NATIONAL
ANIMAL
NUTRITION
PROGRAM

Energy

Energy is governed by the first and second laws of thermodynamics. Sometimes, it helps to translate these laws to animal nutrition.

1st Law of Thermodynamics

Energy cannot be created or destroyed, but it can be transformed.

- **Animal nutrition translation:** Feeds contain energy animals use to fuel production
- (growth, lactation, reproduction).

Energy is not a nutrient. There are a total of six classes of nutrients: water, carbohydrates, proteins, fat, minerals, and vitamins. Of these six, three classes of nutrients provide energy, or permit the transformation of energy, when fed to animals. They are:

Carbohydrates

- 4 calories/gram
- Bulk of feed energy for livestock as they tend to be the least expensive and widely available

Proteins

- 4 to 5 calories/gram
- Too expensive for producers to feed as energy

Fat

- 9 calories/gram
- Used to reduce dust and improve pellet quality in some cases
- Feeding challenges and rancidity limit the quantity of its inclusion in animal diets

Additional Information

Total Digestible Nutrients, or TDN, is another term that continues to be widely used in the livestock industry. The TDN of a feedstuff is a calculated value using the equation:

TDN = % digestible crude fiber (or CF)+ % digestible crude protein (or CP) + % digestible non-fiber extract (or NFE)+ (% digestible ether extractable fat (or EE) * 2.25)

This equation yields a percent TDN value. Many calculations and estimations go into each of the terms in the TDN equation; therefore, this equation should be considered also only as a means of gross comparison. Most energy terms are discussed as unit of energy, calories, kilocalories (kcal), or megacolories (Mcal); however, TDN is often assigned a weight or a percent. Thus, many nutritionists will use a conversion of 1 kg TDN = 4.4 Mcal DE.

2nd Law of Thermodynamics

If no energy enters or leaves the system, the potential energy of the state will always be less than that of the initial state.

- **Animal nutrition translation:** When an animal takes in potential energy and converts it to kinetic energy, then some of the energy will be irreversibly lost (i.e., heat increment)."

Energy is lost in the animal system due to this second law of thermodynamics. These energy terms are used to define how much energy may be afforded from a specific feed or diet to the animal for maintenance and production needs. Thus, energy terminology must be defined and understood:

- **Gross Energy (GE) =** the energy an animal initially consumes from the diet fed. Also known as the "heat of combustion" because this is the energy value obtained when a sample of feedstuff is completely combusted or burned. This term describes the total potential energy in an ingredient independent of animal species interaction.
- **Digestible Energy (DE) =** the GE minus the energy the animals excrete in their feces (this is the majority of the energy "lost" from animal systems), also known as the "apparently absorbed energy."
- **Metabolizable Energy (ME) =** the DE minus the energy lost in nitrogen excretion (urea or uric acid). This value of ME is the more common terminology used when feeding **poultry and pigs** because fecal and nitrogen waste are excreted together. This term is sometimes used to describe the truly digested energy value of a feedstuff.
- **Net Energy (NE) =** a more complicated system of terms, most commonly used for cattle systems like beef and dairy, that try to classify the energy value to feedstuffs or diets based on maintenance and production. Thus, three terms are used commonly:

NE_m – Net energy of maintenance

NE_g – Net energy of gain (most common for growing beef cattle)

NE_l – Net energy of lactation (most commonly used for dairy cattle)