

Sampling the Moisture Content of Alfalfa in the Windrow: A New Tool Helps

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Introduction

The production of high quality hay is vital for the dairy industry and provides revenue to the forage producer. The determination of forage moisture content in the windrow is often a neglected but critical step in the preservation of high quality hay.

Knowing the accurate moisture level of the forage windrow is the key to preserving a high quality product for marketing. This Publication:

- emphasizes the importance of windrow moisture,
- defines the relationship between bale size and moisture levels,
- discusses various methods for determining moisture, and
- describes how an inexpensive windrow sampling tool and a sampling protocol used with an electronic moisture probe can improve the determination of windrow moisture.

Proper windrow moisture levels help avoid mold, fires

Many alfalfa producers harvest at the proper growth stage of the plant to produce high quality hay. At baling time, the stem moisture content is critical for the retention of leaves to the stem, but too much moisture in or on the plant is a hindrance to storage. Moisture necessary for leaf retention can come in two different types.

Stem moisture remains in the plant stem during the curing process. Windrowed hay, given ample time to field-dry, will eventually dissipate stem moisture.

Dew moisture on the outer surface of the stem and leaf is caused by the relative humidity and condensation. Dew moisture is rapidly removed by sunlight or a light breeze and usually only remains for a few hours each day. It is important to recognize the moisture level in windrowed alfalfa at baling time because high moisture levels will cause molding in the stored product, and, in many instances, internal combustion and hay stack fires.

Relationship of bale size, moisture levels, and other quality factors

It is important to match the correct windrow moisture to the size of the bale.

Table 1: Examples of optimum windrow moisture percentage when baled

Bale size	Optimum moisture when baled
16-by-18-inch	18–20%
Half ton	14–16%
One ton	Don't exceed 12–14%

When windrow moistures exceed these recommended levels undesirable effects may occur. White mold growth, a very common occurrence, not only causes palatability to decrease, but may also cause female livestock to abort or deliver premature fetuses.

Browning or burning of the moist forage lowers palatability and increases acid detergent fiber (ADF) and acid detergent protein (ADP) to unacceptable percentages. For example, we sampled a one-ton

bale, which had been baled with moisture content higher than 20 percent. The green, leafy alfalfa hay in the outer edge of the bale retained its original supreme quality. (Supreme quality is defined as having less than 27 percent ADF and greater than 22 percent crude protein. It is important that ADF be less than 30 percent because higher values indicate a lower digestibility level than a lactating dairy cow requires.) The interior of the bale was dark-brown-to-black in color, a result of the browning reaction from heat caused initially by microbial respiration.

High moisture and high density of the bale promote microbial growth. The microbes use sugars and starches and leave the structural carbohydrates, cellulose, and lignin, which compose ADF.

Heat also degrades some protein in the hay, causing it to be indigestible to the cow. ADP, an indication of heat damaged protein, increased from 0.66 percent to 1.66 percent in the interior of the bale. The ADF in the interior of the bale increased from 27 to 40 percent resulting in the quality of the hay changing from supreme to poor quality or feeder hay. This decreases the value by about half, or a loss of about \$60 per ton.

Haystack fire is the most destructive event that is caused by exceeding the recommended windrow moisture levels. The entire stack of stored product is usually lost, along with the risk of losing buildings, facilities, and human life. The above incidences can be avoided if only the producer will test the moisture level in the windrow prior to baling.

Drying methods and equipment

A number of methods are available for drying samples of alfalfa from the windrow. Remember that taking an individual sample from one location in the field is not adequate, and will not reveal the moisture level across the entire field. Similar to testing for quality, where twenty samples from each lot of hay are recommended, we suggest that numerous random windrow samples be taken across the entire field. Ten samples may be adequate in a field with uniform dryness, but 20 samples are necessary under variable conditions.

Laboratory drying

Wet samples can be taken to a local forage-testing laboratory for testing moisture content as well as forage quality. The lab method is very acceptable. **Drawback:** This method does require a number of days for results to be returned to the producer. Because of this time lapse the window of opportunity for correct baling moisture may be lost.

Microwave drying

Microwave oven drying is fast and efficient. However remember the number of samples necessary from each field to insure accurate representation of the entire field. Also, if your kitchen microwave is to be used, the smell may linger for several days. Over-drying can cause dry matter loss or burn the sample, which gives a false moisture content.

Place a glass of water two-thirds full in one corner of the microwave oven to avoid over-drying, and closely monitor the sample as it is quickly drying. The sample size should be between 4 and 12 ounces (100 and 300 grams). Drying time depends on the power setting on the microwave, the mass of the sample, and the moisture content. In general, microwave at the high setting for 4 minutes. Reweigh the sample. Then dry for 1-minute increments until the dry weight remains stable.

Convection oven drying

Large industrial convection ovens are very desirable for drying numerous windrow samples, allowing for ample field samples to be taken. The operator must plan on allowing at least 24 hours of drying time for adequate moisture removal of numerous field samples.

Windrow Sampling Tool



Windrow sampling tool is easily assembled with supplies available at most hardware stores for less than \$10

Windrow Sampling Tool Materials and Cost

2 feet of 2 inch ABS pipe	\$1.00
3 feet of 1 1/4 inch PVC pipe	\$1.60
2 = 1 1/4 inch PVC pipe caps	\$1.00
2" ABS clean out adapter	\$1.60
2" ABS clean out plug	\$0.90

TOTAL ESTIMATED COST \$6.10

Note: Costs are estimates as of July 2003

Drawback: the largest drawback to the industrial convection oven will be in the cost of purchasing the oven for private use.

Koster field drier

The Koster field drier is a versatile and inexpensive forage drier. If the Koster drier is going to be used in the field, an electrical source or portable generator is necessary. The Koster drier will dry individual 100 gram samples (0.22 lb) in approximately 30 minutes, allowing for numerous samples to be dried in one day. One drier may not be adequate for producers with over 500 acres of hay. **Source:** Koster Crop Tester, Inc., 2317 Pearl Rd. (Rear), Medina, Ohio 44256; (330) 220-2116 Fax: (330) 220-1636.

Forage moisture estimation methods

Producers have used unreliable methods of estimating moisture levels of windrowed alfalfa. The concept of "I see my neighbor going to bale his hay and I cut mine the same day, so it must be ready" is a misconception and is absolutely unreliable. The other popular method of twisting and breaking the stem is useful if you wait until the stem actually breaks. However by then the product is too dry and leaf retention is almost impossible to maintain until a dew occurs.

With the many factors that affect the variation of drying time of windrowed alfalfa, it has been difficult to find a simple method of sampling moisture levels. Simple unrealized factors can have great effect on drying time of the windrow. It is difficult to recognize that alfalfa plant maturity, yield variations, and alfalfa varieties can slow down stem drying and decrease quality. Field variation is

extremely critical in moisture retention of the windrow. Low areas trap moisture and allow for dew moisture to settle and linger for extended periods of time. In contrast, higher areas in the field will dry faster and easier because air movement increases moisture evaporation.

The common practice of irrigation prior to harvest is less beneficial than previously thought. Not only is soil compaction increased, but drying time is increased by placing a wet alfalfa windrow on wet soil.

Electronic bale moisture probes also have been designed to sample moisture in windrowed alfalfa. Moisture content in the windrow can be estimated by the strength of the conductivity between two brass pieces of the probe. The percentage of moisture will be displayed on the digital monitor. A limiting factor to this method of moisture detection has been the lack of adequate compaction of the windrowed alfalfa. High density of the moist alfalfa is necessary to ensure proper contact between the two brass portions of the electronic bale moisture probe by the moist product. The range of accuracy listed by one manufacturer is from 20 to 80 percent. Accuracy also depends on having a well-charged battery in the probe. Ambient temperature also affects accuracy of the electronics, but forage contact bridging the brass parts of the tip, a charged battery, and clean brass on the probe are much larger sources of error.

We recommend alfalfa producers sample windrow moisture by using an electronic bale moisture probe and a windrow-sampling tool you can make. It is designed to simulate the compaction of hay in the bale. In addition, the sample may be oven dried to double check probe accuracy.

Calculating windrow moisture

Forage moisture content is calculated by the following formula:

$$\frac{(\text{wet forage weight} - \text{dry forage weight})}{\text{wet forage weight}} \times 100 = \text{percent windrow moisture}$$

Example: An 8-oz sample weighed 6-oz when dried.

$$\text{Moisture content} = (8-6)/8 \times 100 = 25\%$$
$$\text{The dry matter content} = 100\% - 25\% = 75\%$$

This calculation for “as fed” or fresh forage is the most useful to livestock producers and nutritionists in ration formulation. In contrast, soil water content is calculated as the ratio of (wet - dry) relative to the dry soil. The forage dry matter content is then calculated as (100 - moisture content).

Protocol for sampling windrow moisture

Acquiring average windrow moisture can be improved with the help of the inexpensive windrow-sampling tool you can make, and by following a few very simple steps. The box (facing page) shows a list of required materials and their estimated costs.

STEP 1—Take at least 20 random samples per 200 ton of hay.

Selecting the correct location in the field for sampling is not as important as the number of samples that are taken. We suggest that you take at least 20 random samples per 200 ton of hay across the whole spectrum of the field. This assures the producer that adequate representation of the entire field has been collected.

STEP 2—Use hand to roll sample into tool.

Now that one of many sample sites is selected, roll the windrow over-exposing the underneath side. Under normal conditions this site will have bright green, unbleached hay. With your bare hand, feel for the dampest hay in the newly exposed windrow. Fold a small portion of the damp area into a ball and begin twisting the folded hay into the gathering tool. Additional hay from the windrow will need to be added to the tool as you continue to turn the sample into the tool. Continue twisting and adding forage into the gathering chamber until the tool is full.

STEP 3—Use plunger to simulate baled hay compaction.

Use the plunger to compress the gathered materials in the tool, simulating compaction of baled hay. To do this, place the gathering tool with the capped end on the soil surface, exposing the open end in an upward position. Place the plunger in the open end of the gathering tool and force downward. Following this procedure, compress the forage in the gathering tool, simulating compaction of baled hay.

STEP 4—Test for moisture at 4 levels in the tube.

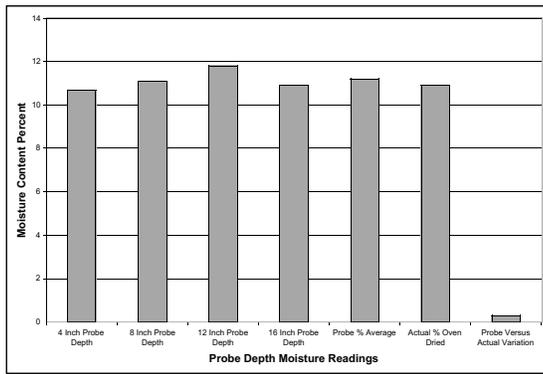
The sample gathering procedure is finished. It is now time to test the gathered sample for moisture. Insert the pointed end of a 20-inch hay moisture tester approximately 4 inches into the gathered sample and take a moisture reading. Continue taking moisture readings at each of the following depths; 4, 8, 12, and 16 inches. Total the four moisture readings and average the numbers. Continue the above procedure across the entire field in random locations. You have now gathered ample moisture samples on which you can confidently base your baling readiness decision.

Important Points to Remember

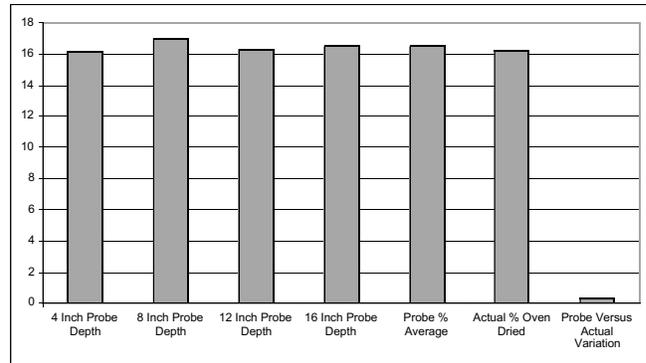
Remember the following points to assure even representation of the entire field when sampling for moisture:

- Take numerous random samples
- Take samples from diverse areas of the field
- Test samples from various windrows
- Take wettest sample from the underneath side of the windrow
- Oven dry sample for accuracy test

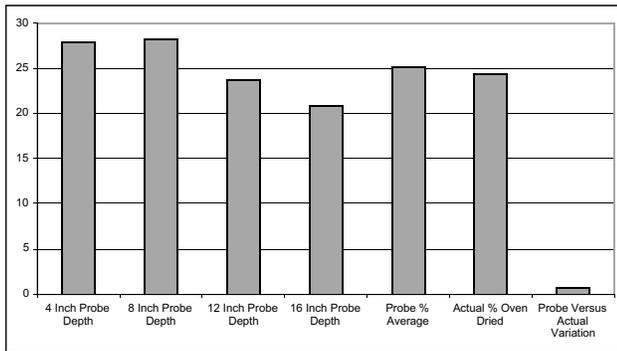




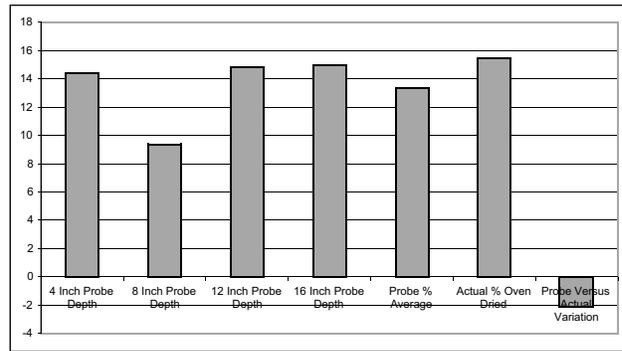
In sample 1, moisture content varies from 10 to 11%, indicating over-dried hay.



Sample 2 has between 15 and 16% moisture and also has low variability in water content.



Sample 3 illustrates that forage moisture can be highly variable within a windrow sample.



Sample 4's unusually low 8-inch moisture estimate (9.4%) occurred because probe's brass became coated with forage residue.

Data collected/figure explanation

Four different producer samples above illustrate accuracy of the tool. Each sample is measured with an electronic bale moisture probe at 4, 8, 12-inch depths, and again at a depth of 16 inches. Moisture readings taken at each depth are totaled. Average percent moisture is calculated and then compared to the actual oven dried sample. The difference in probe average test and actual oven-dried sample is presented in the variation column.

Note that both samples 1 and 2 are stable and close to oven-dried versions. In sample 4, once the electronic probe's tip was cleaned, moisture percentages returned to a more normal range.

Because of the variability within and between different windrows (sample 3), 12 to 20 samples should be used to determine the average moisture content of windrow forage—similar to the reason the same number of samples should be cored from a lot of hay to determine forage quality.

The forage producer should use caution when deciding to bale because, although the average may be acceptable for storage, the natural variation in windrow moisture within a field means that some bales may be from 2 to 4 percent higher than the average. That is more than the margin of error for hay preservation in large, dense bales.

Conclusion

Caution should be taken after multiple samples are gathered. The brass portions of the hay moisture probe may develop poor conductivity due to buildup of moist hay accumulation. Buildup can be easily removed by lightly scouring the brass portions of the instrument with fine steel wool.

Remember that hay moisture testers may vary in readings, and it is necessary to compare your field samples to actual oven dried samples. It is highly recommended that samples occasionally be oven-dried to allow for adjustment in probe accuracy.

Producers need to sample hay in windrows for moisture content to avoid alfalfa quality degradation or haystack losses due to fire. Samples taken from the windrow sampling tool should be oven dried to determine the accuracy of the hay moisture tester probe being used.

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