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From an individual-based model of pig fattening unit to a decision support tool

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Abstract: Pig livestock farming systems face economic (ECO) and environmental (ENV) issues. To cope with these issues and identify innovative strategies, different fattening pig production models have been developed so far. Most of them predict effects of nutrition on growth performance of an average pig (Pomar et al. 2003, van Milgen et al. 2008) without simulating effects of animal performance on associated ECO margin or ENV impacts. Few models associate ECO efficiency (Niemi et al. 2010) or nutrient excretion (Chardon et al. 2012) with farmers' strategies or consider variability in performance among individuals. Recent studies have highlighted the added value of individual-based models to quantify the effects of feeding practices on technical (TEC) and ENV performance of a group of pigs (Brossard et al. 2014, Pomar et al. 2003). We developed a pig fattening unit model able (i) to simulate individual performance of pigs including their variability in interaction with the farmer's practices and (ii) to evaluate the effects of these practices on the TEC, ECO and ENV performance. This fattening unit model is a discrete-event mechanistic model, stochastic for biological traits, with a one-day time step (Cadéro et al. 2017). Figure 1 represents the model and its adaptation as a decision support tool (DST). The pig fattening system articulates three entities: the pig herd, the farm management by the farmer, and the farm structure. Pigs are represented using an individual-based model adapted from the InraPorc model (van Milgen et al. 2008). This model simulates feed intake (FI), body protein and lipid depositions, and the resulting growth and nutrient excretion of each pig, on a daily basis. Each pig is attributed a profile which includes an initial weight and parameters corresponding to its FI and growth potentials, set to generate appropriately the structure of a population of pigs, according to Vautier et al. (2013). Farm management is represented by practices and a calendar of events containing tasks to perform. Each day the farmer receives information from the herd and the calendar of events, processes the events corresponding to the current day, and updates the calendar by adding or removing tasks. The practices include batch management, allocation of pigs to pens, feeding practices and slaughter shipping practices. Farm structure is represented by the number of fattening rooms. This model calculates TEC, ECO and ENV results for each fattening pig and globally for the unit. TEC and ECO results are based on the indicators of the technico-economical management (GTE) French database (IFIP, 2015). ENV impacts are calculated using Life Cycle Assessment, taking into account the impacts from the production of raw materials to the farm gate. ENV impacts of feed ingredients came from the ECOALIM dataset (Wilfart et al. 2016). We considered potential impacts of fattening pig unit on climate change, eutrophication potential, acidification potential, cumulative energy demand, and land occupation.

In order to test the usability of the model, a survey was performed on twenty-two pig farms from western France, with the collection of data on animal performance, batch and shipping management, and farming practices. The GTE indicators of TEC performance and the number of shipping per batch were available. The selected farms were representative of the range of farm management existing in France in terms of batch management, feeding practices, and size of fattening batches. Our objective was to calibrate the model inputs with the practices that each farm surveyed provided, and to compare the simulated TEC results with the observed ones. The final aim was to improve the knowledge for the use of the model as a DST. In a first step

we performed simulations using the same animal characteristics for all farms but with specific farming practices and building characteristics issued from the survey. In the second step, the initial weight of pigs and feeding plan was adapted for each farm. In the third step, animal characteristic for average FI was adjusted for each farm according to actual FI. The results indicated that each step improved the prediction with a reduction of both squared bias and non-unity slope between predicted and observed data. For instance, for feed conversion ratio (FCR) the residual standard deviation was reduced from 0.30 to 0.09 kg feed/ kg weight gain (i.e. from 11.0 to 3.3% of average FCR). It was concluded that using the model as a DST requires a calibration with a precise description of animal and building characteristics, and practices of the simulated farm. After calibration, the DST can be used to evaluate the effect of changes in farming practices on TEC performance, to assess ECO and ENV sustainability of the farm, and to propose improved farm management strategies. This tool will be implemented in the form of a web application in order to be accessible to farmer advisers.

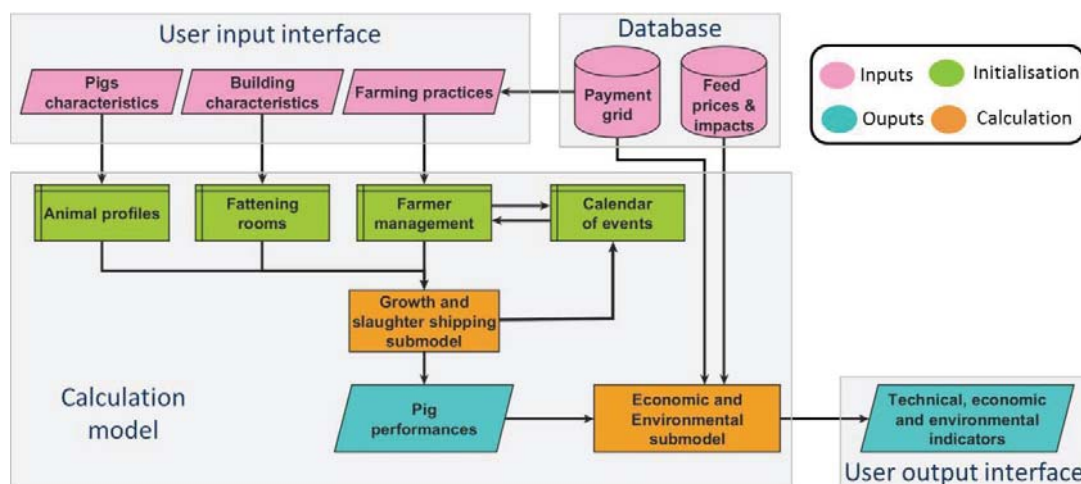


Figure 1. Description of the model and adaptation to a decision support tool

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