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Compost-bedded pack barns in the state of Minas Gerais: architectural and technological characterization

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Abstract. Compost bedding pack (CBP) barns have been receiving increased attention as an alternative housing system for dairy cattle. Thus, a systematic investigation of the primary management practices of dairy cattle in CBP barns in the state of Minas Gerais (Brazil) has proven to be of environmental and economic relevance. The aim of this research was to summarize the compost bed data, barn dimension data and to determine the major interactive factors in the success of bed composting from qualitative and quantitative methods. Data for this study was collected from 16 CBP barns, distributed throughout the southern state of Minas Gerais (Brazil) between March 2017 and July 2018. These data were used to describe the building layouts and dimensions, to identify barn management practices, and to characterize the compost bedding material concerning moisture content. The majority of these barns had feed alleys and driveways; overshot ridges with frequent orientation from NE to SW; bedding process and aeration using mechanical tillage. The average bedding moisture content was found to be 36.9 ± 5.2% (w.b.). Based on the information found, it is possible to evaluate that there is still no defined construction pattern, with a high variation of size and technologies employed.

Key words: dairy cattle, animal facility, management.

INTRODUCTION

Milk production occupies a prominent position in Brazilian agribusiness. When considering milk production in Brazil by region, the state of Minas Gerais was responsible for the largest production volume in 2018, with 9.0 billion liters per year, corresponding to 27% of the total produced in Brazil (Embrapa, 2018).

However, to maintain this growth in production and productivity, dairy farmers need to invest in new technologies and improve their production systems to make their results even more satisfying. For this they need to overcome many challenges, among them, the improvement of the physical structure, thermal environment, and management, which are factors directly related to animal welfare and, consequently, to production (Costa & Silva, 2014).

The Compost bedding pack barn (CBP) has emerged as a viable alternative to conventional milk production structures. The CBP is an alternative loose housing system for dairy cows (Eckelkamp et al., 2014), which allows the animals more freedom of movement and comfort, enabling them to lie down in a more natural manner (Barberg, 2007a). In the CBP, the resting area is covered by a collective bed composed of organic material (Ofner-Schröck et al., 2015).

According to Damasceno (2012), the CBP system provides greater longevity, a dry and safe environment, comfort and well-being to the animal, an increase in production, a reduction of production costs, as well as a correct way of handling organic waste.

The CBP system has gained supporters around the world, who recognize the efficiency of CBP concerning productivity and animal comfort, this success has caused other countries to adopt it to improve their milk activity. The facilities followed U.S. standards, with the same constructive characteristics, management techniques, and system; although changes have been made to these initial system standards, a specific standard in the design and management of the facilities has not been found.

The aim of this research was to summarize the compost bed data, barn dimension data and to determine the major interactive factors in the success of bed composting from qualitative and quantitative methods.

MATERIALS AND METHODS

Characterization of the animal facility

The data for this study were collected in different CBP barns, distributed throughout the State of Minas Gerais between April 2017 to September 2018. Cooperatives and dairy farmers assisted in locating the farms that used the CBP system. A survey was carried out in 14 city of the state of Minas Gerais (Tiros, Sete Lagoas, Lagoa da Prata, Candeias, Perdões, Coqueiral, Santana da Vargem, Ingaí, Varginha, Três Corações, Madre de Deus de Minas, Ressaquinha, and Cláudio) for a total of 20 CBP barns examined (Fig. 1).

Figure 1. Cities in the State of Minas Gerais where CBP barns were visited.

During each visit, a questionnaire was applied to the producer and employees to evaluate the financial management practices and management system. The questionnaire was applied to gather data regarding the facility's design, implantation and production costs, herd characteristics, degree of producer's satisfaction and all management practices, including degree of success when implanting the system, bed and animal management, among others. After completing the questionnaire, the team went to the facility to collect variables related to architectural characteristics, thermal and acoustic environment, bed characteristics (temperature, humidity, pH and penetration resistance), animal handling, lactation, productivity, locomotion score, hygiene score, and body condition score, among others.

Determination of architectural, technological and environmental variables

The following information was collected for the architectural characterization of each of the CBP barns: ridge orientation, dimensions (length and width), structural characteristics (number of posts and material, wall and sidewall height), waterers (type of material, dimensions), feed alley (floor type, length, width and scraping frequency), roof (type and color of tile, roof pitch, eave height, eave overhangs, roof type, etc.). All data were measured with a tape measure and a laser (Bosch, Mod. GLM60, accuracy ± 1.5 mm). The constructed area and resting area of the CBP barns available per animal and the linear meter of waterers and feeder per animal were calculated.

For the technological characterization, the following data were collected: fans (type, quantity, power, and dimension), lighting (type of lamps, quantity, and power), tractor (power and model), implements (type and model) and waste treatment system (lagoon or biodigester).

Instrumentation and data collection

The parameters evaluated for the environmental characterization of the CBP barns were measured inside each animal facility. For this, a grid was drawn on the bed area with nine collection points, according to the methodology used by Damasceno (2012). All data collections were carried out between 12:00 to 16:00 hours.

The environmental variables were measured near the geometric center of the animals (1.5 m height). A portable Digital Thermo-Hygro-Decibel meter-Luxmeter was used to measure air temperature (tbs), relative humidity (RH) and noise level (Instrutherm®, model THDL-400, with an accuracy of ± 3.5%). The air velocity was measured using a hot wire anemometer (Instrutherm®, model TAFR-190, with an accuracy of ± 0.1 m s^{-1}).

Bed temperature and resistance to penetration were measured, and samples were collected to determine the humidity and pH of the bedding. The bed temperature was measured using an infrared thermometer (Incoterm®, model ST-500, measuring range -30 to 260 °C and resolution of 0.1 °C) for the surface temperature and a digital rod thermometer (Tp101, measuring range -50 to 300 °C and resolution of ± 0.1 °C) to measure at a depth of 0.2 m.

A Penetrometer (PenetroLOG PLG1020 and 3.1 kPa resolution) was previously calibrated for use with bed materials in CBP barns. The penetrometer was introduced into the bed (maximum insertion velocity of 50 mm s^{-1}) at each of the nine previously established points, where the sensor measured the penetration resistance of the bed every 1.0 cm, in the bands of 0–5 cm, 5–10 cm, 10–15 cm, and 15–20 cm and recorded the information in the memory. This data was downloaded to the computer and manipulated using the Microsoft Excel®. Bedding samples at different depths were collected to determine the moisture of the bed and to perform corrections of the penetrometer readings.

The samples to determine humidity and pH were taken with the help of an articulated trough with cable, then placed in plastic bags and stored in an airtight container with a lid.

The bedding moisture analysis was carried out following the methodology adopted by Damasceno (2012); For this 10 g of sample was placed in a ceramic container and introduced in an oven at a temperature of 105 °C for 24 hours. After this period, the dry samples were weighed, and the bed moisture was calculated.

Another part of the collected samples was used to determine the pH. The analyses were carried out in the laboratory in the same week of collection, in order to guarantee the reliability of the samples. The pH analysis in the laboratory followed the methodology described by Zhao et al. (2012), where 10 g of sample was collected and diluted in 25 mL of distilled water. The solution (sample and distilled water) was stirred for 3.0 minutes and allowed to stand for half an hour. After this period, the solution was placed in contact with the electrode of a bench pH meter (measuring range 0 to 14, resolution ± 0.01 and accuracy ± 0.02), after waiting for a few moments for the solution to stabilize, the pH value was recorded.

Characterization of the herd

The evaluation of the herd was made through the collection of information about the number of animals, average daily production and animal health (locomotion score, hygiene score, and body condition score). For these variables, two previously prepared evaluators visually assessed the animals and determined the values for each of the scores and then calculated the means of the two evaluations. For facilities with up to 50 animals, the entire herd was evaluated, and for installations with more than 50 animals, at least 50% of the herd was evaluated.

The evaluation of the body condition score was performed according to the methodology proposed by Machado et al. (2008), and was given through visual assessment of the animal's body situation using a scale with values ranging from 1 to 5, and graded every 0.25 points; The extreme numbers 1 and 5 of the scale represent an excessively lean animal and an obese one, respectively. The anatomical parts analyzed in the evaluation were ribs, transverse processes of the lumbar vertebrae, tips of the ilium and ischium, and tail head. At these specific points the disposition of adipose tissue and muscle mass over the bones was visually assessed.

The locomotion score was evaluated using the methodology presented by Sprecher et al. (1997) and was assessed through the observation of the animals on a flat surface while they were walking and standing. A scale with values from 1 to 5 was used, and graded every 0.25 points, numbers 1 and 5, the extremes of the scale, represent normal locomotion and severe lameness, respectively.

The hygiene score evaluation was performed according to the methodology proposed by Cook et al. (2007). For the evaluation, some anatomical parts of the animal such as the leg, udder, flank and upper leg were observed. A scale of 1 to 4 was used, graded every 0.5 points. Number 1: corresponds to the absence of dirt in the evaluated regions; number 2: regions with small dirt spots; number 3: regions with the presence of some dirt plates adhered to the fur; and number 4: regions with dirt plates preventing the visualization of the fur.

Statistical analysis

All the information collected in the field was recorded in spreadsheets and later inserted and manipulated with Microsoft Excel®. For the characterization of the animal facilities that use the CBP system descriptive statistics were used to evaluate the data obtained, thus, the means, standard deviations, minimum and maximum were calculated. Based on the results, frequency histograms were created and the data presented in bar graphs for better visualization.

RESULTS AND DISCUSSION

All CBP barns assessed in the present study were already involved with dairy production, and in the majority of the cases evaluated, the animals were raised in an extensive and semi-extensive system.

The majority of dairy farmers stated that the main factor that motivated them to adopt the CBP system was the need to increase milk production and to reduce the mastitis infection rates in the herd. Approximately 75% of the installations were designed and built, without adaptations, the rest were adapted according to the infrastructure previously in place.

All farmers considered themselves very satisfied with the results achieved, reporting improved herd health and increased productivity. Only 30% of the facilities did not have computers installed on the farm, and in those cases, the farmers were getting updates from magazines, scientific articles, technical assistance and contact with other professionals in the dairy business.

Architectural characterization

The most common roof orientation was Northwest-Southeast (52.9%), with only 29.5% of the facilities being in the East-West direction. According to Damasceno (2012), for the southern hemisphere, the East-West orientation is the most appropriate because it reduces the heating in the largest walls and direct solar exposure during the hottest periods of the day. Radavelli (2018) observed that at least 50% of the CBP barns were in the recommended orientation.

The average dimensions found at the facilities were 73.3 m (length) and 20.6 m (width). Most of the CBP barns analyzed had lengths and widths between 50 and 100 m (Fig. 2, a) and 16 and 22 m (Fig. 2, b), respectively. The average length of the facilities assessed in this study was significantly higher than those observed by Radavelli (2018) and Damasceno (2012). Most of them had an area between 45 and 1,215 m^2 (53.0%), as can be seen in Fig. 2, c.

The mean of the resting area dimensions found at the CBP barns was 64.1 ± 27.1 m (length) and 17.7 ± 4.1 m (width), and the average resting area dimension was 1,134.1 ± 537.6 m^2, with an average value greater than 750.0 ± 551.1 m^2.

The dairy farms had an average herd size of 130 ± 68 animals, ranging from 32 to 325 animals, respectively. The average stock density was 10.4 m^2 per animal. Most of the CBP barns (41.2%) had a stock density between 9.9 and 12.9 m^2 per animal (Fig. 2, d), which is higher than the values observed by Janni et al. (2007) and Black et al. (2014) in the U.S. states of Minnesota (7.4 m^2 per animal) and Kentucky (9.0 m^2 per animal), respectively. However, the mean value is lower than the one found by Radavelli (2018) in the West of the Brazilian state of Santa Catarina (15.2 m^2 per animal).

The majority of CBP barns (52.9%) have a sidewall opening between 3.0 and 4.5 m (Fig. 2, e). The sidewall openings and eaves provide protection against sun, rain, and strong winds while helping to maintain adequate ventilation and animal comfort (Damasceno, 2012).

For the support pillars, the most used material found was metal, present in 53% of the evaluated facilities. The mean eave height was 4.7 ± 0.4 m, with 47.0% of the CBP barns (Fig. 2, f) having a dimension higher than the 4.5 m recommended by Graves &

Brugger (1994). The average eave height is close to the ones found by Radavelli (2018) and Damasceno (2012), 4.3 ± 0.8 m and 4.2 ± 0.5 m, respectively.

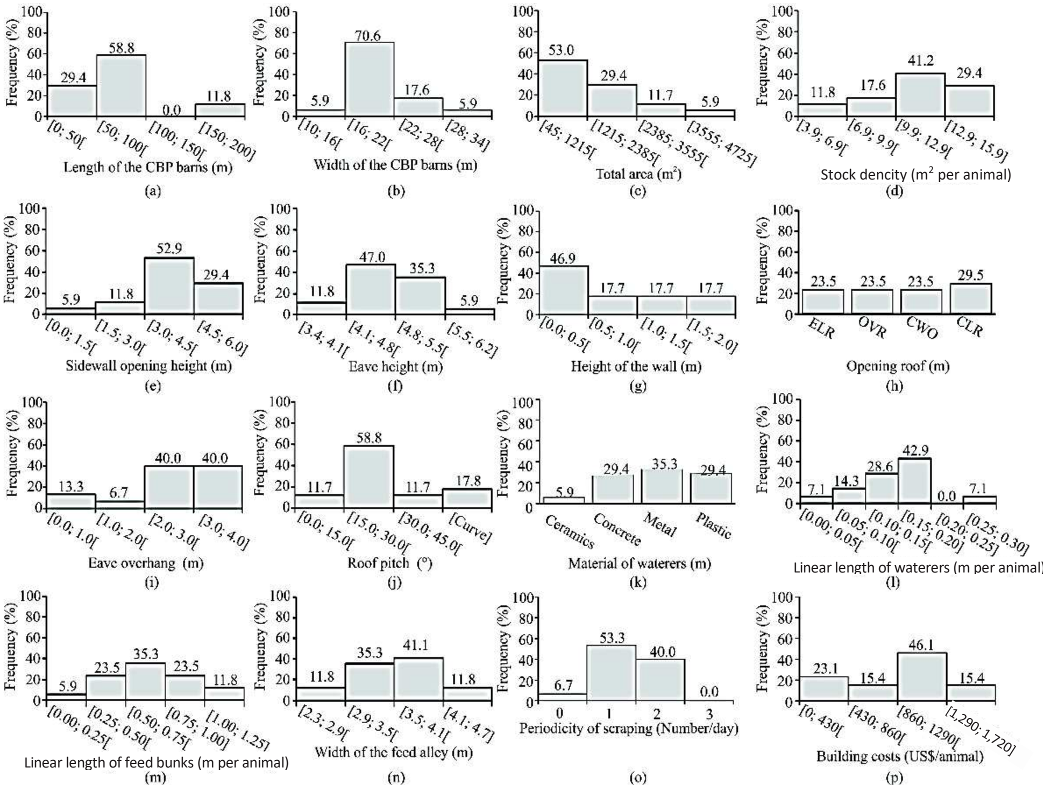

Figure 2. Frequency distribution of: a) Length of the CBP barns; b) Width of the CBP barns; c) Total area of CBP barns; d) Stock density; e) Sidewall opening height; f) Eave height; g) Wall height; h) Roof opening; i) Eave overhang; j) Roof pitch; k) Material of waterers; l) Linear length of the waterers; m) Linear length of feedbunks; n) Width of the feed alley; o) Periodicity of scraping; and p) Building costs.

*ELR – elevated ridge; OVR – overshot ridge; CWO – curved without opening; and CLR – closed ridge.

In the majority of the CBP facilities assessed walls with heights up to 0.5 m were more frequent (46.9%) (Fig. 2, g). If the height of the wall which is intended to contain bedding material is too high it can cause air circulation problems on the bed; if it is too low, it may limit bed replacements, making it impossible to use the bed for more extended periods due to lower volumetric capacity (Damasceno, 2012).

The most common type of roof opening found was the one with the closed ridge - CLR (29.5%), the other three types found (elevated ridge - ELR; overshot ridge - OVR; curved without opening - CWO) had the same frequency (23.5%).

The most common widths for the eave overhang (Fig. 2, i) were between 2.0 to 3.0 m (40%), and 3.0 to 4.0 m (40%). In CBP barns from the state of Kentucky (U.S.), the eave overhang was higher than 1.0 m (Damasceno, 2012). The eave overhang should be big enough to minimize the entry of sunlight and rain through the open sidewall, according to Gay (2009), it should be at least 1/3 of the sidewall height.

A higher frequency (58.8%) was observed for roof pitch between 15 to 30° (Fig. 2, j). The roof pitch and the type of roof opening are constructive characteristics that influence the natural ventilation of the animal facility, contributing to the ventilation of moisture, odors, and gases (MWPS-7, 2000).

According to Damasceno (2012), water intake is a critical factor in milk production and the reproductive performance of dairy cattle, since it regulates dry matter intake, so it is essential to ensure adequate access of the animal to the waterers. In the CBP barns evaluated it was observed that the most common material used for the waterers was metal (35.3%), followed by plastic, concrete (29.4%), and finally ceramic (5.9%) (Fig. 2, k).

It was also observed that there were five waterers per CBP barn. Tavares & Benedetti (2011) recommend that at least 0.10 m of linear length of waterers per animal should be available. When observing the CBP barns evaluated (Fig. 2, l), it was concluded that 78.6% were following the recommendations, a fact that contradicts the reality observed by Damasceno (2012) in the U.S. state of Kentucky, where only 19% of the CBP barns met the recommendations.

On average the feedbunks space per animal was 0.67 ± 0.2 mm, and that 35.3% of the CBP barns (Fig. 2, m) followed the recommendation of 0.75 m or more feederbunk space available per animal (Arachchige et al., 2014). Access to food is another factor that may limit milk production because if there is not enough space for the animals in the feed alley, there will be greater competition among cows, which could damage the adequate food intake of some animals (Damasceno, 2012).

All feed alleys of the CBP barns were covered with concrete, and the mean dimensions was 66.2 ± 25.7 m (length) and 3.3 ± 0.7 m (width), the frequency distribution of the dimensions of the feed alley (Fig. 2, n) was greater between 3.5 and 4.1 m (41.1%). The width values of the feed alley were close to the ones found by Radavelli (2018) and Damasceno (2012), 3.4 ± 1.8 m and 4.1 ± 0.7 m, respectively.

A daily frequency of feed alley scraping was observed in 53.3% of the CBP barns evaluated (Fig. 2, o). In the research conducted by Radavelli (2018), the daily frequency was part of 40.9% of the evaluated animal facilities. The most common ways of performing the scraping were mechanized (66.7%) and manual (26.6%).

The total building costs ranged from 15,150 to 515,000 US$, with an average cost per animal of US$ 877.1 ± 387.1. The significant difference in values may be associated with the type of design and structures used. The cost of building per animal was between 860.0 to 1,290.0 US$ (Fig. 2, p).

Technological Characterization

In all the cases observed, every milk farm had at least one agricultural tractor. The average power of tractors was 67.0 hp, ranging from 54.0 to 75.0 hp (Fig. 3, a). When evaluating CBP facilities in the West part of the State of Santa Catarina, Radavelli (2018) mentions that the average horsepower of tractors was 76.0 ± 12.5 hp. The difference in power can be associated with the type of work performed by the tractors in the facilities and also to the different types of implements used in the bed stirring, as this is one of the activities that demand the most power of a tractor.

According to the frequency distribution of the bed tillage equipment (Fig. 3, b), there was no greater predominance of a specific implement with the Rotary Tiller with Cultivator (RC) having the highest occurrences (27.8%). Radavelli (2018) mentions that 93.3% of the CBP barns evaluated, used a cultivator.

In most of the CBP barns assessed (88.8%), the pack material was stirred twice a day (Fig. 3, c). Bewley et al. (2012), the process was performed at least twice a day. The pack temperature is affected by compost management, more specifically by the machinery used for stirring (Janni et al., 2007). This predominance was also observed by Radavelli (2018) in 53.3%.

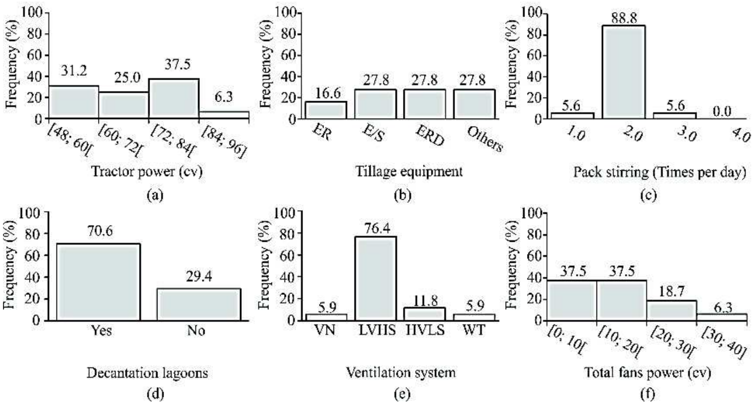

Figure 3. Frequency distribution of: a) Tractor power; b) Tillage equipment used to stir the bed pack; c) Pack stirring; d) Decantation lagoons; e) Ventilation system and f) Fans total power.

*ER – Rototiller; E/S – Cultivator; ERD – Rotary Tiller and Cultivator; Other – Equipment that uses more than one implement; VN – Natural ventilation; LVHS – low volume and high speed; HVLS – high volume and low speed; and WT – acclimatized wind tunnel.

In 70.6% of the CBP barns evaluated (Fig. 3, d), the animals' waste was stored in a decantation lagoon. According to Arceivala (1981), the decantation lagoon process consists in the retention of raw effluents, for a period, which must be sufficient for the organic matter to be stabilized by natural processes.

In most cases (94.1%), the ventilation system used by the CBP barns was mechanical (Fig. 3, e). The mechanical ventilation system used in 76.4% of cases was performed by low-volume high-speed fans (LVHS) and in 11.8 of the cases by high-volume low-speed fans (HVLS). According to Damasceno (2012), LVHS fans were used in 48.0% of CBP barns in Kentucky (U.S.). The average power of the fans was 13.4 ± 6.6 hp (Fig. 3, f), with a minimum and maximum value of 6.0 and 30.0 hp, respectively. These values differ considerably from the results presented by Damasceno (2012) of 5.8 ± 3.1 hp.

Environmental characterization

The mean value of the air temperature (t_{db}) at the surface and 1.5 m height from the bed was 26.9 ± 2.4 °C and 26.7 ± 2.3 °C, respectively (Fig. 4, a and 4, b). The highest thermal amplitude was observed at 1.5 m height from the bed (11.7 °C). The average t_{db} of the CBP barns is generally below the thermo-neutral zone (26 to 28 °C).

The average relative humidity at 0.05 m and 1.50 m height was 48.3 ± 9.3% and 46.4 ± 9.7%, respectively (Fig. 4, c and 4, d). The average humidity of the CBP barns was below the recommended upper limit (70%); however, a large percentage of the installations had an air humidity lower than the lower limit (60%), a condition that is not ideal for maintaining animal welfare.

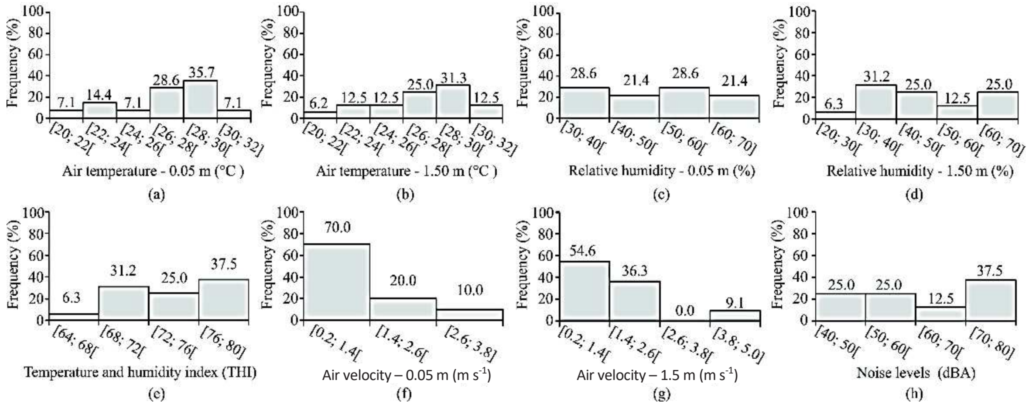

Figure 4. Frequency distribution of: a) Air temperature at 0.05 m; b) Air temperature at 1.50 m; c) Relative humidity at 0.05 m; d) Relative humidity at 1.50 m; e) Temperature and humidity index (THI); f) Air velocity at 0.05 m; g) Air velocity at 1.50 m; and g) Noise levels.

The THI is higher than the valued allowed for adequate thermal comfort of the animals, only in 6.3% of the cases evaluated the THI was less than 68 (Fig. 4, e); The average THI for all CBP barns was 73.6 ± 3.0. These conditions were also verified by Radavelli (2018) who found an average THI of 77.5.

The average air velocity at 0.05 and 1.50 m height was 1.3 ± 0.7 and 1.7 ± 0.8 m s^{-1}, respectively. Most of the air velocity values were between 0.2 and 1.4 m s^{-1} (Fig. 4, f and 4, g). These values are statistically within the recommended range, that is between 1.4 to 2.2 m s^{-1} (Bewley et al., 2012). According to Black et al. (2013), the air velocity close to the surface of the bed should be around 1.8 m s^{-1}.

The most predominant noise levels range was 70 to 80 dBA for 37.5% of CBP barns evaluated (Fig. 4, h). In the barns assessed in this study, higher noise intensities (62.7 ± 9.9 dBA) were produced by the LVHS fans. Dairy cows can adapt to different types and levels of sound pressure; However, stress animals should not be exposed to sudden or high sound pressures; otherwise, this may cause sound stress, which could lead to productivity losses and consequently to economic damages for the producer.

Characterization of the bedding material

The most commonly employed bedding material among the CBP barns evaluated in this study was sawdust (52.9%). The reason for this, according to the dairy farmers, is easy access and cost of the material. However, the growing demand for this product has driven up the price pushing farmers to look for new materials. The prevalence of sawdust use for bedding composition (70.0%) was also observed by Radavelli (2018).

According to Black et al. (2013), the bedding surface temperature tends to have values closer to air temperature. This tendency was verified in this study since the average bed surface temperature at the premises was 22.0 ± 3.6 °C and the average air temperature close to the bed was 26.7 ± 2.3 °C. The frequency distribution of the bed surface temperature (Fig. 5, a) shows that the predominant temperature range was between 20 to 23 °C.

The average bedding temperature at 0.20 m depth was 35.9 ± 3.9 °C, similar to that found by Black et al. (2013) in the U.S. state of Kentucky (36.1 ± 11.0 °C). Most of the bedding temperatures found were between 35 and 40 °C. The bedding temperature at the 0.20 m is below the recommendation in 75% of the CBP barns analyzed (Fig. 5, b). In order to ensure that the bedding is at the proper temperature for the composting process of the material to occur between 0.15 and 0.30 m depth, the temperature should be between 43 and 65 °C (Janni et al., 2007; Bewley et al., 2013).

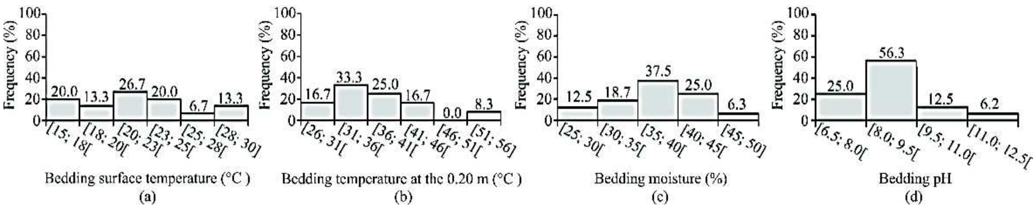

Figure 5. Frequency distribution of: a) Bedding surface temperature; b) Bedding surface temperature at 0.20 m; c) Bedding moisture; and d) Bedding pH.

The average bedding moisture was 36.9 ± 5.2%, lower than the one found by Damasceno (2012), which was 59.0 ± 9.0%. The mean value of the bedding moisture (37.5) of the CBP barns evaluated was between 35 and 40% (Fig. 5, c).

The mean pH value was 9.0 ± 0.8, where the highest and lowest values were 20 cm depth, 11.4 and 7.3, respectively. In most of the bedding materials evaluated, the pH value was between 8.0 and 9.5 (Fig. 5, d). The mean value was close to the one determined by Janni et al. (2007), Radavelli (2018), and Fávero et al. (2015).

The penetration resistance values determined for each bedding layer are shown in Table 1. Table 1 shows an increase in the penetration resistance of the bedding as layer becomes deeper (113.4 to 1079.2 kPa). The deeper bedding layers carry a greater load, from the weight of the upper layers, remaining naturally more compacted. This fact is evidenced by the increase in the mean values of penetration resistance, as the bedding layer get deeper.

Table 1. Penetration resistance values for the different bedding layers

Layer (mm)	Average (kPa)	SD (kPa)	Maximum (kPa)	Minimum (kPa)
0–50	113.4	87.5	414.6	21.9
50–100	529.4	252.3	1,408.7	94.5
100–150	850.1	331.1	1,704.9	186.1
150–200	1,079.2	348.9	1,698.2	319.6

Evaluation of locomotion score, hygiene score, and body condition score

The predominant breed was ¾ Holsteins and ¼ Gyr (35.7%). The average milk production of the herds was 28.4 ± 2.4 kg animal^{-1} day^{-1} (Fig. 6, a), which is higher than the production found by Radavelli (2018) in CBP barns in the south of Brazil, 22.4 ± 3.8 kg animal^{-1} day^{-1}. This difference can be attributed to better food management, herd genetics and animal welfare of the facilities.

The mean locomotion score of the herd was 1.83 ± 0.25. The most frequent range was 1.5 to 2.0 (41.7%), in general, the cows had a good locomotion score, and the incidence of lameness is not common (Fig. 6, b).

The mean hygiene score of the herd was 1.56 ± 0.39 (Fig. 6, c). The frequency distribution of hygiene score showed that dairy cows generally had an excellent hygiene score, which is evident when comparing it to the results obtained by Barberg et al. (2007) and Shane et al. (2010), where the mean scores were 2.6 and 3.1, respectively.

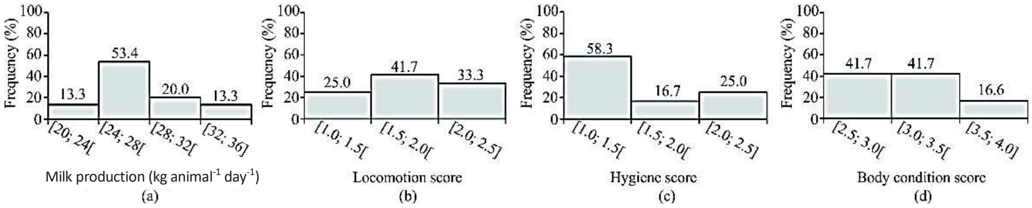

Figure 6. Frequency distribution of: a) Milk production; b) Locomotion score; c) Hygiene score; and d) Body condition score.

The average body condition score of the milking herd was 3.15 ± 0.24 (Fig. 6, d). The body condition score of the animals was satisfactory, and the variations presented are acceptable due to the performance of the evaluation in animals that were at different productive levels and lactation stages.

CONCLUSIONS

In general, dairy farmers were satisfied with the results obtained by the compost dairy barn (CBP), they observed a significant increase in milk production and improvement of herd hygiene and comfort.

The CBP barns architectural characteristics showed great variability in designs, dimensions, and materials used for the creation of the system. Some of these characteristics were not in accordance with the values recommended in the literature, a fact that can cause severe difficulties in the handling and operation of the system.

Cow stocking density on the composted pack is a crucial element of barn management. The average frequency of cow stocking density found in this study was 10.4 m^2 per animal

In general, the bedding was stirred twice a day using a rotary tiller with a cultivator. The LVHS fans are predominant among CBP barns with a high air velocity and noise levels.

The supply of bedding material is one of the biggest concerns for many farmers. Sawdust (52.9%) is being used more frequently, but there was a tendency to increase the use of coffee husk, due to the availability, cost, and accessibility of the material in the assessed regions. The bedding surface temperature was similar to air temperature, 22.0 ± 3.6 °C. The average bedding temperature at 0.20 m depth was 35.9 ± 3.9 °C. The importance of the bedding moisture content is reflected in the bedding temperature. In this study, the bedding moisture was 36.9 ± 5.2%. The moisture content range for minimum aerobic microorganism heat production is 40–60%.

In general, the dairy cows showed a good locomotion score, hygiene score, and body condition score.

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