

Ammoniation of Low-quality Roughages

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When good or medium quality hay is not available, livestock producers may consider feeding ammoniated low quality hays or crop residues. Ammoniation can double or triple crude protein levels in crop residues such as straw and corn stalks and increase digestibility 10 to 30 percent, making them equivalent to prairie hay in feed value. Ammoniation can also boost consumption of those feeds by 15 to 20 percent. Phosphorus, trace minerals and vitamin A should be added to the diet whenever ammoniated residues are fed. Residues treated with anhydrous ammonia may not work well if cows are in thin condition, but as a general rule, cows receiving ammoniated residues will maintain weight and condition during gestation until 50 days prior to calving (Table 1). Additional supplementation will be required immediately prior to calving and during lactation.

Table 1. Effect of ammonia treatment of wheat straw on performance of gestating beef cows.

Treatment	Daily Straw Intake (lb.)	Daily Weight Change (lb.)
Straw + 7 lb Alfalfa Hay	14.8	-0.27
Ammoniated Straw + 7 lb Alfalfa Hay	19.7	+0.40
Ammoniated Straw	26.1	+0.10
Ward et al., 1982		

Ammoniation works best on low quality forages including wheat, barley, and oat straws, corn stover, and very mature, low quality grass hay. Forages with less than 6 percent crude protein and 48 percent TDN (dry matter basis) are candidates for ammoniation. Treatment of medium- to high-quality forages with anhydrous ammonia results in only small changes in digestibility and intake and may cause toxicity problems when fed. Ammoniation of small grain hay may cause cattle to become nervous, irritable, and have convulsions.

Ammonia combines with the moisture in the forage causing the increase in digestibility. Best results are achieved when the forage has greater than 10 percent moisture, with 15 to 20 percent ideal. Ammonia is an excellent fungicide and molds will not grow on ammoniated forages.

Ammoniation is relatively simple and easy to accomplish. Forage stacks must be covered and sealed with plastic to make an airtight environment. The following are steps used to ensure successful treatment:

- Determine the approximate weight of residue or forage to be treated in each stack. Obtain 6 or 8 milimeter black plastic. Most farm supply stores and lumberyards sell various sizes of plastic, with the largest being 40 by 100 feet.
- If possible, locate stacks in an area near where it will be fed with some protection from strong winds, and good drainage.
- Disk the area to loosen the top few inches of soil for anchoring the plastic cover. If a 40 by 100 foot sheet of plastic is used, blade an area about 15 by 80 feet to provide a surface for the bales and loose soil to cover and seal the plastic.
- Stack residue to be treated on the smooth area. If big round bales are used, stack them in a 3- or 6-bale pyramid. The size of the bales and plastic dictates the stacking method. Eleven to 13 bales in length will fit under a 40 by 100 foot sheet of plastic. Leave about 2 inches between bales to allow for maximum exposure to ammonia.
- Cover stacked residue with black plastic and seal the edge with excess loose soil. Leave a small space to insert a pipe for adding anhydrous ammonia at the midpoint of the stack.
- Insert a pipe 6 to 10 feet long at ground level and seal plastic with loose soil around the pipe. Connect the pipe to the anhydrous tank hose with an adapter, usually obtained from the anhydrous supplier. A shut-off valve on the pipe will eliminate backflow of anhydrous when disconnecting after application is completed.
- Add 60 lb of anhydrous ammonia per ton of dry forage (3 percent). Either purchase the amount of anhydrous needed or calculate the pounds of anhydrous per percentage unit on the tank gauge based on net weight of anhydrous in the tank and percentage of fullness on the tank gauge. For example if you are ammoniating 72 bales weighing 1000 pounds each you would need 2,160 pounds of anhydrous ammonia.
 - $72 \text{ bales} \times 1,000 \text{ pounds/bale} = 72,000 \text{ pounds or } 36 \text{ tons}$
 - $36 \text{ tons} \times 60 \text{ pounds anhydrous ammonia per ton} = 2,160 \text{ pounds of anhydrous ammonia needed}$
- Turn on the anhydrous valve slowly until the plastic balloons slightly, then shut it off. Check around the stack for tears in the plastic or leaks around the edge.
- Seal tears with duct tape. Slowly add the remainder of the anhydrous; do not balloon the plastic. Total time for addition of the anhydrous will be 8 to 10 minutes per ton of residue; a 30-ton stack requires about 5 hours.
- After treatment is complete, turn off the valve, remove the pipe, and seal the area where the pipe was removed.
- Temperature affects the time needed for the best results (Table 2). The cooler the temperature, the longer the residue needs to remain sealed in order for the chemical reaction to occur.
- Open one end of the stack 3 to 5 days prior to feeding to let the excess ammonia gas exhaust.

Table 2. Length of time forage needs to be sealed before feeding.	
Ambient Air Temperature	Minimum Time to Seal Stack
Above 86F	1 Week
59 to 85F	1 to 4 Weeks
Below 59F	4 to 8 Weeks

Safety Precautions

Anhydrous ammonia is maintained under pressure. It will burn skin, eyes or throat, and it can explode and burn. Suggested safety precautions include:

1. Check valves, hoses, tanks, and plastic cover over stack for leaks. If leaks are found repair them immediately.
2. Wear goggles, rubber gloves, respirator, and protective clothing when working with anhydrous ammonia.
3. Work upwind when releasing anhydrous ammonia.
4. Have fresh water available to wash off any anhydrous ammonia which contacts your skin.
5. Do not smoke near anhydrous ammonia.
6. Keep children, pets, and livestock away from treatment area.
7. Remember, anhydrous ammonia is corrosive to most metals do not treat near barns or equipment.

If you have come in contact with anhydrous ammonia, seek medical assistance immediately.

Cost of Ammoniation

Cost of anhydrous ammonia and plastic; quality, availability, and cost of low quality forage; and cost of labor need to be considered when evaluating ammoniation. Estimated costs to treat one ton of forage are \$25.50 to \$30.00 for anhydrous ammonia (based on \$850 to \$1000 per ton of ammonia) and \$5.43 to \$9.05 for plastic (\$181 for 6 mil. black and white plastic, 40 by 100 feet; KSI Supply, 1.800.472.6422), for a total of \$30.93 to \$39.05 per ton. If wheat straw costs \$45 to \$50 per ton, total cost of ammoniated wheat straw would be \$75.93 to \$89.05 per ton.

Ammoniation of forages should be considered when prices of medium or high quality roughages are high. Assume a medium quality (51 percent TDN) grass hay is \$100 per ton and untreated wheat straw is 40 percent TDN. Ammoniation increases digestibility or TDN 15 percent; therefore, treated wheat straw would be 46 percent TDN. Treated wheat straw would be 90.2 percent the value of the hay (46 percent TDN / 51 percent TDN) and break even for the treated straw would be \$90.20 (\$100 per ton x 90.2

percent). In this scenario, if a producer could buy and ammoniate wheat straw for less than \$90.20 per ton, this management practice should be considered an affordable way to supply TDN to the cow herd.

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