Most livestock owners can learn how to formulate basic livestock rations. Tools required include nutrition reference books, paper, pencil (with an eraser!), calculator and one brain in reasonable condition. Actually, there are only two steps involved in formulating a ration:

1. Determine an animal’s nutritional requirements.
2. Determine what feeds are needed to meet these requirements.

An animal’s nutritional requirements depend on several things: species, mature size, age, weight, physiologic status (pregnancy, lactation, etc.), level of production (rate of gain, amount of milk produced, etc.), general health, weather, and amount of work. For example, every animal will require more energy just for maintenance in cold weather. Also, working animals have higher requirements than animals at rest. Lactating animals have the highest nutritional requirements of all.

How can you figure out what your animal’s needs are? The National Research Council (NRC) publishes booklets on the average nutritional requirements of the major species. These NRC booklets are available at many Extension offices or you may order or browse them on-line at http://www.nap.edu/browse.html. Go to this site and click on “Agriculture”. A long list of agriculture-related publications pops up, including the NRC’s nutritional requirements for various species. Find the species you are interested in and look for the requirements based on your animal’s body weight and performance level. These nutritional requirement tables are also included in the reference sections of many livestock feeding textbooks.

The major nutrients are water, protein, energy (fats and carbohydrates), vitamins and minerals. The main nutritional requirements to balance for are dry matter, protein, energy, calcium and phosphorus. Protein requirements are reported as grams or pounds of crude protein (CP), total protein (TP) and/or digestible protein (DP). Energy requirements can be reported as pounds of Total Digestible Nutrients (TDN) or megacalories of Digestible Energy (DE), Metabolizable Energy (ME) or Net Energy (NE). Most small-scale producers could use CP and either TDN or DE values to calculate a balanced diet for their animals. The diagram below helps explain this “alphabet soup”:
**Gross Energy** of a feed
- energy lost in feces

**Digestible Energy**
- energy lost in urine and gases

**Metabolizable Energy**
- energy lost as heat produced during digestion

**Net Energy**: available for lactation, growth, work, pregnancy or other production

The limiting factor in determining an animal’s ration is the amount of dry matter the animal can consume in one day—all the required nutrients must be included in this daily dry matter intake or the animal will be undernourished. Dry matter intake (DMI) is reported as a percent of body weight and depends on an animal’s species, physiologic status and stage of maturity. For example: young growing animals and lactating animals need and can consume more dry matter in a day than can a mature animal at rest, on a percent-of-body-weight basis. DMI requirements range from 1.5% of body weight for a mature horse up to 6% of body weight for a heavily-lactating doe or ewe. Because there is an inverse relationship between mature body size and dry matter intake, a heavily-lactating mouse probably has the highest mammalian DMI requirement on a percent-of-body-weight basis!

The way to create the most economical balanced ration is to use roughage as the major feed component. “Roughage” is the term that describes high-fiber feedstuffs such as hay, pasture, cubes or pelleted fiber sources. Roughage (especially pasture) is usually the least expensive feedstuff. “Concentrate” is the term that describes a feedstuff that is high in a certain nutrient such as protein or energy. Soybean meal is an example of a protein concentrate; corn is an example of an energy concentrate. After using roughages as the major portion of the diet, use concentrates to make up any nutritional deficiencies. As a general rule, one pound of roughage can be replaced by 0.6 pounds of concentrate. It is important to realize that the nutritional requirements for many classes of animals can be met with just good quality hay and a mineral mix; this is usually the most economical ration, too.

Reference texts can provide estimates of the nutritional analysis of most feeds. These book values are only estimates, however; much more accurate information is produced by analysis of individual batches of feeds. For example,
the “book value” for crude protein in early bloom, second cutting orchardgrass hay is 11.4%. However, the orchardgrass you actually grow or purchase could have much a much lower protein level for a variety of reasons. If you used the book value, your animals would be fed a ration that is deficient in protein. Contact your Extension agent for information about how to submit feeds for analysis. Commercially available feeds such as concentrate mixes have a feed analysis tag provided so there is no need to run an analysis on them.

Just like with people, there is a great deal of individual variation between animals when it comes to metabolic rates and efficiencies of digestion, so the impact of any ration you develop must be monitored closely and adjusted as needed. Monitor an animal’s nutritional status by regularly assessing its body condition, weight, performance (rate of gain, amount of milk produced, speed, etc.), and general health (bright eyes, ability to heal quickly, pink mucous membranes, good hoof and coat quality, good conception rate). Is the animal gaining too much weight? If so, reduce some of the concentrate you are feeding. Is the animal getting thin? Add more energy. It is important that you make any changes to an animal’s diet slowly so that intestinal bacteria have time to adjust and help with the digestion. Also, it is best to feed all animals several smaller meals per day instead of one large meal.

In the next issue we will run through a couple of ration balancing exercises. Sharpen those pencils!