Ammonium Treatment
of Low Quality Forages For Beef Cattle Feeding

Increased costs of production have caused livestock producers to reduce feed costs whenever possible. Low quality crop residues, because of their availability, receive attention and offer considerable potential for reducing feed costs for cattle farmers; however, because they are low in digestibility, intake by livestock is reduced.

Treatment of low quality crop residues with anhydrous ammonia improves digestibility or total digestible nutrients (TDN) and increases consumption of these forages. The positive effects of ammonia treatment on digestibility and intake of low quality forages make them a viable possibility in feeding programs.

Anhydrous Ammonia Treatment

Type of Forages to Consider: Ammonia treatment is a procedure designed to increase energy availability of low quality forages. Forages to consider for treatment include: wheat straw, barley straw, oat straw, maize straws, very mature, low quality warm or cool season grasses. Most forages that are less than five percent crude protein and 45 percent TDN on a dry matter basis need to be treated with ammonia. 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.

Moisture Content of Forages: The moisture content of the forage to be ammoniated is important. The anhydrous ammonia combines with the moisture in the forage to form ammonium hydroxide. The ammonium hydroxide reacts on fiber components of the forage to cause an increase in digestibility. Ideally, best results of ammonia treatment occur when the forage is greater than 10 percent moisture. Ammoniation of forages less than 10 percent moisture results in smaller increases in forage intake and digestibility.

Ways to ensure moisture in the forage to be treated include:

1. bale the forage shortly after harvest, or
2. bale the forage in early morning or late evening when there is dew on the forage.

Procedure for Anhydrous Ammonia Treatment: The ammoniation procedure is relatively simple and easy to accomplish. The stack of forage must be totally covered and sealed with plastic to make an airtight environment for the anhydrous to be added into. A few simple steps routinely used to ensure successful treatment include:

1. Determine the amount and approximate weight of residue or forage to be treated in each batch, and the availability of plastic in your area. Most farm supply stores
sell various sizes of plastic, with the largest being 4 by 10m. If possible, locate batches in an area with some protection from strong prevailing wind, good drainage, and near where it will be fed.

2. Disk an area to loosen the top one to three inches of soil for anchoring the plastic cover. If 4 by 10m of plastic is used, blade a space about 2m wide and 8m long to provide a surface for the bales and loose soil to later cover and seal the plastic.

3. Stack residue to be treated on the smooth area. If big round bales are used, stack them in a triad (two bales on the bottom and one bale on top) or in a pyramid (three bales on the bottom, two bales on the second row and one on top). Size of the bales and plastic dictates the method of stacking. If the plastic is 6 by 10m, there is usually enough room for 11 to 13 bales per row. Leave about two inches between each set of bales so as much of the bale as possible is exposed to anhydrous ammonia.

4. Cover stacked residue with new six to eight millimeter black plastic and seal the edge of plastic with the excess loose soil. Leave a small space to insert a pipe for adding anhydrous about the midpoint of the stack.

5. Insert a pipe 0.5 to 1m in length on the ground at the midpoint of the stack. Seal plastic with dirt around the pipe and connect the pipe to the hose on the anhydrous nurse tank. An adaptor is required that usually can be acquired from the supplier of the anhydrous. A shut-off valve on the pipe helps eliminate the backflow of anhydrous when disconnecting the adaptor after treatment is completed.

6. Turn on anhydrous slowly, until the plastic balloons slightly, then shut off the flow of anhydrous. Go around the stack and check for minor tears in the plastic, or leaks around the edges of the stack. If there are tears in the plastic, cover them with duct tape. After checking for and taping any holes, add the remainder of anhydrous until the desired amount has been added. Do not add anhydrous so fast the plastic balloons. Total time to treat the residue will be about eight to 10 minutes per ton of residue — a 30 ton stack requires about five hours.

7. Turn off valve after treatment is complete, and remove pipe. Re-seal the area where the pipe was removed.

8. Open one end of the stack three to five days prior to feeding to permit dissipation of the remaining anhydrous gas.

_Safety Precautions:_ Remember anhydrous ammonia is dangerous. If misused it can burn skin, eyes or throat, can explode and burn, and is maintained under pressure. Suggested safety precautions include:

1. Wear goggles, rubber gloves and protective clothing.
2. Work upwind when releasing anhydrous ammonia.
3. Have fresh water available to wash off any anhydrous ammonia that comes in contact with skin.
4. Check valves, hoses and tanks; plastic cover over stack for leaks.
5. **Do not** smoke near anhydrous ammonia.
6. Keep children away from treatment area.

Remember, anhydrous ammonia is corrosive to most metals.
Forage Quality Changes

The digestibility and quality of crop residues is low because of an increase in cell wall components of the plant caused by greater maturity at harvest. Low digestibility slows down the rate of passage of the feed through the digestive tract of livestock, reducing the amount of forage that can be consumed. Ammonia treatment of forages with high cell wall content increases the digestibility and the intake of these feeds.

**Digestibility:** Ammoniating low quality forages increases digestibility 10 to 15%. The increase in digestibility is a result of the water and ammonia combining to cause breakdown of the fiber components of the forage. The ammoniation process essentially pre-digests the fiber so when animals consume the treated forage, breakdown of tough fiber components already has started and total digestibility is increased. An increase in digestibility means an increase in available energy content of the residue.

**Animal Intake:** In feeding trials using ammoniated residues, animal intake increased as much as 22%. These data indicate ammoniated residues are readily consumed if the material is allowed to "air out" three to five days prior to feeding.

The increase in intake of ammoniated residues is primarily due to the increase in digestibility; however, a portion of the increase in animal intake may be attributed to an increased palatability of ammoniated residues. Increased intake of ammoniated residues allows animals to do a better job of meeting their protein and energy requirements by eating more feed.

**Crude Protein:** Crude protein content of residues increases after ammoniation. Ammonia (NH₃) contains nitrogen, and when residues are treated with anhydrous ammonia, the nitrogen component is attached to the fiber parts of the residue. Crude protein analysis measures the amount of nitrogen (N compounds) in a sample whether it be from "true" plant source or added nitrogen compounds (NPN) such as ammonia.

Although the crude protein in ammoniated residues increases, not all that added nitrogen may be used by the animal. Rumen microorganisms use a portion of the additional nitrogen from ammonia treatment because of the increased energy from the treated straw and from any added energy sources.

**Ammoniated Residues:** Forage ammoniation increases the nitrogen content of the roughage as indicated by the increase in percent crude protein. The nitrogen of the treated forage represents a readily available source of ammonia for rumen bacteria, and may meet the nitrogen requirement for optimum rumen fermentation.

When feeding ammoniated forages to beef cows, provide cows access to a mineral mix containing adequate salt, phosphorus and vitamin A. The mineral mix can be provided "free-choice" in loose or block form.
**Feeding Method For Cows:** Three to five days before feeding ammoniated forages, open up one end of the stack and allow any ammonia remaining to escape. Ammoniated forages can be fed three different ways.

- First, they can be fed loose, scattered on the ground. This method lends itself to the greatest amount of feeding losses.
- Second, they can be fed free choice, in slant bar bale feeders.
- Third, they can be ground and fed in bunks or inverted tractor tires.

**Weaned Calves and Replacement Heifers Fed Ammoniated Forages:** Harvested ammoniated crop residues can be used in rations for weaned calves. Ammoniating the crop residue increases calf performance compared to rations that contain untreated residue.

**Toxicity with Ammoniated High Quality Roughage**

Toxicity can be experienced by animals when consuming ammoniated high quality roughage. Neurological signs of toxicity include hyperexcitability, circling, convulsions and sometimes death. Toxicity appears to occur when livestock are fed ammoniated forage sorghum, hybrid sudan, early harvested small grain (wheat, oat, barley) hay, immature brome and fescue hays.

Management practices to consider to avoid toxicity include:

1. Ammoniate only low quality roughage.
2. Anhydrous ammonia should be added at a rate of 3 percent.
3. Do not ammoniate medium to high quality hays.

If toxicity occurs in calves or cows avoid working the cattle and remove treated forage for two to three days. After two to three days, begin feeding cattle half ammonia-treated forages and half untreated forage to eliminate the toxic condition.