UMR Herbivores

Team Feed, Digestion, Microbes Metabolism, and Nutrition (Dinamic)

Empirical modeling of the production of methane emitted by ruminants

In order to quantify and control the impacts of ruminant farming on climate change, at national and international level, our empirical modeling is based on the exploration by meta-analysis of experimental databases, thanks to various large-scale projects international. We have contributed to the improvement of greenhouse gas inventories both at the international level, with the publication of the IPCC (2019), and at the national level, with the development of a new INRA inventory methodology (Eugène et al., 2019). In addition, our work has shown that it is necessary to develop specific equations by country but also by animal category. The emission factors of this new methodology have been integrated into different models and applied to different scales of analysis, both spatial (individual, batch or herd) and temporal (day or year) giving close predictive performance.

Livestock systems face a major global challenge: meeting growing demand for animal products while limiting their environmental impacts and competition for resources for human consumption. It is therefore important, by subscribing to societal changes, to quantify and control the impacts of ruminant farming systems on climate change, at different scales ranging from animals to herds and from national territory to the continent.

At the international level, the IPCC inventories have been updated, thanks to the recent work of the team, based on the gathering and sharing of international databases (6000 data on individual animals). Studies carried out within the framework of a consortium of international research organizations (including our unit at INRAE) have shown that **region-specific enteric methane emission factors** are necessary to achieve the precision required for national inventories (Niu et al., 2018). UMR Herbivores evaluated the performance of methane prediction equations (Benaouda et al., 2019), from a large international database (3183 individual data, 103 in vivo studies, 3 species of ruminants). The specificity of the production systems of the regions considered lies, among other things, in the **level of feeding** of the animals and the **fodder system** (adequacy between the cropping system and the breeding system). We were thus able to conclude that it is necessary to develop specific equations by region but also by animal category. Finally, taking into account dietary strategies to reduce enteric methane, such as lipid supplementation, also improves inventories.

At the level of the French national inventory of enteric methane emissions and excretions (fecal and urinary) of ruminants, a new method has been developed (Eugène et al., 2019). This method aims to improve the accuracy of predictions, following international recommendations. The maximum level of precision can be reached when all the factors modulating methane emissions (enteric and manure) are known and can be taken into account: an accurate and complete description of the supply systems is required, and in particular the factors of energy conversion used to estimate the energy requirements of animals. The main improvement proposed by the new method lies in the use of a simple and robust equation (numerous regimes and data), based on the intake of digestible organic matter, which integrates the effects of digestive interaction and is predicted in a homogeneous manner and consistent between enteric methane and that from manure. In addition, using this same method, the evaluation of the quantities of livestock manure produced on a French livestock scale was carried out. Recent national GHG inventory include these results. In addition, this GHG inventory method can be applied to other countries.

As part of a new international project, predictions of enteric methane emissions and faecal (methane and nitrous oxide) and urinary (nitrous oxide) excretions will be made simultaneously from the same data source. This will reduce the uncertainty in the nitrous oxide predictions. Likewise, the impact of enteric methane reduction strategies on all of these two gases will be analysed. The contribution of stochastic statistical analysis methods will be evaluated in order to understand the effects of climatic hazards on ruminant regimes and therefore on the quality of predictions of GHG emissions, with a view to adapting to climate change.

Publications

Eugène, M., D. Sauvant, P. Nozière, D. Viallard, K. Oueslati, M. Lherm, E. Mathias, and M. Doreau. 2019. A new Tier 3 method to calculate methane emission inventory for ruminants. Journal of Environmental Management 231:982-988. https://doi.org/10.1016/j.jenvman.2018.10.086

Niu et al., 2018. Prediction of enteric methane production, yield, and intensity in dairy cattle using an intercontinental database. Global Change Biology 24(8):3368-3389. https://doi.org/ 10.1111/gcb.14094

Benaouda et al., 2019. Evaluation of the performance of existing mathematical models predicting enteric methane emissions from ruminants: animal categories and dietary mitigation strategies. Animal Feed Science and Technology: 114207. https://doi.org/10.1016/j.anifeedsci.2019.114207

Mansard, L., A. Vigan, M. Meuret, J. Lasseur, M. Benoit, P. Lecomte, and M. Eugène. 2018. An enteric methane emission calculator (DREEM) built to consider feed diversity: Case study of pastoral and sedentary farming systems. Small Ruminant Research 167:6-15. https://doi.org/ 10.1016/j.smallrumres.2018.07.024

Tibi, A., & Therond, O. (2018). Services écosystémiques fournis par les espaces agricoles. Evaluer et caractériser. Quae, 186p.

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