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Anhydrous ammonia treatment of forages

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Quick Facts

- Anhydrous ammonia treatment has 3 major effects on forages: it increases the rate and extent of forage digestion, it increases the crude protein content, and it increases intake by 15 to 20 percent.
- In addition to these major benefits of treating forages, anhydrous ammonia is an excellent preservative.
- Ammoniation should make crop residues adequate in both protein and energy to meet the needs of dry brood cows up to about 50 days prior to calving.
- Ammoniated wheat straw would be inadequate in energy and protein for lactating beef cows, necessitating supplementation of these nutrients in addition to vitamins and minerals.
- While ammoniated wheat straw alone would be inadequate for growing replacement heifers, it could be utilized as a portion of the ration.
- Cost of supplies, as well as value of the forage and the labor involved in treating it should be considered in estimating total cost.

Low quality forages and beef cow herds often are found in the same geographical locations. The increasing cost of producing high quality forages makes it imperative to maximize the use of low quality forages when they are available.

The relatively low nutritive requirements of the mature beef cow during gestation suggests these feeds can best be utilized for fall-winter grazing by spring calving cows. They also may be harvested and fed as supplemental winter feed when weather prevents grazing.

Residues available after grain harvest are typically low in digestibility, available energy and protein. The characteristics of crop residues cause lower intakes and makes supplementation with protein a major concern. Since the gross energy of low quality forages often is comparable to forages of higher quality, one of the challenges facing the beef producer is to find ways to make the stored energy of crop residues more available.

Effect of Anhydrous Ammonia on Poorer Quality Forages

Anhydrous ammonia treatment has 3 major effects on forages:

- *Increases the rate and extent of forage digestion* by making the fiber fraction more digestible. The net effect of this increase in digestibility is to raise the energy level of the forage. For example, untreated wheat straw normally has a TDN value of approximately 41% whereas treated wheat straw should be about 48-50% TDN.
- *Increases the crude protein content.* Anhydrous ammonia treatment of wheat straw usually will double the crude protein content. Treatment of other forages should increase the crude protein content 5-6 percent.
- *Increases intake by 15-20 percent.* Research trials have consistently shown that consumption of treated forages will be 15-20 percent greater than consumption of untreated forages because of the increased digestibility and palatability associated with anhydrous treatment.

In addition to these major benefits of treating forages, anhydrous ammonia is an excellent preservative thereby allowing forages to be baled up to 30% moisture, if they are treated promptly after baling.

Treatment Procedure

Although several treatment techniques such as injection of the ammonia directly into an uncovered bale have been tried, the only acceptable method of treatment is to cover the forage packages with plastic sheeting and then apply the ammonia to the covered material.

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The general procedure is as follows:

1. Stack the forage packages closely together and cover with at least 6 mil black or clear plastic. Heavier plastic is preferable since it is more resistant to punctures and wind damage.
2. Seal the edges of the plastic around the stack with dirt. The quantity of dirt used must be adequate to both seal in the ammonia and hold the plastic in place.
3. Using duct or similar tape, seal any holes in the plastic.
4. Place the ammonia outlet hose under the plastic near the center of the stack. It is best to position the hose prior to covering this portion of the plastic with dirt.
5. Calculate the number of tons of forage under the plastic.
6. Apply the anhydrous ammonia at a rate of about 3% by weight (60 lbs/ton) using an accurate regulator. Although other application rates have been researched, the 3% treatment level appears to give optimum results.
7. After the ammonia has been applied, remove the outlet hose from under the plastic and reseal the opening with dirt.
8. Allow a minimum of 2 weeks for treatment with 4 weeks preferable during cool weather.
9. Be cautious when applying ammonia. Use proper equipment and common sense.

Guidelines for Treating Dry Forages

Type of package that may be treated. Field experience indicates that large round, large or small rectangular bales, and loose stacks may be treated; however, it appears that the large loaf package is less suitable for treatment due to the density of the material in the bottom half of the loaf, especially if the forage is quite wet.

Apply shortly after harvest to minimize weathering losses.

Group packages together for efficient plastic use. To reduce the plastic cost per ton of forage treated, it is important that the bales be arranged to maximize the forage treated per sheet of plastic. For example, a 3 x 2 pyramid stack of round bales (3 bales on bottom, 2 on top), approximately 14 bales long can be treated using a single sheet of 40′ x 100′ plastic. Thus, 15-30 tons of forage, depending on bale weight, can be treated at one time.

Place the stack in a protected area, if possible, to avoid wind damage to plastic.

Keep the forage covered until fed to prevent weathering.

Uncover the material 3 to 7 days prior to feeding to eliminate ammonia odor.

Treated material can be tub-ground before feeding.

Use of abandoned bunker silos is an effective method of reducing treatment cost. Stacking bales in the bunker reduces the quantity of plastic needed to cover the pile.

Table 1 summarizes the results of numerous university ammoniation studies utilizing a variety of dry roughages and treatment rates.

Table 1: Results of several forage ammoniation studies.

University	Forage	% Ammonia Added[1]	% Crude protein		% Digestibility[2]	
			Untreated	Treated	Untreated	Treated
Nebraska	Wheat straw	3.25	—	—	50.3	57.7
Purdue	Wheat straw	2.75	3.5	10.6	—	—
Oklahoma	Wheat straw	1.5 (aqua)	2.8	6.3	29.0	37.0
Oklahoma	Wheat straw	3.0 (aqua)	4.6	11.0	38.4	50.9
Saskatchewan	Wheat straw	3.0	4.0	11.0	38.0	46.5
Nebraska	Corn stover	3.0	—	—	36.8	45.8
Purdue	Corn stover	2.5	5.1	13.0	55.5	62.1
Illinois	Corn stover	3.9	8.0	11.8	46.6	56.8
Guelph	Corn stover	5.0	5.4	8.3	53.2	60.3
Nebraska	Corn cobs	3.0 (aqua)	4.2	9.3	42.7	47.9
Kansas	Sorghum stover	5.0	5.4	16.8	46.2	61.3
Illinois	Soybean straw	3.0	5.5	11.0	40.8	43.4
Kansas	Soybean straw	5.0	4.3	17.1	41.3	50.7
Kansas	Prairie hay	5.0	7.3	16.4	40.2	53.8
Purdue	Grass hay	3.0	7.7	17.8	50.2	64.4
Missouri	Fescue hay	3.0	5.3	12.9	40.0	58.0
Purdue	Fescue hay	3.0	7.9	16.7	39.4	57.4
Purdue	Orchardgrass hay	3.0	7.1	14.2	46.1	54.3
Purdue	Clover-grass hay	1.0	12.1	16.4	60.9	61.9

[1]Approximate % ammonia added by weight to field dried forage; all covered with plastic except 1.5% treated wheat straw.

[2]% dry matter digestibility determined by either in vitro or metabolism trials.

Use of Ammoniated Forages in a Cow Herd Nutrition Program

Gestating beef cows—Ammoniation should make crop residues adequate in both protein and energy to meet the needs of the dry brood cow up to about 50 days prior to calving. Only vitamin and mineral supplementation would be required during this time. Extremely cold weather would, however, necessitate energy supplementation of ammoniated wheat straw. At about 50 days prior to calving the condition of the cows should be assessed and the supplementation program adjusted accordingly to supply additional nutrients needed during this critical period of gestation. Ammoniation treatment of other forages such as prairie hay, brome hay, fescue hay and sorghum-sudan hybrids also would improve their quality and reduce the supplemental needs for gestating beef cows.

The results of feeding trials evaluating ammoniated wheat straw and corn stover for gestating cows are shown in Tables 2 and 3, respectively.

Lactating beef cows—Ammoniated wheat straw would be inadequate in energy and protein for lactating beef cows, thereby necessitating supplementation of these nutrients in addition to vitamins and minerals. For all practical purposes, ammoniated wheat straw could be equated with and fed the same as untreated prairie hay since it is similar in nutrient content. Although the feeding of ammoniated prairie hay, brome hay and other similar quality forages to lactating beef cows is an area requiring further research, ammoniation should make these feedstuffs adequate for the lactating beef cow in terms of protein and energy, under normal feeding conditions. In summary, cow/calf producers should consider ammoniating low and medium quality roughages that are to be fed to gestating and lactating beef cows.

Table 2: Effect of treating wheat straw with ammonia on intake and gain of gestating cows and dry matter digestibility.[1]

Item	Untreated	3.5% Ammonia Treated	6% Liquid Supplement[3]
Number of cows	24	24	24
Daily straw intake[2], lb	19.3	23.0	17.8
Average daily gain, lb	0.26	0.88	0.10
Straw digestibility:			
In vitro analysis	50.3	57.7	49.7
Sheep digestion trial	53.6	59.7	52.4

[1]*Faulkner* **et al.**, University of Nebraska, 1981; 72-day wintering trial.
[2]Straw was fed free choice in bale feeders in addition to 16.3 lb of alfalfa-brome hay per head fed 3 times weekly; salt and minerals were fed free choice.
[3]6% by weight of a urea-molasses based 32% protein supplement was sprayed on the straw at the time of baling.

Use of Ammoniated Forages in a Growing Program

While ammoniated wheat straw alone would be inadequate for growing replacement heifers, it could be utilized as a portion of the ration, if supplemental protein, energy, vitamins and minerals were provided. Correspondingly, it could make up a portion of the ration for wintering calves. Again, as with the cow herd, it can be considered comparable to prairie hay in growing programs.

Table 3. Effect of ammoniating and supplementing corn storer on performance of dry brood cows.[1]

Corn stalk treatment[2]	Body weight Change (lb)	Condition Score Change[3]
Untreated + 2 lb corn supplement	-96.5	-.82
Untreated + 2 lb urea supplement (42%)	-60.0	-.50
Untreated + 2 lb soybean supplement (39%)	-46.0	-.21
2.5% ammonia + 2 lb corn supplement	+16.0	-.07

[1]*Saenger* **et al.**, *Purdue University, 1980; 70-day trial with 56 bred cows.*
[2]*All supplements provided necessary minerals and Vitamin A; crude protein content of the untreated and treated stover was 5.4 and 11.7%, respectively.*
[3]*Visual body condition score: 1 = very thin, 5 = very fat.*

Table 4 illustrates the results of a steer feeding trial using ammoniated grass hay.

Table 4. Effect of ammoniation of grass hay and supplementation on steer performance.[1]

Supplement (lb/head/day)				
Corn	Soybean meal	Hay[2]	Daily gain (lb)	Hay intake (lb/DM/day)
0	0	Untreated	0.35	8.7
0	0	Ammoniated	0.81	10.5
4	0	Untreated	1.00	8.0
4	0	Ammoniated	1.56	9.5
3	1	Untreated	1.00	8.0
3	1	Ammoniated	1.53	9.8

[1]*Lechtenberg* **et al.**, *Purdue University, 1980; 90-day trial with 60 head of 500-lb steers.*
[2]*Crude protein and lamb dry matter digestibility of the treated and ammoniated hays were 7.1 vs. 14.2% and 46.1 vs. 54.3%, respectively.*

Safety Precautions

- Check all fittings on the ammonia tanks, regulator, valves and hoses before use.
- Wear rubber gloves and goggles.
- Work upwind as much as possible.

- Check water tank on ammonia tank and fill if low or empty.
- Locate the forage stack on a level site since ammonia will partially condense to form a liquid pool during application. This could result in a dangerous situation if the ammonia is not contained under the plastic. If a low or sloped area exists, extra dirt should be placed against the plastic in this area. This is especially important if bales are stored in a bunker.
- Don't ammoniate high nitrate forages since the ammonia would create an additional non-protein nitrogen burden on the animal. Ammonia, itself, will **not** produce nitrate toxicity, however.

Costs

Most researchers estimate the cost of plastic and ammonia at approximately $10 to $15 per ton of forage treated. The value of the forage and the labor involved in treating it also should be considered in estimating the total cost. If the forage is purchased prior to treatment, then total costs could easily approach $50 to $70 a ton.