



Spatial distribution of bed variables, animal welfare indicators, and milk production in a closed compost-bedded pack barn with a negative tunnel ventilation system

Rafaella Resende Andrade^{a,*}, Ilda de Fátima Ferreira Tinôco^a, Flávio Alves Damasceno^b, Gabriel Araújo e Silva Ferraz^b, Letícia Cibele da Silva Ramos Freitas^c, Cecília de Fátima Souza Ferreira^a, Matteo Barbari^d, Fátima de Jesus Folgôa Baptista^e, Diogo José de Rezende Coelho^a

^a Federal University of Viçosa, Department of Agricultural Engineering, Av. Peter Henry Rolfs, Campus University of Viçosa, Viçosa, Minas Gerais, Brazil

^b Federal University of Lavras, Department of Engineering, Lavras, Minas Gerais, Brazil

^c State University of Maringá, Department of Agricultural Engineering, Campus do Arenito, Cidade Gaúcha, Paraná, Brazil

^d University of Florence, Department of Agriculture, Food, Environment and Forestry, Via San Bonaventura, Firenze, Italy

^e Universidade de Évora, Escola de Ciências e Tecnologia, Departamento de Engenharia Rural, MED - Instituto Mediterrâneo para a Agricultura, Ambiente e Desenvolvimento, Évora, Portugal

ARTICLE INFO

Keywords:

Animal welfare
Compost barn
Dairy cattle
Model-based geostatistics
Udder hygiene
Spatial variability

This research aimed to characterize, evaluate and compare the spatial distribution of the leading bed variables, animal welfare indicators, and milk production in a closed compost-bedded pack barn (CBP) with a negative tunnel ventilation system, for summer and winter periods. The study was carried out in a CBP located in the Zona da Mata region, Minas Gerais, Brazil. The geostatistical modeling technique evaluated the variables of temperature, moisture content, and pH (on the surface and depth of 0.20m) across the length of the bed. Bed samples were characterized for carbon (C), nitrogen (N), and C:N ratio. Cows housed in the CBP were assessed for locomotion and hygiene scores and average milk production. To evaluate the thermoregulation of the cows, the respiratory rate (RR) and surface temperature (ST) were measured. Geostatistical analysis showed spatial dependence and the non-uniformity of the spatial distribution of bed variables. The worst levels of bed temperature and moisture were found in the regions close to the evaporative cooling plate, surrounding the feeding alley, and in the region with the highest cow stocking. The C:N ratio, obtained in both climatic seasons of the year, remained outside the recommended range for ideal composting. During the summer and winter, the bed variables' values suggest that the material was below levels for optimal composting; however, the aerated inner layer was biologically active. The high animal density significantly impacted the worsening of the bed moisture content and internal temperature. In general, dairy cows showed adequate hygiene (score of 1 and 2) and locomotion (score of 0 and 1) scores for the two climatic seasons evaluated, indicating good welfare conditions. In relation to RR and ST, the summer period presented less favorable environmental conditions. During winter, the average milk production was 28.1 ± 7.2 kg day⁻¹, and during summer, it was 26.9 ± 6.7 kg day⁻¹.

1. Introduction

Dairy farming substantially changed in recent years, and, as a result, there is a need to intensify and adapt processes to increase efficiency improve animal welfare conditions and reach a more sustainable production. Housing systems and management practices have a strong influence on the welfare of dairy cattle and milk quality, highlighting the extreme relevance of the breeding environment choice (Biasato et al.,

2019). This concern is intensified in countries with tropical and subtropical climates, such as Brazil, which has high temperatures and humidity for long periods of the year (Castro Júnior and Silva, 2020).

Traditionally, in the intensive farming system, dairy cows' housing options consist mainly of confinement in Loose Housing, Tie Stall, and Free Stall (Blanco-Penedo et al., 2020). However, more recently, the compost-bedded pack barn (CBP) type of containment system has been widely used to by milk producers in several regions of the world (Bewley

* Corresponding author.

E-mail address: rafaella.andrade@ufv.br (R.R. Andrade).

<https://doi.org/10.1016/j.jtherbio.2021.103111>

Received 10 April 2021; Received in revised form 30 September 2021; Accepted 20 October 2021

Available online 23 October 2021

0306-4565/© 2021 Published by Elsevier Ltd.