Energy

In designing a grow-finish nutritional program, it is important to understand the responses to changing dietary energy and the impact on economic decisions. This fact sheet will discuss dietary energy effects on growth performance, formulating on a nutrient to calorie ratio, energy sources and quality, as well as fiber.

Influence on Growth Performance

Energy System

Ingredient energy values and the dietary energy system utilized must be constantly evaluated to ensure energy costs are minimized. This is because different energy systems provide varying accounting of the differences in energy utilization derived from ingredients based on their composition. The NE system is the most accurate in estimating the energy value of ingredients in a diet and the influence of dietary energy on growth performance. Because of this, diet formulation should be conducted with the net energy system due to the differences in measuring energy losses from digestion and absorption. This will aid in evaluating the different effects dietary energy can have on pig growth and carcass performance.

Growth Performance

Understanding how energy influences maintenance and tissue accretion is important as this will change throughout the grow-finish period and dictate growth performance.

Historically, increasing the energy concentration of the diet has shown to improve pig growth performance (De la Llata et al., 2001). Although, this response is dependent on the pigs' phase of growth. Producers must understand how pigs respond to dietary energy in the grow-finish phase of production as the growth performance response to increasing energy in the diet can change based on genetics, health status, environmental temperature, and stocking density.

Early in a pig's life, lean growth and, thus, daily gain, is limited by feed intake. As pigs grow and feed intake increases, lean deposition eventually reaches a plateau, where further increases in energy intake don't increase growth (Figure 1). In earlier periods where feed intake is lower, a linear response in lean growth can be observed as energy intake increases. Thus, pigs will respond to the increasing dietary energy with increased growth. In situations where feed intake is high and pigs are on the plateau for lean growth, a diminishing response to increasing energy is observed. Whether pigs are on the linear or plateau portion of the response to energy depends on the genetics, health status, and feed intake of the pigs. Producers must understand where the plateau occurs in order to determine optimal energy level in the diet.

Furthermore, increasing the dietary energy concentration in a diet increases feed costs and potentially has negative consequences on carcass composition. An economic evaluation should be conducted to determine if the improvements in pig growth performance are greater than the increased dietary costs associated with the added dietary energy.

Energy Sources and Quality

Fats and oils are commonly added to grow-finish diets. This is because these ingredients contain approximately 2.25 times more energy and the energy within these ingredients are highly digestible compared to cereal grains. The most common forms of fats used in diet formulation are animal fats derived from the rendering industry while the most common forms of oils used are extracted from seeds (link to general nutrition guide on energy sources). When considering the inclusion of a fat or oil source to increase energy density of the diet, fat quality should be evaluated as it can influence digestibility and energy value. Furthermore, it should be understood that grow-finish pigs will deposit fat in a similar fatty acid profile as the dietary fat or oil source being supplemented to the diet (Gatlin et al., 2002). This is important as fats and oils differ in their degree of saturation and this will effect grow-finish carcass composition and pork quality. This should be understood as it may limit the fat source that can be used in diet formulation in an effort to avoid discounts for carcasses and optimize economic success.

Nutrient to Calorie Ratio

Nutrient to calorie ratios must be considered when setting the energy level in diet formulation. This is because the energy content of the diet will dictate the amount of feed consumed by growing-finishing pigs. In general, increasing energy concentration of growing-finishing pigs diets will result in reductions in voluntary feed intake. The reductions are the results of pigs adjusting their voluntary feed intake to meet their daily nutrient demands while maintaining a constant energy intake (Nyachoti et al., 2004). But it should be understood that essential nutrients such as amino acids and phosphorous in the diet must be adjusted with this increasing energy concentration of the diet. Because voluntary feed intake will be reduced, daily intake of these essential nutrients will also be decreased. This decrease in nutrient intake may limit growth performance and thus the nutrient:calorie ratio must be adjusted accordingly. Therefore, to maintain a constant level of intake of these essential nutrients, the concentrations of these nutrients must be increased simultaneously with increased energy concentration in the diet.

The importance of this nutrient to calorie ratio can be observed when determining the lysine level in diet formulation. It is well established that lysine is the first limiting amino acid in swine diets as it is the most important substrate for generating body protein (Liao et al., 2015). This relationship shows that increasing lysine intake with energy intake will improve protein deposition and weight gain (Chiba et al., 1991; Marcal et al., 2017).

Fiber

Fiber concentration of ingredients should be considered as greater concentrations can decrease the digestibility of energy through decreased lipid digestibility (Wilfart et al., 2007). Although, the negative relationship between energy digestion and fiber inclusion may be improved with increasing pig age and weight due to increased retention time through the digestive process. This allows for greater inclusion rates of fiber in grow-finish diets (Le Goff et al., 2002). However, the type of fiber utilized in diet formulation should also be considered as this can affect nutrient digestibility to different degrees. While both insoluble and soluble fiber decrease energy digestibility, inclusion of moderate to high levels of insoluble fiber (i.e., wheat middlings and dried distillers grains with solubles [DDGs]) ingredients decrease the digestibility of energy toa greater extent than soluble fiber ingredients (i.e., sugar beet pulp and citrus pulp; Owusu-Asiedu et al., 2006).

Growth Performance

The effects of fiber utilization on grow-finish growth performance should be considered when evaluating the dietary energy level and use of high-fiber ingredients in diet formulation. It has been reported that including high levels of DDGS in grow-finishing diets does not affect growth performance compared to a corn-soybean meal diet, but reductions in performance have been observed in other studies (Linneen et al., 2008; Nemechek et al., 2015; Coble et al., 2017). The inconsistency in the response to DDGS could be attributed to the large variability in its nutrient composition. Dried distillers grains with solubles commonly have greater concentrations of crude fat, CP, and fiber than corn. The energy content varies with changes in oil and fiber components (Peterson, 2007; Graham et al., 2014). Graham et al. (2014) developed an equation based on oil content of DDGs sources to predict their NE content (Figure 2). Therefore, NE values should be used to provide more accuracy in diet formulation and an equation is available to aid in prediction of NE values of DDGs sources.

Fiber Withdrawal Strategies

Because reductions in performance can be observed when feed contains high fiber ingredients, nutritional strategies can be developed to alleviate these negative responses. An effective strategy that has been utilized is switching from high fiber diets to low fiber diets (fiber withdrawal) shortly before marketing. Withdrawing high fiber ingredients from the diet and switching to a corn-soybean meal diet has been observed as an effective tool at recapturing growth performance and carcass yield losses before marketing (Asmus et al., 2014; Graham et al., 2014; Soto et al., 2017). The benefits from the withdrawal strategy can be attributed to the energy and fiber relationship on feed intake. Feeding high fiber ingredients increases gut fill due to the increased dietary bulk density and can limit energy intake (Whittemore, 2001). Furthermore, reduced carcass yield is observed when high fibrous diets are fed throughout the grow-finish phase as the intestinal contents at harvest are increased (Asmus et al., 2014; Coble et al., 2017). By switching from a high fiber diet to corn-soybean meal diets, carcass yield can be improved. This diet switch should be done with the last diet before final marketing. However, the response to fiber withdrawal depends on the level of fiber in the diet and duration of the withdrawal (Lerner et al., 2018). An economic evaluation must be conducted to determine if withdrawing high fiber ingredients from the diet before market will optimize economic success.

The inclusion of high fiber ingredients should be considered in growing-finishing pig diets as they can help alleviate high feed costs; however, the negative effects on growth performance as well as carcass performance should be considered. An economic evaluation should be conducted when using high fiber ingredients in diet formulation to determine appropriate inclusion rates and feeding duration.

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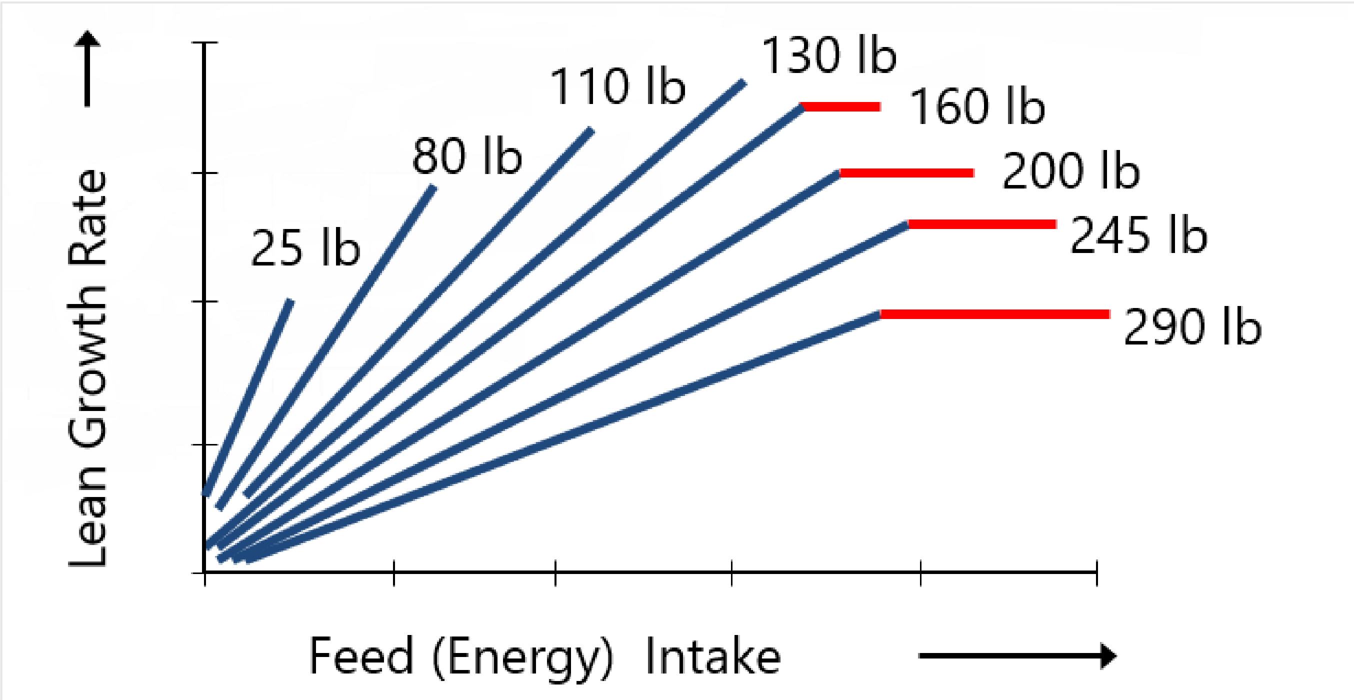

Figure 1. Influence of energy intake on lean growth rate. Lines indicate lean growth rate in relation to feed intake at different pig body weights.

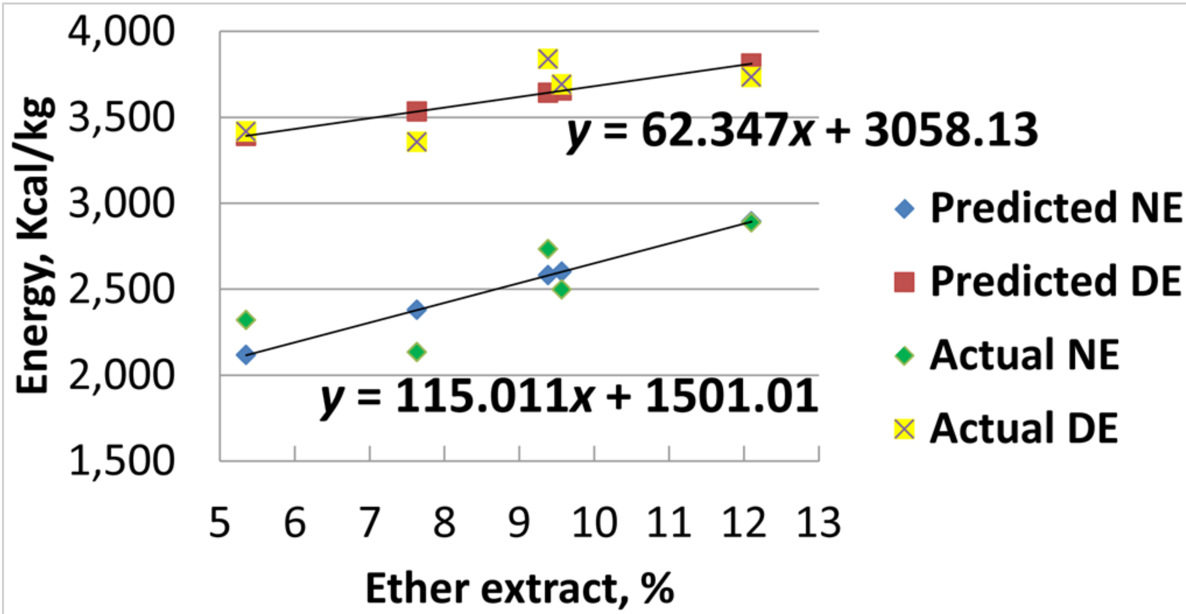

Figure 2. Predicted and measured DE and NE values of distillers dried grains with solubles sources varying in oil content (as-fed basis) using equations created in stepwise regression. DE (n = 5), adjusted R_2 = 0.41; NE (n = 5), adjusted R_2 = 0.86 (Graham et al., 2014).