Assessment of Heat Stress Impact on Daily Activity Pattern of Dairy Cattle

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Abstract

The behaviour of dairy cattle changes when they are exposed to settings that cause heat stress. As a result, the analysis of changes in behaviour may serve as an indicator of abnormalities in either the environment or the body itself. In addition, precision livestock farming tools enable the individual and ongoing monitoring of animal behaviour, which might serve as a method for determining whether or not animals are treated properly. The goal of this study was to assess the effect that heat stress has on the behaviour of dairy cows. The research was conducted during the summer of 2022, in a dairy farm located in the north-east of Romania. A total 40 cows, with ages ranging from 3 to 5 years, average days in milk (DIM) and milk production of 85 +/- 35 days, respectively 21 +/- 2.2 kg (mean +/- SD) were included in the study. Temperature and Heat Index (THI) were computed each day, for the entire period of the study. Data regarding the individual activity pattern of each animal were provided by the AfiFarm software. The findings indicated that heat stress impacted animal behaviour, a significant correlation being observed between heat stressed and non-heat-stressed regarding the activity period ($p < 0.05$), respectively the rest period ($p < 0.05$). As the THI increased, the general activity and resting pattern were modified, implicitly impacting animal welfare. Precision livestock farming sensors and analysis of daily patterns may be excellent tools for monitoring animal behaviour and detecting heat stress-related changes.

Keywords: activity pattern, dairy cows, heat stress, precision livestock farming.

1. Introduction

Given the significant impact that elevated temperature and heat stress have on the health and performance of dairy cows, it is reasonable to anticipate that the climate conditions for cattle farming will decline over the course of the next few decades [1,2]. The behaviour of dairy cattle changes when they are exposed to settings that cause heat stress. As a result, the analysis of changes in behaviour may indicate abnormalities in the environment or the body itself [3-5]. In addition, precision livestock farming tools enable the individual and ongoing monitoring of animal behaviour, which might serve as a method for determining whether or not animals are treated properly [6]. The goal of this study was to assess the effect that heat stress has on the behaviour of dairy using a farm management system based on pedometers and software.

2. Materials and methods

The research was conducted on a dairy farm in the northeast of Romania during the summer of 2022 (47.1562961; 27.6493904). A total of 40 Romanian Black spotted cows, with ages ranging from 3 to 5 years, average days in milk (DIM), and milk production of 85±35 days, respectively 21±2.2 kg (mean±SD) were included in the study. Temperature and Heat Index (THI) were computed each day, for the entire period of the study using the Thermotool mobile app provided by CCPA-G group environmental sensors. The information regarding the activity patterns from each cow was registered via the pedometers and

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assessed via the Affimilk software. The description of the behaviours detected by the Affimilk pedometer are the following:

Activity = Average number of steps taken by the cow in the period between milkings (STEPS).

Rest = Detected when the animas is standing or lying down motionless.

The locomotor activity was divided into the daytime (between morning and afternoon milking on the same day – 07:00 am to 04:00 pm) and night-time (between afternoon and morning milking on the next day – 04:00 pm to 07:00 am).

The locomotor activity with corresponding THI was processed using analysis of Spearman's correlation coefficient (r) using the GraphPad Prism software.

3. Results and discussion

In our study, the activity period, resting period as well as comfort of the groups were directly affected by the THI. A strong diurnal trend in resting time, with greater resting times at night than throughout the day. To produce milk beyond their genetic potential, cows must rest for as long as possible (within their typical range for that production time). The pedometers collected activity data every second, and the system summarized the number of minutes allocated to each activity, per animal every hour. The dynamic of the THI over the three months taken into study is presented in Figure 1.

Heat stress reduced the time spent for resting by over 3 minutes per hour as the THI increased (Table 1).

Dairy cow welfare has long been overlooked, but it has recently received increased attention from both scientists and policymakers [7,8]. The health and well-being of dairy cattle are important from a both ethical and economical points of view, especially due to their potentially productive longevity. Lying behaviour in dairy cows is well recognized as a valuable measure of their health and welfare [9,10]. Sick cows or those with laminitis frequently increase their daily laying time [11]. Heat stress can be problematic for high-producing dairy cows, with negative effects on performance, reproduction, and welfare. Excessive standing, one of the behavioural techniques used in response to heat load, exposes more of the cow's surface area to potential cooling via convection, evaporation, and radiation, but it additionally enhances the likelihood of lameness, which may emerge months later. A sophisticated cow monitoring system is an excellent place to start for data-driven animal care.

In competitive terms, having comprehensive information about animal welfare leads to confidence. A cow monitoring system provides a lot of the information required such as milk production, milk conductivity, health issues, period of activity or rest, as well as group comfort. Restless cows, with an atypical resting behaviour, are more easily monitored with this type of system.

Modifications in the behaviour of dairy cows under heat stress have already been reported in previous studies [12]. According to a study conducted by Ramón-Moragues et al., 2021, an increase in THI leads to an increase in activity as well as alterations in feeding behaviours, as well as a decrease in ruminating and resting, which is detrimental to the welfare of the animal [13]. Precision livestock farming, sensors and the modelling of daily patterns proved to be helpful instruments for observing animal behaviour and identifying deviations that were brought on by heat stress [14].

Table 1. Average (± standard deviation) number of minutes per hour allocated to every activity in dairy cows subjected to heat stress (HS) and in dairy cows not subjected to heat stress (NHS)

Group	Parameter	Average	SD	Min	Max	*rs*	*p*
Heat stressed	Rest	17.61	0.27	16.88	17.89	0.984	p=0.001
Non-Heat stressed	Rest	14.22	0.11	14.10	14.50		
Heat stressed	Activity	7.71	0.15	7.36	8.1	0.981	p=0.001
Non-Heat stressed	Activity	7.43	0.10	7.22	7.67		

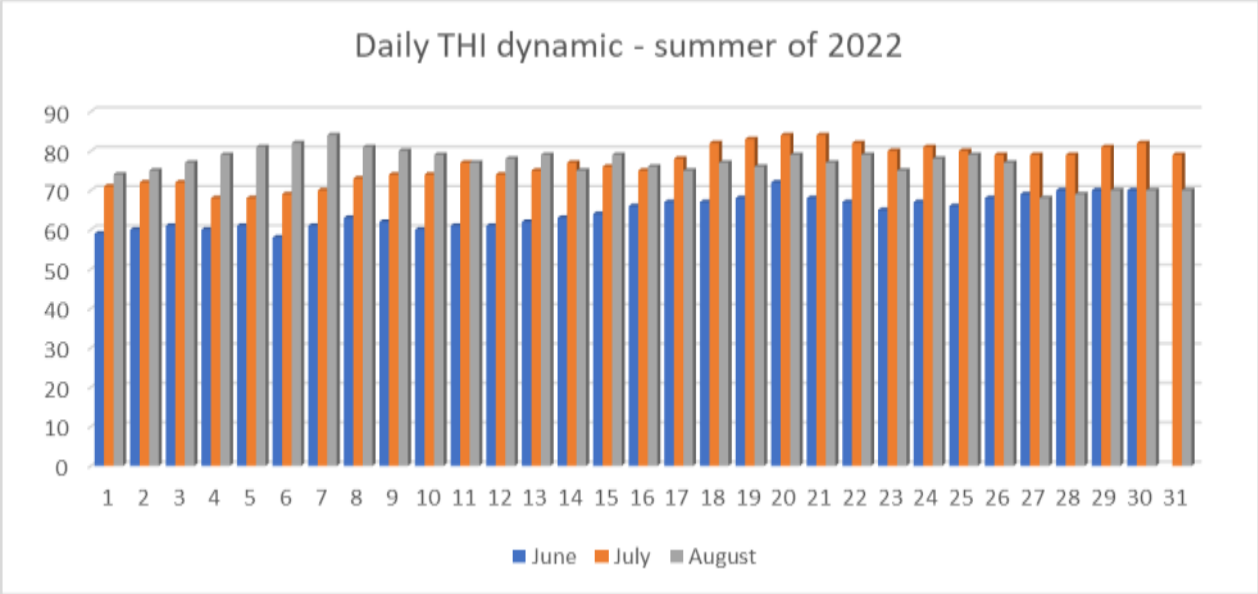

Figure 1. The dynamic of the THI in the summer of 2022 at the location of the dairy farm taken into study

4. Conclusions

Dairy cows suffering from heat stress decrease the amount of time spent ruminating, the amount of consumed forage, and the amount of time they spend lying down, resting. Their activity pattern is also modified, as they spend more time looking for cooler places in the barn.

The findings of this study indicate that heat stress impacted significantly the animal behaviour in the farm taken into study. The general activity and resting pattern were modified as the THI increased, implicitly impacting animal welfare.

Precision livestock farming sensors and analysis of daily patterns may be excellent tools for monitoring animal behaviour and detecting heat stress-related changes.

Ethical Statement

The study was conducted in accordance with the European Union's Directive 2010/63/EU on the protection of animals used for scientific purposes.

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