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G93-1168 Moisture Testing of Grain, Hay and Silage

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Moisture Testing of Grain, Hay and Silage

This NebGuide offers methods to help producers test moisture content of grain, hay, silage and other feeds.

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Knowing the moisture and dry matter (DM) content of feeds is important to farmers for several reasons:

- Livestock performance depends on DM consumed; thus, DM content must be known to accurately formulate rations.
- Knowledge of moisture content is needed for harvest decisions during haying and silage chopping and for safe storage of grains, hay, and silage.
- Moisture content is a major factor related to the value, or price, of forages and grain.

Every producer should be able to test for moisture. Several methods are available. It is important to remember that a "squeeze" test is not a very accurate method for estimating forage moisture content when making silage or hay.

Moisture Meters and Probes

Moisture meters usually provide satisfactory estimates of moisture content of grains and oilseeds when moisture content is below 25 percent. However, large errors may occur at higher moistures.

Estimates of forage moisture using moisture probes and meters[1] are often unreliable. The accuracy of these probes is affected greatly by the density of the forage being tested, the source of the moisture in or on the forage, and operator skill and experience.

Probe estimates of forage moisture are more reliable when forage is densely packed. This type of forage will be tightly compressed around the probe and much of the probe will be in direct contact with forage. Windrow, loose packages and forage wagon estimates using a probe are not recommended because the estimate can vary a great deal just by wiggling the probe. Moisture meters that use chopped forage and compress this forage in a small chamber give relatively consistent results.

Probe estimates often are very inaccurate when dry hay begins to absorb moisture as humidity increases. Because electronic probes measure the resistance or conductivity of electricity in the hay, a small increase in moisture on the surface of the hay may increase conductivity dramatically. This increase due to surface moisture is much greater than if the moisture was evenly distributed inside the stems and leaves. As a result, the probe and meter tend to estimate that forage contains much more moisture than it actually does.

Although moisture probes and meters have limitations, a skilled and experienced user can receive valuable guidance from them. Before relying on the results of these instruments, compare results from the meter with results using oven drying. Adjust moisture readings as needed to assure accuracy. In addition, identify harvest conditions that permit accurate as well as inaccurate readings from a particular probe. Finally, develop a consistent method of probing. Many users have found that more accurate estimates occur as the probe is being inserted into the hay rather than waiting until the probe is inserted all the way.

Oven Drying Methods

Oven drying evaporates water from the sample, allowing measurement of moisture as weight loss. This can be accomplished using either a specialized feed drying oven, such as a Koster tester®, a conventional laboratory oven, a toaster oven, a traditional convection oven, or a microwave oven. Regardless of the oven used, proper test procedures must be followed. Materials needed:

1. A sample of grain or forage, representative of the entire lot to be tested. Forage sampling methods are described in NebGuide *G77-331, Sampling Feeds for Analyses*. **Note**: If the sample is not tested immediately following sampling, seal it in an airtight container such as a glass jar or a good quality freezer bag to avoid changes in moisture content.

2. A plate or pan on which the sample will be dried (the container must be "microwave safe" when using the microwave). High moisture forage requires at least a 5 ' 7 inch pan or 9 inch plate. **Caution**: Do not use paper plates.

3. A gram scale, accurate to at least 1.0 gram, is necessary. The scale should have a capacity of at least 500 grams. Such scales are sold by drug and hardware stores as well as agricultural supply houses.

4. A traditional oven or a microwave oven.

Traditional Oven Method

The oven method can be used for either forage or grain but **requires 1 to 3 days of drying the sample**

to obtain results.

Forage

1. Collect sample. Chop hay crop forages into 1 to 2 inch lengths for ease of handling. Grain crop forages must be chopped to 1/2 inch lengths or less.

2. Weigh the container and record scale reading.

3. Weigh the sample in the container and record scale reading (exactly 100 g of sample will simplify calculations).

4. Spread sample evenly in the container (maximum depth is 1 1/2 inches).

5. Place uncovered container and sample into 190 to 210°F oven for 24 to 48 hours, stirring at 6 to 12 hour intervals.

6. Remove, reweigh container and sample, and record scale reading.

7. Determine the sample moisture content according to procedures outlined in the section on calculating moisture content.

Whole Grains and Seed

- 1- 4. Steps same as for forage.

- 5. Place uncovered container and sample into oven set at the temperatures and for the times indicated in *Table I.*

- 6-7. Steps same as for forage.

Table I. Oven temperature and heating period to determine moisture content.

Item	*Oven temperature*	*Heat time*
	(°F)	(Hours)
Corn	220	72
Soybeans	220	72
Sunflower	265	3
Rye	265	16
Sorghum	265	18
Wheat	265	19
Barley	265	20
Oats	265	22

Microwave Method

The microwave method is a rapid method useful in evaluating forage moisture levels before ensiling or baling. This method is **not very effective on whole grains** but can work on cracked or ground feeds.

- 1-3. Steps same as for traditional oven method.
- 4. Spread sample evenly in the container (maximum depth is 1 1/2 inches), but leave a small depression in the center so the forage sample looks a little like a donut.
- 5. Place container with sample into microwave and begin drying at high power setting. The wattage of the microwave, evenness of heating (a turntable helps), and amount of material and its moisture content will influence how long to dry the sample. Begin by using short drying periods -- 2 minutes for haylage, silage or fresh material; 1 minute for dry hay. As experience with an individual microwave and forage increases, adjust times accordingly.
- 6. Remove, reweigh container plus sample, and record the weight.
- 7. Mix the forage, rotate the container and return it to the microwave. Continue drying for 30 seconds if forage is nearly dry, one minute if still moist. **WARNING**: High moisture forage can get extremely hot and can burn. If forage gets too hot to mix comfortably by hand, use a lower power setting until forage is nearly dry.
- 8. Repeat steps 6 and 7 until forage weight does not decrease by more than 1 gram from last weight. If forage starts to char or burn, use the previously recorded weight.
- 9. Calculate the moisture and dry matter content.

Calculating Moisture Content

To calculate the moisture content of a sample, divide the moisture weight removed in drying by the fresh weight of the sample, then multiply by 100. Example:

	Example scale readings	*Example data*
1. Take weight (wt) of pan (wt 1)	14 g	
2. Place fresh sample in pan (wt 2)	114 g	
Fresh sample weight = (wt 2 - wt 1 or 114 g - 14 g)		100 g
3. Dry and weigh sample plus pan again (wt 3)	50 g	
Dry sample wt (wt 3 - wt 1 or 50 g - 14 g)		36 g
Moisture wt = (fresh wt - dry wt or 100 g - 36 g)		64 g
Moisture % =	moisture weight divided by fresh sample weight	x 100
Moisture % =	64 divided by 100	x 100 = 64%

If you have a scale which permits you to tare the container (initially adjust the scale to zero with the container on the scale), the percent moisture can be calculated simply by subtracting the dry weight in grams from 100 (if the original wet weight was 100 grams). The final weight is the dry matter content of the sample.

Selling and Buying on a Dry Matter Basis

You should always consider the value of a feed on a dry basis. For example, No. 2 corn is quoted at $2.50 per bushel. It can have 15.5 percent moisture (84.5 percent DM).

How much is 56 pounds of corn containing 26.9 percent moisture (73.1 percent DM) worth without taking into consideration drying cost and handling loss?

Value of corn ($) =	[Actual DM % of corn divided by DM % of No. 2 corn]	x Price of No. 2 corn ($)
Example:	[73.1% divided by 84.5%]	x $2.50 = $2.16/bu

Another example involves corn silage. If silage is quoted at $25 per ton on a 40 percent dry matter basis, but the delivered silage tests only 32 percent dry matter, what is its appropriate price per ton?

Value of delivered corn silage ($) =	[Actual DM % of silage delivered divided by DM % of quoted silage]	x quoted silage price ($)
Example:	[32% divided by 40%]	x $25 = $20/ton

Hay stored indoors may be 12 percent moisture (88 percent DM) and worth $66 per ton but hay stored outdoors or immediately after baling may be 20 percent moisture (80 percent DM). What is its value, assuming identical quality?

Value of outdoor or fresh hay ($) =	[DM % of outdoor or fresh hay divided by DM % of indoor hay]	x hay price ($)
[80% divided by 88%]	x $66 = $60/ton	

Moisture Guidelines for Forages and Grains

Table II provides recommended moisture levels for harvest and successful storage of grains and forages under several common conditions.

Table II. Moisture content guidelines for various feeds.

Feedstuffs	*Moisture level, %*	*Comments*
Corn grain	30-34	For high moisture ear corn (ensile or preserve with acid treatment).
	27-31	For high moisture shelled corn (ensile or preserve with acid treatment).
Corn grain stored in aerated bins	18	Safely stores to April 1.
	15 1/2	Safely stores to June 1.
	14	Safely stores for one year.
	12-13	Safe for long term storage.
Silage and	75	Seeps too much; may need preservative.

haylage	70	Store in bunker, trench, or stack.
	60-65	Store in a conventional upright silo.
	50-55	Difficult to ensile satisfactorily; too dry to pack well, *greater chance of heat damage, molds and even spontaneous combustion*; may preserve satisfactorily if the crop is immature, fine chopped, and stored in an upright silo of excellent construction.*
	40-50	Store in an oxygen limiting silo (practically air tight).
Hay	35+	Too wet for hay, likely to mold and overheat.
	25-35	Can be preserved as loose stacked hay in cage or on poles in low humidity conditions.
	20-25	Will probably require a preservative for satisfactory storage in bales.
	15-20	Stores well as hay; dense and large packages should be near 15% moisture.
	<15	Excessive leaf losses can occur. Minimize loss by picking up during high humidity (night).
*Finely chopped forage may cause metabolic problems and cause cattle to go off feed.		

Summary

Knowing the moisture, or DM, content of forage at the time of harvest is essential for making high quality hay and silage. Dry matter content of feeds also is needed to accurately formulate rations. Likewise, knowing the moisture content of grains allows for safer storage. Using the methods outlined in this NebGuide will allow you to accurately measure the moisture content of the forages and grains you harvest or purchase.

[1]Available from farm supply stores and catalogs.

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