

## **A WHOLE FARM-MODEL TO SIMULATE THE ENVIRONMENTAL IMPACTS OF ANIMAL FARMING SYSTEM: MELODIE**

Chardon X.<sup>1,2,4</sup>, Rigolot C.<sup>1,2</sup>, Baratte C.<sup>1,2</sup>, Martin-Clouaire R.<sup>3</sup>, Rellier J.P.<sup>3</sup>, Raison C.<sup>4</sup>, Le Gall A.<sup>4</sup>, Dourmad J.Y.<sup>6</sup>, Poupa J.C.<sup>8</sup>, Delaby L.<sup>1,2</sup>, Morvan T.<sup>7,8</sup>, Leterme P.<sup>7,8</sup>, Paillat J.M.<sup>7,8,10</sup>, Espagnol S.<sup>5</sup>, and Faverdin P.<sup>1,2\*</sup>

1 INRA, UMR1080, Production du Lait, F-35590 St-Gilles, France

2 Agrocampus Ouest, UMR1080 Production du Lait, F-35000 Rennes, France

3 INRA, UR875 Biométrie et Intelligence Artificielle, 31326 Castanet-Tolosan, France

4 Institut de l'Elevage, F-35652 Le Rheu, France

5 IFIP, F-35651, Le Rheu, France

6 INRA, UMR1079, SENAH, F-35590, St-Gilles

7 INRA, UMR1069, SAS, F-35000, Rennes, France

8 Agrocampus Ouest, UMR1069 SAS, F-35000 Rennes, France

9 INRA, UMR1302 SMART, F-35000, Rennes, France

10 CIRAD, Unité Recyclage et risque, F-34398 Montpellier, France

\* corresponding author : Philippe FAVERDIN, INRA, UMRPL F-35590, St-Gilles, France.

Email : [philippe.faverdin@rennes.inra.fr](mailto:philippe.faverdin@rennes.inra.fr)

The ex-ante environmental evaluation of farming system is an increasing demand to propose new evolutions of animal farming systems. Modelling is a promising approach to reduce the cost and the delay to study the relationship between farming management and risky emissions. The simulation of impacts of alternative decisions is essential to better analyze ex-ante changes in farm management, but is rarely considered in environmental models.

MELODIE simulates the flows of carbon, nitrogen, phosphorus, copper, zinc and water within the whole animal pig and dairy farm over the long term. The model is structured according the ontology of agricultural production systems (Martin-Clouaire and Rellier, this meeting) to better represent the interactions between the biotechnical system and the decision system. MELODIE upscales dynamic models developed at the field or animal scale by considering the management of the whole farm system concurrently with the livestock farming system. The biotechnical module simulates the nutrient flows at a daily time step for each entity of the sub-models simulating soil/crop, animal and manure related processes. The decision module is organised through activity plans. MELODIE represents decisions at two time scales: every year, for drawing annual activity plans and every day for the context-dependant application of this plan. The plans are partly generated by a planning sub-model which is used annually to translate general objectives and constraints into crop and manure allocations to each plot. Due to the interactions between the biotechnical system and the decision system at different time scales, MELODIE is able to simulate adaptative evolution of livestock farming system under different long-term climate series. The goal is to study the emerging properties of the system. Besides, because the nutrient flows within the farm are dynamically simulated, it is possible to study both the spatial and temporal heterogeneity of the environmental impacts.

This approach enables a better understanding of variability in farming systems according to climate. Applied to nitrogen losses, it shows that the indicator "nitrogen farm surplus" varies greatly from year to year in mixed dairy farms and is poorly correlated to nitrate losses within years, but is a pertinent indicator of nitrate losses over several years.

MELODIE is intended for use in research, not as a decision support system for farm management. It is a framework for virtual experimentation on animal farming systems, and could be extended to deal with other issues than nutrient flows.