62. Best and worst pigs ranked on their environmental impacts are not the same in conventional and alternative systems: insights from an individual-based model

E. Janodet [a,b], H. Gilbert [a], L. Brossard [b], D. Renaudeau [b], F. Garcia-Launay [b]

[a] GenPhySE, Université de Toulouse, INRAE, ENVT, 31326 Castanet-Tolosan, France
[b] PEGASE, INRAE, Institut Agro, 35590 Saint-Gilles, France

Corresponding author: Florence Garcia-Launay. E-mail: florence.garcia-launay@inrae.fr

Introduction: In pig production, feeding strategies and genetic selection are main levers of improvement of the economic and environmental performances. Feeding strategies for reduced environmental footprint include the use of various least-cost opportunity feeds (LCOF), organic resources (ORG) and/or on-farm available resources (LOC) whereas genetic selection is made on pigs fed with conventional (CONV) feed ingredients with high net energy and digestible protein contents. Therefore, it is not clear whether the best pigs in conventional systems are still the best ones in systems using alternative feed ingredients. Life Cycle Assessment (LCA) is an internationally standardized method to evaluate the environmental impacts of agricultural products, considering all the resources and emissions associated to the production process from cradle-to-farm gate. The objective of this study was to characterize by simulations best and worst pigs on technical and environmental criteria using LCA, in a CONV and 3 alternative systems based on LCOF, ORG or LOC resources.
Material and methods: We developed a methodology to phenotype each individual pig via the evaluation of the environmental impacts obtained for a hypothetical pig production system where this pig is the average animal of the fattened population. Experimental data collected for 732 entire Large White males, further named EXP pigs, were used to adjust their growth profiles using InraPorc® software (InraPorc, 2006). Each individual EXP profile was used to generate 1000 individual profiles centered on this individual, leading to a virtual population. For each of these populations, growing and finishing feeds with CONV, ORG, LOC or a minimum of 50 % LCOF were least-cost formulated to cover the requirements of the average EXP pig. For each population, technical performances and economic evaluation were simulated with an individual-based model derived from Cadéro et al. (2018), and environmental evaluations per kg live body weight at farm gate were obtained through LCA based on these performances. They were averaged to assess the individual performance of each EXP pig. A principal component analysis was applied to environmental and economic performances, to identify their main drivers. Hierarchical clustering was used to group pigs with similar responses.
Results and discussion: Three clusters of pigs were distinguished. Cluster 1, with best environmental and economic performances whatever the system considered, combined low feed conversion ratios (FCR), high protein deposition (PD) potential and relatively low impacts-feeds in the CONV system. Cluster 2, characterized by high FCR and low PD potential, displayed intermediate or worst environmental performances in all systems, despite receiving relatively low-impact feeds. Cluster 3 had similar feed efficiency and economic performances as Cluster 1, but higher initial amino acid (AA) requirements during growth, resulting in relatively high-impact feeds in the CONV system, and an intermediate PD potential. Therefore Cluster 3 had worst climate change impact in the CONV system, but low to intermediate climate change impact in the alternative systems. In these systems, the range of feed impacts was reduced by the use of alternative ingredients, limiting the potential of differentiation of impacts based on feed formulae. For acidification impact, with lowest contribution of feed production, Cluster 3 had intermediate impact in the CONV and alternative systems, given its relatively good FCR.
Conclusion and implications: Contrary to previous studies, we show that pigs with lowest environmental impacts are not exactly the same in every systems and should not be identified solely on the basis of their feed efficiency, in particular in conventional systems. In that case, other pig characteristics, such as initial AA requirements and protein deposition potential, should be accounted for to lower the environmental impacts of pig production.
Acknowledgements: The authors acknowledge Alliance R&D for the experimental data used in this study.
Financial support: This study was part of a Ph.D. supported by INRAE and received no other specific grant from any funding agency, commercial or not-for-profit section.

References:

Cadéro, A., Aubry, A., Brossard, L., Dourmad, J.Y., Salaün, Y., Garcia-Launay, F., 2018. Modelling interactions between farmer practices and fattening pig performances with an individual-based model. Animal 12, 1277–1286. https://doi.org/10.1017/S1751731117002920.
InraPorc. 2006. A model and decision support tool for the nutrition of growing pigs. https://inraporc.inrae.fr/inraporc. INRA – UMR SENAH, Saint-Gilles, France.

doi: 10.1016/j.anscip.2025.07.309

63. Evaluation of enteric methane emissions from dairy cattle for spot sampling schemes using quantitative approaches

H.J. van Lingen [a], G. Foggi [b], A. Wang [b], M. Niu [b], S. van Gastelen [c], A. Bannink [c], J. Dijkstra [d], J.L. Ellis [a]

[a] Department of Animal Biosciences, University of Guelph, 50 Stone Road East, Guelph N1G 2W1, Canada
[b] Animal Nutrition Group, Department of Environmental Systems Science, ETH, Zurich 8092, Switzerland
[c] Livestock Research, Wageningen University & Research, PO Box 338, 6700 AH Wageningen, The Netherlands
[d] Animal Nutrition Group, Wageningen University, PO Box 338, 6700 AH Wageningen, The Netherlands

Corresponding author: Henk J. van Lingen. E-mail: hvanling@uoguelph.ca

Introduction: Measuring daily enteric methane (CH_4) emitted from dairy cattle using spot sampling, as applied in GreenFeed systems, requires accurate frequency and timing of gas collection. Measurement accuracy increases with sampling frequency (Lee et al., 2022),

and a minimum sampling frequency is particularly required for dairy cattle fed restrictedly (Van Lingen et al., 2023). The aim herein is to assess the accuracy of sampling schemes for dairy cattle enteric CH_4 emissions across various studies using simulation approaches.

Material and methods: Data were taken from five *in vivo* experiments in which CH_4 emission was measured for 72 h using climate respiration chambers with sampling intervals ≤ 15 min. Four experiments applied feeding at 80–95 % of *ad lib* twice daily and the fifth twice daily *ad lib* feeding. Per observation, smoothing splines were fitted to the CH_4 emission data using a penalized least squares objective function to control the wiggliness of the curve. The area under the curve (AUC) of the smoothing splines quantifies the daily CH_4 production. Next, to estimate daily CH_4 production from the fits, 5 different sampling schemes with and without error inclusion were applied, including sampling at 0.5, 1, and 2 h intervals starting at 0, 0 and 0.5 h from morning feeding, respectively (0.5_0.0, 1.0_0.0, 2.0_0.5), at 6 h intervals starting at 2 h from morning feeding (6.0_2.0), and at 1, 7 and 16 h from morning feeding (1.0 + 7.0 + 16.0). Further, raw data points were sampled using the 5 sampling schemes.

Results and discussion: Fitted smoothing splines commonly followed the data points showing the two post-prandial peaks per day (Fig. 1a), which indicated the applied penalty on the least squares was appropriate. CH_4 productions sampled from smoothing splines without error inclusion for the 0.5_0.0, 1.0_0.0, 2.0_0.5, 6.0_2.0 and 1.0 + 7.0 + 16.0 sampling schemes were not different from the AUC for 3, 3, 2, 0 and 0 out of the 4 restricted feeding datasets, respectively (*e.g.* Fig. 1b). Error-included smoothing spline sampling for the 5 sampling schemes had CH_4 productions not different from the AUC for 3, 3, 3, 2 and 0 out of these 4 datasets, respectively. For raw data sampling, this applied to 5, 5, 4, 4 and 1 of these 4 datasets, respectively. For the *ad lib* data, no sampling scheme differed from the AUC for all 3 procedures.

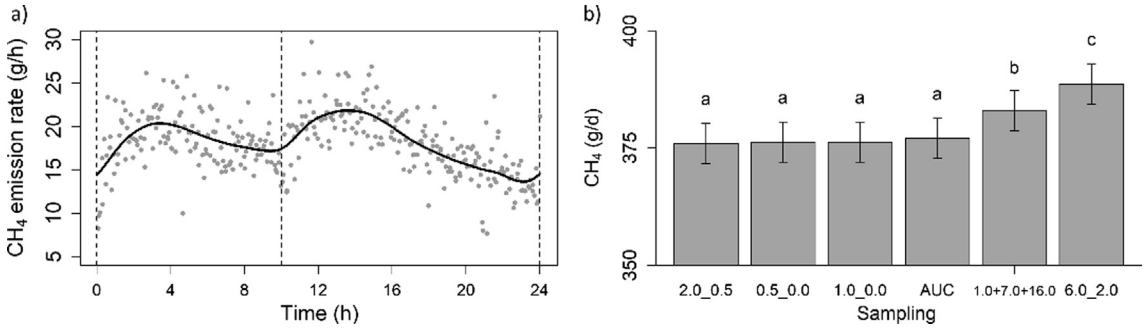

Fig. 1. a) Smoothing spline fit of CH_4 emission rates from morning feeding. Vertical dashed lines indicate feed delivery. b) CH_4 emissions computed from the AUC, by sampling every x.xh starting at y.yh from morning feeding (x.x_y.y), and at 1.0, 7.0, and 16.0h from morning feeding.

Conclusion and implications: CH_4 production different from the AUC occurred less with increasing sampling frequency. Error-included sampling from smoothing splines and raw data sampling, particularly, had more sampling schemes with CH_4 production not different from the AUC compared to smoothing splines sampling without error inclusion. Raw data sampling assesses the quality of the smoothing splines fits. Multiple draws of error-included sampling from smoothing splines decreases the standard error of the mean and may next mimic multiple days of GreenFeed gas spot sampling.

References:

Lee, C., Beauchemin, K.A., Dijkstra, J., Morris, D.L., Nichols, K., Kononoff, P.J., Vyas, D., 2022. Estimates of daily oxygen consumption, carbon dioxide and methane emissions, and heat production for beef and dairy cattle using spot gas sampling. Journal of Dairy Science 105, 9623–9638. https://doi.org/10.3168/jds.2022-22213.

Van Lingen, H.J., Fadel, J.G., Kebreab, E., Bannink, A., Dijkstra, J., van Gastelen, S., 2023. Smoothing spline assessment of accuracy of enteric hydrogen and methane production measurements from dairy cattle using various sampling schemes. Journal of Dairy Science 106, 6834–6848. https://doi.org/10.3168/jds.2022-23207.

doi: 10.1016/j.anscip.2025.07.310

64. Dynamics of enteric methane production during the first week of feeding an oil-encapsulated bromoform investigational veterinary product to beef steers

D.J. Innes [a], T. Gyeltshen [a], P.S. Alvarez-Hess [b], S. Jacques [b], M.J. Auldist [b], F.C. Cowley [a]

[a] School of Environmental and Rural Science, University of New England, Armidale, NSW 2351, Australia
[b] Rumin8 Pty Ltd, West Perth, WA 6005, Australia

Corresponding author: David Innes. E-mail: david.innes@une.edu.au

Introduction: Logistic model estimates showed that 95 % of the transition from baseline to suppressed enteric methane (CH_4) production occurred within 63 h of ruminal infusions of synthetic bromoform ($CHBr_3$), and 95 % of the return to baseline occurred within 109 h after infusion withdrawal (Muizelaar et al. 2024). In beef steers, we have previously shown a 94 % decrease in enteric CH_4 yield after feeding an oil-encapsulated bromoform (30 mg e$CHBr_3$/kg DM Rumin8 Pty Ltd, Australia) in a feedlot diet (Gyeltshen et al. 2025). We hypothesised that feeding e$CHBr_3$ to beef steers, rather than using ruminal infusions, would reduce CH_4 within 7 days, and the total reduction and speed of reduction would be dose dependent.