PhD School on Agriculture, Environment and Bioenergy

(http://sites.unimi.it/dottorato_aab/)

(XXXIV cycle, 2018-20)

Project draft

1. Field of interest

AGR/19

2.Project title

Precision livestock farming: innovation to improve health, welfare and performances in dairy cattle

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4. Relevance of the topic and state of the art:

Lombardy is one of the most important Italian regions for dairy productions; it produces approximately 41% of Italian cow milk (CLAL, 2018). The Lombardy dairy sector will be competitive in the international dairy market if they will be able to achieve high standards of efficiency and quality in the various stages of the production process. One factor that can significantly limit the efficiency of the production process at farm level is represented by animal welfare that is related to the state of health of the animals and influences the quantity and quality of their productions. Conditions of poor welfare can, in fact, result in an increase in pathological situations and a decrease in the productive and reproductive performances of cows. Conversely high levels of production are often associated with greater risks of diseases or stress; in fact, the genetic selection for the increase in production can alter the ability of the animal to adapt to the environment and favor pathologies of various kinds such as ketosis, mastitis, ovarian cysts, lameness (Oltenacu and Broom, 2010). Furthermore, highproduction cows are particularly sensitive to high temperature and humidity conditions mainly due to the intense production of metabolic heat (Berman, 2005). Housing, facilities and management methods have a considerable influence on the welfare and health conditions of the cows (Algers et al., 2009). As highlighted by Abeni and Bertoni (2009), characteristics, hygiene level and management of the rest area and litter, the availability of food and water, the microclimatic conditions and the animal density are factors that significantly influence the welfare and health of the cows, especially in intensive farms. In relation to the problem of heat stress in particular, it must also be considered that climate changes require adaptations of the structures and management of dairy farming to ensure an adequate level of animal welfare (Gauly et al., 2013). Heat stress in the dairy cows leads to a reduction in production and fertility with consequences on farm profitability but also on environmental sustainability. Effective tools to cope with these challenges have been provided by Precision Livestock Farming which is nowadays increasingly applied through the control of quali-quantitative parameters of production, behavior, and animal welfare, including real-time control of individual animal positions.

The project aims to study the relationship among housing facilities and management, environmental parameters, cow welfare, health and productive/reproductive performances in order to provide integrated solutions for real-time support in dairy farming optimization. Moreover the environmental sustainability of the solutions will be evaluated through Life

Cycle Assessment (LCA) methodology, one of the key approaches for the evaluation of the environmental sustainability of the agricultural sector.

5.Layout of the project (draft)

5.1. Materials & Methods:

A sample of 4 dairy cattle farms characterized by similar number of animals, similar production levels but different barn design and cooling systems will be identified. In the sample farms several parameters will be measured in the three periods during the year: cold, thermoneutral and hot periods, respectively.

In each period the microclimatic conditions in the barn, in the premilking waiting area and in the milking parlour will be continuously monitored: inside air temperature, humidity, air velocity and luminance.

In each farm during the monitoring periods the activities of the cows (standing, walking, feeding, ruminating or lying down) will be continuously recorded by using 3D accelerometers applied to a limb of 10 animals in the group of lactating cows. The same 10 animals will be monitored in terms of several physiological parameters as early indicators of heat stress: body temperature and rumen pH, using rumen boluses, heart rate and blood and urine parameters. The automatic recording of the activity of the 10 cows will be supported by time lapse photo recordings to register and classify the main activities (resting, feeding, drinking, etc.) of the whole group of lactating cows (one group of animals per farm will be selected).

On all the lactating cows of each farm, further measurements will be made to monitor key parameters indicative of cow welfare and health conditions: Body Condition Score, Locomotion Score (lameness indicator), milk production, milk composition (fat, protein and lactose percentages; urea; BHB), differential milk somatic cell count, feed intake (group level), reproductive performances.

The collected data will be used to develop a model for assessing the risk of reduced productivity in relation to the conditions of the animals and their environment. Data on the effect of heat stress measured within the 4 selected herds, will be used to determine the economic cost and the environmental impact for every degree or each point of thermal heat index above the optimum.

5.2.Schedule and major steps (3 years):

| Activities | 1 st year | | | | 2 nd year | | | | 3 rd year | | | |
|-------------------------|----------------------|---|---|---|----------------------|---|---|---|----------------------|---|---|---|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| Literature review | | | | | | | | | | | | |
| Identification of farms | | | | | | | | | | | | |
| Monitoring period | | | | | | | | | | | | |
| Data analysis | | | | | | | | | | | | |

6. Available funds (source and amount)

META - PSR Regione Lombardia OP. 1.2.01, P.I. A.Sandrucci, contributo UNIMI: € 137515,84 FORAGE4CLIMATE - LIFE15CCM/IT, P.I. UNIMI A.Sandrucci, contributo UNIMI: € 326712,00

6. Literature:

- Abeni, F., Bertoni, G. (2009). Main causes of poor welfare in intensively reared dairy cows. Italian Journal of Animal Science, 8 (suppl1), 45-66.
- Algers, B., Bertoni, G., Broom, D., Hartung, J., Lidfors, L., Metz, J., Rushen, J. (2009). Scientific report on the effects of farming systems on dairy cow welfare and disease1: Report of the Panel on Animal Health and Welfare (Question No EFSA-Q-2006-113).
- CLAL (2018) www.clal.it
- Gauly, M., Bollwein, H., Breves, G., Brügemann, K., Dänicke, S., Daş, G. Lohölter, M. (2013). Future consequences and challenges for dairy cow production systems arising from climate change in Central Europe—a review. Animal, 7(05), 843-859.
- Oltenacu, P. A., Broom, D. M. (2010). The impact of genetic selection for increased milk yield on the welfare of dairy cows. Animal welfare, 19(1), 39-49.

