Careful nutrient management is needed to deal effectively with the increased density of the pork industry in some areas and the increased public concerns regarding nutrient excretion and odour emissions. Successful management of nitrogen and phosphorus is key for sustainable pork production to address these public concerns. For example, nitrogen excretion in the form of ammonia is a concern because of its impact on the work environment inside the barn and also outside the barn for its potential impact on the environment. Swine production has been recognized as a major source of ammonia, which is a noxious gas for humans and animals and contributes to bad odour. The main component of ammonia emission originates from excretion of nitrogen in the form of urea in urine. Faecal nitrogen is less volatile than urinary nitrogen, because faecal nitrogen is bound chemically within proteins or other compounds. Phosphorus is excreted in urine and faeces, and could have a major impact on the environment if not managed properly.

Two projects are discussed in this article, and each project was focused toward specific dietary manipulations to alter nutrient excretion. Specific actions to improve nutrient digestibility should coincide with a reduced nutrient excretion in the faeces. Over-supplementation of diets with nutrients to ensure maximum pig performance may cause excessive amounts of nutrients excreted in faeces and urine, and pigs should be fed closer to their requirement to reduce nutrient excretion. Finally, the ratio of nitrogen excreted in urine versus faeces can be affected using dietary manipulations. Project 1 investigated two nutritional strategies, dietary particle size reduction and enzyme supplementation, as a means to increase nutrient digestibility and thereby reduce nitrogen and phosphorus excretion. Project 2 investigated reducing dietary protein and fermentable fibre as means to alter nitrogen excretion.

**Project 1: Particle size and enzyme supplementation**

Three dietary particle sizes (400 mm, fine, 4/64”-screen; 700 mm, medium, 8/64”-screen; 850 mm, coarse, 10/64”-screen) were obtained by grinding barley and field pea samples across different hammermill screens. Four enzyme treatments (control; carbohydrase [α-glucanase with xylanase], CHO; phytase, PHY; and PHY + CHO) were also compared in the same study. Phytate and fibre (including α-glucans and xylans) can be regarded may reduce nutrient digestibility. Diets were based on barley (70%) and peas (25%).

A fine particle size reduced faecal nitrogen excretion by 15 and 18% compared to the medium and coarse particle size, respectively.

Grinding ingredients more finely will thus improve nitrogen digestibility, but it will be at the expense of increased energy costs and time required to grind ingredients. Practical aspects of feeding diets with finely-ground ingredients have not been determined, for example wear of the hammers or bridging of feeders. Unlike the decreasing effect on faecal nitrogen, urinary nitrogen excretion increased by 13 and 15% with medium and fine particle size, respectively, compared to coarse particle size (Figure 1).

Overall fine particle size reduced total nitrogen
available phosphorus costs around $25/kg. Based on these assumptions, the value of the phosphorus released by phytase per tonne of feed may thus be as high as $13.50/tonne of feed.

Phytase and Diet Costs
Phytase supplementation reduced total nitrogen excretion by 4%, while carbohydrase supplementation lowered faecal excretion by 5%. Apparently, nitrogen digestibility was reduced by phytate and fibre, and these limitations were partly overcome by adding supplemental enzyme. Surprisingly, fine particle size reduced faecal phosphorus excretion by 12% compared to medium particle size (Figure 2). As expected, phytase supplementation reduced faecal phosphorus excretion by 28%, indicating that phosphorus digestibility in a diet including field peas and barley is limited by phytate. In this study, phytase released 0.54 kg available phosphorus per tonne of diet. Di-calcium phosphate presently costs around $473/tonne and each tonne provides 18.5 kg phosphorus; in other words, available phosphorus costs around $25/kg. Based on these assumptions, the value of the phosphorus released by phytase per tonne of feed may thus be as high as $13.50/tonne of feed.

Project 2: Reduced dietary protein and fermentable fibre
Two levels of dietary protein (high, 18.5% and low, 15.6%) and three sources of fibre (control, soy hulls (SH; 15%), and sugar beet pulp (SBP; 20%)) were tested. Diets (wheat, barley, soybean meal, and corn starch) were supplemented with synthetic amino acids to meet an ideal digestible amino acid profile.

Urinary nitrogen excretion was 26% lower for low protein compared to high protein diets (Figure 3), with a similar nitrogen retention or protein deposition. Urinary nitrogen excretion is therefore a reflection of excess nitrogen absorbed by the pig. Reduction of protein content while balancing for digestible amino acids is an effective way to reduce nitrogen excretion, especially urinary N and therefore ammonia emissions. Although average daily gain was not affected by reducing dietary protein, further research is required to maintain nitrogen retention.

Faecal nitrogen excretion was increased 6% for soy hulls and 9% for sugar beet pulp compared to control (expressed as a percentage of nitrogen intake; Figure 4). Percentage urinary nitrogen excretion was reduced 8% for soy hulls and 10% for sugar beet pulp compared to control. Soy hulls and sugar beet pulp contain fermentable fibre and this fibre functions as an energy source for bacteria in the large intestine. These bacteria use excess nitrogen in the pig as their nitrogen source, and nitrogen excretion is therefore shifted from urine to faeces. The reduced urinary nitrogen excretion will be directly related to a reduction in ammonia emissions. Voluntary feed intake and body weight gain and feed efficiency were not affected by adding sugar beet pulp to the diet. Using fibre sources high in fermentable carbohydrates can shift nitrogen excretion from urine (urea N) to faeces (protein-bound N), thereby reducing chances of ammonia emission.

For both the dietary treatments, there is a diet cost involved to reduce urinary nitrogen excretion. The actual cost will depend on the starting point for implementing the treatment. Using the diet price achieved with accurate nutrient requirements and least-cost diet formulation and the present ingredient prices as starting point, reducing dietary protein by 1%-unit in a wheat-based finisher pig diet may cost up to $10 per tonne of diet, and inclusion of 10% sugar beet pulp will cost $14 per tonne of diet. Clearly, dietary manipulations to reduce urinary nitrogen excretion work to reduce the environmental impact of the swine industry; however, the present cost to apply these strategies may hamper their implementation.

The Bottom Line
Nutrient management is becoming increasingly important for sustainability of the swine industry. Reducing particle size below 700 mm proved effective in altering nitrogen excretion patterns, while the addition of phytase proved very effective in improving digestibility of dietary phosphorus. The addition of carbohydrase showed little evidence of reducing total nitrogen or phosphorus excretion. A reduction of dietary protein content while balancing for digestible amino acids will especially reduce nitrogen excretion in urine. With dietary fermentable fibre, part of urinary nitrogen excretion can be shifted toward nitrogen excretion in faeces, and thus reduces volatile nitrogen that contributes to bad air quality. Together, results indicate that nitrogen and phosphorus excretion patterns can indeed be altered by diet manipulation.