Technical Bulletin

Why Forage First®?

Key Points

- Forages are critical for proper GI health and function and should serve as the foundation of a horse's diet.
- The quality of forage is important since forages account for most of the horse's diet. Forage quality is determined by maturity at harvest, plant species, soil fertility, and harvest conditions.
- A forage-only diet will create nutrient deficiencies and must be balanced by the correct supplementation for the activity level of the equine.
- Forage-deficient diets can result in behavioral changes and stable vices such as wood chewing, cribbing, pawing, stall-walking, and weaving.

The GI (gastrointestinal) tract of the horse was designed to process large amounts of long-stem forages to meet energy, protein, vitamin, and mineral requirements. However, forages are unable to supply 100% of nutrient demands for horses under maximum production and performance. As a result, concentrates (grains, by-products, fats, supplements, etc.) must be included in the diet to fully meet a horse's nutrient requirements. Since, forages are critical for proper GI health and function, they should serve as the foundation of a horse's diet.

Forage and Gastrointestinal Health

Forages are the basis for a healthy gut! Inadequate forage intake (< 1.5% of BW) increases the risk of gastric ulcers, colic, dysbiosis (impaired gut microflora), and/or behavioral changes. Understanding the effect of forages on the horse is critical for every horse owner.

Gastric Ulcers Equine gastric ulcer syndrome (EGUS) affects more than 60% of show horses and 90% of race horses. Ulcers occur most commonly in the upper stomach which, unlike the lower stomach, does not secret bicarbonate for buffering (protection). Saliva produced during chewing serves as a natural buffer and is the only protection the upper stomach has from gastric acid. Forages stimulate copious amounts of saliva production and have a greater buffering capacity in comparison to concentrates (Figure 1). When compared to grass hays, alfalfa has a greater buffering capacity due to its increased calcium and protein content. The stomach continually secrets acid regardless of intake (fasting vs fed). Forages have a slower passage rate when compared to concentrates, thus leaving the stomach "fuller" for a longer time period. Combine these two facts and it's easy to see how diets with adequate forage intake have greater gastric pH and decreased risk of EGUS.

Colic The equine hindgut requires the "bulk" of a long-stem forage for proper function. As seen in Figure 1, the lower gut has many loops which are more likely to twist in horses consuming a forage-deficient diet. Additionally, low-forage diets require a greater amount of concentrate to meet the horse's daily nutrient requirements. A large, single meal of a concentrate can exceed the digestive capacity of the small intestine, thus allowing starch and sugars to escape enzymatic digestion and enter the cecum. Excessive starch and sugar in the cecum can cause uncontrolled fermentation which may result in cecal acidosis, colic, laminitis, and/or dysbiosis.

Dysbiosis Forages are comprised of two components—cell contents and cell walls. Cell contents contain a majority of the plant's protein, fat, nonstructural carbohydrates (NSC—starches and sugars), vitamins, and minerals. These nutrients are digested primarily in the small intestine (Figure 1). Cell walls consist of structural carbohydrates (cellulose and hemicellulose) and lignin. Structural carbohydrates, commonly called fiber, are resistant to enzymatic digestion in the small intestine, thus passing into the hindgut (cecum and colon). The hindgut of the horse contains a vast microbiome of bacteria, protozoa, yeasts, and fungi. These microbes ferment structural

carbohydrates, producing volatile fatty acids (VFA) which are then absorbed and used by the horse for energy. Without a steady supply of fiber into the hindgut, dysbiosis can occur whereby beneficial microbiota populations decrease, giving opportunity for pathogenic bacteria to increase. This can result in decreased fiber fermentation and damage to the lining of the lower gut, thus inhibiting nutrient absorption. Recent research has even linked dysbiosis to impaired immunity.

Behavioral Changes Long-stem forages have a filling effect within the GI tract and without them horses will have a constant feeling of hunger. Forage-deficient diets can result in behavioral changes and stable vices such as wood chewing, cribbing, pawing, stall-walking, and weaving. Ad libitum (free-choice) access to a high-quality forage not only helps the horse feel full but will also decrease boredom in a stalled setting.

Forage Quality

Forages account for most of a horse's diet, as such forage quality should be of primary concern. The main factors that influence forage quality include maturity at time of harvest, plant species, soil fertility, and climatic conditions at harvest.

Maturity at time of harvest

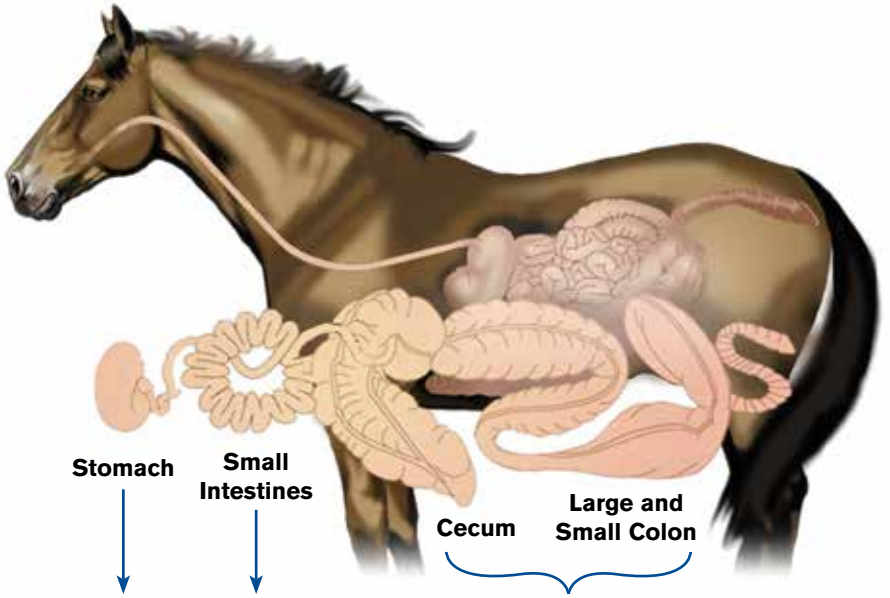
As plants mature they become less digestible. This is a function of increasing concentrations of lignin, a complex polymer that gives rigidity and structure to a plant and is virtually 100% indigestible. It can be assumed that "stemmy" and "coarse" hay would have a greater concentration of lignin and therefore be less digestible. To truly understand a hay's maturity, and subsequent quality, a forage analysis is required. Neutral detergent fiber (NDF) quantifies the concentration of cellulose, hemicellulose, and lignin, while acid detergent fiber (ADF) measures cellulose and lignin. Neutral detergent fiber is inversely related to voluntary dry matter intake (DMI) while ADF is inversely related to digestibility. Since both fractions increase as a plant matures, hays with lower levels of NDF and ADF are preferred.

Table 1. Typical proximate analysis of varying hay types*

Forage Type	DE[a], Mcal/lb	CP[b], %	NDF[c], %	%ADF[d], %
Warm season grasses	0.74	9.05	61.49	30.87
Cool season grasses	0.83	11.04	48.41	30.95
Legumes	0.93	17.26	35.99	28.02
Mixed Grass + Legume	0.88	15.64	43.18	42.11

*Adapted from NRC, 2007 using as fed values at mid-maturity
[a]Digestible energy; [b]Crude protein; [c]Neutral detergent fiber; [d]Acid detergent fiber

FIGURE 1 Illustration of equine digestive anatomy and physiology



Greater forage intake:
Increases saliva production

Dilutes hydrochloric acid

RESULTS:
Decreased risk of gastric ulcers.

Helps promote appetite.

Enzymes digest fat, protein, and starch/sugar found in forages

RESULTS:
Decreases feed costs.

Decreases the need for concentrates.

Greater forage intake:
Helps maintain a healthy pH of the large intestines

Helps promote a healthy microflora population

VFAs provides up to 70% of a horse's energy requirement

Produces B vitamins through fermentation

RESULTS:
Decreases feed costs and the need for concentrates

Decreases the risk of digestive upsets

Supports gut health

Plant species Forages can be divided into three main categories—warm season grasses, cool season grasses, and legumes (Table 1). At the same stage of maturity, warm season grasses (i.e. Bermuda, big bluestem, switchgrass, and indiangrass) are lower in quality compared to cool season grasses (i.e. brome, fescue, timothy, and orchardgrass) as they are lower in protein and energy due to their greater NDF and ADF content. Legumes (i.e. alfalfa and clover) are greater in protein, energy, and calcium compared to grasses.

Soil fertility Soil nutrient content (primarily nitrogen and minerals) directly influences the nutrient content of the forage. Proper fertilization is critical for grasses as nitrogen deficient soils will subsequently produce low-protein forages. Soil mineral content greatly varies from state to state which impacts the mineral profile of the forage. Selenium can be used to illustrate this fact where hay grown in the Western U.S. may contain 1.5 mg/kg selenium. The same species of hay grown in the Midwest may contain only 0.2 mg/kg selenium. It is impossible to estimate a hay's mineral content; therefore, a forage analyses must be performed to determine actual nutrient content.

Climatic conditions at harvest Forages harvested for hay must be allowed to dry in the field before baling can occur. Inadequate drying time will result in high-moisture (> 20% water) hay which will cause molding within the bale. Detected by smell and discoloration, mold produces toxins which may be lethal if consumed by the horse. On the other hand, excessive drying time in the field will result in greater leaf loss during baling, ultimately decreasing the protein and energy content of the hay. Excessively dry hay will also contain more dust which if inhaled may cause lung problems such as acute pneumonia. If a forage is rained on after cutting it can be allowed time to dry but will contain less vitamins and energy due to leaching of nutrients.

Table 2. Daily nutrient requirements for horses*

Class	Weight, lb	DE[a], Mcal/d	CP[b], g/d
Maintenance	100	16.7	630
Moderate work	100	23.3	768
Lactation, 1st month	1100	31.7	1535
Growth, 12 months	706	18.8	846

*Adapted from NRC, (2007)
[a]Digestible energy; [b]Crude protein

Table 3. Digestible energy (DE) and crude protein (CP) content of horse feeds‡

Feed	DE (Mcal/lb)	CP (%)
Fermentable Fibers*		
Beet pulp	1.35	8.8
Soybean hulls	1.30	12.5
Cereal Grains*		
Corn	1.55	8.3
Oats	1.37	12.4
Other*		
Wheat middlings	1.38	16.6
Vegetable oil	4.17	0.0
Molasses	1.38	4.3
Rice bran	1.37	9.5
ADM GLO® Products		
HEALTHY GLO® Meal	2.25	14.0
HEALTHY GLO® Nuggets	2.25	13.0
MOORGLO®	2.00	14.0
POWERGLO®	1.70	13.0
SENIORGLO®	1.55	14.0
JUNIORGLO®	1.50	19.0
PRIMEGLO®	1.55	14.0
ADM Patriot® Products		
Feed Easy® Complete	1.35	14.0
Quick Performance™	1.60	14.0
Performance	1.50	14.0
Ultra-Fiber™	1.40	13.0
Mare & Foal	1.50	16.0
Senior Complete	1.50	14.0

‡As fed values
*Adapted from NRC (2007)

Intake

The voluntary DMI of horses is typically 2 to 3% of their body weight (BW) per day and is largely affected by the digestibility and quality of the diet. Therefore, an 1100 lb horse would be able to consume 22 to 33 lb of DM/day. As state previously, NDF is a key indicator of forage maturity and DMI. As such, a mature hay with greater NDF would have a lower voluntary DMI, thus requiring more concentrate to be fed.

Nutrients

Depending on forage quality, a horse may be able to meet most of his or her dietary needs through forage alone. However, no forage, regardless of quality, can meet 100% of a horse's daily nutrient requirements. Consequently, the use of concentrates and/or supplements is needed to balance forage deficiencies.

Energy Horses require anywhere from 15 to 34.5 Mcal of digestible energy (DE) per day, depending on their size, class, and workload (Table 2). Forages typically provide 0.7 to 1.0 Mcal of DE/lb depending on quality. Using an 1100 lb horse as an example, 25 lb of forage could provide 17.5 to 25 Mcal DE/day. This may easily meet his or her daily energy requirement and failure of horse owners to recognize this fact leads to over-nutrition. Not only is over-nutrition expensive to the owner but can cause deleterious effects in the horse such as obesity, insulin resistance, and laminitis. Hard-working horses or lactating mares would not be able to meet their energy demands from hay alone, thus requiring a concentrate to balance this deficiency. For those horses that require additional energy, fermentable fibers (structural carbohydrates), starch and sugars (nonstructural carbohydrates), and/or fat can be used. Table 3 lists the DE of commonly used feedstuffs and ADM horse products. For horses that require greater starch and sugar intake to maximize performance, careful consideration must be given to the amount of feed delivered in one meal. Overconsumption can result in GI and metabolic disturbances such as colic and laminitis. Fat is considered the "safer" alternative to starch and sugars as it cannot cause acute colic. However, overconsumption of fat may result in overweight and obese horses and decrease fiber fermentation in the hindgut. Regardless of your horse's need for energy, ADM has the right product to help maximize performance while helping support gastric health.

Protein The crude protein (CP) of forages varies greatly and is dependent upon species, maturity, and soil fertilization. Warm season grasses may contain only 5% CP while a high-quality legume may contain 22% CP. Similarly, the CP requirement of horses varies and can range from 540 g/d to 1535 g/d. Using our 1100 lb horse eating 25 lb of forage per day, forage alone could provide anywhere from 567 g/d to 2497 g/d. As with energy, the forage could easily meet a horse's daily CP requirement (Table 2). However, excess CP is not a significant contributor to overweight/obese horses as it's an inefficient energy source when compared to fat and carbohydrates. Table 1 and 3 lists the CP of commonly used forages, concentrates, and ADM horse products. Our equine products contain high-quality protein sources, such as soybean meal, rich in essential amino acids (EAA). Additionally, ADM equine feed products are fortified with additional EAA such as lysine, methionine, and/or threonine. Adequate intake of EAA are critical for proper growth, performance, and reproduction.

Vitamins and Minerals Vitamin concentrations in forages are largely dependent upon forage quality and age. These highly volatile compounds lose their potency quickly due to high temperatures, high humidity, and direct sunlight. On the other hand, minerals are extremely stable and their concentrations within a forage, as discussed previously, are governed by the mineral content of the soil. All forages, regardless of quality, will not be able to supply all vitamins and minerals required by horses. Therefore, GROSTRONG® vitamin/mineral products are provided in ADM products to correct for these deficiencies.

Selecting the Correct Forage

As discussed previously, the nutrient profile of different forage species varies greatly (Table 1). It is important to understand the differences between these categories to avoid under- or over-nutrition. Grasses can provide all or most of a horse's energy and protein requirements if they fall into the idle or light work category. Feeding alfalfa to these horses would likely result in over-nutrition. However, there are many instances where a horse would benefit from a legume such as alfalfa. Growing horses, performances horses, lactating mares, and hard keepers all have an elevated requirement for energy, protein, and calcium. Alfalfa has a greater concentration of these nutrients when compared to grasses and can be utilized in these instances to help decrease the need for additional supplementation.

Conclusion

Although it may seem counterproductive for a feed company to support feeding less concentrates and more forages, we at ADM Animal Nutrition™ believe in feeding horses like horses. We understand forages should be the foundation of a horse's diet and adequate intake is critical to his or her health and wellbeing. However, we also recognize that a forage-only diet will create nutrient deficiencies. Regardless of your horse's activity level or stage of production, we have a product to balance your horse's diet, support a healthy GI tract, and help maximize their performance. ■