MEASUREMENTS RELATIONSHIP AMONG COMPOST BEDDED PACK BARN FARMS IN SIX EUROPEAN COUNTRIES DURING THE WINTER AND SPRING SEASON

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ABSTRACT – Compost bedded pack barn (CBP) is a housing system for dairy cows, which consists of a large area covered with bedding materials where the cows can rest and exercise freely, associated with a feeding area with solid floor. Some vantages of this alternative system are the comfort provided to dairy cows and the possibility to reach higher milk yield. The aim of this paper is to present preliminary results to compose a diagnose of 20 CBP farms measurements in terms of bedded area space per cow, air temperature and relative humidity, pack temperature and pack moisture, collected in six European countries (Italy, Germany, Austria, Sweden; Slovenia; The Netherlands) during the period between November 2017 and May 2018, in order to describe eventual relationship among the farms. During the monitoring period it was observed that Austria presented the highest density of cows per area of facility and CBP located in Italy presented the lowest density. The values of air temperature and relative humidity of the air showed large variations among countries and months. As expected, February resulted to be the coldest month and May was the warmer month. Climate and weather can affect bedding conditions and, consequently, the management in CBP, especially in the winter, because they can influence the evaporation of water from the pack and, consequently, leading to an increase in pack temperature and moisture. During the monitoring period, Slovenian showed the smaller pack temperature and Dutch CBP showed the highest pack, both measured during the winter. These preliminary results showed that maintaining adequate pack temperature and moisture in CBP may be a challenge under European climatic conditions (winter and spring season), even with relatively large space per cow. A high pack temperature may help keeping the bedding dry, especially during the winter period. Further analysis will be performed to better understand bedded pack dynamics and help producers with CBP maintaining a dry and comfortable surface for the cows.
Keywords: Compost-bedded pack barns, Freewalk, dairy cows, housing.

INTRODUCTION

Compost-bedded pack barns (CBP) are an alternative housing system for dairy cows, which is known to potentially improve animal welfare compared with other conventional systems such as free stalls and straw yards (Bewley et al., 2017). Cows in CBP are provided with a large open bedded area on which they can lie, stand and walk

freely. Generally, the CBP system requires a large space per cow, and an adequate animal density is crucial to maintain sufficient pack hygienic conditions. In literature, suggested space allowances in CBP range from 7.4 to more than 15 m^2/cow (considering just the bedded area) depending on climate, barn characteristics, bedding availability and pack management (Janni et al., 2007; Galama et al; 2011).

The most commonly used bedding materials in CBP are sawdust and wood shavings (Janni et al., 2007). Other materials including straw, peanut shells, woodchips and compost have also been used (Galama, 2014; Leso et al., 2018, Favero et al., 2015). The bedded pack is aerated one or two times per day to promote evaporation and maintain a soft and hygienic surface for the cows (Leso et al., 2013). Pack moisture, in particular, seems too deeply affect animal welfare in CBP. High pack moisture has been related to poor cow cleanliness and increased risk of mastitis (Eckelkamp et al., 2016).

In Europe, CBP has spread rapidly over the last few years. Despite that, limited knowledge is available to date about the solutions developed in different countries and their management. The aim of this paper is to present preliminary results to compose a diagnose of the situation and describe relationship among 20 CBP farms measurements (bedded area space per cow, air temperature and relative humidity, pack temperature and pack moisture) collected in six European countries (Italy, Germany, Austria, Sweden; Slovenia; The Netherlands), during winter and spring season (period between November 2017 and May 2018).

MATERIAL AND METHODS

This study is a part of the EU-funded project “FreeWalk” (ERA-NET SUSAN). Such project focuses on alternative housing systems for dairy and beef cattle, including CBP, and will end in 2020.

The study was conducted on 20 commercial dairy farms located in Italy (n. 6), Slovenia (n. 1), Austria (n. 3), Germany (n.6), the Netherlands (n. 5) and Sweden (n.1). All farms included have CBP housing system for lactating cows. In each country, a local research team visited the farms twice during the period between November 2017 and May 2018. All researchers involved received adequate training before the beginning of the experiment to ensure consistency of the data collected. Visits during November,

December, January and February were considered winter visits, while those during March, April and May were considered spring visits.

During the first visit, a data logger capable of measuring air temperature and relative humidity was installed in each barn. The loggers were set to take one measure per hour of both parameters. During each visit, pack temperature at 20-cm depth was measured using a hand-held data logger provided with a penetration thermometer. Each compost barn pack was subdivided in 9 equal areas in which pack temperature was measured. Samples of bedding were collected from the same 9 areas and analysed to determine pack moisture. Samples were dried in a 100°C oven for 24 h and weighted before and after drying to determine pack moisture. At the beginning of the experiment, farms were also surveyed to determine total bedded area in CBP. Number of cows in each barn was obtained from national DHI, which allowed calculating bedded area space per cow. All data were collected and shared using a dedicated web server. Data was processed using Microsoft Excel. Results are presented as mean±SD.

RESULTS AND DISCUSSION

Spaces per cow over the bedded area measured in the CBP involved in the study are summarized in Table 1. Spaces per cow could vary along the world, Barberg et al. (2007) report an average peck area of 8.6 of 8.6 m^2/cow in Minnesota (USA), Black et al. (2013) found 9.0 m^2/cow, Galama (2014) found that in Netherlands to keep the pack dry the bedded area of 15 m^2/cow is recommended, but with pack aeration systems a 12 m^2/cow may be also adequate. According to Black et al. (2013), higher densities may lead to increased pack compaction and excessive moisture. In this study it was found that Austria presented the highest density of cows per area and CBP located in Italy presented the lowest density.

Table 1. Bedded area space per cow measured in the compost-bedded pack barns included in the study grouped by country.

	Bedded space per cow (m^2/cow)		
Country	Min	Mean	Max
Italy	9.45	14.52	23.25
Germany	9.80	14.26	23.80
Austria	4.96	10.35	16.24
Sweden	11.41	11.68	11.94
Slovenia	12.00	12.25	12.50

The Netherlands	11.00	13.50	15.00

The wide geographic distribution of farms included in the project Freewalk allowed observing different climatic conditions. During the monitoring period, February resulted to be the coldest month throughout Europe, with average month temperatures ranging from -2.47°C in Sweden to 3.81°C in Italy (Figure 1). As expected, May was the warmer month with mean temperatures up to 17.04°C in Slovenia. Relative humidity also showed large variations among countries and months, ranging from 59.6% in Germany during November to 95.3% in the Netherlands during December (Figure 2).

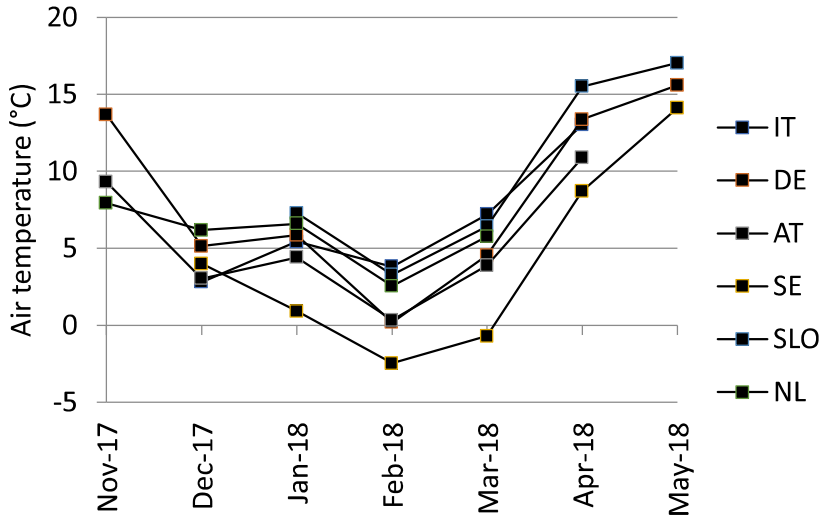

Figure 1. Mean month air temperature measured inside 20 compost-bedded pack barns grouped by country (IT=Italy, DE=Germany, AT=Austria, SE=Sweden; SLO=Slovenia; NL=the Netherlands)

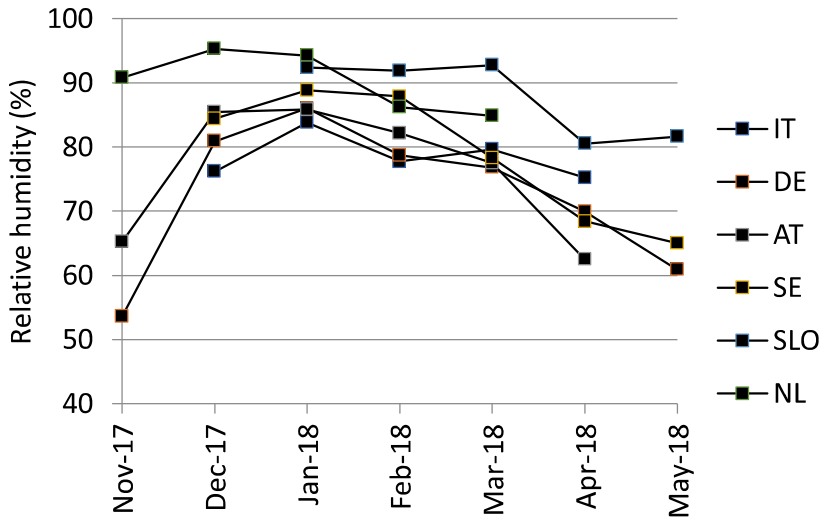

Figure 2. Mean month relative humidity measured inside 20 compost-bedded pack barns grouped by country (IT=Italy, DE=Germany, AT=Austria, SE=Sweden; SLO=Slovenia; NL=the Netherlands)

Climate and weather are known to affect bedding conditions and management in CBP. Winter is certainly the most difficult part of the year as the cold and moist air conditions limit the evaporation of water from the pack, usually leading to an increase in pack moisture (Bewley et al., 2017). To promote pack drying in CBP, authors suggest that a high pack temperature should be maintained, especially during winter. Pack temperatures (at 20-cm depth) and pack moisture measured in the CBP included in this study are reported in Figures 3 and 4. During the monitoring period, pack temperature ranged from 7.9±3.6°C to 31.3±12.8°C, both measured during winter in Slovenian and Dutch CBP, respectively (Figure 3). Pack temperature showed a higher range of variation during the winter period than during spring, confirming that winter weather may pose some challenges in managing CBP.

According to Bewley et al. (2013) and Eckelkamp et al., (2016), CBP require an adequate range of moisture and air temperature for the best functionality. If the air temperature increases consequently pack temperature increases too. This was probably because greater air temperature allowed the pack to maintain a greater heat level.

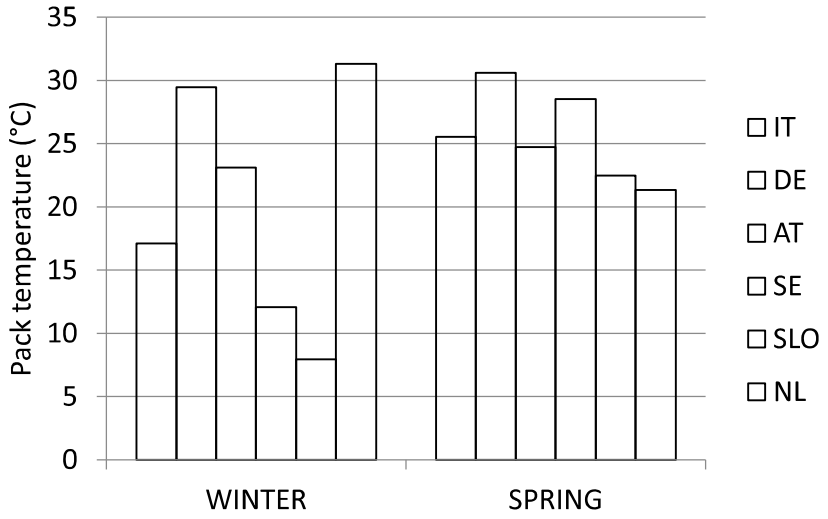

Figure 3. Mean±SD season pack temperature in 20 compost-bedded pack barns grouped by country (IT=Italy, DE=Germany, AT=Austria, SE=Sweden; SLO=Slovenia; NL=the Netherlands)

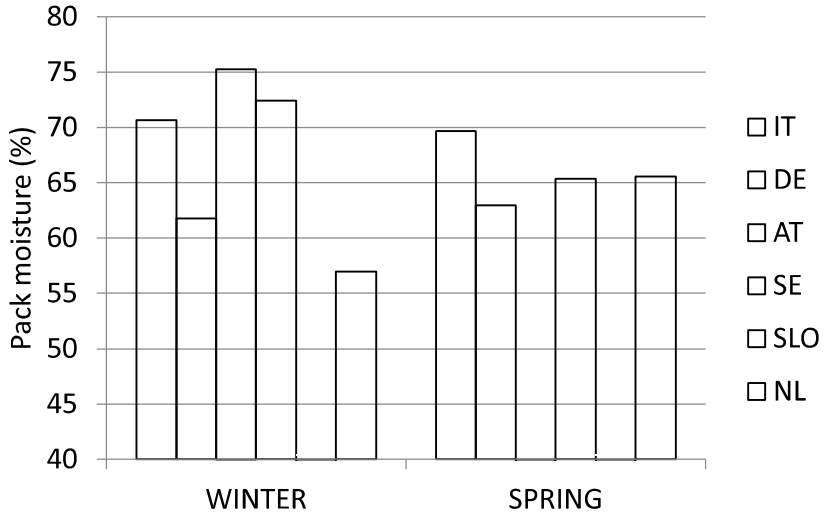

Figure 4. Mean±SD season pack moisture in 20 compost-bedded pack barns grouped by country (IT=Italy, DE=Germany, AT=Austria, SE=Sweden, SLO=Slovenia, NL=the Netherlands)

Pack moisture also showed a higher variation during winter period, ranging from 56.9±4.6% to 75.3±1.1% in Dutch and Austrian CBP, respectively (Figure 4).

Results partially support the concept that, during the winter period, maintaining high pack temperature may help controlling pack moisture in CBP. The relatively high pack temperatures measured during winter in Dutch (31.3±°C) and German CBP (29.4°C) were associate with the lowest pack moistures (56.9±4.6% and 61.8±8.8% in the Netherland and Germany, respectively). High pack moisture measured in Austria (75.3±1.1%) and Italy (70.6±5.0%) during winter instead were linked with low pack temperatures (23.1±5.1°C and 17.7±6.8°C in Austria and Italy, respectively).

When the pack moisture is high it can affect the cow's welfare-related parameters such as cleanliness, that strictly depend on pack management. If pack moisture content increases and the air temperature decreases, consequently herd hygiene score increases. These results corroborate to the made by Eckelkamp et al. (2016) that affirm that pack moisture also decreased with increasing air temperature inside the CBP. The decrease in pack moisture decreased the ability of CBP material to adhere to animals, resulting in a lower hygiene score at greater air temperature. When the pack gets too soft, which may be a consequence of increased pack moisture or incorrect pack stirring, cows may sink into the pack and thus deeply limits cow comfort in CBP leading to undesired behavioural responses. This relationship seems to exist rather independently from bedded space per

cow and weather conditions, which were thought to impact bedding moisture to a larger extent.

CONCLUSIONS

Results showed that maintaining adequate pack temperature and moisture in CBP may be challenging under European climatic conditions, even with relatively large space per cow. A high pack temperature may help keeping the bedding dry, especially during the winter period. Results reported, however, are preliminary and represent just a limited part of the information that will be collected in the longer monitoring period planned for the project "FreeWalk", which will end in 2020. Further analysis will be performed to better understand bedded pack dynamics and help producers with CBP maintaining a dry and comfortable surface for the cows.

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