Introduction

A successful nursery feeding program contains several components, but the most important are to: 1) match dietary nutrient levels and ingredients with weight and age of the nursery pig; 2) maximize feed intake, because newly weaned pigs are in an extremely energy deficient state and early intake helps maintain a healthy intestine; and 3) appropriately adjust pigs (based on age, weight, health status, etc.) to lower cost diets (usually grain-soybean meal diets) as quickly as possible after weaning to reduce total feed cost. The concepts are relatively simple and can be applied in a variety of situations around the world.

Objectives

Discuss nutritional and management considerations for the nursery pig, such as:
- Factors that influence diet formulation
- Detail phase feeding programs
- Ingredient usage in nursery diets
- Nutrient recommendations by nursery pig weight

Factors that influence diet formulation

*Match dietary nutrient levels and ingredients with weight and age of the nursery pig*

The rapidly changing and unique biology of the young pig must be considered in selecting sources and levels of amino acids, carbohydrates and fat. The main considerations for the young pig should be their: 1) high level of body protein deposition; 2) low level of feed intake; 3) developing immune system; 4) high lactase and low amylase, maltase, and sucrase digestive enzyme activities at birth (see Figure 1); and 5) limited ability to utilize dietary fat.

The newly weaned pig has a tremendous capacity for protein deposition in relation to the level of feed intake. Thus, diets must be formulated with high levels of digestible amino acids. Utilizing low digestible amino acid sources increase N flow to the intestine, possibly contributing to increased bacterial proliferation. The reduction of disease exposure will improve health status and increase the amino acid requirements of the young pig by increasing the level of protein deposition.

**Figure 1.** Adapted from Manners et al. (1972) [1] and Kitts et al. (1956) [2]
Because feed intake is limited, a highly digestible carbohydrate source is advantageous, both to stimulate feed intake and supply an available source of energy. This is even more important considering weaned pigs utilize dietary fat to a lower degree immediately post-weaning. The high lactase enzyme levels at birth and high digestibility of lactose make crystalline lactose or one of several lactose sources (dried whey, deproteinized whey, whey permeate, etc.) an excellent carbohydrate source for young pigs. As long as the diet contains a basal level of lactose, several other carbohydrate sources can be used for the remainder of the diet while achieving acceptable performance. When using a cereal grain as a main carbohydrate source (corn, sorghum, wheat, barley, or oat products), finely grinding these ingredients (600 to 750 microns) is important to improve digestibility and pellet quality. An important point in formulating diets for very young pigs (< 10 days) is their limited ability to digest sucrose at birth. Thus, sugar should not be used in diets for pigs less than 10 days of age.

The low feed intake of young pigs often leads nutritionists to feed high levels of fat to increase the energy density of the diet. Unfortunately, fat utilization from the diet is limited in the pig before approximately 35 days of age. Poor utilization of dietary fat is not well understood and may be due to a combination of factors including low digestibility during the initial period from changing fatty acid type compared to milk fat after weaning. Also, newly weaned pigs have limited ability to catabolize fat from body stores. However, added dietary fat is extremely important from a feed manufacturing standpoint because it helps lubricate the pellet mill die, and, thus, improves pellet quality of starter diets that contain high levels of milk products. The bottom line is that fat utilization increases with age and fat should be used strategically in the first diets after weaning as an aid in pelleting rather than as a main energy source. As the pig’s digestive enzyme systems mature and fat metabolism improves, fat can serve as an increasingly important energy source in dietary phases 3 and 4.

**Importance of feed intake**

Newly weaned pigs cannot consume enough feed to meet their energy needs for protein deposition. They are in a highly energy dependent state. Thus, providing energy in a form that the piglet can utilize results in improvements in growth rate and lean deposition. Comprehension of this concept will lead to an understanding of the varying responses to diet complexity in different situations.

Feed intake (and, thus, energy intake) is highly dependent on environmental factors. If feed intake is compromised due to health status, environment, management, or other factors, diets that contain a variety of specialty ingredients (commonly called complex diets) can help serve as an aid to increase consumption. Lactose, spray-dried animal plasma, and other palatable ingredients typically used in complex diets will increase feed intake of early weaned pigs. However, if feed intake is excellent due to improved environment and minimal disease exposure, the dependency on complex diets fed to nursery pigs can be reduced. In addition, improvements in immune function can occur when fed ingredients such as spray-dried animal plasma [3].

Key points in understanding the interaction of diet complexity and feed intake are: (1) feed intake drives growth performance in early weaned pigs; (2) complex diets improve feed intake primarily for the first few weeks after weaning; and (3) diet complexity can and should be reduced rapidly as impact on feed intake declines with age and to effectively control feed cost per unit of gain.

The majority of studies have shown that increased feed intake in the post-weaning period will increase nursery growth rate, and that this weight advantage is maintained and in some instances increased in the finishing phase compared with pigs with poor feed intake after weaning [4]. Studies also show that increased feed intake will dramatically reduce the risk of enteric disease in the nursery phase [5] as a reduction in feed intake is the primary factor in reduced intestinal integrity post weaning [6, 7].

Photo courtesy of National Pork Board
Adjust pigs to lowest cost diets as quickly as possible after weaning

The main purpose of the nutritional program in the nursery is to adjust the pig to dry feed and prepare them for the grow–finish stage. If we adjust pigs to the ingredients used in the grow–finish diets too slowly, feed cost unnecessarily increases. Thus, an understanding between excellent performance and low diet cost must be reached.

The strategic use of soybean meal provides an example of how this concept influences ingredient selection for starter diets. Common grow–finish diets are grain-soybean meal-based. Because these are the lowest cost diets, the goal is to adjust pigs to them as quickly as possible. Strategic use of soybean meal allows us to rapidly adjust pigs to high levels of soybean meal after weaning. An alternate approach would be to delay exposure to soybean meal until pigs are older to prevent any possible hypersensitivity (allergic) reaction, which is an immune stimulation of the gastrointestinal tract in young pigs to high levels of glycinin and beta conglycinin found in soybean meal and typically results in diarrhea. When exposure to soybean meal is reduced or delayed, typically this requires greater use of specialty ingredients like dried whey, fish meal, spray-dried blood meal, and spray-dried animal plasma. This approach can result in excellent performance in the nursery [8], but pigs then have to be slowly acclimated to soybean meal in later diets and feed costs are increased.

Phase feeding program recommendations for nursery pigs

The type of phase feeding program implemented should be matched to the weight and age of pigs at weaning in your operation (Table 1). Most swine operations use a four-phase program for nursery pigs; however, it can vary from three to six phases [9]. As pigs become heavier or older at weaning, the amount of the most complex diets (Phases 1 and 2) fed after weaning might be able to be reduced. Decisions to alter budgets and nutrient density should be individual decisions depending on management, health status, pig age/wt, etc. In some cases with exceptionally heavy pigs at weaning (> 15 lb) or perhaps for the very heaviest pigs within a weaning group, the Phase 1 and/or Phase 2 diet could be eliminated from the feeding program. Adhering to the expected feed usage guidelines in Table 1 will help minimize over-feeding some of the expensive starter diets. If wean-to-finish facilities are used, these feed allowances may need to be increased slightly, because of the potential greater use of floor feeding and feed wastage.

<table>
<thead>
<tr>
<th>Feed/pig, lb</th>
<th>Pig Weaning Weight, lb</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Phase 1</td>
<td></td>
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<tr>
<td>Phase 2</td>
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<tr>
<td>Phase 3</td>
<td></td>
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<tr>
<td>Phase 4</td>
<td></td>
</tr>
</tbody>
</table>

By phase feeding, producers can match the nursery pig’s nutrient requirements and digestive capabilities with the most economical diet possible, yet achieve maximum performance in the nursery. Although the Phase 1 and Phase 2 diets are the most expensive, the low amount of feed used and excellent feed efficiency make the cost of these diets justifiable. Phase feeding of the Phase 1 and Phase 2 diets is often done on an individual pen basis while Phase 3 and 4 diets are budgeted to the average weight of the entire group.

Variation in weaning weight

Research has examined the variation in individual pig weights from several groups of pigs at weaning and has found that the standard deviation (SD) of individual pig weight is consistently close to 2 lb [10]. Also, the distribution of pig weight commonly approximates a normal distribution or the classic bell-
shaped curve. Table 2 illustrates the expected percentage of pigs to be at a given weight within a group of weaned pigs. For example, in a group of pigs with an average weaning weight of 10 lb, approximately 2% will weigh less than 6 lb, 14% from 6 to 8 lb, and 34% from 8 to 10 lb. The proportions are similar for pigs weighing more than the mean, with 34% weighing from 10 to 12 lb, 14% from 12 to 14 lb, and 2% greater than 14 lb. Thus plus and minus 2 lb from the mean weight will encompass 68% of the pigs, with 16% greater than 2 lb and 16% less than 2 lb from the mean.

<table>
<thead>
<tr>
<th>Pig Weight (lb)</th>
<th>8 lb</th>
<th>9 lb</th>
<th>10 lb</th>
<th>11 lb</th>
<th>12 lb</th>
<th>13 lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2 lb</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2–3 lb</td>
<td>0.5%</td>
<td>0.1%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3–4 lb</td>
<td>1.7%</td>
<td>0.5%</td>
<td>0.1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4–5 lb</td>
<td>4.4%</td>
<td>1.7%</td>
<td>0.5%</td>
<td>0.1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5–6 lb</td>
<td>9.2%</td>
<td>4.4%</td>
<td>1.7%</td>
<td>0.5%</td>
<td>0.1%</td>
<td></td>
</tr>
<tr>
<td>6–7 lb</td>
<td>15.0%</td>
<td>9.2%</td>
<td>4.4%</td>
<td>1.7%</td>
<td>0.5%</td>
<td>0.1%</td>
</tr>
<tr>
<td>7–8 lb</td>
<td>19.1%</td>
<td>15.0%</td>
<td>9.2%</td>
<td>4.4%</td>
<td>1.7%</td>
<td>0.5%</td>
</tr>
<tr>
<td>8–9 lb</td>
<td>19.1%</td>
<td>19.1%</td>
<td>15.0%</td>
<td>9.2%</td>
<td>4.4%</td>
<td>1.7%</td>
</tr>
<tr>
<td>9–10 lb</td>
<td>15.0%</td>
<td>19.1%</td>
<td>19.1%</td>
<td>15.0%</td>
<td>9.2%</td>
<td>4.4%</td>
</tr>
<tr>
<td>10–11 lb</td>
<td>9.2%</td>
<td>15.0%</td>
<td>19.1%</td>
<td>19.1%</td>
<td>15.0%</td>
<td>9.2%</td>
</tr>
<tr>
<td>11–12 lb</td>
<td>4.4%</td>
<td>9.2%</td>
<td>15.0%</td>
<td>19.1%</td>
<td>19.1%</td>
<td>15.0%</td>
</tr>
<tr>
<td>12–13 lb</td>
<td>1.7%</td>
<td>4.4%</td>
<td>9.2%</td>
<td>15.0%</td>
<td>19.1%</td>
<td>19.1%</td>
</tr>
<tr>
<td>13–14 lb</td>
<td>0.5%</td>
<td>1.7%</td>
<td>4.4%</td>
<td>9.2%</td>
<td>15.0%</td>
<td>19.1%</td>
</tr>
<tr>
<td>14–15 lb</td>
<td>0.1%</td>
<td>0.5%</td>
<td>1.7%</td>
<td>4.4%</td>
<td>9.2%</td>
<td>15.0%</td>
</tr>
<tr>
<td>15–16 lb</td>
<td>0.1%</td>
<td>0.5%</td>
<td>0.5%</td>
<td>1.7%</td>
<td>4.4%</td>
<td>9.2%</td>
</tr>
<tr>
<td>16–17 lb</td>
<td>0.1%</td>
<td>0.5%</td>
<td>0.5%</td>
<td>1.7%</td>
<td>4.4%</td>
<td>9.2%</td>
</tr>
<tr>
<td>17–18 lb</td>
<td>0.1%</td>
<td>0.5%</td>
<td>0.5%</td>
<td>1.7%</td>
<td>4.4%</td>
<td>9.2%</td>
</tr>
<tr>
<td>18–19 lb</td>
<td>0.1%</td>
<td>0.5%</td>
<td>0.5%</td>
<td>1.7%</td>
<td>4.4%</td>
<td>9.2%</td>
</tr>
<tr>
<td>&gt;19 lb</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.1%</td>
</tr>
</tbody>
</table>

**Nutrient Recommendations**

We believe the nutrient recommendations in Tables 3, 4, and 5 will result in a “best cost” feeding strategy for most producers the majority of the time. However, certain conditions (i.e., specific genetic populations, economic, nutrient availability, nutrient profile, and nutrient interactions) may exist that require significant deviations from the recommendations presented.

Although crude protein values still appear on feed labels and in some feeding recommendations, we did not list dietary protein recommendations because pigs do not require protein in their diet. Instead they require amino acids, which are found in protein. The recommended levels for the most critical amino acids are provided in Table 3. Lysine is the first limiting amino acid in grain soybean meal based diets. Lysine recommendations are provided on a total basis and a standardized ileal digestible (SID) basis. Formulating diets on a SID basis allows one to account for differences in the useable amino acids present in the diet and more closely meets the pig’s amino acids needs while minimizing excess nitrogen excretion.

The recommendations for threonine, methionine, methionine+cysteine, tryptophan, isoleucine, valine, arginine, histidine, leucine, phenylalanine and phenylalanine + tyrosine are also expressed on an SID basis. These recommendations were derived from an optimal pattern or ratio among amino acids that are presented in PIG Factsheet #07-02-03 (Understanding Swine Nutrient Recommendations).
Table 3. Amino acid, calcium and phosphorus recommendations for nursery pigs (as-fed basis)\textsuperscript{ab}

<table>
<thead>
<tr>
<th>Type of diet</th>
<th>Phase 1 9 to 11</th>
<th>Phase 2 11 to 15</th>
<th>Phase 3 15 to 25</th>
<th>Phase 4 25 to 45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weight, lb</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 to 11</td>
<td>0.35</td>
<td>0.55</td>
<td>1.10</td>
<td>2.20</td>
</tr>
<tr>
<td>11 to 15</td>
<td>0.32</td>
<td>0.45</td>
<td>0.80</td>
<td>1.25</td>
</tr>
<tr>
<td>Assumed daily feed intake, lb</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.35</td>
<td>0.55</td>
<td>1.10</td>
<td>2.20</td>
<td></td>
</tr>
<tr>
<td>0.32</td>
<td>0.45</td>
<td>0.80</td>
<td>1.25</td>
<td></td>
</tr>
<tr>
<td>Assumed daily gain, lb</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.32</td>
<td>0.45</td>
<td>0.80</td>
<td>1.25</td>
<td></td>
</tr>
<tr>
<td>Dietary metabolizable energy, Mcal/lb</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.59</td>
<td>1.58</td>
<td>1.50</td>
<td>1.50</td>
<td></td>
</tr>
</tbody>
</table>

--- % of diet ---

Lysine, total, % 1.70 1.65 1.44 1.38
Standardized ileal digestible, %

<table>
<thead>
<tr>
<th></th>
<th>Phase 1 9 to 11</th>
<th>Phase 2 11 to 15</th>
<th>Phase 3 15 to 25</th>
<th>Phase 4 25 to 45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lysine</td>
<td>1.56</td>
<td>1.51</td>
<td>1.31</td>
<td>1.25</td>
</tr>
<tr>
<td>Threonine</td>
<td>0.97</td>
<td>0.94</td>
<td>0.81</td>
<td>0.78</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.44</td>
<td>0.42</td>
<td>0.37</td>
<td>0.35</td>
</tr>
<tr>
<td>Methionine + cysteine</td>
<td>0.90</td>
<td>0.88</td>
<td>0.76</td>
<td>0.73</td>
</tr>
<tr>
<td>Tryptophan</td>
<td>0.27</td>
<td>0.26</td>
<td>0.22</td>
<td>0.21</td>
</tr>
<tr>
<td>Isoleucine</td>
<td>0.86</td>
<td>0.83</td>
<td>0.72</td>
<td>0.69</td>
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<tr>
<td>Valine</td>
<td>1.01</td>
<td>0.98</td>
<td>0.85</td>
<td>0.81</td>
</tr>
<tr>
<td>Arginine</td>
<td>0.65</td>
<td>0.63</td>
<td>0.55</td>
<td>0.53</td>
</tr>
<tr>
<td>Histidine</td>
<td>0.50</td>
<td>0.48</td>
<td>0.42</td>
<td>0.40</td>
</tr>
<tr>
<td>Leucine</td>
<td>1.56</td>
<td>1.51</td>
<td>1.31</td>
<td>1.25</td>
</tr>
<tr>
<td>Phenylalanine + tyrosine</td>
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<td>1.42</td>
<td>1.23</td>
<td>1.18</td>
</tr>
<tr>
<td>Phenylalanine</td>
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<td>0.91</td>
<td>0.78</td>
<td>0.75</td>
</tr>
<tr>
<td>Calcium, %</td>
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<td>0.85</td>
<td>0.85</td>
<td>0.75</td>
</tr>
<tr>
<td>Phosphorus, total\textsuperscript{c}, %</td>
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<td>0.70</td>
<td>0.70</td>
<td>0.65</td>
</tr>
<tr>
<td>Phosphorus, available, %</td>
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<td>0.55</td>
<td>0.45</td>
<td>0.37</td>
</tr>
<tr>
<td>Phosphorus, digestible, %</td>
<td>0.57</td>
<td>0.53</td>
<td>0.40</td>
<td>0.33</td>
</tr>
</tbody>
</table>

--- g/Mcal ME ---

Lysine, total 4.85 4.74 4.35 4.17
Standardized ileal digestible

<table>
<thead>
<tr>
<th></th>
<th>Phase 1 9 to 11</th>
<th>Phase 2 11 to 15</th>
<th>Phase 3 15 to 25</th>
<th>Phase 4 25 to 45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lysine</td>
<td>4.45</td>
<td>4.34</td>
<td>3.96</td>
<td>3.78</td>
</tr>
<tr>
<td>Threonine</td>
<td>2.77</td>
<td>2.70</td>
<td>2.45</td>
<td>2.36</td>
</tr>
<tr>
<td>Methionine</td>
<td>1.26</td>
<td>1.21</td>
<td>1.12</td>
<td>1.06</td>
</tr>
<tr>
<td>Methionine + cysteine</td>
<td>2.57</td>
<td>2.53</td>
<td>2.30</td>
<td>2.21</td>
</tr>
<tr>
<td>Tryptophan</td>
<td>0.77</td>
<td>0.75</td>
<td>0.67</td>
<td>0.64</td>
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<tr>
<td>Isoleucine</td>
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<td>2.38</td>
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<td>2.09</td>
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<tr>
<td>Valine</td>
<td>2.88</td>
<td>2.81</td>
<td>2.57</td>
<td>2.45</td>
</tr>
<tr>
<td>Arginine</td>
<td>1.85</td>
<td>1.81</td>
<td>1.66</td>
<td>1.60</td>
</tr>
<tr>
<td>Histidine</td>
<td>1.43</td>
<td>1.38</td>
<td>1.27</td>
<td>1.21</td>
</tr>
<tr>
<td>Leucine</td>
<td>4.45</td>
<td>4.34</td>
<td>3.96</td>
<td>3.78</td>
</tr>
<tr>
<td>Phenylalanine + tyrosine</td>
<td>4.19</td>
<td>4.08</td>
<td>3.72</td>
<td>3.57</td>
</tr>
<tr>
<td>Phenylalanine</td>
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<td>2.36</td>
<td>2.27</td>
</tr>
<tr>
<td>Calcium</td>
<td>2.57</td>
<td>2.44</td>
<td>2.57</td>
<td>2.27</td>
</tr>
<tr>
<td>Phosphorus, total\textsuperscript{c}</td>
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<td>1.97</td>
</tr>
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<td>1.58</td>
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<td>1.12</td>
</tr>
<tr>
<td>Phosphorus, digestible</td>
<td>1.63</td>
<td>1.52</td>
<td>1.21</td>
<td>1.00</td>
</tr>
</tbody>
</table>

\textsuperscript{a}All diets are full-fed under thermoneutral conditions.
\textsuperscript{b}Recommended amount relative to dietary metabolizable energy (ME) density; energy values of ingredients from PIG Factsheet \#07-07-09 (Composition and Usage Rate of Feed Ingredients for Swine Diets) were used in the calculations.
\textsuperscript{c}Total phosphorus values will be reduced with increasing levels of added phytase in each diet. However, P release from phytase is reduced 30% when growth promoting levels of Zn are added [17].
Ranges are presented for recommended additions of lactose, salt, trace minerals and vitamins to nursery diets (Table 4) to offer feed manufacturers and producers greater flexibility in preparing and utilizing products based on our recommendations. This approach affords more flexibility and convenience and often reduces costs associated with handling and storing multiple products. In addition, the ranges acknowledge that information gaps exist in trace mineral and vitamin nutrition of pigs, making it difficult to establish firm recommendations. Except for salt, the minimum values generally represent the total amount required in the diet according to the NRC (1998) [11]. Also, university publications were reviewed to help determine the range of each vitamin and mineral inclusion level [12-16]. Upper values do not represent safe or tolerance levels, but instead a reference point above which further additions will not likely improve perfor-

<table>
<thead>
<tr>
<th>Type of diet</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
<th>Phase 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weight, lb</td>
<td>9 to 11</td>
<td>11 to 15</td>
<td>15 to 25</td>
<td>25 to 45</td>
</tr>
<tr>
<td>Assumed daily feed intake, lb</td>
<td>0.35</td>
<td>0.55</td>
<td>1.10</td>
<td>2.20</td>
</tr>
<tr>
<td>Assumed daily gain, lb</td>
<td>0.32</td>
<td>0.45</td>
<td>0.80</td>
<td>1.25</td>
</tr>
<tr>
<td>Dietary metabolizable energy, Mcal/lb</td>
<td>1.59</td>
<td>1.58</td>
<td>1.50</td>
<td>1.50</td>
</tr>
</tbody>
</table>

### Lactose, %
- 20 to 25
- 15 to 20
- 5 to 10
- 0

### Minerals

- **Salt, %**
  - 0.15 to 0.40
  - 0.15 to 0.40
  - 0.25 to 0.40
  - 0.30 to 0.40

- **Sodium, %**
  - 0.25 to 0.45
  - 0.20 to 0.45
  - 0.20 to 0.45
  - 0.15 to 0.45

- **Chloride, %**
  - 0.25 to 0.45
  - 0.20 to 0.45
  - 0.20 to 0.45
  - 0.15 to 0.45

- **Copper, ppm**
  - 6 to 20
  - 6 to 20
  - 6 to 20
  - 5 to 20

- **Iodine, ppm**
  - 0.14 to 0.35
  - 0.14 to 0.35
  - 0.14 to 0.35
  - 0.14 to 0.35

- **Iron, ppm**
  - 100 to 180
  - 100 to 180
  - 100 to 180
  - 80 to 180

- **Manganese, ppm**
  - 4 to 30
  - 4 to 30
  - 4 to 30
  - 3 to 30

- **Selenium, ppm**
  - 0.30 to 0.30
  - 0.30 to 0.30
  - 0.30 to 0.30
  - 0.25 to 0.30

- **Zinc, ppm**
  - 100 to 180
  - 100 to 180
  - 100 to 180
  - 80 to 180

### Vitamins

- **Vitamin A, IU/lb**
  - 1,000 to 5,500
  - 1,000 to 5,500
  - 1,000 to 5,500
  - 800 to 5,500

- **Vitamin D₃, IU/lb**
  - 100 to 500
  - 100 to 500
  - 100 to 500
  - 90 to 500

- **Vitamin E, IU/lb**
  - 7 to 35
  - 7 to 35
  - 7 to 35
  - 5 to 35

- **Vitamin K, mg/lb**
  - 0.23 to 4
  - 0.23 to 4
  - 0.23 to 4
  - 0.23 to 4

- **Riboflavin, mg/lb**
  - 2 to 8
  - 2 to 8
  - 2 to 8
  - 1 to 8

- **Niacin, mg/lb**
  - 9 to 30
  - 7 to 30
  - 7 to 30
  - 6 to 30

- **Pantothenic acid, mg/lb**
  - 6 to 20
  - 5 to 20
  - 5 to 20
  - 4 to 20

- **Choline, mg/lb**
  - 0 to 200
  - 0 to 200
  - 0 to 200
  - 0 to 200

- **Biotin, mg/lb**
  - 0 to 0.10
  - 0 to 0.10
  - 0 to 0.10
  - 0 to 0.10

- **Folic acid, mg/lb**
  - 0.009 to 0.03
  - 0.008 to 0.03
  - 0.008 to 0.03
  - 0.007 to 0.03

- **Vitamin B₁₂, mg/lb**
  - 0.0 to 0.06
  - 0 to 0.06
  - 0 to 0.06
  - 0 to 0.06

- **Vitamin B₆, mg/lb**
  - 0 to 2
  - 0 to 2
  - 0 to 2
  - 0 to 2

---

*a All diets are full-fed under thermoneutral conditions.

*b Minimum values generally represent the quantity recommended by the National Research Council [11]. Additional values used represent university recommendations [12 – 16]. Upper values do not represent safe or tolerance levels, but instead a reference point above which further additions will not likely improve performance. We do not necessarily recommend supplying the minimum or upper levels on a routine basis. Specific recommended dietary additions of trace minerals and vitamins to pig feed are shown in Table 4.

c Levels of 125 to 250 ppm from copper sulfate or tri-basic copper chloride can be added to Phases, 1, 2, 3 and 4 for growth promotion.

d Maximum legal addition is 0.3 ppm.

*e Levels of 2,000 to 3,000 Zn ppm from zinc oxide (or other zinc source) can be added to Phases, 1, 2 and 3 for growth promotion.

*f Menadione activity
mance. Formulators should avoid the minimum and the highest nutrient concentrations in Table 4 in favor of intermediate values.

Specific recommendations for lactose, salt, trace mineral and vitamin additions to nursery diets are shown in Table 5. The values represent our best estimate of trace mineral and vitamin needs of nursery pigs in practical situations. These values are based on NRC requirements to which a safety margin has been added. These levels assume that natural feedstuffs provide none of the nutrient of interest. Those seeking nutritional information for manufacturing basemixes and premixes for swine diets may learn more in PIG Factsheet # 07-02-06 (Trace Minerals and Vitamins for Swine Diets).

Table 5. Specific recommended dietary additions of lactose, trace minerals and vitamins from concentrates, base mixes or premixes for nursery pigs.

<table>
<thead>
<tr>
<th>Type of diet</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
<th>Phase 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weight, lb</td>
<td>9 to 11</td>
<td>11 to 15</td>
<td>15 to 25</td>
<td>25 to 45</td>
</tr>
<tr>
<td>Assumed daily feed intake, lb</td>
<td>0.35</td>
<td>0.55</td>
<td>1.10</td>
<td>2.20</td>
</tr>
<tr>
<td>Assumed daily gain, lb</td>
<td>0.32</td>
<td>0.45</td>
<td>0.80</td>
<td>1.25</td>
</tr>
<tr>
<td>Dietary metabolizable energy, Mcal/lb</td>
<td>1.59</td>
<td>1.58</td>
<td>1.50</td>
<td>1.50</td>
</tr>
<tr>
<td>Lactose, %</td>
<td>23</td>
<td>18</td>
<td>7.2</td>
<td>0</td>
</tr>
<tr>
<td>Minerals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium, %</td>
<td>0.25</td>
<td>0.20</td>
<td>0.20</td>
<td>0.15</td>
</tr>
<tr>
<td>Chloride, %</td>
<td>0.25</td>
<td>0.20</td>
<td>0.20</td>
<td>0.15</td>
</tr>
<tr>
<td>Copper, ppm</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Iodine, ppm</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>Iron, ppm</td>
<td>165</td>
<td>165</td>
<td>165</td>
<td>165</td>
</tr>
<tr>
<td>Manganese, ppm</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Selenium, ppm</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>Zinc, ppm</td>
<td>165</td>
<td>165</td>
<td>165</td>
<td>165</td>
</tr>
<tr>
<td>Vitamins</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin A, IU/lb</td>
<td>3,000</td>
<td>3,000</td>
<td>3,000</td>
<td>3,000</td>
</tr>
<tr>
<td>Vitamin D₃, IU/lb</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Vitamin E, IU/lb</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Vitamin K, mg/lb</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Riboflavin, mg/lb</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Niacin, mg/lb</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Pantothenic acid, mg/lb</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Choline, mg/lb</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Biotin, mg/lb</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Vitamin B₁₂, mg/lb</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Folic acid, mg/lb</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Vitamin B₆, mg/lb</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Salt is usually added at the rate of 5 to 7 lb/ton in nursery diets to help provide a significant portion of the total dietary sodium and chloride recommendations.

Recommendations for sodium and chloride represent total dietary amounts, not additions.

Maximum legal addition is 0.3 ppm.

Levels of 3,000 ppm Zn for Phases 1 and 2 and 2,000 ppm Zn for Phase 3 from zinc oxide (or other zinc sources) should be added to growth promotion; or 125 to 250 ppm Cu from copper sulfate or tri-basic copper chloride in Phases 1, 2, and 3.

Menadione activity.

Key ingredients and feeding recommendations for each nursery phase

Phase 1 Diet (weaning to 11 pounds)
The high amino acid fortification of the Phase 1 diet necessitates multiple protein sources to meet the young pig’s nutritional needs. Several of the following protein sources often are used in combination in
the Phase 1 diet to meet the amino acid requirements and to stimulate feed intake: spray-dried animal plasma, fish meal, dried whey, blood cells, poultry meal, whey protein concentrate, spray-dried blood meal, soybean meal, and further processed soy products. Other protein sources can certainly be used, but you should check with a nutritionist before making any substitutions for ingredients in the diets.

Although spray-dried animal plasma is expensive, it is useful to stimulate maximal feed intake in the period immediately after weaning. Most studies show a linear response in feed intake and daily gain with increasing animal plasma, thus, most nutritionists include 4 to 7% animal plasma in the Phase 1 diet, depending on the other protein source combinations included in the diet. In addition to the feed intake benefits, spray-dried animal plasma improves intestinal health and immune system function.

Spray-dried blood meal and spray-dried blood cells have very high lysine content (7.5 to 8.5 %) and, thus, can be used in the Phase 1 diet in small quantities as a concentrated amino acid source. However, spray-dried blood meal, blood cells, and animal plasma are relatively low in the amino acids methionine and isoleucine. Due to these deficiencies, it is critical that supplemental methionine is added to the Phase 1 diet for optimal performance. Recent research has suggested that the isoleucine level should be approximately 60% of the lysine level when blood meal is included in the diet.

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

The source and level of soy protein in diets for early weaned pigs can vary based on a large number of factors including weaning age, health status and overall management. Some approaches have led to no soybean meal 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 of moist extruded soy products compared to soy products that have not been moist extruded. A more common approach by nutritionists is exposing the young pig to increasing levels of soybean meal in each nursery diet will allow them to overcome the hypersensitivity to soy protein more quickly without causing a long-term reduction in pig performance. In the Phase 1 diet, the level of soybean meal is usually 12-15% of the diet or less under this philosophy. The second approach is substantially less expensive than the first. Soy sources of proteins should be discussed with your nutritionist and checked for antinutritional components and protein quality to make sure that the product wasn’t under or over processed.

Research shows that there is a linear increase in daily gain with increasing lactose concentrations in the diet. The Phase 1 diet generally contains between 20 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 high quality whey permeates (80% lactose) or crystalline lactose (100% lactose) can replace the lactose in the diet provided by dried whey. These other lactose sources become increasingly important due to their lower cost relative to edible-grade dried whey. When replacing dried whey in the diet, care must be taken to determine the replacement of amino acids provided by whey in addition to lactose. The protein in whey is a high quality protein that must be replaced with another high quality protein source.
The appropriate source of the remainder of the carbohydrate fraction is another area of controversy. The controversy concerning carbohydrates is whether corn or further processed grains like roasted corn or oat products should serve as the main grain source. Finely-ground oat products (oat groats, oat flour) can improve stool consistency and pig appearance. Although these further processed carbohydrate sources are used by some nutritionists, corn is often the most economical carbohydrate source for the remainder of the diet. Wheat, milo, or other grains also can serve as the main grain source in the Phase 1 diet.

The appropriate fat level in the Phase 1 diet depends on the level of milk products in the diet and the skill of the pellet mill operator. As mentioned earlier, diets containing high levels of 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 (i.e. burn) 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 usually 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 promoting levels of antibiotics are normally included in the Phase 1 diet. Growth promoting levels of zinc (ZnO at 1,500 to 3,000 ppm or other Zn sources) are often added to the Phase 1 diet. When zinc oxide is used for growth promotion, high levels of copper (125 ppm) from added copper sulfate or other sources may provide an additive benefit, however the research with both high levels of zinc and copper in the diet are conflicting. Sources of zinc, other than zinc oxide do not appear to offer the same increase in growth performance. Additional information about zinc sources can be found in the PIG Factsheet #07-02-06 (Trace Minerals and Vitamins for Swine Diets).

Scientists have observed improvements in growth performance when certain feed additives, such as an organic acid are added to the Phase 1 diet. Organic acids are thought to compliment the normal acid secretion in the pig’s stomach to help reduce pH which aids in protein digestion. Additional information about feed additives such as organic acids and the differences between sources can be found in the PIG Factsheet #07-03-03 (Feed Additives for Swine).

Phase 2 Diet (11 to 15 pounds)
The Phase 2 diet is a natural extension of the Phase 1 diet and contains many of the same ingredients. 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.

Because pigs receiving the Phase 1 diet are adjusted to dry feed, the Phase 2 diet generally contains less specialty ingredients such as spray-dried animal plasma. For instance, the Phase 2 diet may only contain 2 to 3 percent spray-dried animal plasma compared to 4 to 7 percent in a Phase 1 diet. Some nutritionists remove spray-dried animal plasma from this stage if the pigs are of older weaning age and have high feed intakes at this stage. Spray-dried blood meal, fish meal or poultry meal also may serve as major protein sources. Because the pigs are acclimating to soybean meal while being fed the Phase 1 diet, the transition diet can contain higher levels of soybean meal (up to 20 percent) without risk of hypersensitivity.

The lactose level in the Phase 2 diet also is decreased compared to the Phase 1 diet. However, it is still critical that the Phase 2 diet contain 15 to 20% lactose for optimal pig performance. A high quality fat source (3 to 5 percent) is added to the Phase 2 diet for the same reason as the Phase 1 diet (improved pellet quality). As in the Phase 1 diet, antibiotics, an organic acid, and zinc oxide and/or copper sulfate should be maintained in the Phase 2 diet for growth promotion.

Phase 3 Diet (15 to 25 pounds)
By the time the pigs weigh 15 pounds, they already will have consumed 1.5 to 8 pounds of feed depending on weaning weight. Feeding behavior is established and, thus, lower cost, less complex diets can be fed. The Phase 3 diet is corn-soybean meal-based with dried whey (or other source of lactose) and spray-dried blood meal or fish meal or poultry meal serving as specialty ingredients. It is crucial that appropriate levels of amino acids are maintained in this diet to allow the pig to achieve its genetic potential for lean growth. With the decrease in cost of crystalline threonine, we are now able to use higher levels of supplemental lysine in combination with added methionine and threonine to maintain a high amino acid concentration while maintaining soybean meal levels between 26 and 28 percent. Several different ingredient
options are used depending on the preferences of the nutritionist and economics of the ingredients. Depending on the source of specialty ingredients used, maximum inclusion of supplemental amino acids generally depends on minimum amino acids ratios of isoleucine or tryptophan relative to lysine. As individual ingredient prices change, alterations to Phase 3 diets must be considered. For example, removing the lactose from the Phase 3 diet and replacing it with an alternative ingredient or simply with corn or ingredient alternatives such as DDGS may reduce growth rate, but may be more profitable (cost/lb or margin over feed) when the price of lactose is very high.

Many producers make this diet on the farm and feed in meal form. If an economical fat source, such as choice white grease, is available, the diet often will contain 3 to 5% added fat. Antibiotics, zinc oxide and copper sulfate are used as growth promoters in the Phase 3 diet. Research indicates 2,000 ppm zinc and/or 125 - 250 ppm copper is the optimal inclusion level in this phase.

**Phase 4 Diet (25 to 45 pounds)**

The Phase 4 diet is a simple grain-soybean meal diet formulated to the appropriate nutrient levels for this weight of the pig (Table 3). Again like in earlier nursery diets, higher levels of supplemental dietary lysine in combination with added methionine and threonine can be used to replace a portion of the soybean meal in the diet. The Phase 4 diet is the lowest cost diet in the nursery feeding program. However, because consumption of this diet is the greatest, it usually accounts for over 50% of the total feed cost from weaning to 45 pounds. Thus, Phase 4 diet cost is critical. Specialty ingredients, such as blood meal, fish meal or dried whey, are cost prohibitive. Research also indicates that the use of specialty ingredients is unnecessary for maximal performance during this stage.

The fat level of the Phase 4 diet will depend on the price and availability of fat. Pigs will respond with improved average daily gain and feed efficiency with increasing levels of fat in the Phase 4 diets up to approximately 3%. Elevated levels of zinc oxide or organic acids are generally not used in the Phase 4 diet; however, antibiotics can serve to improve growth promotion. Some nutritionists may choose to use 125 to 250 ppm of copper from copper sulfate in this diet for growth promotion.

**Summary**

Swine producers can have a successful nursery nutrition and management program by matching dietary nutrient levels and ingredients with weight and age of the nursery pig as well as maximizing feed intake. Also, because newly weaned pigs are in an extremely energy deficient state and early intake helps maintain a healthy intestine. Finally, to minimize nursery feed costs, properly adjust pigs to lower cost diets appropriately throughout the nursery period.

**References**


7. Spencer J. What can we do nutritionally to help these pigs start better (does it pay to spend more money?). In the Proc. of the 39th AASV. March 9th, 2008.


Frequently asked questions

How important is ingredient quality for starter pigs?

Ingredient quality can dictate the success of a nutritional program for young pigs. Ingredients are selected for their palatability, digestibility, and nutrient content. Simple laboratory assays for nutrients often reveal very little about the quality of specialty ingredients for starter diets. Often specialty ingredients and ingredient suppliers have to be selected from past experience and research trials with actual feeding data, rather than on analyzed specifications.

Ingredients that cause the greatest quality concern due to the number of products and suppliers are animal protein and lactose sources. Fish meal, blood meal, and animal plasma should only be purchased from a supplier using spray-drying technology. Spray-drying minimizes the chances the ingredient will be heat-damaged. Select menhaden fish meal is considered to be a high quality fish meal in the United States but other excellent fish meal sources are available. Several blood meal (cell) sources are available; however, only a few suppliers are producing spray-dried blood meal. Currently, all animal plasma produced in the United States is spray-dried.

Differences in quality exist between various sources of dried whey. If whey is excessively heated, it will result in a brownish color, indicating caramelization of the sugar (lactose). This lowers the feeding value of the product. Thus, only whey that has been spray-dried is often recommended for use in starter diets. White color is desirable, although some good quality whey may have a pinkish or yellowish color from carry-over of the cheese color. A granular whey particle compared with a fine particle, absence of black specs, and an ash concentration below 9% are indicative of high quality dried whey.

There are several forms of dried whey products commonly used as high quality products that are used in the place of spray-dried whey with equal performance. The most commonly used include whey permeate, deproteinized whey, and L-lactose. Other products such as partially delactosed whey, partially demineralized whey, and partially delactosed and partially demineralized whey can be successfully used to replace spray-dried whey. The amount of lactose and/or minerals removed from the dried whey will affect the actual amount of protein and ash present. The key to substituting a lactose source for dried whey is to know the lactose concentrations and replace on an equal lactose basis, and then choose an appropriate protein source to replace the amino acids provided by the dried whey.

How does weaning age affect lifetime performance?

Research has shown that increasing weaning age through 21 days linearly increases growth rate and reduces mortality from weaning to market. In these studies, wean-to-finish growth performance and
productivity (as measured by ADG, mortality, off-test weight per day of age, and weight sold per pig weaned) improved as weaning age increased from 12 to 21 days of age. Linear improvements in growth and mortality rate largely occurred in the initial 42 days post-weaning period, with some ongoing growth improvements in finishing performance. These studies suggest increasing weaning age up to at least 21 days can be an effective production strategy to improve wean-to-finish growth performance in a multi-site production system.

Are more complex diets needed for pigs weighing less than 8 pounds?

When weaning pigs at a young age, a percentage of the pigs may weigh less than 8 pounds at weaning. The Phase 1 diet can normally be used for these pigs, but extra attention must be given to ensure pigs start eating within 48 hours after weaning (methods are described below). Using a specialty “Intensive Care” diet, which is more complex, can help improve feed intake necessary for these small pigs. However, the key to using a diet of this type is to limit the usage to pigs weighing less than 8 pounds to prevent feed cost from becoming excessive.

What about compensatory gain?

Some people believe that slower growth rate in the nursery phase as a result of feeding simple grain-soybean meal diets will be made up for in the growing–finishing phase by compensatory gain. This is not true. Research has shown that every additional pound a pig weighs coming out of the nursery will result in fewer days to market. However, in growing–finishing pigs, if growth performance is decreased for a short period by low nutrient intake (i.e., lysine), there may be compensatory gain when pigs are switched to an adequate diet. Therefore, the ability for compensatory gain will depend upon the severity and duration of a deficiency, whether it is ingredient and(or) nutrient induced, and the age of the pig when it occurs.

Should the starter diets be pelleted?

Whether to feed the Phase 1 and(or) the Phase 2 diet as pellet or in meal form is a controversial area. Producers and nursery managers have definite opinions on which they prefer. While a few studies would suggest no difference between meal and pelleted diets, the majority of studies favor pelleting these diets. Not only does this improve pig growth performance, it dramatically improves the flow ability characteristics of the diet. We recommend pelleting the Phase 1 and Phase 2 diets. A small diameter 3/32- or 1/8-inch pellet or crumble should be used for these diets. Young pigs have difficulty swallowing larger pellets while eating at the feeder. These pigs will take a mouthful of feed to the resting area and allow saliva to soften it before swallowing. This process limits feed intake and increases wastage. However, the drawback of using small diameter pellets is that friction through the pellet die is increased which may increase heat damage of the dietary proteins and carbohydrates.

Another disadvantage with small diameter pellets is reduced throughput through the feed mill. Therefore, it is critical to supplement fat (5 to 6 %) to pelleted nursery diets and have skilled operators running the pellet mill.

If meal diets are to be used, producers must realize feed wastage will be approximately 20% greater and daily gain slightly lower for pigs fed meal diets compared to those fed pelleted or crumbled diets in our experience. Producers feeding meal diets with large amounts of specialty ingredients also must be careful not to limit feed intake through poor feeder management. Meal diets bridge and do not feed down and flow out of feeders easily leading to restricted or reduced feed intake. Several dietary adjustments can be made to help with flow ability. These include decreasing the added fat content and using granulated sources of blood cells, animal plasma, whey or whey permeate, or using a protein-lactose supplement that is added to the corn and soybean meal that is in a crumble form.

The Phase 3 and 4 diets can be fed as a meal or pellet. Feed efficiency will be 5 to 8% better with a pelleted diet than with a meal diet in these stages. The feed efficiency improvement is due to a decrease in feed wastage and moderate improvement in ADG. A larger pellet (5/32 or 3/16 inch) can be used for these older pigs. The decision to pellet the Phase 3 and 4 diets should be based on the expected change in feed efficiency and the potential for an increase in daily gain versus feed manufacturing costs.
**Should I provide creep feed before weaning?**

Research has shown that little creep feed will be consumed before three weeks of age. However, piglets that become eaters of creep feed have been shown to have improved growth performance post-weaning compared to piglets that have been offered creep but did not consume any creep feed. In the past, weaning age was typically less than 18 days and it was thought that creep feeding was unnecessary. However, with the shift to older weaning ages, creep feeding may offer some advantages with acclimating pigs to feed. If a producer chooses to creep feed, it is recommended that the feed be provided on a daily basis to keep a fresh diet in front of the baby pig. Creep feed should be stored in a cool and dry environment to aid in maintaining freshness during storage prior to feeding. It is recommended that the same diet used as a creep feed should be fed during the first week after weaning. Provide easy access to water to encourage creep feed intake. Research on the effects of creep feeding on pig growth is needed before a definitive recommendation can be made.

**Should I provide a liquid feed supplement either before and (or) after weaning?**

Research has shown that providing pigs a liquid feed supplement either before or a short period after weaning will increase average daily gain. However, these studies also show that the extra weight gain from providing a liquid supplement is either not maintained to the end of the nursery phase or not great enough to provide an economical return to the cost of the liquid supplement and extra labor. Therefore, the decision whether to provide a liquid supplement must be made on the potential to reduce death loss due to starvation and fall back or cull pigs leaving the nursery. The potential to reduce death loss in the nursery will need to offset the added cost associated with the milk replacer, the equipment needed to distribute the milk replacer, and the added labor costs needed to maintain the equipment. It is extremely important that the milk replacer is kept fresh and the equipment kept clean and disinfected.

**Should young pigs be limit fed during the first week after weaning?**

Pigs should NOT be limit fed after weaning. Feed intake is critical during this stage. Some producers believe that pigs will adapt to dry feed faster if limit fed several times per day. The theory is that pigs should be fed several small meals similar to when nursing the sow. However, you simply cannot feed the pigs often enough to prevent reductions in daily gain and pig weight out of the nursery. Pigs can be offered feed several times per day on a feeding board, but fresh feed should always be present in the feeder. Also, diluting the energy level of diets immediately after weaning with fibrous products may help decrease the incidence of scours, but it prevents maximum growth as pigs have a very low capability for fiber digestion early in life and is not recommended.

**What type of feeder should be used?**

This answer will vary depending on the age of pigs at weaning and type of facility. Pigs weaned at less than 15 days of age still exhibit feeding behavior as if nursing the sow. Newly weaned pigs try to eat at the same time, and thus, feeder space must be available to accommodate all the pigs in the pen in the immediate post-weaning period. A properly designed, non-solid partition encourages proper social interaction and maximal feed intake, while preventing the small pigs from laying and defecating in the feeders or becoming trapped in the partition. With traditional dry feeders, a minimum of 6 inches per feeding space for nursery feeders and at least 1 feeding place for every 4 pigs in the pen is recommended.

Single-stage nurseries in which pigs are kept from weaning to 70 pounds may require up to 12 inches per feeding space. In wean-to-finish barns (feeders with 12 inch openings), approximately 0.80 inches of feeder space per pig is adequate until approximately 6 weeks after weaning, then 1.6 inches of feeder space per pig is needed.

The feeder should be easily adjustable and facilitate the free flow of feed with a feed agitator that can be easily manipulated by the pigs. Feeder adjustment often has a larger impact on minimizing feed wastage than actual design. In many cases, excellent feed efficiency and growth performance can be achieved with a wide variety of different feeders. There is often wide variation in feed wastage among nurseries within the same production system demonstrating the importance of the person in the barn adjusting the feeders.
Should a feeding board or mat be used?

Feeding boards or mats can be used to help supply adequate feeding space during the first week after weaning. The feeder board must be either disposable or made of an easily cleaned material like plastic or rubber to prevent problems with diseases, such as coccidiosis. If used, feeding boards must be properly managed or excessive feed wastage will occur. Also, feeding boards should be promptly removed from the pen after the pigs are eating readily from the feeder (3 to 4 days after weaning). Remember to always have feed present in the feeder, even when using feeding boards.

How should feeders be adjusted properly?

Approximately 50% of the feeding pan should be visible in the first few days after weaning. As the pigs become more accustomed to the location of the feed and adjust feeding behavior, the amount of the feed in the feeding pan should be adjusted to keep approximately 50% coverage. Also, feed agitators need to be tested frequently to ensure that the buildup of fines does not prevent them from working freely.

What type of waterer is best for young pigs?

Either nipple or cup waterers can be used for nursery pigs. Water intake is critical in the newly weaned pig. Thus, water availability should be carefully monitored to ensure that all pigs have access to water. If nipple waterers are used, an unguarded center flow water nipple works well for pigs weaned less than 16 days of age to facilitate drinking and prevent dehydration. Guarded or “Bite down” nipple waters are suitable for pigs weaned greater than 16 days of age. Regardless of the type of nipple waterer, the correct height adjustment is essential to ensure pigs can drink easily. Cup waterers have been demonstrated to reduce water wastage compared with nipple waterers. In commercial facilities it is recommended to have at least two nipple waterers per pen (unless using wet dry feeders) and up to 10 to 15 pigs per waterer. In systems using cup waterers, it is not uncommon to only have one cup waterer per pen. Also, when using wet-dry feeders, the waterer in the feeder is typically turned off until the pigs are on the Phase 2 or 3 diets.

How can we encourage feed intake to prevent “starve outs” after weaning?

Teaching feeding behavior to a small number of pigs is critical. Some pigs in an early weaning system are developmentally younger and not as quick to learn to eat. Even highly complex and very expensive diets will not encourage all young pigs to eat. As diet complexity decreases, techniques to manage the problem pigs become more important. By using management strategies to encourage young pigs to start eating feed, producers have been able to save the 1 to 2% of young pigs that can be commonly lost to starvation with less attentive managers. One such strategy is the use of a gruel (diet mixed with a small amount of water) to encourage pigs to eat. However, care should be taken so that pigs do not become used to the gruel and are not encouraged to eat dry feed. As discussed earlier in this report, the use of liquid supplements may be another option. However, in addition to the liquid supplement, dry feed should be in the feeder at all times and the liquid supplement allowance reduced quickly to encourage dry feed intake. Offering liquid supplement too long after weaning will sometimes result in a second “weaning lag” similar to the transition from sow milk to dry feed.

Another strategy is to individually teach pigs to eat that do not learn on their own. The procedure is described as follows. After pigs enter the nursery, they should have feed present for them to eat. However, pigs should be allowed time to adjust to the surroundings, waterers, and feeders before the manager worries about intervention. The critical time period for intervention for pigs that have not started to eat after weaning is approximately 36 to 60 hours after weaning. Pigs that are consuming feed will begin to have round abdomens; whereas pigs that have not begun to eat will be gaunt. Pigs that are not consuming food after 36 to 48 hours postweaning should be identified and marked. Each pig not consuming feed should be individually encouraged to eat by taking a small hand full of pellets, wetting them from the nipple waterer, and gently placing the pellets in the pig’s mouth. The moist pellets stick to the tongue of the pig, start to dissolve and are swallowed. The next step is to carefully set the pig down near the feeder so the pig associates the food in its mouth with the feeder. For large groups of pigs, a syringe with the tip removed also can be used to dose individual pigs with gruel instead of hand feeding pellets. It is important to perform
these procedures gently. Hence, these methods rely on patience and an understanding of animal behavioral principles. Providing as little as 20 to 30 grams of feed will provide the energy to keep the pig from starving.

Data from France indicates that approximately 90% of the pigs will have eaten by 30 hours after weaning. Therefore the most critical time to identify and intervene to teach pigs to eat will be 30 hours after weaning.

**Should separate sex feeding be practiced in the nursery?**

Research has shown no benefit to split sex feeding pigs during the nursery stage. Rather, feed budgeting decisions should be made based on pig weight and weaning age and not gender in the nursery. Thus, sorting into the nursery based on gender is a management decision that may aid in reduction of labor and reduced handling stress of sorting at the end of the nursery if the pigs are split sexed fed during the finishing stage.

**How should pigs weaned at 5 to 7 weeks of age be fed after weaning?**

Is it important to feed them a complex diet immediately following weaning? Pigs that are weaned at five to seven weeks of age will have a more advanced digestive system due to potentially being provided creep feed for a longer period of time and being exposed to sow lactation feed. While research is lacking, it is recommended that these pigs be weaned onto a diet containing some specialty ingredients, not just soybean meal as the sole protein source (Phase 4 diet). Typically a Phase 3 diet should be used to stimulate feed intake and provide a transition to the Phase 4 diet. For pigs over 25 lbs at weaning, a feed budget amount of 2 lbs per pig of a Phase 3 diet should be adequate to provide the transition to the Phase 4 diet. However, if small pigs are present (< 15 lbs), they should be divided from the larger pigs and fed a Phase 2 diet at weaning until they reach 15 lbs and then the Phase 3 diet until they reach approximately 25 lbs.

**Does health status of nursery pigs affect nutrient requirements?**

Since nutrient requirements are largely dictated by the growth rate, high health pigs generally require increased nutrient density, specifically amino acids and energy, due to their improved growth rate (lean gain) over low health status pigs. Health challenged pigs may be fed higher levels of vitamins and trace minerals to stimulate their immune system and increase their amount per day consumption of their nutrients, as their feed intake is generally lower than in high health pigs. This also stresses the importance of using highly digestible ingredients that also assist with improving immune function such as spray-dried animal plasma and using growth promoting levels of zinc and/or copper.