IMPORTANCE OF DRY MATTER IN BEEF CATTLE DIETS

K-STATE Research and Extension

The concept of dry matter (DM) is fundamental in beef cattle nutrition, yet it can be overlooked or misunderstood in everyday feeding situations. Understanding DM is essential for formulating cost-effective diets and supplementation programs.

While having accurate values for all nutrients is important for meeting animal requirements, the DM content for a feed ingredient can significantly affect what is fed to an animal in terms of diet composition (i.e., the relative proportions of various ingredients fed) and the absolute amount of an individual feedstuff or total ration fed. Both can affect cattle health, performance, and the cost of a feeding program.

This publication outlines what DM is, how the terms DM and as-fed (AF) are determined, the appropriate usage of these terms, and examples of the typical DM of feedstuffs. Although this publication is written regarding beef cattle nutrition, the fundamentals discussed apply to feeding scenarios for dairy cattle and small ruminants, in addition to any species in which feedstuff DM content varies.

What is Dry Matter?

Dry matter, by definition, represents the proportion of feed remaining when the moisture from a feedstuff sample of any given quantity is completely removed. Dry matter is the portion of a feedstuff that is not water. Except for pure forms of some micronutrients, such as minerals and vitamins, nearly every other feedstuff commonly used in nutritional programs for beef cattle gains or loses moisture depending on storage conditions.

Dry matter can be expressed in absolute amounts (i.e., lbs or tons) or percentage units. While it is most often discussed in the context of percentage units, a practical way to think about DM is in terms of 100-pound units.

For example, if a feedstuff, such as wheat silage, has a DM content of 27%, that means that for every 100 pounds of total ingredient, there are 27 pounds of actual dry feedstuff matter and 73 pounds of water. If an initial quantity of 100 actual pounds of this feedstuff was taken and all water removed, and 27 pounds of dry ingredient remaining were measured, then 73 pounds of water were removed (100 pounds total – 27 pounds of DM = 73 pounds water). Likewise, 300 actual tons of this ingredient would equate to 81 tons of dry feedstuff matter and 219 tons of water. Expressed on a percentage basis, DM = 100 – % moisture. For wheat silage with a DM content of 27%, this would be determined mathematically as 100% – 73% water = 27% DM.

Remember the following key points with DM and moisture:

1. % DM = 100 – % moisture
2. % Moisture = 100 – % DM
3. DM can be expressed as either absolute amounts (of any unit of weight measure) or percentage units

Dry matter does not refer to the physical form of the ingredient. Liquids, pellets, cubes, some tubs and blocks, granular meal-type feeds, and mash/slurry products such as potato or bakery wastes all contain a dry and moisture component. Various classes of feeds such as by-products, dry and fresh harvested forages, grazed forages, grains, protein sources, and silages all contain various levels of DM depending on harvesting and processing conditions that influence retained moisture. Nearly all feeds consist of moisture and dry components regardless of how a feedstuff visually appears or feels to the touch.

What is the Dry Matter of Typical Feedstuffs?

Typical DM values of some feedstuffs most common to beef cattle operations in Kansas are reported in Table 1. Additional feedstuff DM values are available in K-State Research and Extension publication *Nutritional Composition of Feedstuffs for Beef Cattle*, MF3648 (https://bookstore.ksre.ksu.edu/pubs/MF3648.pdf).

Values reported are averages ranging from 5 to 20 percentage units above or below average values that may be

observed for a feedstuff, depending on the type. Feeds like soybean meal, wheat middlings, cubed and pelleted feeds, and grains, except when ensiled or steam-flaked, do not vary greatly in DM content.

Grain processing by-products such as gluten feed or distillers grains often vary significantly due to differences in the manufacturing and drying processes of different plants. Likewise, silages and freshly harvested forages may vary greatly in moisture content due to plant maturity and weather conditions at harvest.

It is common for ingredients fed on beef cattle operations to be stored for several months or longer before being fed. In general, as feeds are stored for increased time, they have greater potential to gain moisture, particularly for those stored uncovered.

It is good practice to analyze feedstuffs for DM content before initial feeding to help ensure both formulation and delivery accuracy. Recheck regularly throughout the feeding period if DM is suspected to change and/or if feeds are exposed to significant precipitation events. The methods in which DM content may be determined are discussed in K-State Research and Extension publication *Measuring the Effects of Dry Matter in Beef Cattle*, MF3676 (*https://bookstore.ksre.ksu.edu/pubs/MF3676.pdf*).

Is it on a Dry Matter Basis or an As-Fed Basis?

The terms DM basis and AF basis are used in beef cattle nutrition to communicate the expression of the reported value. The terms can refer to the percentage composition of a diet, an amount fed to an animal daily (i.e., ration), and/or the nutrient content of either a complete diet or an individual ingredient itself.

When the term AF basis is used, the assumption is made that moisture is accounted for within that value. As-fed basis also refers to what is being fed, given that the animal consumes both the moisture and dry component of either a feedstuff or a diet, not just the DM portion.

When the term DM basis is used, it refers to a given value under the assumption that the moisture is completely removed from that value. Continuing with the wheat silage example, if you feed a calf 35 pounds per day of wheat silage, that amount would be considered to be on an AF basis. On this basis, it is assumed that the moisture is accounted for within that value, and the animal consumes both the moisture and dry component of the feedstuff.

Conversely, on a DM basis, it is assumed there is no moisture accounted for within that given quantity. On a DM basis, this 35 pounds of silage AF would equate to 9.45 pounds per day (35 pounds × 0.27 = 9.45 pounds), with a silage DM content of 27%. Think about this from the standpoint of the relative difference in the proportions of DM and moisture consumed within the given quantity.

1. If the calf consumes 35 pounds of silage in total on an AF basis, and
2. The silage is 27% DM or 73% moisture, then
3. 35.0 pounds AF × 0.73 = 25.55 pounds of moisture, then
4. 35.0 pounds AF – 25.55 pounds of moisture = 9.45 pounds of DM

How are Dry Matter and As-Fed Values Converted?

Nutrient Composition Values

Remember the concept of dilution when converting feedstuff composition values between an AF and DM basis. If you directly compare DM and AF basis values for any one nutrient of a feedstuff, the values will *always* be lower when expressed on an AF basis because water within a given amount of the feed dilutes the other nutritional components. Conversely, any composition value will *always* be relatively higher when expressed on a DM basis because the moisture content is removed or assumed to be removed from the feedstuff sample.

A good resource further describing this concept, including mathematical operations for converting nutrient values and feeding amounts and calculating DM of a total ration, is *Feed Dry Matter Conversions*, available from the University of Nebraska (*https://extensionpubs.unl.edu/publication/g2093/feed-dry-matter-conversions*).

When values are expressed on a DM basis, there is no moisture in the given quantity of feedstuff, thus nothing to dilute nutritional components. When converting

Table 1. Typical DM values of common feedstuffs.

Feedstuff	% DM
Alfalfa Hay	91.0
Corn Silage	33.0
Corn Grain, Dry Rolled	85.0
Corn Grain, High Moisture	70.5
Prairie Hay	88.0
Modified Corn Distillers Grains with Solubles	47.8
Sorghum Sudan Hay	69.0
Wet Corn Distillers Grains with Solubles	31.4
Wheat Grain, Steam Flaked	83.0
Wheat Straw	91.8

composition values from a DM to an AF basis, multiply the DM basis reported value by the DM content of the ingredient in decimal form.

Using our wheat silage example, if it tested 10.4% crude protein on a 100% DM basis that would equate to 2.8% on an AF basis if it is 27% DM or 73% moisture (10.4% × 0.27 = 2.8%). To adjust a composition value from an AF to a DM basis, take the AF basis value and divide it by the DM content in decimal form.

2.8% CP AF basis ÷ 0.27 = 10.4% CP DM basis

Again, because we are removing moisture, the nutrient is more concentrated and numerically higher. This method for converting back and forth between an AF and DM basis can be followed for any nutrient provided the DM content of the ingredient is assumed or known. Conversion functions are summarized in Table 2.

Remember the following key points when converting DM and AF values:

1. Nutrient values will always be **higher on a DM basis** (i.e., concentrated as water is gone)
2. Nutrient values will always be **lower on an AF basis** (i.e., diluted as water is present)

Amounts To Be Fed

When determining amounts fed on either an AF or a DM basis, remember that water contributes to the total amount consumed, as animals do not just ingest only the DM portion. **Amounts fed will *always* be lower when expressed on a DM basis because the water is removed** from the value. Appropriately, **amounts fed will *always* be higher when expressed on an AF basis because water contributes to the total value**.

When converting amounts fed from an AF to DM basis, multiply the AF value by the DM content in decimal form. This can be done for either an individual ingredient or a total diet. In the wheat silage example, if a calf consumes 35 pounds per day AF, that would equate to 9.45 pounds per day on a DM basis if the silage DM content is 27% (35 lb × 0.27 = 9.45 lb). To correct an amount from a DM to AF basis, take the DM basis value and divide it by the DM content in decimal form.

9.45 lb DM basis ÷ 0.27 = 35.0 pounds AF basis

Again, because we are accounting for the water being fed, the amount is numerically higher on an AF basis.

Remember the following key points when converting DM and AF amounts:

1. Amounts fed will always be **higher on an AF basis (water is present)**
2. Amounts fed will always be **lower on a DM basis (water is gone)**

Summary

The basics of dry matter are critical for optimizing beef cattle nutrition, ensuring precise diet formulation, and managing costs effectively. Remember, 1) nearly all feedstuffs contain both a dry and moisture component, affecting their nutritional value and the amounts required to meet dietary needs 2) differentiating between DM and AF basis is essential for accurate diet formulation and nutrient analysis, as these terms reflect whether moisture is included in the reported values, and 3) properly converting between DM and AF basis is vital for understanding the actual nutritional content of a diet or feedstuff and appropriate feeding amounts.

Table 2. Conversion functions using wheat silage as an example.

Nutrient Values	Have	Action	Constant		Want
	DM Basis	×	Decimal Form of DM	=	AF Basis
	10.4% CP	×	0.27	=	2.8% CP
	AF Basis	÷		=	DM Basis
	2.8% CP	÷	0.27	=	10.4% CP

Amounts Fed	Have	Action	Constant		Want
	AF Basis	×	Decimal Form of DM		DM Basis
	35.0 lb	×	0.27	=	9.45 lb
	DM Basis	÷		=	AF Basis
	9.45 lb	÷	0.27	=	35.0 lb

In the companion article to this publication, *Measuring the Effects of Dry Matter in Beef Cattle*, MF3676 (https://bookstore.ksre.ksu.edu/pubs/MF3676.pdf), the determination of dry matter and how those values influence diet composition, performance, and the economics of feeding scenarios is discussed further.

References

Reiling, B. Feed Dry Matter Conversions. University of Nebraska-Lincoln. G2093. October 2022. *Feed Dry Matter Conversions*, G2093 (https://extensionpubs.unl.edu/publication/g2093/feed-dry-matter-conversions).

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