PIC® Nutrition Update

July 2016

Principles and decision making in diet formulation

From a macro level, once growth and feed intake in the specific production system are known, the first step in diet formulation is to define the most economical net energy (NE) level. The second step is determining the standardized ileal digestible (SID) lysine (Lys) dietary concentration based on the SID Lys:NE ratio. Next, the other SID amino acids (AA) are defined as a ratio to SID Lys. Finally, the levels of macro minerals, trace minerals and vitamins are defined to achieve the requirement in amount of nutrients (i.e., grams, milligrams, or International Units) per pig per day.

The economic implications of fixed time vs. fixed weight

A key concept to consider when formulating diets for a specific production system is to understand if the system is marketing pigs on a fixed time or a fixed weight basis. Fixed time means that the system does not have extra or flexible space in the production flow. For example, when a finishing barn reaches 120 days of placement, the pigs are marketed and the barn is emptied for the next group of pigs. Fixed time can also be explained as being space short and fixed weight as space long. Fixed weight program, however, means that the system has some flexible amount of space available in the production flow and, thus, pigs can be left in the barn until they reach a target weight optimum for the given carcass value payment structure of the processing plant. The difference between these two scenarios is important because it changes the relative value of growth rate. The value of weight gain in a fixed time system is more valuable given the fixed constraint on number of growing days available; however, in the fixed weight system, pigs can stay in the barn at a fixed space cost (i.e., $0.11/pig/day) and, therefore, the economic value of weight gain by a given nutritional or management strategy is smaller compared to a fixed time scenario. Production systems will often be on a fixed weight basis during winter when pigs are growing at a faster rate and on a fixed time basis during summer when pigs are growing at a slower rate. The important point is that these two scenarios represent the range of economic optimums and evaluating both scenarios can be an effective tool for evaluating economic sensitivity of dietary changes.

The concept of optimum nutrient levels to maximize profitability in a fixed time program relative to fixed weight scenario is illustrated in Figure 1A. Tryptophan (Trp) to Lys ratio can have a significant impact on growth rate. In this specific scenario, varying tryptophan to lysine ratio has a much larger economic impact on a fixed time system than a fixed weight system simply because weight gain offers a greater marginal economic return compared to the fixed weight scenario. For additional information on the value of alternative Trp to Lys ratios, please visit http://www.lysine.com/en/tech-info/TrpLys.aspx to download a free dynamic economic calculator for the most economic Trp to Lys ratio specific to a production system.

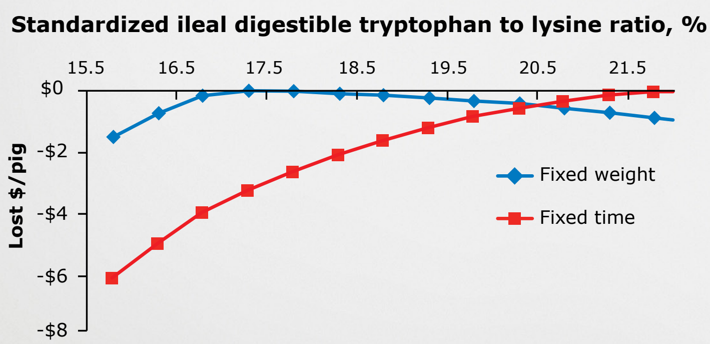

Figure 1A. Standardized ileal digestible tryptophan:lysine ratio for maximum profit on a fixed time and fixed weight basis (PIC 337 × 1050; Kansas State University and Ajinomoto Heartland, 2016).

Principles and decision making in diet formulation (cont.)

Strategies for diet formulation

There are multiple strategies, or targets, that are commonly used for diet formulation. Some of the commonly used approaches are:

- Growth performance basis
  - Maximize average daily gain (ADG)
  - Minimize feed efficiency (F/G)
- Cost reduction basis
  - Minimize cost per lb of diet
  - Minimize feed cost per lb of gain
- Profit maximization basis
  - Maximize income over feed cost (IOFC)
  - Maximize income over feed and facility costs (IOFFC)
  - Maximize income over total cost (live or carcass)

A summary showing how these targets can impact formulation strategies and the resulting diets is shown in Figure 1B. These results show the levels of SID Lys to optimize the different strategies listed above. Note that the SID Lys level to maximize profit is greater than that to minimize cost. The economic optimum SID Lys level is dynamic and depends on the market prices. Each of these concepts, and some of the relative risks and rewards, are explained below in more detail.

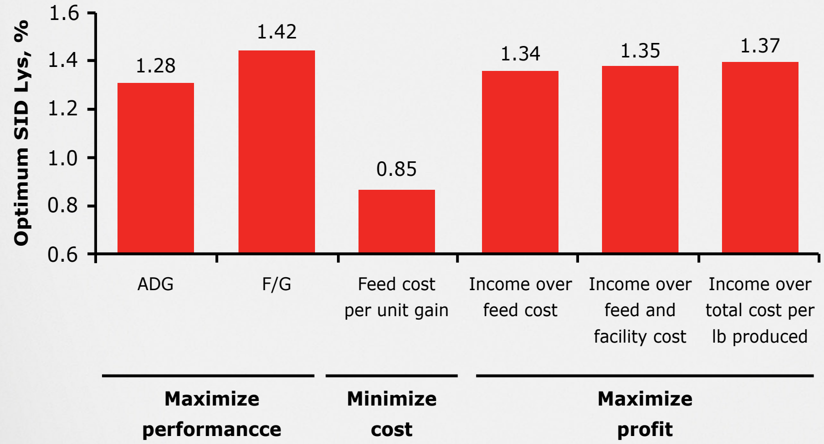

Figure 1B. Example of levels of standardized ileal digestible lysine to optimize different outcomes for PIC pigs (45- to 55-lb pig; PIC internal data).

Formulating for maximum performance

The SID Lysine level to improve F/G is generally greater than that to maximize ADG. However, formulation targeting maximum performance does not take into account any economic measurement but only considers the impact on the biological response.

Formulating for minimum cost

To minimize the diet cost, the nutritionists set the nutrient levels needed and use a least cost formulation software to achieve the minimum diet cost possible but still meet the needed requirements.

Thus, diet cost is technically an economic variable; however, it does not account for any changes in performance. Feed cost per lb of gain is calculated by multiplying F/G by the cost per lb of feed and, therefore, feed cost per lb of gain takes into account F/G. However, this approach does not take into account any changes in ADG, pig price, or the cost of each extra day in the barn.

Principles and decision making in diet formulation (cont.)

Feed cost per lb gain = (Feed:gain x $ per lb of feed)

Formulating for maximum profit

Income over feed cost (IOFC), on the other hand, takes into account the market price and the value of weight gain under a fixed time scenario:

IOFC = (market price per lb live weight × weight gain) - (feed cost per lb gain × weight gain)

Income over feed and facility costs (IOFFC) is similar to IOFC, however it is suitable for a fixed weight scenario:

IOFFC = (market price per lb live weight × weight gain) - (feed cost per lb gain× weight gain) - (cost per pig space × days in the phase)

Putting it all together

The formulation concept of feed cost per lb of gain generally leads to the conclusion of cheaper diets; however, often that is not necessarily the optimum level to maximize net profit. Income over total cost (IOTC) takes into account the dilution effect of the extra gain over each lb of live or carcass produced. For example, let's assume that the cost of the weaned pig was $40. Therefore, a production system with 266 lb of gain from weaning to market results in a cost of $0.1504 per lb that will be related to the cost from the weaned pig. However, if a given nutritional or management strategy increases the weight gain to 270 lb, the cost per lb related to that initial weaned pig cost will change to $0.1481 or 1.5% reduction in cost.

To calculate income per lb of live weight produced:

$$IOTC_L = \left\{ \frac{\left[(\text{market price per lb x 2000}) - \left(\left({}^{2000}/_{\textit{market weight}} \right) \text{x} \left(\textit{feed cost per pig + other costs per pig + feeder pig cost} \right) \right) \right]}{2000} \right\}$$

Or to calculate income per lb of carcass weight produced:

$$IOTC_C = \left\{ \frac{\left[(\text{market price per lb of carcass x 2000}) - \left((2000/\textit{market weight/\%yield}) \text{ x } (\textit{feed cost per pig + other cost per pig + feeder pig cost}) \right) \right]}{2000} \right\}$$

The following examples use these principles for comparison of a few specific scenarios and the impact on income over feed cost and income over total cost on a carcass basis:

Diet cost should have manufacturing and delivery included and not just ingredient cost because this is a more accurate reflection of the cost of the feed consumed and the value of the performance differences.

Comparison of minimizing cost vs. maximizing profit per pig

	SCENARIO 1	SCENARIO 2[a]
Assumptions	Fixed time/no added fat diet	Fixed time/3% added fat diet
ADG, lb	1.800	1.854
F:G	2.800	2.632
Days on feed	112	112
Diet cost, $/lb[b]	0.104	0.111

[a]Assuming each 1% added fat improves gain by 1% and F:G by 2%. This response can vary from system to system and by season.
[b]Assuming costs of soybean meal, corn, and choice white grease at $350/ton, $3.60/bu, and $0.31/lb, respectively.

Principles and decision making in diet formulation (cont.)

Calculations
Scenario 1 (no added fat): 112 x 1.80 = 201.6 lb gain in the finishing
Feed cost per pig = 201.6 x 2.80 x $0.104 = $58.71

Scenario 2 (3% added fat): 112 x 1.854 = 207.7 lb gain in the finishing
Feed cost per pig = 207.7 x 2.632 x $0.111 = $60.68

In conclusion, the feed cost per pig in scenario 2 is $1.96 greater than scenario 1.

Thus, scenario 1 has the lowest feed per cost per pig;

However, in scenario 2 there are more pounds produced per pig. Thus, this needs to be taken into consideration:

Considering the market pig price equal $0.55/lb and recalculating using IOFC:

Scenario 1:

$IOFC_{(Sc1)}$ = ($0.55 x 201.6) – ($58.71) = $52.17 per pig

$IOFC_{(Sc2)}$ = ($0.55 x 207.7) – ($60.68) = $53.56 per pig

In conclusion, the income over feed cost per pig in the scenario 2 is $ 1.38 better than scenario 1, thus, adding fat in this scenario is more profitable.

Income over total cost
Assumptions
Carcass yield = 74%
Carcass price = $0.75/lb
Feeder pig cost (50 lb) = $55
Other costs (facilities/transport/medicines/vaccines/slaughter) = $14.56 per pig

Calculations on a live basis

$$IOTC_{L\ sc1} = \left\{ \frac{\left[(\$0.55 \times 2000) - \left(\left({}^{2000}/_{(50+201.6)}\right) \times (\$58.71+\$14.56+\$55.0)\right)\right]}{2000} \right\} = \$0.0402 \text{ per lb live weight produced}$$

$$IOTC_{L\ sc2} = \left\{ \frac{\left[(\$0.55 \times 2000) - \left(\left({}^{2000}/_{(50+207.7)}\right) \times (\$60.68+\$14.56+\$55.0)\right)\right]}{2000} \right\} = \$0.0446 \text{ per lb live weight produced}$$

Scenario 2 (3% added fat) is 10.9% ($0.44/cwt) more profitable than 1 (no added fat) in this market situation on a live basis.

Principles and decision making in diet formulation (cont.)

Calculations on a carcass basis

$$IOTC_{L\ sc1} = \left\{ \frac{\left[(\$0.75 \times 2000) - \left((2000/(50+201.6)/0.74) \times (\$58.71+\$14.56+\$55.0)\right)\right]}{2000} \right\} = \$0.0611 \text{ per lb carcass weight produced}$$

$$IOTC_{C\ sc2} = \left\{ \frac{\left[(\$0.75 \times 2000) - \left((2000/(50+207.7)/0.74) \times (\$60.68+\$14.56+\$55.0)\right)\right]}{2000} \right\} = \$0.0670 \text{ per lb carcass weight produced}$$

Thus, scenario 2 (3% added fat) is 9.7% ($0.59/cwt) more profitable than 1 (no added fat) in this simulation.

In conclusion, there are multiple strategies and approaches for diet formulation. It is important to use an approach that takes into account the value of performance (i.e., ADG, F/G, yield) but also the fixed time or fixed weight nature of the system. Therefore, using approaches such as income over feed (and facility) costs or income over total cost on a carcass basis are suitable solutions to robustly maximize the profitability of swine operations.