Classification of compost barns system of milk producers from cooperatives in the mission region

Classificação do sistema de celeiros compostos de produtores de leite de cooperativas na região de missão

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ABSTRACT

This work classifies the dairy farms that use compost barns (CB) as a feedlot system for dairy cows in the Brazilian subtropical region, in terms of farm structure, constructive aspects, environmental and compost bedded pack characteristics, and reports the variability among the dairy farms that adopted it. Additionally, this research identifies structural and management factors that interfere in the compost bedded pack quality. The data were obtained *in loco*, with facilities measurements, herd observations and collection of technical information, in 30 dairy farms. The clustering analysis, based on 12 variables, resulted in the formation of three groups: conventional and adapted CB (n=18, with new and adapted facilities, of different sizes, full time using, with adequate pack characteristics or not), large conventional CB (n = 6, larger barns, more similar to American models, full time using) and, partial use CB (n = 6, used in hot hours of the day or rainy season, with better pack characteristics among groups, although do not have mechanical ventilation and the pack is revolved only once a day). In addition to the consolidated variables related to the pack management and quality (DM, OM, pH, W, C:N ratio, temperature and density), it is reported that the stirring frequency, resting space area per animal, presence of mechanical ventilation on the barn, type of material used to compose the bedded pack and local relative humidity are factors that influence the main variables of the pack and can be key points for the success of the CB system in subtropical regions of Brazil.

Key words: Cooperatives, Compost barn**,** animal comfort, productivity.

RESUMO

Este trabalho classifica as fazendas leiteiras que utilizam celeiros de compostagem (CB) como sistema de confinamento para vacas leiteiras na região subtropical brasileira, em termos de estrutura da fazenda, aspectos construtivos, características ambientais e das embalagens com cama de composto, e relata a variabilidade entre as fazendas leiteiras que o adotou. Além disso, esta pesquisa identifica fatores estruturais e de manejo que interferem na qualidade das embalagens compostadas. Os dados foram obtidos in loco, com medições de instalações, observações de rebanhos e coleta de informações técnicas, em 30 fazendas leiteiras. A análise de agrupamento, baseada em 12 variáveis, resultou na formação de três grupos: CB convencional e adaptado (n = 18, com instalações novas e adaptadas, de diferentes tamanhos, uso em tempo integral, com características de embalagem adequadas ou não), convencional grande CB (n = 6, celeiros maiores, mais semelhantes aos modelos americanos, uso em tempo integral) e, CB de uso parcial (n = 6, usado em horas quentes do dia ou estação chuvosa, com melhores características de embalagem entre os grupos, embora não têm ventilação mecânica e a bolsa é girada apenas uma vez ao dia). Além das variáveis consolidadas relacionadas ao manejo e qualidade da embalagem (MS, MO, pH, relação W, C: N, temperatura e densidade), é relatado que a frequência de agitação, área de repouso por animal, presença de ventilação mecânica no celeiro, o tipo de material utilizado para compor a embalagem acamada e a umidade relativa local são fatores que influenciam as principais variáveis da embalagem e podem ser pontos-chave para o sucesso do sistema CB em regiões subtropicais do Brasil.

Palavras-chave: Cooperativas, Celeiro de compostagem, conforto animal, produtividade.

1 INTRODUÇÃO

Milk is one of the most consumed foods, if not the most consumed by the world population. As a product of paramount importance in food, milk quality and food safety are increasingly being demanded by the world population. In view of this, it is essential for both industries and producers to increasingly produce a high quality product, which obeys the limits determined by current legislation. In the northwestern region of Rio Grande do Sul, dairy farming is one of the most used crops in agriculture, with income from a large part of farmers (Stracke, et al, 2021).

In a previous study, we developed and highlighted the application of Chemistry content that may assist in the improvement of agricultural production techniques, using rice husk ash as a molecular water reservoir for soybean production (Stracke, et al, 2020).

The compost barn (CB) is a confinement system for dairy cattle that aims to provide greater comfort, well-being and longevity in the productive life of the animals (Barberg et al., 2007), which was developed by cattle producers in milk in the American state of Virginia in the 1980s and 1990s. However, it was only after 2001 that it spread to other American states (Janni et al., 2007). In the CB, the animals have free access to a bed area composed of organic material, usually sawdust, which is revolved daily to incorporate the animal's feces and oxygen. This process favors the development of aerobic microorganisms that compost the residues present in the environment, which causes a decrease in their humidity and results in a dry and comfortable place for the animals (Shane et al., 2010).

The success of the system basically depends on the management of the bed to maintain a constant composting process, and the balance between several physical and chemical factors of the environment are paramount. According to Bewley and Black (2013), the maintenance of the composting process depends on the C: N ratio, on the temperature, humidity, aeration and pH of the bed in equilibrium, to provide a dry bed with a low pathogenic microbial population. These factors can be directly affected by the constructive characteristics of the facilities, by the handling of the bed, by the stocking rate adopted and by other characteristics not yet described or understood.

According to American publications (Janni et al. 2007, Barberg et al. 2007; Black et al., 2013), CB-type installations follow certain structural standards, have different equipment that help to maintain an adequate environment for both animals and to maintain the quality of the stable bedding, and has the characteristics of the composting process well established. However, in recent years there has been a spread of this technology, that is, the use of CB to countries that are improving the activity of dairy cattle, as is the case in Brazil. However, its development has certain peculiarities, even among Brazilian regions due to the great environmental and climatic diversity of the country. This situation causes a certain diversity in the construction characteristics, as well as in the management standards adopted. Given the above, the hypothesis is that there is variability between the characteristics of the CB installed in the Brazilian subtropical region. Finally, the authors' objectives with this research are to classify the UPLs that use CB in the Brazilian subtropical region, and to compare them in terms of property structure, constructional, environmental characteristics, and bed quality; and, to identify structural and management factors that interfere in the main characteristics of the quality of this bed.

2 MATERIAL AND METHODS

The survey was carried out in eight municipalities in the western region of Rio Grande do Sul, between the months of December 2020, January and February 2021. In total, 10 milk producing units (UPL) made up the sample.

This survey of the number of properties that used the CB system, took place through the COOPERATIVES advised by the Support Center for Milk Products and Processes through consultation with Cooperatives, private companies providing technical assistance for dairy cattle, and related professionals the production chain serving rural producers, in the Missions region of Rio Grande do Sul.

A technical visit by UPL was carried out, always in the afternoon between 13:00 and 18:30 hours. At the time, physical and structural characteristics of the UPL, number of animals housed in the system, the animal category, racial characteristics, and the time spent in the facility (total or partial) were surveyed. Still, characteristics of food management (number of treatments per day, use of total mixed feed), and zootechnical indexes of the herd were raised.

To survey the general management, constructive and environmental characteristics of the systems, and the physical and chemical characteristics of the bed, the following procedures were used: the structural measures were taken using conventional and digital metric measuring tapes; the dry bulb temperature and wet bulb temperature were taken by means of a thermohygrometer (Incoterm®, scale -10ºC and 50ºC, error of ± 1ºC); the temperature of the black globe was recorded by reading a common thermometer, coupled to a hollow sphere of polyethylene painted in matte black. The equipment was allocated inside each stable, arranged in its geometric center (considering the total area of the CB). All environmental assessments were carried out between 2:30 pm and 6:30 pm. The registration of the internal environmental variables of the shed was carried out every 10 minutes, and presented in the form of average, maximum and minimum, during the evaluation period. The microclimate external to the confinement was also determined by a similar set of thermometers, installed at a height of 1.5 m above the ground surface, inside a meteorological shelter. However, the records of environmental variables were performed every hour, and presented as an average. The instantaneous wind speed (m / s) was recorded at times coinciding with temperature measurements, using a multifunctional hot wire anemometer (Instrutemp®, ITAN-800). The globe temperature and humidity index (ITGU) was determined according to Buffington et al. (1981).

The temperature of the bed surface was measured at six points equally distributed considering the bed of the stables, using a pyrometer (Fluke series 60). At these same six points, the temperature was also measured at a depth of 20 cm, using a digital stem thermometer (Incoterm, ref. 9790.02.1.00, fab 01/2008), according to a methodology adapted from Black et al. (2013), and the depth of the bed, with the aid of graduated iron rods, which were inserted in the bed area, around the collection points. After measurements of temperature and depth, a bed sample was taken, according to the methodology proposed by Black et al. (2013), to estimate its specific mass. The samples were stored in plastic bags and packed in isothermal boxes. Afterwards, the individual samples were weighed, for later estimation of the specific mass of the beds, according to Jobim et al. (2007). Subsequently, a sample pool was performed by UPL, to obtain a representative sample of the entire stable. The analyzes of dry matter, mineral matter, and pH of the bed, were performed in duplicate, according to AOAC (1990). From these analyzes, moisture and organic matter contents were estimated mathematically. The nitrogen content was determined by the Kjeldahl method and the carbon content according to the EMBRAPA (1997) methodology, and these values were used to determine the Carbon: Nitrogen ratio. In the composite sample, the water retention capacity was also determined, according to a methodology adapted for soils (ISO 11465, 1993). The particle size distribution was performed using an adapted methodology by Damasceno (2012), in which the unchanged sample, dried for 24 hours in air, was added in an automatic stirring at 80% frequency, remaining 3 minutes under agitation. The sieves used had sieves of 9.5, 4.75, and 2 mm, plus the bottom portion. After stirring, the percentage retained in each sieve was quantified.

Multivariate analysis was performed, with a reduction in the size of the data, in which the most significant variables for variability were selected, through principal component analysis. From the new dimension of the data, cluster analysis was performed, using the kmeans methodology to define the groups, and through iterations the optimal number of groups was determined, according to the Silhouette method as an adjustment measure. Fischer's discriminating analysis was used to assess the quality of the definition of the groups. Analysis of variance and Tukey's test or Pearson's chi-square test were performed for the variables present in the reduced data, to assess the effect of the groups on each variable. Descriptive statistics was used for the different groups of farms, which were defined through cluster analysis. For statistical analysis, the “stats”, “factoextra”, “MASS” and “cluster” packages of the statistical software R (R CORE TEAM, 2017) were used.

3 RESULTS AND DISCUSSION

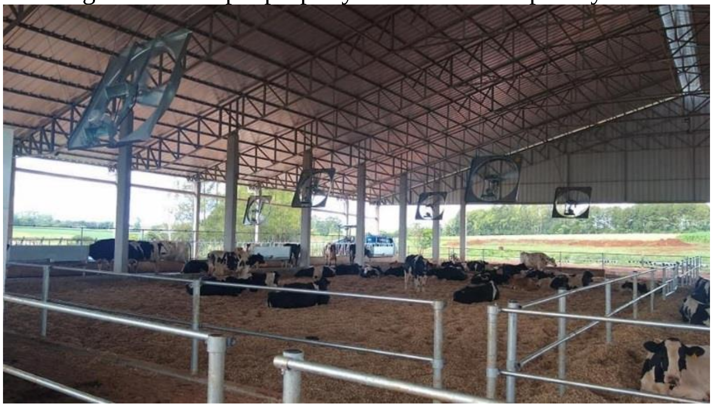
Studies have been carried out in order to characterize several production systems. In the geographic region object of this research, works like the one by Wernke et al. (2016) and Canabarro (2015), which characterized production systems based on milk quality, and that of Hötzel et al. (2014), related to the management of calves. However, there is little literature describing dairy cattle production systems, in feedlots, in Brazilian subtropical regions.

Specifically, the work of Janni et al. (2007), Barberg et al. (2007), Damasceno (2012) and Black et al. (2013), described the main characteristics of the CB system in the United States, however, they did not go deeper into classifying properties that use this production system, and assess whether there are differences in management or system characteristics between producers, considering that the stables seem to be more homogeneous with each other, in terms of structural and bedding characteristics of the CB. In this context, this article is a pioneer in research that classifies, studies and identifies differences between properties that use the CB system, which is booming in Brazil.

The properties evaluated in the present research are located in eight municipalities that together were responsible for 6.8% of the state's milk production in 2016, according to the Brazilian Institute of Geography and Statistics (IBGE, 2016).

From the survey of numerous characteristics related to the properties and the production system, the analysis of main components pointed out that only 12, of the total variables surveyed, would be responsible for the greatest variability of the data. Therefore, these 12 variables were used to classify the properties in different groups, which are: MO, MS, pH, C: N ratio, the water holding capacity and the density of the bed, the width of the shed, the total area of the bed, bed turning frequency, presence of mechanical ventilation in the shed, upper bed temperature before turning, and depth of bed depth before turning (Figure 1).

Figure 1. Example property of the barn compost system



Group one was made up of 18 UPLs, and group 3, made up of 6 UPLs. As structural characteristics of both groups, the sheds had the smallest widths and smallest bed areas. Therefore, group two, composed of 6 UPL, was formed by properties that had the largest warehouses of the CB type. Still, it can be said that in this group, CBs were used for the containment of animals on a full-time basis, with the largest number of drinkers arranged inside the shed, due to the greater number of animals, which allows meeting the demand of the herd, which in some cases they were separated by production batch. The greater number of drinking fountains is important due to the dominance of some animals, reducing disputes in these places (Bewley et al., 2012). The allocation of drinking fountains must also be considered, they must be installed in the feeding lane, opposite the feeders, avoiding drinking fountains in the bed area (Ofner-Schröck et al., 2015). Due to the general characteristics of this group 2, it was called conventional large CB.

Regarding the physical-chemical characteristics of the beds of the CB, group three had the lowest pH values, highest C: N ratios, highest DM content and highest bed surface temperature prior to turning. Still, in group 3 none of the UPLs had mechanical ventilation in the bed area of the CB, and most of the revolving was carried out only once a day, since 100% of the properties in this group only used the CB facilities in hot periods. of the day, or rain. Thus, group 3 was called partial use CB. The higher bed surface temperature may be due to some specific characteristics of the UPL that make up group 3. Among them, the lowest bed depth observed for this group, with values between 20 and 40 cm, can be highlighted. which can cause a more superficial composting process, consequently raising the surface temperature of the bed. Another factor that can contribute to an increase in the surface temperature is the absence of equipment for ventilation of the installations, which leads to the accumulation of heat generated by the composting process and to raise the surface temperature of the bed. The lack of ventilation may also have been aggravated by the lower average height of the ridge (5.78 m) and also by the absence of louver (in 83.33% of the UPL). This opening in the highest part of the roof is intended to help remove hot air, maximize the ventilation of the facilities, which contributes to the cooling of the environment (Bewley et al., 2012).

In group 1, the lowest levels of OM and W, and of the C: N ratio were observed. It can also be stated that, all the UPLs that had CB adapted from other facilities, belong to this group, and correspond to 22.2% of the total (4 UPL). Group 1 was called conventional and adapted CB.

The amount of bed replaced in the UPL of the conventional and adapted CB groups and partial use CB was less than for group 2, large conventional CB. This difference may possibly be caused by the size of the bed area existing between the groups, since group 2 has a significantly larger bed area compared to the others, requiring more voluminous replacements. Another difference that exists in the group of large conventional CB is related to the frequency of replacement of the bed, since all the UPLs in this group performed monthly replacements, unlike the other groups where some UPLs perform monthly replacements, or less frequently, between 2 to 3 months. Among the structural characteristics, the height of the ridge can also be highlighted. This variable, despite not being part of the set of variables that were used to form the groups, was tested independently. For the large conventional CB group, the average height was higher than the other groups, with 8.57 m (being the same for the conventional and adapted CB group, with 6.43 m and the partial use CB group, with 5 , 78 m; P <0.02). This characteristic may have been influenced by the fact that all large conventional CB systems were designed as new installations, that is, they were not adapted warehouses, used previously for another activity, such as some properties present in group 1 (conventional and adapted CB). It is worth mentioning that the ridge height, related to the height of the right foot, interferes with the roof angle, and this factor can have a strong influence on the air circulation inside the installations (Chastain, 2000). And, that roof slopes between 30 to 50% have good results in terms of natural ventilation (MWPS-7, 2000).

The difference observed for the DM content of the bed, may be related to the available bed area / animal and the temperature in depth of the bed. Parameters that may be influenced by the climatic characteristics of each region (Eckelkamp, 2014). In work developed by Black et al. (2013), in the American state of Kentucky, the authors describe the average bed area of 9 m2 / animal, values that can reach 6 m2 / animal for small breeds (Janni et al., 2007), as they can reach up to 15 m^2 / animal in systems with a lower frequency of bed replacement (Klaas et al., 2010). The high standard deviation observed for the variables “bed area per animal” and “bed temperature in depth” may have contributed to the absence of statistical differences between the groups evaluated. The group of partial use CB, had availability of 16.15 m2 / animal, the group of conventional and adapted CB 14.38 m2 / animal and the group of conventional large CB, 13.50 m2 / animal.

The variable “bed depth temperature before turning”, could be considered an indicator if there was an adequate composting process between the period between the previous turning and the current (evaluated) turning of the beds. For it is expected that the better the composting process, the higher temperatures would be found, in addition to the lower moisture content (or higher DM content). The bed depth temperature before turning did not differ between groups, and their average values did not reach the recommended for groups 1 and 2, as Stentiford (1996) states that temperatures between 45 and 55 ° C maximize the degradation of the material . However, part of the UPLs of all groups had a bed depth temperature within the range considered ideal, especially those in group 3 (partial use CB). In addition to material degradation, this temperature range, according to Black et al., (2013), helps to keep a dry and comfortable bed for animals.

However, the hypothesis that 4 or 5 ° C (numerical difference found between groups) cannot interfere with the composting process and affect the DM content of the bed, and this dynamics of temperature change in CB beds cannot be ruled out. between turns, and for longer periods, should be studied in different climatic conditions.

Among the factors that can contribute to the maintenance of the DM of the raised bed, the period of use of the CB systems can be highlighted, since all the UPLs that constitute the CB group of partial use, present the strategic use of the CB system, that is, the animals housed only certain periods of the day. Usually at warmer times of the day, or periods of high rainfall, which keeps animals protected from adverse weather factors. However, care must be taken, as prolonged periods of high rainfall can result in high humidity in the bed and compromise the composting process and cause problems secondary to the herd.

Another variable that may be affected by the available bed area per animal is the C: N ratio, which showed higher values in the partial use CB group (group 3). However, all the observed values were below the ideal ratio of 25 to 30: 1 (NRAES54,1992). It is worth mentioning that microorganisms need about 25 times more carbon than nitrogen (NRAES-54.1992), and there is a direct relationship with the bed stocking rate, which will determine the incorporation of feces and urine, sources of carbon and nitrogen, for the composting process.

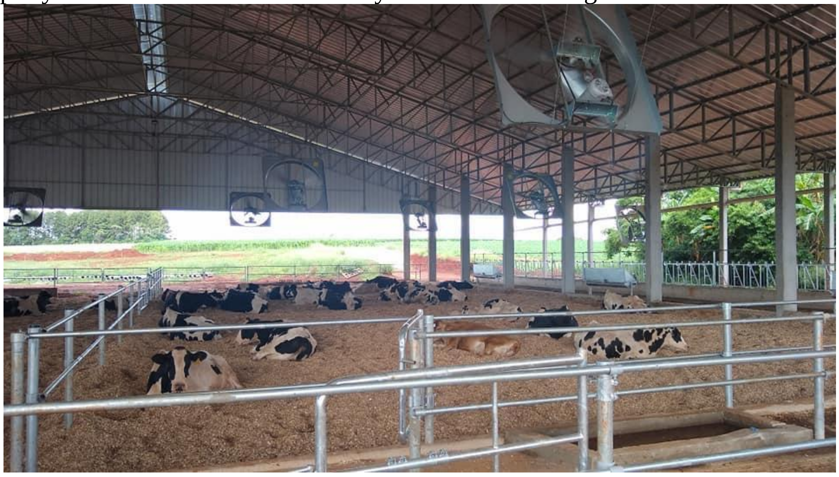
The longer use of the bed, observed for groups 1 and 2 (conventional and adapted CB and large conventional CB), may be related to the higher pH value found for these UPL. A longer occupation period leads to a greater incorporation of nitrogen in the medium, confirmed by the C: N ratio that was lower in these two groups, leading to an increase in the pH of the bed. According to Changirath et al. (2011), during the initial stages of decomposition there is formation of organic acids, and afterwards the composting continues and the acids become neutralized, and the mature compound generally has a pH between 6.0 and 8.0. The values found were slightly higher than this recommended range.

The water retention capacity (W) showed no difference between groups 2 (conventional CB of large scale) and 3 (CB of partial use), but both differed from group 1 (conventional and adapted CB), which had the lowest W According to Changirath et al. (2011) and Damasceno (2012), materials that absorb a lot of water or urine are not suitable as bedding material, as they result in less porosity in the bed and hinder the composting process. In the research by Changirath et al. (2011), the authors observed that W increased with decreasing particle size, materials with a high proportion of fine particles are not recommended. In this sense, research should be carried out to define bedding materials suitable for different technical characteristics (examples of stocking rates, turnaround frequencies, different climatic conditions, bed usage time, etc.).

In view of the above, it can be considered that the partial use CB group had the best bed characteristics, among the groups analyzed in the present study. It was this part-time use that in a way allowed these properties to not have mechanical ventilation and to revolve the bed only once a day (which also reflects in lower costs and investments). Partial use means that the litter does not receive the same amount of waste as in systems that have animals confined 100% of the time. This use of CB-type sheds on a part-time basis is a feature that has not yet been reported in scientific research. And that, in a way, mischaracterizes the use of CB systems as being a confinement for intensive production, since the animals are released, mainly for grazing, in the coolest hours of the day.

However, despite the UPLs in the partial use group have the best bed characteristics, without the most intensive handling, and with less investment, such as the absence of mechanical ventilation, these are more subject to changes in the quality of the bed. Prolonged periods of climatic adversity can force these UPLs to use the CB intensively, and due to the lower frequency of turning and the absence of mechanical ventilation, a great impact on the composting process can occur, coming to affect the quality of the bed. Another negative point of the absence of the mechanical ventilation system in the CB, is that this equipment has the purpose of helping to remove the humidity from the environment and, improving the thermal comfort of the animals inside the facilities. Although there were no differences in the THI and ITGU indexes between the different groups (due to the absence of very adverse weather conditions during the research period), these parameters can help and demonstrate the importance of the ventilation system for the animals' comfort, according the figure 2.

Figure 2. Property with mechanical ventilation system demonstrating the confort of the animals.



In contrast, part of the UPLs evaluated for intensive uses, referred to here as "conventional" (which are those designed as close as possible according to American models), or with facilities adapted, regardless of their size (large, medium, small), in a way In general they need investments and management corrections, so that they reach ideal values that allow better composting of the litter (and therefore, better degradation of manure, adequate drying of litter, and improvement of the animal ambience).

3.1 IDENTIFICATION OF THE VARIABLES THAT INFLUENCE THE BED QUALITY OF THE COMPOST BARN

Among the main factors that influence the maintenance of the functionality of the CB system, the quality of the bed is the highlight, the resting place of the animals, in which they stay the longest period of the day. In this sense, the authors of the present research sought to understand what are the main factors and characteristics that influence the maintenance of the quality of the bed of the CB. Among the physical and chemical characteristics of the bed most studied and evaluated in scientific research are the MS, temperature, MO, pH, W, C: N ratio and bed density (Janni et al. 2007, Black et al., 2013) ; Bewley and Black 2013; Ofner-Schröck et al., 2015). However, these characteristics can also be influenced by numerous factors related to daily handling, constructive characteristics, aspects related to animals, which are not yet fully understood and known. In this sense, first some of the main variables were listed (response variables, Table 3), to be tested using the proposed model and the adjustments used. With that, the variables that were significant ($P < 0.05$) in the variation of that response variable were obtained, in the sense of identifying other factors related to CB (mentioned above), that could interfere in characteristics already consolidated as a management key that are to MS, MO, pH, C: N, W ratio and bed density, as well as its temperature in depth.

According to Bewley and Black (2013), the composting process depends on several factors that must be in balance. Otherwise, the process may in fact be compromised.

In the present study, it was identified that Organic Matter has shown to influence MS, W and C: N ratio, possibly by providing substrate for microorganisms that perform the composting process. However, this substrate must present a balance between the components, especially regarding the C: N ratio, to consequently maintain the balance between DM and bed moisture. The composition of OM also influences the C: N ratio because when part of the available C is difficult to degrade, coming from sources such as cellulose, hemicellulose and lignin, a higher initial C: N ratio is advisable, since the bioavailable carbon is lower than total carbon (Valente et al., 2009).

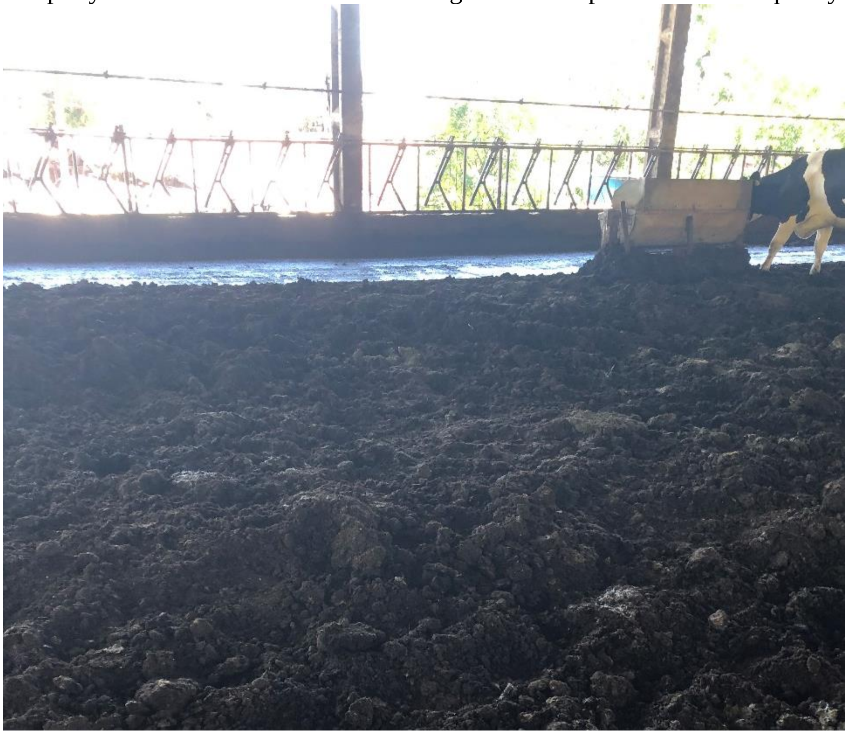
The DM content had an influence on OM, pH, W and C: N ratio. In this sense, Richard et al. (2002) affirm that materials with 30% humidity inhibit microbial activity, and that a medium with humidity above 65% provides a slow decomposition, which also causes the anaerobiosis of the environment. In general, it can be said that excess moisture causes lack of oxygen for the composting process, which inhibits the development of microorganisms that cease the composting process, which interferes directly or indirectly in all the factors mentioned above. .

Among the management variables, the frequency of bed turning was highlighted, which influences the bed's deep temperature, W, and the C: N ratio. This daily management directly affects the incorporation of oxygen in the medium, a key factor, since according to Diaz et al. (2007), after a few hours of composting, the oxygen level drops to very low levels and the oxygen must be incorporated by turning the material. The presence of oxygen results in aerobic composting where the only products are CO2, H2O and energy. On the other hand, in an anaerobic composting, CH4 is produced with low molecular weight organic acids, which result in an unpleasant odor (Kiehl, 2004). Thus, the presence of oxygen caused by the overturns results in the maintenance of the composting process, which generates an increase in temperature, which is the result of the degradation of the materials or substrates present in the bed (carbon and nitrogen). In addition, it results in the evaporation of moisture and in a dry and comfortable bed for the animals.

The dimension of installation sizing was also important. Among them is the availability of bed area per animal, which influenced the DM of the bed. As explained above, this variable has several recommendations in the literature. However, there are many factors that interfere with this recommendation. In the focus region of the present study, the usual practical recommendations vary from 10 to 14 m2 / animal. However, the smaller the area available per animal, the greater the incorporation of feces and urine in the bed, which can lead to an increase in the moisture content of the material, which then will require more careful and adequate handling, so as not to compromise the process of composting. In this sense, to avoid handling errors, the producer must start with a smaller capacity, monitor the bed conditions and gradually increase, because the factors of animal and bed management, the local environmental conditions, and the characteristics of the material used influence the quality of the bed.

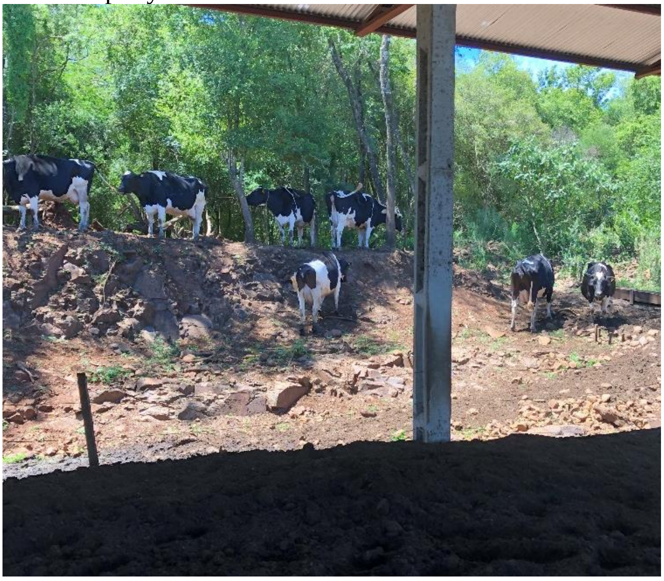
Taking into account the influence that environmental characteristics can have on the quality of the bed, an effect of the RH of the air measured inside the facilities was observed on the DM of the bed. According to Black et al. (2014), the surface temperature of the bed accompanies the environmental conditions, and the RH of the air can also cause a decrease in DM mainly in the surface layer of the bed. In addition, it may possibly hinder the evaporation of moisture present in the bed, as it has high RH in the air. This factor can have a great impact on UPLs that use the CB system partially, that is, in periods with high rainfall, where the RH of the air rises, and the maintenance of animals inside the facilities is prolonged, as they can result in drastic changes bed quality in a short period of time. Factor that can be aggravated by the fact that UPLs that use CB partially, have less intensive bed management routines, such as less turning frequency, in addition to not having mechanical ventilation systems.

Figure 2. Property that has less intensive bed management with problems in bed quality.



The period of use of the CB sheds (full or partial), also had an effect on the DM of the bed. Factor that possibly resulted in the largest DM of the bed found in the CB of group 3 that was determinant to be characterized as “CB of partial use”. In those cases where the animals do not remain confined all day, the incorporation of manure in the bed area is less, which can prolong the composting process, due to the lack of nitrogen for the microorganisms (Figure 3). According to Valente et al. (2009), the lack of N is limiting in the process, as it is essential for the growth and reproduction of microorganisms. This lower incorporation of waste also results in higher DM maintenance, due to these components having higher humidity than the bedding material.

Figure 3. Property where the animals do not remain confined all day.



In addition to the factors mentioned above, others may also have an influence on the response variables. However, due to the interaction between these factors, more specific studies are needed, which may contribute to the identification of other variables that influence the quality of the bed of the CB.

4 CONCLUSIONS

This work demonstrated that the UPLs that work with CB system in the mission region of Rio Grande do Sul, are somewhat heterogeneous, due to the identification of three different groups, through cluster analysis. The differences between the groups were due to the following variables: MO, MS, pH, C: N ratio, water retention capacity and density of the CB litter, area of the available litter per animal, shed width, turnover frequency. bed, presence of mechanical ventilation, upper temperature of the bed before turning and depth of bed temperature before turning. The three groups received the following names: conventional and adapted CB, large conventional CB, and partial use CB.

The compost barn (CB) systems are heterogeneous, and the warehouses are characterized by their different sizes, on the part of which they are adapted from facilities already present in the milk producing units (UPL), and part of which are built for exclusive use in the CB system. In an unprecedented way, the use of the CB system is reported partially, in periods of climatic adversities (hottest times of the day and times of high rainfall). Fact that influenced the denomination of group 3 (partial use CB) that had the best bed characteristics (MS, C: N, pH and W ratio) even with less intensive bed management and without the presence of mechanical ventilation in the warehouses. However, it is worth mentioning that the ventilation system, in addition to helping to remove moisture from the environment, also aims to help in the thermal comfort of the animals, being recommended its use even in UPL that use the CB partially.

In addition to the variables already studied and defined as fundamental for the composting process (MS, MO, pH, C: N, W ratio, density and temperature), the frequency of turning, availability of bed area per animal, presence of mechanical ventilation in the facilities, the type of material used for the composition of the bed and the local relative humidity, are factors that influence the main variables of the bed, and can be a key point for the success of the CB system in the region of the Missions of Rio Grande do Sul.

In conclusion, it can stand out, to avoid handling errors, the producer should start with a smaller capacity, monitor the bed conditions and gradually increase, because the animal and bed management factors, the local environmental conditions, and the characteristics of the material used have an influence on the quality of the bed.

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