AgroLab, Inc.
Feed Nitrate Fact Sheet
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UNDERSTANDING FEED TEST REPORTS

Moisture-The measure of the amount of water in the feed on an ―as is‖ or ―as fed‖ basis.

Dry Matter-The amount of dry matter in the feed or the percentage of feed that is not water.

Crude Protein-It is termed ―crude‖ protein because it is not a direct measurement of protein but a measurement of the total nitrogen in the feed (nitrogen x 6.25= crude protein). Crude protein includes true protein and non-protein nitrogen (NPN) such as ammonium and urea.

Digestible Protein-Although useful in specialized situations, protein nutrient requirement is based on crude protein value that has been adjusted for digestibility. Do not use digestible protein values except with the guidance of a livestock nutritionist.

Acid Detergent Fiber (ADF)-This constituent consists of cellulose, lignin, and heat damaged protein. It is closely related to indigestibility of forages and is the major factor in calculating energy content of feeds. The lower the ADF the more energy the feed contains and the more digestible it will be.

Neutral Detergent Fiber (NDF)-The total fiber content of forage is contained in the NDF or cell wall fraction. This fraction contains cellulose, hemicellulose, lignin, and heat damaged protein.
NDF gives the best estimate of the total fiber content of feed and is closely related to feed intake. As NDF values increase, total feed intake will decrease. A low percentage of NDF is desirable. Grasses will contain more NDF than legumes at a comparable stage of maturity.

Total Digestible Nutrients (TDN)-TDN represents the sum of digestible crude protein, crude fiber, nitrogen free extract, and ether extract (fat). Multiply ether extract by 2.25 to compensate for the higher caloric value of fats. TDN tends to overestimate the nutritive value of forages compared to Net Energy (NE). TDN is estimated from the ADF content of feeds.

Net Energy Lactation (NE_l)- For dairy cattle, net energy of lactation is used to meet both maintenance and milk production requirements. NE_l is usually expressed in megacalories (Mcal) per hundred weight.

Net Energy Maintenance (NE_m) and Net Energy Gain (NE_g)-Feed energy is used less efficiently for depositing new body tissue than for maintaining existing body tissue. NE_m is the net energy value of feeds for maintenance. NE_g is the net energy value of feeds for the deposition of body tissue, growth, or gain. Both NE_m and NE_g are needed to express the total energy needs of growing cattle.

Heat Damaged Protein / Acid Detergent Insoluble N- Excess moisture in hays or too little moisture in the presence of too much oxygen in haylages result in heating and caramelization. Some proteins become bound to the lignin during the heating process, which makes them unavailable to the animal. Heat damaged forages are characterized by a brown to black color and a sweet caramel-tobacco aroma. Palatability is often increased because sugars become condensed and turn to syrup during heating.

The overheating that causes this reaction is most common in silage stored at less than 65 percent moisture and in hay stored above 20 percent moisture.

When the heat damaged protein to crude protein ratio is greater than 15% it indicates that harvest and/or storage conditions were less than ideal and excessive heating occurred. Adjusted Crude Protein (ACP) should be used to balance rations rather than crude protein if the amount of heat damage exceeds 11% to 15% as outlined below.

Less than 10%-Normal forage. Use crude protein value.

From 11 to 15%-Some protein may have been damaged. Consider using ACP rather than crude protein for high producing dairy cows.

More than 15%-Use ACP rather than crude protein for all ration calculations.

Adjusted Crude Protein-The amount of crude protein, after being corrected for heat damaged or bound protein. It should be used in place of crude protein as described above.

Minerals-When calcium and phosphorus supplements are needed, periodically analyze feeds for these elements. Trace minerals are commonly added as insurance against deficiencies. Trace minerals should be checked periodically, or when a specific case suggests the need.

NITRATE IN LIVESTOCK FEEDS

Nitrate is found in most all forages. When consumed by ruminants, nitrate is normally reduced to ammonia, which is then absorbed by the body or excreted as urea. The problem occurs when forages with excessively high concentrations of nitrate are fed to livestock. High nitrate feeds, when digested, create an intermediate product, nitrite, which is the cause of nitrate poisoning.

Nitrate poisoning occurs when nitrite is absorbed into the blood where it changes the red-colored blood pigment, called hemoglobin, to methemoglobin. Hemoglobin caries oxygen from the lungs to the other tissues, but methemoglobin cannot carry oxygen. Poisoning occurs when the methemoglobin concentration in the blood stream is so high that the oxygen carrying capacity of the blood is reduced to a critical level. As this occurs, blood changes in color to a dark chocolate brown. Death, abortions and reduced milk production result from nitrate poisoning. Animals will vary in tolerance to nitrate; usually young, pregnant, weak, parasitized or ill livestock are most susceptible.

Nitrate in feeds is reported usually in parts per million (ppm) nitrate-nitrogen (NO3-N). See the table below for animal response to various concentrations of NO3-N in forages.

ANIMAL RESPONSE TO NITRATE NITROGEN CONCENTRATION

NO_3-N ppm "dry basis"	Animal Response
Less than 1400	Safe
1400 – 2100	Marginal, use caution when feeding. Can cause reduced milk production, abortions and low rate of gain. It would be best to limit daily use to ½ of the total daily dry matter intake.
2100 – 3000	Feeds in this range should be limited to 1/3 of the total daily dry matter intake.
3000 – 4000	Feeds in this range should be limited to ¼ of the total daily dry matter intake.
4000 – 5000	Feeds in this range should only be 10 – 15% of the total daily dry matter intake.
Greater than 5000	Do not feed – death may occur

A simple algebra equation will help you decide how much high nitrate feed can be mixed with a low nitrate feed to obtain a safe level.

$$N = [(1400-L)/(H-L)] \times 100$$

H= ppm NO_3-N of high nitrate feed

L= ppm NO_3-N of low nitrate feed

N= percent high nitrate feed that can be mixed with low nitrate feed.

Potential forage nitrate concentration can be reduced at harvest time. Harvest only mature plants. Raising the cutter bar avoids harvesting the nitrate that concentrates in the bottom third of the stalk. Ensiling forages often reduces nitrate content by 40 to 60% during fermentation.

Avoiding nitrate poisoning once the crop is harvested is possible through various management techniques. The first step is to always have forages tested for nitrate. Once exact nitrate concentration is known, high nitrate forages can be mixed with low nitrate forages to dilute the total nitrate concentration to a safe level. High-energy rations will help livestock tolerate higher nitrate content. Adding either vitamin A or iodized salt to the feed or feeding free choice will also help livestock tolerate elevated nitrate levels.

Feeding livestock small quantities of feed frequently allows a higher nitrate feed to be consumed without toxic effects. Gradually introducing a higher nitrate feed allows animals to adjust to the change. Balanced rations, particularly high carbohydrate rations, tend to reduce potential nitrate problems.

Any feed known or suspected to be high in nitrate should not be fed damp; the dampness seems to increase toxicity. Clean water should be available at all times, frequent intake of water appears to increase the total amount of nitrate that can be consumed daily without harmful effects. Nitrate toxicity rarely occurs from water alone. Water high in nitrate can contribute to nitrate poisoning.

CAUSES OF HIGH NITRATE FEEDS

Nitrate is taken up from the soil by plant roots and converted into amino acids, proteins and other nitrogenous compounds. This conversion takes place in actively growing leaves with the highest concentration of nitrate found in the stalks, before conversion takes place. Excessive amounts of nitrate may occur when any stress causing an abrupt decrease in plant activity occurs.

Stress conditions include:

a. Shading or low light intensity
b. Weather such as drought, frost, hail and temperatures below 55^{o} Fahrenheit
c. Herbicides, particularly 2, 4-D
d. Plant diseases

MANAGE FORAGES FOR SAFE NITRATE LEVELS

Many of us have heard the stories of dead cattle and abortions caused by feeding high nitrate forages. With planning, the problems caused by high nitrate feeds can be avoided.

Nitrogen is essential to efficient plant growth, however too much N can create nitrate toxicity problems in forages. Nitrate is absorbed by plant roots and transported throughout the plant. Nitrate in the leaves is converted to proteins. When nitrate uptake is greater than leaf demand for producing protein, nitrate accumulates in the stalk or stem of the plant.

Any interference with normal plant growth results in a potentially higher concentration of nitrate in the plant. Drought stress is the most commonly observed factor increasing the level of nitrate. Other known factors are; shading, diseases, herbicides, plant species, and stage of growth. Nitrogen fertilization should be monitored to minimize the risk of nitrate accumulation.

Any feed with the possibility of being high in nitrate should be tested. Nitrate tests are a fast, inexpensive way to know where you stand before you feed a potentially poisonous forage. When taking samples it is important to get a representative sample of the feed. A nitrate test is only as good as the sample taken. We recommend that you use a hay probe to take your sample. The hay probe will sample portions of many individual plants, while a sample pulled from a bale by hand may only result in the stalks of a couple of plants. Silage samples should be taken from several spots in the silo. Send all samples to the laboratory in sealed plastic bags.

Plant factors also influence nitrate content. Plant species vary in the amount of nitrate accumulated. Certain weeds, such as pigweed and lambsquarter, are often high in nitrate. Oat and millet hay, corn, sorghum and sudan forage often have high nitrate content. Legumes store very little nitrate. Various parts of the plant contain different levels of nitrate. Stalks are highest in nitrate content followed by leaves, while grain contains the least. Nitrate content decreases with plant maturity. High fertility adds to the potential nitrate content.

Nitrate accumulates in plants only when there is excess nitrate in the soil. Plants do not make nitrate, they just absorb nitrate from the soil. Always plan a fertilization program that prevents excess nitrate in the soil.

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