Título: ANIMAL ACTIVITY TO IMPROVE THE WELFARE AND ENERGY AND PRODUCTIVE EFFICIENCIES IN INTENSIVE PRODUCTION BUILDINGS OF PIGLETS

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Resumen: Livestock sector is currently facing two great challenges: achieve a more environmentally friendly production and to ensure animal welfare in the building, taking into account the productivity. One of the most efficient ways of approaching such claims is through climate control system and environmental control. In this sense, and thanks to the development of Big Data and concepts such as Smart Farming, new mechanisms are emerging to be employed as an indispensable tool to achieve the objectives referred.

These new tools include new control algorithms of climate control system, which allows the inclusion of different variables. Among the huge variety of variables that could be employed inside a livestock farm, activity or animal behaviour is one of the more promising. The activity is able to integrate into a single variable, elements related to animal welfare as well as the air quality of the room.

In this thesis, submitted under the modality of compendium of publications, it is pursued to improve animal welfare and energy and production efficiency in weaned piglet farms. For this goal, the possibilities to integrate the animal activity in the incipient systems of predictive climate control are evaluated. During two breeding cycles, different environmental variables and variables related to animal were recorded in a room with weaned piglets from 6 to 20 kg of live weight. The 10-min averages of the measured values of 30 variables, at 1-s intervals, were stored in a data logger. Among these variables, highlight the temperature, humidity, carbon dioxide concentration (CO2), air velocity or animal activity.

In order to measure animal activity, a robust reliable and low cost measurement method was established. This method use passive infrared detectors. The validity of these measurements was checked by comparing them with a direct observation of the animals, by a qualified person. The registered values by both methods were on agreement, with values of Concordance Correlation Coefficient of 0.86 and Spearman Coefficient Correlation of 0.90. However, the accuracy was not constant; it was higher at the beginning of the cycle, when the animals were smaller. Afterwards, a spectral analysis of the complete series of activity was performed using the Fast Fourier Transform (FFT) and Continuous Wavelet Transform. This process confirmed the influence of the types of environmental and management factors on animal activity, such as light/dark periods or the distribution of food. In addition, it was established a range of sinusoidal equations
that define the activity of the piglets.

In general, during the cycle the animals showed two peaks of activity at 10:00 and 18:00 h, with a night rest period between 22:00 and 07:00 h. Nevertheless, during the first half of the cycle, a simpler behaviour pattern was detected, with a single peak of activity, mainly due to the less competition for space in the pen. Finally, these activity patterns were used in a hybrid model which combined The Discrete Wavelet Transform with Artificial Neural Network, so-called Wavelet-Neural Network. The results from this model, used for CO2 prediction in livestock buildings, predict the following value of concentration with a root mean square error of 154 ppm. In addition, a delay of almost one hour between the moment of activity and its response in the gas concentration was detected. Despite everything, the best predictive results were achieved by a model with an autoregressive character that used the past values of the own CO2 series, which is indicative of the high inertia of this variable in the room.

In conclusion, it was confirmed that the activity measurement system through passive infrared sensors is a reliable and economical method that allows registering animal behaviour patterns. These patterns, or own activity values, could be used in predictive models of indoor climate in order to achieve a more efficient control of climate control systems.