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"Sustainable Pig Feed for the Future"
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The Global Feed LCA Institute: harmonized methodology and LCA database for sustainable feed production

(Topic 3: inventory methods and documentation)

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1. Introduction

The Global Feed LCA Institute (GFLI) is an independent, non-profit institute created by the feed sector to develop an Animal Nutrition Life Cycle Analysis database (a LCA database of feed materials) to make it possible for the feed and livestock sectors to calculate the environmental footprint of products in a transparent and trustworthy manner.

The GFLI database is made up of feed specific datasets calculated using a harmonized methodology based on FAO's Livestock Environmental Assessment and Performance (LEAP) partnership guidelines (on Animal Feed Supply Chains and later, on Feed Additives) and also aligned with the EU Product Environmental Footprint category rules (PEFCR Feed for Food Producing Animals). This alignment with the FAO-LEAP and EU-PEF guidelines for feed ensures the integrity and quality of GFLI's feed datasets.

The GFLI database makes it possible for the feed, livestock and aquaculture sectors to access robust, harmonized feed LCA data so they can work toward their sustainability goals:
In this way, GFLI represents the first step/a catalyst needed to encourage the production of feed with a lower footprint/tonne, and therefore, to produce food products with a lower footprint/kg (meat/farmed fish/dairy/egg).

2. Material and methods

The key note presentation details general information about the Institute and the database in a PowerPoint presentation. Key takeaways are:

- Mission and vision of the Institute; the GFLI envisions to become the global reference for feed emissions through LCA through its mission statements of providing a globally accessible, evolving animal feed ingredient Life Cycle Analysis (LCA) database, supporting compliant, credible, and transparent environmental assessment of animal feed ingredients and their role in the environmental footprint of animal derived products; and fostering continuous improvement of the environmental performance of animal derived products;
- The database covering ≥1,830 datasets of main feed ingredients from Europe, North America and Brazil in regional and sectoral averages, with a future inclusion of company-specific 'branded data';
- The role of the GFLI and the database for simplifying reporting duties, fulfilling scope 3 emission requirements, & harmonizing methodologies within the animal protein value chain, through the connections with stakeholders and finding pathways for partnerships;
- How to connect and participate with your own LCA journey through GFLI through GFLI's branded data. Validating companies own lifecycle assessment of their chain of custody through a rigorous methodology to accept primary data to benchmark own ingredients against the GFLI database and communicate validated data within the supply chain.

3. Conclusion

The GFLI stands for and by the feed industry to bring insights to the emissions related to animal feed ingredients, bringing a solution for high quality secondary datasets for the feed industry and downstream partners relying upon this data to make comprehensive assessments of feed and food products. Through the support of, currently 41, GFLI members, and the continuous discussions for partnerships with stakeholders and research institutes, the GFLI hopes to achieve its vision to be the reference for high-quality secondary LCA database as well as play a role in primary data sharing through an acknowledged and credible methodology.

4. Acknowledgements & references

Special thanks to SEGES Innovation, whom invited the Global Feed LCA Institute to speak at the Pig Research Summit 2024. More information about GFLI can be found on the GFLI website: www.globalfeedlca.org or in the online leaflet here: https://globalfeedlca.org/wp-content/uploads/2024/09/GFLI-Leaflet.onlineversion.pdf

O3-1

Beyond Feed PEFCR. The case of PEF-based Environmental Footprint of Soy Protein ingredients.

Authors and affiliation:
Practitioners of the study:
Waldemar Hemdrup and Julie Larsen, PEF experts, Charlotte Thy, Senior Product Developer, Bureau Veritas Solutions Denmark

Commissioners of the study:
Hans Jørn Holm, Global Sales Manager, Marianne Madsen, R&D Manager, TripleA

Introduction:
Soy protein is often an important part in compound pig feed, yet its environmental impact remains of critical concern. This abstract presents a comprehensive analysis of the environmental footprint associated with soy protein as a feed ingredient aiming at improving animal nutrition and gastric health. Employing the EU PEF methodology, the environmental impact across 16 distinct environmental footprint categories is evaluated. The system boundary is set to cradle-to-gate.

Material and Methods:
This study presents a thorough assessment of a Danish soy protein feed ingredient for both South American and European soy sources, using the PEF method. The PEF methodology is an LCA method set forth by the EU, with the aim to standardize the assessment method of products. The PEF methodology utilizes the so called PEFCR which sets down assumptions and methodological rules for the practitioner to follow for a specific product category. When a PEFCR doesn't exist the PEF-methodology must be applied. In this study the Feed PEFCR were used in combination with the PEF-methodology, as seen in Figure 1. It was possible to present the environmental impact of the studied products according to 16 environmental impact categories in a comparable way. This ensures a holistic representation of the environmental impact and helps to avoid burden shifting. As the product is an intermediate product, cradle-to-gate has been assessed. Data collection includes activity data from TripleA and their suppliers, and secondary EF 3.1 compliant datasets.

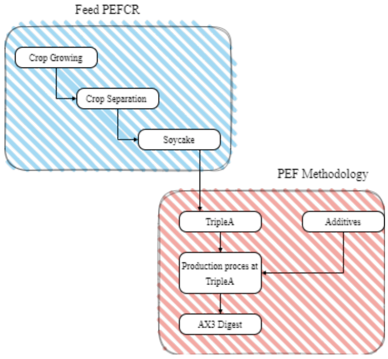

Figure 1 Application of the PEF methodology and the Feed PEFCR in the study.

Results and Discussion:
The study proves that it is relevant and possible to utilize the Feed PEFCR in combination with the PEF methodology to understand the environmental impact on products within the pig feed industry. The Global Warming Potential (GWP) results of the AX3 Digest GMO bulk, one of the TripleA products assessed in the study, is presented both with soybean meal (SBM) sourced from Brazil and EU in Figure 2.

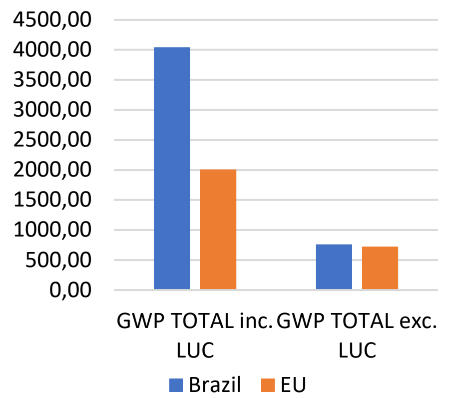

Figure 2 GWP results for AX3 Digest GMO bulk with SBM from Brazil and EU

The bulk freight of SBM from Brazil to DK is by ship and has an impact of less than 1%. Further it was found that around 95% of the impact of climate change was from the Raw material, and the remaining 5% comes from the stages Production, and End-of-Life treatment of packaging. The study further found that SBM produced in EU has a 50% lower impact when looking at GWP incl. Land Use Change (LUC), but a very limited difference when looking at GWP excl. LUC. This means that, when looking at GWP excl. LUC, the reduced environmental impact is very low, and other aspects, such as price, become a higher priority for TripleA and their customers.

TripleA's product AX3 Digest GMO has a very high protein content of 68% and a documented high protein digestibility. There is a need to not only address the environmental impact by mass, but also other relevant parameters such as protein and digestibility.

Conclusion and Implications:
This study shows a practical example of the PEF methodology used in the pig feed industry. It shows the developments a company can make in their quest to understand their environmental impact and improve this. This gives an understanding of how changes in the value chain will affect the environmental impact. With this study TripleA has established a baseline for their products. Triple A got valuable insights and documentation from the PEF-study. The baseline for the product outlining areas of improvements for future actions was established. Insights into the effect of soy sourcing were gained. Further the preference of the PEF-methodology for primary data allowed for taking regard of access to a low carbon energy source at the production site.

References:
1. PEFCR Feed for food-producing animals, Version 4.2, February 2020.
2. PEF/OEF 2021 Recommendations from the European Commission.
3. Larsen, J. M., & Hemdrup, W. C. (2023). Product Environmental Footprint PEF Report of AX3 Digest.

P3-1

A novel approach to understanding the vitamin D3 status of gilts globally using dried blood spot cards

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Introduction:

Gilt preparation is the foundation for securing the future of the valuable sow herd as well as its progeny, leading to more sustainable swine production. Strong and well-developed bones and joints, a robust and competent immune system and a well developed reproductive system are critical to a gilt's success. The importance of vitamin D3, specifically the active form, 1-25-dyhydroxyvitamin D3 for calcium metabolism and hence skeletal health, the function of the locomotory system and more recently the immune system are well known. The effects of vitamin D on physiological functions depend on the circulating plasma concentration achieved in swine however the vitamin D status of swine is rarely evaluated and therefore risks can go unseen. To overcome limitations around sampling, a new methodology has been developed with dried blood spot (DBS) cards that allows for quick and easy sampling on-farm combined with LC-MS/MS analysis for determination of circulating 25-OH-D3 levels and hence the ability to survey the vitamin D3 status of a broad population of gilts.

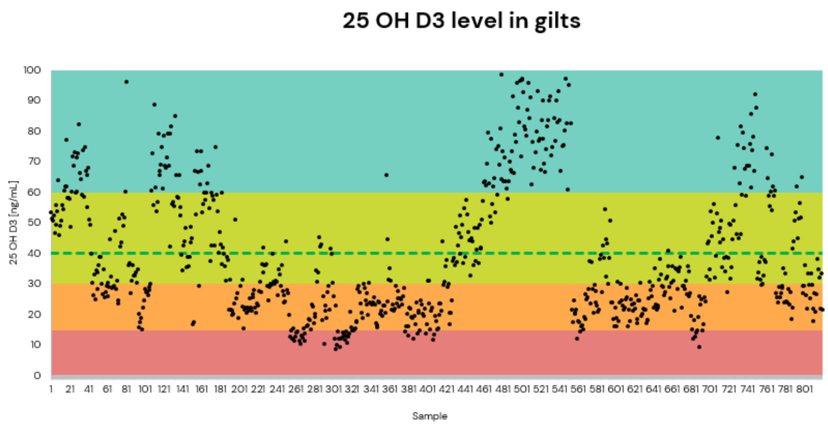
Material and methods:

A total of 883 gilts (111.4 ± 44 kg BW) from 47 farms across 14 countries were included in a survey to assess their vitamin D3 status. The geographical spread of this survey included animals from North America, Europe and Asia. A single drop of blood was collected from the ear vein of gilts and placed on a DBS collection card. The DBS card was allowed to dry at room temperature for 1 h before being placed in a sealed envelope and shipped to the lab for analysis. In addition, a third of the samples collected were via the traditional approach of plasma collection under the supervision of a veterinary. The samples were analysed for 25-OH-D3 concentration by using a validated DBS & plasma sample extraction method combined with LC-MS/MS analysis. The sample results were interpreted based on the dsm-firmenich vitamin D3 recommendations ranges for growing pigs for performance and muscle growth (references on request).

Results and discussion:

The average concentration of 25-OH-D3 for the population of gilts surveyed was 40.3 ng/mL but ranged from 8.8 ng/mL to 135 ng/mL. The cohort of gilts included animals that were fed vitamin D3 as the classical form of D3 as well as animals that received vitamin D3 in the form of 25-OH-D3 or a combination of both. Vitamin D3 levels in feed ranged from 800 to 4000 IU total vitamin D3. Only 21% of all gilts sampled were in the optimum vitamin D3 range to support immune competency and optimum reproductive performance (>60 ng/mL). 35% of the gilts had adequate circulating vitamin D3 levels to support Ca & P metabolism necessary for bone health (30-60 ng/mL). 39% of gilts had insufficient level to support bone health (20-30 ng/mL) and 5% of gilts had deficient circulating vitamin D_3 levels (<20 ng/mL) and are at risk of not being selected or premature culling due to lameness issues.

Figure 1. A survey of the vitamin D3 status of 883 gilts from 14 different countries based on circulating 25-OH-D3 concentrations in blood where each dot on the graph represents an individual gilt.



> 60 ng/ml	Optimum level that could trigger positive effects on immune competence, gilts selection rate, farrowing time and milk secretion
30–60 ng/ml	Adequate level for calcium and phosphorus metabolism and bone health
21–29 ng/ml	Insufficient level for calcium and phosphorus metabolism and bone health, with pigs at risk for bone disorders – e.g. reduced selection rate in gilts – prolonged farrowing time and milk release in sows. Insufficient for immune competence
<20 ng/ml	Deficient level for calcium and phosphorus metabolism – high probability of bone disorders e.g., rickets, osteomalacia, osteochondrosis – farrowing time, milk secretion and immune competence

Conclusion and implication

One of the main reasons for premature culling of sows is due to bone and joint issues resulting in lameness. This survey found that 44% of all gilts sampled had inadequate levels of vitamin D3 to support Ca and P metabolism and hence bone health. Similarly, 79% of all gilts tested had circulated levels of 25-OH-D3 that were lowering than the ideal level of above 60 ng/mL which ensures that the immune and reproductive functions are properly optimized. This survey has revealed for the first time the vast differences in vitamin D3 status of gilts across global, even within country and also highlighted the opportunity that exists to adapt the nutrition of gilts to improve their overall vitamin D3 status.

P3-2

Enhancing the sustainability of the pork industry via the dietary supplementation of a nutritional emulsifier

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Of the different livestock species, swine are responsible for 13.7% of the global greenhouse gas emissions (1). Life cycle assessments (LCA) of the pork production chain reported that feed production accounts, in average, for 46.5% of the industry's total carbon footprint (2). It is therefore critical to optimize the carbon footprint of feed production to enhance the sustainability of the pork industry. One way to limit the environmental impact of feed is by improving the efficiency of nutrient utilization. By supporting nutrient digestibility, animal protein production can be optimized by decreasing the use of feed raw materials. The inclusion of feed additives is therefore interesting to consider, especially nutritional emulsifiers as they can enhance nutrient (e.g. fat) digestion and absorption in the small intestine of animals. The objective of this study was to evaluate the impact of a nutritional emulsifier on the carbon footprint of the fattening pig industry.

In this study, a LCA was conducted with the SimaPro9 software (PRé Sustainability B.V.) and the databases of Agri-footprint 5.0 (Blonk Consultants), Ecoinvent 3.5 (ecoinvent) and Agribalyse (ADEME and INRAE). This LCA measured the environmental impact of a nutritional emulsifier (Excential Energy Plus, Orffa Additives B.V.) through the whole life cycle, from cradle-to-farm gate. The following cycle steps were included in this LCA: nutritional emulsifier production, feed production, feed processing, livestock production system, transport, energy and water consumption. The functional unit was defined as 1kg of pig live weight. Three trials, carried out in three different countries, were included in this study:

1) Commercial farm in Belgium: wheat-based diet, 2 treatments (control; nutritional emulsifier as top-dressing), 2 replicates/treatment, a total of 512 pigs, reared for 118 days until a live weight of 124 kg.
2) Commercial farm in the Philippines: corn-based diet, 3 treatments (control; energy-reduced diet with nutritional emulsifier; nutritional emulsifier as top-dressing), 6 replicates/treatment, a total of 270 pigs, reared for 63 days until a live weight of 94 kg.
3) Research facility (UNALM) in Peru: corn-based diet, 2 treatments (control; energy-reduced diet with nutritional emulsifier), 6 replicates/treatment, a total of 54 pigs, reared for 29 days until a live weight of 47 kg.

The ReCiPe 2016 method was selected to perform the life cycle impact assessment (LCIA) and included global warming potential (GWP), terrestrial acidification potential (TAP), freshwater eutrophication potential (FEP) and land use (LU).

For each of the 4 parameters of the LCIA for each experiment and each treatment, the difference (percentage increase or decrease), between the control and the treatments including the nutritional emulsifier, are outlined in Table 1. Within all experiments and with both application strategies, the supplementation of the nutritional emulsifier decreased the GWP. Similar results were observed for the TAP and FEP, except for the experiment in Peru. Reason is the replacement of soybean oil by corn through diet reformulation. With regards to TAP and FEP, corn scores are worse than soybean oil scores in the used databases. The LU was also reduced by the use of the nutritional emulsifier, except in the experiment carried out in the Philippines with an energy-reduced diet. This may be attributed to the poorer feed conversion ratio (2.49 and 2.44 for the treatment and control diets, respectively).

Impact categories		**Belgium – Top dressing**	**Philippines – Energy-reduced**	**Philippines – Top dressing**	**Peru – Energy-reduced**	**Average**
GWP	kg CO_2 equivalent	-1.81%	-3.79%	-4.73%	-2.73%	**-3.27%**
TAP	kg SO_2 equivalent	-0.98%	-0.05%	-1.73%	+0.30%	**-0.62%**
FEP	kg P equivalent	-2.43%	-1.19%	-4.19%	+0.08%	**-1.93%**
LU	m^2	-2.55%	+0.53%	-8.11%	-1.97%	**-3.03%**

Table 1 – Differences on environmental impact parameters between the treatments with or without a nutritional emulsifier.

Based on these experiments, the dietary supplementation of the nutritional emulsifier reduces the environmental impact of the pork production. For all trials, the global warming potential expressed as CO_2 eq/kg pork was reduced by 3.27% on average. The parameters related to acidification, eutrophication and land use depended on the feed efficiency of the animals and database of the raw materials used. For the 4 impact categories, the application of the additive in an energy-reduced diet was the most effective. In conclusion, a beneficial impact of the nutritional emulsifier on the LCA of swine was observed, which was in correspondence with former LCA for broilers and turkeys.

(1) The Food and Agriculture Organization of the United Nations. Global Livestock Environmental Assessment Model Version 3. 2022.

(2) Yang, P.; Yu, M.; Ma, X.; Deng, D. Carbon Footprint of the Pork Product Chain and Recent Advancements in Mitigation Strategies. Foods 2023, 12, 4203.

P3-3

LCA demonstrates that benzoic acid reduces the environmental impact of modern farming.

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Introduction:

Gaseous pollution due to ammonia (NH_3) generated by pig farms leads to environmental problems affecting air quality, the health of humans and animals and the neighborhood. Nutritional strategies, such as low protein and/or high fiber diets, are widely researched to reduce nitrogenous gas emissions. The dietary supplementation of benzoic acid (BA) at 1% has been recognized as a technique for decreasing ammonia emissions from pig farms (IRPP, 2017). Moreover, BA dietary inclusion at 0.3 and 0.5% have been associated with higher growth rates and better feed efficiency in pigs (Zhai *et al.*, 2017) which impacts positively the environmental footprint of pig production. The magnitude of impact can be evaluated by life cycle assessment (LCA), a standardized methodology (ISO 14040/44) that allows identification of environmental hotspots and comparison between systems. The objective of this study was to evaluate effects of incorporating 0.5 % BA in the diet of fatteners on zootechnical performance and to calculate the impact of this strategy on the environmental footprint using LCA.

Material and methods:

A total of 432 fattening pigs were used in 3 batches of 144 pigs (31±3.1 kg BW) per batch. For each batch, pigs were randomly placed into 2 identical rooms, containing 12 pens/room and 6 pigs/pen, and assigned to one of two treatments. Basal diets included corn, barley, wheat and sunflower meal as main ingredients and feed enzymes (phytase and xylanase). BA (VevoVitall®, dsm-firmenich) was included at 0.5%. A two-phase feeding was used including 14.4% CP (grower) and 13.1% CP (finisher). For each batch, zootechnical performance was recorded, gaseous emissions were measured continuously, and validation by mass balance. LCA was performed for the accumulated period of 3 batches, including the impact of feed production, housing and slurry management using an attributional approach. The results were given according to the 19 impact categories of the EU PEF methodology using Sustell™ LCA software (ISO: 14040/44)

Results and discussion:

Improvements in average daily gain (977 vs 944 g/d, $p < 0.001$) and feed conversion ratio (2.53 vs 2.63, $p < 0.001$) were detected between treatments. The incorporation of BA reduced NH_3 emissions by 17 % on average. Over the 19 environmental impact categories and after normalization, 5 categories, including Global Warming Potential (GWP100 — fossil, biogenic and land transformation), land use (LU), terrestrial eutrophication (TA), freshwater eutrophication (FE) and marine eutrophication (ME), were found to be the most relevant impact categories for this study. Feed production, animal inputs and emissions contributed similarly to climate change (GWP100) in both groups. However, the inclusion of BA in the diet helped to reduce by 2.4%, 3.3%, 11.3%, 3.0 and 4% in GWP100, LU, TA, FE and ME, respectively (Table 1), mainly through improved performance.

Table 1. Impact assessment per kg of LW for the 0.5% BA dietary inclusion vs control

LCA	Unit	Control	Control + BA 0.5%	Change %
Global Warming Potential - Climate change	Kg CO2 eq	2.61	2.55	-2.38
Land use	Pt	333.22	322.20	-3.31
Eutrophication, terrestrial	mol N eq	0.22	0.20	-11.31
Eutrophication, freshwater	Kg P eq	0.0008	0.0008	-2.97
Eutrophication, marine	Kg N eq	0.0176	0.0169	-4.04

Conclusion and implication

BA supplementation at 0.5% in fatteners diet and reduced ammonia emissions measured in farm and improved performance. Consequently, environmental impact was lower as demonstrated though LCA. This confirms that routine inclusion of BA into nutritional program is one of the best practices to mitigate the environmental impact of pig production.

References

IRPP, 2017. Best Available Techniques (BAT) reference document for the intensive rearing of poultry and swine. Industrial Emissions Directive 2010/75/EU

Zhai H., Ren W., Wang S., Wu J., Guggenbuhl P., Kluenter A-M., 2017. Growth performance of nursery and grower-finisher pigs fed diets supplemented with benzoic acid. Animal Nutrition 3:3, 232-235.