

Energy Requirements for Growth and Reproduction

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The majority of the diet cost is associated with meeting the energy needs of pigs. Energy is produced when the carbohydrates, fats, and protein in feeds are metabolized by oxidative processes in the body. The chemical reaction is quite simple: the carbon, hydrogen, and oxygen in carbohydrates, fats, and protein react with inhaled oxygen to form carbon dioxide, water, and energy. This is essentially the same oxidative reaction that occurs when combustible material is burned. In the body, much of the energy that is produced from this reaction is captured in the form of high-energy phosphate bonds. These bonds ultimately release this stored form of energy for a multitude of functions, including activities that keep the pig alive (breathing, heartbeat, etc.), synthesis of body protein and fat for growth, physical activity, and many other functions.

Some of the energy produced when feed nutrients are metabolized is not retained by the body but is lost as heat. Some of this heat is useful in that it is used to maintain body temperature. The rest is dissipated from the body. In pigs, most of the heat is dissipated through vaporization of water in the lungs. The water vapor is then expired from the lungs.

Energy can be expressed in a variety of terms. For example, appliances that produce or remove heat in homes and buildings have energy expressed as British Thermal Units (BTU). The Europeans use the “joule” to express units of energy. Here in the USA, we use the “calorie” system to express energy in feeds and energy requirements of animals. Typically, energy is expressed as kilocalories (kcal, or 1,000 calories) or megacalories (Mcal, or 1,000 kilocalories).

Not all of the potential combustible energy in feeds can be utilized by animals, mainly due to the fact that some feeds are poorly digested. Therefore the gross energy (GE, the energy released when material is burned in a calorimeter) content of a feed is meaningless. Digestible energy (DE) is a very useful expression of energy value in that it takes into account the energy components that the animal digests. Metabolizable energy (ME) is also a useful expression of energy in that it further corrects the DE term for the energy lost in the urine and combustible gasses. In the USA, ME is most often used, but DE is also used to some extent. Net energy (NE) is a further refinement and is probably the best system of all. However, there is still much to be learned about the NE contributions of feedstuffs, so adoption of such a system is still a few years in the future.

Table 1 shows the DE and ME content of a few commonly used feedstuffs in pig feeding. Note that corn at 12% moisture (88% dry matter) and dehulled soybean meal at 90% dry matter contain approximately the same amount of ME (1,535 kcal per pound). Thus a typical corn-soy diet consisting of 97.5% corn and dehulled soybean meal and 2.5% minerals and vitamins will contain approximately 1,500 kcal of ME per pound.

We have fairly good information on the energy requirements of swine. For growing pigs, the daily energy requirement is the sum of the energy required for maintenance, for protein and fat synthesis in the lean tissues of the body, and for body heat regulation. Obviously, genetically

superior lean pigs with fast growth rates will require more energy to support the high lean tissue deposition than slower growing pigs. Generally, when pigs are fed a high-energy feed (such as corn-soybean meal) on an ad libitum basis, they will consume enough feed to meet their energy requirement. Exceptions might be in fast growing pigs during the postweaning stage and growing-finishing pigs with a high lean growth rate and low appetite for feed. In those cases, energy may be limiting. But in most cases, pigs will consume more energy than they actually need, and that additional energy is deposited as fat.

Table 2 shows typical ME and feed intakes (corn-soy type diet) of pigs of various weights under ideal conditions. These intakes will be affected by environmental temperature. Intakes will increase when pigs are in a cold environment (due to more energy needed to maintain body warmth) and will decrease when they are in a hot environment. Excessive crowding also will reduce feed intake. Feed intakes are also influenced by the energy concentration in the feed. Intakes will decrease if the feed is high in energy (such as when fat is added to the diet), and intakes will increase when low-energy feeds are fed. Note that barrows consume more energy and feed than gilts after they reach about 70 pounds in weight.

During gestation, gilts and sows require energy for maintenance, for the developing fetuses and supporting tissues of pregnancy (placenta, fluids, udder development, etc.), for some increase in the sow's body tissues needed for the upcoming lactation, and for body heat regulation. Generally, 6,000 to 6,500 kcal of ME per day (or 4 to 4.5 pounds of a corn-dehulled soybean meal type diet) in an ideal thermoenvironment will meet the energy needs of pregnancy.

During lactation, energy is needed for maintenance, for milk production, and body heat regulation. The energy requirement for milk production far exceeds the requirements for other functions and also far exceeds the requirements during pregnancy. In fact, good milking sows often cannot consume enough feed energy to meet their requirements and must draw from their body energy stores during lactation. Daily requirements during lactation for high producing sows may range from 18,000 to 22,000 kcal of ME per day in an ideal thermoenvironment, or 12 to 14 pounds per day of a corn-dehulled soybean meal type diet.

Providing sufficient energy to sows during lactation is extremely important. Otherwise, excessive weight loss can result in delays to postweaning estrus. Sows should be full fed during this critical time. Self feeders can be used or, better yet, sows can be hand fed three to four times daily, giving them all that they will eat. Maintaining a comfortable temperature in farrowing barns or using water drippers on the sow's neck and shoulders to cool her is very important to maintain appetite and prevent excessive weight loss.

Table 1. Energy content of some commonly used feedstuffs for swine

| Feedstuff | Dry matter % | DE kcal/lb | ME kcal/lb |
|--|-----------------|---------------|---------------|
| Corn | 88 | 1,585 | 1,535 |
| Grain sorghum | 88 | 1,520 | 1,500 |
| Wheat, soft red winter | 88 | 1,570 | 1,500 |
| Barley | 88 | 1,370 | 1,310 |
| Oats | 88 | 1,245 | 1,220 |
| Soybean meal, dehulled | 90 | 1,675 | 1,535 |
| Soybean meal, 44% protein | 90 | 1,570 | 1,430 |
| Meat meal, 60% protein | 94 | 1,225 | 1,180 |
| Whey, dried | 96 | 1,515 | 1,450 |
| Wheat middlings | 88 | 1,380 | 1,360 |
| Feed grade fat | 100 | 3,900 | 3,700 |
| Dicalcium phosphate, ground limestone, salt | 100 | 0 | 0 |

Adapted from *Nutrient Requirements of Swine*, 1998, National Research Council

Table 2. Daily energy and feed intakes of weanling, growing, and finishing pigs

| Body weight, lb | ME, kcal/day Mixed sexes | Feed, lb/day | | |
|--------------------|-----------------------------|--------------|---------|-------|
| | | Mixed sexes | Barrows | Gilts |
| 10 | 945 | .63 | - | - |
| 15 | 1,470 | .98 | - | - |
| 20 | 1,980 | 1.32 | - | - |
| 30 | 2,970 | 1.98 | - | - |
| 40 | 3,930 | 2.62 | - | - |
| 70 | 5,720 | 3.81 | 3.87 | 3.75 |
| 100 | 7,025 | 4.68 | 4.89 | 4.48 |
| 150 | 8,595 | 5.73 | 6.13 | 5.32 |
| 200 | 9,670 | 6.45 | 6.92 | 5.98 |
| 250 | 10,550 | 7.03 | 7.39 | 6.67 |

Adapted from *Nutrient Requirements of Swine*, 1998, National Research Council. Feed intake assumes ad libitum consumption of a corn-dehulled soybean meal diet containing 1,500 kcal ME/lb and a thermoneutral environment .