How Do I Select Quality Hay?

Hay is an important part of the diet for horses and livestock so it only makes sense to choose a high quality hay to feed to your animals. There are two methods of hay evaluation: visual and chemical.

Visual Evaluation

A visual evaluation can give you a rough estimate of the overall quality of the hay. There are several traits to consider when visually evaluating hay:

Color

Just because a bale of hay has a pretty, green color does not mean that it is high quality hay. Color should be considered in your selection process but should not be the main factor in choosing hay. A green color usually means that the hay contains a high level of protein and vitamins but that same bale of hay could also be high in nitrates and low in digestibility. Hay that is a beige color is usually sun-bleached but could also be hay that was rained on prior to baling. Rain can leach nutrients from hay and decrease its quality. Dark brown hay (tobacco colored) is usually a sign that the hay has been heat damaged after being baled too moist or rained upon after baling. Hay quality is seriously affected in hay that has been heat damaged and mold may be present.

Stage of Maturity at Harvest

As grass matures, the nutritional content of the grass begins to decrease. The stems become tougher and more fibrous and protein and energy levels can decrease. The presence of seedheads and course, thick stems can indicate that the grass was cut for hay at a mature stage of growth and is therefore a lower quality of hay. Because the leaves contain most of the energy and protein the plant has to offer, hay that is leafy with very few seedheads is usually of higher quality.

Texture

Choose hay that has soft and flexible stems. Tough, thick stems will not be as desirable to the animal and can also be an indication that the grass was overly mature when baled for hay.

Presence of Foreign Material

It is important to make sure that the hay is free from insects or trash. Blister beetles can be toxic to horses and certain types of weeds can be toxic to horses and livestock. It can be difficult to distinguish a toxic weed from a non-toxic weed once the plant has dried down and been baled with the hay. Also, weeds that were not completely dried prior to baling can cause moldy areas within the bale. It is best to just avoid hay that has weeds or trash in the bales.

Checking for Mold

Hay should not smell "old" or musty. It should have a fresh, clean smell. Hay that smells bad was probably baled too wet or was stored improperly and has molded. Hay should also not be dusty. Dusty hay can cause breathing problems in some animals. In many cases, the dust is actually mold spores. To distinguish between dusty hay and moldy hay, shake out a flake of hay from the bale. If the dust appears as a grayish-white color, it's mold. Also, if the flakes are hard or stick together in clumps, the bale has molded.

Chemical Evaluation

A chemical evaluation can give a much more accurate impression of hay quality. It is recommended that all hay be tested prior to feeding to ensure that it is *safe* and that adequate nutrients are being provided to the animals being fed.

Who tests the hay?

Hay samples are tested in Raleigh by the North Carolina Farm Feed Testing Service, which is a cooperative effort of the NC Department of Agriculture and Consumer Services and NC Cooperative Extension. Samples can be sent to the laboratory from any of the county offices of NC Cooperative Extension. A full analysis of the hay will cost $10 per sample. There is no charge to test for nitrates only. Test results will usually be available in 7-10 business days.

The following is a sample feed analysis report:

SAMPLE NUMBER	: 7777	
DESCRIPTION	: SAMPLE 1	
FORAGE TYPE	: GRASS FORAGE	
FORAGE FORM	: HAY	
MATURITY STAGE	: VEGATATIVE, NO HEADS	
LABORATORY : RESULTS :	AS SAMPLED BASIS	DRY MATTER BASIS
Dry Matter, %	80.77	
Crude Protein, %	13.76	17.03
Unavailable Protein, %	1.91	2.36
Adjusted Crude Protein, %	13.22	16.37
Acid Detergent Fiber, %	30.27	37.48
TDN, %	50.61	62.66
NE(lactation) Moal./lb.	0.42	0.52
Calcium, %	0.51	0.63
Phosphorus, %	0.38	0.46
Sodium, %	0.05	0.06
Magnesium, %	0.23	0.29
Sulfur, %	0.16	0.20
Potassium, %	2.36	2.93
Copper, ppm	8.	10.
Iron, ppm	129.	159.
Manganese, ppm	53.	66.
Zino, ppm	65.	80.
Nitrate Ion, %	1.41	1.74

What do the test results mean?

The test report will have two columns of values: As Submitted Basis and Dry Matter Basis. The values in the Dry Matter Basis column are the ones that you will focus on when reading a test report. These values reflect the results of the analysis once all of the water was removed from the hay sample and will allow you to compare the quality of different feedstuffs more equally.

The first value to examine on the report is the percentage of **Crude Protein** (CP). In our sample test report for a grass hay, the crude protein of this particular batch was 17.03%. Grass hays, such as bermudagrass or timothy, are typically lower in protein than legume hays, such as alfalfa.

Next, we'll examine the digestibility of the hay. Two values are typically used for this. In horses, focus on the **Acid Detergent Fiber** (ADF) value. As the ADF value increases, the digestibility and quality of the hay decreases. In our sample report, the ADF value for this hay was 37.48%.

If we're dealing with ruminants (cattle, sheep, or goats), we'll typically use the value for **Total Digestible Nutrients** (TDN). As TDN increases, hay quality increases. In our sample, the TDN is 66.62%.

To determine what the CP, ADF, and TDN values mean in terms of hay quality, look at Table 1 for ruminants and Table 2 for horses listed below. There you'll find indicators of high, average, or low quality hays based on whether the hay is a legume, a grass/legume mixture, or a pure grass hay.

Another very important value to consider on the test report is the percent **Nitrate Ion.** Ideally, we would like for this value to be zero but hay that contains a small percentage of the nitrate ion can still be fed safely as long as the value doesn't exceed a certain level. You will find more information on feeding high nitrate hay in the *Nitrates 101* chapter of this booklet.

One last value that may be of importance to some horse owners is **Non-structural Carbohydrates (NSC).** This value reflects the "sugar" content of the hay and is of importance to horses who are prone to founder or have metabolic disorders. For these horses, a lower NSC value is desired. Hays that test higher in NSCs can be soaked in water prior to feeding to lower the NSC content and make the hay more suitable for these horses.

Table 1. Forage quality indicators for ruminants

Forage Type	High Quality	Average Quality	Low Quality
Legumes (e.g. alfalfa)	CP 18-23% TDN 60-65%	CP 15-17% TDN 55-59%	CP below 15% TDN below 55%
Grass/Legumes (e.g. fescue/clover)	CP 15-18% TDN 59-62%	CP 11-14% TDN 55-58%	CP below 11% TDN below 55%
Grass (e.g. bermudagrass)	CP 12-14% TDN 58-65%	CP 9-11% TDN 54-57%	CP below 9% TDN below 54%

Table 2. Forage quality indicators for horses

Forage Type	High Quality	Average Quality	Low Quality
Legumes (e.g. alfalfa)	CP 18-23% ADF below 30%	CP 15-17% ADF 30-37%	CP below 15% ADF above 37%
Grass/Legumes (e.g. fescue/clover	CP 15-18% ADF below 30%	CP 10-14% ADF 30-37%	CP below 10% ADF above 37%
Grass (e.g. bermudagrass)	CP 12-14% ADF below 30%	CP 8-11% ADF 30-37%	CP below 8% ADF above 37%

Nitrates 101

Nitrate poisoning is a problem that all horse and livestock owners in eastern North Carolina should be aware of. Forages can be tested for nitrate content at no cost and it is recommended that ALL forages be tested before being fed to horses and livestock. You can't determine the nitrate content of forage just by looking at it.

How do high nitrates occur?
Under normal growing conditions, plants take up nitrogen from the soil, which is then stored as nitrates in the plant. The plant will later convert this nitrate to protein. Any type of stress to the plant, including drought or prolonged cloudy weather, can interrupt this process. The plant may continue to store the nitrates, rather than convert them to protein, and the nitrates will accumulate within the plant.

Are forages that are "sprayed on" (i.e., fertilized with animal waste) more likely to have high nitrates?
No. Any forage can accumulate nitrates under the right conditions. The type of fertilizer used has no effect on whether the hay will be high in nitrates. Excessive fertilization or the improper timing of fertilization *does* affect whether the forage will be high in nitrates. Environmental conditions that may stress the plants, such as drought, can also play a role.

How Do Nitrates Affect Livestock & Horses?
Nitrates interfere with an animal's ability to carry oxygen in the blood. High nitrates in forages can cause reduced feed consumption and growth rates, lowered milk production, and abortions. If nitrates reach dangerously high levels, it can cause death.

What are the signs of nitrate poisoning?
Nitrate-poisoned animals show symptoms of suffocation, including labored breathing, lack of coordination, and blue mucous membranes. The most reliable symptom of nitrate toxicity is a chocolate brown coloration of the blood. Other signs include: diarrhea, frequent urination, and frothing at the mouth.

What Nitrate Levels are Safe for Cattle, Sheep, and Goats?
If these animals are gradually introduced to nitrates, they can adapt to tolerate higher levels of nitrates in the diet. The following table shows the levels of nitrates that can be tolerated in the diet and how those forages should be used.

Management considerations for use in feeding forages with various levels of nitrate:

Level in Forage (Dry Basis) Nitrate Ion %	Feeding Precautions Unadapted Animals	Adapted Animals
0.0 - 0.25	**Safe:** Generally considered safe.	**Safe**
0.26 - 0.50	**Slight Risk:** Should not make up more than 50% of total intake for pregnant ruminants.	**Safe**
0.51 - 1.00	**Moderate Risk**: Do not feed to pregnant ruminants. Limit to less than 50% total intake for all others.	**Slight Risk**
1.01 - 1.50	**High Risk:** Exercise extreme caution when feeding. Limit to 33% of the ration.	**Moderate Risk**
1.51 - 2.00	**Severe Risk:** Do not feed to any animals free choice. If using in a mixed ration limit to 25% of the ration.	**High Risk**
2.01 - 2.50	**Extreme Risk:** Do not feed at all.	**Severe Risk**
2.51 and up	**Extreme Risk:** Do not feed at all.	**Extreme Risk**

What levels of nitrates are recommended for horses?

Forage that tests no higher than 0.50% nitrate is safe for horses. Generally, it's best not to choose hay for horses that tests higher than 0.65% nitrate. Higher nitrate hays will need to be "diluted" so that the total nitrate in the diet is at a safe level. The Table below shows methods of diluting high nitrate hay in the horse's diet.

Methods of adjusting the nitrate content of rations when feeding forage high in nitrates

Nitrate%	**Forage** Maximum % of total ration	**Grain** Minimum % of total ration
0.5	100	0
0.75	(0.5 ÷ 0.75) = 67	(100 – 67) = 33
1.0	(0.5 ÷ 1.0) = 50	(100 – 50) = 50
1.25	(0.5 ÷ 1.25) = 40	(100 – 40) = 60
1.5	Don't feed: it would require too much grain	

Adapted from L.D. Lewis (1995).

For more assistance on managing high nitrate levels, contact your local office for North Carolina Cooperative Extension.

How Do I Take a Hay Sample?

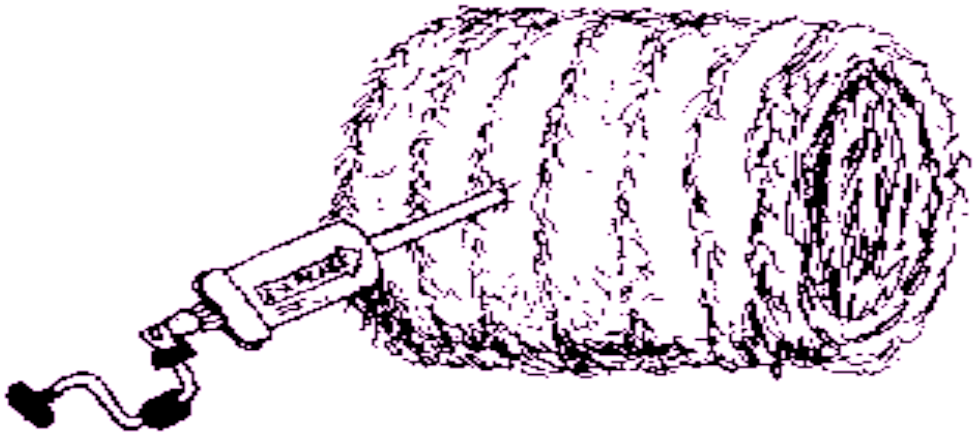
The quality of your analysis report is only as good as the sample that was tested. So if you send a poor quality sample, your hay will be poorly represented in the analysis report.

In order to receive an accurate report on the quality of your hay, you'll need to send a "representative sample" from each lot of hay. This sample will represent the average quality of the hay. A lot of hay can be defined as hay that was cut from one field within a 5 to 7 day period of time.

The most accurate way to take a hay sample is using a core sampler. This equipment is available at most Cooperative Extension offices in the area. Using this method, you will need to gather enough samples to fill a quart sized plastic bag. This will usually amount to sampling 10 or more bales of hay.

If you are unable to obtain a core sampler, grab samples can also be tested. The best way to do this is to open several bales and take samples from the center of the bale. Take enough samples to tightly pack a gallon sized plastic bag. This method is not going to give you results that are as accurate as if you'd used a core sampler but can be helpful if you need to test the hay and don't have the right equipment available.

Test results are usually available within 7 to 10 business days. A complete nutrient analysis will cost $10 per sample. If the sample is tested only for nitrates, there is no charge.



Tips on Selling and Purchasing Hay

It is customary in many areas to price hay by the bale. Purchasing and selling hay by the ton is rapidly becoming a more equitable method of buying hay. Purchasing hay by the ton allows buyers to know precisely how much hay they are getting for their money, provided the hay is cured properly and accurately weighed. The following charts can be used as a guide to convert from bale prices to ton prices

Useful Conversion Formulas

To convert the price per ton to price per bale:
1) determine average weight of bales you are purchasing in pounds.
2) divide the price per ton by 2,000 and multiply the results by the average weight of the bales to determine the price per bale.

Example: You are considering purchasing hay at $160 per ton. You determine the average bale weighs 50 pounds. What is the price per bale?

($160/ton) divided by (2000lb/ton) multiplied by (50 lb/bale) = $4.00 per bale

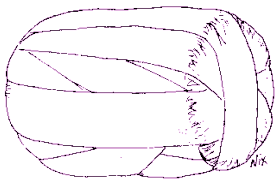
To convert price per bale to price per ton:

1) determine average weight per bale.
2) divide 2,000 by the average weight per bale to get the number of bales per ton.
3) multiply the number of bales per ton by the price per bale to get the price per ton.

Example: You are considering purchasing hay for $4 per bale. What would you be paying for each ton of hay purchased? You determine the average bale weight to be 45 pounds.

(2000 lb/ton) divided by (45 lb/bale) multiplied by ($4.00/bale) = $177.78 per ton

Haylage



Haylage, also known as round bale silage, is another approach to preserving forage in eastern North Carolina. Haylage is simply forage that is baled at a higher moisture content than dry hay and then stored in a sealed plastic wrap. Because of the high moisture level and air-tight environment, the forage ferments and is preserved by acid production during fermentation. This method has certain advantages and disadvantages over other forage harvesting and preservation systems.

Advantages

- Decreased curing time needed from cutting to baling, which makes weather less of a factor in forage harvesting.
- Potential for more timely harvest of large quantities of forage.
- Decreased need for mechanical handling and time curing to dry the forage reduces the loss of leaves, the most digestible part of the plant.
- Potential for higher feed quality bale through leaf preservation and possible nitrate reduction.

Disadvantages

- Increased harvest cost per bale vs. conventional cured hay.
- Disposal of used plastic wrap.
- More likely to spoil as compared to silage in traditional silos.
- Risk of forage spoilage if integrity of wrap is not maintained. Birds and rodents can puncture plastic and holes must be covered.
- Transportation of bales is limited due to cost of moving high-moisture bales.

How is Haylage Made?

The forage is cut as if for hay-making but is baled at 50-60 percent moisture rather than at 18-20 percent moisture. Baling at the proper moisture content is the single most important variable. Baling haylage with too much moisture reduces the feed quality of the forage and reduces the amount of dry matter stored per bag, greatly increasing storage cost. Baling haylage with inadequate moisture reduces fermentation and increases mold production, greatly increasing storage losses.

Storage

Successful storage depends on many factors. The storage site should be cleared of stubble and sharp objects. Some people even place an old piece of plastic on the ground before placing the bales. Rodents can chew through the plastic wrap or bag, which will greatly increase storage losses. Spray the perimeter of the stack to kill weeds that harbor rodents and insects. Do not cover the bales with an extra layer of plastic because it makes an ideal nesting site for rodents. Find a shady area, preferably on a north facing slope, to avoid temperature fluctuations that can degrade both the haylage and the plastic.

If you find holes in the bagged bales, patch them as soon as possible. Wind causes loose plastic to billow out, providing an air exchange that usually spoils most of the outer layer of the bale. Bags are rarely reusable because of minor pinholes.

Effect of Ensiling on Nitrate Level
Ensiling forage as haylage can be a management strategy for high-nitrate grass. Scientific literature suggests an average of 50% reduction in nitrate in ensiled forages due to the de-nitrification process.

Research conducted by Karen Spivey and North Carolina State University in 1997 on bermudagrass harvested as haylage suggested that up to a 90% reduction in nitrate concentration could be achieved by ensiling bales at very high moisture levels (75-80%).

Feeding Haylage
Feeding haylage is similar to feeding large round bales of hay in that conventional feeding rings can be used. With the high investment in wrapping bales, it is essential to control feeding losses. Some studies have shown up to a 50 percent loss when large round silage bales are fed to cattle without being placed in a ring feeder. This loss can be reduced to 10-20 percent by using a simple ring feeder. The use of an elevated hay wagon can reduce feeding losses to below 10 percent.

Haylage can be safely fed to cattle, sheep, and goats. It is not recommended for horses because of the risk of mold. If the haylage is improperly harvested or the plastic is damaged during storage, mold and mycotoxins can form in the bale. This can be toxic to horses and haylage should therefore be avoided if possible.

The problem with feeding haylage to goats or sheep lies in reducing waste, as these small ruminants can get inside a typical ring feeder. When feeding individually wrapped haylage bales to any species, it is best to feed to a sufficient number of animals so they can eat an entire bale within one or two days. If multiple bales are ensiled in a plastic tube, the tube may be opened to remove individual bales and resealed without significant spoilage for up to two weeks

Hay Storage and Feeding Losses

Hay losses can cost you a great deal of money throughout the year. Whether these losses are from heat damage, fire, or feeding, there are ways that you can manage your hay supply to help reduce their effects.

Internal Heating and Fire Risk

Hay that goes through a heating process can sometimes lead to fires that are started internally in the bales. This heating process happens as a result of microorganism activity in hay that has been stored at a high moisture level. Even if the heating doesn't result in a fire, it will greatly reduce the forage quality of the bale.

The best way to avoid internal heating is to avoid baling hay at high moisture levels. Hay in round bales should be no more than 18% moisture and hay in small, square bales should be no more than 20% moisture. Bales that contain higher levels of moisture are at a much greater risk of combustion. If you suspect that the hay has been baled too wet, the bales should not be stored inside the barn for two to three weeks until the risk of combustion due to heating has passed.

It's best to monitor the temperature of hay for the first week or two after baling to ensure that there is no danger of fire. A compost thermometer available at many home and garden stores is very useful for this. Just insert the thermometer down into the bale and wait for the temperature reading to hold constant. As long as the temperature remains below 120º, the hay is at a safe temperature. If the hay is in the 120º to 140º range, then there is a slight risk and the hay should be monitored further until the temperature drops. If the hay reaches 160º or higher, the hay is at a very high risk of catching fire.

Other Storage Concerns

The most important part of hay storage is to protect hay bales from moisture. The amount of moisture from the soil absorbed into hay bales can be decreased by storing bales off of the ground on wooden pallets, telephone poles, or cross ties. Gravel or rock pads can be put down in areas where bales will be stored outside on the ground. The goal is to avoid having the bales in direct contact with the soil but allowing some air flow under the hay is also desirable.

Storage barns or shelters are most ideal for protecting bales from the weather but hay that must be stored outside can be protected from moisture by covering it with tarps or plastic covers. Direct contact with the soil should still be avoided so rock pads or wood pallets are still useful in these situations.

Feeding Losses

Feeding losses of up to 60% have been observed in feeding trials where no attempts were made to reduce the losses. Simple changes in management can save a great deal of money by reducing the amount of hay lost during feeding. These losses occur when the hay is trampled, urinated or defecated upon, weathered, or refused by the animals.

It's important to consider the location where hay is normally fed. Low lying areas that may remain wet should be avoided as well as bare areas that could become muddy. It is best if feeding areas are moved to different areas around the pasture. This is because feeding areas tend to become muddy and have compacted soil in the areas where animals linger around the hay. If the feeding area remains in the same area, gravel can be used to fill the area and provide a solid foundation for feeding.

Always use a round bale feeder to keep animals from lying on or trampling the hay and to keep the bales from sitting directly on the ground. Shelters can also be useful to protect bales from rainfall but the more important management consideration would be to protect the bale from soil contact.

Hay Directory Update Form

This publication is now available through the Internet at:
http://www.ces.ncsu.edu/onslow/AG/hay/ and is linked to other forage related websites.

This hay directory is provided as a service to hay producers and buyers. In order to be included in the next update of the hay directory, please complete and return this form to:

Emily M. Adams
NCCE - Onslow County Center
4024 Richlands Hwy.
Jacksonville, NC 28540
(910) 455-5873
FAX (910) 455-0977
E-mail: emily_adams@ncsu.edu

****

Contact Name: _____

Address: _____ City: _____ State: _____ Zip: _____

County: _____

Telephone Number: _____

E-mail Address: _____

Type of Hay: (Ex: Hybrid Bermuda)_____

Bale Type: (Round/Square/Wrapped Haylage)_____

_____

Number of Bales of each type: _____

Average Weight of each type: _____

Forage Test Available (Yes/No/Upon Request): _____

Delivery Available(Yes/No/Upon Request): _____

Please circle the title that best describes you:

Hay Producer / Hay Broker / Retailer / Hay Buyer