Section 2
Feed Management

Approximately 70 percent of the nitrogen in the pig's diet is voided/excreted by the pig as feces and urine[8]. This excess nitrogen can be released into the atmosphere as nitrous oxide or ammonia. A reduction in these gas emissions from hogs can be achieved by adopting various feeding strategies.

In addition to reducing GHG emissions, improving feed efficiency also improves production efficiency, by reducing the amount of feed required to achieve a similar rate of weight gain. Most scientists agree that a combination of genetic selection and feed management are two important strategies that lead to a reduction in nutrient excretion, and therefore a reduction in GHG emissions from swine.

Economics

Recent research determined that for each 0.1 unit of improvement in feed efficiency an Alberta producer could save a $1.80 dollar per pig, assuming a feed cost of $200 per tonne[9].

Credit: Alberta Agriculture, Food and Rural Development

Feed Reduced Protein Diets Balanced with Synthetic Amino Acids

Greenhouse Gas Benefit

Reducing dietary protein in feed is an effective strategy to reduce nitrogen excreted in urine and manure. Increasing the quality of protein in feed while decreasing the total amount of protein in the diet can directly reduce the resulting GHG emissions from both the pig and manure.

The effect of reducing nitrogen excretion through manipulating dietary protein is well documented. Several studies conducted at the Prairie Swine Centre Inc. in Saskatoon, Saskatchewan have showed a 22 to 48 percent reduction in urinary nitrogen excretion and a 23 percent reduction in fecal nitrogen excretion from pigs fed low crude protein diets (CPs of 13.8 percent and 15.7 percent) supplemented with amino acids compared to high protein diets (CPs of 18.5 percent and 19.7 percent)[10,11,12]. A reduction in total nitrogen excretion may reduce the land base needed for sustainable manure application providing other nutrients do not become a limiting factor[11]. Thus, reducing nitrogen excretion from the animal ultimately reduces both nitrous oxide and ammonia gas emissions directly from manure.

Researchers at the University of Alberta indicate there may be an additional benefit to reduced protein diets. Studies have shown reduced CO_2 emissions from the animal are possible due to improved utilization of dietary energy[13]. Researchers found that reducing dietary protein in a barley based diet, while supplementing with amino acids, reduced GHG production by 14.3 percent and 16.4 percent in sows and finisher pigs, respectively or approximately 10 percent for each 10 percent reduction in the ration crude protein content[14]. Animal performance was not affected by the dietary protein content reduction in this study. Therefore, feeding strategies that result in more efficient nutrient use help to maintain healthy, productive livestock, and may improve profitability. However, please note that the pigs themselves emit little direct GHGs relative to the GHG emissions from the manure itself.

Impact on Odour

Practices that reduce nutrient intake and improve the nutrient availability of feed will impact the amount of nitrogen in the manure. Less nitrogen in the manure will result in less volatilization of nitrogen into ammonia, thereby reducing odour emissions during storage. In addition, decreasing the amount of fermentable material in manure can reduce odour[15]. Ammonia emissions have been found to decrease by 8.1 percent for every 0.1 percent reduction in crude protein between 20 percent and 13 percent of total dietary content[16]. Other research has determined similar results between dietary levels of 18.7 percent and 13 percent and between 16.5 percent and 12.5 percent crude protein levels, respectively[17,18].

Economics

Researchers at the Prairie Swine Centre Inc. assessed the economic value of low protein pig diets compared to high protein diets and determined that feed costs were about $5 per pig (assuming November 2003 feed prices) less for the low crude protein diet compared to the high crude protein diet[19]. However these researchers did also state that the economics depends on the cost of the raw crude protein source versus the cost of the synthetic amino acids supplements.

A study conducted by researchers[20] examined the reduction of GHG emissions in swine through diet manipulation. They found that a diet low in protein, with amino acid supplements, reduced CO_2 production by pigs by 2.5 percent to 6.1 percent compared to conventional diets. The overall reduction in GHG emissions (measured in CO_2 equivalents) by finishing pigs was 7.4 percent on a low protein corn based diet, and 14.3 percent on a low protein barley based diet. GHG emissions from sows were reduced by 16.4 percent on a low protein barley based diet. They concluded that diet manipulations reduce GHG emissions from both the pig and from manure.

Include Phytase Enzymes in Feed Rations

Greenhouse Gas Benefit

Phosphorous is an important nutrient for swine growth and development. However, hogs cannot digest much of the phosphorus contained in cereal grains. As such, mineral phosphorus is added to many swine diets to provide the necessary nutrient content. Unfortunately, much of this phosphorous is not easily utilized by the animal, resulting in a large proportion of the phosphorous being excreted in the manure. The addition of the phytase enzyme as a feed additive can reduce the amount of phosphorous in hog manure by increasing the digestibility of the phosphorus found in cereal grains, thereby reducing the need for inefficient phosphorous supplements.
In general, the addition of phytase in swine diets will allow the phosphorous content of the diet to be reduced by 0.1 percent and will improve feed utilization by one to two percent[21]. In addition, the benefits of phytase can be realized without an effect on hog performance, carcass quality, or bone strength[21].

Credit: Alberta Agriculture, Food and Rural Development

In addition to improving the digestibility of phosphorous by 27 to 30 percent, phytase also improves the digestibility of protein, thus reducing nitrogen excretion in manure[21]. Similar research results showed that phytase supplementation results in a 28 percent reduction in fecal and total nitrogen excretion[10]. This reduction of nutrients in the manure in turn will reduce the land-base requirements for manure phosphorous application. Including phytase in the diet also has additional benefits, such as:

- *Environmental benefits:* Since phosphorous in feed is poorly digested, most of it ends up in manure. With the use of phytase, the buildup of soil phosphorus levels is reduced when the manure is continually spread on a limited land base.
- *Improved nutrient efficiency:* Phytase can also increase the digestibility and availability of calcium and other trace minerals, which can improve feed utilization[5].
- *Economics:* Currently, phytase addition to the hog ration may increase feeding costs. The cost of the phytase may be offset by the savings associated with lower amounts of phosphorous and calcium supplements in the diet[5]. However, this depends on current prices of feed and supplements. Continual refinement of ration costs, based on available ingredients is recommended in order to balance minimal manure nutrient excretion with the lowest cost ration formulation.

Phase Feeding

Greenhouse Benefit

Hogs require different amounts of protein as they grow, therefore, protein content in feed needs to change for hogs in different growth stages to avoid feeding excess protein. Therefore, frequent changes in diet formulation to more closely match the changing requirements of the hog as it grows will decrease the quantities of excreted nitrogen, phosphorus, and other nutrients. Phase feeding allows rations to be modified to the nutrient requirements of the hog as it grows to limit the nitrogen and phosphorus excesses associated with feeding a single ration. Phased feeding also allows a producer to tailor energy requirements to the needs of the hog, thus reducing manure carbon content and methane production potential during manure storage.

Phased feeding combined with a reduced protein diet formulation can significantly reduce a farm's manure nitrogen production. Potentially, as a sample calculation, an operator, who is finishing 1000 hogs from 23 to 110 kg, and lowers crude protein by half a percent, about 1458 kg of manure nitrogen can be reduced (Table 2) if feed conversion efficiency remains constant.

Similarly, formulating separate diets for gestating and lactating sows may reduce nitrogen, phosphorus, and other mineral excretions by as much as 20 percent. In Ontario, calculations show that changing to a two-phase feeding system, the pigs' nitrogen needs would be met more precisely which would result in a 12 percent reduction in the amount of nitrogen in manure[5]. Therefore, this helps to limit the amounts of nitrous oxide emitted into the atmosphere, when the manure is land applied to meet the appropriate crop nutrient needs.

Table 2 – Potential Nitrogen Reduction in Manure[22]

Ration	High CP %	Low CP %
Grower	19.5%	19%
Finisher I	17.5%	17%
Finisher II	17%	16.5%
Manure Nitrogen Produced	5678 kg	4220 kg

Split-Sex Feeding

Greenhouse Gas Benefit

Split sex feeding also helps to reduce the amounts of nitrogen and phosphorus excreted in hog manure. Gilts fed to appetite consume less feed than barrows, but gilts have similar or greater lean tissue growth rates. Therefore, diets for gilts need higher levels of amino acids and other nutrients than barrows. When put in mixed sex groups, diets tend to be over-formulated for barrows, which result in greater amounts of nutrient excretion. Furthermore, an increased fat deposition and decreased rate of lean deposition occur at an earlier growth stage in barrows than in gilts; thus dietary protein and amino acid levels can be more precisely changed at different growth stages for each sex[23]. Through split-sex feeding, feed intake for each gender can be met, which reduces input costs and the amounts of nitrogen and carbon excreted in the manure.

Credit: Ontario Farm Animal Council Animal Agricultural Photo Library

Wet/Dry or Liquid Feeding Systems

Greenhouse Gas Benefit

Wet/dry feeders increase feed efficiency by reducing the amount of feed required to achieve a desired weight gain. This means less nitrogen is excreted in the manure and also decreases the amount of manure produced. Preliminary results from the Prairie Swine Centre Inc. indicated that manure volume was reduced by up to 43 percent and average daily gain of pigs was 1.2 to 7.4 percent higher using wet/dry feeders versus dry feeders[24].

An additional benefit is that wet/dry feeders are reported to reduce pig water usage by 10 to 40 percent in the growth-finisher area[21], therefore reducing both energy costs and GHG emissions. Reduced barn water use produces a less-dilute manure, which translates into reduced energy and transportation costs to handle the manure nutrients. This will allow manure to be transported further at a similar cost, and allows a producer to apply manure nitrogen to a larger land base and avoid a high nitrogen concentration buildup close to the production site. Spreading a less-dilute manure can also reduce the production of nitrous oxide emissions from soil as soils will be less saturated after manure application, compared to a more watered down manure product.

Currently Alberta Pork is conducting a year long research and demonstration study in High River comparing different nipple drinkers to water conserving ball-bite drinkers to determine their impact on pig water consumption in a fully slated grower barn. The impact on the ease of manure handling, manure nutrient composition, and the effect of feed crude protein content on water use will also be examined. If the manure volume can be reduced by using a water conserving drinker system, the GHG emissions associated with handling manure from the farm may be reduced. For more information about this study, contact Dennis McKerracher at Alberta Pork at (780) 474-8288.