Identifying Environmental Hotspots in Swine Production

Priscila J. R. Cruz, Sailesh Menon, Caitlyn M. Phillips, and Charles W. Rice

Purpose
To highlight the critical stages of swine and crop production that contribute most to environmental impacts.

Importance
Swine production provides essential food, but it also creates environmental pressures. Some stages of production contribute more heavily than others, and these are referred to as environmental "hotspots". In swine systems, the largest hotspots are often related to feed production and manure storage application.

For instance, overuse of nitrogen fertilizers in corn and soybean production can lead to nutrient runoff, which impacts rivers and lakes. Likewise, manure that is not properly manages can release methane and nitrous oxide, two powerful greenhouse gasses. Identifying these hotspots helps farmers focus on the practices that matter most, including reducing emissions, protecting soil and water, and improving long-term farm sustainability.

Major Hotspots
Feed Production
The largest source of environmental impact in swine production comes from growing feed sources, including corn and soybeans make up majority of the diet. The use of nitrogen fertilizer above crop needs results in significant nitrous oxide emissions. Phosphorus is another concern: when applied in excess, it can runoff into streams and rivers, resulting in negative impacts on water quality and resulting in algal blooms. In fact, as much as 30% of the greenhouse gas footprint of soybean production comes directly from nitrogen fertilizer use (Romeiko et al., 2020).

Manure Management
Handling swine manure presents both opportunities and risks. Direct land application can improve soil fertility, but over-application can leads to nutrient overload, runoff, and groundwater contamination. Storage systems such as deep pits and lagoons help contain manure but also release methane and nitrous oxide. Composting can reduce manure volume and stabilize nutrients, though it can also yield large carbon losses by up to 72% during this process (Bernal et al., 2009). On average, manure management adds ~3,390 kilograms of carbon dioxide equivalents for every ton of pork produced, making manure management a critical environmental hotspot.

Soil Quality Considerations
The long-term health of soil is closely tied to crop production patterns. Continuous corn production with heavy nitrogen inputs can acidify soil, deplete nutrients, and reduce productivity over time. Expanding soybean production onto marginal lands brings its own risks, including higher erosion rates and emissions tied to land use change. These practices not only reduce yields, but also weaken soil's ability to store carbon and cycle nutrients effectively.

Regional Variability
The impact of manure on crop production varies by soil type and region. In the Midwest, manured soils had 39% more organic carbon than untreated soils (Nunes et al., 2020), but sandy soils can leach nutrients, reducing benefits and risking water pollution. Clay loam soils retain carbon and nutrients better, while sandy soils are more vulnerable to losses. This variability underscores the need to tailor manure and crop management to local soil conditions for best results.

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Practical Application

Environmental hotspots in swine production highlight where improvements are most needed. Feed production is one of the largest contributors, with nitrogen fertilizer use responsible for up to 30% of soybean greenhouse gas emissions (Romeiko et al., 2020). Manure is another major factor, representing 12-15% of all livestock waste in the United States (Barbazán et al., 2009; Herrero and Thornton, 2013), and its management alone can add nearly 3,390 kilograms of carbon dioxide equivalents for every ton of pork produced. Soil impacts also depend on how and where crops are grown. Continuous corn with high nitrogen inputs leads to soil acidification and nutrient depletion, while soybean expansion on marginal lands increases erosion and land use change emissions. Regional conditions play a strong role as well; Midwestern soil treated with manure show higher carbon storage, but sandy soils are more prone to nutrient leaching. Together, these findings show that focusing on feed practices, manure handling, and region-specific soil management is key to reducing the environmental impact of pork production.

Key Takeaways

- Feed production is a major hotspot; nitrogen excretion drives up to 30% of soybean meal greenhouse gas emissions (Romeiko et al., 2020)
- Manure management is a large contributor, adding ~3,390 kg CO_2e per ton of pork produced
- Storage systems (i.e., deep pits and lagoons) release methane and nitrous oxide
- Composting reduces volume but loses up to 72% of the carbon (Bernal et al., 2009)
- Soil issues include acidification from continuous corn and erosion from soybean expansion on marginal lands
- Regional differences matter: manure increases soil carbon in the Midwest, but risks leaching in sandy soils
- Hotspots show where targeted changes can greatly reduce the environmental impact of pork production

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