Mineral excretion and environmental impact of typical U.S. swine diets

Julian Arroyave, Katelyn N. Gaffield, Mike D. Tokach, Joel M. DeRouchey,
Jason C. Woodworth, Robert D. Goodband, and Jordan T. Gebhardt

Consumer concerns about the sustainability of livestock production are growing, which means farm success is no longer measured by growth and economic performance alone. In addition to growth and efficiency, producers are now encouraged to consider the environmental impact of their practices, with the goal of finding the right balance between productivity and sustainability.

Multiple methodologies can be applied to estimate environmental impact; however, Life Cycle Assessment (LCA) is one of the most used as it provides a comprehensive view of the entire production chain (from feed ingredient sourcing to animal performance, manure management, and commercialization), allowing producers and researchers to identify key areas where improvements can reduce both costs and environmental footprint.

The LCA impact can be estimated using several categories; however, the focus for this fact sheet will be on global warming potential, land use, and water use. In addition, the excretion of Zn, Cu, K, and S is reported, since the accumulation of these minerals in manure and soils has been linked to concerns such as antimicrobial resistance, plant toxicity, and odor emissions.

Calculations

The diets described in the fact sheet, *typical swine diets in the U.S industry*, were used as a base to estimate the LCA impact and mineral excretion. The LCA values were obtained using economic allocation from the 2024 Global Metrics for Sustainable Feed (GFLI) report. Mineral excretion was calculated using equations from the *Zinc, Copper, Potassium, Sulfur, and Iron Excretion in Pigs* fact sheet, with values estimated based on the total mineral intake of each diet.

Life Cycle Assessment values

Because over 35% of pigs are grown in Iowa, values for Iowa were used for corn. Country level values for the U.S. were used for soybean meal (SBM) and corn distiller grains (DDGS).

When comparing the typical swine diet options, including DDGS and/or fat reduced global warming potential and water use per pig, indicating a smaller environmental footprint compared to corn–soybean meal diets. Land use remained similar across all diet formulations.

Mineral excretion

Compared with a corn-soybean meal-based diet, use of DDGS increased mineral excretion, due to the greater endogenous mineral concentration present in the DDGS compared with the corn and SBM (Table 1).

On a pig basis, 52% of total Zn excretion occurs during the nursery period, primarily due to the pharmacological levels of Zn used to control post-weaning diarrhea. In contrast, only 14.6%, 3.1%, and 19.5% of total Cu, K, and S excretion, respectively, occur during the nursery phase (Figure 1). These results suggest that efforts to reduce Zn excretion should target nursery diets, while strategies to lower Cu, K, and S excretion should focus on finishing diets.

IOWA STATE UNIVERSITY · IFEEDER Institute for Feed Education & Research · UNIVERSITY OF MINNESOTA · KANSAS STATE UNIVERSITY · NC STATE UNIVERSITY · pork checkoff

Table 1. LCA values and mineral excretion with different formulation strategies

	Corn + SMB	Corn + SBM + DDGS	Corn + SMB + Fat	Corn + SMB + Fat + DDGS
LCA values[1]				
Global warming, kg CO_2-eq/pig	294	252	278	236
Land use, m^2 crop-eq/pig	2.79	2.77	2.79	2.76
Water consumption, m^3/ pig	4.02	3.32	3.97	3.27
Mineral excretion, g/pig				
Zn	41	42	41	43
Cu	19	19	19	19
K	1,735	1,717	1,799	1,776
Fe	27	28	27	29
S	159	288	172	300

[1] Life cycle assessment values were obtained using economic allocation from the 2024 GFLI report. Corn values were based on Iowa-specific data, whereas SBM and DDGS values were derived from country-level reported data.

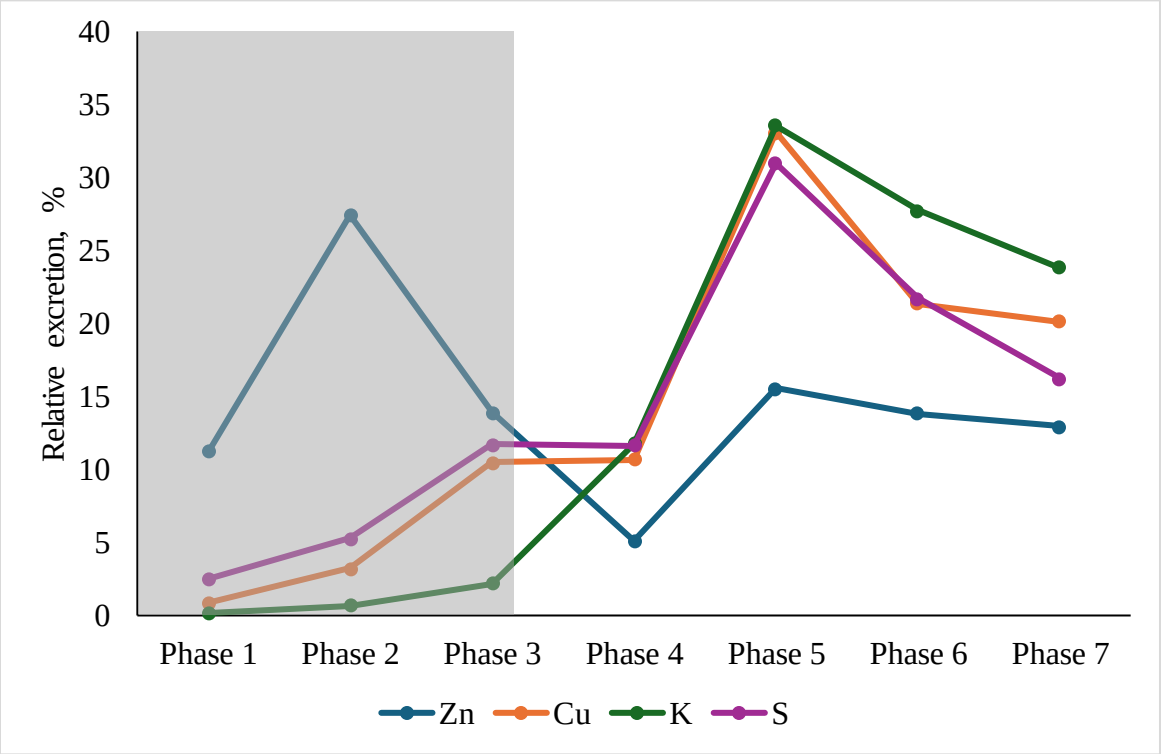

Figure 1. Relative excretion of Zn, Cu, K, and S during the nursery (gray shadow section) and finishing period for pigs fed corn-SBM diets.