Measuring Dry Matter: What is the Standard?

Industry experts have identified feeding management, specifically accurate and frequent assessment of silage dry matters to ensure consistent diet delivery, as one of the key areas of opportunity for dairy operations. In order to properly manage dry matter at the bunk or mixer wagon, the question many producers ask is what should be the gold standard for dry matter measurement?

Bringing the gold standard to Cargill.

There are several published research papers on the subject of dry matter measurement, and most agree that the 60°C oven dry matter that is corrected for sample residual moisture is the absolute gold standard. Some of the literature before the mid-1990s used the 135°C oven as the gold standard. But in the early 2000s, the argument was proven that a significant amount of organic volatile compounds that were not moisture were also driven off at the higher temperature. This led to 60°C as the gold standard we use today.

In 2003, the Cargill Elk River Forage Lab took the step to reach the gold standard in its laboratory by measuring the residual moisture in the 60°C dried samples and correcting the reported results for a true dry matter. This residual moisture is usually 2 to 2.5 percentage units on a forage that is around 35% dry matter, having been dried at 60°C for 16 hours. The Cargill lab used Karl Fisher moisture analysis, a procedure that measures moisture directly and not as weight loss on oven drying, to validate the corrected 60°C oven method for dry matter analysis. This residual moisture corrected 60°C dry matter is the dry matter the lab measures today using ovens and is the dry matter on which the NIR calibrations for both lab NIR (near infrared) machines and the Reveal® analysis device are based.

What variation will we see?

Now that we understand what the gold standard is for measuring dry matter, we looked into what the variation is within the gold standard. Data in Figure 1 (corn silage) and Figure 2 (alfalfa haylage) illustrates a large sample of forage sampled 20 times to determine dry matter with both a 60°C oven or a lab-based NIR machine. The orange bar is the average dry matter of the 20 samples, the blue bar is the minimum, and the grey bar is the maximum dry matter number resulting from measuring the same sample 20 times.

In all cases, both the oven and the NIR machine results report a range in dry matter. Also notice that the range is slightly bigger with the NIR than the oven. The coefficient variation (CV) for corn silage oven samples is 1.55% and for the NIR machine is 3.10%; for the alfalfa samples the CVs are 2.16% for the oven and 2.81% for the NIR machine.

The key takeaway is that even the gold standard has error around the mean predicted dry matter number. The average dry matter of the 20 samples within a forage class are pretty close to each other, but a one-time spot sample may not be equal to the average. The only way to get closer to the true mean is to take multiple samples and average them. This is where NIR has an advantage because we can quickly analyze multiple samples to better approximate the true mean dry matter rather than the time it takes to dry down a sample.

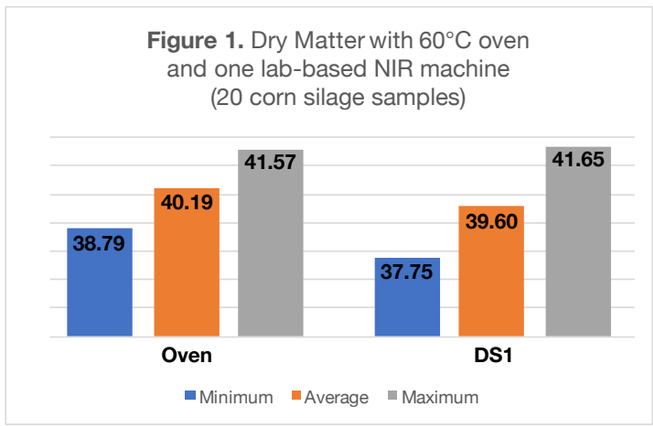

Figure 1. Dry Matter with 60°C oven and one lab-based NIR machine (20 corn silage samples)

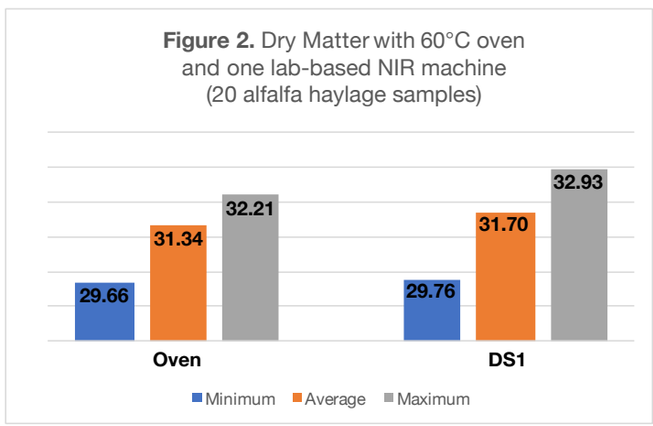

Figure 2. Dry Matter with 60°C oven and one lab-based NIR machine (20 alfalfa haylage samples)

Key Takeaways

- Reveal® analysis dry matter calibration is based on the 60°C moisture corrected oven dry matter used in lab analysis.
- The key to accurately measuring dry matter is to use the same tool consistently.
- Since all methods have variation and error, it's best to analyze multiple samples and average the results.
- Samples dried with a Koster Moisture Tester needed between 50-70 minutes to dry completely. Common on-farm practice of drying samples for 40-45 minutes may not adequately remove all moisture, resulting in erroneous dry matter.

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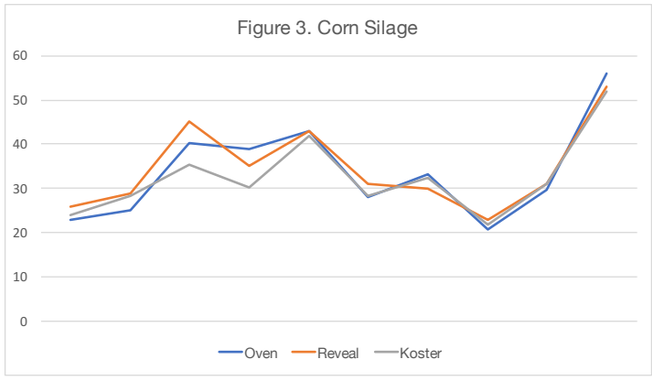
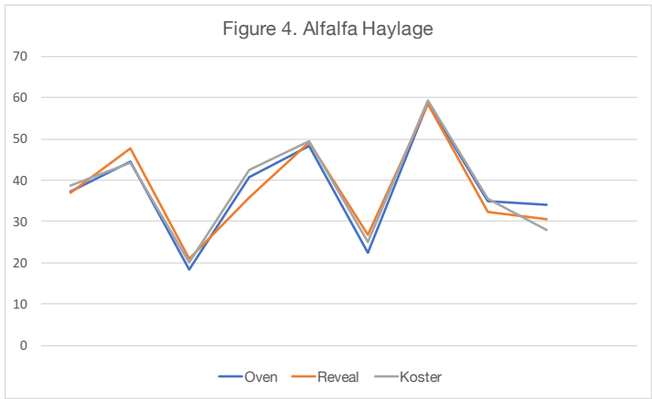
Where does Reveal® fit?

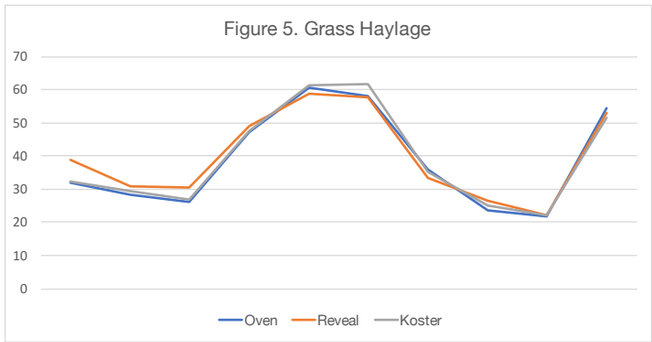
To better understand how the Reveal® analysis fits within dry matter measurement, we ran an experiment at the Cargill Elk River Forage Lab to look at dry matter from samples of corn silage, alfalfa haylage and grass haylage. Results are reported in Figures 3, 4, and 5.

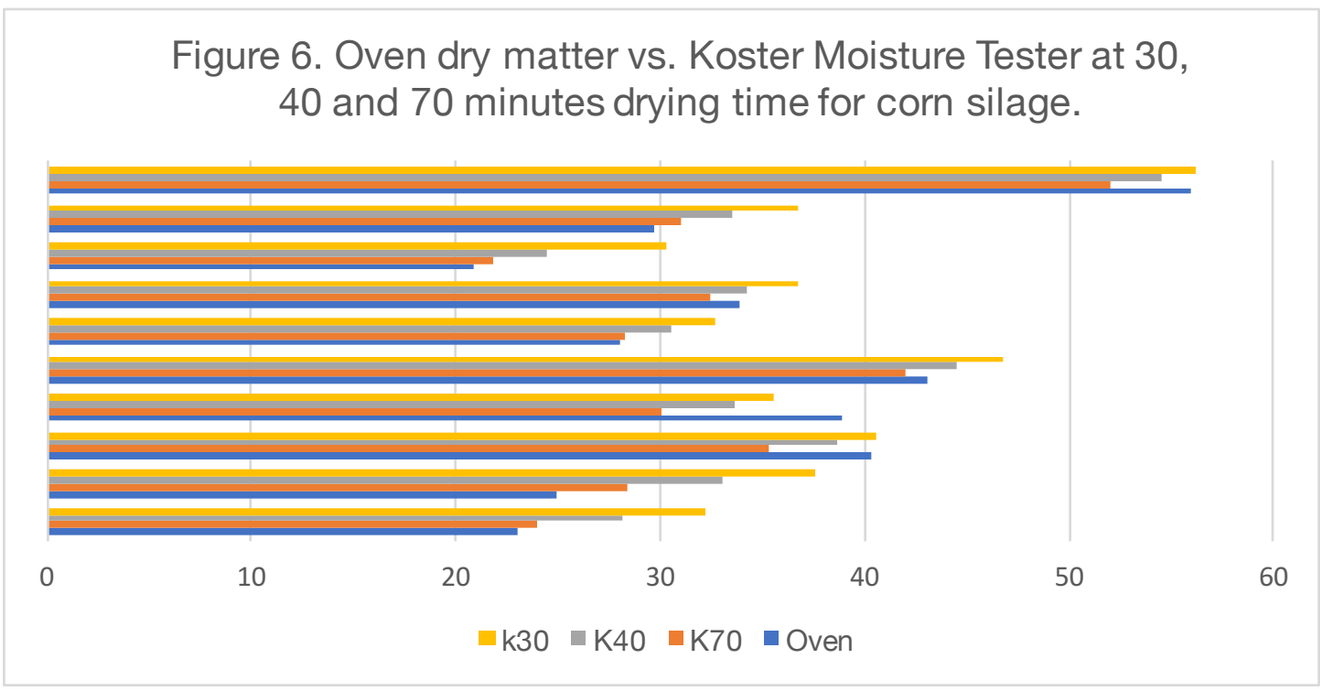
In this experiment, we compared results from the oven in the lab (60°C residual moisture corrected), the Koster Moisture Tester and Reveal® analysis. Remember that the Reveal® analysis dry matter calibration is based on the 60°C moisture corrected oven dry matter whereas the Koster Moisture Tester is not corrected for moisture. In the figures below, the oven standard is blue, Reveal® analysis is orange and the Koster Moisture Tester is grey. Both the Koster Moisture Tester and Reveal® analysis do a good job of predicting the oven dry matter. If we look at the CV for the oven above, it is likely none of the dry matter predications across the methods is different. The main advantage Reveal® analysis would have over the Koster Moisture Tester is simplicity and speed.

The Koster Moisture Tester requires a sample to be representatively taken and then dried until the moisture content ceases to vary. This requires the significant time to re-weight the sample every 10 minutes after the initial drying period of 30 minutes, calculate the current dry matter and determine if that is final dry matter. In our lab experiment, the time required for samples to completely dry varied between 50 and 70 minutes. For the Reveal® analysis, the person on-farm just needs to collect the representative sample and scan it. In fact it would take less than 10 minutes to take three representative samples, scan them separately, and average the dry matters to get a better prediction of mean dry matter than a single spot sample would under any method. In addition, under drying the sample when using the Koster Moisture Tester is a significant risk (especially on dairies under a time crunch) which will cause the error to grow. Figure 6 shows different Koster Moisture Tester drying times compared to oven dry matter, where the blue bar represents the oven gold standard.









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