The effect of climate change on dairy cattle behaviour in a cow barn in North Greece and possible effects on energy consumption

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Keywords: Energy Savings, Dairy cattle behaviour, Climate change, Animal welfare, Animal productivity
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Abstract

Dairy cattle farming is considered as one of the major contributors on waste production that affects climate change. On the other hand, the radical change on environmental conditions leads to more intense weather phenomena which are characterized by higher temperatures during the summer period. In the current study a cow farm in North Greece was monitored in order to evaluate possible issues on animals welfare due to weather change conditions. Climatic conditions inside and outside the barn were measured and were connected to specific indicators of animal welfare and productivity such as time spent at the feedlot, resting minutes, heat, milk production etc. All the above parameters seem to relate to weather variations and affect the animal behavior as it occurs by the results of the monitoring period. Also, these parameters have a significant impact on energy consumption as cooling systems are used to mitigate the effects of heat stress and inefficient feeding is realized.

1. Introduction

Climate change affects livestock and especially animals who cannot suffer high temperatures or temperature and humidity index (THI). Heat stress has significant effect on dairy production (Liu *et al.,* 2019). One indicator of this situation is THI which is used to evaluate the heat stress in dairy farms (Liu *et al.,* 2019). To mitigate heat stress though energy should be consumed in equipment installed for cooling purposes such as fans, pumps for fog or evaporative cooling systems etc. (Worley, 2016). Also, water may also need to be consumed in these systems for cooling purposes. These practices have been proven efficient towards the cooling of cow barns in warm climates however they can contribute to the greenhouse gases emissions as most of the times they consume fossil fuels or electricity (Du *et al.,* 2022) for their operation. The use of passive methods such as shading or enhanced natural ventilation can be proven very useful towards this direction as they reduce the heat stress impact while at the same time they are not accompanied with energy or resources consumption (Firfiris *et al*.,2019). To design a proper and efficient passive cooling system, the exact impact of the heat stress on cows' welfare should be defined as long as the local climatic conditions including prevailing winds, barn orientation etc.

In this work, the monitoring of a cow barn in North Greece has been performed and the connection between climatic conditions and welfare and productivity factors have been established. The monitoring included climatic conditions, animal behavior indicators, cows' productivity and the installed equipment operation hours (fans), to check the energy consumption for cooling purposes. The results of this study can lead to contribute to the efficient methods to mitigate the heat stress of cows with low-cost energy systems, mostly passive methods, and techniques.

2. Materials and Methods

2.1 Experimental barn and measurements

The selected barn is in Kolchiko Lagkada, a region near Thessaloniki. The barn's characteristics can be seen in Table 1.

Table 1. Experimental barn description

Characteristic	Value
Barn dimensions and constructive elements	
Width	27.20 m
Length	103.60m
Ridge height	9.5m
Gutter height	4.85m
Surface	2817.92 m^2
Roof covering	Polyurethane panel
Equipment installed	Horizontal and roof fans to enhance ventilation
Location	
Coordinates	40°44'18.8"N 23°07'09.1"E
Farming details	
Livestock type	Holstein dairy cows
Number of animals	>300

The experimental period was from June 2020-September 2021. Even though the most critical period for dairy cattle is the summer, measurements were taken also during winter months. The parameters that were measured were temperature and relative humidity in 3 different positions in the barn. One of them was positioned at the north side, the second one at the south side and the last one at the center of the barn. Another sensor was installed outside the barn to measure the ambient environmental conditions (again temperature and relative humidity). The sensors that were used were (MX1101-HOBO Temperature/Relative Humidity Data Logger). The welfare parameters that were measured were time spend at the feedlot, resting minutes and heat. These three parameters were measured by collars information via an automatic system installed by the farmer, which in generally aims to supervise the behavior of animals and detect possible health issues (when time spend at the feedlot, or eating minutes are not in the proper level), while the heat indicates the periods when the cows are at their reproductive period. However, the signal that detects possible heat, comes from increased movement of the cow's head and in general increased activity. In this study it will be examined whether this can be affected by weather conditions and not caused by heat period.

Same for milk production there are data concerning the milk production for each cow for specific days as it is taken by milk measurements in the milk parlor id daily basis. Fans operation was also measured.

All the above data were taken for about 25 animals. Since the measurement period lasted almost 2,5 years, some of the animals were finally removed from the herd. So, 10 animals that remained the whole examined period will be studied. Among these animals four of them had also a special collar which provide information about rumination time. This information is very important since it provides a more specific view of the time that the animal spend on feeding compared to resting.

2.2 Data analysis and correlation

To correlate the examined data the daily average temperature and relative humidity were calculated which were initially taken every 15 minutes. Time spent at the feedlot, rumination time (4 animals) and milk productivity are measured also in a daily basis. As far as it concerns the heat- activity, this is given by a graph in an hourly basis. This data was transposed in variation of activity compared to the previous day. The fans operation were transposed in energy consumption taken into account the nominal power of the equipment installed.

The correlation between each of the above parameter was examined with the climatic conditions to realize whether they relate to the temperature and relative humidity and in which grade. The correlation uncertainty was considered to conclude in the most accurate results.

3. Results and discussion

According to the results of the above approach there is a clear correlation between weather conditions and some of the animal's welfare indicators such as time spend at the feedlot and milk productivity. Even if in some cases the heat relates to weather conditions, the fact that it is also depended in biological functions of the animals makes the outcome of a clear result more difficult for this parameter. The fans were operating most of the time, so it is obvious that the heat stress is very intense and artificial equipment needs to operate almost in a continuous function to retain the proper conditions inside the barn. This operation model is accompanied with energy consumption so low cost and easy to operate passive systems could lead to energy conservation.

Conclusions

This works provides important findings connected with climate change issues and the effect on livestock. Recommendation concerning low-cost energy systems and methods to mitigate the heat stress on dairy cattle are examined. The connection between animal welfare indicators and climate conditions can help on taking actions to mitigate inefficient feeding, increase milk productivity and as an extension reduce the operation cost of the barn. All the above contribute to less energy and resources consumption as the management and operation of the farm is performed more efficiently.

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Acknowledgments

The authors would like to acknowledge the European Union's **Horizon 2020 and STARGATE (reSilienT fARminG by Adaptive microclimaTe managEment (STARGATE) project (grant number no. 818187).) project** for funding the work and Kefalas brothers for allowing us to use their cow barn for experimental procedures.