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ECO-FRIENDLY FEED FORMULATION AND ASSOCIATED ENVIRONMENTAL IMPACTS OF PIG PRODUCTION

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INTRODUCTION Livestock production significantly contributes to global environmental change through: greenhouse gas emissions, water pollution, soil acidification, and primary energy consumption, particularly in areas with high concentrations of livestock production. Environmental impacts of pig production mainly originated from feed production, direct farm energy use (electricity, gas and oil consumed) and emissions from housing and manure management (Basset-Mens et al., 2005; Reckmann et al., 2012). In particular, depending on production system, animal feeding accounts for 55 to 75% of impacts associated with climate change, 70 to 90% of those associated with energy use and 85 to 100% of those associated with land occupation (Dourmad et al., 2014). Therefore, there is a possibility to reduce environmental impacts by selecting feed ingredients with low impacts like alternative protein sources, as peas, faba beans or high-protein co-products (Wilfart et al., 2016). The traditional feed formulation is only based on feed cost and does not consider its environmental impacts. Including impacts of feed ingredients into the feed formulation problem has been proposed as a way to reduce the impacts of pig production. To this end, Garcia-Launay et al. (2018) developed a multi-objective (MO) formulation method based on environmental impacts of feed ingredients calculated by Life Cycle Assessment (LCA). The objective of this study was to test the ability of this innovative formulation methodology in growing pigs to reduce the environmental impacts of pig production. Additionally to the calculation of environmental impacts due to feed formulation, an integrated experimental evaluation of the diets on pig production performances was performed and the environmental impacts of the management of slurry was studied.

METHODOLOGY Two different formulation methodologies were compared: a formulation in accordance with practices in commercial farms (Control-diet) and MO formulation (Eco-diet). In the Control-diet formulation, only feed cost was minimized while in MO formulation (Garcia-Launay et al., 2018), the objective function included

global environmental impacts calculated through LCA, i.e. climate change (CC), non-renewable and fossil energy demand (NRE), acidification (AC), eutrophication (EU) and land occupation (LO). Twelve pigs (40 kg initial BW) were housed individually in metabolism cages equipped for feed and water intake measurement and separated collection of feces and urine, and fed one of the two diets (6 pigs per diet). After 14 days of adaptation to diet composition and housing conditions, the metabolism cages were placed in respiratory chambers for 7 d to measure feed and nutrient intake, and gaseous emission from animal (CO_2, CH_4, NH_3, N_2O) with a multigas analyzer (Innova model 1412). During the measurements in respiratory chamber, feces and urine were collected separately per pig for 4 subsequent days then slurries were reconstituted and subsequently analysed for pH, dry matter (DM), organic matter (OM), total nitrogen, total carbon and chemical oxygen demand.

RESULTS AND DISCUSSION In the Eco-diet, proportions of cereals and oilmeals decreased whereas those of alternative protein sources (peas, faba beans or high-protein co-products) increased, in comparison with the Control-diet. At feed level, the Eco-diet reduced CC, NRE, AC and EU impacts without modification on LO impact in comparison with the Control-diet. At animal level, we did not observe any effect of the dietary treatment on growth performance (daily gain, daily feed intake, feed conversion ratio) and on the gaseous emissions measured in respiratory chamber during 7 days (CO_2, CH_4, NH_3, N_2O). The daily amount of DM (230 g with the Control-diet vs 270 g with the Eco-diet) and OM (183 g with the Control-diet vs 218 g with the Eco-diet) excreted per pig per day were different between treatments leading to different chemical oxygen demand of slurry (114 g O_2/kg with the Control-diet vs 124 g O_2/kg with the Eco-diet). This higher OM excretion for the Eco-Diet results from its higher fibre content, with lower OM digestibility. This might contribute, depending on slurry management, to higher potential methane losses during storage or to increased energy production during anaerobic digestion, with contrasted effects on CC impact. However, in order to evaluate more precisely these effects the biomethane potential (BMP, L CH_4/g OM) remains to be measured.

Keywords: Environmental impacts, Feed ingredients, LCA life cycle assessment, Pig systems, Respiratory chambers, Manure management.

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