Interpreting Corn Silage Quality Test Results

Overview

Corn silage test results are of little value unless they are understood and used. Not only can the results be used to balance feed rations, but they can also help to improve crop management if the test results indicate the forage sample is of unsatisfactory quality.[1]

Silage Quality Terminology – Interpreting a Silage Quality Laboratory Report[2,3]

% Moisture – Percent water in a sample, measured by weight after drying. The optimum range depends on the type of storage structure. For bunker silos, the moisture content should be in the 60% to 70% range. For upright silos, the recommended range is 60% to 65%.

% Dry Matter (DM) – All the nutrients in a feedstuff, other than moisture, and the inverse of percent moisture. DM is needed to properly balance a feed ration, as all nutrients are reported on a DM basis. Harvesting corn silage too early, or too late, can result in DM values being outside the recommended range of 30% to 40%.

Crude Protein (CP) – This is the total percent of protein in a silage sample. It includes true protein and non-protein nitrogen (N) such as urea N or ammonia N. The test for CP does not provide information about amino acid composition or the digestibility of the protein. The values are normally in the range of 6.5% to 10.0%. Low CP values could be attributed to a lack of adequate N fertilization or heavy weed infestation.

Lignin – This is an organic compound that is the part of plant cell walls that make them rigid. It is indigestible fiber and does not provide energy to the animal. The more mature a plant becomes, the greater the lignin content. The typical range for lignin is 2% to 4%, with lower values being more desirable. The lignin test is not consistent and is rapidly being replaced by the uNDF240 test.

Neutral Detergent Fiber (NDF) – Measures all the fiber content in a sample including lignin, cellulose, and hemicellulose, which are substances that constitute the cell walls of plants. NDF (sometimes reported as **aNDF**) values should be in the range of 36% to 48% and are important in RFV and energy calculations. Variation is generally a result of the production environment the silage crop was grown in, as well as the corn product. Lower values are desirable since high fiber diets can limit feed intake by the animal. Less digestible fiber remains in the rumen longer than highly digestible fiber. Analysis reports may include a calculation designated **NDFom** (NDF organic matter) which corrects for the ash content in the sample due to soil contamination.

Interpreting Corn Silage Quality Test Results

Neutral Detergent Fiber Digestibility (NDFd) – Measures the maximum potential digestion of the NDF portion of a feedstuff. Ration balancing programs use various timepoints for this calculation, typically 24, 30, or 48 hours (hrs) depending on the assumptions built into the program. The most commonly used is NDFd30hrs, with ranges of approximately 45% to 65% for dual purpose corn products. The higher the value the more digestible the feedstuff. Higher digestibility allows for greater dry matter intake and enhanced animal performance since feed can move through the rumen faster.

Undigested Neutral Detergent Fiber (uNDF) – This is the portion of fiber that cannot be digested after various fermentation times (12, 24, 48, or 240 hours). uNDF240 is the fiber portion of a feedstuff that is completely indigestible. The uNDF240 analysis is replacing the lignin analysis. The values should range from 8% to 13% with a lower value being preferred because it means more fiber is digestible. Results are reported as % of Dry Matter.

Starch – Starch (glucose) is a complex carbohydrate in grain. It is the most important source of readily available energy in silage with values typically ranging from 25% to 40%. These percentages can vary based on the overall grain to stover ratio of a corn product. Corn silage that is high in starch will also be low in NDF. It is recommended that you also refer to the starch yield, which is the overall pounds of starch per acre.

In-vitro Starch Digestibility (IVSD7) – Is used to analyze the inherent starch digestibility after 7 hours to simulate the ruminal starch digestibility. This value is highly dependent on harvest timing but also on the endosperm characteristics of a corn product (soft vs. vitreous). Values range from 58% to 72% and higher values are preferable.

Milk per Ton (Milk/ton) – Expressed as pounds of milk per ton of silage (lb/ton). This provides an estimate for silage and projects the milk production from one ton of silage using a multitude of quality parameters. It is an index developed by researchers at the University of Wisconsin-Madison. It was designed as an index for ranking forages and is not a prediction of actual milk production. The range is typically about 2700 to 3400 lb/ton.

Milk per Acre (Milk/ac) – Expressed as pounds of milk produced per acre (lb/ac). This is an index that takes into account the yield and quality of the silage. The calculation is based on Milk/ton multiplied by the dry matter yield per acre.

Beef per Ton (Beef/ton) – Expressed as pounds of beef produced per ton of silage (lb/ton). This is an index that takes into account the yield and quality of the silage. Provides an index derived from a TDN value that is calculated using protein, fiber, fat, ash, and fiber digestibility measurements.

Ash – Ash is the remaining residue after all the organic matter in a sample has been incinerated. The organic matter can be calculated as: 100 – Ash = organic matter. The ash content could include contaminants such as sand or silt and has zero energy value.

Minerals – These include calcium (Ca), phosphorus (P), magnesium (Mg), and potassium (K) expressed as a percentage of each in the feed sample.

Fat – also known as ether extract (EE) – Is a crude measurement of fat. It contains mainly lipids as well as fat-soluble vitamins and is high in energy content. Fat provides 2.25 times more energy than carbohydrates and is an important source of vitamins.

Total Fatty Acids (TFA) – This is a sum of all fatty acids in a sample and is the preferred fat analysis used for most ration balancing programs.

Interpreting Corn Silage Quality Test Results

Total Digestible Nutrients (TDN) – This represents the sum of digestible crude protein, carbohydrates, and fat. TDN is a calculated forage parameter that provides one of the most common ways to determine the concentration of available energy in a silage sample. These digestible nutrients vary with plant maturity. The older the forage, the lower the TDN concentration and vice versa.

Net Energy System – The amount of digestible energy in silage can be expressed in three net energy values: net energy for lactation (NE_L), net energy for maintenance (NE_m) and net energy for gain (NE_g). Digestible energy used for lactation and maintenance is used more efficiently than it is for gain. The values can be expressed as megacalories per pound (Mcal/lb) or megacalories per kilogram (Mcal/kg).

Table 1. Summary of silage sample laboratory analyses, desired range of values, and possible causes of a value being outside of the desired range.

Analysis	Desired Range	High or Low Values Preferred?	Possible cause to be outside of the desired range[4]
Silage moisture (%)	65 – 70 Bunker 60 – 65 Upright		
DM (%)	30 – 40		Harvested too early or too late
CP (%)	6.5 – 10.0	High	Lack of N fertilizer, soil N losses, heavy weed competition
Lignin (%)	2 – 4	Low	
NDF (%)	36 – 48	Low	Variation usually due to the production environment
NDFd30hr	45 – 65	High	
uNDF	8 – 13	Low	
Starch	25 – 40	High	Stress or crop immaturity can reduce starch
IVSD7	58 – 72	High	
Milk/ton (lbs/ton)	2700 – 3400	High	
Ca	0.25		Low soil pH, weed contamination in the silage sample
P	0.23		
Mg	0.18		
K	1.20		K levels above 1.0 are generally an indication of high soil K
TDN (%)	62 – 74	High	Influenced by crop maturity; TDN becomes lower with increased maturity
NE_L (Mcal/lb)	0.64 – 0.75	High	High fiber amounts can result in lower NE_L

Sources:

[1] Garcia, A., Thiex, N., Kalscheur, K., and Tjardes, K. 2003. Interpreting corn silage analysis. South Dakota State University. https://openprairie.sdstate.edu/cgi/viewcontent.cgi?article=1124&context=extension_extra

[2] Dairyland Laboratories. 2021. Terms and definitions of a feed analysis report. Dairyland Laboratories, Arcadia, WI. https://www.dairylandlabs.com/resources/feed-and-forage/articles-papers-and-presentations

[3] Quality and feeding. University of Wisconsin. Corn Agronomy. http://corn.agronomy.wisc.edu/Silage/S006.aspx

[4] Roth, G. W. and Heinrichs, A.J. 2001. Corn silage production and management. PennState Extension. https://extension.psu.edu/corn-silage-production-and-management

Legal statements