GENETIC PROGRESS SIGNIFICANTLY IMPACTS GREENHOUSE GAS EMISSION INTENSITIES IN GLOBAL PORK PRODUCTION

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I. INTRODUCTION

The environmental sustainability of food production systems, including net greenhouse gas (GHG) emissions, holds increasing significance in defining dietary recommendations. Therefore, to maintain a portion of animal-based foods in these recommendations, it's imperative to further mitigate the net GHG emission intensities from animal husbandry systems. Pigs, as monogastric animals, exhibit lower enteric methane (CH_4) production compared to ruminants. The primary sources of net GHG emissions in pig production systems stem from manure storage, encompassing nitrous oxide (N_2O) and CH_4, as well as feed production, which includes both N_2O and carbon dioxide (CO_2). Genetic selection has resulted in improvements in reproductive and growth performance while selecting for more robust animals to minimize mortalities. Genomic selection has assisted in improving the accuracy of these traits. Since the integration of genomic selection into the pig breeding program in 2014 [1], advancements in animal performance have been significantly augmented. The aim of this study was to determine whether a model based on Integrated Pollution Prevention and Control (IPCC) methodology could accurately represent the reductions in GHG emissions resulting from genetic advancements in pork production.

II. MATERIALS AND METHODS

The GHG estimates encompass various emissions components within pork production. These include enteric and manure storage CH_4, as well as direct and indirect N_2O emissions from pig-barns and manure (in buildings and storage). Additionally, emissions from feed production, whether domestic or imported, comprise estimates for direct and indirect N_2O emissions from both manure and synthetic fertilizer, soil carbon change (CO_2), and direct and indirect energy use (expressed as CO_2 equivalents (eq.). Furthermore, the GHG emissions intensity estimates encompass GHG emissions from the production process and transportation of purchased feeds, as well as GHG emissions resulting from direct energy use in pig-barns. All stages of the pig's life, including sow and replacement of gilts, are accounted for in the analysis. GHG emissions are standardized as CO_2 equivalents to consider the global warming potential of the respective gases over a 100-year time horizon: CH_4 kg × 25 + N_2O kg × 298 + CO_2 kg × 1 [2]. The IPCC methodology-based model has been crafted and integrated into a GHG calculator tailored for pig farmers [3]. Minor adjustments to this model enable the calculation of the impact of traits selected for within the genetic program. Genetic trends spanning from 2014 to 2023 were derived using genomic estimated selection values from selection candidates across four breeds, encompassing fourteen traits. The impact of these fourteen parameters on GHG emissions was evaluated based on their respective marginal economic value (MEV) concerning total feed consumption and the volume of manure produced.

III. RESULTS AND DISCUSSION

The model facilitated the estimation of impacts on net GHG emission intensities by leveraging available production data from pork production, as outlined in Table 1.

Table 1. GHG emissions presented with percentage distribution

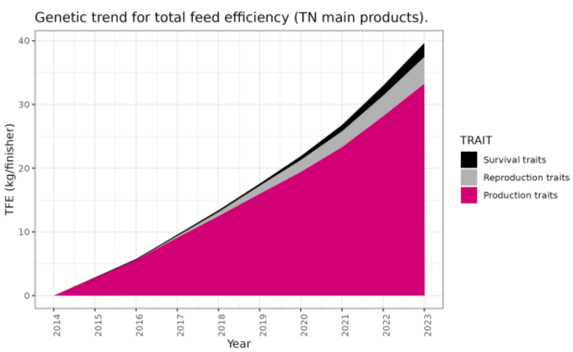
Sources and type of GHG emissions	Percentage distribution
Feeds	81%
Electricity and Transport	4%

Enteric CH_4	6%
Manure CH_4	5%
Manure N_2O	4%

In this study, we exclusively present the percentage distribution to emphasize that a substantial percentage (96%) of emissions from pigs to the farm gate originate from feed and manure. Emission levels vary among farms and countries [4]. Some nations have heightened emissions due to high-emission feed, while others may face significant emissions from manure management systems such as large lagoons. Nevertheless, in most cases, the combined influence of feed and manure governs emissions in pig production, directly impacted by the quantity of feed consumed and the efficient utilization of its nutrients, particularly nitrogen.

Among the parameters investigated, the feed conversion ratio (FCR) for finishers emerged as the most crucial. Further parameters were examined, and the fourteen parameters with the most significant effects include growth and feed intake in boar tests, drip loss, mothering ability, total born piglets, sow longevity, vitality, rear-to-finisher mortality, stillborn piglets, piglet growth, carcass yield, farrowing rate, interval between weaning and first insemination, and wean-to-rear mortality. These parameters are ordered based on the importance of the genetic progress of each trait on GHG emission intensities over the last nine years.

Figure 1 - The aggregation of 14 traits within the Topigs Norsvin selection program results in an enhancement of approximately 40 kg in total feed efficiency (TFE), leading to reduced feed consumption per finisher over a span of 9 years.



The effects of estimated genetic gain on total feed efficiency for the 14 parameters are depicted in Figure 1. Correspondingly, the improvements resulting from estimated genetic gain led to an annual reduction of 4.4 kg of total feed efficiency (TFE) per finisher. Considering a world average of 6 kg of CO_2 eq. per kilogram of carcass weight [4], this translates to a yearly reduction of 7.1 kg of CO_2 eq. per finisher.

IV. CONCLUSION

Over the past decade, genetic advancements have played a crucial role in reducing greenhouse gas emission intensities in global pork production. Feed and manure account for the largest impact on emissions and thus focus should be on traits like FCR to reduce emissions.

REFERENCES

1. Nordbø, Ø., et al. (2014). Genomic relationships improve prediction for selected traits in Norsvin Landrace and Duroc. *Proceedings of the 10th World Congress of Genetics Applied to Livestock Production*.
2. IPCC. (2007). Changes in atmospheric constituents and radiative forcing. In S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, & H. L. Miller (Eds.), *The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (p. 996). Cambridge, UK and New York: Cambridge University Press.
3. Bonesmo, H., & Enger, E. G. (2021). Effects of genetics and management on greenhouse gas emissions in Norwegian pork production. *Livestock Science, 254*, 104746.
4. Gerber, P. J., et al. (2013). Tackling climate change through livestock: A global assessment of emissions and mitigation opportunities. Food and Agriculture Organization of the United Nations (FAO).