USING DROUGHT-STRESSED CORN: HARVESTING, STORAGE, FEEDING, PRICING AND MARKETING

ISSUED: 8-88
REVISED:

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Stored soil moisture and rainfall during the growing season directly affect the development of the corn crop in Kentucky. Dry seasons over the past several years have greatly reduced stored soil moisture. Therefore, a severe shortage of rain during the growing season drastically affects the critical stages of corn, reducing the potential for grain and silage yields on nonirrigated corn.

Every year some farmers ask, "How can I best use drought-stressed corn? What factors do I consider?" This publication answers these questions.

The Alternatives

If you are a livestock producer, you have a much less severe problem than does the crop producer. If your corn shows any significant lack of pollination it may have more value to harvest it as silage rather than as grain. The feed value of silage made from barren corn plants will be lower than normal corn silage. With proper supplementation you can maintain animal performance. So, as a livestock farmer, you just need to determine which fields are good enough to save for corn grain and then harvest the rest as corn silage.

The crop producer, on the other hand, must decide how to best market or use stressed corn. Here are some alternatives:

- Plow down the field early and prepare for planting of wheat or barley after collecting any possible disaster payments. (Fertilizer value should be about $4 to $5/ton of wet material).
- Let the corn mature as grain, assuming that the harvesting costs will be more than offset by the value of the corn grain harvested.
- Sell to a livestock producer, either as a standing crop or as corn silage. This alternative may not appear to be very viable in areas with many acres of damaged corn and relatively few livestock farms. In that case, the cash crop farmer may best harvest the corn silage, store it on the farm and sell it later as feed.
- Harvest the corn silage and buy cattle to feed.
- Feed cattle by contract for other farmers who are short of feed.

Nitrates

The first and most important factor to understand about nitrates is that in sufficient quantity they will poison cattle. You also need to understand other factors to avoid having problems with nitrates in drought conditions.

Nitrate Toxicity

Nitrates may accumulate in corn that has been heavily nitrogen fertilized and has had growth slowed or stopped by drought. This accumulation is a greater problem in young plants and is reduced with plant maturity. Figure 1 shows the sections of a corn plant that may accumulate nitrates. In times of drought when few if any cars are made and normal stalk growth is decreased, nitrate levels in corn may easily become high enough to cause animal toxicity.

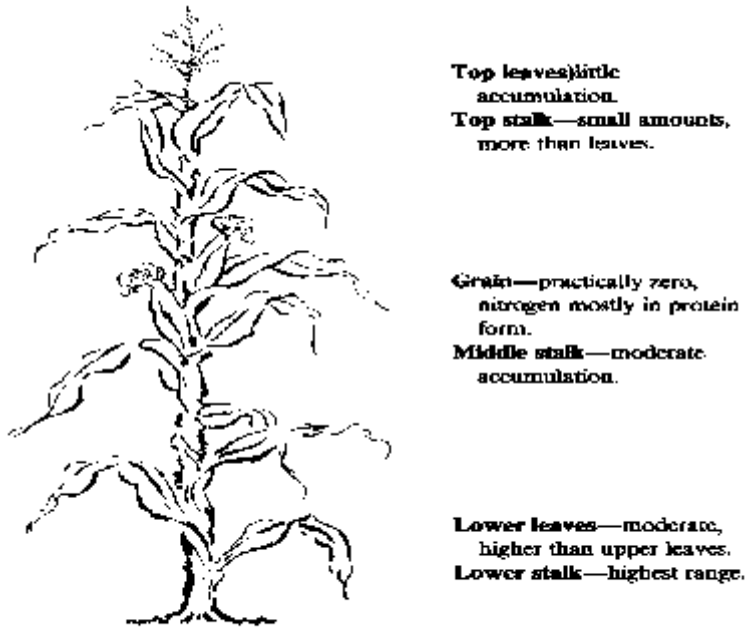

Figure 1.—Normal Accumulation of Nitrates in the Corn Plant

When it rains and the plant begins to grow again, nitrate accumulations may increase for a few days, creating very high concentrations in the plant. Ultimately these levels will decrease if the plant maintains normal growth and sets an car. DO NOT harvest corn for a few days after heavy rain has stimulated renewed growth.

When cattle consume nitrate, the compound is converted to nitrite and then to ammonia by rumen bacteria. The ammonia may then be converted to bacterial protein and utilized by the animal. The conversion of nitrate to nitrite occurs more rapidly than the conversion of nitrite to ammonia. Thus, in times of high nitrate consumption, nitrite may accumulate in the tureen and be absorbed into the blood. Nitrite changes the oxygen-carrying capacity of hemoglobin in the blood, so death from nitrate poisoning is really due to a lack of oxygen.

Symptoms of nitrate toxicity can vary but will generally include:

••increased pulse rate,
••labored breathing,
••muscular tremors,
••staggering,
••cyanosis (a darkening of mucous membranes due to oxygen deprivation)
••others.

In some cases blindness and abortion may also occur. If you suspect nitrate toxicity, call a veterinarian immediately and remove animals from the source of nitrates. Recovery can be expected if animals are detected and treated in time.

Avoiding Nitrate Toxicity

In times of drought it is tempting to feed the stressed corn crop directly to cattle. DON'T DO IT! As already stated, plant nitrate levels may be high and readily lead to toxicity. Do not graze, green chop or bale drought stressed corn to help avoid nitrate toxicity.

Herbicides may not work normally under drought conditions and weeds may accumulate in drought stressed corn. The following weeds can accumulate toxic levels of nitrate: Johnson grass, pigweed, common lambs quarter, wild sunflower, Canada thistle, black nightshade, jimson weed and barnyard grass. Nitrate concentrations peak in these weeds at prebud to bud and decrease as they mature. Do not let cattle have access to fields with a lot of these weeds.

Animals vary in their tolerance to nitrates, so you may still use feeds containing significant levels of nitrate with proper management. The first step in avoiding toxicity is knowing the nitrate content of your feed. Guidelines for using feeds containing known levels of nitrate are given in the following table.

Nitrate analysis may be reported as nitrate nitrogen (NO3-N) or as potassium nitrate (KNO3). Be sure you understand which expression your report is using. The following table gives conversion factors for other expressions to nitrate.

Some reports may give parts per million (ppm) instead of %. To convert ppm to %, divide ppm by 10,000 (move the decimal point 4 places to the left).

% Nitrate (NO_3) in Dry Matter	**Feeding Instructions**
0.0-0.44%	Safe to feed. Be cautious with pregnant and young animals at upper level of range.
0.44-0.88%	Generally safe when fed with balanced ration. For pregnant animals limit to one-half of total dry ration. Be sure water is low in nitrates. May experience lowered production and Vitamin A deficiency symptoms in 6-8 weeks in some cases.
0.88-1.50%	Limit to 1/4 of total dry ration. Fortify well with energy, minerals and Vitamin A. May have a milk production loss in 4-5 days and possible reproduction problems over period fed.
Over 1.5%	Toxic. Do not feed. Sudden death, abortion, severe depression, difficult breathing may occur.

Expression	**Multiplication Factor to Convert to Nitrate (NO_3)**
Nitrate Nitrogen (NO_3-N)	4.40
Potassium Nitrate (KNO_3)	0.61

Ensiling Reduces Nitrate

Cutting drought-stressed com for silage is the best way to use it because 40% to 60% of the nitrate can be reduced during fermentation. Because fermentation takes 2 to 3 weeks to complete, do not feed drought-stressed corn silage for at least 3 weeks after the silo has been filled.

Moisture level influences how long fermentation takes, as well as influencing how well it works. For ensiling corn suspected of high nitrate, the optimum is 65% water (35% dry matter) and the minimum is 60% water (40 dry matter). If the moisture level is too low, fermentation activity will be reduced and

less breakdown of nitrate results. If it is too high, you get seepage losses and a sour-smelling silage which livestock will not readily consume.

Sampling Instructions

If you are going to green chop or graze your drought-stressed corn, you should definitely first test the corn for nitrate content. However, if you are going to put your corn in the silo at the proper moisture content and follow other steps to provide good quality silage, testing is less important. Nitrates can be tested by most commercial forage testing labs in Kentucky. See your Cooperative Extension agent for costs and addresses.

Be careful in sampling to ensure a representative sample.

- Take samples from chopped forage from various locations in the field which represent all levels of plant stress.
- Mix the samples in a bucket and put about 1 pint of material in a sealed plastic bag.
- Keep the time short between sampling and getting to the lab.
- Refrigerate the samples, especially if you take a day or more before you get to the lab. If you let green or wet samples stand at room temperature or higher, they may lose nitrate through action of denitrifying bacteria and enzymes.

Harvesting and Storing Decisions

Determining Ear Development

If a plant without an ear has tasseled and shed pollen, it will be barren. Where pollination has occurred, small white blisters are visible about 1 week after pollination. These kernels will continue to develop to maturity if the plant gets water. If your corn is not going to develop ears or will have a drastically reduced grain yield, then this publication is for you.

When to Cut

To avoid nitrate toxicity, you need to put your corn in a silo for 2 to 3 weeks. There, it will ferment, reducing the nitrate level tremendously. But timing is very important. Put corn in the silo when it is 30 to 40% dry matter (optimum, 35%), because fermentation only works well at a certain dry matter range. To get the right dry matter content, let the corn mature as long as possible before chopping it for silage. If the corn does not dry down to 30% before a frost, wait 7 to 10 days after frost to let the stalks dry before chopping. Green, barren stalks will contain 75-90% water (10-25% dry matter). If weather stays hot and dry, then moisture content drops, but if rain comes before plants lose green color, they can stay green until frost.

Dry matter of corn going into upright silos should be 30 to 40% and should be closer to 30% for trenches and stacks.

How do you determine your corn's moisture content? Use this rapid Grab Test to estimate percent dry matter, if a more precise method is not available. Squeeze a handful of finely cut plant material as tightly as possible for 90 seconds. Release your grip and note the condition of the bail of plant material in your hand.

- If juice runs freely or shows between the fingers, the crop contains 15 to 20% dry matter.
- If the bail holds its shape and your hand is moist, the material contains 25 to 30% dry matter.
- If the ball expands slowly and no dampness appears on your hand, the material contains 30 to 40% dry matter.

•If the ball springs out as you open your hand, the crop contains less than 40% dry matter.
Using a microwave oven will give a quick and reliable moisture test as well. You will need a small scale weighing in grams or ounces. Follow these procedures to determine moisture level:
(1) Collect a representative sample of fresh forage.
(2) Chop the forage into small (1 to 2 inch) pieces.
(3) Weigh a representative sample (100 grams or 3 to 4 ounces).
(4) Spread the sample uniformly and thinly on a microwave safe dish and place in the oven.
(5) Heat for 1 to 2 minutes and reweigh. Reheat for 30 seconds and reweigh. Continue this procedure until 2 consecutive weights are about equal. If the forage chars, use the previous weight.
(6) Calculate the percent moisture by the formula: % moisture = [(W1-W2)/W1] x 100
Where W1 = Forage weight before heating, W2 = Last forage weight taken (dry weight)
(7) Calculate dry matter this way: 100 - % moisture
You will get more accurate results if you run several samples and average them.

Storing the Silage

If upright silos in good condition and designed for storing high moisture crops are available, you can use them in the normal way. Drought-stressed corn may contain more moisture than appears. Wait until it has dried down to the 30 to 40% dry matter range before ensiling.
Upright silo storage capacity for more than a normal amount of silage is usually not available. The advisability or even the possibility of providing permanent storage for silage put up on an emergency basis is questionable.

Temporary Silage Storage

As temporary storage, the above ground stack and the below ground unlined trench are readily available alternatives. A cubic foot of silage in a stack or trench will weigh about 40 lb.
Select a well-drained site for a stack or trench to exclude surface water and provide best access under wet weather conditions.
Cover tightly with 6 mil polyethylene plastic sealed with soil around the edges and held down with soil or old automobile tires.
Compact the silage by running a tractor over it several times. A wheel tractor gives better compaction than a crawler type.
Good compaction and an airtight cover reduce storage losses that come from air contamination. Silage in a stack or trench has a greater exposed surface and a shallow depth, and because packing it is difficult, you may lose 10 to 15% or more. This storage loss is actually a storage cost and seems justifiable since you may need temporary silage storage for only 1 year.

Silo Gases Can Kill

Potentially lethal gases occur when any ensiled material is fermenting but forages containing high nitrates are especially prone to this problem. Nitric oxide, and nitrogen dioxide and tetroxide are lethal and will begin to form shortly after you begin silo filling. They are most deadly 12 to 60 hours following first filling. They are heavier than air and will accumulate above the silage in a silo, in the chute and in the silo room, and will flow out the silo juice drain.
Nitrogen dioxide and tetroxide are yellow to reddish-brown and smell like laundry bleach. They may be toxic at concentrations too low for you to see or smell them. These gases will leave a characteristic

yellowish-brown stain on wood, silage or any other material they contact. BE SURE TO TELL YOUR SPOUSE AND CHILDREN ABOUT THESE DANGEROUS GASES.

Safety Precautions

DO NOT let anyone enter the silo before you run the blower for 10 to 15 minutes to completely ventilate the silo, chute and silo room. Do this ventilating while you are filling the silo and also whenever anyone enters the silo for 2 to 3 weeks after the filling is complete.

Leave the chute door open at the surface of the silage to keep gases from accumulating in the silo.

Call a doctor immediately if anyone is exposed to nitrogen oxide gases from silage. Medical treatment may prevent death and minimize injury.

Feeding Aspects

Feed Value

The energy content of drought stressed corn silage depends on how much the grain yield was reduced. The following table shows this effect:

Description	**TDN %**
Corn Silage - no ears	55
Corn Silage - few ears	62
Corn Silage - well cared	70

Adapted from National Academy of Science, Nutrient Requirement for Beef Cattle, 1984.

Research comparing animal performance on drought damaged versus normal corn silage is shown in the following table. Calves consuming drought silage gained 9.6 and 30% less than calves consuming normal silage. Energy supplementation of 6 lb of corn per head daily made the gain equal when the ration was balanced for protein. Thus an energy deficiency was "limiting animal performance."

Gain on Normal and Drought-Damaged Corn Silage

	Normal	**Drought**	**% Change**
Trial 1			
Number	44	44	
ADG	2.06	1.88	9.6
Trial 2			
Number	18	56	
ADG	1.72	1.32	30

Crude protein content of drought corn silage generally is greater than normal silage but the form is changed. Drought silage contains high levels of nonprotein nitrogen and little natural protein. Do not use

protein supplements containing NPN with drought silages, as too much soluble nitrogen is already present in the feed. Use natural supplements, such as soybean meal, cottonseed meal, distillers grain and others.

Drought-stressed ear corn contains a higher proportion of cob to grain. While normal ear corn is 20% cob and 80% grain, ears from drought-stressed corn may contain 50% or more cob, which reduces the energy value and increases the fiber content. Shelled corn from drought-stressed plants contains 92-100% of the feed value of normal corn on a dry matter basis. Test weight is lower; a larger volume of feed is required for comparable production. However, market discounts on low test weight corn are greater than the reduced feed value, making this corn a relatively good buy for the livestock feeder.

Management Considerations

To Avoid Nitrate Toxicity

•If you must chop or pasture drought stressed corn, limit intake to avoid off-feed or nitrate toxicity. Provide other feeds before pasturing or limit pasturing time.

•Supplement with other forages or feeds to avoid excess intake and dilute potentially dangerous silage.

•Add vitamin A [50,000 International Units (IU) for dairy cows, lower levels for heifers and beef cattle] to compensate for less carotene conversion to vitamin A.

•Feed a small number of animals and watch them carefully before feeding a large number of animals.

To Supplement Changed Nutrient Content of Feed

•DO NOT supplement drought stressed corn with nonprotein nitrogen (NPN), such as urea.

•Provide supplemental protein by adding natural protein sources, like soybean meal or other economical natural protein sources.

•Additional grain is necessary to provide adequate amounts of energy needed by both beef and dairy cattle.

•Test your forages to determine their nutrient content. Doing so can help you achieve well-balanced rations which minimize stress and, thus, improve productivity in cattle.

Valuing/Pricing Corn Silage

Producers considering using a corn crop as a forage rather than as grain must make an economic decision based on the value of the forage versus the potential income from corn sales. Obviously, if the value of the forage/silage use is greater than the grain value, using or selling the crop for forage will be more profitable.

The livestock feeder must determine the most that can be paid for drought stressed silage and starts out by determining the value of regular corn silage on a per ton basis, "in the bunk." Since a standing crop will be bought to make silage, the buyer deducts the costs of taking a standing crop through to make feed. This sets the maximum value the buyer can pay for a ton of corn silage standing in the field.

The corn producer, on the other hand, must determine a reservation price based on what is given up. This includes the value of the fertilizer removed with the crop plus the possible income forgone from harvesting any grain.

The worksheet (see last page) has been designed to make it easy for you to figure a maximum value you can pay for silage, to make adjustments for your costs and to compare these to crop's value as grain. If you are a livestock feeder needing feed, you are a potential buyer. If you are a grain producer, you are a potential seller. And, if you have a corn crop in the field and can feed livestock you must

decide if you should use it for grain or for silage.

As you use the worksheet, you will see that it begins by helping you determine how much you can value silage to feed to cattle. You then subtract all the costs involved in making silage equivalent to regular silage from the drought-stressed corn crop. These costs include lower feeding value, harvest and silage-making costs, spoilage, transportation, etc. After you subtract these costs from the maximum feed value, you will know the most you can afford to pay for the standing crop.

The worksheet also takes you through steps to see if you should sell (or use) the crop as silage or sell whatever grain is in the field and plow down the rest. This is easy to do by figuring the value of the corn (yield times price minus the combining cost) and adding the fertilizer value. Since the most difficult part is collecting the information, we give you suggestions to use in the worksheet itself and in the text following.

(A) Value of Silage--The feeding value of drought-stressed corn is 70-90% that of regular corn silage when measured on a dry matter basis. Drought corn silage without grain is actually higher in crude protein but is lower in total digestible nutrients compared to normal well-eared silage.

Our suggested formula for pricing regular corn silage with 30-32% dry matter is to multiply the market price of corn by 6 and then add $2-$3/ton to cover the added costs of harvesting and storing corn silage as opposed to corn grain. On a feed value basis, a ton of 30% dry matter corn silage will substitute for about 1/3 ton of hay or 8-10 bu of corn grain. Therefore, compared to $100 hay or $2.50 corn, normal corn silage is worth about $22 to $30/ton. And, with the higher hay and corn prices of drought situations, the feed value may be $30 to $40/ton.

With corn at $3.25/bu, protein meal at $400/ton and hay at $125/ton, normal corn silage is worth about $36/ton in a feeder cattle backgrounding program and about $29 in a dairy operation. If corn can be purchased through the Emergency Feed Assistance Program (near $1.50/bu) and with protein at $400 and hay at $100/ton, the silage value is lower. It would be worth about $25/ton for the backgrounder and about $22 for the dairy.

The "rule of thumb" formula applies to the value of normal corn silage on a ready-to-feed basis. Lower feeding values, higher harvest costs and other factors make the value of drought-stressed corn silage lower.

(B) Lower Feeding Value Due to Drought Stress--The quality of silage made from drought-stressed corn may be lower than that of normal corn. Its feeding value will be 70% to 95% that of normal corn. Silage of lower dry matter is of even lower value.

(C) Spoilage/Feeding Loss--In some situations the silage will be made in temporary silos (above ground and trench silos, for example). In addition, feed handing equipment and feeders may not be suited for silage. As a result, 10% to 20% of the silage may be lost before it reaches the cattle.

(D) Cost of Harvest and Silage Making--The full cost of these operations is about $50 to $60/acre. The "out of pocket" (only fuel and repairs) is about $10 to $20/acre. The cost used should include all cash costs including any hired labor. The use of temporary silos (such as making silage on top of the ground, covered with plastic) may add to this cost.

(E) Transportation Cost--In some cases, the corn crop may not be dose to the point of silage use. Transportation cost is at least $2/ton and will range to over $5/ton if the round trip for the wagon, including unloading, exceeds an hour per load.

(F) Grain Value--The value of the grain given up should include the expected yield times the net price available. Harvest and marketing costs should be subtracted to produce a NET returns figure. Cash

costs for combining are $7 to $10/acre and full costs are in the $27 to $35/acre range.
(G) Fertilizer Value--If the corn is sold as silage, the nutrients in the plant will not be available for following crops. If the entire plant is removed, one ton of corn silage will remove about 12 lb of nitrogen, 4 lb of phosphorus and 12 lb of potassium. The value is affected by cropping plans. If a crop is to follow immediately, the nitrogen can be utilized. Otherwise most of the nitrogen will be lost. If the grain is removed, fewer nutrients will be available. At today's prices, the fertilizer value with grain removed is about $4.50/ton of forage.
Guidelines: Reservation prices, on a per ton basis (the minimum price the seller can accept), for grain yields from 20 to 40 bu/acre and prices from $3 to $4/bu are mostly in the $13 to $18 range. Even when grain yields increase, reservation prices remain quite stable because forage yields also rise. A few exceptions are when forage yields are low compared to corn value. In these cases reservation prices are in the $22 to $30/ton range.
Maximum "in the field" values cover too broad a range to generalize ($42 to $2/ton). These depend both on the particular use and on the cost of making and feeding silage. But in situations with high feed costs (corn over $3/bu and hay at $100/ton or higher) and low harvest/silage making costs, "at the field values" are in the $18 to $28/ton range. In situations of high feed costs and low silage making costs, the economics suggest that the highest value of the corn crop is for silage for many situations when grain yields are 40 bu or less.

ASCS Program Possibilities
Government Drought Assistance Program
In any drought year, farmers should check with local ASCS and Farmers Home Administration offices. Federal loans and payments, if available, will vary from year to year.

SILAGE VALUE WORKSHEET

Value to a Livestock Feeder	**Example**	**Your Farm**
Value of Silage (Ready-to-Feed) (A) range: $30 - 40/ton	$40	----------
Deductions		
Lower Feeding Value Due to Drought Stress (B) range: 5% - 30% loss	minus $4 (10%)	----------
Spoilage/Feeding Loss (C) range: 5%-15%	minus $4 (10%)	----------
Cost of Harvest and Silage Making (D) range: $2 - $10/ton	minus $5	----------
Transportation (E) range: $2 and up	minus $2	----------
TOTAL DEDUCTIONS	minus $15	----------

MAXIMUM VALUE OF CORN IN THE FIELD	$25/ton	----------
Value to a Corn Producer (Forgone)	**Example**	**Your Farm**
Estimate Forage Yield (F) range: 2 - 20 tons/acre	5 tons/Ac	----------
Fertilizer Value (G) range: $3 - $6/ton	5 tons x $4/ton = $20/Ac	----------
ADD: Grain Value Yield 30 bu/Ac Price $3/bu	30 bu x $3/bu = +$90/Ac	----------
DEDUCT: Harvest & Marketing Costs	minus$20/Ac	----------
VALUE PER ACRE	$90/Ac	----------
VALUE PER TON Divide value per acre by estimated forage yield	$90 divided by 5 tons per Ac = $14/ton	----------

SUMMARY In the Field Values per Ton

Livestock Feeder (Buyer)	$25/ton
Crop Producer (Seller)	$14/ton

In this example if the crop is to be sold, any price between $25 and $14 will be profitable for both buyer and seller. A crop producer will benefit from using the crop as silage as long as the livestock feeder value is greater than $14.