Cost-Effective Feeding Strategies for Grow-Finish Pigs

Kari Saddoris-Clemons, Jason Schneider, Carolina Feoli, Douglas Cook and Betsy Newton

Akey, 250 W. Clay St., Lewisburg, OH 45309 USA
Email: bnewton@akey.com

Introduction

Feeding programs are evaluated by a variety of methods including feed cost, feed cost/kg gain, Revenue Over Feed (ROF), and Margin Over Feed and Facility Cost (MOFFC). Working to minimize feed cost is a common goal but can be misleading if strict nutrient requirements are not observed, because pig performance (average daily gain and/or feed efficiency) may suffer. Evaluating feed cost/kg live weight gain allows for a comparison of average daily gain (ADG) and feed efficiency (G/F) between feeding programs. However, it still fails to take into account possible differences in carcass yield and quality. Evaluating ROF is a more accurate assessment of a feeding program, as it takes into account ADG, G/F and the amount paid for the carcass. In order to determine the most cost-effective feeding strategy for grow-finish pigs, ROF (or MOFFC) should be used when formulating feeding programs.

This paper will summarize some of the nutrition and management strategies that should be considered when developing a cost-effective feeding strategy for grow-finish pigs.

Nutritional Strategies

The specific feeding strategy which results in the highest profit opportunity is often dependent on feed costs. When feed costs are low, emphasis is placed on feeding strategies resulting in the highest ADG. When feed costs are high, emphasis switches more toward G/F. Strategies to improve either gain or efficiency must be carefully evaluated to ensure the predicted performance
improvements will pay for the increased diet costs and provide a reasonable return.

**Dietary Energy**

Feed efficiency improvements from high energy vs. low energy diets are well documented. A review of experiments feeding increasing levels of dietary energy from liquid fat suggest up to a 2% improvement in efficiency for every 1% added fat. In addition, ADG can improve 1% for every 1% added fat, although this response is less consistent than improvements in feed efficiency (Baudon et al., 2003). The magnitude of the growth performance response to added fat is often less in winter months when intakes are higher. When adding liquid fat and increasing dietary energy concentration, daily feed intake decreases and thus a change in dietary lysine concentration is required to maintain lysine intake. Replacing cereal grains with fat and increasing SBM to maintain the available lysine to calorie ratio will increase diet costs. The fat to corn cost ratio determines the point at which including fat becomes cost effective. Fat: corn ratios need to be less than 3:1 for fat to be cost effective based solely on feed conversion. If additional gain is valuable (as would be the case in space limited systems), fat: corn ratios greater than 3:1 may be cost effective (Table 1).

Table 1. Diet savings or cost per pig for a 6-phase corn-SBM diet program averaging 3.5% fat compared to a program with no fat.

<table>
<thead>
<tr>
<th>Fat:Corn Price Ratio</th>
<th>Diet cost increase vs. no fat, $/ton</th>
<th>Cost/pig difference vs. no fat, $</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5:1</td>
<td>12.58</td>
<td>-0.675</td>
</tr>
<tr>
<td>3.0:1</td>
<td>15.43</td>
<td>0.185</td>
</tr>
<tr>
<td>3.5:1</td>
<td>18.20</td>
<td>0.995</td>
</tr>
<tr>
<td>4.0:1</td>
<td>20.96</td>
<td>1.825</td>
</tr>
</tbody>
</table>

Cost/pig only includes diet costs and assumes feed efficiency improvement of 2% for every 1% added fat in diets changing from 3200 to 3400 kcal/kg. Corn price, $167.50/ton.

**Alternative Ingredients**

An alternative ingredient is defined relative to a commonly used and accepted set of ingredients in a particular geography. Thus, what constitutes an alternative ingredient will vary regionally. Cereal grains, specifically corn, wheat, barley, sorghum and oats comprise the largest percentage of dietary energy in most North American swine diets and quite often by-products of
grain processing are considered “alternative” ingredients. Two examples are given below.

Bioenergy policy in North America has led to a large increase in the production of corn-based ethanol and its by-product distillers dried grains with solubles (DDGS). The quality and nutrient content of DDGS varies from plant to plant due to differences in corn growing conditions and composition as well as differences in the ethanol manufacturing process itself (grinding, drying, fat extraction, etc.). Akey has developed a database containing more than 100 DDGS sources from North American plants, which allows formulation of diets using the energy and amino acid contents of each DDGS source. This, along with the usually favorable price position of DDGS vs. corn, has allowed us to increase use of DDGS in swine diets. During the poor economic climate of 2008-2009, high levels of DDGS provided dietary cost savings significant enough to justify sacrificing daily gain in order to maximize ROF for producers long on space. This dynamic illustrates why ROF is a preferred metric vs. only evaluating live performance and diet cost.

Another by-product of the grain milling sector that is extensively used in swine diets is wheat middlings. While midds normally have even lower energy levels than DDGS, the price per unit of energy for wheat midds vs. other cereal grains is typically cost effective. Wheat midds contain more available phosphorus and amino acids than corn. However, feed flowability can be an issue when large amounts of midds are added to meal diets. Therefore, inclusion rates are often limited to a maximum of 15-20% in mash feeds. Other by-products may be used in swine diets, including hominy feed, corn gluten meal, or bakery and cereal products. These by-products may differ widely in their nutrient composition and may only be available on a regional basis.

The decision to use DDGS, or any other by-product, and how to use it (e.g., dietary level within and across production phases and withdrawal strategies) depends on many factors including shadow price, growth performance objectives, by-product quality, accuracy of nutrient prediction, mycotoxin levels, carcass fat iodine value restrictions, and carcass yield objectives. The most important strategy for utilizing by-products in swine diets is centered on rapid and accurate nutrient analysis of each source under consideration, and the resulting shadow price of the by-product in diets. Addition of large amounts of by-product to a cereal grain based diet may decrease diet energy concentrations and negatively affect feed efficiency. However, if diet cost savings are large enough, ROF may be improved, making by-products a valuable tool and a staple of swine diets for the foreseeable future.
Crystalline Amino Acids

Crystalline amino acids are used to reduce diet cost, reduce excess levels of intact protein, reduce nitrogen excretion, and improve the dietary amino acid balance. When formulating diets with crystalline amino acids, setting minimum ratios of essential amino acids relative to lysine is critical to maintain the proper balance of amino acids for protein accretion and growth. The specific mix of cereal grains, protein sources and by-products in a diet, and the resulting amino acid pattern, dictate the maximum levels of crystalline amino acids which can be used. When intact protein sources (e.g., soybean meal, canola meal, pork meat and bone meal, etc.) are expensive and crystalline amino acids are cheap, savings of many dollars per tonne can be achieved. Defining upper limits for crystalline amino acid use is accomplished through research trials and determined by levels which support maximum growth performance and feed efficiency.

Additives

The decision to include a feed additive depends on whether it reduces or increases feed costs, and if it increases feed costs, does it consistently improve feed efficiency or ADG in well designed and replicated research trials. If an additive has a claim for improving feed efficiency, a quick way to determine if it is cost justified is to multiply the expected percentage of improvement by the average cost of the grow-finish diets. This value represents the maximum amount that can be paid for the additive per tonne of finished feed and still break even (Table 2). This method works best for additives that are included on top of current diet formulations (e.g., growth promoting antibiotics and copper sulfate), not additives that require a reformulation of diets (e.g., phytase and Paylean®).

Table 2. Break even costs for feed additives at various feed efficiency improvements.

<table>
<thead>
<tr>
<th>Additive</th>
<th>Feed efficiency Improvement</th>
<th>Breakeven cost for additive, $/tonne&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3%</td>
<td>6.00</td>
</tr>
<tr>
<td>B</td>
<td>5%</td>
<td>10.00</td>
</tr>
<tr>
<td>C</td>
<td>7%</td>
<td>14.00</td>
</tr>
</tbody>
</table>

<sup>a</sup> Assuming grow-finish feed averages $200/tonne

An additive that can reduce feed cost without affecting performance is the enzyme phytase. Phytase releases phosphorus bound to the phytate molecule, making it available to the animal. Phytate is found in many common
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dietary ingredients including corn, wheat and soybean meal. Phytase reduces diet costs by replacing expensive inorganic phosphate sources, and when assigned the proper phosphorus release value, results in equal performance and decreased phosphorus excretion by pigs.

The economics of Paylean® depend on the inclusion level and the duration of Paylean feeding. In the US, most producers include Paylean at 5 to 10 ppm in the last finishing diet. Addition of 5 ppm of Paylean for 21-24 days prior to slaughter can improve feed efficiency by 10-15% and ADG by 10%. Paylean can be used at higher levels (7 to 10 ppm) to take advantage of improvements in carcass quality. Lean yield can be improved by 3% in some situations (Watkins et al., 1990; Armstrong et al., 2004). Inclusion of Paylean requires a reformulation of diets to higher amino acid levels in order to achieve improvements in performance and carcass yield, which further increases diet cost. Few growth performance benefits are obtained above the 5 ppm level and in order to see a cost benefit of the higher levels of Paylean, carcass premiums must be achieved.

- **Management Strategies**

**Marketing Strategies**

Market weight is generally decided based on hog prices, feed cost and contractual obligations to the packer. The optimum end weight is that at which the ROF cost is maximized. Marketing pigs earlier reduces kilograms sold and keeps overhead costs high. Keeping pigs past their optimal weight will not cover the expense of the extra feed or facility time.

Marketing strategies often dictate feeding strategies. When pigs are marketed on a fixed weight basis, market price dictates the optimal market weight, and days are flexible. In this situation, G/F may dominate over ADG as the driving force behind formulation decisions. When days are flexible and feed costs are high, it is even possible to explore feeding strategies that have little effect on efficiency but slightly reduce gain in exchange for feed cost savings. Systems that can maintain pigs longer in the barn can take advantage of strategies that reduce feed cost (low energy, high by-products, etc.) and increase profit opportunity per unit of gain. In this case, MOFFC must be evaluated to determine if diet cost savings are large enough to offset increased yardage and feed delivery costs by increasing days to market.

Days to market, however, are not always flexible. In some systems, pigs are marketed on a fixed time basis and therefore need to achieve a specific weight in a given number of days to meet packer and other obligations. In this situation, ADG needs to stay a driving force behind formulation decisions. In
these systems, reducing feed cost/kg gain is only a benefit if gain is not reduced and days to market are not affected.

**Split Sex Feeding and Phase Feeding**

Management practices should be considered when optimizing the use of resources and adjusting the supply of dietary nutrients closer to the actual needs of the pig. Barrows and gilts have different nutrient requirements at each phase of production. The rate of protein deposition in barrows is greater than in gilts, requiring more grams of amino acid intake per day. However, barrows consume 3 to 8% more feed on a daily basis than gilts, which allows them to achieve the required intake of amino acids even if a less dense diet is offered. Diets with lower amino acid density satisfy the needs of barrows, but not those of gilts. Some production systems have the equipment and logistics in place to feed barrows and gilts different diets. This makes it possible to avoid overfeeding barrows or underfeeding gilts. The savings in feed cost that result from this practice can range from $0.25 to 0.40 per pig.

The rate of protein deposition also varies with age in a curvilinear fashion. Protein deposition rates increase up to 100 kg body weight (depending on the genotype) and then decline. Diets for younger pigs must have high levels of nutrients to meet requirements for protein deposition and are thus more costly. Phase feeding allows pigs to be fed closer to their nutrient requirements at each stage of growth and prevents overfeeding of expensive nutrients. Phase feeding should be designed in a way that enough diet phases are fed to improve accuracy and timing in the supply of nutrients, but not so many that management becomes complicated and induces errors in implementation of the strategy. A common error can occur when using too many phases given the range in weight and age of pigs on one feed system, which is to switch to the next diet when there is still a subpopulation of younger, lighter animals that has not reached the weight for diet change. The result is poor uniformity in the barn, increasing the likelihood of light pigs at market.

**Feed Form**

Ingredient and feed processing are equally important aspects of the overall nutrition program for swine operations. An extensive amount of research has been conducted over the years on the impact of grain particle size and feed form (mash or pellet) on growth performance and efficiency. Fine grinding of cereal grains improves efficiency of feed utilization and may lead to improved growth performance. It is not uncommon to realize a 1.5% improvement in feed efficiency for every 100 µm decrease in particle size from 1200 to 500 µm. While fine grinding of cereal grains may improve feed efficiency, care must be taken if the feed is ground to <600 µm because feed may bridge in
bins or feeders, resulting in out-of-feed events. Grain that is ground too fine may also increase the incidence of gastric ulcers.

Some producers choose to further process feed into pellets. Pelleting swine feed can improve feed efficiency 4-6% in all phases of production due to increased diet digestibility and reduced feed wastage. A disadvantage to pelleting is producers may not be able to utilize high amounts of alternative ingredients such as DDGS without sacrificing pellet quality or mill throughput. While pelleting increases diet manufacturing cost, improvements in feed efficiency and feed ingredient costs usually more than offset it, resulting in savings of $1-3/pig.

Genetics

Factors including lean growth potential, shape of the growth curve and the feed intake characteristic of different genotypes of pigs dictate the lysine: calorie ratios used in diets. Some genotypes have more rapid growth early than others, or better feed efficiency and thus better nutrient utilization. Adjustment of diets and weight phases accordingly improves the accuracy of delivering nutrients to support growth at the best feed cost.

Conclusions

Rising feed costs over the past five years have created challenging conditions for swine producers. To maximize profit opportunity, producers must be diligent in developing feeding strategies that result in best returns over feed and/or margin over feed and facility costs. There are no “one size fits all” nutrition or management strategies that work for every producer. A complete analysis of a given production system, including milling capability, ingredient availability and cost, genetics, pig flow and system efficiency as well as packer requirements, must be undertaken to develop the most cost effective feeding strategy for a given producer.

References
