NURSERY PIG NUTRITION AND MANAGEMENT
PART 1: DIET FORMULATION

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Weaning pigs at 5 to 14 days of age has provided a new challenge for nutritionists. These 2.5 to 5 kg pigs need a palatable, dry diet that will allow them to achieve performance expectations. This challenge has been met and exceeded as many feed companies are currently offering a feeding program tailored to the needs of the segregated early weaned (SEW) pig. Feeding programs are available that allow excellent growth performance with extremely young pigs. Before adopting an SEW program or discussing individual diets, producers must consider the many unique challenges of feeding SEW pigs. Thus, this paper has been written in two parts. In part 1, key aspects of diet formulation for SEW pigs will be presented and discussed. In part 2, feeding management procedures will be discussed. We find that feeding management is as important as diet formulation.

PHASE FEEDING STRATEGY

A key challenge in feeding the SEW pig is devising a phase feeding strategy that encourages maximal feed intake and performance, while minimizing feed cost from weaning to 23 kg. Results of recent trials at Kansas State University indicate the traditional three-phase nutritional program should be altered for SEW management.

The research indicated a four-phase nutritional program should replace the traditional three-phase nursery program for pigs weighing less than 5 kg at weaning (Table 1). A complex, highly palatable SEW diet is designed for pigs weighing less than 5 kg. Due to economical considerations, a less complex, transition diet is used in SEW phase-feeding programs to replace the traditional phase I diet from 5 to 7 kg. From 7 to 11.5 kg and 11.5 to 23 kg, the recommended diets are similar for SEW and conventionally weaned pigs.

Regardless of the phase feeding strategy that a producer or feed company decides to employ, development of a proper feed budget will help keep nursery feed costs competitive. The feed budget should be used as a target for the amount of each diet that each pig receives from weaning to 23 kg. An example feed budget listed in Table 2 is for the diets proposed in Table 1. This budget should be adapted to the weight of pigs on a particular operation after the optimal weaning age is determined. Strict discipline when using an accurate feed budget is critical to prevent feeding the expensive diets longer than the desired weight range. Often, this is the major cause of high feed cost in the nursery. Recently, many of our producers have had great success in limiting cost by reducing the quantity of each diet that must be fed. For example, the quantity of SEW and transition provided per pig is lowered from 1 and 2.25 kg/pig to .5 and 1 kg/pig, respectively. In order for a major reduction in the feed budget to work well, several critical pieces must be in place including: 1) receiving a high quality

weaned pig, 2) excellent facilities and management, and 3) excellent quality ingredients and pellets in the diet.

Table 1. Sequence and composition of phase-feeding programs for early or conventionally weaned pigs.

Early Weaning (10-17 days of age)	Pig Weight	Conventional Weaning
SEW Diet	< 5 kg	
Transition Diet	5-7 kg	Phase 1
Phase 2	7-11.5 kg	Phase 2
Phase 3	11.5-23 kg	Phase 3

SEW Diet

Corn based
1.7 to 1.8% Lysine
.48 to .5% Methionine
18 to 25% Lactose
5 to 8% Spray-dried porcine plasma
10 to 15% Soybean meal
6% Added fat
1 to 2% Spray-dried blood meal
3 to 6% Select menhaden fish meal
Pelleted

Transition Diet

Corn and soybean meal based
1.5 to 1.6% Lysine
.42 to .44% Methionine
15 to 20% Lactose
2 to 3% Spray-dried porcine plasma
20 to 30% Soybean meal
3 to 5% Added fat
2 to 3% Spray-dried blood meal and/or
3 to 5% Select menhaden fish meal
Pelleted

Phase 1 Diet

Corn based
1.5 to 1.6% Lysine
.42 to .44% Methionine
15 to 25% Lactose
5 to 8% Spray-dried porcine plasma
15 to 20% Soybean meal
5% Added fat
0 to 3% Spray-dried blood meal or
select menhaden fish meal
Pelleted

Phase 2 Diet

Corn and soybean meal based
1.35 to 1.45% Lysine
.37 to .40% Methionine
10% Edible-grade dried whey or
lactose equivalent
2 to 3% Spray-dried blood meal or
4 to 5% Select menhaden fish meal
0 to 5% Added fat
Pellet or meal form

Phase 3 Diet

Corn and soybean meal based
1.25 to 1.35% Lysine
.34 to .37% Methionine
No added specialty ingredients
Pellet or meal form

Table 2. Feed allowances per pig (weaning to 23 kg) for various phase feeding programs

	Weaning age, days			
Diet, kg	7	14	21	24
SEW	2.25	1	-	-
Transition	2.25	2.25	-	-
Phase 1	-	-	1.8	.7
Phase 2	7	7	7	7
Phase 3	22	22	22	22

AMINO ACID LEVELS

Nutrition for the SEW pig is a relatively new area of research. Amino acid levels have received the most attention and we are only beginning to understand the amino acid requirements of these high health pigs. Research from Iowa State University has demonstrated that 5 to 25 kg SEW pigs have higher amino acid requirements than conventionally-reared piglets (Figure 2). The amino acid requirements of the SEW pig have been further refined with additional research at Kansas State University. The 4 to 7-kg pig requires approximately 1.6% lysine (3.6 grams) to maximize daily gain and feed efficiency. (Figure 3). The research from Kansas State University and Iowa State University also demonstrates that the amino acid requirements for SEW pigs remain much higher than previous expectations. Amino acid recommendations in Table 3 have been developed from these trials.

Figure 2. Influence of Immune activation on lysine requirement

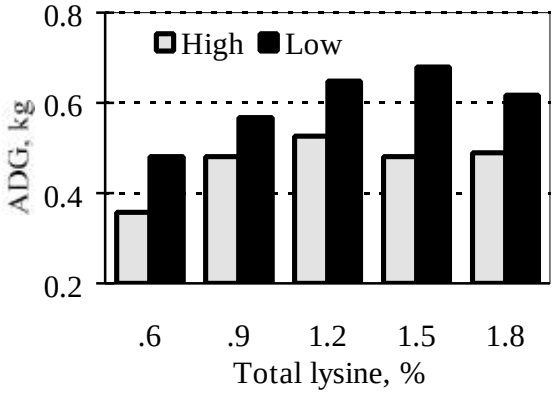

Figure 3. Influence of lysine level on growth rate from 4.5 to 7 kg

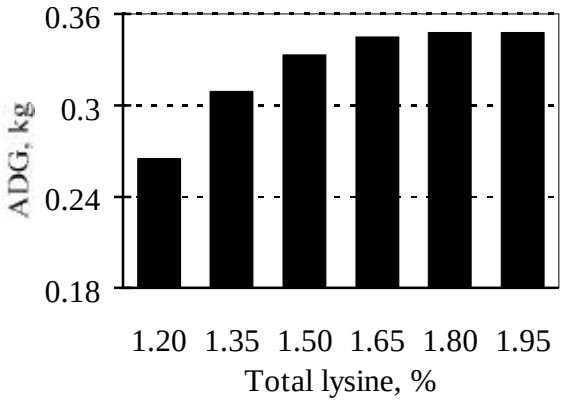

Table 3. Recommended lysine levels for segregated early weaned pigs.

Diet	Pig Weight, kg	Total Lysine, %	Digestible Lysine, %
SEW	< 5	1.7 - 1.8	1.4 - 1.5
Transition	5 - 7	1.5 - 1.6	1.25 - 1.35
Phase II	7 - 11.5	1.35 - 1.45	1.10 - 1.2
Phase III	11.5 - 23	1.25 - 1.35	1.05 - 1.15

Other amino acids also must be maintained in the proper ratio to lysine to achieve optimal performance. For example, research has shown that the correct methionine:lysine ratio is as important as the total lysine level in the diet (Figure 4; trial conducted from 3.8 to 8.3 kg body weight). Appropriate levels of other amino acids relative to lysine, as adapted from research at University of Illinois and Kansas State University, are shown in Table 4.

Figure 4. Influence of methionine: lysine ratio on average daily gain

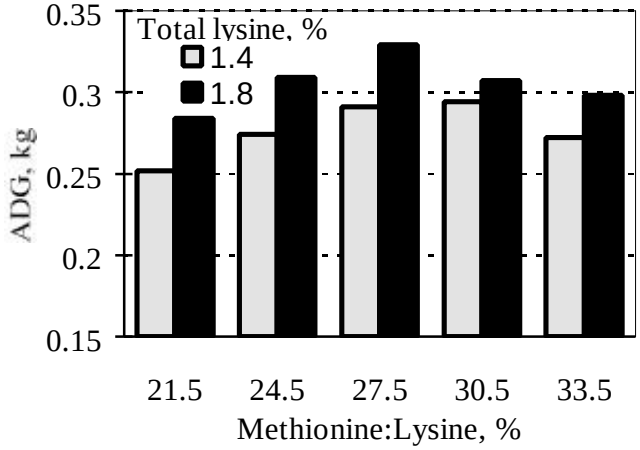

Table 4. Recommended level of amino acids relative to lysine

Amino Acid	Ratio
Lysine	100
Isoleucine	60
Methionine	27.5
Met & Cys	55
Threonine	65
Tryptophan	18

SEW DIET (Weaning to 5 kg)

The high amino acid fortification of the SEW diet necessitates multiple protein sources to meet the young pig's nutritional needs. Several of the following protein sources are often used in combination in the SEW diet to meet the amino acid requirements and to stimulate feed intake: porcine plasma, fish meal, skim milk, whey protein concentrate, spray-dried blood meal, soybean meal, and further processed soy products.

The only protein source considered to be essential in this diet is spray-dried animal plasma. Although plasma is expensive, it is necessary to encourage maximal feed intake in the period when getting pigs on feed immediately after weaning. Increasing the level of plasma from 0 to 15% in the diet for SEW pigs results in a linear increase in pig performance. However, the greatest portion of the

response is evident with the first 5% inclusion of plasma. Thus, most nutritionists include plasma in SEW diets at 5 to 7% depending on the other protein sources included in the diet.

Spray-dried blood meal has a very high protein content (85 to 95%) and thus, can be used in the SEW diet in small quantities as a concentrated amino acid source. However, both spray-dried blood meal and blood plasma are deficient in methionine. As illustrated in Figure 4, it is critical that synthetic methionine is added to the SEW diet for optimal performance.

A high quality fish meal or whey protein concentrate is often used as an additional protein source to encourage feed intake and to achieve the correct amino acid levels. Dried skim milk is still being used in this diet in some instances. However, research has indicated that the skim milk can be replaced with much lower cost protein sources without sacrificing performance. In fact, some trials have found improved feed intake when removing skim milk from the diet.

The source and level of soy protein in diets for early-weaned pigs has been a controversial subject among swine nutritionists. Some nutritionists believe soybean meal should not be included in the first diet after weaning to prevent an allergic reaction to the unprocessed soy protein. These nutritionists typically will use a further refined soy protein such as soy protein concentrate, isolated soy protein or extruded soy protein concentrate to replace the soybean meal portion of the diet. If a refined soy product is used in the diet, several research trials have demonstrated an advantage to the moist extruded soy products compared to soy products that have not been moist extruded.

Other researchers take a different approach. They believe that exposing the young pig to increasing levels of soybean meal in each diet will allow them to overcome the hypersensitivity to soy protein more quickly without causing a long-term reduction in pig performance. The second approach also is substantially less expensive than the first.

The appropriate level and source of soy protein for the SEW pig is not well researched. We choose to recommend a low level of soybean meal in the SEW diet as a means of acclimating the young pig to soy protein. We also believe that early exposure to soy protein may be more beneficial than negative. Pigs are born with an immature immune system. Over the first few weeks of life, the immune system is educated to distinguish between native and foreign proteins. If exposed to foreign proteins, such as soy protein, at a very young age, the immune system will be trained to recognize them as native. The early exposure allows us to include soybean meal at higher levels in subsequent diets without reducing growth performance.

The appropriate carbohydrate source is yet another area of controversy. Although it is well accepted that high levels of lactose must be included in the SEW diet, some nutritionists believe the grain source is also critical. The SEW diet should contain 18 to 25% lactose. High levels of lactose are beneficial; however, care must be taken during processing as high levels of milk products increase the difficulty of pelleting the diet. A high quality, edible-grade dried whey is the most common source of lactose. Dried whey contains approximately 70% lactose. Research has shown that a high quality whey permeate (80% lactose) or straight lactose (100% lactose) can replace a portion of the dried whey in the diet. These other lactose sources become increasingly important due to their lower cost relative to edible-grade dried whey.

The controversy concerning carbohydrates is whether corn (or another grain source) or a further processed oat product should serve as the main grain source. Finely-ground oat products (oat groats, oat flour) improve product appearance and can improve stool consistency and pig appearance. However, research indicates there are no differences in pig performance when comparing oat flour to corn ground to 600 microns. Oat products are often two to three times the cost of corn. Thus, we recommend corn as the main grain source in the SEW diet. Wheat, barley, or hull-less oats can replace corn in the SEW diet without detrimental effects on performance.

The appropriate fat level in the SEW diet depends on the level of milk products in the diet and the skill of the pellet mill operator. Milk products are difficult to pellet. If the diet did not contain any added fat, the friction in the pellet die can become too great and denature the protein in the milk products. Typically, 5 or 6% added fat is sufficient to lubricate the pellet die. A high quality fat source, such as choice white grease, soybean oil or corn oil, should serve as the main fat source. Choice white grease is the most economical of these fat sources. Coconut oil is another excellent fat source for the young pig, but is simply too expensive to use in the diet. Tallow, restaurant greases, and poor quality yellow grease should not be used in the diet for early weaned pigs.

Growth promotant levels of antibiotics are normally included in the SEW diet. Research has demonstrated that 2,000 to 3,000 ppm zinc from zinc oxide is a better growth promotant for early-weaned pigs than the previous recommendation of copper sulfate. A low inclusion rate acidifier also improves growth and feed efficiency in the SEW diet. Do not overlook the importance of minerals such as sodium and chloride. Recent research at Ohio State University notes that the young pig cannot produce adequate hydrochloric acid in the stomach. Thus, addition of a chloride source is very important. Our recent research supports the requirement for sodium (>.25% of the diet) and chloride (>.5% of the diet) in great excess of previously suggested requirements.

TRANSITION DIET (5 to 7 kg)

The transition diet is a natural extension of the SEW diet and contains many of the same ingredients. The transition diet also is similar to the Phase I diet that would be used in a conventional weaning program. However, the complexity of the diet is decreased as the pigs are already consuming feed and do not need high levels of the complex ingredients to stimulate feed intake.

The main difference between a conventional phase I diet and the transition diet is the level of spray-dried plasma. Plasma is added to the diet primarily to increase feed intake. Since pigs receiving the SEW diet are adjusted to feed, the diet contains only 2 to 3% blood plasma compared to 6 to 8% in a phase I diet. Spray-dried blood meal or select menhaden fishmeal also may serve as major protein sources. Since the pigs were acclimated to soybean meal while being fed the SEW diet, the transition diet can contain higher levels of soybean meal (20 to 25%) without risk of hypersensitivity.

The lactose level in the transition diet also is decreased compared to the SEW diet. However, it is still critical that the transition diet contains at least 15% lactose for optimal pig performance. A high quality fat source (3 to 5%) is added to the transition diet for the same reason as the SEW diet

(improved pellet quality). As in the SEW diet, antibiotics, an acidifier, zinc oxide, sodium, and chloride should be maintained in the transition diet as growth promotants.

PHASE 2 (7 to 11.5 kg)

By the time the pigs weigh 7 kg in a SEW system, they already will have consumed 2 to 4 kg of feed. Feeding behavior is well adjusted and, thus, lower cost, less complex diets can be fed. The phase 2 diet is grain-soybean meal based with dried whey and spray-dried blood meal or fishmeal serving as the only specialty ingredients. It is crucial that high levels of amino acids are maintained in this diet to allow the pig to express its genetic potential. In order to reduce total feed cost, it is also crucial that spray-dried blood plasma is not included in this diet.

Many producers make this diet on their farm and feed it in a meal form. If an economical fat source, such as choice white grease, is available, the diet should contain 3 to 6% added fat. Antibiotics and zinc oxide are used as growth promotants in the phase 2 diet. Research indicates 2,000 ppm zinc is the optimal inclusion level.

Phase 3 (11.5 to 23 kg)

The phase 3 diet for SEW pigs is a simple grain-soybean meal diet formulated to higher levels of amino acids than needed with conventional weaning. This is the lowest cost diet in the SEW program. However, since consumption of the phase 3 diet is the greatest, it usually accounts for 50% of the total feed cost from weaning to 23 kg. Thus, phase 3 diet cost is critical. Specialty ingredients, such as blood meal, fishmeal or dried whey, are cost prohibitive. Research also has indicated use of specialty ingredients is unnecessary for maximal performance during this stage.

The fat level of the diet will depend on the ability of the producer or feed company to economically purchase fat. Pigs will respond with improved average daily gain and feed efficiency with increasing levels of fat in the phase 3 diet. Thus, 3 to 6% added fat is a common recommendation. High levels of zinc oxide should not be used in the phase 3 diet. Copper sulfate and antibiotics can serve as effective growth promotants.

CONCLUSION

Nutrition of the SEW pig is a relatively new field. Individual diets in the phase feeding system will continually be updated as new research becomes available. Current knowledge allows us to achieve excellent performance with economical diets. We simply must follow the basic rules of staging diet complexity and cost to match the weight of the pig, while not compromising on ingredient quality. Feed budgets are a critical component of an SEW nutritional program to avoid excess feed cost. Future breakthroughs will allow us to further reduce feed cost while maintaining the delicate balance between performance and economics.