



Drought-related issues in dairy cattle nutrition

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INTRODUCTION

Adverse weather conditions like drought present the dairy producer with some major challenges. The largest problem is having enough forage available to feed all animal groups. The second significant problem is forage quality. The obvious questions to ask during drought situations are: 1) Should hay or other forage be purchased? 2) Should forage intakes be kept at the minimum level recommended? 3) Should more high-fiber feeds be used? The economics of the situation including effects on cash flow and interest charges should receive top priority. The palatability of the items being evaluated and their suitability for use in the feeding system should also be considered.

In addition to the aforementioned items, there are other risk factors that occur during a drought that can have a substantial impact on animal performance. Nitrates, prussic acid and other poisons can jeopardize both production and health of animals. Poisonous plants and weeds can be an issue and should not be overlooked.

There are several other publications available from Penn State that address drought-related issues. They include:

- DAS 96-24 Reducing Heat Stress on Dairy Cows
- DAS 93-4 Sources of Food Processing Wastes, Hay, and Feed Ingredients
- DAS 97-17 Feeding during Shortages of Home-Grown Feeds
- DAS 93-21 Mold and Mycotoxin Problems in Livestock Feeding
- DAS 92-107 Prevention and Control of Nitrate Toxicity in Cattle
- UD 016 From Harvest to Feed: Understanding Silage Management

NUTRITIVE VALUE OF DROUGHT-STRICKEN CORN SILAGE

Drought-stricken corn can make nutritious silage. Absence of ears does not imply that corn silage lacks fermentable energy. Forage portions should contain reasonably high levels of soluble sugars. As corn approaches maturity, the energy level and dry matter yield increase. It is recommended to allow corn to develop as fully as possible, even if ears and grain are lacking.

There are wide variations in the nutritive content of drought-stressed corn silage (Table 1). It may have an energy value 85 to 100 percent of normal corn silage or it may be quite different. Very young corn prior to tasseling may contain as much as 14 to 16 percent crude protein. A standard forage analysis is highly recommended along with testing for levels of nitrates. If it becomes necessary to harvest very short immature corn (up to and including silking stage), it is not prudent to add a non-protein nitrogen (NPN) source like ammonia or urea at the time of ensiling. Preferably, the dry matter content of droughty silage should be in the range of 30 to 40 percent to make satisfactory silage. If the corn did not set ears and is green, or if the ears are all brown and the stalk is green, the moisture content may be too high, but hot, dry weather can cause rapid moisture drops. Careful observations of moisture changes are needed to determine the best time to harvest.

Another weather related complication is frost on drought-stressed corn. When frost occurs on immature plants, it will appear drier than unfrosted corn of the same moisture content. Even though leaves may brown off along the edges and dry rapidly after a few sunny days, the green stalk and ears do not. The crop will continue to accumulate dry matter and should be left in the field until it reaches the appropriate moisture content. Immature plants that are killed will likely contain too much moisture for immediate ensiling. These plants will dry slowly and dry matter losses will increase as the dead plants drop their leaves. The best option is to leave the crop in the field until it reaches the appropriate dry matter level, unless losses appear too high or harvesting losses will increase dramatically.

Pricing drought-damaged corn silage is similar to normal corn silage with a few adjustments. The best method is to sell on the basis of tons of dry matter. For example, corn silage at 27 percent dry matter is worth 77 percent as much as corn silage at 35 percent dry matter ($27 \div 35 = 0.77$) when priced on an as-fed basis. Thus moisture will be taken into account if pricing is done on a dry matter basis. Several samples of silage should be taken during ensiling to ensure the dry matter determination is representative.

Generally, drought-damaged corn may be lower in energy and dry matter, but similar or higher than usual in protein level. Prices can be adjusted accordingly. For example, if the total digestible nutrients is 62 percent instead of the usual 70 percent, the value of the corn silage would be adjusted downward by 89 percent ($62 \div 70$) from the usual corn silage price. See Table 2 for more examples on pricing corn silage.

NUTRITIVE VALUE OF DROUGHT SOYBEANS AS FORAGE

Drought or immature soybean plants can be used as a forage crop. Plants should be allowed to mature as much as possible before harvesting. Some pod or bean development enhances feeding value of plants harvested either as hay or silage. Soybean forage is high in calcium and should be avoided as the major forage source for dry cows.

If the plants are going to be ensiled, it is recommended to do so before plant moisture drops below 60 to 65 percent. If possible, mix soybeans with other forages, preferably during ensiling to enhance palatability. If plants are high in moisture and lack pod or bean development, it is suggested to add 100 to 200 pounds of a ground grain per ton when direct-cutting rather than wilting to 60 to 65 percent moisture. The stems of soybean plants are not very palatable, and animals will sort them out if given the opportunity. Chopping soybean hay and feeding it in a total mixed ration will help prevent sorting.

If soybean forage contains substantial amounts of developed beans, you may need to reduce the amount of other fats and oils in the ration for lactating cows based on the analyzed fat content of the soybeans. It may be difficult to dry down pods for hay if beans are too well developed. Cows can be pastured on soybeans and if cows are removed before all stems are eaten, there may be regrowth.

As with any forage, soybeans should be analyzed for their nutrient content. Table 3 lists the expected nutrient content of soybean forage. It is also advisable to check the label of any herbicide used for possible restrictions on feeding soybean forage to livestock.

ALTERNATIVE FORAGE SOURCES

Alternative forage sources generally are lower in protein than good quality alfalfa and lower in energy than corn silage. The animal groups that would best utilize these forage alternatives and help extend forage supplies would be the medium and late lactation cows, older heifers, and dry cows. Nutrient composition may be quite variable in ingredients used as forage substitutes and may require regular sampling and analyzing. Forage alternatives should be used as short-term solutions to forage shortages. *Recommendations in this section are for emergency situations when conditions have resulted in less than ideal feeding circumstances using normal forages.*

Straw

When used in a balanced ration with adequate protein, mineral, and vitamin supplementation, straw can help maintain ruminants in a normal state. Because it is relatively low in many nutrients it should

replace only 15 to 20 percent of the normal forage dry matter in rations or be fed at about four to six pounds daily to lactating cows. Straw is also well suited for feeding dry cows and young stock.

Corn cannery waste

Cannery waste consists of husks and cobs with some waste ears. Quality usually varies from load to load, depending on the number and placement of waste ears and missed kernels. The nutrient composition is similar to corn silage, but cannery waste tends to be lower in energy than well-eared corn silage. Dry matter ranges from 16 to 32 percent and the silage acid content may be high. Both of these factors can depress intake. Cannery waste should be limited to less than 15 percent of the ration dry matter for high producing animals. More can be fed to medium and low producing cows. The high moisture content of corn cannery waste can make the hauling cost of dry matter high. It can also result in high losses due to seepage.

Corn stover

Corn stover is the fodder minus the ears. It is comparable in energy content to average hay and makes very good feed for heifers and dry cows. Sweet corn stover that is relatively green in color will exceed mature field corn stover in feeding value. The biggest limitation in feeding corn stover is its physical nature. Ensiling while it is still green or mixing dry material with higher moisture haycrop forage after a killing frost may make it more acceptable to cows. It also may be baled, particularly as large, wrapped bales. Anhydrous ammonia may be applied to increase its protein equivalent content and help in preservation. Usually 20 to 35 pounds of anhydrous ammonia may be applied per ton of dry stover via bale injectors or equipment on the baler. This should increase the protein content to about 10 to 14 percent on a dry matter basis.

Stover is relatively devoid of vitamins A and E. It is recommended that the amount fed be limited to about 20 percent of the normal forage dry matter fed to lactating cows. Stover may provide up to 1/3 of the forage dry matter for dry cows or bred heifers until two to four weeks prior to expected calving, then limit it to 20 percent or less. For large breed cows, about five to six pounds of stover dry matter can be fed. The key is to include it in a well-balanced ration with proper amounts of protein, minerals, and vitamins.

Pea-vine silage

Silage can be made from waste left over after pea harvest. Pea-vines will contain around 25 percent dry matter when direct cut. They should be wilted to 35 to 40 percent dry matter to ensure good fermentation and palatable silage. The nutrient content of pea-vine silage is listed in Table 4. The greatest limitation on amounts to feed is with the dry cows because of its high calcium content.

Bean silage

Snap or lima bean forage may be used in feeding dairy cattle. The vines with beans attached may be fed as green-chop or ensiled. Also the vines minus the beans may be used. The vines should be chopped to make them more palatable to cows. It is preferable to mix the bean vines with other forage at feeding or ensiling. Overall feeding value and ensiling characteristics will vary according to how green the leaves are at harvest. Cutting earlier before the leaves turn much in color results in better silage and higher intakes. The expected analysis of bean forage is comparable to pea-vine silage and/or mixed mainly grass forage. It is best to limit the feeding of bean silage to 60 to 80 percent of the usual intake for forage dry matter.

Apple pomace with hulls

There are two distinct types of apple pomace available. The one that's suggested as a forage substitute is apple pomace with appreciable amounts of rice hulls, wood chips, or other pressing agents.

Despite using these poorly digested pressing agents at low levels on a fresh basis, they represent a sizable portion of the total dry matter.

Apple pomace with such pressing agents should be considered a high-moisture forage substitute. Due to their high fiber content, low digestibility, and lack of particle size, they should provide a maximum of 15 to 20 percent of the total ration dry matter for milk cows and 20 to 25 percent for heifers and dry cows. Rumen impaction from wood chips or rice hulls has occurred at a level of 40 percent. Urea should not be used in rations with appreciable levels of apple pomace with pressing agents since energy levels may not permit sufficient microbial protein synthesis.

Considerable quantities are usually available from early fall until mid-spring. Its handling and keeping qualities are similar to wet brewer's grains, at least during cooler weather. Apple pomace as delivered to the farm may contain 30 to 35 percent dry matter. Some shrinkage may occur due to moisture loss, seepage of solids, and fermentation, especially during warm weather.

The expected nutrient content is listed in Table 4. It is important to periodically test apple pomace to determine the type being fed. Some processors may switch from one type to another or different types may be produced among their plants. Check fiber levels to determine which type is being fed. Check the material, particularly in air-dried form, for rice hulls or wood particles.

Forage extender supplements

In addition, many feed companies also offer forage extenders, which are more concentrate type feeds that are high in fiber. These can be used as partial replacements for forage in the diet without detrimental results.

FORAGE POISONING PROBLEMS

Nitrate toxicity

Drought conditions may increase nitrate levels in forages to the point of possible toxicity. Drought-stricken fields of corn, sorghum, and sudangrass are most apt to contain harmful levels of nitrate, particularly those that have been heavily fertilized with manure or nitrogen. Numerous weeds such as pigweed and lambsquarter are nitrate accumulators. Any forage that is suspected of containing high levels of nitrates should not be grazed or green-chopped.

Although nitrate levels in drought-stricken corn may be high, ensiling usually reduces more than half the nitrates to ammonia, which can be utilized by the rumen bacteria. For this reason, nitrate toxicity rarely occurs when feeding ensiled drought corn. However, if drought damage was extreme and high levels of nitrogen were applied to the soil, a nitrate test on the silage should be conducted, (Table 5).

Rate of nitrate intake is the most critical factor influencing possible toxicity. This is affected by rate of forage dry matter intake in a given period of time and its nitrate content. Forages containing under 1,000 parts per million (ppm) nitrate-nitrogen (NO₃-N) on a dry matter basis may be fed free-choice or with no restriction on meal size. That's provided the total level of NO₃-N in the total ration, including water, is kept at a safe or low risk level. Stored forages containing higher levels generally require limiting meal size to avoid elevated methemoglobin levels in the blood and other toxic effects.

A single meal refers to the amount of stored forage dry matter consumed during one episode of eating that may range from a few minutes to two hours. High nitrate forage should not be fed again for two to three hours after completion of the previous feeding. Observe animals closely for symptoms of toxicity two hours following the start of a meal consisting of a suspected or high nitrate forage (over 1,000 to 1,300 ppm NO₃-N). The color of mucous membranes in the vagina, mouth, or eyes will turn

from pink to a grayish-brown at a methemoglobin content of 20 percent or higher. This is the earliest sign of a possible toxicity occurring with slight to acute symptoms. Acute symptoms include rapid breathing, incoordination or staggering, and signs of suffocation. Freshly drawn blood from animals with nitrate poisoning may be chocolate brown in color.

Prussic acid poisoning

Sorghum, sudangrass and their crosses, and Johnsongrass may contain dangerous levels of prussic acid. Wild cherry and some other plants also may contain prussic acid. Risk of prussic acid poisoning may be reduced if sorghum-sudangrass is at least 30 inches high before harvesting and Piper sudangrass is at least 18 inches high.

Frosted material should not be used unless it is completely killed or dried and should be cut no earlier than four to seven days after a killing frost. If material is stunted by frost, delay using it until after a killing frost or ensile the material. Ensiling does not always alleviate the danger of prussic acid poisoning. It generally does, however, after about four weeks of ensiling. This is especially true if harvest is delayed until after a second or killing frost occurs.

Symptoms of toxicity are similar to nitrate toxicity. Affected animals suffer because the oxygen carrying capacity of their blood is reduced. Freshly drawn blood from animals suffering from prussic acid toxicity may turn brilliant or cherry red upon exposure to air.

Silo gas poisoning

Excess nitrates in silage crops leads to increased development of silo gas (nitrogen dioxide) from the crop when stored in the silo. Plants wilted by the drought or crops ensiled after a prolonged drought-breaking rain are likely to have accumulated excess nitrates. Much of the excess nitrates are stored in the lower portion of the stalk. Two recommendations to help limit excess nitrates when making silage are to avoid harvesting crops after a drought-breaking rainfall until several days of sunshine occur and to cut the plant higher than normal.

Nitrogen dioxide gas can form within hours of filling a silo and may last for a period of two to three weeks or more. Be on the alert for bleach-like odors and/or yellowish brown fumes at the base of the silo. It is advised that people and animals stay clear of the silo for at least three weeks after filling. After this time period, the danger of nitrogen dioxide gas is greatly reduced. Steps should be taken to adequately ventilate the silo before entering.

The silo chute door closest to the level of silage should be open. Run the forage blower for 15 to 20 minutes. This will allow the nitrogen dioxide to escape when the blower is turned on. Adequate ventilation at the base of the silo should be provided to expel the gas. Silo feed rooms may need to be ventilated by the use of open windows and fans for a period of three weeks after filling the silo. Avoid contamination of barn areas by keeping the doors between the silo or feed room tightly sealed.

If entry into a silo is absolutely necessary within the first 10 days after filling, a self-contained breathing apparatus should be worn. Additionally, an observer should be stationed on the silo blower platform and visible contact with the person entering the silo maintained.

Table 1. Nutritive value of corn silage harvested at various stages of maturity and conditions

Stage of maturity	Dry matter, %	Crude protein, %	Net energy of lactation, Mcal/lb
Pre-silk	10.0	12.4	0.62
Silk	15.0	11.3	0.64
Milk	21.0	7.0	0.67
Over-ripe	45.0	9.1	0.62
Droughty-few ears, stunted	25.0	9.9	0.62
Non-pollinated-growthy mature	27.0	7.6	0.70

Table 2. Estimating the economic value of corn silage

1. NORMAL CORN SILAGE: Divide the grass hay price by .90, multiply by .75, and multiply by the corn silage dry matter percent.
Example:
 Corn silage with 33.5% dry matter and grass hay @ \$94/ton
 • $\$94 \div .90 \times .75 \times .335 = \$26.24/\text{ton}$.
2. NORMAL CORN SILAGE: 7 to 10 times the value of dry shelled corn depending on the quality of the corn silage.
Example:
 Corn silage with 33.5% dry matter and dry shelled corn @ \$2.40/bu.
 • $\$2.40 \times 7 = \$16.8/\text{ton}$ to $\$2.40 \times 10 = \$24/\text{ton}$
3. DROUGHT CORN SILAGE: To obtain a relatively fair price, analyze the corn silage for at least dry matter, crude protein, and energy. One way of adjusting a normal corn silage price is to make a price adjustment based on energy. For example, if the NE_L on droughty corn silage were .62 Mcal/lb. instead of the usual .74 Mcal/lb., the value would need to be adjusted downward, to 84% of the normal values listed in examples 1 and 2. Example 1 corn silage price of \$26.24/ton would become \$22.04/ton; example 2 corn silage price range of \$16.8-\$24 would become \$14.1-\$20.2 /ton.
4. DROUGHT CORN SILAGE: Feed evaluation factors can be used to determine a price for corn silage. The following price listings are based on a drought corn silage analysis of 25% dry matter, 9.9% crude protein, and .62 Mcal/lb. NE_L.

Shelled corn \$/bu.	Legume hay \$/ton	48% soybean meal \$/ton	Corn silage value/ ton 25% dry matter	Corn silage value/ ton dry matter
\$2.50	\$130	\$160	\$34.56	\$138.24
		\$200	\$31.97	\$127.88
		\$240	\$29.39	\$117.52
		\$280	\$26.81	\$107.24
		\$320	\$24.22	\$96.88
\$3.00	\$130	\$160	\$35.47	\$141.88
		\$200	\$32.88	\$131.52
		\$240	\$30.30	\$121.20
		\$280	\$27.71	\$110.84
		\$320	\$25.13	\$100.52
\$3.50	\$130	\$160	\$36.37	\$145.48
		\$200	\$33.79	\$135.16
		\$240	\$31.21	\$124.84
		\$280	\$28.62	\$114.48
		\$320	\$26.04	\$104.16
\$4.00	\$130	\$160	\$37.28	\$149.12
		\$200	\$34.70	\$138.80
		\$240	\$32.12	\$128.48
		\$280	\$29.53	\$118.12
		\$320	\$26.95	\$107.80

Table 3. Expected nutrient content of soybean forage

Stage of maturity	CP %	ADF %	NDF %	NE _L Mcal/lb.	Ca %	P %	Mg %	Fat %
Average silage	17.3	40.0	48.2	0.56	1.36	.47	.34	5.1
Average hay	16.5	35.0	-	0.55	1.20	.47	.32	-
Midbloom	17.8	40.0	-	0.54	1.25	.49	.34	5.4
Seed developing	17.5	35.0	-	0.59	1.20	.47	.32	-
Seed dough stage	16.8	39.0	-	0.63	1.15	.45	.30	4.1

Note: CP=crude protein; ADF=acid detergent fiber; NDF=neutral detergent fiber; NE_L=net energy of lactation; Ca=calcium; P=phosphorus; Mg=magnesium. All values are on a dry matter basis.

Table 4. Expected nutrient content for alternative forage sources

Forage substitutes	DM %	CP %	ADF %	NDF %	NE _L Mcal/lb.	Ca %	P %	Mg %	K %
Straw	90.0	4.1	54.0	78.0	0.46	.21	.08	.12	1.11
Pea-vine silage	25.0	13.1	49.0	59.0	0.58	1.31	.24	.39	1.40
Corn cannery waste	24.0	8.0	34.0	55.0	0.69	.30	.20	.24	1.15
Corn stover, dry	87.0	6.5	44.0	69.0	0.54	.38	.20	.21	1.43
Corn stover, silage	31.0	6.4	43.0	67.0	0.56	.36	.31	.24	1.54
Apple pomace with rice hulls	27.0	4.9	53.0	69.0	0.39	.10	.07	.05	0.37

Note: DM=dry matter; CP=crude protein; ADF=acid detergent fiber; NDF=neutral detergent fiber; NE_L=net energy of lactation; Ca=calcium; P=phosphorus; Mg=magnesium. All values are on a dry matter basis.

Table 5. Nitrate levels in forage for dairy cattle

Nitrate ion (NO ₃)	Nitrate nitrogen (NO ₃ -N)	Recommendations
%	ppm	
0.0-0.44	0-1000	Safe to feed under most conditions.
0.45-0.75 ^a	1000-1700 ^a	Gradually introduce to ration. Feed some concentrate. Test all feeds and water. Dilute to 0.40% NO ₃ or 900 ppm NO ₃ -N in the total ration dry matter. Restrict single meal size.
0.76-1.00	1700-2300	Possible acute toxicity. Feed in a balanced ration with concentrate included. Dilute to 0.40% NO ₃ or 900 ppm NO ₃ -N in the total ration dry matter. Restrict single meal size.

^a If one forage contains over .44% NO₃ or 1000 ppm NO₃-N, test all forages, water, and possibly concentrates. Include nitrate intake from water as part of dietary intake.

This publication is available in alternative media on request.

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