Lesson 9: Energy

Energy in Feedstuffs

Overview
Most feedstuffs provide energy. While fats, oils, and grains have the highest energy content, roughages and mineral supplements have little or no energy content. It is important to calculate the energy content of feedstuff in order to formulate a diet that meets the animal’s nutritional requirements.

It is also important to measure the net energy available to an animal from a feed to determine such things as lactation levels for dairy cattle, maintenance and gain for feedlot beef cattle, etc. However net energy is difficult to measure as some energy is lost in the digestive process in the form of feces, urine, gases, and heat. The nearest substitute to net energy is digestive energy, as it is much easier to measure. Digestive energy is the potential energy of the foodstuff minus the energy lost in feces. Digestive energy varies from one species to another, and is affected by the animal’s health and its environment.

Grains form the most popular feedstuffs due to their availability and high energy content. Corn and processed sorghum grains (milo) are the most popular grains. Oats and barley grains are also used as feedstuff, though the two are not as high in starch as corn and milo. Oats are rich in fiber and are preferred by horse owners.

Definitions
Intake Energy
Energy available in the feedstuff. It is also known as potential energy.

Digestible Energy
Digestible Energy is intake energy (energy available in the feedstuff) minus what is lost in the feces.

Metabolizable Energy
Metabolizable Energy is digestible energy minus what is lost in urine and gases.

Net Energy
The energy that is available to the animal after consumption, digestion, and metabolization of the feedstuff. Metabolizable energy minus what is lost as heat.

Total Digestible Nutrients
The energy measure for beef cattle by measuring nutrients lost in the feces. It is similar to digestible energy. To calculate: digestible carbohydrate + digestible protein + digestible fat x 2.5.

| Thermo neutral Zone |
The temperature at which there is optimum digestion of feedstuff (highest value for digestible energy) for a particular species.

Potential Energy
Energy available in the feedstuff. Same as intake energy.

Available Energy
Same as net energy.

Readily Available Carbohydrate
Carbohydrates that can be digested easily and available for the body’s use. Starch and sugar are two such carbohydrates.

Fumonisin
A type of mycotoxin fatal to horses.

Mycotoxin
Poison produced by actively growing mold.

Maize
The corn grain in Britain.

Milo
Processed sorghum grain used as animal feed.

**Measuring Energy Value of Feedstuffs**

**The Energy Scheme**
It is important to measure the energy value of feedstuff specific to each species in order to economically provide a diet which meets the animal’s nutritional requirements. The net energy available to the animal after the digestion of the feedstuff is the most important measurement. It is useful for measuring lactation of dairy cattle, the maintenance and gain for feedlot beef cattle, etc. However, it is difficult to measure as some energy is lost in the digestive process in the form of feces, urine, gases, and heat.

Remember that energy is never created, and never lost. The “energy scheme” of the energy consumed by an animal through feedstuff displays how energy is lost in the various stages of digestion:

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Absorption of energy: Digestion occurs in the GI tract, where feedstuff is broken into smaller nutrients. These nutrients are then absorbed from the small intestine, rumen, and cecum into the blood or lymph.
Digestible Energy
A good substitute for net energy is digestible energy (GE). It is the easiest to measure because one only needs to subtract the energy lost in the feces from the intake energy. Collecting feces is much easier than collecting the urine, gases, and heat produced during the process of digestion.

Digestible energy differs from one species to another, as the process of digestion is different for different species. Ruminants, non-ruminants, monogastrics, all have different processes of digestion. DE values cannot be calculated for poultry.

Digestible energy is also affected by the animal’s health. A bad set of teeth would adversely affect the animal’s ability to chew, which in turn will reduce DE. An unhealthy GI tract can also lower DE values.

A thermo neutral zone is required for optimum DE values. If the environment is too cold the animal generates more heat, and more energy is lost. If the environment is too hot, the animal suffers heat stress, which leads to increased metabolic rate, due to which more energy is lost. Also, an animal eats less feed when it is heat-stressed. Thus, it is important to maintain the right temperature for the animal. This is called a thermo neutral zone. The right temperature is different for different species. Animals have the capability of adapting to slow changes in the surrounding temperature. For example, animals have thicker hair coats in winter. Also, animals can tolerate cooler temperatures much better than warmer temperatures.

Ranking Feedstuff

The Rankings
The energy content of feeds is as follows:
1. Fats, oils = highest energy content
2. Grains = high energy content
3. Protein supplements = intermediate energy content
4. Roughages = relatively low energy content
5. Mineral supplements = no energy content

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High Energy Feedstuffs

There are four main feedstuffs in this category. All of them contain readily available carbohydrate (starch, sugar) or fat/oil.

1. Grains (starch)
2. Fats/oils
3. Potatoes/tubers (starch)
4. Sugars/candies

Potato and sweet potato waste are by-product high-energy feeds due to their high starch content. However, the sweet potato slurry with low pH can damage a cow’s teeth.

Grains

Grains are the most popular feeds. These are plant seeds that are rich in starch, and thus a good source of carbohydrates for animals. The most popular grains in the U.S. are corn, sorghum, oats, barley, and wheat. Grains contain a protective outer covering which needs to be disrupted so that the animal can easily digest the starch inside. For this reason ground grains lead to higher DE values than whole grains.

Corn Grain

Corn (called “maize” in Great Britain) is the most popular grain used as animal feed. 75% of the grain fed in the U.S. is corn, as it grows in most parts of the U.S. It can be fed to all species (including humans and pets). It is also very digestible and palatable and does not cause nutritional problems when fed using the proper procedures. It is important to bear caution while feeding corn to animals because it is dense in energy. Also, the grain should be tested for fumonisin, which is a type of mycotoxin that is fatal for horses.

Sorghum Grain

Sorghum is the second most popular grain used as animal feed. It is not as high-yielding as corn and grows in regions with less rainfall. However, it is heat-resistant, and more pest-resistant than corn. Since the grain is quite small, it can pass through the GI tract of the animal without being digested. Therefore it has to be processed before being fed to the animal. Once processed (the processed sorghum grain is known as milo), its energy value is equivalent to that of corn.
**Oat Grain**

Oat grain is more expensive than corn and sorghum grain, and is mainly used in horse feeds. It has a fibrous coating which makes it high in fiber. Thus the oat grain has less energy per pound than corn or milo. Horse owners prefer oat grains to other grains due to its high fiber content, and also because its starch is readily digested causing fewer digestive problems in the animal. Also, the oat grain is mold-resistant and has no mycotoxins.

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**Barley Grain**

The barley grain is similar to the oat grain, but it needs to be processed in order for its starch to be digested by the animal.

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**Wheat Grain**

The wheat grain is high in energy. Like corn and unlike oats it has no outer fibrous coating. Wheat is consumed by humans and is not a popular animal feed because it forms a pasty mass inside the animal if consumed in large amounts.

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**Fats and Oils**

Fats and oils are high in energy. They improve the palatability of a feed by reducing its dustiness. The sources of fats are plants (like the vegetable oils typically used in restaurants) and animals (usually provided as rendering byproduct (i.e. leftover products from when animals are processed for their meat)). Ruminant animals cannot digest high levels of fat because they have evolved on low-fat diets. When a ruminant is fed more than 5% fat, the extra is wasted in the feces because it cannot be digested. However, monogastrics (dogs, cats, pigs, humans) can digest high levels of fat.