UMR Herbivores
Performances of animals and herds Team (PERAQ)

Studying the robustness of dairy cows via modeling approaches to help selecting animals and compose herds with built-up resilience

The selection of robust animals capable of coping with environmental perturbations and adapting to changes in their management setup is a major challenge for the design of sustainable livestock systems that integrate the principles of agroecology. With the arrival of Luciano Mendes, we are developing a robustness index for dairy cows based on the analysis of the interactions between productive and functional traits in order to take into account the trade-offs (negative correlations and synergisms) between biological functions, which are likely to occur when animals are facing a constraint. This index can then be used to search for the most relevant animal combinations to increase herd resilience.

The design of low-input and resilient herbivorous systems relies in part on the selection of robust animals (Phocas et al., 2014), that is, animals able to maintain their life functions (growth, reproduction, lactation, health) in situations of perturbations (Friggens et al., 2017) and on the implementation of breeding practices that will allow us to play on the diversity of individual robustness in order to improve the herd’s ability to cope with system disturbances (Blanc et al., 2010). The work developed by Luciano Mendes at the animal level aims to 1/ propose a multi-trait-based method for evaluation of animal robustness, which is able to account for the priorities between life functions that are expressed when animals are submitted to constraints (Blanc et al., 2013), 2/ to describe the variability of individual robustnesses that can be observed within a herd, and 3/ to show if it is possible to predict the longevity of animals from the robustness profile that they express at the beginning of their productive career. These first works are building blocks to analyze and characterize the variability of individual robustness within a herd. They will then make it possible to reason, using simulation tools, the design of resilient herds by playing on the combination of the robustness of the individuals that compose them (Blanc et al., 2010). This work will thus contribute to the challenge 3 (#defi 3) of the strategic plan of the PHASE Department, titled “Diversity to increase the efficiency, robustness and resilience of livestock systems”.

Initially, the work consists of modeling dairy cow’s life functions, and is based on data from long-term experiments conducted with the herds from experimental units of INRA (Herbipôle). However, the realization of long-term experiments being expensive, one of the operational challenges of Luciano Mendes’ project is to develop modeling tools to analyze the robustness trajectories of different types of cows (by genetic potential, lactation number, physiological stage, breed) subjected to contrasting perturbation regimens (nature, frequency, amplitude) in order to study intra-herd diversity aspects that play a role on herd robustness.

We first built a database including 1162 lactations monitored from Holstein (n = 163), Montbéliarde (n = 200) and Tarentaise (n = 73) cows with measurements of traits that account for body weight, body reserves, health status, lactation and reproduction performances and forage and concentrate intake during the winter period. Then we developed a multi-trait framework for assessing robustness of dairy cows based on two main stages: a) For each of the traits selected to characterize the different functions of life (growth, lactation, reproduction, survival), calculate an elementary robustness indicator (dimensionless coefficient) that accounts for the relative deviation of the trait under a given constraint (e.g. nutritional), as compared to the value of the trait in normal situation; b) integration of all elementary indicators in a global index of robustness taking into account the interactions between functions (trade-offs). The next step is to validate the index of robustness on other data sets and to identify which combinations of functional traits (state of health, body reserves, etc) and productive traits (milk production, reproduction, live weight, etc) observed at first lactation allows us to predict at best the longevity of dairy cows in a low-input system.

This work will make it possible, on one hand, to propose robustness indicators for the selection of animals and, on the other hand, to quantify the gains of resilience that can be expected at the herd level by varying the diversity of the robustness of the individuals that compose it.

Publication / patent

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