Protein and Fat Deposition

A relationship exists between protein deposition and energy intake in regard to grow-finish growth performance. This relationship changes in different stages of grow-finish as the pig becomes heavier and understanding this change allows for the development of nutrient requirements.

Energy for Maintenance vs. Growth

Dietary energy is utilized for maintenance and growth. Maintenance energy requirements are the amount of energy needed for basal metabolic functions and to maintain body weight (Velayudhan et al., 2015). Under normal growing conditions, after maintenance needs are met, pigs will prioritize lean tissue deposition and then direct nutrients towards fat deposition (Bikker et al., 1996). Therefore, a relationship exists between energy supply above maintenance requirements and protein and fat deposition rates.

Energy Intake and Protein Deposition Relationship

Two different phases of growth exist in the grow-finish period that describes the influences of dietary energy intake on protein deposition. Early in the growing period, a linear relationship exists between dietary energy intake and protein deposition (Campbell and Taverner, 1988; Bikker et al., 1994). This relationship reveals that increasing dietary energy intake under non-limiting amino acid conditions will linearly increase protein deposition in growing pigs up to their upper limit to protein deposition (PD_{max}) and then plateau (Figure 1). This indicates that pigs are in an energy dependent period of growth. Body protein increases linearly with energy intake until the Pdmax is reached (Bikker et al., 1996). Increases in energy intake above that needed for Pdmax will increase the rate of lipid deposition and can result in fatter carcasses and poorer feed efficiency.

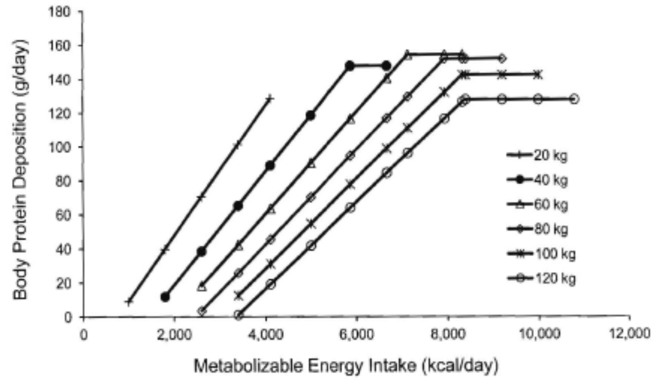

Figure 1. Relationship between protein deposition (g/d) and ME intake (kcal/day) in growing gilts at different bodyweights (NRC, 2012).

Although increasing dietary energy intake can increase protein deposition in growing pigs, the physical capacity for feed intake limits dietary energy intake and thus protein deposition. Conversely, increasing dietary energy intake in pigs during the late finishing phase of production can lead to increases in lipid deposition versus protein deposition (Figure 2).

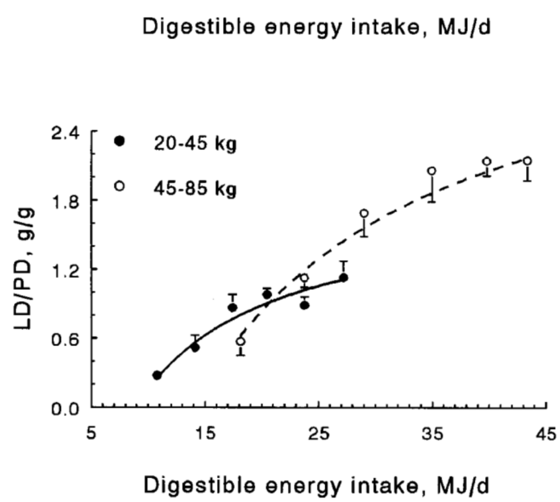

Figure 2. Lipid deposition to protein deposition ratio (g/g) at different energy intakes in 2 different weight ranges of pigs (Bikker et al., 1996).

This observation can be explained in the changes in body composition as a pig ages. The rate of lipid accretion rapidly increases as pigs enter the late finishing phase of production while lean tissue accretion rates stay relatively constant (Figure 3).

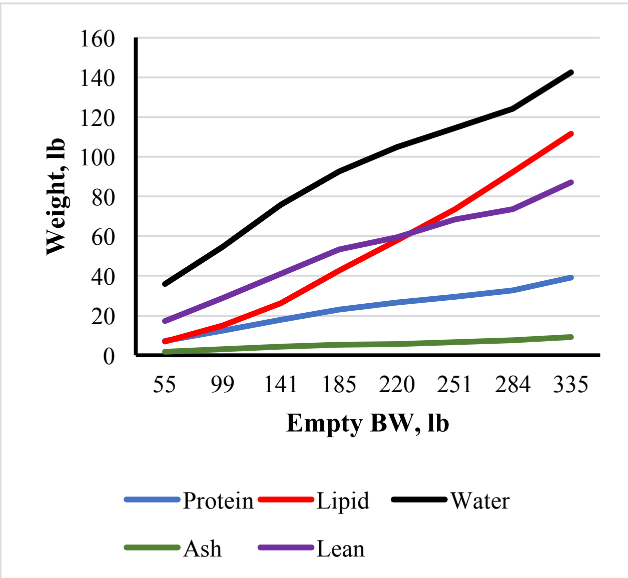

Figure 3. Changes in chemical body composition with increasing body weight (Adapted from Wagner et al., 1999).

This phase of growth is considered the protein dependent phase because energy intake no longer limits protein deposition.

Limiting energy intake in early phases of the grow-finish period can negatively affect protein deposition and growth, but overfeeding energy in later periods can lead to increases in lipid accretion. Understanding this helps aid in determining the number of dietary phases used in the nutritional program, the weight ranges of these dietary phases, and nutrient requirements in an effort to maximize protein deposition and optimize economic success.

Gender Differences

Gender should be taken into consideration when developing nutrient recommendations as energy intake and protein deposition between barrows and gilts differ (Figures 4, 5).

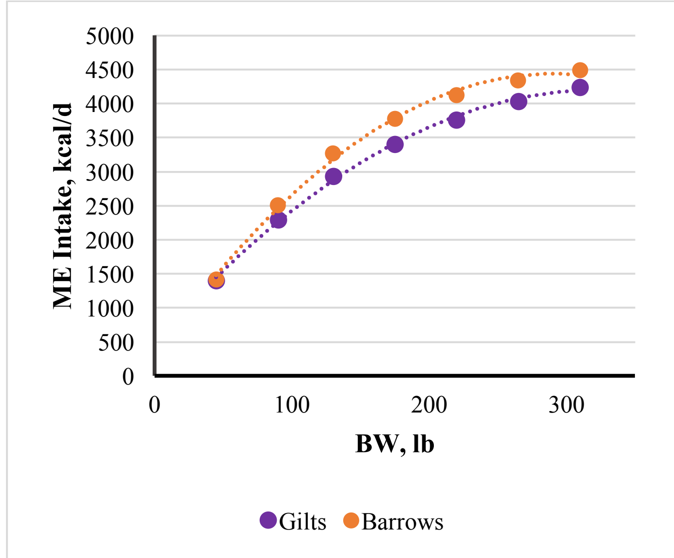

Figure 4. Typical daily ME intakes of barrows and gilts between 45 and 310 lb (Adapted from NRC, 2012).

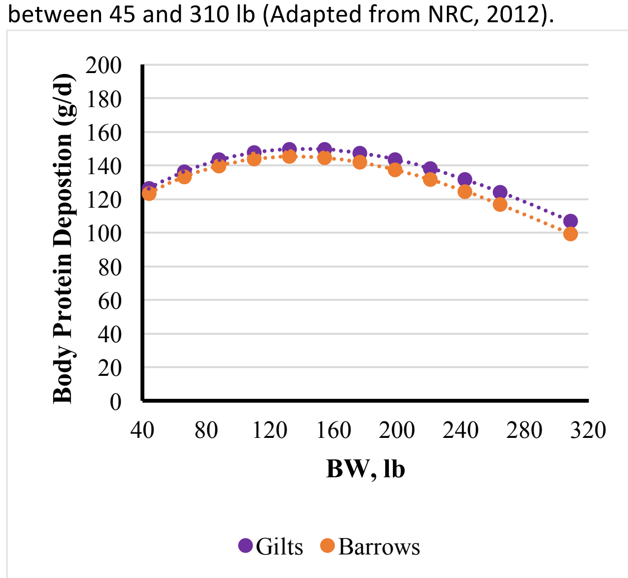

Figure 5. Typical whole-body protein deposition curves in gilts and barrows between 40 and 320 lb (Adapted from NRC, 2012).

Metabolizable energy (ME) intake is greater in barrows in the grow-finish stage versus that of gilts while the protein deposition rates are greater in gilts than barrows.

Genetic Differences

Understanding Pd_{max} allows for a relationship to be established between energy intake and body protein deposition at various stages of the grow-finish period in a production system (de Lange, 2001). Genetic line being used should be taken into consideration as different genotypes exhibit different protein accretion rates at different body weights (Figure 5).

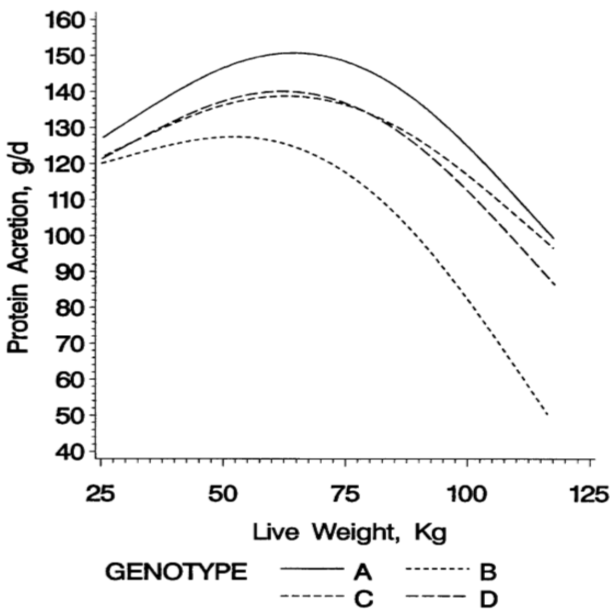

Figure 5. Differences in protein accretion rate between 4 different genetic lines (Schinckel and de Lange, 1996).

Different genetic lines will reach PD_{max} at different points in the grow-finish period. After Pd_{max} is reached, rates of protein accretion decline. In general, genetic lines selected for high protein accretion will reach Pd_{max} at heavier weights and the rate of protein accretion decline will be less than genetic lines selected for average or low protein accretion. Furthermore, under commercial conditions, grow-finish pigs can be exposed to numerous environmental stressors. Genetic lines will respond differently to environmental stressors such as high stocking density, heat stress, disease, etc. and this can significantly limit expression of their true genetic potential for Pd_{max}. Due to this, producers should understand the environmental conditions of their production system so that they can better understand their specific protein accretion rates and its relationship with energy intake to establish nutrient requirements.

In summary, a relationship exists between energy intake and protein deposition. Limiting energy intake in early phases of the grow-finish period can negatively affect protein deposition and growth, but overfeeding energy in later periods can lead to increases in lipid versus protein accretion. Producers should also understand that differences in the expression of this relationship exist between gender and genetic lines and must be considered when developing nutrient requirements.

References

Bikker, P., Verstegen, M.W.A. and R.G. Campbell. 1996. Performance and body composition of finishing gilts (45 to 85 kilograms) as affected by energy intake and nutrition in earlier life: II. Protein and lipid accretion in body components. Journal of Animal Science. 74:817-826. doi:10.2527/1996.744817x

Bikker, P., Verstegen, M.W.A., Campbell, R.G. and B. Kemp. 1994. Digestible lysine requirement of gilts with high genetic potential for lean gain, in relation to the level of energy intake. Journal of Animal Science. 72:1744-1753. doi: 10.2527/1994.7271744x

Campbell, R.G. and M.R. Taverner. 1988. Genotype and sex effects on the relationship between energy intake and protein deposition in growing pigs. Journal of Animal Science. 66:676-686. doi:10.2527/jas1988.663676x

De Lange, C.F.M., Marty, B.J., Birkett, S., Morel, P. and B. Szkotnicki. 2001. Application of pig growth models in commercial pork production. Canadian Journal of Animal Science. 81:1-8. doi: 10.4141/A00-006

NRC. 2012. Nutrient requirements of swine. 11th revised edition. Natl. Acad. Press., Washington D.C.

Schinckel, A.P. and C.F.M. De Lange. 1996. Characterization of growth parameters needed as inputs for pig growth models. Journal of Animal Science. 74:2021-2036. doi.org/10.2527/1996.7482021x

Velayudhan, D.E., Kim, I.H. and C.M. Nyachoti. 2015. Characterization of dietary energy in swine feed and feed ingredients: A review of recent research results. Asian Australian Journal of Animal Science. 28:1-13. doi:10.5713/ajas.14.0001R

Wagner, J.R., Schinckel, A.P., Chen, W., Forrest, J.C. and B.L. Coe. 1999. Analysis of body composition changes of swine during growth and development. Journal of Animal Science.77:1442-1466. doi.org/10.2527/1999.7761442x