

Reducing climate change impacts from livestock farming:

Pork Industry



Summary

The pork industry is a significant contributor to global carbon emissions, climate change, water usage, waste generation, and biodiversity loss. However, there is hope for meaningful change. By working together and utilising data-driven simulations to test various scenarios across the value chain, we can identify the best solutions for a sustainable transition. These solutions must balance financial viability, animal welfare, and environmental impact.

This comprehensive white paper offers a clear guide through the challenges, strategies, and tactics needed to address these issues. Unibloom's platform transforms these insights into actionable plans, optimising your pathway to success. Through data-backed simulations, it ensures alignment on investment strategies, cost savings, and effective climate solutions across all departments, as well as with external partners and stakeholders. By collaborating through this approach, we can achieve the ambitious climate and business targets set for 2030—more affordably, efficiently, and effectively. Enjoy the reading and connect with us to learn more!

What you'll learn:



Climate: How pork production affects global carbon levels and natural resources.



Regulations: Agreements like the Paris 1.5C & commitments and regulations like Science Based Targets, CSDDD & CSRD push for lower emissions and climate actions.



Challenges: Intensive farming = high emissions, especially in major producers like China.



Solutions: Sustainable practices, investments and life cycle assessments (LCAs) are key.

Who will benefit:



Sustainability Action/ Project Leads



Innovation & Procurement Leads



Supply Chain Leads



Feed Suppliers & Suppliers of Energy and Equipment



Steps for a greener, financially viable Pork Industry



Better Feed:

Use LCA data to develop low-carbon and climate friendly feed.



Manure Management:

Advanced techniques to cut emissions.



Energy Efficiency:

Adopt energy-saving tech.



Sustainable Farming:

Boost productivity while reducing impact.



Stay Compliant:

Follow global and local emission rules.



Engage Locally:

Work with farmers and communities for a sustainable shift.



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Background: Climate change and the Pork Industry



The pork industry is recognised as a significant contributor to global carbon emissions due to various activities such as feed production, manure management, and energy use. **These activities collectively add to the industry's carbon footprint**, making it imperative to address these emissions to ensure environmental sustainability and compliance with regulatory demands.

Over the past two decades, considerable research and efforts have been directed towards understanding and mitigating the environmental impacts of pig production systems.

Livestock farming
accounts for

14.5%

of global total
anthropogenic
greenhouse gas
(GHG) emissions

Yutao Wang et al.

Journal of Cleaner Production

The global pork industry faces substantial challenges as it seeks to mitigate its impact on climate change. Public concern and media scrutiny over the environmental footprint of food production are intensifying. **Additionally, the industry is under increasing pressure to comply with domestic and international regulations aimed at reducing GHG emissions.**

Key international bodies, such as the United Nations Framework Convention on Climate Change (**UNFCCC**) and the Intergovernmental Panel on Climate Change (**IPCC**), alongside the European Union, have set ambitious climate targets for 2030, detailed in reports such as the “European Green Deal” and the “IPCC Special Report on Global Warming of 1.5°C.”





31%

The agri-food system was responsible for 31% (17 GtCO₂e) of global anthropogenic emissions

53%

53% of methane (CH₄)

78%

and 78% of nitrous oxide (N₂O)

Food and Agriculture
Organization

From the Kyoto Protocol to the Paris Agreement, a growing number of countries have pledged to binding CO₂ reduction targets, with the ultimate aim of limiting global warming to below 1.5–2.0°C above preindustrial levels. The transformation of agri-food systems is central to these climate action goals. According to the Food and Agriculture Organization (FAO), in 2019, **the agri-food system was responsible for 31% (17 GtCO₂e) of global anthropogenic emissions, 53% of methane (CH₄), and 78% of nitrous oxide (N₂O).**

This is largely driven by a growing global population and increased consumption of animal-sourced foods, which continue to elevate the demand for meat and exert pressure on climate targets. Specifically, **pork production contributed approximately 747 Mt of GHG emissions in 2021**, making it the second-largest contributor to global meat production emissions.

The rise in demand for pork has led to the prevalence of intensive farming practices, which account for about **61%** of global pork production due to their higher productivity and centralised management.

However, this shift from traditional household farming to intensive production can lead to increased GHG emissions, despite improvements in yield and management efficiency. For example, China, the world's largest pork producer, **consumes 42% of the world's pork, with around 75% of its pigs raised in intensive farms.**

**Pork production,
therefore, has a
significant environmental
footprint, contributing
approximately**

11%

**of the Chinese food
footprint excluding
feed emissions.**



The ambition to achieve net-zero emissions has driven countries to commit to sustainable intensification practices. Numerous efforts have been made using **life cycle assessment (LCA)** to quantify the potential environmental benefits and impacts of mitigation measures applied across the pork production supply chain.

These regulatory pressures coincide with natural changes affecting biophysical conditions, such as more frequent and severe weather events, which impact the stability and productivity of pig farming. The social implications are also significant, with these challenges directly affecting farmers, local businesses, and rural communities worldwide. As the pork industry adapts to these changes, it must balance environmental sustainability with economic viability to ensure a stable food supply and support for regional economies.

1.1 Importance

Focusing on the pig industry is crucial due to its significant contribution to GHG emissions. **In Table 1, the pig industry accounts for 13.7% of total livestock GHG emissions, making it the second-largest contributor after cattle.**

Table 1. The GHG emission contributions from different types of livestock

GHG Emissions (Tg CO₂ Equivalent/Year)

Species	CO ₂	CH ₄	N ₂ O	Total
Cattle	1029.35 (65.9%)	2300.46 (61.9%)	494.05 (54.0%)	3823.86 (61.8%)
Pig	369.83 (23.7%)	325.09 (8.8%)	152.22 (16.7%)	847.13 (13.7%)
Chicken	32.04 (2.1%)	424.86 (11.4%)	115.59 (12.6%)	572.49 (9.2%)
Buffalo	89.29 (5.7%)	329.53 (8.9%)	94.53 (10.3%)	513.35 (8.3%)
Goat	20.13 (1.3%)	173.07 (4.7%)	30.31 (3.3%)	223.50 (3.6%)
Sheep	22.02 (1.4%)	160.70 (4.3%)	27.44 (3.0%)	210.15 (3.4%)
Total	1562.66 (100%)	3713.70 (100%)	914.13 (100%)	6190.48 (100%)

Key sources of emissions within the pig industry include enteric fermentation, which contributes 33.2%, and manure management, which accounts for 28.5% of emissions (Table 2). Additionally, both direct and embedded on-farm energy use contribute **12% and 8.2%** respectively. By addressing these major sources of emissions, targeted strategies can be implemented to reduce the overall environmental impact of the pig industry, making it an important focus for mitigating climate change.

Table 2. The GHG emission sources from the global pig industry

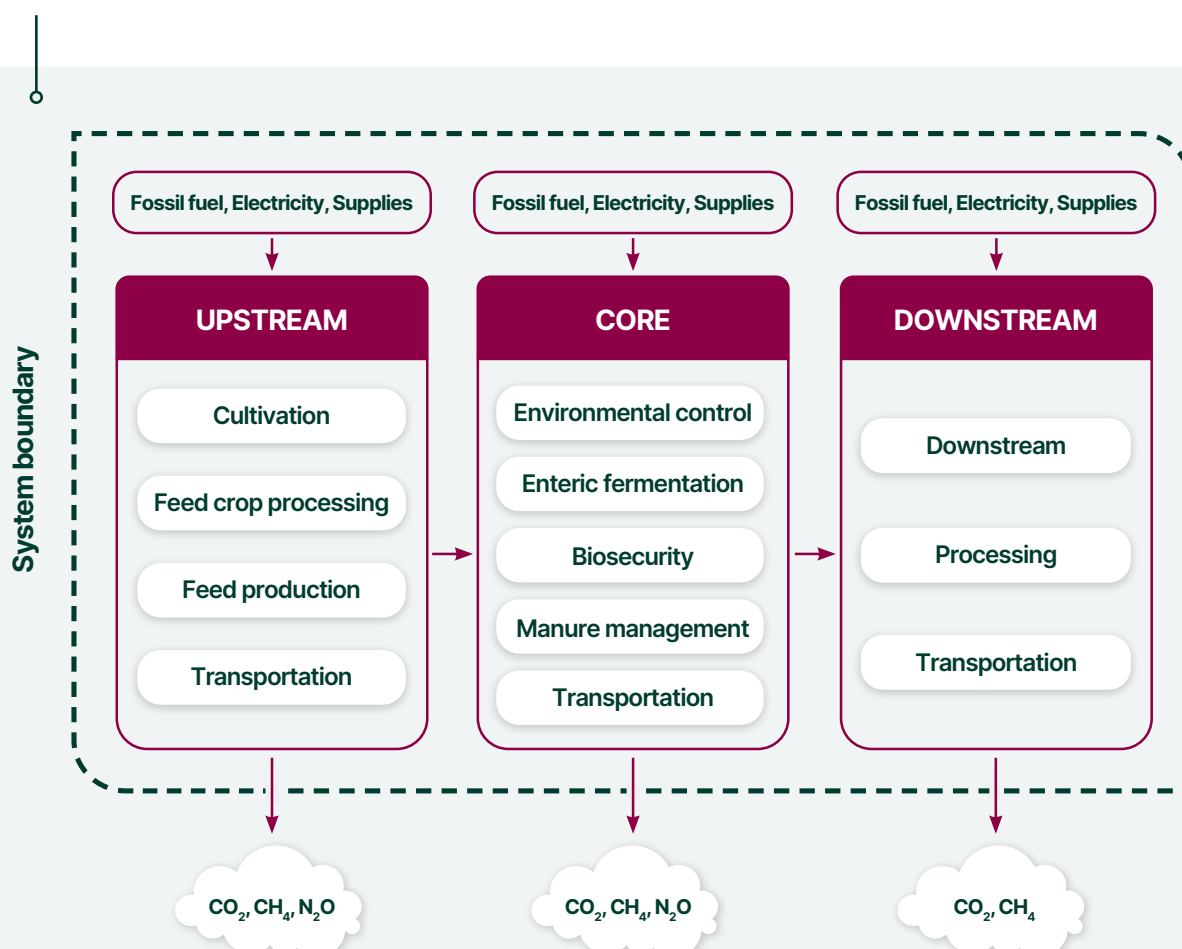
Item	Percentage	Emissions (Megagram)
Enteric fermentation (CO ₂)	33.2	281,072,770
Manure (N ₂ O)	28.5	241,017,553
Direct on farm energy (CO ₂)	12.0	101,792,650
Embedded on farm energy (CO ₂)	8.2	69,774,277
Feed (CH ₄)	6.0	50,422,302
Manure (CH ₄)	3.3	27,585,401
Land use (N ₂ O)	3.2	26,893,778
Feed (N ₂ O)	3.1	25,908,407
Post farm (CO ₂)	2.1	18,104,037
Feed (CO ₂)	0.5	4,549,406
Total	100	847,120,585

Addressing the emissions from pork production is crucial for mitigating climate change, ensuring sustainable agricultural practices, and meeting increasingly stringent regulatory requirements. **A study conducted on pig production systems in the UK over an 18-year period highlighted substantial reductions in environmental impacts due to advancements in animal performance and feed composition.** These improvements underscore the importance of continued innovation and implementation of best practices in reducing the carbon footprint of pork production.

1.2 Scope

This white paper aims to provide a comprehensive overview of the primary sources of GHG emissions in pork production and to present detailed strategies and practical guidelines for reducing these emissions (Fig. 1). Drawing on insights from recent research, including a LCA of British and EU countries pig production systems, the paper will cover advancements in **feed efficiency, sustainable manure management, energy efficiency improvements, breeding and genetic advancements, and carbon sequestration practices**. The goal is to equip pork producers, industry stakeholders, and policymakers with the knowledge and tools necessary to enhance sustainability and reduce the environmental impacts of pork production.

Figure 1. Overview of life cycle system of the pork production chain.



2

Main sources of GHG emission



2.1 Transportation

Transportation in this context involves three main stages.

Firstly, feed ingredients are transported from their point of origin to feed mills. Secondly, the processed feed is then transported from the feed mills to the farms. Lastly, pigs are transported from the farms to slaughterhouses.

Studies have highlighted that the transportation of feed ingredients is a notable source of GHG emissions within feed production, accounting for approximately 34% of the carbon footprint in this stage. Furthermore, the transportation of animals to slaughterhouses and the subsequent delivery of processed products to markets also significantly contribute to carbon emissions. For instance, research by Chen et al. calculated that the transportation segment in the pork supply chain in China accounts for **52.37%** of the GHG emissions across the entire supply chain.

The contribution of transportation to carbon emissions can vary widely depending on regional conditions and practices, ranging from **2.2% to 10%** of the total emissions in different contexts (Table 3).

Table 3. The contributions of different sources to the GHG emissions of the pork production chain.

Transportation	Feed Production	Pig Production	Enteric Production	Manure Management	Slaughtering
8.2%	42.6%	3.8%	3.1%	39.2%	-
-	46%	15.0%	5%	34%	-
2.2%	28.6%	2.7%	9.6%	56.9%	-
2.2%	27.8%	2.6%	9.3%	42.9%	-
5%	26%	17%	-	50%	-
10%	68%	11%	-	20%	-
10%	68%	14%	-	19%	-
-	68%	5%	4%	19%	7%

2.2 Feed production

The carbon footprint of feed production in the pork industry is significant, primarily due to the energy consumption involved from the cultivation of crops to the processing of feed.

The cultivation of feed crops contributes substantially to carbon emissions, mainly through the use of fossil fuels for seeds, pesticides, fertilisers, and agricultural machinery. **According to Zhou et al., the cultivation stage alone accounts for 66% of the total emissions in feed production.**

Feed processing also demands considerable energy, which includes electricity for various processes such as material reception, grinding, mixing, conditioning, pelleting, cooling, storage, and packaging.



**the cultivation stage
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66%

**of the total emissions
in feed production.**



The CO₂ emissions from feed processing alone amount to approximately

9.03 Tg
annually

Fang et al.

*Environmental Impacts Assessment of
Large-scale Multi-floor Pig Farming Systems*

Each of these stages involves specific equipment and machinery that consume electricity, indirectly leading to CO₂ emissions. The emission coefficient varies depending on factors such as fuel type, electricity sources, and production efficiency.

For example, Fang et al. reported that processing **1000 kg** of pig feed generates **28.03 kg** of CO₂. Given the global production of **322 Tg** of pig feed per year, the CO₂ emissions from feed processing alone amount to approximately **9.03 Tg** annually.

The energy consumption for feed production and processing represents a major portion of the total energy use in pork production, exceeding **50%** as noted in some studies. Overall, the contribution of feed production to the carbon footprint in the pork industry ranges from **26%** to **68%**, highlighting the significant potential for carbon mitigation in this area (Table 3).

2.3 Pig production

Paris et al. highlighted that

50%

of the energy required to produce 1 kg of pork is related to electricity consumption on pig farms.



The modern pig industry is characterised by intensive and automated production systems, which include automatic feeding management and environmental control. These systems involve feed transport, automatic feeding, ventilation, insulation, and heating in pig houses, all of which consume substantial amounts of electricity.

Additionally, lighting systems, especially the provision of 16 hours of lighting for sows to promote oestrus, contribute to energy consumption. Although the electricity used for lighting is relatively low compared to the total electricity consumption, it is still a noteworthy factor when calculating the carbon emissions of the entire pig production chain.

Paris et al. highlighted that 50% of the energy required to produce 1 kg of pork is related to electricity consumption on pig farms.

Pig production also involves various consumables, such as medications, cleaning supplies, personal protective equipment, maintenance items, vaccinations, and semen collection supplies. The production and transportation of medications, which include vaccines, immune enhancers, and treatment drugs, consume energy and contribute to GHG emissions. Maintaining cleanliness and hygiene in pig pens requires disinfectants and detergents, whose production and transportation also lead to carbon emissions.

The maintenance of pens and electrical equipment further adds to energy use and carbon footprints, which can vary significantly depending on regional differences, environmental conditions, and management practices.

According to available data, the contribution of the pig production sector to emissions ranges from 2.6% to 17.0% (Table 3).

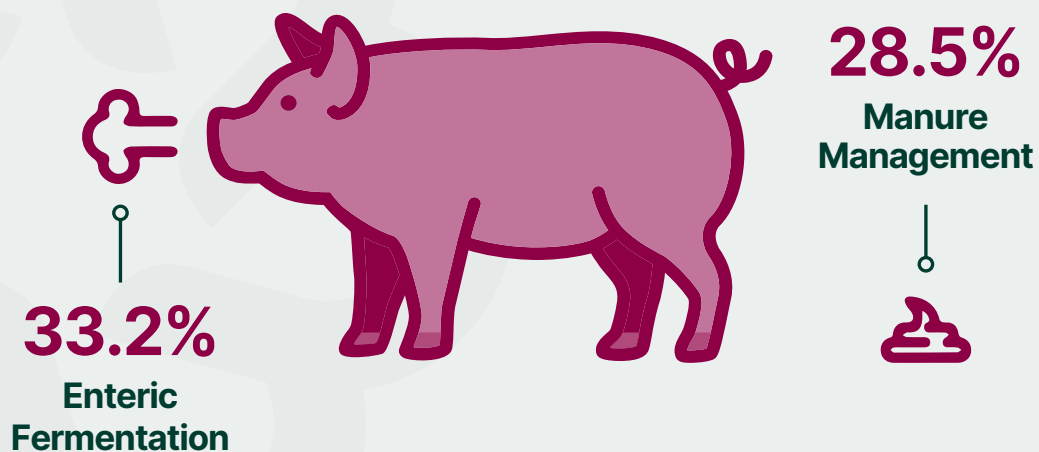


2.4 Enteric fermentation

Enteric fermentation is a natural digestive process in pigs and other livestock that contributes significantly to GHG emissions, particularly CH_4 . This process involves the breakdown of organic matter in the digestive system by microorganisms, producing gases such as CH_4 , CO_2 , and H_2 as by-products.

In pigs, methane-producing bacteria in the intestines convert CO_2 and H_2 into CH_4 . This methane production is closely related to the animal's growth stages and the dietary fibre content of their feed. As pigs grow and their diet changes, the amount of methane they produce can vary significantly. For example, growing pigs on a standard diet can emit between **0.2% to 0.5%** of their gross energy intake as methane, translating to approximately **3.4 litres** of methane per day for an average slaughter pig.

Sources of Pig GHG emissions (Table 2)



In the USA enteric fermentation from swine contributes to around

21
MILLION

metric tonnes
(MMT) of
CO₂ equivalent
emissions annually.

Globally, the contribution of CH₄ emissions from enteric fermentation in pigs is substantial. Although it is generally lower compared to ruminants like cattle, it still plays a crucial role in the overall carbon footprint of pig production. In the United States, for instance, enteric fermentation from swine contributes to around **21 million metric tonnes (MMT) of CO₂ equivalent emissions annually, which includes emissions from manure management.**

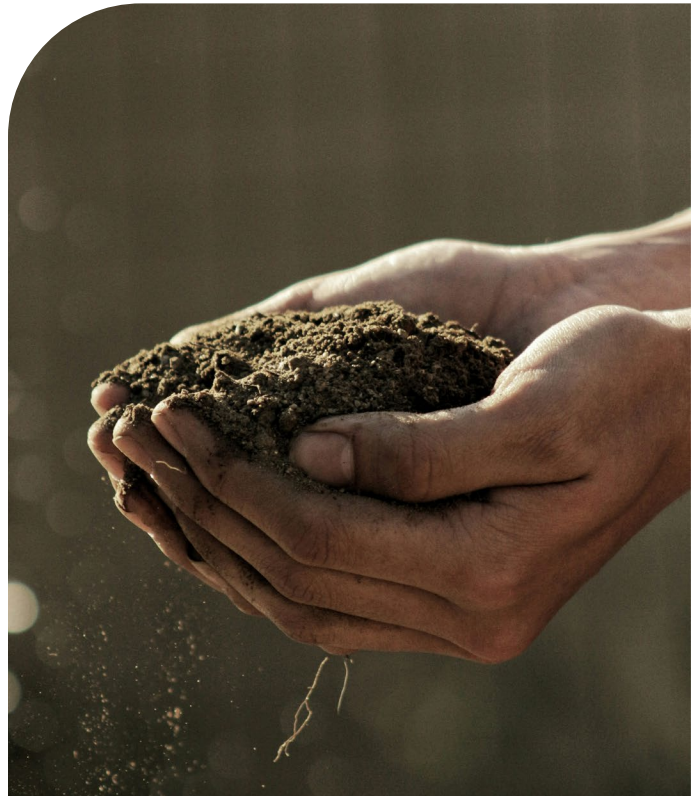
Addressing methane emissions from enteric fermentation in pigs involves various strategies, such as dietary modifications to reduce fibre content and enhance feed efficiency, which can help lower methane production. These strategies are crucial for mitigating the environmental impact of pig production and achieving more sustainable livestock farming practices.



2.5 Manure management

The management of pig manure significantly contributes to GHG emissions, primarily CH_4 . The process starts with microbial activities that decompose organic matter into volatile fatty acids, CO_2 , and H_2 . This microbial activity generates heat, creating an optimal environment for methanogenic bacteria to convert acetate, CO_2 , and H_2 into methane under thermophilic conditions.

Studies have shown that carbon emissions from pig manure during composting are particularly high compared to other livestock and poultry manure. **Factors such as the materials used for composting, the initial carbon-to-nitrogen ratio (C/N), moisture content, and ventilation rate all influence GHG emissions from manure management.**



It is estimated that pig manure management can produce around 18 g/ CH_4 /day per pig using machine learning algorithms to model emissions accurately.



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Manure management practices, such as anaerobic digestion, can significantly mitigate methane emissions. In the United States, various anaerobic digestion systems are employed, with covered lagoons being the most popular, processing manure from nearly 400,000 hogs at over 20 sites. These systems help capture CH₄, which can then be flared or used to generate renewable energy, reducing overall emissions.

However, economic barriers remain, as implementing anaerobic digestion systems often requires significant capital investment and changes to existing manure management practices. Lastly, **the contribution of manure management to the overall GHG emissions of the pork production chain varies widely, ranging from 19.0% to 56.9% (Table 3), depending on the specific management practices and regional conditions.**

2.6 Wastewater

The wastewater management process in pig production involves several steps, each with specific machinery and energy consumption requirements that contribute to GHG emissions.



First step: Filtration via grid system

The initial step in wastewater management involves a grid system that removes solids and floating particles from the wastewater. This step primarily consumes energy through the machinery used for filtration. The efficiency of this process is critical to reducing the load on subsequent treatment stages.



Second step: Collection system

In the second step, a collection system balances the wastewater and adjusts its volume. The main energy consumption in this step comes from mixers that homogenise the wastewater, ensuring consistent treatment in the following stages.



Third step: Solid-liquid separation system

This stage involves separating solid faeces from the liquid component through filtration and screw pressing. The solid-liquid separator is the primary energy consumer here, as it performs the mechanical separation needed to reduce the volume of solids in the wastewater. The anaerobic system process employs anaerobic bacteria to ferment dissolved organic carbon (DOC) in the wastewater. During this process, DOC is hydrolysed, producing CH_4 and removing organic matter from the wastewater. This stage is crucial for reducing the organic load and generating biogas, which can be captured and utilised as an energy source.



Final step: Further degradation

The final treatment stage involves aerobic processes to further degrade organic pollutants and provide denitrification and phosphorus removal, thereby improving the quality of the effluent to meet discharge standards. This stage consumes significant electricity, particularly through the use of water pumps, circulation pumps, and blowers that ensure adequate oxygenation and mixing.



2.7 Slaughtering



Studies have shown that the carbon footprint of pig production varies from

0.6

to

6.75 kg

CO₂e per kg of pig live weight.

The carbon footprint of the pig slaughtering process, although often less discussed, is a significant contributor to overall GHG emissions in pig production (Table 3). Studies have shown that the carbon footprint of pig production varies from 0.6 to 6.75 kg CO₂e per kg of pig live weight.

Slaughtering and processing require substantial energy for refrigeration, ventilation, heating, and equipment operation, which all contribute to carbon emissions.

Additionally, these operations use large amounts of water for cleaning, sanitation, and processing, further adding to the carbon footprint through energy consumption for water heating and wastewater treatment.

Refrigeration and cold storage, essential for maintaining meat quality, consume significant amounts of electricity, leading to additional CO₂ emissions. In China, for instance, it was reported that slaughtering and processing pork consume approximately **81.2 kWh** of energy and produce **22.08 kg** of CH₄ emissions per **1000 kg** of carcass weight. This underscores the importance of employing energy-efficient technologies and low-energy refrigerants to reduce emissions.

The carbon footprint associated with slaughterhouse operations and meat processing can vary widely depending on the energy sources, waste management practices, and processing techniques employed.

According to Wei et al., the carbon footprint of pork is about **3.8 kg** CO₂e per kg, with slaughtering contributing approximately **7%** to the overall emissions of the pork production chain. Different pork products also have varying environmental impacts, with one serving of pork cuts (1 kg) equating to **2.25 to 4.52 kg** CO₂e.

According to Wei et al., the carbon footprint of pork is about 3.8kg CO₂e per kg, with slaughtering contributing approximately 7% to the overall emissions of the pork production chain



3 Mitigating GHG emissions

3.1 Transportation

One effective strategy is optimising transportation routes to ensure the shortest and most efficient paths are used. By doing so, the distance travelled by vehicles is minimised, which in turn reduces fuel consumption and emissions. **Studies have shown that optimising routes can decrease GHG emissions by 13% to 18% at this stage.**



Adopting fuel-efficient vehicles is another key strategy. These vehicles are designed to use less fuel per kilometre travelled, thus reducing the overall carbon footprint. Electric vehicles (EVs) or hybrid vehicles offer even greater potential for emissions reductions, as they produce fewer GHGs compared to conventional diesel or petrol vehicles.



Combining the transportation of feed ingredients, live pigs, and processed products can streamline logistics and enhance efficiency.

Consolidating shipments to ensure that vehicles are fully loaded can also significantly reduce emissions. This practice reduces the number of trips required, thereby cutting down on fuel consumption and associated emissions. For example, combining the transportation of feed ingredients, live pigs, and processed products can streamline logistics and enhance efficiency. Where feasible, reducing the distances that goods and animals need to be transported can have a substantial impact.

Establishing regional slaughterhouses and processing facilities closer to farms can minimise the distance that pigs need to be transported, thus reducing emissions. Similarly, sourcing feed ingredients locally can also lower transportation-related emissions. Policy measures and technological advancements play a crucial role in supporting these strategies. Governments can provide incentives for the adoption of fuel-efficient and electric vehicles, as well as for the development of localised supply chains. Technological innovations, such as advanced logistics software, can help optimise route planning and shipment consolidation, further enhancing efficiency.

3.2 Feed production

As a result, GHG emissions during the cultivation phase can be lowered by

13%

to

22%

Reducing the use of synthetic nitrogen fertilisers, optimising fertiliser management, and increasing the rotation of leguminous crops can effectively lower GHG emissions. Leguminous crops, which biologically fix nitrogen, can reduce the need for synthetic fertilisers, thereby decreasing CO₂, N₂O, and NH₃ emissions associated with fertiliser manufacture, transport, and application.

Different feedstock materials have varying carbon footprints due to differences in cultivation practices. Optimising nitrogen fertiliser application rates by using the best estimate for an economic optimum nitrogen rate, growing crops with lower nitrogen requirements, and ensuring accurate application, such as calibrating application machinery, can improve efficiency and reduce nitrogen fertiliser use.

Implementing precision fertilisation and efficient irrigation management can reduce the input of chemical fertilisers during the cultivation of forage crops, leading to increased crop yields and diminished losses of reactive nitrogen. **As a result, GHG emissions during the cultivation phase can be lowered by 13% to 22%.**





Nitrification inhibitors can slow the microbial conversion of ammonium-N to nitrate-N, reducing the risk of nitrogen loss through leaching or denitrification, and thus increasing the nitrogen-use efficiency of fertilisers. **Research has shown that using nitrification inhibitors and urease inhibitors not only reduces NH_3 and N_2O emissions but also lowers the extent of nitrogen leaching to the surface and groundwater.**

Research has shown that using nitrification inhibitors and urease inhibitors not only reduces NH_3 and N_2O emissions but also lowers the extent of nitrogen leaching to the surface and groundwater.

For instance, inhibitors such as dicyandiamide and N-(n-butyl) thiophosphoric triamide significantly reduce N_2O emissions when applied in combination with ammonium nitrate and urea fertilisers.

Adopting sustainable farming practices can also effectively mitigate carbon emissions during feed production. Organic agriculture can enhance soil organic carbon content, reduce chemical usage, and safeguard agricultural ecosystems, thereby efficiently sequestering carbon and reducing emissions.

Establishing an ecosystem-friendly crop planting structure can further contribute to emission reduction. For example, increasing the cultivation areas of wheat, sorghum, soybeans, and vegetables has been shown to lower emissions, while expanding the cultivation areas of rice, maize, and peanuts can elevate emissions.

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3.3 Renewable energy

Renewable energy sources, such as solar, wind, and geothermal energy, provide a sustainable alternative to fossil fuels like coal, oil, and natural gas, which are primary contributors to carbon emissions. Among these, solar energy is particularly compatible with agricultural production activities, including pig farming.

However, the high initial costs associated with solar-powered operations, particularly for the installation of panels and related infrastructure, pose a challenge. Reducing the costs of sensors and control units for solar energy conversion can mitigate this issue considerably, making solar energy a more viable option.

Installing energy-efficient heating equipment and utilising geothermal or other renewable energy sources for heating can contribute to reducing the carbon footprint of pig farming operations.

Proper insulation in pig pens during the colder autumn and winter months can also prevent heat loss, thereby reducing the need for electricity and fossil fuels for heating. This measure alone can result in significant energy savings and lower emissions. Additionally, upgrading equipment and replacing outdated devices with energy-saving alternatives can enhance energy efficiency. For instance, installing energy-efficient heating equipment and utilising geothermal or other renewable energy sources for heating can contribute to reducing the carbon footprint of pig farming operations.



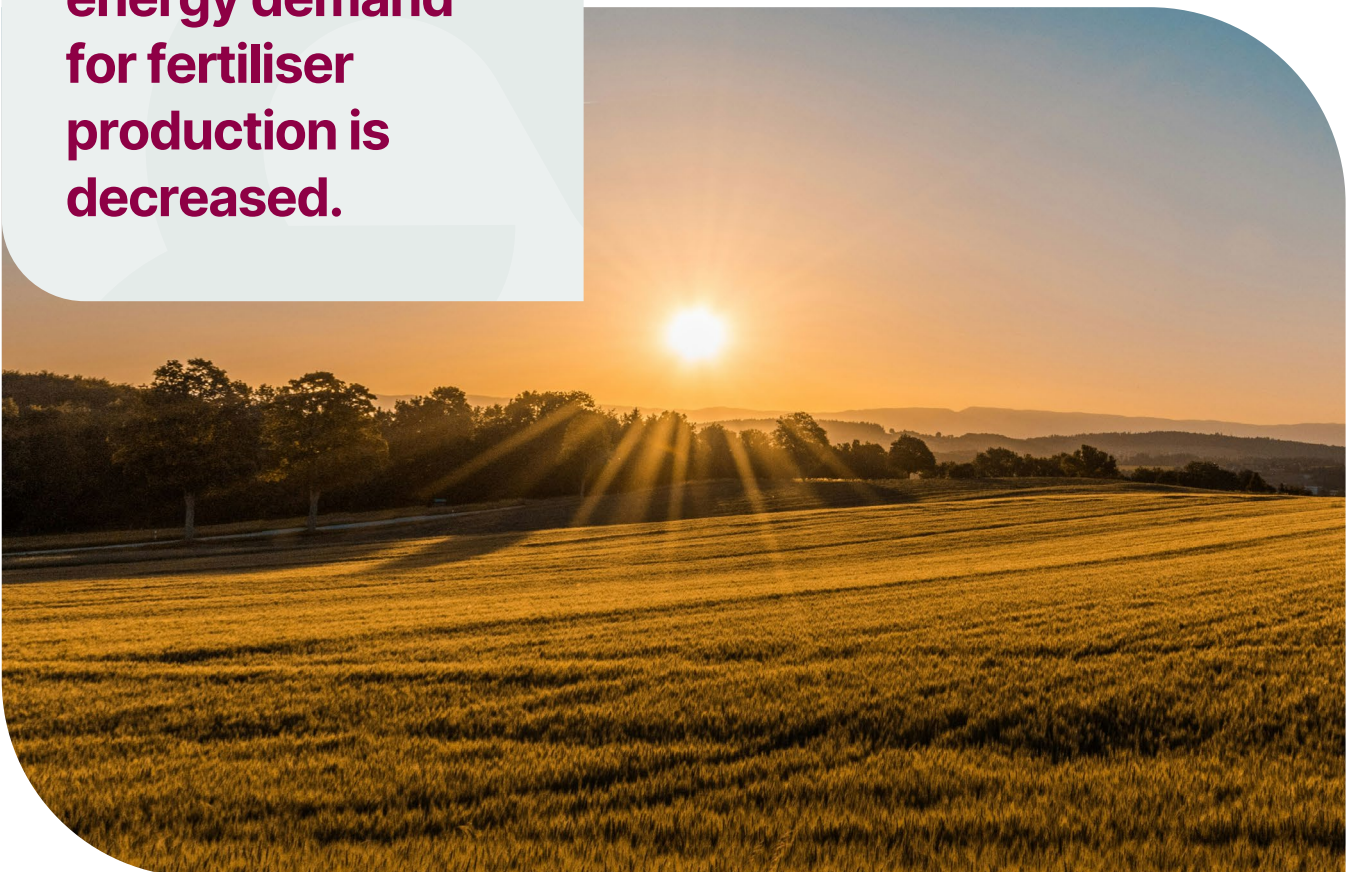
3.4 Manure management

In medium-scale pig farming areas, nearby farmland can effectively utilise manure as a substitute for a portion of chemical fertilisers, thereby reducing CO₂ emissions associated with fertiliser production.

By replacing energy-intensive chemical fertilisers with pig manure, the overall energy demand for fertiliser production is decreased.

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Additionally, increasing the organic matter in soil through the application of pig manure can enhance soil's carbon sequestration capacity, reducing atmospheric CO₂ levels and mitigating global warming.





Controlling the ventilation rate (0.1–0.3 L/kg/min), maintaining a moisture content of

60–65%

and achieving a carbon-to-nitrogen (C/N) ratio of 20–25, can effectively reduce GHG emissions.

It is important to recognise that the nutrient content in pig manure varies among different farms due to differences in feed composition and pig digestion rates. **Proper composting practices, such as controlling the ventilation rate (0.1–0.3 L/kg/min), maintaining a moisture content of 60–65%, and achieving a carbon-to-nitrogen (C/N) ratio of 20–25, can effectively reduce GHG emissions.**

Before applying pig manure to fields, it is essential to determine the nutrient content of the manure and apply it in a manner that meets the nutrient requirements of the crops. Regulating the scale of pig farming based on the land's capacity for manure assimilation and designing pig feeding strategies according to the specific growth characteristics of local crops are recommended practices.

Minimising the use of antibiotics in pig production is crucial to prevent residual antibiotics from entering the environment and food chain, which can have adverse effects on human health. The intensification and large-scale operations in pig production often result in manure production exceeding the absorption capacity of nearby farmland.

To address this, a combination of technologies such as freezing, concentration, and membrane filtration can be employed to treat the manure. This involves anaerobic fermentation of the manure, processing the solid fraction into organic fertiliser through composting, treating the liquid fraction through reverse osmosis to meet wastewater discharge standards, and freezing and concentrating the remaining slurry to refine the nutrients.



Minimising the use of antibiotics in pig production is crucial to prevent residual antibiotics from entering the environment and food chain, which can have adverse effects on human health.

Large-scale pig farms should also improve facilities for separating rainwater and wastewater and implement water-saving measures in pig houses, such as regulating water flow and using water-saving drinkers, to reduce the overall volume of slurry.

Installing separate drainage pipes during the disinfection and cleaning of pens can enhance the effectiveness of manure treatment. A significant number of trace elements, such as copper and zinc, are used in pig farming to meet the nutritional requirements of animals and promote growth, leading to their accumulation in pig manure.

Research has shown that after applying pig manure as fertiliser, the concentrations of copper, zinc, lead, and cadmium in the soil can increase significantly by 73%, 32%, 106%, and 127%, respectively.



4

Case studies

4.1: Tracking back the last 18 years of pig production in the UK

Over the past two decades, the pig production industry in Great Britain has undergone significant transformations, aimed at reducing its environmental impacts. The study **“Changes in the environmental impacts of pig production systems in Great Britain over the last 18 years”** by Ottosen et al. (2021) provides a comprehensive analysis of these changes through a novel LCA approach.



Over the past two decades, the pig production industry in Great Britain has undergone significant transformations, aimed at reducing its environmental impacts.

The LCA method developed in this study addresses the challenges posed by sparse historical data, enabling an accurate estimation of environmental impacts resulting from pig production over a span of **18 years**.

Global warming
potential (GWP)
decreased by
approximately

37%

for indoor
systems and

35%

for outdoor systems

To quantify these changes, the study integrates nutritional requirement modelling and feed composition analysis into the LCA framework, using historical data from the Agricultural and Horticultural Development Board (AHDB). The findings reveal substantial reductions in environmental impacts across various categories for both indoor and outdoor pig production systems.

For instance, global warming potential (GWP) decreased by approximately 37% for indoor systems and 35% for outdoor systems.

Similarly, significant reductions were observed in terrestrial acidification potential (TAP), freshwater eutrophication potential (FEP), agricultural land use (ALU), and fossil resource scarcity (FRS).

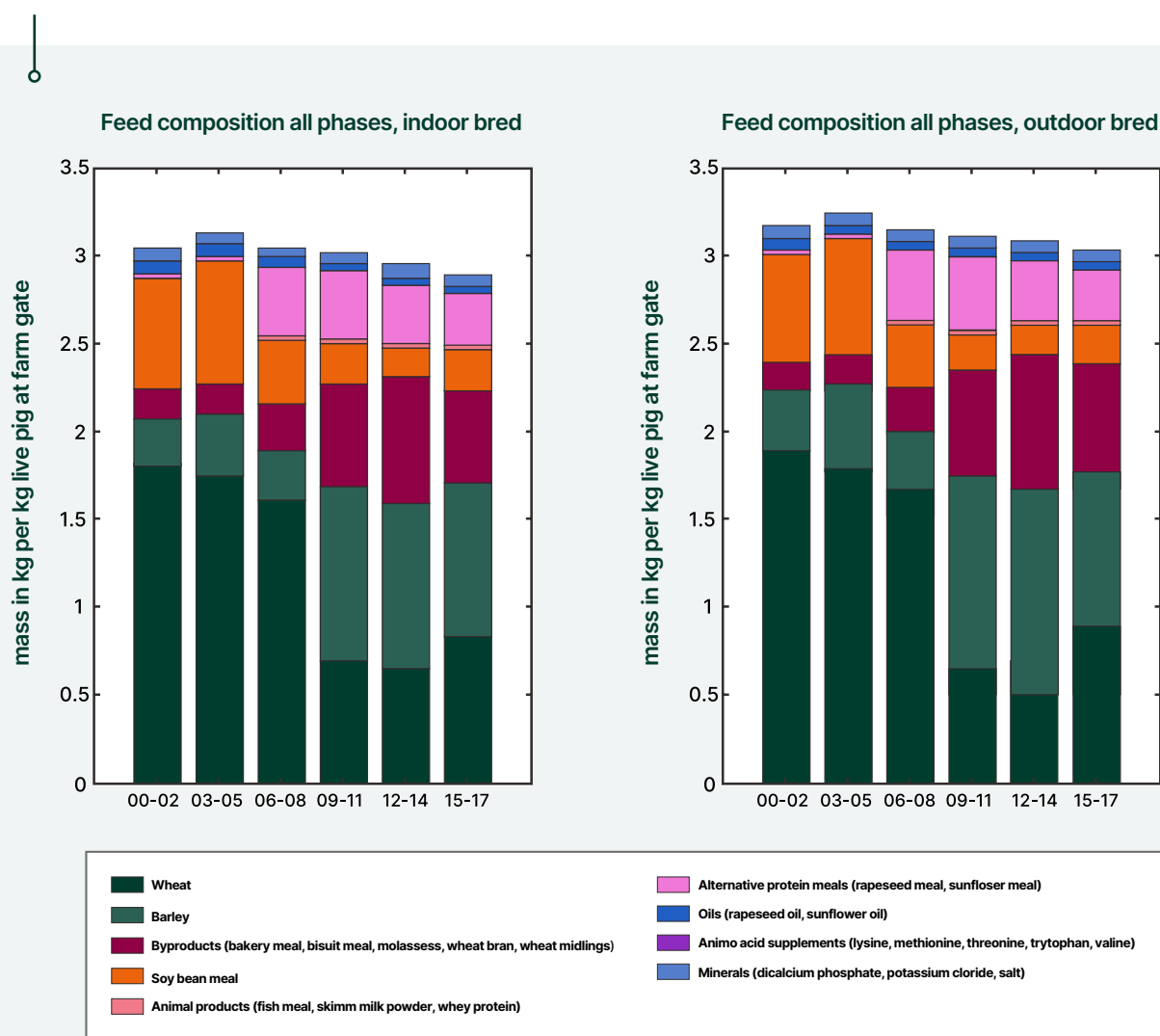


Changes in feeding composition

The changes in feed composition for indoor and outdoor bred pigs over the last 18 years are illustrated in Figure 3. **For both indoor and outdoor bred pigs, there was a significant shift in the types of feed ingredients used. Notably, the use of wheat and oils decreased, while the inclusion of barley and various co-products increased.**

These changes were driven by a general reduction in the energy concentration required in the feed for finisher pigs and gilts. Specifically, the energy concentration for finisher feed dropped from 13.7 to 11.0 MJ ME/kg over the period, reflecting an adjustment to typical feed specifications.

Figure. 3. Overview of feed mass and composition required to produce one kg of live pig at farm- gate for indoor and outdoor breed pigs during 3-year intervals.



The inclusion of soybean meal in the feed also decreased, supplemented instead by an increased use of pure amino acid supplements. However, the levels of tryptophan and valine remained unchanged. Despite these variations, the protein concentration in feeds for production pigs remained relatively stable throughout the period.

For both indoor and outdoor bred pigs, there was a significant shift in the types of feed ingredients used. Notably, the use of wheat and oils decreased, while the inclusion of barley and various co-products increased.

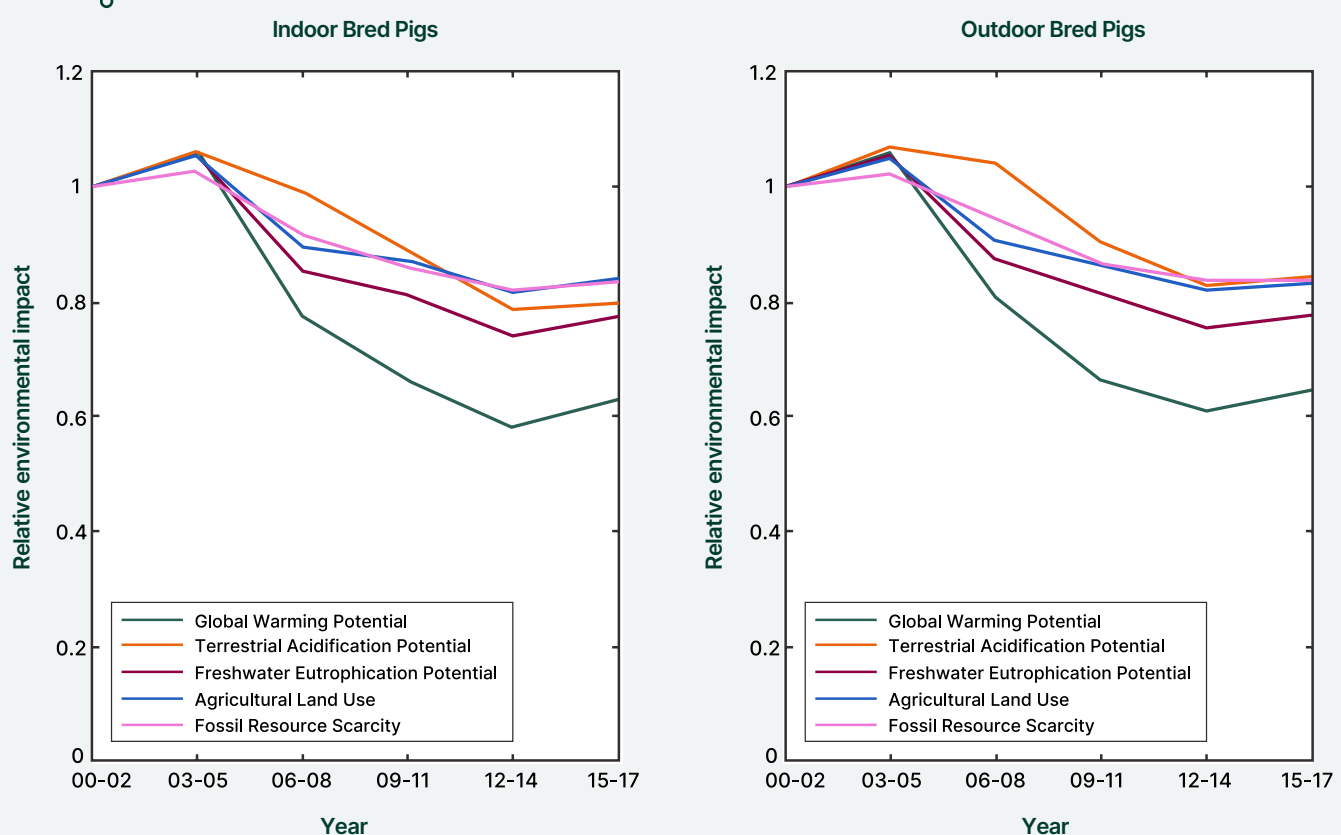
The trend towards greater use of amino acid supplements can be attributed to their reduced costs, making them a more economically viable option for maintaining the necessary nutritional balance in pig feed.



Environmental Impacts of different feeding compositions

Following an initial increase during 2003–2005, all environmental impacts exhibited a downward trend, stabilising towards a plateau by 2015–2017.

Figure 4. The trends in the predicted relative environmental impacts for indoor and outdoor bred pigs from 2000 to 2017.



Over the period from 2000 to 2017, the GWP per kilogram of live weight for indoor bred pigs decreased by **37.0%**, from **3.82 to 2.41 kg CO₂ equivalent** per kilogram of live weight. **Moreover, TAP, FEP, ALU, and FRS were reduced by 21.2, 22.55, 15.8, and 16.5% respectively.**

Similarly, for outdoor bred pigs, GWP per kilogram of live weight decreased by **35.4%**, from **3.82 to 2.47 kg CO₂ equivalent** per kilogram of live weight. TAP, FEP, ALU, and FRS were reduced by **16.4, 22.3, 16.8, and 16.1%.**

The early weaner phase made minimal contributions to the overall environmental impacts, accounting for **5.35%**, **3.66%**, **5.68%**, **3.13%**, and **5.70%** for GWP, TAP, FEP, ALU, and FRS, respectively, due to the small feed intake during this phase.

The finishing phase had the highest contribution to all environmental impacts, with average contributions of **31.6%**, **39.3%**, **36.5%**, **40.5%**, and **38.7%** for indoor bred pigs, and **31.0%**, **44.7%**, **35.6%**, **39.4%**, and **37.9%** for outdoor bred pigs for GWP, TAP, FEP, ALU, and FRS, respectively.

The finishing phase was also a significant factor in the reduction of GWP, contributing **41.4%** less in 2015–2017 compared to 2000–2002. The reproduction phase was associated with large reductions in GWP, TAP, FEP, ALU, and FRS, with reductions of **55.9%**, **39.1%**, **46.7%**, **41.4%**, and **37.9%** for indoor bred pigs, and **49.3%**, **32.6%**, **44.3%**, **41.9%**, and **34.8%** for outdoor bred pigs between 2000 and 2017.

The early weaner phase made minimal contributions to the overall environmental impacts, accounting for **5.35%, **3.66%**, **5.68%**, **3.13%**, and **5.70%** for GWP, TAP, FEP, ALU, and FRS, respectively, due to the small feed intake during this phase.**



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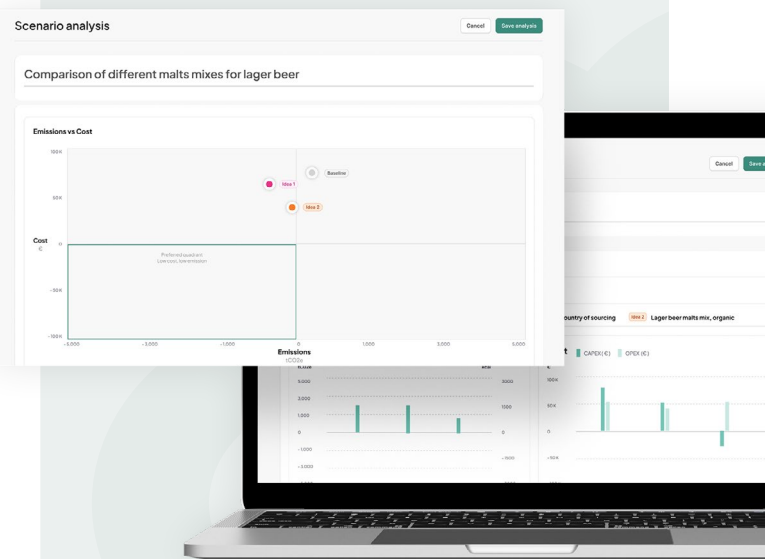
Big retailers ie IKEA, McDonalds, Tesco, Ahold, Ica have committed to SBTi



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Thank you!

References

<https://www.sciencedirect.com/science/article/abs/pii/S0959652623024101>

<https://www.sciencedirect.com/science/article/abs/pii/S0308521X21000160>

<https://www.sciencedirect.com/science/article/pii/S2590123023001810>

https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

<https://www.ipcc.ch/sr15/>

<https://unfccc.int/process-and-meetings/the-paris-agreement>

<https://doi.org/10.1016/j.resenv.2022.100104>

<https://doi.org/10.1038/s41893-022-00965-x>

<https://www.mdpi.com/2071-1050/12/22/9442>

https://foodandagricultureorganization.shinyapps.io/GLEAMV3_Public/

https://www.sciencedirect.com/science/article/pii/S0308521X21000160?fr=RR-2&ref=pdf_download&rr=89881bcb6cfe60fe

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6714588/>

<https://www.fao.org/faostat/en/#data/GT>

<https://www.thepigsite.com/articles/the-effect-of-light-type-on-gilt-performance>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7593325/>

https://www.ipcc-nggip.iges.or.jp/public/gp/bgp/4_1_CH4_Enterick_Fermentation.pdf#:~:text=URL%3A%20https%3A%2F%2Fwww.ipcc

<https://swine.extension.org/pork-production-and-greenhouse-gas-emissions/>

<https://www.fao.org/in-action/enteric-methane/background/en/>

https://www.ipcc-nggip.iges.or.jp/public/gp/bgp/4_1_CH4_Enterick_Fermentation.pdf#:~:text=URL%3A%20https%3A%2F%2Fwww.ipcc

<https://core.ac.uk/download/pdf/84841011.pdf>

<https://www.epa.gov/agstar/anaerobic-digestion-swine-farms>

<https://www.sciencedirect.com/science/article/pii/S0301479723017814>

<https://www.sciencedirect.com/science/article/abs/pii/S0048969723067396>

<https://www.eea.europa.eu/en/topics/in-depth/electric-vehicles>

<https://www.frontiersin.org/journals/veterinary-science/articles/10.3389/fvets.2021.689012/full>

<https://www.sciencedirect.com/science/article/pii/S0160412023002817>

<https://www.sciencedirect.com/science/article/abs/pii/S0378429022000971>

<https://www.mdpi.com/2077-0472/13/11/2092>

<https://www.sciencedirect.com/science/article/abs/pii/S0306261921016822>

<https://www.nature.com/articles/s41561-021-00690-8>

<https://farmcarbontoolkit.org.uk/toolkit-page/energy-efficiency-advice-for-pig-farmers/>

<https://wbcsdpublications.org/upgrading-and-replacing-equipment-and-assets-to-improve-energy-efficiency/>

<https://t.ly/msAGE>

<https://www.frontiersin.org/articles/10.3389/fvets.2021.750733>

<https://www.sciencedirect.com/science/article/abs/pii/S0921344922003263>

<https://porcinehealthmanagement.biomedcentral.com/articles/10.1186/s40813-023-00347-5>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8578682/>

<https://www.hampshirechronicle.co.uk/news/23095154.british-public-increasingly-concerned-environmental-impact-food/>

<https://www.ncbi.nlm.nih.gov/books/NBK305182/>

<https://www.ft.com/content/81c0fe03-6569-422c-bda9-82f5a9631c57>

<http://www.fao.org/3/i3460e/i3460e.pdf>

<https://www.alltech.com/agri-food-outlook>

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