IMPROVING PRODUCTION EFFICIENCY IN NURSERY AND FINISHER PIGS

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Volver a: Vº Congreso

Globally, pork production has becomes a very competitive industry. Consumers continue to demand safe, high quality pork products at competitive prices compared to other high protein food alternatives. To ensure sustainability of the swine industry, pork producers must continue to look for technologies to improve production efficiency while lowering cost of production and producing a quality product. This paper will review some of the key nutritional strategies that US Swine producers are using in nursery and finisher pigs to improve production efficiency and profitability.

Improved production efficiency in the pig actually starts in the farrowing facility. Table 1 (Provimi Research, 1997) shows the impact of initial pig weight entering the nursery on final pig weight out of the nursery. Data from over 60,000 nursery pigs in our commercial nursery indicates that for every 1 kg heavier pig entering the nursery there is a 1.63 kg heavier pig at 45 days. Research at Ohio State (1991) reported that pigs weighing 4-5 kg at weaning reached 105 kg body weight 8 days later than pigs weaned at 5.5 kg or higher. Therefore, developing sound sow nutrition and piglet management programs in the farrowing facility to result in maximum weaning weights will promote improved nursery-finisher p erformance.

Table 1. Impact of Initial Weight on Final Nursery Weight

Initial Weight, kg	Predicted Final Weight, kg
3.6	19.8
4.1	20.6
4.5	21.2
5.0	22.0
5.5	22.9
5.9	23.5
6.4	24.3
6.8	25.0

*[13.89+(iwt*1.63)] , *N=2,840 Pens (22 pigs/pen),45 Days;* R^2*=.27*
Provimi Research, 1997

NURSERY PHASE

Prestarter Diets

Numerous research trials have clearly shown that performance the first week following weaning has a dramatic effect on future pig performance. Kansas State University (1992) reported that piglets gaining less than 150 grams the first week following weaning took four more days to reach market weight compared to piglets gaining over 150 grams (Table 2). To ensure good nursery-finisher performance, producers should feed a highly palatable and digestible prestarter diet that promotes rapid gains for the first 7 days post weaning.

Table 2. Effect of week one performance on subsequent performance to market.

Daily gain 1st week after weaning (g)	Post-weaning weight, Kg			Days to Mkt
	28 days	56 days	156 days	
< 0	**14.7**	30.1	**105**	**183**
0 - 150	16	31.8	108	179
150 - 250	16.9	32.5	111	175
> 250	**18.2**	34.7	**113**	**173**

Kansas, 1992; Average initial wt. 6.2 kg

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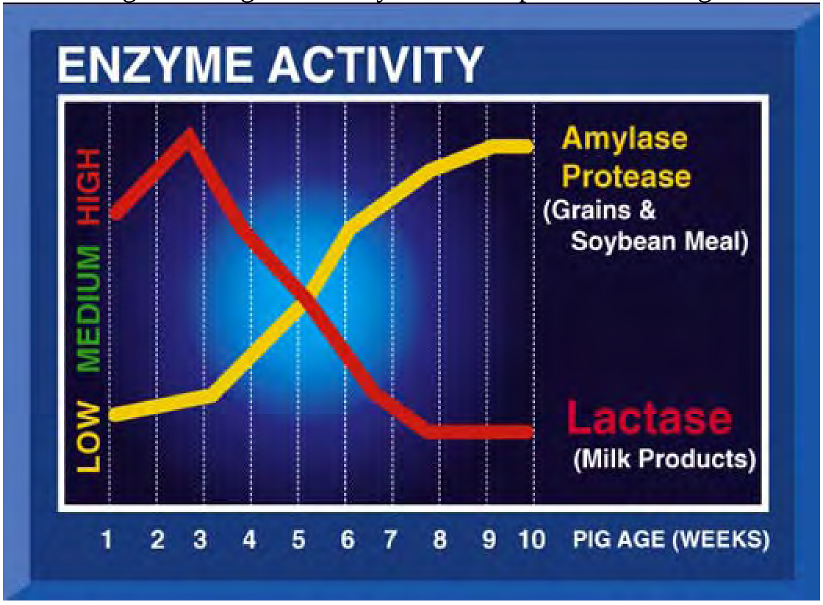
The following feeding and management strategies are proven to improve post-weaning nursery performance:

1) Encourage early water consumption
2) Keep feed fresh
3) Optimize temperature and ventilation
4) Stimulate early feed consumption by mat and/or gruel feeding
5) Feed highly palatable diets designed for the young pig

Digestive Enzyme Development

The enzyme activity in the young pig's digestive tract changes dramatically during the first 6-8 weeks following birth (Figure 1). The rate of digestive enzyme development depends on age at weaning, health status, environment, management and nutrition provided to the pig. To ensure that nursery diets are both palatable and digestible it is important to understand this enzyme development process and develop diets that work with this biological system. Prestarter diets high in whole grains and soybean meal vs. processed grains, blood proteins, milk proteins and liquid fat will result in lower feed intake and reduced gains the first week post-weaning.

Figure1. Digestive Enzyme Development in the Pig



Himmelburg (1988) fed 21 day old weaned pigs a simple corn-soybean meal diet vs. a complex diet containing multiple protein sources plus fat. He noted 120 grams per day higher gains for pigs fed the complex diet (Table 3) compared to the simple diet. He also showed that pig performance was higher the longer he fed the complex diet. Ingredient types and inclusion levels in nursery diets should be adjusted through out the first 6-7 weeks following weaning to account for these changes in digestive capacity.

Table 3. Performance of Pigs fed a Simple Vs. Complex Nursery Diet.

Diet Type	ADG, gms
Simple	270
Complex	390

Pigs were weaned at 3 weeks of age: 28 day trial, Himmelberg, 1988, Univ. of Nebraska

Amino Acid Nutrition

Due to the young piglets high lean vs. fat growth it is important to provide diets that are high in amino acid density during the nursery phase. We have conducted 50+ feeding trials (900 -1000 pigs per trial) over the last 7 years to more clearly define the optimum amino acid requirement of the nursery pig. Results from these trials have shown that the level of each amino acid and the ratio of one amino acid to another in the diet can have dramatic effects on piglet performance.

Table 4. Effects of Amino Acid Balance on Prestarter Performance (10 day trial)

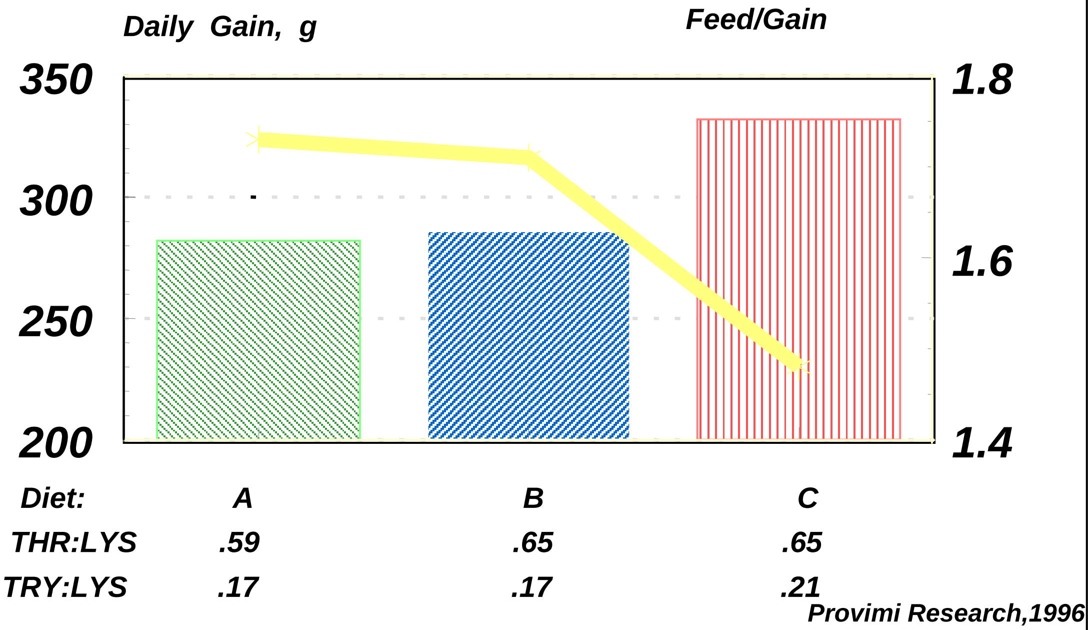


Table 4 shows how improving the amino acid balance in a nursery diet can enhance pig performance. Increasing the threonine: lysine ratio in prestarter diet B had a slight positive effect on both gain and feed/gain compared to diet A. However, increasing both the threonine: lysine and the tryptophan: lysine ratios together (diet C) greatly improved pig performance. We now formulate nursery diets for exact levels of six limiting amino acids rather than lysine alone. This results in higher gains, improved feed efficiency and lower cost of gain for nursery pigs.

PHASE AND BUDGET FEEDING

To meet the changing nutrient demands of the early-weaned piglet and control diet cost producers have implemented multi-phase nursery feeding programs that change diets based on feed intake and digestive enzyme changes (Figure1). Phase feeding program allows a producer to fine-tune the nursery diets to optimize performance and control cost of production. The key factors to consider in designing a starter feeding program are: 1) Age and weight at weaning, 2) Length of time in nursery, 3) Number of diets to be fed, and 4) producer goals and expectations. Table 5 shows an example nursery phase feeding program for piglets weaned at 22 days of age. Research in our commercial nursery as well as field data has confirmed that budget feeding a four phase nursery program from 5-25 kg will optimize performance and cost.

Table 5. Designing a Starter Feed Program.

Farm A

Weaning Age: 22 Days
Weaning Wt.: 5.5 Kg.

Number of Feeds: 4 Diets
Time in Nursery: 7 Weeks

5,5 Kg — 13,5 Kg — 25 Kg

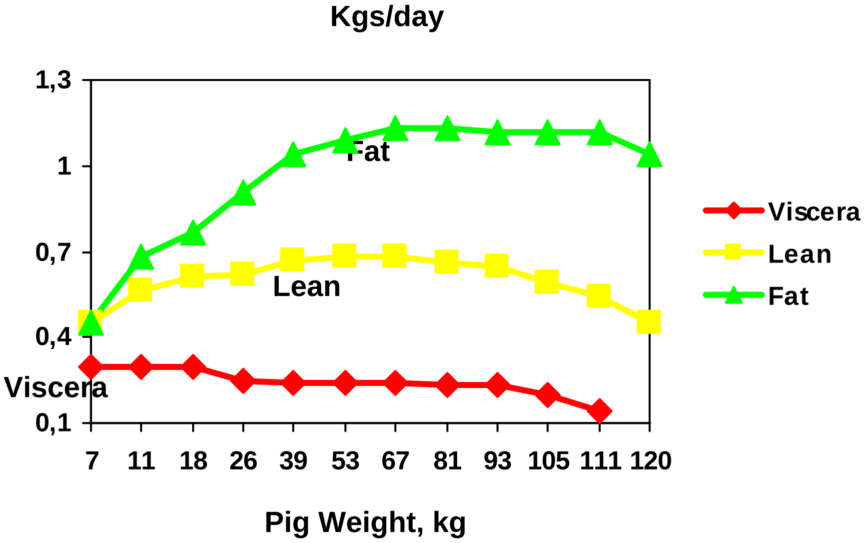
1	2	3	4

	Budgt, Kg	Diet
1	1	Prestarter 1
2	4	Prestarter 2
3	6.5	Starter 1
4	20	Starter 2
Total Feed	31.5 Kg	
F/G	1.62	

FINISHING PHASE

To properly formulate diets for finishing pigs it is very important to understand the rate and composition of the gain in the pig. Figure 2 shows the total tissue accretion curve of a pig from 7 to 120 kg. Note that the rate and composition of the weight gain changes as the pig increases in body weight. Viscera gain decreases while lean and fat gain increases. The amount and ratio of lean to fat gain is very dependent on the genetic potential of the pig for lean growth. Over the last 10 years, dramatic genetic improvements in the potential for lean growth have occurred. Some pigs can now approach .8 kg of lean gain per day at 60-70 kg of body weight.

Figure 2. Total Daily Tissue Accretion Curve in the Pig.

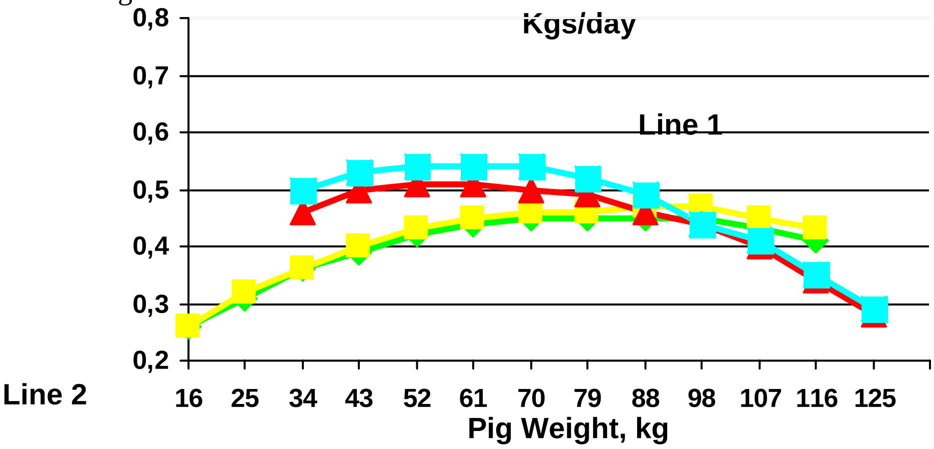


Campbell et al., 1985

NUTRITION-GENETIC INTERACTIONS

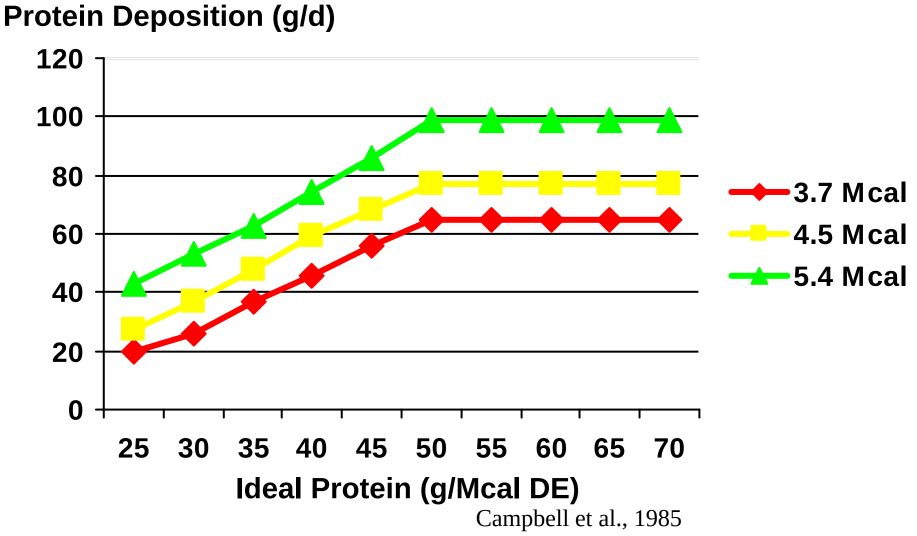
Genetic differences in the pig can affect their response to increased levels of amino acids and energy in the diet. Figure 3 shows the response of two genotypes to increasing the ME level (added fat) in the diet. Line 1 responses to fat addition while line 2 does not. Also note that the response in line 1 is greater in the grower phase vs. the finisher phase. It is important to understand the nutrition-genetic interaction when designing finisher feeding programs.

Figure 3. Effect of Genetic Line and ME Level on Lean Gain. Provimi Research, 1993



We have tested over 25 different genotypes during the last 15 years in our research program. Our studies are designed to identify the nutrient requirements of the genotype for maximum genetic potential by varying the nutrient density of the test diets. We have seen large differences between genotypes for key amino acids and energy. In fact we have found that each genotype has an ideal amino acid to energy ratio at which, gain, feed efficiency and carcass quality are maximized. This concept is shown graphically for ideal protein in Figure 4. The ideal amino acid to energy ratio will vary at different points on the growth curve. This is primarily due to the changes in rate and composition of the gain (Figure 2).

Figure 4. Relationship of Protein Deposition to Protein:Calorie Ratio Fed at 3 Levels of DE Per Day



Recently we validated this lysine:calorie concept in two high lean genotypes marketed in the US. Gilts were fed one of four diet regimes (4 phases) varying in lysine to calorie ratios. Overall performance data for the two genotypes (across all four treatments) are shown in Figure 5-7. Line 2 gilts gained .916 kg/day vs. .866 kg for Line 3 gilts. Average daily feed intake was almost identical at 4.75 kg/day. The improved gain for Line 2 gilts at the same feed intake resulted in improved feed efficiency for Line 2 gilt. The biggest differences in feed to gain ratio occurred after 60 kg. The overall data (by line) was then used to predict the optimal lysine calorie ratio needed to optimize daily gain. We found that Line 2 gilts require a higher lysine to calorie ratio (1.3 g lysine/kg) compared to Line 3 gilts (Figure 8). Having this valuable information allows the nutritionist to be more accurate in developing feeding programs for different genotypes.

Figure 5. Daily Gain (kg) for Genetic Line 2 and 3 Gilts.

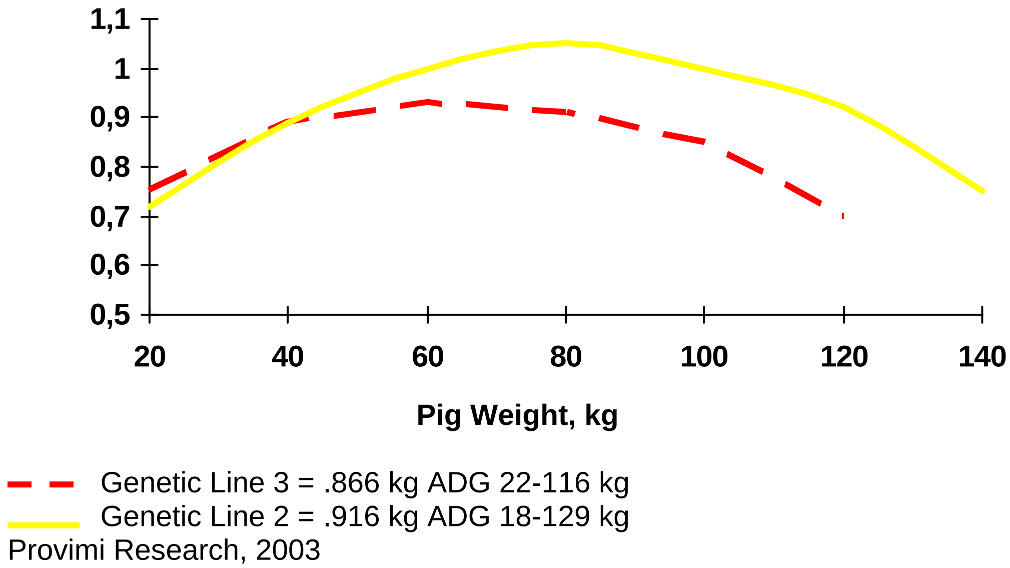
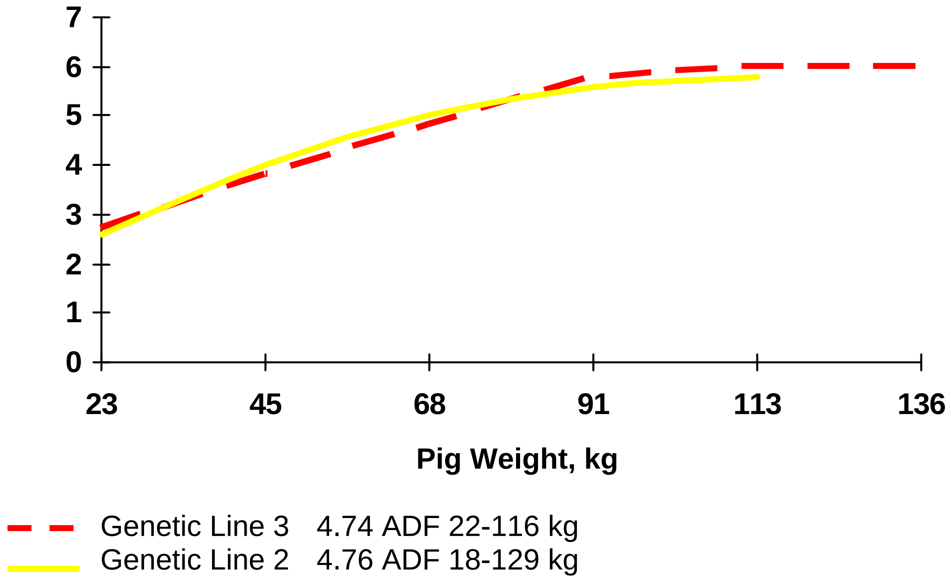
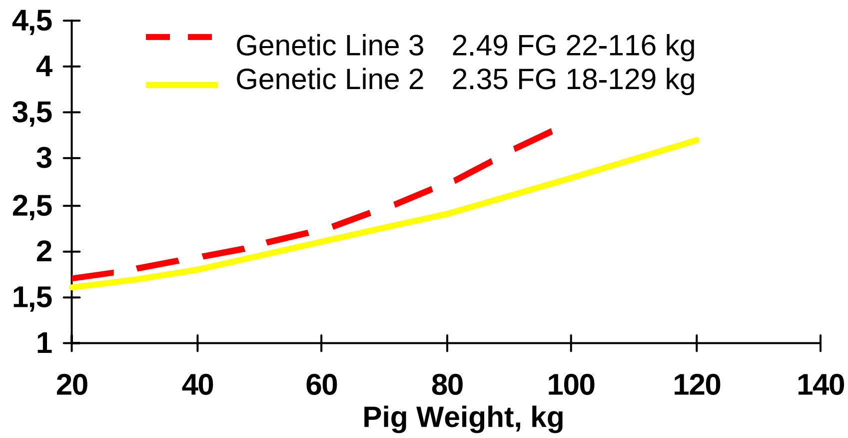


Figure 6. Daily Feed Intake (kg) for Genetic Line 2 and 3 Gilts.



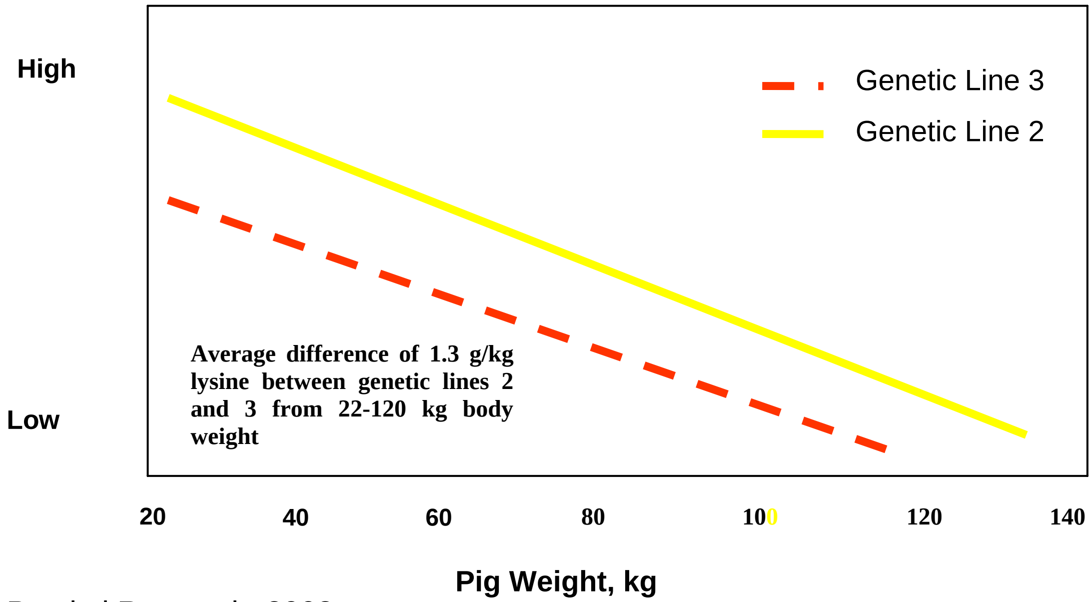
Provimi Research, 2003

Figure 7. Feed to Gain Ratio for Genetic Line 2 and 3 Gilts.



Provimi Research, 2003

Figure 8. Lysine: Calorie Ratio to Optimize Daily Gain in Genetic Line 2 vs. 3 Gilts.



Provimi Research, 2003

ECO-NUTRITION

There are many critical eco-nutrition issues that we must address in the swine industry today. The primary ones affecting producers in the US are: 1) odor pollution, 2) nitrogen pollution, and 3) phosphorus pollution. A number of feed additives (IE. Yucca products) have been developed and used today to help reduce ammonia levels in swine barns. Governmental regulations are currently being developed to control or limit nitrogen and phosphorus levels in soils. These regulations will require that we minimize the quantities of water, nitrogen and phosphorus entering the barn , maximize their retention (utilization) within the pig carcass, and thus minimize their elimination into the external environment. Nutritional technologies are available today to assist swine producers with solutions to these critical eco-nutrition issues.

High Amino Acid Supplemented Diets

Research has determined that swine have a daily requirement for up to 10 key amino acids rather than for total protein. Historically, we have evaluated the quality or density of a swine diet by its crude protein level. The quality and suitability of a swine diet should be based on its individual amino acid levels not crude protein. Up until 2-3 years ago the cost of supplementing individual amino acids rather than high protein supplements (i.e., soybean meal) was more expensive. However, many suppliers of amino acids have improved the efficiency and volume of amino acid production. This has resulted in lower amino acid costs for the four most limiting amino acids. High amino acid supplementation to swine diets now offer both a means to lower nitrogen excretion into the environment and a lower production cost.

Many research trials have been conducted to validate that high amino acid supplemented diets will perform equal to high crude protein diets. Some trials have shown that feed efficiency and carcass quality may be slightly poorer with low protein amino acid supplemented diets. It is very important to understand the requirements for amino acid levels and ratios when developing these diets.

We have conducted a number of finisher trials to determine the limitations and opportunities to maximize the use of synthetic amino acids in swine diets. In a recent trial a five-phase feeding program was fed that varied in amino acid supplementation levels from high to low (Table 6). Daily gain and feed intake were not affected by amino acid level. (Table 7). However, feed efficiency decreased linearly with increasing level of amino acid supplementation. Carcass quality was not affected by level of amino acid added. This data supports the use of high amino acid supplementation in swine finisher diets. The most cost-effective level of amino acids to supplement will depend on feed ingredient and amino acid cost.

Table 6. Effect of Lysine-HCl Level on Growth Performance
Lysine-HCl Level, kg/1000 kg

Treatments:	Hi	Medium	Low
Phase 1	3.0	3.0	1.75
Phase 2	3.0	3.0	1.75
Phase 3	3.0	3.0	1.75
Phase 4	3.0	2.25	1.5
Phase 5	3.0	1.5	1.5

Diets balanced to ensure threonine, methionine, and tryptophan were not limiting.
35 – 118 kg Feeding Range
Provimi Research, 2002

Table 7. Effect of Lysine-HCl Level on Pig Performance From 34 to 118 kg.
Lysine-HCl Level, kg/1000 kg

	High	Med	Low	SEM
ADG, kg/d	.77	.78	.80	0.019
ADFI, kg/d	2.05	2.02	2.06	0.036
Feed to Gain [a]	1.20	1.17	1.17	0.020
Carcass Yield, %[b]	75.1	74.1	75.3	0.431
Lean Yield, %	54.3	54.3	54.8	0.324
Carcass Backfat, mm	17.8	17.8	17.8	0.020

[a] Lysine linear P<.05
[b] lysine quadratic P<.05
Provimi Research, 2002

At high soybean meal and low to moderate amino acid costs (2003/04) we successfully used very high amino acid supplementation levels while maintaining animal performance and reducing overall production cost. We have some producers that continue to use high amino acid levels to reduce nitrogen levels in the manure. Research has shown that for every one percent reduction in crude protein there is approximately an 8 percent reduction in nitrogen excreted in the feces (Gaines, et al., 2003).

PHYTASE SUPPLEMENTATION

Phytate is a form of bound phosphorus present in many feedstuffs that reduces phosphorus digestibility by the pig. In corn-soybean meal diets, over 35% of the phosphorus present is in the phytate form. Due to this phytate phosphorus, we add organic phosphorus (Dicalcium Phosphate) to pig diets to increase the available phosphorus level and meet the animal's requirement. The phytate phosphorus is excreted in the feces and leads to high levels of phosphorus where swine effluent is applied.

Phytase is a commercially produced enzyme that breaks down the phytate compound and releases the phosphorus from ingredient for use by the animal. Diets supplemented with Phytase are higher in available phosphorus, therefore reducing the level of organic phosphorus that is added meet the animal's requirement. This lowers the total level of phosphorus in the diet and the amount of phosphorus excreted by the animal. Phytase technology allows producers a means to control the level of phosphorus contained in their waste management plans.

Table 8 presents the results of a finisher trial we conducted to compare the performance of pigs fed diets with and without phytase. Overall pig performance was numerically improved with phytase addition. Fecal phosphorus was reduced by 25%. It is estimated that over 85% of the finisher pigs in the US are currently fed diets containing phytase.

Table 8. Effect of Phytase on Grow-Finish Pig Performance

	Control	Phytase	Diff., %
Initial Wt., kg	24.9	25.2	
Final Wt., kg	112.6	112.5	
Days on Feed	102	97	-4.9
Daily Gain, kg	0.86	0.89	4.2
Daily Feed, kg	2.48	2.54	2.7
Feed/Gain	2.88	2.84	-1.4
Fecal P, %	1.43	1.06	25.9

Four-phase G/F program used with 500 FTU/kg in diets 1 & 2 and 270 FTU/kg in diets 3 & 4.
Phosphorus reduced to NRC levels in Phytase diets. 235 pigs per treatment.
Provimi Research, 1998.

The cost of feeding phytase will primarily depend on the ingredient cost for organic phosphorus and the phytase enzyme. For diets formulated on energy density, fat prices will also be a factor. In the US, diets containing phytase are lower in cost due to decreasing phytase enzyme cost and increased organic phosphorus cost.

SUMMARY

Swine producers will continue to be under pressure to increase productivity while maintaining or lowering production cost. This paper has presented some of the key nutritional strategies currently used in the US to increase production efficiency in nursery and finisher pigs.

Designing and implementing a phased nursery feeding program that optimizes the digestive capacity of the pig will result in the best cost of production. Budget feeding also helps ensure that the correct diet is being fed at each step in the program.

Continued changes in the genetic potential of finishing pigs require that we understand the rate and composition of growth in different genotypes. Using this knowledge we can design feeding programs with the optimum amino acid and energy level to maximize the genetic potential of the pig.

Eco-nutrition is becoming more important in swine production. By using amino acid and enzyme technology we can now manage the efficiency of nitrogen and phosphorus utilization on swine farms to meet both nutritional and environmental requirements.

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