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Using FIRE® to Improve Feed Ration Plans

Proper feed ration planning can reduce feed costs, reduce odors and nutrient wastes, and improve carcass value. Reducing excess lysine by 0.1% can add approximately $1.20 per head in feed savings. Increasing lysine to an appropriate level to improve lean by 0.5% can increase net income by $0.62 per pig without considering improved feed efficiency and faster growth. Reducing feed expenses and improving production can increase profitability, especially during periods of low hog prices.

Typical lysine requirements are based on research farm estimates of industry "average" animals. Such animals probably do not represent your genetics and the tests certainly do not take into account the conditions found in your facilities. As Dr. Mike Tokach noted at the 1999 NPPC Lean Growth Modeling Symposium, the variability in production conditions between farms makes tests with the same genetics a meaningless predictor of actual performance.

This article outlines the basic procedures used to develop farm-specific growth curves and lysine requirements. An example from the Osborne Demonstration Farm is used to demonstrate the calculations.

Procedures

Lysine requirements are based on feed intake, animal weight, and protein accretion. Protein accretion can be measured using serial ultra-sound or can be estimated by using starting-weight and final-carcass measurements. This article describes a method of estimating protein accretion from packer carcass data and starting weights using FIRE feeding data. A basic outline of the procedures to determine lysine requirements is:

1. Export FIRE® feed intake data to a spreadsheet.
2. Compute daily feed intake (DFI) as a function of weight.
3. Determine days on feed from entry weight to market weight.
4. Calculate final fat free lean index (FFLI) and final fat free lean (FFL).
5. Estimate initial FFL.
6. Estimate mean fat free lean gain (M.)
7. Derive a protein accretion (PA) curve based on M for different animal weights
8. Predict lysine requirements as a function of weight and PA.

A final section shows how this method, using FIRE feeding data, can significantly improve profitability.

Exporting FIRE® Feeding Data

Feed intake curves are easily generated from FIRE feeding data. Prior to off-testing animals, export the daily data using the Files-Export data function. This creates a comma-delimited file that can be imported into a spreadsheet. The resulting data file has eight columns showing:

1. Station number,
2. Date,
3. Tag Number,
4. Animal ID,
5. Feed Intake,
6. Feeder Visits,
7. Feeder Occupancy Duration, and
8. Animal Weight.

If barrows and gilts are maintained separately and fed with different feeds, you should analyze feeding requirements separately by sex. This is done by feeding each sex on separate FIRE feeding stations or by going back into the spreadsheet and sorting the data by sex, using animal identification.

Determining Daily Feed Intake (DFI) as a Function of Weight

Feed intake as a function of weight is required to set lysine levels appropriate to DFI and PA. Determining DFI curves should be performed on data from all animals. If animals were removed from the pen at different weights, all data for analysis should be truncated when the first group of animals was removed. Using data after the largest animals are removed from a pen will result in biased curves and incorrect feeding recommendations (Schinckel and deLange, 1996)

Determining DFI as a function of weight is most easily done in MicroSoft Excel® by making an XY plot of the weight and feed-intake data, and then adding a third order polynomial trendline to the graph. To do this:

1. Select the columns to be plotted and select plot. A wizard will then walk you through as follows:
2. Selecting the XY (Scatter) plot,
3. Selecting the data range and series to plot (the weight column as X, the Feed Intake column as Y),
4. Putting titles and legends on the graph, and
5. Placing the graph in a separate page.

The equation of the data can be found by clicking on the data, right-clicking the mouse, and selecting Add Trendline. Select the polynomial and increase the order to three. Also select the options tab and check the option to display the equation on the graph. The spreadsheet will then display the curve and equation of DFI as a function of animal weight. For the animals from our Demonstration Farm, the DFI as a function of animal weight was:

$$\text{DFI (lb/d)} = -0.0002 * \text{weight}^3 - 0.0031 * \text{weight}^2 + 0.3514 * \text{weight} + 2.7601 \quad \text{(Eq. 1)}$$

Determine Days from Entry to Market

The spreadsheet data is easily used to determine the average entry and ending weights, and to calculate the number of days to achieve final weight.

Use the average function to determine the average starting and ending weights of the animals. Most spreadsheets allow subtracting starting dates from ending dates to determine days of growth, although it may be necessary to reformat the results into a number instead of a date. If animals are serially removed from the pen, the average number of days to achieve market weight will be required rather than the days to when the first animals were marketed. This can be estimated by averaging the marketing date for all animals or by calculating:

days from initial to final weight =
(average market weight – average starting weight) * days from starting weight to when first group marketed / (average all animals' weight when first group marketed – average beginning weight)

(Eq. 2)

Determine Final Fat-Free Lean

Final fat-free lean can be estimated from one of several procedures depending on the carcass data available from a packer. The Demonstration Farm sells animals to a packer that provides hot carcass weights and last rib midline backfat measurements. The average slaughter weight from the Demonstration Farm is 238 lbs, with an average carcass weight of 174 lbs and an average backfat depth of 0.77 inches. The National Research Council (1998) provides three calculations for determining FFLI. For carcass weight and backfat measurements the recommended equation is:

FFLI = 51.537 + (0.035 * hot carcass weight, lb) - (8.979 * last rib midline backfat on hot carcass, in.)

(Eq. 3)

For the animals from the Demonstration Farm, this calculation gives a FFLI of:

FFLI = 51.537+0.035*174-8.979*0.77 = 50.9%

Calculations of FFLI using Fat-O-Meter probe data use the equation:

FFLI = 51.537 + (0.035* hot carcass weight, lb)
- (12.260 * fat probe on hot carcass, in.)

(Eq. 4)

and FFLI from backfat and loin eye areas are calculated with the equation:

FFLI = 0.95 *[7.231+ (0.437* hot carcass weight, lb) –
(18.746 * tenth rib fat depth, in.)
+ (3.877 * tenth rib loin eye area, in^2)]
/ (hot carcass weight, lb)

(Eq, 5.)

Final fat-free lean (FFL) is then calculated as:

final FFL = FFLI * hot carcass weight, lbs.

For the Demonstration Farm, the FFL is:

final FFL = 50.9% * 174 lbs = 88.6 lbs.

Estimate Intial Fat Free Lean

The initial FFL is estimated with equations similar to the final FFL. For weights of 30-60 lbs, the FFL of all animals are similar and can be calculated as:

initial FFL (lbs) = 0.95 * [-3.65 + 0.418 * live weight, lbs]

(Eq. 6.)

For the Demonstration Farm, the initial FFL is:

initial FFL = 0.95 * [-3.65 + 0.418 * 50 lbs] = 16.4 lbs.

Estimate Mean Fat-Free Lean Gain (M)

Schinckel and deLange (1996) describe calculations of protein accretion using M. Mean fat-free lean gain is calculated from initial and final FFL using the equation:

M (lb/d) = [FFLI * hot carcass weight (lbs)
- initial FFL (lb)]
/ days from initial to final weight.

(Eq. 7.)

From the previous calculations for the Demonstration Farm,

M = [51.9 * 174 - 16.4] / 94 = 0.768 lb/d.

The actual equations used by Schinckel and deLange are given in g/d, so the results in lb/d must be multiplied by 453.6 g/lb to convert them to the proper units. For the Demonstration Farm, this conversion gives an M of 348 g/d.

For split sex feeding situations, the calculations of FFL, M, and PA should be done separately for each sex. Based on average daily gain from the Demonstration Farm, the gilts grew 1.02 times faster then average and barrows grew that same proportion slower than average. For the Demonstration Farm, M should be adjusted proportionally for the sexes, giving an M of 0.794 lb/d (361 g/d) for the gilts and 0.748 lb/d (340 g/d) for the barrows.

Derive a protein accretion (PA) curve

The PA curves can be predicted using the equations of Schinckel and deLange (1996.) For gilts the PA curve equation is:

PA = (284.9-0.485*M)
* exp[(-0.08238 + 0.0003202 * M) * weight
+ (-6.8 - 0.023 * M) / weight
+ (0.000656 - 0.000002699 * M) * $weight^2$]

(Eq 8.)

Where exp is the exponential function. The equivalent equation for barrows is:

PA = (146.3 + 0.064*M)
* exp[(-0.03022 + 0.0001266 * M) * weight
+ (-15.2 + 0.006 * M) / weight
+ (0.0002104 -0.000001076 * M) * $weight^2$]

(Eq. 9.)

The PA equations were entered in a spreadsheet (available on request) and used to calculate average daily PA for each ten lb. weight increment from 50 to 240 lbs.

Predicting Lysine Requirements

Lysine requirements are related to basal metabolism required to keep an animal alive plus an amount proportional to protein accretion. Under non-thermally stressing conditions, basal metabolic energy and lysine requirements are proportional to (animal weight)$^{0.75}$.

Additional calculations were added to the PA calculation spreadsheet to predict daily lysine requirements. The equation for lysine requirements (Dritz *et al.*, 1997) is:

Lysine (g/d) = [0.036 * weight$^{0.75}$ (kg)
+ 0.066 * PA (g/d) / 0.60 (efficiency of lysine use)]
/ 0.88 (true digestibility of lysine in diet)
(Eq. 10.)

Lysine requirements as a percentage of DFI can be calculated as:

Lysine (%) = Lysine (g/d) / DFI (g/d) * 100%
(Eq. 11.)

Daily feed intake (Eq. 1) and lysine requirements on a mass and percentage basis (Figure 1) were added to the spreadsheet.

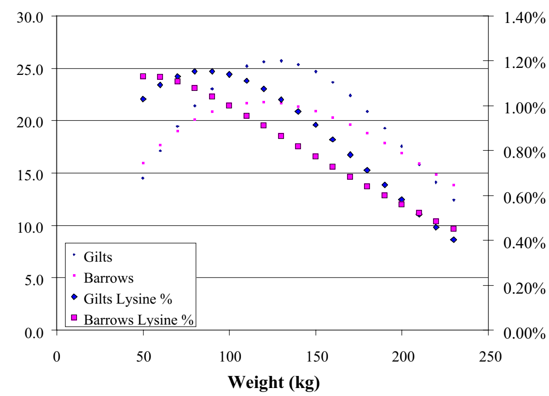
The calculated lysine requirements from this procedure were also compared to present feed rations used on the Demonstration Farm. The new Lysine requirements suggested were 1.10% from 50 lbs to 180 lbs, 0.95% from 130 to 150 lbs, 0.80% from 150 to 180 lbs, and 0.65% for 180 lbs to market weight. Our previous feed rations provided 1.21% lysine from 50 to 75 lbs, 1.10% from 75 to 125 lbs., 1.00% from 125 to 150 lbs., 0.80% from 150 to 200 lbs, and 0.64% for above 200 lbs.

Improved Rations, Improved Profitability

A predicted cost for every ten pound increment of weight gain using the existing and recommended rations was calculated by multiplying the ration cost ($/lb) by 10 lbs gain * 2.75, the average feed:gain ratio from this production test. For the previous feed rations, the sum of feed costs from 50 to 240 lbs is $32.60 per animal. In comparison, the new feed recommendations would cost $32.29, a savings of $0.31 per pig. Multiplying an increase in return per pig of $0.31 by 300 sows and 2.25 farrowings per year and 10.5 pigs/farrowing gives a net increase in profits of $2,200 per year return or an average of $7.33 per sow managed. Even this small improvement in feed ration quickly covers the investment in FIRE® feeding equipment. For the 7,100 pigs annual production of our Demonstration Farm, the investment of $11,500 for a FIRE station, ACCU-ARM weighing race, 25 RFID tags, PC interface, power supply, and FIRE software has a pay-back in 5.2 year with an annual return on investment of 19%. Increasing animal numbers reduces the payback time and annual return on investment proportionally. Actual improvements in profitability may be greater if current rations are further off target then this example. For such an example, deLange and Scheures (Modeling the growth in the Pig, p 187-208) describe an instance where adjusting feed rations saved an Australian producer AUS$100,000 (US$64,000) per year on a 1,200 sow operation.

Additionally, feed intakes, growth, and carcass lean can be compared to that expected for your genetics. If differences exist during specific periods or over the whole growth of the animals, then a target for improvement can be made. Such benchmarking improves a manager's ability to recognize opportunities and improve profitability. Correct estimates of lysine requirements can also reduce odor levels and nutrient loading of lagoons.

Practice with FIRE feeding data makes this procedure an easy route to improved control and profitability. For more information, contact Osborne Engineering Services at 800-255-0316.



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