Basics of Alpaca Nutrition, *Part 1*

by Nancy Irlbeck, PhD

Nutrition is one of the major keys to animal health. Without a sound nutrition program, an animal will be unable to produce fiber or a cria to its maximum genetic potential. Limitations in the supply of nutrients can and do compromise an animal's immune system. Therefore, having a working knowledge of the nutrients needed by the animal, and what feeds will supply those nutrients, is one of the most important steps in managing an animal. I strongly suggest that if you do not have a livestock background and are not familiar with herbivorous hoofstock, research the alpaca and what it needs BEFORE you bring it home. There are a lot of questions to be asked before you actually feed an alpaca, and I will attempt to address those in this text. There is not enough space to cover all the aspects of nutrition and the feeds that are used to feed these animals, but I will do my best to address some of the "basics."

An animal can live for long periods of time with limited nutrients. The animal body has a unique way of "borrowing" nutrients from other parts of the body to enable life to continue. But there is a price for this "borrowing" and sooner or later those borrowed nutrients need to be replaced or the animal will be come ill and may even die. Until the animal "crashes," it is not obvious that there is a problem, and often the only symptoms that something is wrong may be subtle changes in production, a lower yield of fiber, or a cria of low birth weight and vigor. Records are a vital part of a production system and an alpaca owner needs to record body weights on a regular basis.

In addition to proper feeding management, I encourage you to get to know your animals – really know them. Individuals that have worked with livestock previously – cattle, sheep, goats – are aware of subtleties for which one should watch. These subtleties are factors that can never be learned from a book, little things that can only be learned from actually working with animals. You might hear one of these individuals say, "That animal does not feel well," and you think the person is "bonkers." The animal appears to be exhibiting normal eating and mobility patterns. But beware, it may be the way the animal is holding its head, or perhaps it is standing by itself. Either way, an individual raising alpacas has to become familiar with his animals from the beginning. Get in with your animals. Walk among them, watch them, and know what is normal. All animals are creatures of habit and if you are familiar enough to know "normal" and are watching closely, you will be aware when something is wrong. Do not be a "fenceline" manager. Combining these concepts and proper feeding management, you will be well on your way to a successful venture into the alpaca husbandry.

Nutrition is not always easy – it is a puzzle. And there are many pieces to that puzzle including management, behavior of the animal, potential disease, physiological status (i.e., pregnant, lactating, growing), economics involved with forage and grains, and of course, what is available to feed the animal. Becoming aware of these puzzle pieces and how they fit together is a good start when feeding the alpaca. Be aware that the nutrient requirements for the alpaca are not known. Data from small ruminants like sheep and goats have been extrapolated for alpacas to obtain an estimated requirement. I have incorporated those estimates in *Table 1*. All values shown in the table are presented on a dry matter basis (DM). What that means is that alpacas consume grass, hay, and grains of differing moisture contents and it is difficult to directly compare nutrient contents with feed having varying amounts of water. Thus, if one uses dry matter nutrient values (all water removed), this allows nutritionists and producers to directly compare the values. This is done for all other species, too.

Table 1. Estimated Nutrient Requirements of Llamas and Alpacas – Dry Matter Basis (DM)[1]

Nutrient	Level	Source
Crude Protein, %	8-14	Johnson, 1989
DE [2], Kcal[3] /kg BW	33	Carmean, 1992
Calcium, %	0.3-0.85	Van Saun, 1999
Phosphorus, %	0.16-0.40	Van Saun, 1999
Potassium,%	0.5-1.0	Van Saun, 1999
Magnesium,%	0.12-0.20	Van Saun, 1999
Copper, ppm[4]	13-15	Van Saun, 1999
Iron, ppm	60-130	Van Saun, 1999
Manganese, ppm	45-55	Van Saun, 1999
Selenium, ppm	0.4-0.6	Van Saun, 1999
Zinc, ppm	40-50	Van Saun, 1999
Vitamin A, IU[5] /kg	3000-3500	Van Saun, 1999
Vitamin D, IU/kg	3000	Extrapolated
Vitamin E, IU/kg	17-20	Van Saun, 1999

1. Irlbeck, 2000
2. DE: Kcal of Digestible Energy (DE) per kg of body weight (BW) of an animal at maintenance (DE is another more definitive energy expression than the traditional method of TDN (Total Digestible Nutrients). Animals that are growing, lactating, or in the third trimester of gestation will have a higher energy requirement.
3. Kcal: kilocalories (a measure of energy)
4. ppm: parts per million, or milligrams/liter
5. IU: International Units

Gastrointestinal Tract

Understanding what kind of gastrointestinal tract (GIT) an animal has is an integral piece of the nutrition puzzle, and is key to understanding how an animal is fed. Types of GIT vary among the animal kingdom based on animal diets. The GIT is defined as the part of an animal's body from the mouth, esophagus, stomach, small and large intestine, and down to the anus.

For example, a carnivore has a very short GIT because its meat-based diet is very digestible and a larger tract would not be needed. An animal that consumes forages like grass and hay (herbivore) must have a much larger tract as it needs to house the symbiotic microbe population. The microbe population is needed to break down or ferment cellulose, cellulose being a major component of plants. Mammals cannot digest cellulose. Yet cattle, horses, sheep, and even alpacas consume forages and seem to do quite well, but it is because of a resident microbe population. The microbes produce an enzyme called cellulase to ferment cellulose found in plants. Without this enzyme, forages could not be fed to the above animals. Also, because of the sensitive nature of those symbiotic microbes and how they are affected by what we feed them, great care needs to be taken. If the microbes were to be hampered in any way by what we feed the alpaca, then the animal can be compromised. Symbiotic means that the microbes and the alpaca both are dependent on each other. The alpaca provides a "home" and food supply for the microbes, and the microbes ferment that food and produce volatile fatty acids. Volatile fatty acids provide a source of energy for the alpaca.

The alpaca is an herbivore and is classified as a pseudo-ruminant. Being a pseudo-ruminant means that the alpaca (like the llama) is similar to a ruminant animal (cattle, sheep, goats, and deer), but is not exactly. Ruminants cannot all be fed the same, so care needs to be taken which ruminant model is used for comparison with an alpaca. Cattle are able to do quite well on large quantities of low quality forage, the alpaca cannot. The feeding principles for the sheep and goat are closer to what alpacas need than those for cattle. Because of its size and metabolism, the alpaca needs high quality forages. I will discuss how you can determine a high quality forage momentarily.

When evaluating GIT differences, the most important GIT difference is the stomach. The stomach of the alpaca is not the same as what we think about for people, for dogs, or even the horse. The alpaca stomach has three parts – Compartments I, II, and III. Compartment I is the largest, and is analogous to the rumen in cattle, sheep, and goats. It is here in Compartment I that microbial fermentation of the fibrous portion of plants occurs.

Compartment II is much smaller than the first and it is here that buffering agents and more digestive enzymes are added to the digesta (partially digested food). When the digesta leaves Compartment II, it enters Compartment III where nitrogen (urea) is recycled, and more buffers and digestive enzymes are added. The lower portion of Compartment III is analogous to the stomach of the human, horse or dog – it is here that protein digesting enzymes and hydrochloric acid are added. It is also here that microbes attached to food particles coming from Compartment I are also digested, becoming what we call microbial protein – an important source of amino acids for the alpaca as they are for ruminants like cattle, sheep and goats. I have been asked to explain when an alpaca "chews its cud," a behavior that is actually pretty fascinating to observe in alpacas. Well, a short answer is that the animal grazes and collects the food in C1. When the animal is at rest (that is, when it is cushing), it will eructate the cud from C1 and ruminate.

So How Do We Feed the Alpaca?

Many scientists, myself included, indicate that when feeding animals, we need to consider what the animal was fed in its native habitat. For example, alpacas are South American camelids, and we need to closely evaluate what

the animals are being fed in South America. Yes that is true. But we also have to consider that individuals raising alpacas in South American most often do not have the available resources that we in the United States have to feed animals. Animals in South America are quite often fed a subsistence ration and when consuming that kind of diet, they do not produce fiber and young at the same level as they do in the United States. They also do not live as long. If there is a consistent problem feeding in the United States, it is usually in our zeal to take care of these animals in the best possible way, we over-feed them. Rarely do alpacas get underfed in the United States, unless it is in ignorance.

So where do we start? In *Table 1,* we see that llamas and alpacas require 9 -14% crude protein (CP) on a DM basis. Alpacas require a higher plane of protein than the llama, thus we would use a value of 12-14% CP for the alpaca. But what does this mean and how do you supply 12-14% CP to your animals? The best way to provide an explanation is to talk about the nutrients in conjunction with the feeds that provide them. The best place to start would be the most important nutrient – water.

Water

Water is the first nutrient of importance. Good quality water is becoming more difficult to acquire with the increase in human population. Regardless of the challenges of finding a good water source, we must keep in mind that an animal can only survive a brief time without water – the amount depending on environmental conditions. To determine if you are providing good quality water, have it tested. Test your water, even if it is city water, and definitely if it is well water. Many owners, many veterinarians and even nutritionists forget water when problems occur with an animal. But test the water for what? In *Table 2,* I have listed a few "good" water standards. There are many other measures (i.e., individual minerals) of "good" water, but this is a start. If your water source meets these requirements and is low in bacteria, herbicides, and other chemicals, at least you know that it is probably safe for the animals to drink. But, you also need to be aware of the mineral content of your water. For example, if it is high in iron, that iron may tie up other nutrients like zinc and copper. If zinc or copper is tied up and are no longer available to the animal, the immune system is compromised, as is fleece quality.

Table 2. Good Water Standards for Livestock Use

Total Solids	Less than 1000 ppm[1]
Hardness	Less than 1000 ppm
Sulphates	500 ppm or less
Nitrates	Less than 45 ppm
Iron	Less than 5 ppm[2]
Sodium	500 ppm or less

Source Unknown
1. ppm: parts per million, or milligrams/liter, 2. Bauder, 1998

Forages and Grains – The Carbohydrates

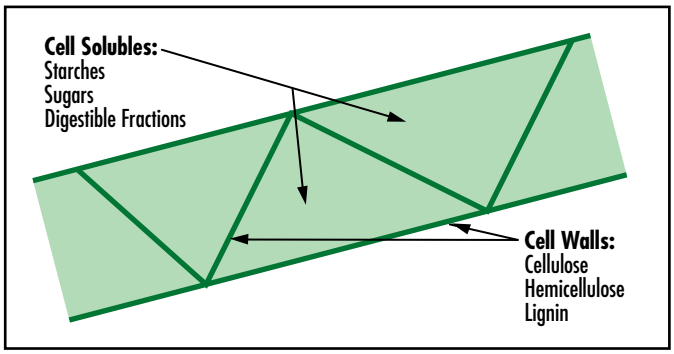
As indicated earlier, the alpaca is an herbivore – it eats plants. Plants are carbohydrates. Carbohydrates are divided into two categories: (1) complex carbohydrates like cellulose and hemicellulose; and (2) readily available carbohydrates like sugars and starches. So what does that mean and how do I apply it to feeding the alpaca? Complex carbohydrates are forages such as grass and alfalfa hay *(Table 3),* grass that is grazed by the animals, and any shrubs and tree material that the animals may consume. Readily available carbohydrates are grains – barley, corn, oats, and wheat *(see Table 4).*

Forages

Lets talk about the complex carbohydrates – forages first. So what kind of hay should you feed to your alpaca? I can tell you idealistically, however, actual economics often plays a major role in determining exactly what an animal is being fed. I will provide you with the basic principles of what to use when evaluating forages like grass and alfalfa hays, but what you actually feed depends on where you live. Hays are not all the same as a multitude of factors affect the potential nutrient variability. Factors include the maturity of the forage when it is cut for hay, what was the weather when the hay was harvested, as well as losses due to harvesting and storage techniques. All producers know that if you want it to rain, cut down the hay!

In general, there are two types of forages – legumes and grass. The most common legume fed in the United States is alfalfa, called lucerne in most other parts of the world. Clover, another legume, is also occasionally fed to livestock in the U.S. and other countries. Nutritionally, legumes are higher in protein and calcium than are grasses. There are, in general, three types of grasses: (1) cool season grass; (2) warm season grass; and (3) southern grasses. Examples of common cool season grasses include brome, timothy, and orchard grass. Cool season grasses do better in a temperate climate when it is cooler and there is ample moisture. Examples of warm season grasses are big and little bluestem, Indian grass, and switchgrass. Warm season grasses do better when the temperature is higher and under drought-like conditions. Rotations of cool and warm season grasses are common to allow for seasonal changes. Southern grasses such as Bermuda grass are much lower quality than cool or warm seasons grasses – partially because they are grown in a much hotter climate. It is important for you to become familiar with the type of forages (and their idiosyncrasies) commonly fed/grown in your part of the country before you feed alpacas!

Now let me discuss the simplistic components that make up a plant *(figure 1).* A plant can be divided into cell solubles and cell walls. Cell solubles are starches, sugars – readily available carbohydrates that are digestible by all animals. Cell walls are the important part that we will use to determine forage quality. They are made up of lignin,



cellulose, and hemicellulose. For this discussion, let us say that lignin is not digestible by animal or microbial enzymes. Thus, the more lignin in a forage, the more indigestible it is, as the lignin ties up the rest of the plant components. The more mature forages are, the greater the lignin content. In general, the hotter the environment when a forage is grown, the higher the lignin content of that forage. Thus, management of the forage crop (and luck) is critical when producing high-quality forages.

In Compartment I of the alpaca GIT, the cellulose from forages is fermented by microbes. When the forage is more mature, there is more lignin and the cellulose fermenting capability of the microbes is diminished. The hemicellulose found in forages is digestible by animals and microbial enzymes, but again if there are high amounts of lignin, the capability to digest hemicellulose will be decreased.

Often, alpaca producers do not produce their own forages, but purchase it from various sources. Thus, when purchased, the alpaca owner needs to sample that forage and have it analyzed. But what does that mean? What do you ask for when having forages analyzed and then how do you interpret the information that you get back from the laboratory? My recommendation is to ask for **proximate analyses** (includes CP and others), **fiber analyses** (to be defined shortly) and if possible, the **calcium** and **phosphorus** levels. There are other measures that can be done, but at least this will provide enough information to determine forage quality.

Fiber analyses will be the focus of the next few paragraphs as these will help in determining the quality of your forage. Fibers are based on the principles of a scientist, Dr. Peter Van Soest, who developed the detergent fiber technique in the 1960's. Thus, the techniques are also called the Van Soest fiber analyses. There are two of Dr. Van Soest's measures we are going to use in this discussion and what data you will need to ask for in the analyses request. They include: (1) acid detergent fiber (ADF); and (2) neutral detergent fiber (NDF). The ADF content of a plant includes lignin and cellulose concentration, while the content of NDF content of the plant includes the lignin, cellulose, and hemicellulose concentrations. So what does an ADF or NDF level mean and how can you apply it to feeding the alpaca and determining quality of the forage being fed to your alpacas?

First, let's look at the ADF concentration of the plant. The level of ADF can be used to determine how digestible forages are – digestible dry matter (DDM). If a feed is more digestible, then an animal can eat more and get greater energy and nutrient content from it, thus it is of higher quality. In *Table 3,* I have listed feeds of varying maturities with corresponding ADF and NDF values. In general, the more immature a forage is when harvested, the higher the quality and the lower the ADF value. Likewise, the more mature the forage, the lower the quality, and the higher the ADF value. The % NDF can be used to determine the dry matter intake (DMI) of forages (remember, we have to remove all the water to calculate intake). Like the % ADF, % NDF can be used to determine forage quality. The higher the forage quality, the lower the % NDF and the higher the DMI. Conversely, the lower the forage quality is, the higher the % NDF and the lower the resulting DMI for the feed.

An alpaca consumes less than a ruminant. On average, a ruminant consumes 2 to 2.2% of its body weight in DM, while an alpaca at maintenance consumes on average 1.8 to 2.0% of body weight DM. Animals of differing physiological stages (growing, lactating, gestating) will eat more than an animal at maintenance. Animals at maintenance may consume more than 1.8 to 2.0% of their body weight, but then they are often prone to obesity. Listed below are the equations that can be used to calculate DDM and DMI, and thus assist in making a decision on forage quality.

Digestible Dry Matter (DDM) – for Ruminants

% DDM = 88.9 – (0.779 X %ADF).

For example - if the % ADF = 31, then
% DDM = 88.9 – (0.779 X 31) = 64.75%

This means that the forage is 64.75% digestible. Compare this to the values given in *Table 3.* Note: In the equation, 88.9 and 0.779 are constants and cannot be changed.

Dry Matter Intake (DMI) – for Ruminants

% DMI = 120/% NDF

For example – if the % NDF = 40, then
% DMI = 3% of the animal's body weight

A % DMI value of 3.0% means that the forage is high enough in energy that an animal could eat 3% of its body weight! That is very high-energy forage when you are looking for 1.8 to 2.0% for animal maintenance. This quality of forage would be excellent for females in late gestation and early lactation, assuming that the protein level is also adequate – and in the majority of cases, if the digestibility and resulting energy is higher, then so is the protein content. Note: In the equation, 120 is a constant and cannot be changed.

For maximum quality and quantity, alfalfa is harvested at what we call 1/10 bloom. That means that approximately

1/10 of all blossoms on a plant or plants in the field are in bloom and the rest have not yet blossomed out. This is called early bloom in reference texts. In general, the more blossoms open on a plant the greater the maturity. In Colorado, it is usually possible to have three harvests or cuttings of alfalfa. At higher altitudes this may be reduced to a single cutting (if alfalfa can be grown at all), while in other parts of the country, six or more cuttings can be harvested. Emphasizing Colorado management in this dialogue, the first cutting of alfalfa in the season is usually of lower quality than later cuttings as it has larger stems, fewer leaves and more weeds. Later cuttings (second, third and fourth) have smaller stems and more leaves. Since the majority of the nutrients are in the leaves, the more leaves, the higher the quality of the forage. Later cuttings are usually of highest value and if managed correctly may bring a premium to the producer. The first cutting is usually classified as beef cow hay. The second and third cuttings of a forage is targeted by horse people. The third and fourth are considered dairy quality (if cut at an immature stage), as the highest quality forage is essential for maximum milk production. Therefore, the later cuttings of a season are of higher quality in a perfect scenario. A perfect scenario is not realistic in most situations, as rainfall and other "situations" will affect the potential quality, even if you have harvested it at the perfect time.

Table 3. Nutrient Content[1] of Forages Commonly Fed to Alpacas (Dry Matter)

Forage	% CP	% ADF	% NDF
Alfalfa, pre-bud	23	28	38
Alfalfa, early bloom	20	30	40
Alfalfa, mid-bloom	17	35	46
Alfalfa, mature	15	41	53
Alfalfa-grass, midbloom	15	38	55
Alfalfa-grass, mature	12	42	52
Brome, late vegetative	14	35	63
Brome, late bloom	8	49	81
Orchardgrass, late vegetative	18	31	55
Orchardgrass, early bloom	15	34	61
Wheat straw	4	54	85

1. Pioneer, 1995

Grass is normally harvested only twice in Colorado – thus, there are only two cuttings. At higher altitudes, there will only be one cutting. When harvesting grass for hay, the more immature the grass is when cut, the higher the quality of forage. As the plant matures, seedheads develop and as they begin to emerge, the quality of the hay goes down. If all of the plants have seed heads, the hay is now called mature hay, and is of lower quality. Generally, the first grass hay cutting of the season is of higher quality. As the season advances and temperatures increase, the amount of lignin in the plant increases, lowering the digestibility. Therefore, the earlier, more immature cuttings are of higher quality than later cuttings. It is possible to break open a bale of hay and look for the number of blossoms and seed heads. The more blossoms and seed heads found, the more mature the hay and the lower the quality.

Once the forage has been harvested or purchased, it needs to be stored correctly to protect nutrients in the feed. The best form of storage is to put the hay in an enclosed barn or shed. If that is not possible, a tarp can be draped over the stack of hay and secured. Either way serves to protect the forage from losing nutrients to bleaching from the sun or leaching of nutrients by rain or snow. After one year's storage there is a decline in the nutrient content, so it is best to appropriate that amount of forage that can be fed in one year's time.

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