

**Use of Microwave Drying to Determine Moisture Content in Forage  
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## **Introduction**

Knowing the moisture (dry matter) content of forage at the time of harvest and storage is essential for making and preserving high quality silage and hay. Knowledge of dry matter content is also important for accurate formulation of rations. Hay harvested and stored at too high a moisture content (greater than 20%) will result in spoilage and possible spontaneous combustion. Harvesting hay when it is too dry results in excessive leaf loss; this reduces the feeding value and increases dry matter loss. Harvesting forage for silage at too high or too low a moisture content results in improper fermentation, which reduces feeding value.

A squeeze test is not an accurate method for estimating forage moisture content while making hay or silage. Resistance-type moisture detectors are available for rapid moisture determination of forage, but these devices are usually expensive and vary in accuracy. They have questionable value. A portable electric drying unit is also available but requires considerable time when determining the moisture content of forage. Under good drying conditions the moisture level of the forage in the field may have changed substantially before the test is completed.

## **Procedures for Obtaining Representative Samples**

**Proper sampling is essential** if an accurate moisture content is to be obtained. Procedures for obtaining representative samples from various types of forage are as follows:

**Forage in windrow (hay making).** Care must be taken to obtain a representative sample from windrows. Avoiding "slug" areas and "very thin" areas, cut 6-inch sections from several locations in the windrow. If the windrow is dry, extreme care must be taken to avoid losing the leaves. Cut the sections into 1/2 to 1 inch sections for use in the moisture determination.

**Forage in windrow (silage making) or standing crop.** If forage in the windrow, or standing corn or sorghum is to be harvested with a forage chopper, a few hundred weights of forage can be chopped from a representative part of the field. A small sample is then collected from various locations in the forage wagon and blended thoroughly for use in the moisture determination.

**Conventional square bales.** A bale probe should be used to collect samples. The probe should be approximately 12 to 18-inches long, hollow, and at least 3/8-inch in diameter. Most probes are designed to attach to an electric drill or brace. Many Purdue Cooperative Extension Service Offices in Indiana have a bale probe that may be obtained for short-term usage by residents. Probes must be kept sharp so they will cut through, rather than slide past stems. Known sources of probes include:

- \* A cut-off metal golf club shaft. The handle end of the shaft is also cut off, a plastic bag attached to the end of the handle with a rubber band, and the user drives the golf club shaft into the end of a bale by hand.
- \* Heavy-duty sampler. "California Belly Buster" is an 18-inch probe with 1/2-inch internal cutting diameter. Malm Metal Products, P.O. Box 4299, Santa Rosa, CA 95402.
- \* Penn State forage sampler is an 18-inch probe with 3/4-inch internal diameter available in hand brace or electric drill modes. Nasco Farm and Ranch Catalog, 901 Janesville Avenue, Ft. Atkinson, WI 53538, Phone: 1-800-588-9595.
- \* Northwest Ag forage probe is a 12-inch probe with a 1/2-inch internal diameter, equipped with sample collection box and electric drill mode. Northwest Ag, P.O. Box 238, Culver, OR 97734.
- \* Oakfield hay sampler is a 1/2-inch metal probe. Oakfield Apparatus, Inc., P.O. Box 65, Oakfield, WI 53065.
- \*Utah State hay sampler is a 1/2-inch electric drill, 15-inch steel barrel with a 1/2-inch internal cutting diameter. It contains a built-in sample collection box. Information available from Dr. Jim Bushnell, Extension Agronomist, Utah State University, Logan, UT 84322, Phone (801) 750- 2259.
- \*Hay Chec. is a 16-inch machine steel probe, 7/16-inch inside diameter cutting edge. It has a large body with handles for hand use. The probe fits at one end and a threaded receptacle at the other end to receive sample jars. A.M. Hodge Products, P.O. Box 202005, San Diego, CA 92120-0925, Phone 1-800-854-3565.

A minimum of 20 average-looking bales, representative of the lot, should be selected for sampling. Steps in obtaining samples from these representative bales are as follows:

1. Take one core drilling from an end of each bale. Insert the probe near the center of the bale's end at a right angle to the surface. (Figure 1).



**Figure 1. Proper technique for sampling conventional square bales.**

2. Place drillings in a clean plastic bucket.
3. Thoroughly mix drillings.
4. Put the mixed drillings in a sealed plastic bag until moisture determination can be made.
5. Repeat procedure for each lot, making sure not to mix drillings of different lots.

If a bale probe is not available, reach inside each sample bale and carefully remove a handful of forage. With a pair of shears, cut each sample into 2-inch sections. Mix all samples from a lot and again remove about one quart for moisture determination.

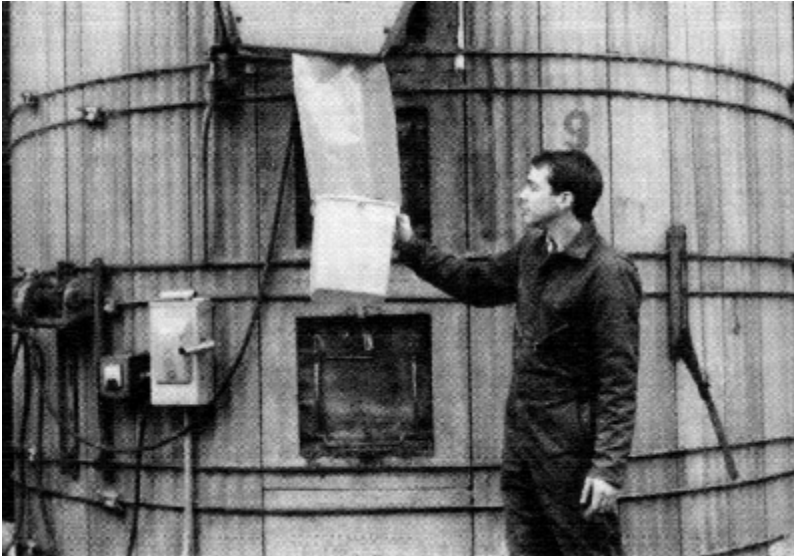
**Large round bales and stacks.** Ten sampling bales or compressed stacks from each lot should be randomly selected. The bale probe is used to make drillings from two different locations from each selected bale or stack. Drillings should be made at the top of each stack; bales should be probed from the sides (not the ends). Mix the drillings from each lot and place in a sealed plastic bag until moisture determination can be made. If a bale probe is not used, sample these large packages by hand as described for conventional square bales, with the exception that two or three handfuls should be removed rather than a single handful.

**Loose hay.** Samples should be taken from at least 12 random locations in the mow or on the stack. To make bale-probe drillings, stand on the stack and insert the probe vertically where the hay is compressed between your feet. If a bale probe is not used, obtain samples by hand using the procedure suggested for large package hay.

**Silage.** Sampling a lot when filling the silo would be one way of getting representative samples for moisture determination. However, this sampling method gives an indication of moisture when the forage entered the silo, but it may not provide an accurate

assessment of its dry matter composition after fermentation. Follow suggested silage sampling procedures:

- \*Collect about 2 gallons of silage in a clean plastic container by taking handfuls at random from 20 different locations on the exposed face or surface (avoid rotted silage on top) or by passing the container beneath the chute several times (once a minute), collecting one or two quarts at each pass while the silage is unloading (Figure 2). Mix subsamples thoroughly and seal about one quart in a plastic bag for moisture determination.



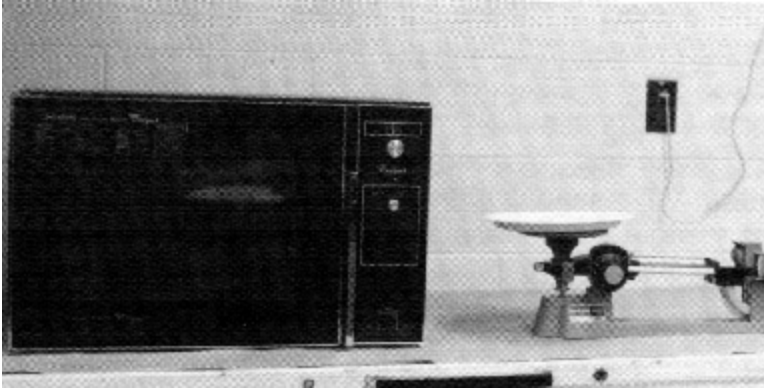
**Figure 2. Obtaining a representative silage sample.**

To identify different silage lots, several bales of straw, shavings, or shredded paper can be fed through the blower when the last of each lot is ensiled. The presence of silo gases should be of utmost concern when obtaining silage samples from the surface of upright silos.

### **Technique for Moisture Determination**

The following technique describes how a microwave oven can be used to determine moisture content in forages in a matter of minutes with the accuracy close to that obtained when using accepted research methods.

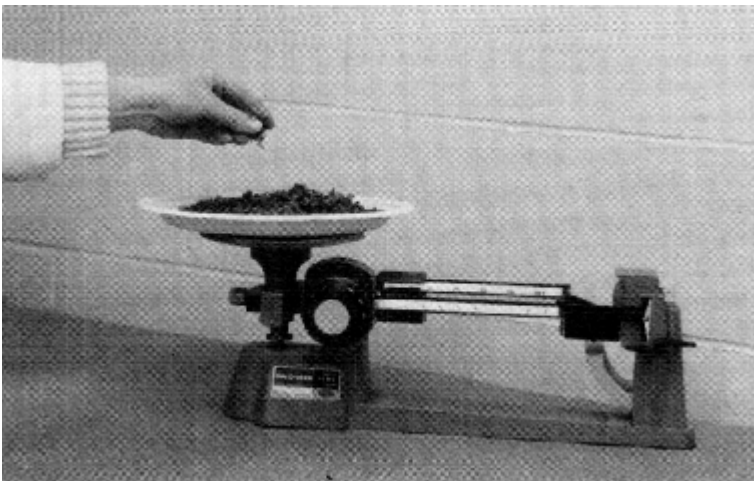
All that is needed is a small scale, paper plate, water glass, and a microwave oven (Figure 3). The accuracy of the results are dependent upon the quality of scale used. A diet scale measuring in grams will give reasonably good results, although a scale weighing to 0.1 gram is preferred. This type of balance is available from most farm catalog supply houses.



**Figure 3. Moisture determination equipment.**

The procedure for determination of moisture (dry matter) content with the microwave oven is as follows:

1. Place a preweighed large paper plate (9-inch minimum) on the scale and weigh out exactly 100 grams of the representative forage sample (Figure 4). A smaller sample can be used but the 100-gram sample makes for easier calculations.



**Figure 4.**

2. Spread the forage evenly on the paper plate.

3. Place an 8 oz. water glass, three-quarters full of water, in the back corner of the microwave oven (Figure 5); keep water level constant during oven use. This will protect the oven magnetron when sample moisture is low. The setting of adjustable microwave ovens should be 80% to 90% of maximum power.



**Figure 5.**

4. Initially, dry legume or grass samples in the 50% to 70% moisture range for eight minutes. Then weigh and record sample weight. Mix the sample and place it in the oven for two minutes; remove and weigh. If the weight has not changed more than one gram, use this value. If the change is greater than one gram, continue drying using additional one-minute intervals until the weight change is less than one gram. For greater accuracy, continue drying until the dry weight is constant.

5. If corn or sorghum is to be utilized for silage, use a longer initial drying period of 14 minutes, followed by a two minute period, and finally one minute drying intervals.

6. For forage with a moisture content of less than 30%, an initial drying time of four minutes should be used. Then weigh the samples following the same procedure as for the wetter forage above, using one minute drying intervals until the weight change is less than one gram.

7. Be careful not to char the sample. If this occurs, it means the oven was set too high, the drying time was too long, or the glass of water in the rear of the microwave oven was omitted. Discard the charred sample and repeat the test.

8. Use the following equation to calculate the moisture content. Keep in mind, since the wet and dry weights include the weight of the paper plate (unless scale can be tared to zero with paper plate on scale), the weight of the paper plate must be subtracted from the wet and dry weights before making the following calculation.

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

If you have a scale which permits you to tare the paper plate (initially adjust the scale to zero with the paper plate on the scale), the percent moisture can be calculated simply by

subtracting the dry weight in grams from 100 grams (the assumed original wet weight). The final dry weight is the dry matter content of the sample.

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