

Sustainability in the Swine Industry: Understanding the Life Cycle Assessment of the Pork Supply Chain

The overarching goal of the swine industry is to provide high-quality protein to feed the world's growing population. Improvements in production efficiency are continually being made to create a better and more sustainable product. Sustainability in the swine industry can be calculated using a Life Cycle Assessment (LCA). An LCA is a holistic approach to analyze the cumulative environmental impacts of the different phases of swine production. Swine production LCAs can inform producers and consumers how certain production practices impact the environment.

The methodology of an LCA can be divided into four sections: goal and scope definition, inventory analysis, impact assessment, and interpretation.

The goal and scope section of an LCA focuses on how the assessment can help the production system, and what important parameters need to be included in the other sections.

Inventory analysis outlines how materials and energy act within the production system, and its environmental outcomes.

Information collected from the inventory analysis is used for the impact assessment to determine how the development of the product or goods influences the system and, subsequently, the environment.

Interpretation of the LCA ties everything together allowing producers and consumers to understand the environmental impacts of producing a product.

Publication of LCAs regarding livestock production is common in Europe, but is scarcer in the US. European LCAs are not directly applicable to pork production in the US because of inherent differences in swine industry management practices. The University of Arkansas created LCAs specific to the US swine industry that focus on carbon, land, and water consumption estimates. The system boundary of the pork supply chain for the swine LCAs encompasses feed production, live animal production phases (sow farm, nursery, finisher), transportation, processing, packaging, distribution, retail, and consumption/disposal. As a result, pounds of carbon dioxide, square feet of land, and gallons of water are the functional units for a 4-oz. serving of pork prepared and consumed. These analyses are useful to both producers and consumers, allowing for increased understanding of the pork supply chain's impact on the environment.



Carbon Life Cycle Assessment

The Carbon LCA focuses on the greenhouse gas emissions produced in the pork supply chain. Greenhouse gases are produced by both natural and man-made activities and contribute to heating the environment. Current concern regarding these gases is due to the rapid accumulation of greenhouse gases within the Earth's atmosphere. To compare atmospheric effects of greenhouse gas emissions, the global warming potential metric was developed. Carbon dioxide has a global warming potential of 1, representing the baseline greenhouse gas. Relative to carbon dioxide, the global warming potential for methane is 25, and for nitrous oxide, 298. Methane has a greater global warming potential compared to carbon dioxide, but a significantly shorter atmospheric lifetime (12-15 yr.) degrading into carbon dioxide or water. All three of these gases, carbon dioxide, methane, and nitrous oxide, can impact sustainability in the swine industry. The emission of greenhouse gases from each stage of swine production is estimated using specific equations. Pounds of methane and nitrous oxide are converted to carbon dioxide equivalents using the global warming potential parameters mentioned above for ease of calculating and interpreting emission estimates.

Land Life Cycle Assessment

The transition from raising hogs outdoors to today's commercial production systems has impacted the amount of land used by the swine industry. With the implementation of specific housing norms for the various stages of production, the Land LCA has supplementary impacts other than just the square footage of the animal housing units. Factors such as farming land, packaging and processing plants, retail (grocery stores), and consumption now are included in estimating land LCA. The functional unit for land analysis is square meters per year based on land occupation to produce a pork product. Crops have limitations due to the growing seasons, but in this LCA cropland is calculated as occupied for the entire year if designated for swine production. Approximately 15 million acres of land are used for swine housing or feed in the US.

Water Life Cycle Assessment

Water often is an overlooked nutrient, but it has important roles in swine production, from providing hydration to the pigs to crop irrigation. Water usage varies by production phase for swine. A study in 2010 reported finishing as the greatest water usage phase and farrowing the least. Watering systems (nipple, cup, wet/dry feeder) are associated with different wastage rates, with the highest wastage contributed to nipple drinkers. Outside of the barn, the greatest factor impacting the water footprint of swine production is linked to crop irrigation. Irrigation is essential during times of drought to produce an adequate crop yield for the year. Water use for the US swine industry is estimated to be 525 billion gal. per year.

Summary

The overall footprint estimated for a 4-oz. serving of pork is 2.48 lb. of carbon dioxide, 9.75 sq. ft. of land per year, and 8.2 gal. of water. Combining and evaluating all three LCAs is important in understanding the swine industry's overall impact on the environment. Within the pork supply chain, swine diet had the highest effect on the environment across all LCAs. Swine ration accounted for 96% of land occupation and 83%–93% of water usage (dependent on feed source). For the Carbon LCA, feed was included within the sow production and grow/finish phases, indicating diet among the major environmental impacts of the pork supply chain.

The grow-finish production phase had the highest overall environmental impact, contributing 52.5% to the carbon footprint, 68% of feed designation, and 75% of on-farm water footprint. Understanding the factors that impact the environmental footprint of swine production can help producers prioritize production strategies for making positive strides toward reducing the environmental footprint of pork production, while continuing to improve production and farm profitability.

Key Points

- Life Cycle Assessment (LCA) can be used as a tool to help swine producers and consumers understand the environmental impacts of pork production.
- The grow-finish phase in swine production has the highest environmental impact on all LCAs.
- Feed contributed the most carbon dioxide produced, land occupied, and water used for swine production in the pork supply chain.

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