Energy in Swine Nutrition

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Introduction

Energy is the most expensive component of a practical pig diet. With feed representing about 50% of the total cost of farrow-to-finish production, meeting the energy specifications of the feed represents more than 30% of the total cost of raising a pig to market. It is therefore easy to understand the current interest in energy, given the rising cost of corn over the past 24 months and the impact of biofuels on its availability.

Corn is the main source of energy in practical diets, so when its price or supply is under pressure, the pig industry is greatly affected. While the cost of corn has declined in recent months, and a drop in the world price of oil has “trimmed the sails” of the ethanol sector, the swine industry can expect continued competition for its most basic of feed ingredients.

Given the importance of energy in the cost of production, it is surprising to note that we know considerably less about energy than most other nutrients in the diet of the pig. This deficit in our knowledge must be corrected, if the pork industry is to effectively deal with the changing realities of the feed marketplace.

Role of Energy

Energy plays a very important and central role in the nutrition of the pig; it is obviously required for all metabolic processes. Nutritionists tend to think of energy filling two roles; the first is in maintenance and the second is in productive functions, such as growth, lactation or pregnancy.

Maintenance requirements for energy include all of those basic functions required to keep the pig healthy and alive. Therefore, it includes body temperature regulation, body fluid regulation, respiration, digestion, blood flow, muscle tone, normal tissue turnover and so on. Disease can increase the pig’s maintenance requirement by either reducing the efficiency with which dietary energy is used, or by increasing the energy required for maintenance functions, especially that required to operate the immune system.

The actual requirement for energy to support protein gain and lipid gain will obviously depend on the growth of the pig and the composition of that growth. While the basic efficiency of using energy for fat gain is higher than that for protein gain, the difference in efficiency, expressed at the level of overall growth of the pig favors lean gain, because protein gain is associated with a considerable amount of water (protein + water = lean gain); lipid gain involves much less associated water.

Sources of Energy

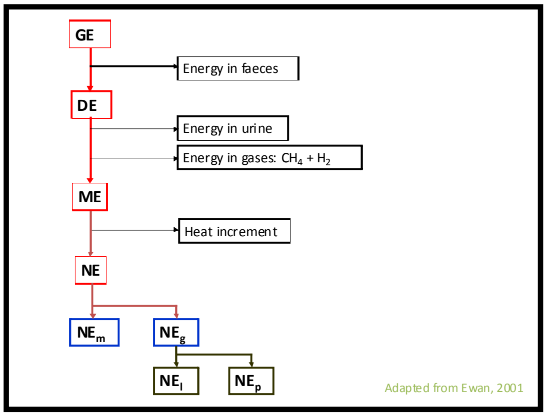
Energy is unlike any other nutrient in the diet of the pig. For example, meeting the pig’s requirement for lysine can be accomplished solely by supplying lysine in the diet, either as intact protein from such ingredients as soybean meal, or as a synthetic amino acid. Similarly, meeting the pig’s requirement for vitamin A is accomplished by adding vitamin A, or its precursor, to the diet. However, the requirement for energy can be met by adding protein, carbohydrate (starch and fiber) or fat to the diet, as they all supply energy to the pig. Thus, meeting the pig’s requirement for energy is considerably more complex than it is for other nutrients.

The problem is further compounded by the fact that protein, starch, fiber and fat are used with different levels of efficiency by the pig. Fat is a very efficient energy source, especially if the dietary fat is transformed directly to body fat in the pig. Conversely, fiber and protein are used with much less efficiency, because a certain amount of intermediate metabolic activity is required to convert them into useable forms of energy in the body. Starch efficiency is mid-way between these other groups. This issue is distinct from that of the digestibility. For example, one can have a highly digested ingredient, but if it contains high levels of protein, or low levels of fat, it will have less metabolically available energy than an ingredient of equal digestibility but lower levels of protein. The difference among these dietary components is due to the “heat increment” of their use. Stated another way, heat increment is the energy required to convert absorbed energy into a form more readily useable by the pig. The heat increment for protein and fiber is higher than that for starch, which in turn is higher than that for dietary fat; in turn, the heat increment associated with the use of different ingredients will also differ, due to their differing content of protein, fiber, starch and fat. If we select ingredients for use in pig diets without considering their heat increment, we can make errors in their true value as an energy source.

One can therefore see why corn is such a good source of energy for the pig. It contains high levels of starch and fat, and relative to other ingredients, lower levels of fiber and protein. Therefore, the energy in corn will be used very efficiently by the pig. Conversely, corn distillers grains will be used less efficiently, because the starch has been removed, resulting in higher relative quantities of fiber and protein; the saving grace of distillers grains (DDGS) is the high concentration of fat. However, there is increasing interest in removing fat from DDGS, a practice that would make DDGS much less valuable in the diet of the pig.

Measuring Energy

Typically, the DE (digestible energy) and the ME (metabolizable energy) systems are the most common in the U.S. In Europe and in western Canada, where more diverse diets have historically been the norm, a third energy system called NE (net energy) is increasingly common. Net energy has the advantage of addressing the issue of heat increment; the difference between ME and NE is called the heat increment.



Adapted from Ewan, 2001

As described above, the energy consumed by the pig that is not lost in the feces or the urine, or as heat increment, is used for both maintenance (NEm). Once the needs of maintenance are addressed, the rest will be used for growth (NEg). In turn, NEg will be divided between the energy required for protein gain (NEp)and lipid (fat) gain (NEl).

From an ingredient evaluation perspective, few would argue that the NE system is superior to the DE and ME systems, because it addresses this issue of heat increment. Historically, most of the research on net energy has been directed at ingredient evaluation. What is less clear is the ability of the NE system to predict animal performance more effectively than DE and ME. That is a point of considerable research at the present time. Our research so far has indicated that NE is not superior to DE or ME in predicting overall bodyweight gain or body protein gain, but is superior in predicting fat gain, and the lipid:protein ratio of gain. Further research is underway at the present time. However, the trend to increased adoption of NE in North America is driven primarily by benefits accruing from ingredient evaluation, with the assumption that NE will be no worse than DE or ME in predicting animal performance. Our research has suggested that, if the formulator is familiar with the practical application of NE in the field, this assumption is reasonable.

It is therefore clear that we will see more research on dietary energy in the future. This will be driven by its cost in the total budget of pork production, the uncertainty of where energy will come from in the future and the impact of energy in the diet on overall pig productivity and performance.