DROUGHT-STRESSED CORN

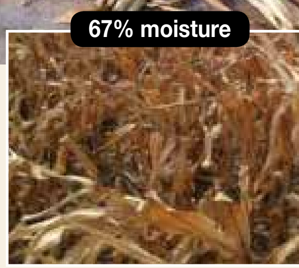
On average, corn utilizes 24-27 inches of water per acre during the growing season. Timing and duration of drought stress will determine yield loss. Silk emergence is the most critical time to avoid drought stress with early vegetative growth being the least critical period for drought stress. Repeated moisture stress during the silk to tassel stage can result in grain yield losses as high as 50 percent. Corn silage yields may be 50 to 90% of normal due both to shorter plant height and loss of kernel development. If little or no grain is present, a general rule is there will be one ton of 70% moisture yield per foot of plant height.

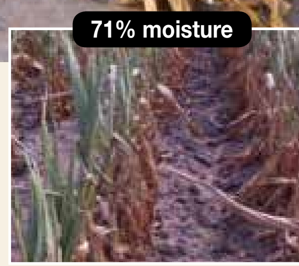
An advantage of growing corn for silage is less water is required to raise silage than to grow a grain crop. Corn silage is harvested before black layer or physiological maturity is reached, thereby reducing the amount of water needed to fully mature the crop. Depending on soil type and available water, harvesting irrigated corn for silage can reduce the number of irrigations needed by one to two compared to corn harvested for grain.

Green, barren stalks will typically be much wetter than they appear in the field containing upwards of 75 to 90% moisture because there is no grain to dry down the moisture contained in the stalks. It is recommended to sample plants and conduct dry matter tests at a laboratory, with a microwave or Koster® Moisture Tester. The tendency is to harvest drought-stressed corn too early and too wet causing excess effluent (run-off) and the loss of nutritious sugars. Hybrid maturity, drought tolerance, and late-season plant health may influence harvest timing significantly. If conditions remain hot and dry, silage harvest may occur earlier than normal. Harvest assessment will be required on a field-by-field basis. For example, spider mite infestation, whose activity is greater under hot and dry conditions, may warrant earlier harvest. If the corn has any grain, the kernel milkline can be a general indicator to determine the proper time to chop, but given the variability in droughty corn, whole-plant sampling is still the best approach.

Drought can result in the crop ranging from barren plants with no ears or starch to varying levels of starch (grain)

EXAMPLE OF HOW LACK OF EAR DEVELOPMENT AFFECTS WHOLE PLANT MOISTURE CONTENT





Whole plant samples from Colorado on 8/14/12 demonstrating high moisture content even in severely drought-stressed plants due to lack of ear (starch) development

depending upon stress at pollination and subsequent kernel abortion. It is important to realize that starch deposition is the primary driver of lowering the moisture in the chopped plant. The stover is often much wetter than expected in droughted corn because ear development is lacking. North Dakota State University researchers tested standing corn, including the cob, for moisture content on August 15, 2018 and found:

- Corn with the entire plant still green, tasseled and having two cobs in the R2 kernel stage (early kernel, no denting and no milk) was at 77.4 percent moisture.
- Drought-stressed corn with the bottom three to four leaves that were brown tested at 76.5 percent moisture. The plants had one cob in the R2 kernel stage.
- Drought-stressed corn with the bottom four to seven leaves that had turned brown and no cobs had a moisture content of 67.9.

In these situations, energy will be partitioned more into sugar and fiber in the stalk and leaves rather than to grain. Studies conducted by Michigan State University indicate that severely stressed corn (short plants with essentially no ears) still had a feeding value of approximately 70% of normal corn silage due to the highly digestible fiber and sugar content. Due to the potential variability, it is important to analyze droughty corn silage for dry matter, NDF (neutral detergent fiber), NDF digestibility, sugar, starch and nitrates (see FEED section). Consider segregating storage based on fields that may have relatively higher feed value.

FROSTED CORN

Corn plants that have been frosted prior to harvest can experience premature leaf or whole-plant death. The plant may remobilize stored carbohydrates from the leaves or stalk tissue (leading to standability issues) to the developing ears, but yield and nutritional potential will still be lost mostly from the cessation of starch deposition. Approximate yield losses due to premature death of leaves (but not stalks) range from 36, 31, and 7% when the leaf death occurs at R4 (dough), R5 (early dent), and half-milkline (R5.5) stages of kernel development.

Loss of nutrient value from leaf loss or undesirable microbial/fungal growth can be minimized if the crop is harvested as soon as possible after the frost. Post-frosted corn is predisposed to spoilage organisms with the onset of warm days and cool nights, coupled with high humidity from rainy/drizzly conditions. Fortunately, husks tend to open up and dry down rapidly following a frost which mitigates the ear condensation although stalks will retain considerable moisture. Fungi growth often attributed to conditions set up by a frost, were many times already active in the field prior to the frost event.

Corn that has experienced a killing frost at ⅓ to ½ milk line maturity will typically be below 72% moisture and can be harvested soon after the event. Corn that is pre-dough stage will be too wet (>75% moisture) to harvest and may require several days in the field to dry to acceptable harvest moistures (to prevent excess effluent). If the frost event did not freeze kernels and only damaged the top of the plant leaving leaves around the ear still healthy, the plant will continue to mature and lay down starch in the kernel.

Leaves of immature frosted plants make the crop appear very dry but most of the moisture is in the stalk further compounded by lack of starch which also serves to dry down the plant. If harvest must proceed, it is possible (but inconvenient) to add dry materials (e.g. dry corn, beet pulp etc.) to the silage to increase the dry matter. For example, one bushel of dry corn per ton of immature silage will increase the silage dry matter by 1.5% units.

Immature corn that has experienced a killing frost will have high sugar content in the stalk from sugars that will not be translocated to the kernel. This helps to improve the crops nutritive value to offset reduced starch levels. However, these excess sugars will also provide nutrients for spoilage organisms to grow during feed out. These high sugar corn plants will also have a natural population of fermenting bacteria (epiphytes) that will be greatly reduced by the frost event. For these reasons, a combination *L. buchneri* inoculant is highly recommended. A “combination” product means that the inoculant contains both homofermentative strains to quickly reduce pH along with a *L. buchneri* strain to inhibit yeast growth at feed out.

NITRATES

Similar to silo gas, the potential for high nitrate levels occurs when crops such as corn, sorghum, and some grasses are exposed to stress situations including drought, hail, frost, cloudy weather and fertility imbalance. Immature corn that undergoes these stressors accumulate toxic nitrate concentrations in the lower portion of the stover when crop yield is less than the supplied nitrogen fertility level and due to reduced plant biochemical functions impeding nitrogen from being converted to crude protein in the kernel. If it rains, three days should be allowed before resuming harvest as plants that recover from stress will eventually convert nitrates to a non-toxic form. Nitrates are not only responsible for lethal silo gas but when fed to animals, they induce symptomatic labored breathing due to interfering with the blood's ability to carry oxygen.

If the crop has been stressed or shows a marked reduction in grain content, a forage nitrate analysis is advised. As a general recommendation, feeding programs should be modified if the only source of post-fermented feed contains more than 1,000 PPM of nitrate-nitrogen. It is best to feed stressed crops as silage rather than fresh, green-chop because fermentation typically reduces plant nitrate levels by approximately 40-50 percent. When feeding ruminants non-fermented, droughty corn stalks as a major source of their diet (e.g. wintering beef cows), producers need to closely monitor nitrate levels.

Drought or stressed silages that have not been inoculated should ferment a full three weeks before feeding. If a sorghum or corn crop is inoculated with a reputable product, nitrate levels should be reduced by 40-50% in a matter of a few days. Ruminants can be fed higher nitrate feeds if the rumen bacteria are given time to adapt by gradually increasing the volume of high-nitrate feed in the ration and if cattle are fed more frequently than normal. Problems also can be reduced by diluting the stressed silage with other feeds and avoiding the use of non-protein nitrogen sources, such as urea or ammonia.

It is a common recommendation to leave a higher stubble (e.g. 12") when chopping drought-stressed corn to reduce the nitrate accumulation that occurs in the lower portions of the stalk. However, most growers are in need of forage inventory during drought conditions. Therefore, it is acceptable to chop at normal heights (4-6") to increase forage inventories given that the fermentation process will degrade 40-50% of the nitrates and if the silage in question will not be the sole forage. For example, nitrate-N levels of up to 2000 ppm are acceptable if the post-fermented feed if limited to 50% of the entire diet. This means that the pre-fermented crop could have levels upward of 3500-4000 ppm nitrate-nitrogen.

PRUSSIC ACID

Under certain conditions, sorghum and sudangrass is capable of releasing hydrocyanic acid (HCN or prussic acid), which makes them potentially dangerous for grazing. In the plant, HCN is attached to a larger molecule, a cyanogenic glucoside called dhurrin. Dhurrin itself is harmless, as it is simply a compound consisting of a sugar and a non-sugar molecule. However, a two-step enzymatic process results in two hydrolysis products with the final one being HCN.

Prussic acid accumulates in sorghum and sudangrass and increases rapidly following stress. Poisoning occurs when animals graze young sorghum plants, or drought-stunted or stressed plants. Sorghum plants are poisonous after a frost that kills the tops but not the crown, or when new growth is brought on by rain following a drought. If new shoots develop after a light frost, grazing should not occur until after a killing frost.

Minimum plant growth for safe grazing, green-chopping or silage making is 18 inches for sudangrass and 30 inches for sorghum-sudangrass. Forage sorghums should be headed out. If frosted at these stages, producers should wait three days before grazing or ensiling. If the plants are frosted before these maturity stages, two weeks should be allowed before grazing or ensiling. High nitrogen and low phosphorus soil fertility increases the risk of both high nitrates and prussic acid. The ensiling process will not decrease the prussic acid level in sorghum silage, however,