILPF), which offers natural shading by the forest, providing greater thermal comfort and, consequently, avoiding economic and productive losses arising from heat stress (SALLES et al., 2015; SALMAN et al., 2021; SOUZA et al., 2021).

4 ANIMAL HEALTH

Animal health is the state of the whole animal in which it achieves improvement in its functions simultaneously with the ecosystem in which it develops, respecting the natural environment, producing maximum benefit without annulling the resource base on which the community depends, linked to the social and economic situation and the cultural level (ASTUDILLO, 1990; DUNLOP & MARBERT, 2004).

Animal health covers animal diseases, while public health involves the control of risks in the food chain, thus providing safe food supply and animal welfare (BRASIL, 2022).

Thus, the set of actions aimed at preventing losses caused by the production of diseases of infectious, parasitic and nutritional nature, is called health. In this situation, to certify the animal health is necessary to have the existence of veterinary services well structured, capable and trained for the detection and application of control measures and eradication of diseases (SÁ JUNIOR, 2004).

Among the main losses when the herd is taken to heat stress, animal health is the most important point in animal production. Therefore, the diagnosis, control and prevention of the main agents that cause diseases in herds is an essential point to ensure animal health and avoid economic losses (RODRIGUES, 2020, BARCELLOS et al., 2019). We can highlight problems related to reproduction, digestive health, the whole mammary and locomotor apparatus of dairy animals (GRÖHN et al., 2003). In addition, there are other elements that contribute to cause important losses and productive costs, and also damage to animal welfare, such as infectious diseases, infertility and laminitis (RUSHEN, 2001; BEAUDEAU et al., 2000; BROOM and FRASER, 2007).

Massote et al. (2019) state that among the diseases that most affect the dairy herd worldwide, bovine mastitis has a great importance, in which the disease has generated great economic losses for the producer, for the industry and also for public health. It is a disease that causes major problems faced by the dairy industry, being mastitis a common disease in Brazil and worldwide, which causes a major influence on the performance of the whole system (SAAB et al., 2014).

Therefore, it is extremely important to diagnose and treat early, so that there is a decrease in damage to both the animal, the producer and the industry (MAIOCHI et al., 2019; MASSOTE et al., 2019).

4.1 MASTITIS

This disease is characterized by inflammation of the mammary gland promoted by various factors, being caused by bacteria about 90% of the time, and may have clinical manifestations presenting signs such as edema, hyperthermia, hardening and pain of the mammary gland and/or appearance of lumps, pus or changes in the milk; and also, there may be subclinical manifestations, in which presents only changes in the composition of the milk, not being evident to the human eye (TOZZETTI et al., 2008). And this manifestation favors the dissemination of the disease through the herd, giving a false tranquility in relation to mastitis to the producer. However, it is considered that for each clinical case of the disease 35 subclinical cases occur (FONSECA & SANTOS, 2000).

Santos (2017) claims that mastitis is the most important disease for dairy cattle in Brazil and worldwide, causing economic losses by decreasing the quality and quantity of milk and bringing losses to the rural producer. And for the detection of this disease, we have as diagnostics the appearance of milk using the black-bottom mug test, physical examination of the udder, somatic cell count (SCC), California Mastitis Test (CMT) and bacterial culture, and the first two tests are done to detect the clinical form and the others the subclinical form of the disease.

According to Bressan (2000), it is a disease that has an inflammatory process of the mammary gland and comprises a complex multifactorial character, which involves various etiological agents, environment and also factors belonging to the animal.

This triad is directly related to welfare, where Hurnik et al. (1995) state that welfare is established as the state of harmony between the animal and its environment. However, in relation to animal husbandry, there are several factors that affect thermal comfort. Brito & Brito (2000) say that, besides the interaction of the triad that sustains mastitis as a consequence, they are influenced by physical, chemical, thermal or microbial factors as well. And in consideration of thermal factors, the increase in ambient temperature causes a reduction in the metabolic rate, in which when producing milk in large quantities the animal generates a high production of internal heat (Silva, 2000), and may cause stress and consequently interfere in the animal's health. And in a study by Bond et al. (1967), they showed that a shade that blocks the sun's rays reduces the radiant heat in the animal by approximately 30%.

Santos & Fonseca (2007) indicated for better management of the herd, that the incidence of clinical mastitis is less than 1% per month and the prevalence of the disease is 15%, for good health of the mammary gland.

And to reduce the risks of occurrence and transmission of mastitis, several measures should be taken, from hygiene during milking to cleaning the facilities and the environment where the animal is, and also the cow itself, sustaining the herd's health and milk quality. However, the adoption of new management methods and the awareness about the damages caused by mastitis both by producers and technicians are extremely important in the dairy property. Prevention ends up being the best way, considered the keyword within this industry, because the high prevalence of the disease in the herd, the high cost of treatments and the damages and losses in production, justify the need for prevention and control institutions (OLIVEIRA, 2012).

4.2 PARASITISM

Diseases of parasitic origin affect animals of various species throughout the Brazilian territory. Cattle herds are susceptible to various diseases that, manifesting clinically or not, affect the production and animal health and generate economic losses resulting from the control of infections or parasitic infestations. With this, there is also a decrease in animal production and a drop in animal health and welfare indices, which negatively affect the quality of the final product (ALVES et al., 2016; VENTURINI, 2016; PEGORARO 2019).

The parasite-host relationship is based on the parasite's need to benefit from another organism to obtain food and complete its life cycle. Thus, the installation and progression of parasitoses depend on the triad formed by the parasite, environment, and host. Some factors, such as the number of infective stages of parasites in the environment, seasonality and susceptibility of the host allow or delay the growth of parasites to times when conditions are favorable (GRISI et al., 2014; DANTAS et al., 2015; MONTEIRO, 2011).

The host is influenced by several internal and external factors, which modulate the ability of the herd to tolerate possible environmental pathogens. Among these factors is the management of the herd, pasture, nutrition, climate, physiological state, age, breed of animals and immunity. An example of this is the drop in immunity that occurs in cows near the end of gestation and beginning of lactation, allowing these animals to be susceptible to infections and infestations by parasites during this phase (ABBAS & LICHTMAN, 2000; TRONCO, 2013).

The parasites that are important to cattle farming are divided into endoparasites and ectoparasites, classified according to where they develop in the host, parasitizing the body internally or externally, respectively. Endoparasites are divided into groups, of which the group of helminths, commonly known as worms, have relevance for affecting the gastrointestinal tract (GIT) of cattle, especially in young animals (FORTES, 2004; TAYLOR, 2010; MONTEIRO, 2011).

The Nematoda class comprises the main worms responsible for infections in the GIT of dairy cattle and cause a drop in the development and production of animals. These parasites are characterized by their cylindrical shape and reach the host through the L3 larva, the infective form that is in the environment during the free-living stages. Cattle become infected by ingesting the larvae present in the pasture, which enter the GIT and remain there until they reach the adult stage (TAYLOR, 2010; MONTEIRO, 2011; FORTES, 2004).

Ectoparasites include insects, ticks and mites that parasitize the body externally, causing infestation. The dairy herd is often affected by flies such as Haematobia irritans, Dermatobia hominis ooxys and the tick Rhipicephalus (Boophilus) microplus. In addition to direct parasitism by these ectoparasites, they can serve as vectors for protozoa and bacteria, leading to other diseases of importance, such as hemoparasitoses (FONSECA et al., 2009; BOGO et al., 2017; DUARTE et al., 2017; GÁUDIO et al., 2018; ÁVILA et al., 2020).

Parasitic infestation usually occurs in a mixed form, in which there are different genera or species of parasites in the host. The high parasite load causes economic losses and decrease in several indices related to animal production, such as drop in milk production, retardation in the development of young animals and, in more severe cases, can lead the animal to death (FONSECA et al., 2009)

Herds that have control over parasites have better production rates, health and animal welfare. These conditions, together with proper management practices, can lead the herd to achieve the maximum genetic potential of production. For this, it is essential the diagnosis of parasites that affect the herd for the implementation of treatment, control planning and prophylaxis of these diseases (ECKSTEIN, 2013).

The diagnosis of helminthiases should be established by the set of clinical evaluation and laboratory tests, because the clinical signs resulting from gastroenteritis tend to be similar, requiring laboratory evaluation for the diagnosis of the etiologic agent. Thus, necropsy and coproparasitological exams can be used to identify the worms that parasitize the herd (UENO & GONÇALVES, 1998; MONTEIRO, 2011; DE ALMEIDA et al., 2020).

The necropsy can be used when there is death of cattle in the herd, so that the identification of adult and immature forms of gastrointestinal worms is performed. The coproparasitological examination, on the other hand, is done through stool samples from cattle, which should be collected and sent for analysis. There are several techniques for the identification of endoparasites that can be used to detect certain phases of the cycle (ENDO et al., 2015; UENO & GONÇALVES, 1998).

The identification of eggs and oocysts can be performed by techniques such as egg count per gram of feces (OPG), Gordon & Whitlock (1939) modified technique, which allows a quantitative assessment of the parasite load of the herd for the establishment of a control program. However, some parasitoses are not differentiated through the identification of eggs, thus, it should be performed the coproculture, roberts and o'sullivan 1950 technique, which allows the growth and identification of nematode larvae (UENO; GONÇALVES, 1998; ARAÚJO e LIMA, 2005; AMARANTE & AMARANTE, 2016; DE FREITAS PAIXÃO et al., 2016).

Broom (2017) says that the silvipastoral system is characterized by the presence of pasture, shrubs with edible leaves and trees, can avoid the incidence of solar radiation, offering thermal comfort. Moreover, with integrated systems there is an improvement in nutrition, body condition, and health of the animals due to the greater presence of tick and fly predators in the environment, leading to a decrease in these parasites in the animal's body.

This type of production system can bring benefits to the animals, especially with regard to thermal comfort, through lower incidence of solar radiation, milder temperatures and greater retention of moisture (BALBINO et al., 2011). However, these more favorable microclimatic conditions may also favor the development and maintenance of nematode larvae in the environment.

5 SILVIPASTORAL SYSTEM

In summary, the iLPF system is a propitious strategy to reconcile eco-efficiency with socioeconomic development, as well as combining increased productivity with conservation of natural resources. Thus, this combination of pasture and trees tends to be used more in agropastoral regions with fragmentation and isolation of natural forest remnants or degraded pasture (BALBINO et al., 2011; SILVA, 2006; FRANCHINI et al., 2011).

According to Pires (2006), the most efficient way to combat heat stress is to create an integrated management and environmental system, aiming to keep the animal's body temperature normal or close to it (38 to 39 ºC) most of the day. In addition, for dairy cows the best shade is provided by trees, as they offer good wind circulation, evaporation of leaves, and also protection from solar radiation (COSTA, 2012). Carnevalli et al. (2019) reported that integration systems with the presence of trees offer improved thermal comfort by providing shade for the cattle, because it provides an environment with a milder temperature.

When the combination between livestock and forestry occurs, Kinchel et al. (2014) defines it as a production system that integrates the livestock component (pasture and animal) and forestry, in consortium. This production system is more directed to areas with difficulty to implement crops, so it includes only the forestry and livestock components in the same area.

But for a successful silvipastoral system, the choices of both trees and forage crops must be made with great care and attention. According to Macedo et al. (2008), the trees for this type of system should not have very dense canopies to allow the passage of light and that the stem should be high, such as the eucalyptus, which, by having a high trunk, deep roots, and a narrow canopy, provides shade to animals when managed correctly. However, the shade factor should not be the sole, exclusive, and isolated choice of forage, because not always the species that are tolerant to shade are more productive in certain levels of shade. And the grasses that perform best in this type of system are: B. decumbes, B. brizantha and P. maximum. These and other plant species need for their growth and productivity in addition to solar radiation, water, temperature, nutrients and CO2 (MACEDO, 2010).

Efficiently for dairy farming, the silvipastoral system provides an environment with lower temperature, compared to places that do not have shade. The search for shaded environments by these animals during the summer season shows the need for shade, especially when using tree species with globose and dense canopies, where the animals live in a more favorable environment (LEME et al., 2005). In studies, Schütz et al. (2010) reported that dairy cattle can identify shadier locations to protect themselves from solar radiation, causing caloric stress to decrease.

6 CONCLUSION

This study has shown that the silvipastoral system contributes to the improvement of animal health and welfare, making the environment where the animal is located warmer and with more shaded places, thus reducing heat stress.

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