Establishing Phase Feeding Programs and Feed Budgets

Understanding the rate at which pigs grow in a specific production system provides more accurate determination of nutrients and feed amounts. Understanding growth curves, how to develop growth models, and establishing customized phase feeding programs will be discussed in this factsheet.

Growth Curves

To aid in development of feeding programs, producers should understand the changes in growth rate of pigs during the grow-finish period. When body weight is plotted versus age, the typical growth curve follows a linear shape (Figure 1). After plotting BW versus age, producers can calculate ADG at different timepoints and depict ADG versus weight (Figure 2). It can be observed that pigs undergo rapid periods of growth in the early stages, reach a maximum, and decline at heavier bodyweights. Growth curves should be developed as average daily gain versus body weight to develop nutrient requirements. As the growth rate slows, less nutrients are required to support maintenance and growth. This allows for more accurate diet formulation by preventing excess nutrients being supplied from the diet. Furthermore, producers should understand that the point at which grow-finish pigs reach their maximum growth rate can vary based on genetic line used. Different genotypes will exhibit different rates of protein accretion and this will change the point at which protein deposition is maximized.

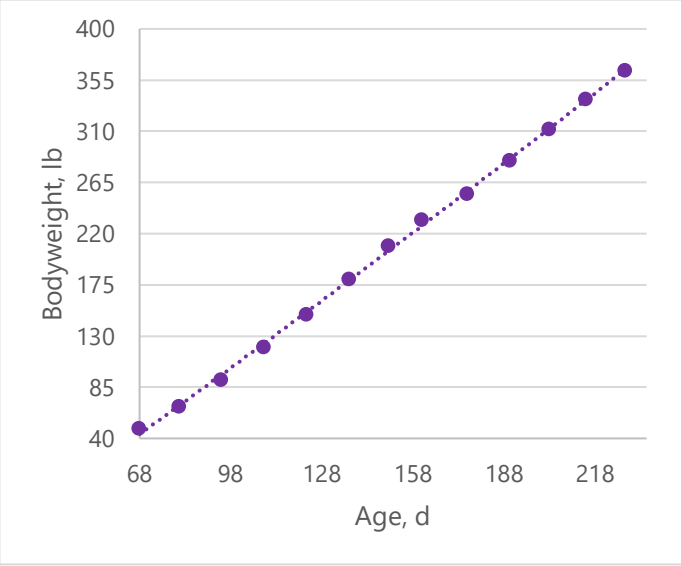

Figure 1. Diagram of a typical growth curve of body weight vs age for growing-finishing pigs from birth until market (Adapted from Lerner, 2019).

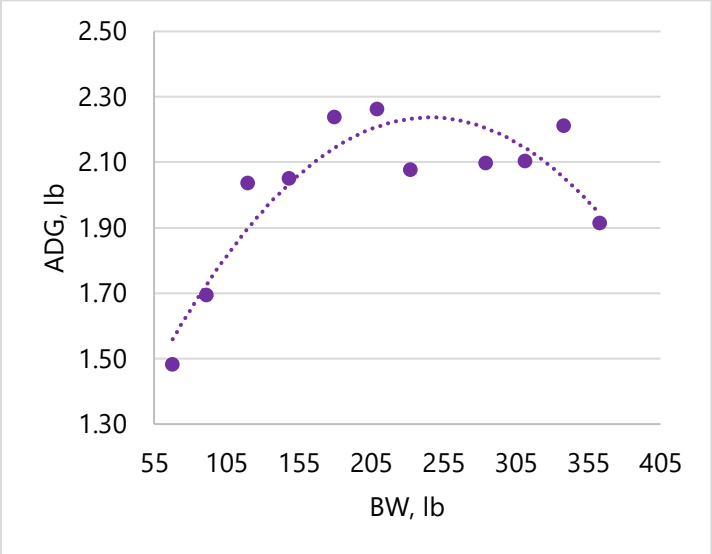

Figure 2. Diagram of a typical growth curve of ADG vs body weight for growing-finishing pigs from weaning until market (Adapted from Lerner, 2019).

Growth and Feed Intake Curve Model Development

Development of grow-finish growth models can be achieved by either using reference modelling equations provided from sources such as the NRC (2012) or using farm-specific data. Both methods can be used in an effort to understand the nutrient requirements of grow-finish pigs at varying stages of production. Knowing these nutrient requirements will allow for customization of feed budgets for individual farms and estimate the optimal marketing weight to optimize economic success.

The first step in developing growth models to predict performance is to correctly quantify farm specific model inputs needed to develop these models (de Lange et al., 2001). The specific model inputs needed are dependent on whether a reference equation is utilized to generate growth curves or a farm specific growth curve is developed. If a reference equation is utilized, the model inputs needed are mature bodyweight, growth rate, age at maximum growth rate, energy intake and energy required for maintenance (NRC 2012, Rostagno, 2017). Although these reference equations are accurate in predicting growth rate, these equations were developed under ideal growing conditions and may not best represent farm specific growth rates.

Inputs for the reference equations required for these models may not be available in production systems. Thus, production systems may want to develop their own specific growth model. This allows for the accurate determination of the upper limit to protein deposition (Pd_{max}) for a specific farm. Accurate determination of PD_{max} is important as it aids in estimating the amino acids required for actual protein deposition being achieved. Growth and tissue accretion curves can be developed that are specific to a production system through serial scanning (Smith et al., 1999;). From these scanning methods, tissue accretion and growth curves can be developed that allow producers to determine nutrient requirements at different stages of the grow-finishing period.

Once daily nutrient requirements are determined from acquired protein deposition curves and a relationship is established between energy intake and protein deposition, estimates of feed intake should be determined. It is important to accurately estimate feed intake as this will determine the optimal level of dietary nutrients needed to support observed growth rates. If body protein, lipid rates, and maintenance energy are known inputs, reference equations are available from the NRC (2012) to determine daily energy to support observed growth rates. If these inputs are unavailable, production systems can develop their own actual growth and feed intake curves. To develop these curves, 3 to 4 pigs of each gender from at least 6 different pens must be weighed at least 5 different timepoints throughout the grow-finish period. At each of these timepoints, feed disappearance is measured. Average daily feed intake is then calculated between these different timepoints and plotted against bodyweight to determine actual feed intake. This actual feed intake curve can be compared to reference intake curves to understand where nutritional or management practices can be improved to optimize growth (de Lange et al., 2001).

Once growth and feed intake curves are established, a phase feeding program can be developed based on the various weight ranges and growth rates to provide adequate nutrients for protein deposition and minimize excessive lipid deposition.

Phase Feeding

Phase feeding is a strategy where multiple diets are fed to a group of pigs based on feed budgets or weight ranges to closely meet the pigs nutrient requirement. It is generally understood that grow-finish pigs nutrient requirements decrease over the entirety of the grow-finish period and phase feeding is employed to meet these changing nutrient demands (Figure 1).

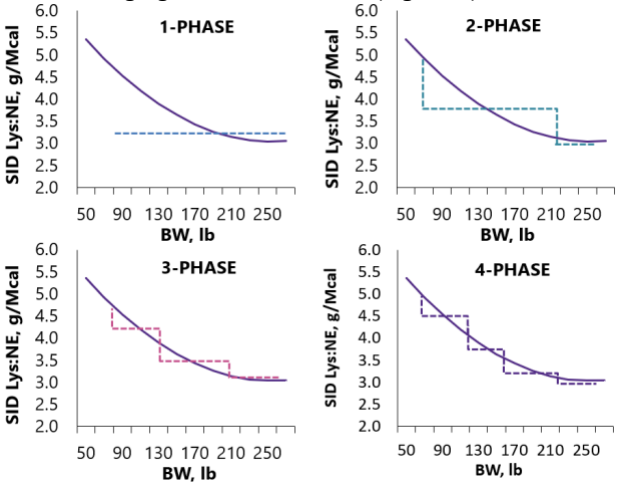

Figure 1. Diagram of phase-feeding strategies (dash line) in relation to estimated lysine requirement (solid line) expressed as a ratio of SID lysine to net energy (Menegat et al., 2019).

Nutrient requirements must be accurately estimated as the pig progresses through the grow-finish period to optimize growth performance and economic output. In the past, we have recommended 5 to 6 dietary phases

from 50 lb to market weight. This is to closely meet the pig's changing nutrient requirements and reduce nutrient excretion in waste. However, recently it has been shown that these 5 to 6 phase programs may not provide greater economic return than a 3 to 4 phase system (Menegat et al., 2019). In some cases where pigs might be underfed, compensatory growth is achieved by pigs either increasing voluntary feed intake or improving feed efficiency. To achieve compensatory growth, pigs require adequate, if not greater amino acid concentrations in the finishing period to exhibit the potential benefits (Whang et al., 2003). As long as diets fed prior to pigs being marketed meet or exceed the pigs' requirement, compensatory growth can occur and recapture lost performance due to diets being below their requirement in earlier phases (Main et al., 2008; Menegat et al., 2019). However, if the amino acid restriction is too long or severe and the compensatory period too short, compensatory growth may not occur. The number of dietary phases and nutrient fortification should be carefully evaluated with a nutritionist.

On the other hand, decreasing the number of diets fed can provide benefits to the feed manufacturing process by improving feed mill efficiency and simplifying mill logistics (Moore et al., 2013). Therefore, if feed intake and initial BW are accurately determined in a production system, simplifying phase-feeding programs can optimize growth performance and economics of a feeding program.

Establishing Feed Budgets

Once the number of phases are determined in a feeding program, customized feed budgets within the dietary phases can be established. Using customized feed budgets based on feed efficiency, a specific amount of feed is delivered to a group of pigs to gain a predetermined amount of weight. This avoids changing diets based on visual observation which may under- or over-estimate the group's actual weight. It also avoids errors made when changing diets based on a set time period. Therefore, making diet changes based on feed efficiency will be the most accurate method of matching diets with the appropriate weight range.

The inputs needed to design a customized feed budget includes feed efficiency for the specific system and the beginning and ending weight of the desired weight range. The number of dietary phases fed can vary, but based on close-out information, the pounds of feed required for a specific weight range can be determined. This amount is then multiplied by the number of pigs fed and the total amount of feed required can be estimated (Table 1).

Feed budgets can also be matched with either mixer capacity, the amount a feed truck can deliver, or bin capacity at the site. For example, if the delivery truck can hold 24 tons of feed, diets can be changed on 24 ton increments to avoid partial deliveries which will reduce feed mill and delivery efficiency.

If data necessary to develop customized feed budgets is not available, a calculator is available that helps producers develop a feed budget program. To utilize the calculator, the producer inputs their beginning weight, ending weight, and feed efficiency. Then, the producer determines the ending weight for the desired number of phases. The pounds of feed per pig will then be calculated for each phase. Table 2 provides an example of a 5 phase feeding program.

Improvements in feed efficiency will decrease the amount of feed needed for each phase. This can be observed in the differences of amount of feed needed between barrows and gilts using the same number of phases and weight ranges within these phases (Table 2).

Using feed budgets based on feed efficiency allows for more accurate determination of the amount of feed needed for a group of pigs to gain a predetermined amount of weight to avoid excesses or deficiencies in nutrients being provided.

In summary, understanding changes in growth rate of grow-finish pigs allows for more accurate development of growth curves. Reference equations exist to aid in the development of growth curves, but producers can develop growth curves that are specific to their production system. This allows for more accurate determination of nutrient requirements at different stages of the grow-finish period and allows for development of a phase feeding program specific to a production system.

References

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Table 1. An example on how to create a customized feed budget based on estimated F/G and weight range	
Assumptions:	Calculations
Weight Range: 50 to 90 lb Estimated F/G = 2.25:1 Total Gain: 40 lb Number of pigs being fed: 600	Feed per pig = (Total lb of gain per pig) × Estimated F/G = 40 × 2.25:1 = 90 lb/feed per pig Tons of feed to be delivered = (Total lb of feeder per pig × total number of pigs) = 90 × 600 = 54,000 lb (27 tons)

K-State Grow-Finish Feed Budget Program

Gilt Feed Budget		
Closeout Feed Efficiency		
Initial wt	Final wt	F/G
50	285	2.7

Initial wt	Final wt	lb/pig
50	90	**78**
90	130	**90**
130	180	**130**
180	230	**150**
230	285	**187**

Barrow Feed Budget		
Closeout Feed Efficiency		
Initial wt	Final wt	F/G
50	285	2.9

Initial wt	Final wt	lb/pig
50	90	**84**
90	130	**97**
130	180	**140**
180	230	**161**
230	285	**201**

Mixed Sex Feed Budget		
Closeout Feed Efficiency		
Initial wt	Final wt	F/G
50	285	2.8

Initial wt	Final wt	lb/pig
50	90	**81**
90	130	**94**
130	180	**135**
180	230	**155**
230	285	**194**

Table 2. Example of a customized feed budget program based on estimated F/G and body weight ranges (KSU Feed Budget Calculator).