

Evaluation of the environmental performance for Danish pig production:

Historic development and potential reduction of the carbon footprint applying best available technologies.

Abstract of industrial Ph.D thesis for a broader scientific audience
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The agricultural sector provides a majority of nutritional and energy requirements for the global population, although this sector is a major contributor to multiple environmental impact categories. Climate change (global warming) is the most recognized of these impact categories, that occurs through emissions of greenhouse gases that include carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) to name a few. The objective of this Ph.D. was evaluating the environmental impacts of Danish pig production, primarily related to greenhouse gases and their potential mitigation areas. The life cycle assessment methodology was applied enabling a detailed systematic analysis to be performed, that includes evaluating if a greenhouse gas mitigation option performs worse in other environmental impact categories. When applying the life cycle assessment methodology, a products carbon footprint can be calculated, which is expressed in carbon dioxide equivalents (kg*CO₂-eq, typically per kg of product). The historic development of Danish pig production was evaluated between 1860 to 2020 resulting in a carbon footprint estimate per 1 kg of pig live weight (a live slaughter pig weight approximately 120kg). The historical findings were that 19th century and early 20th century's carbon footprints were the lowest, although they applied production methods that would be economically and socially unusable in modern pig production. A systematic literature review was performed to identify published life cycle assessments evaluating pig production, that provided an overview of environmental impact results and expected performance of the differing technologies and production systems. Based on the findings provided by the systematic review, optimizing the slaughter pig feed mixture was evaluated among the best options for mitigating the carbon footprint of Danish pig production. When calculating the carbon footprint of agricultural products, it's important to decide on which land use change assessment method to apply, since these methods will substantially affect the products carbon footprint. A life cycle assessment was performed on the average 2021 Danish pig production, that was compared to a production system providing the slaughter pigs with optimized feed applying multiple land use change assessment methods. The reduction towards the carbon footprint ranged between 2.4% and 13%, depending on which land use change assessment method was applied. Thereafter, a life cycle assessment was performed on a two low-carbon pig production system that included optimized feed mixtures and the best available technologies, that was similarly compared to the average Danish pig production. The low-carbon production systems were 26% and 31% lower in carbon footprint compared to the average Danish production system (depending on the land use change assessment method applied). The thesis provides a broad overview of pig production and its associated environmental impacts, that includes its carbon footprint (among many others). Additionally, it provides an indication of feasible reduction to the carbon footprint of pig production when applying best available feeds mixtures, practices and technologies.