Innovations can significantly cut greenhouse gas emissions in Europe's pork supply chains

Incentives are needed to accelerate adoption of measures

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By 2030, greenhouse gas (GHG) emissions in the pork supply chain can be reduced by an average of more than 20% in western Europe, mainly through innovations in feed and manure management.

Regulatory and market initiatives are driving the reduction in GHG emissions from pork production across Europe. While feed and pig manure are major contributors to GHG emissions in the pork supply chain, there are several existing measures that can and are already being implemented to significantly reduce these emissions.

To realize the untapped potential of measures to reduce GHG emissions and to encourage their adoption, the market and possibly governments must provide incentives to pig producers. An important precondition for an incentive scheme is the development of measurement and accounting systems for emissions reductions that facilitate the fair distribution of rewards and risks through the supply chain. We see a number of initiatives coming from animal protein companies, retailers, and sector organizations. However, the international nature of the pork supply chain makes these efforts challenging.

Pork supply chains need to change

As regulatory and market requirements to reduce GHG emissions intensify, pork supply chains across Europe will also need to bring down emissions. The Paris Agreement aims to substantially reduce global GHG emissions to keep the global temperature rise well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit it to 1.5C above pre-industrial levels. In line with this global ambition, the European Green Deal's Fit for 55 package aims to reduce GHG emissions by at least 55% by 2030 across the economy and to achieve carbon neutrality in the EU by 2050.

Voluntary market initiatives by food retailers, foodservice operators, animal protein companies, and the financial sector (e.g., Net-Zero Banking Alliance) are also driving action to reduce emissions in the pork supply chain. The pork industry understands this. Many companies in the pork supply chain have committed to significant GHG emissions reductions, are following the guidelines of the Science Based Targets initiative (SBTi), and are actively taking steps to map and reduce emissions in their supply chains.

GHG emissions in pork supply chains will be affected by other changes, such as measures to manage nutrient cycles (e.g., nitrogen) and changes in animal welfare standards (which may increase emissions).

To be consistent with the goals of the Paris Agreement, the net emissions reduction from pork production should be in the order of 50% by 2030 in western Europe, but the reduction in emissions intensity will depend on future production levels.

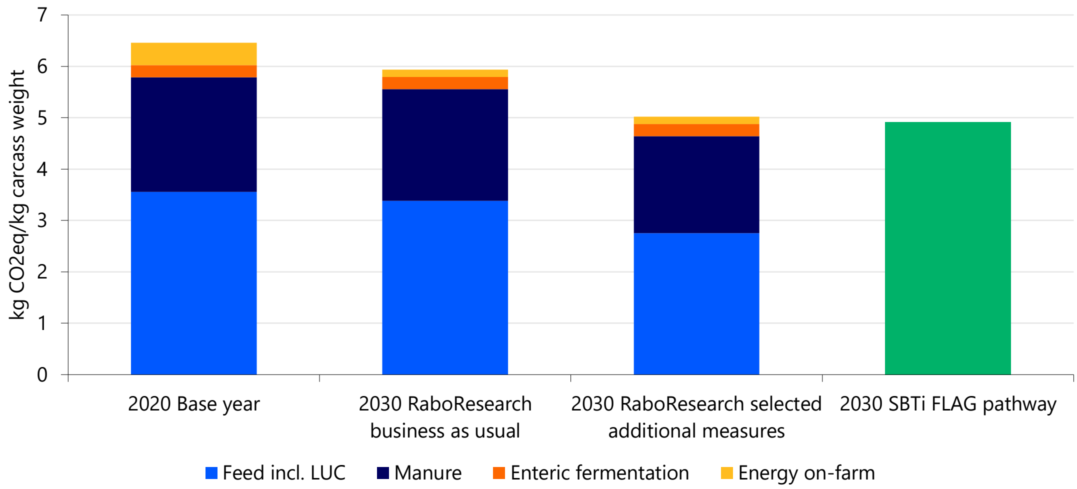
Pork production expected to reduce emissions intensity by at least 22% by 2030

RaboResearch foresees that the emissions intensity per kilogram of pork in western Europe[1](cradle to farmgate) will decline by about 22% (see the RaboResearch selected additional measures scenario in figure 1). This scenario assumes the use of 100% deforestation-free soy for pig feed, increased use of byproducts and local ingredients in feed, increases in feed efficiency and daily growth of pigs, and increased adoption of manure-management practices to reduce methane emissions from manure. Of the total reduction in emissions intensity, 8% will come from changes already underway in the sector, such as increased on-farm use of renewable energy and on-farm productivity improvements throughout the chain (see the RaboResearch business-as-usual scenario in figure 1). Effective systems for measuring and accounting GHG emissions in pork supply chains are already being developed and will play a key role in distributing rewards and risks in the supply chain and encouraging the uptake of GHG emissions-reduction practices.

Some supply chains and countries will exceed this expected average reduction in emissions intensity. In the Netherlands, for example, the sector expects to reduce the carbon footprint of pork by 40% to 50% by 2030.

Our projected reduction in emissions intensity is in line with the SBTi Forest, Land, and Agriculture (FLAG)[2] pork commodity pathway, which calculates a 24% reduction in the emissions intensity of pork.

Figure 1: Significant reduction in average GHG emissions intensity of pork projected for 2030 in western Europe



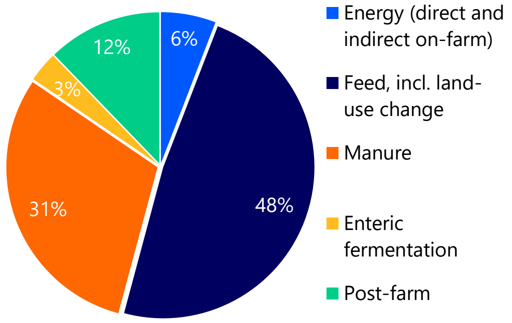
Source: SBTi FLAG, FAO GLEAM, Rabobank 2024

[1] Western Europe refers to a group of countries defined by the FAO Global Livestock Environmental Assessment Model (GLEAM) in 2010.

[2] SBTi FLAG provides guidance for companies to set science-based targets, including land-based emissions reductions and removals, that are aligned with the 1.5C goal of the Paris Agreement.

Feed and manure management are hot spots for GHG emissions in the pork chain

Figure 2: Distribution of GHG emissions in the pork supply chain in western Europe



Source: FAO GLEAM, Rabobank 2024

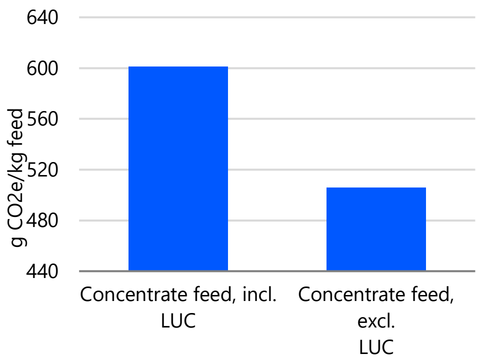
As feed and manure emissions represent the largest share of emissions in the supply chain, they also offer the greatest potential for reduction. In conventional pig-farming systems in western Europe, feed (i.e., production, processing, transport, and land-use change) accounts for 48% of total supply chain emissions.

On-farm emissions (i.e., from manure, enteric fermentation, and energy use) account for 40%, and post-farm emissions (i.e., processing and post-farm transport of pork) account for 12% (see figure 2).

However, there are large differences between countries in Europe and between supply chains. In the Netherlands, about 50% to 65% of total pig supply chain emissions come from feed production, approximately 30% to 45% from on-farm emissions, and approximately 5% from post-farm emissions. The variation in feed and on-farm emissions between pig farms can also be relatively large, as it depends on farm-specific factors, such as productivity, feed composition, and manure management.

In Europe, grains such as wheat, barley, corn, and coproducts from the food and biofuel industries such as rapeseed meal, palm kernel expeller, and soymeal are among the most important components of pig feed. In the Netherlands, wet byproducts from the food industry, such as wheat starch slurry, steamed potato peels, and wet wheat distillers' grains, are also widely used and account for about 10% of total pig feed volume.

Figure 3: GHG emissions from concentrate feed for fatteners, with or without land-use change



Source: Agrifirm, Blonk Consultants 2023, Rabobank 2024

The share of different feed ingredients and the corresponding GHG emissions per unit of ingredient ultimately determine the carbon footprint of feed. Soymeal generally has the highest GHG emissions factor per unit in the feed ration due to the contribution of land-use change[3] (LUC). The EU imported 14m metric tons of soybeans and 17m metric tons of soymeal in 2022, of which about 50% originated from Brazil, where soy has a high emissions intensity because of LUC in parts of Brazil. In the Netherlands, LUC accounts for about 20% of the concentrate feed for fattening pigs (see figure 3).

[3] Land-use change refers to the conversion of natural ecosystems such as forests, wetlands, savanna, highly biodiverse wetlands, peatland, and high-carbon-stock land into agricultural areas.

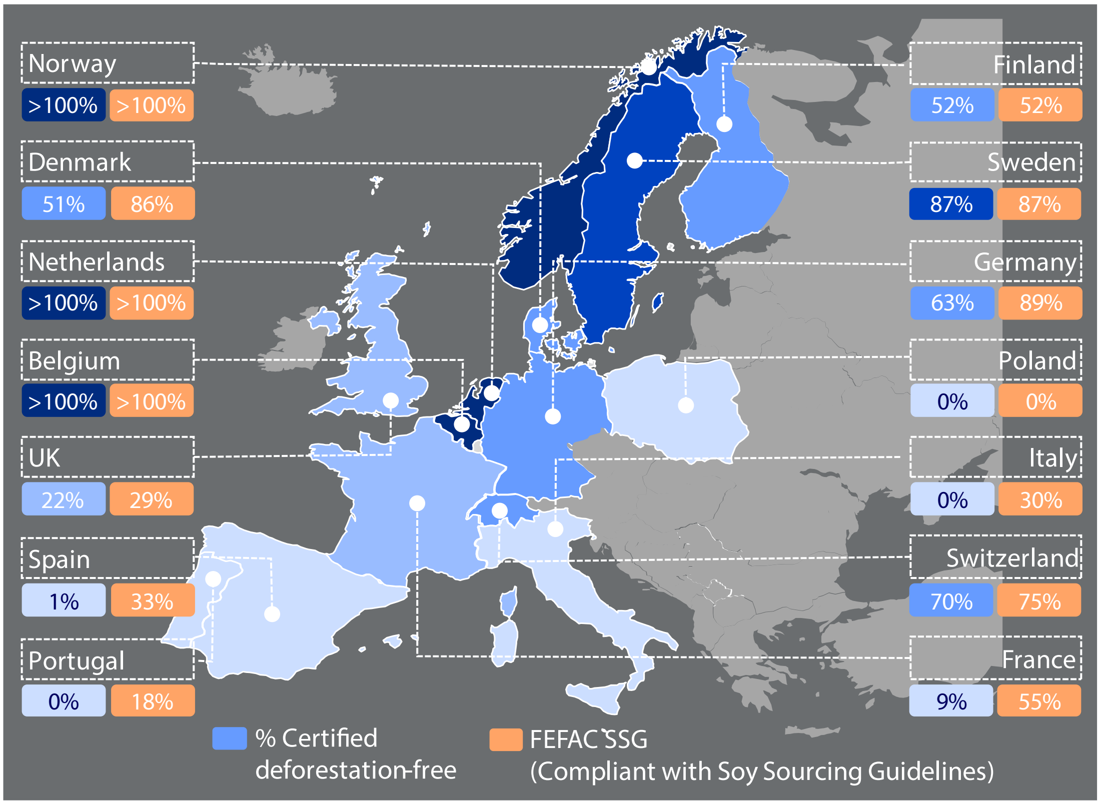
Three key ways to reduce GHG emissions from feed

1. **Eliminating the land-use-change element from feed** is becoming a focal point in the European feed industry. Typically, there have been two approaches to this issue.

- *Using deforestation/conversion-free soy and palm products*

This option will primarily depend on the decisions of feed companies to source ingredients. As demand from the food industry for deforestation-free products is expected to increase (e.g., due to collective industry commitments such as the UK Soy Manifesto, the French Soy Manifesto, and commitments from individual retail chains such as Ahold Delhaize), the share of deforestation/conversion-free feed ingredients in Europe will also increase. The European regulation on deforestation-free products (EUDR), which came into effect in 2023, has also added urgency to the transition to deforestation/conversion-free soy that can be traced back to production locations. Figure 4 suggests that, in 2021, about 24% of soymeal consumption in the EU-27, UK, Norway, and Switzerland was certified deforestation-free.[4]

Figure 4: Share of certified responsible and deforestation-free soy in 2021



Note: The calculation of deforestation-free soy only includes volumes that are benchmarked as deforestation-free by Profundo in 2019 (i.e., RTRS, Proterra, ISCC+, Danube/Europe Soy, CRS and SFAP Non-Conversion).
Source: IDH et al., European Soy Monitor, Rabobank 2024

- *Replacing (part of) soymeal with other protein-rich ingredients*, such as Category 3 animal byproducts (PAP) and (local) protein-rich crops (such as lupine, grass protein) with a lower CO2 footprint. For example, the carbon footprint of poultry PAP per kilogram of product is a quarter of that of soymeal (including LUC).

[4] Certified deforestation-free does not necessarily mean EUDR-compliant, as the compliance requirements have yet to be finalized.

2. **Increasing the use of food-industry residuals and former foodstuffs** is another strategy for reducing emissions from land-use change. This option also includes liquid feeds using wet byproducts, as they generally have a lower footprint compared to dry ingredients (the drying process is quite energy intensive). In the Netherlands, this is a common practice – over 50% of fattening pig farms use wet byproducts in feed rations to some extent. Although the inclusion of liquid feed in feed rations usually leads to a reduction in total feed costs, it is generally only economically feasible on larger farms (over 3,000 fattening pigs) due to the required investment in on-farm liquid-feed installations.

   In Europe, the untapped potential to increase the share of wet/dry byproducts in the total feed ration is relatively high. According to the European Former Foodstuff Processors Association, in 2017 only 5% of the total food loss and food waste in the EU, approximately 5m metric tons per year, was converted into animal feed. However, they expect the volume of former foodstuffs processed into animal feed to increase to about 7m metric tons by 2025. Although waste streams and byproduct streams will decrease as regulations tighten, there will always be byproduct streams that cannot be used for human consumption and cannot be further reduced. The challenge is to manage the logistics in an economically feasible way, as transportation of such products, especially considering the larger volumes of wet byproducts, can increase costs.

3. **Leveraging improvements in genetics/breeding and farm management**: Breeding programs aim to continuously improve the feed-conversion ratio, which helps to reduce emissions on the pig farm by reducing feed intake. In the Netherlands, the average feed conversion ratio improved by about 4% over the past 10 years, and similar trends can be observed in other pork-producing countries. We expect this trend to be sustained in western Europe in the coming years. The adoption of precision-feeding techniques has the potential to further improve feed efficiency. The contribution of methane emissions from pigs (through enteric fermentation) is relatively small compared to emissions from feed and manure, but gains can also be made in this area in longer-term breeding programs.

Case study: Feed solutions are already available for Dutch farmers to reduce feed emissions

Building on the above strategies, such as reducing LUC associated with feed ingredients and increasing the use of byproduct streams, feed companies are already offering feed solutions with a lower carbon footprint.

Some feed companies offer dry feed concentrates with a lower carbon footprint. For example, Agrifirm's sustainable feed concept, Feed Forward, was launched in 2022. Feed Forward reduces the carbon footprint of feed by approximately 15% to 30% compared to the reference fattener concentrate (excluding and including LUC, respectively). But there are also other feed companies offering circular feed and significant GHG emissions reductions by using residual streams from the foodstuff industry, such as Nijsen company and Voerwaarts.

Adding liquid feed (using wet byproducts) to the feed ration can also reduce the footprint of fattener feed by 10% to 30%, depending on the share of liquid feed in the total feed ration. In the Netherlands, the share of liquid feed in the total feed ration on fattening farms using liquid feed ranges from 30% to 60%.

The price impact of low-emission feed varies – there are feed solutions with a more limited price impact, while fully circular concepts are usually more expensive (due to scarce raw materials). Regardless of whether the additional costs associated with lower-emission feed are limited or higher, in both cases incentives will be needed to encourage adoption due to tight producer margins. In addition, feed efficiency may deteriorate when using lower-carbon-footprint feeds, which can impact feed intake, production costs, and overall carbon-footprint reduction throughout the chain.

Manure management is another area where large reductions in GHG emissions can be realized

More frequent removal of manure from the barns, rather than storing manure for months in manure basements, can reduce GHG emissions from manure by 80% to 90%. The level of reduction depends on the specific manure system and the frequency of manure removal (see table 1).

Table 1: Selected manure-management systems per animal category, showing GHG emissions reduction

Manure-management systems	*GHG emissions-reduction potential from manure*	*Applicable to*
Daily manure removal (e.g., systems from De Hoeve - Stal van de Toekomst; Kamplan)	90%	Fattening pigs, weaned piglets
Manure capture and flushing with liquid (weekly, daily)	70% to 90%	Fattening pigs, weaned piglets
Separating solid and liquid fraction	90%	Fattening pigs
Manure pans	80%	Lactating sows
Manure cooling	50%	Fattening pigs, weaned piglets, lactating, dry, and pregnant sows

Source: Aarnink et al., 2019

Not all manure systems can be implemented in all animal groups due to differences in the indoor layout of barns. While a number of systems are available for fattening pigs and weaned piglets, there is less choice in effective systems for lactating sows and dry and pregnant sows. A proper manure-management system can significantly reduce indoor manure emissions, but emissions outside the barn depend on the type of storage or further processing of the manure. Due to the relatively higher biogas yield compared to sow manure, fattening farms in particular can benefit from combining daily or weekly manure-removal systems with small-scale manure-digestion installations on the pig farm. Manure digestion at a centralized, industrial-scale location is also beneficial in terms of GHG emissions reduction, although logistically it can be more challenging, as manure usually has to be transported over longer distances and is associated with a lower GHG emissions-reduction potential compared to on-farm digestion. In the Netherlands, about 14% of pig manure is processed through anaerobic digestion, while in Denmark it is about 17%. In both cases, most of the manure is processed in large-scale plants.

Manure-management systems that reduce emissions at source often come with other benefits, such as an improved barn climate, which can also lead to higher animal welfare, improved animal health and productivity, as well as reduced nitrogen emissions. However, manure management at source offers relatively low NH_3 reduction (approximately 60% to 70%) compared to an air scrubber (85% to 90%). Prioritizing maximum reductions in nitrogen emissions may therefore hinder the uptake of at-source measures. This is of particular concern in the Netherlands, where the reduction of nitrogen emissions is currently at the center of political and policy discussions.

Clearer business case and stronger market incentives needed to scale solutions

A wide variety of options are already available to reduce GHG emissions, with the potential to reduce emissions by at least 22% by 2030. However, most of these options come at a higher cost than current conventional practices. New business models are therefore needed to recover costs and generate a return on investments. Feed solutions are relatively easy to implement (reversible, no/limited investment required depending on the type of feeding) with varying cost impacts, but farmers are still unlikely to switch feed if they are not compensated for their efforts. Investing in a manure-management system is more capital intensive and involves a higher risk. What if the reduction potential is not fully realized? While there may be some increase in productivity due to a better barn climate, the returns are less obvious.

Case study: Dutch energy targets support a business case for on-farm manure digestion

A potential business model for innovative manure-management systems could be to combine daily manure removal with manure digestion and green gas production to supply energy to the grid. This could be a profitable case for fattening pig farmers. Profitability will ultimately depend on a number of key factors, such as the scale of production (at least 15,000 metric tons of manure per year), the biogas yield (depending on the freshness of the manure and how well the system is managed), and the level of subsidy for green gas production. Additional value can be created by using the digestate, although that also requires additional techniques and processes to be implemented on the pig farm.

The Dutch government has high ambitions to increase the level of green gas production by 2030 (i.e., aiming at a production of 2bn cubic meters per year, which is eight times the current production in the Netherlands). Ambitions are also set in the broader EU context. The EU aims to achieve 100% renewable gas in the grid by 2050, with an intermediary target of 20% by 2030.

Dutch and European pig farmers have the potential to contribute to these ambitions, but there are also some barriers to the uptake of these technologies. In the Netherlands, for example, the amount of subsidy for green gas is set each year, and farmers have no guarantee of future returns and the payback on their investment, creating uncertainty for investments. However, the government's ambitions for green gas production suggest that demand will increase, and prices will rise. Questions also remain about how to measure and account for emissions reductions in pork production due to improved manure management on such farms and whether or to what extent farmers would be rewarded. Besides, there are not many fattening farms in the Netherlands that have the scale to supply the volume of manure needed to operate a small-scale biodigester efficiently. Cooperation between neighboring farms can be a solution, but this adds complexity.

In short, the potential for emissions reduction in pig production is significant, but progress is needed in two main areas to realize this untapped potential:

- First, measurement and accounting systems that are recognized by the market and by the government need to be developed further. This will require cooperation between supply chain players, including across national borders, due to the international nature of pork supply chains.
- Second, incentives must be provided to pig producers based on proper measurements. Ultimately, incentives will need to come from the market, for example, in the form of price premiums, long-term agreements, and retail concepts, but also from the government in the form of subsidies and more predictable policies that encourage the uptake of certain technologies (e.g., renewable energy policies that also encourage the use of animal manure). Reducing GHG emissions from agriculture and other industries is in the interest of society as a whole, and as such the costs associated with a more sustainable pork supply chain need to be fairly distributed across a larger group, including consumers, taxpayers (through government subsidies), and the stakeholders in the sector.

The past two years have been challenging for the European pork sector, but this should not distract producers and companies in the pork supply chain from working toward their 2030 targets. If the sector fails to make progress in reducing GHG emissions, there is a risk that governments will intervene and dictate the measures that need to be taken.

Imprint

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