HAY AMMONIATION AND ENERGY/PROTEIN SUPPLEMENTATION FOR HEIFER DEVELOPMENT

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INTRODUCTION

During the winter, many Florida cattle producers graze replacement heifers on dormant tropical grass pasture such as bahiagrass, and supplement the cattle with hay and an energy-protein feed such as molasses-urea. Historically, this feeding program (hay plus molasses-urea) has not provided the nutrition necessary to develop heifers so they can be bred as yearlings. In a summary of beef-forage practices in south central Florida, 51% of beef cattle producers indicated that heifers calved their first time at three years of age or older. Forty-eight percent of all producers surveyed indicated that nutrition was the most serious problem limiting reproduction in beef cattle.

One reason many Florida cattle producers do not attempt to breed heifers as yearlings is low quantity and/or quality of forage (stockpiled pasture, hay) available for the heifer during the first winter following weaning. Also, a greater level of feeding is required for a two year old first-calf heifer so she will rebreed to calve at three years of age.

Approximately 750,000 acres of permanent improved grassland are used for hay production in Florida each year, with an average yield of approximately 5,000 lbs/acre. In the summary of beef-forage practices in south central Florida, 81% of livestock producers indicated they used hay. Results from the University of Florida Extension Forage Testing Program indicated that the average crude protein (CP) concentration of Florida grown hay was 7%, and the average total digestible nutrient (TDN) content was 43%. Yearling heifers require a diet that is 11 to 12% CP and 60 to 65% TDN. Low quality hay plus an energy-protein supplement such as molasses-urea may not provide the nutrition necessary to develop a heifer during her first winter after weaning so that she can be bred as a yearling.

Anhydrous ammonia treatment has increased the CP concentration and TDN of low quality hay. Cattle fed ammoniated hay consume more hay and gain more weight than those fed nontreated hay. Natural protein feeds (for example cottonseed meal, soybean meal or feather meal) have increased the performance of young growing cattle above that obtained with urea supplementation. The objective of this paper is to describe the use of ammoniated hay plus a molasses-natural protein supplement as a nutrition/management program for developing heifers to calve at two years of age.

PRODUCTION CYCLES

Figure 1 shows an example of a heifer production cycle using a 90 day calving season for the cow herd from November through January, and a weaning date of August 1. If the heifer is born December 1, she will be 8 months of age at weaning. It is advisable to have a short calving season for first-calf heifers (approximately 60 days), and for the calving season to begin approximately 30 days before that of the cow herd. Use of an early, short breeding season ensures that bred heifers will calve in a short time-frame early in the season. If a two-year-old first-calf heifer calves late in the calving season, she will likely have difficulty rebreeding to calve again at three years of age. If this happens, the advantage of calving at two years of age is lost. Heifers that do not become pregnant during the short breeding season can be sold, or managed to calve at three years of age.

Using a 60 day calving season beginning 30 days before that of the cow herd, indicates that two-year-old, first-calf heifers would calve in October and November, meaning they would be exposed to a bull from January through February of the year following weaning. This results in approximately 140 days from weaning until the heifer is exposed to the bull. This example can be shifted and rotated during the year for different production systems and locations in Florida; however, no matter what the weaning, breeding and calving dates, the heifer will have approximately 140 days from weaning to breeding. If the heifer weighs 500 lbs at weaning, and it is desirable for her to weigh from 650 to 700 lbs when exposed to a bull, she must gain from 1.0 to 1.5 lbs per day from weaning to breeding.

PRODUCTION SYSTEMS

It should be noted that developing heifers to breed as yearlings may not be appropriate for every ranch. Ranches that have extensive management, for example grazing native range much of the year and do not feed hay, or ranches that do not grow improved tropical grasses or winter annuals, or ranches that have heifers with a high percentage Brahman breeding may choose to calve heifers as three- year-olds. Increased management and nutrition are required to develop heifers for calving at two years of age, and to ensure rebreeding for calving at three. However, many options are available to achieve this goal depending upon production systems, location in Florida, forages available, environmental conditions and breeding.

Using the above example for south-Florida, at weaning in August-September heifers can be placed on fertilized, 4 to 5 week regrowth limpograss, bermudagrass or stargrass pastures until the first of January when winter annuals are usually available. However, bermudagrass and stargrass may be frosted and killed before January 1, particularly in northern Florida, resulting in a lack of forage availability and quality before availability of winter annuals. Winter annuals are usually available before January 1 in northern Florida. Limpograss usually grows longer into the fall and winter than bermudagrass or stargrass, and many producers are having success rotationally grazing limpograss and providing small amounts of supplemental protein. Winter annuals can usually be grazed from approximately January 1 until mid- to late-March. This program should provide the nutrition/management necessary to develop heifers for breeding as yearlings.

A potential problem area for the above program is dry weather during September through November resulting in limited grass growth at weaning, and poor stands of winter annuals. Also, some livestock producers may not have the option or desire to grow these tropical grasses or winter annuals. Hay can be a consistent and reliable source of feed; however, the low quality hay made by most Florida cattle producers is expensive because it supports little or no animal performance. It is for this reason that we have investigated the improvements in animal performance by treating hay with anhydrous ammonia, and energy-natural protein supplementation of ammoniated hay.

PROCEDURES FOR TREATING HAY WITH ANHYDROUS AMMONIA

An important aspect of hay ammoniation is that there are no complicated procedures to follow. The procedure is simple, not too costly, and can be accomplished with locally available materials. There are many variations on procedures used for ammoniation, depending upon available equipment. The only requirement is that the hay and ammonia be enclosed in a "container" for about a month before feeding. This "container" is usually a sheet of black plastic that is used to cover the hay and sealed in the ground to enclose the hay stack air-tight. Hay in many different storage arrangements (round bales, square bales) can be ammoniated. The key is to arrange the hay stack to minimize costs of materials and labor for each specific situation, and still provide proper conditions for ammoniation. Arrangement of hay bales depends upon equipment available, size of plastic available and the number of bales to be treated. As an example, at the Agricultural Research and Education Center-Ona round bales weighing approximately 800 lbs are produced. Bales are arranged in a pyramid shape with three bales on the bottom, two in the middle and one on the top. Fifteen rows of three bales each are used for the bottom row. Bales in the middle row are staggered on top of the bottom row, resulting in 14 rows of 2 bales each. Top bales are staggered on top of the middle row, resulting in 13 bales. This results in a total of 86 bales per stack. As the hay is stacked, a small space (2 to 3 inches) is left between cut edges of adjacent bales so that ammonia can circulate within the stack.

A small trench (1 to 2 feet deep) is dug around the stack to secure the plastic. A 40 X 100 ft piece of 6 mil thickness black plastic will cover the hay stack described above. The plastic is placed over the stack, and the edges placed into the trench and covered with soil to seal the stack air-tight. After the plastic is placed over the hay stack and sealed into the trench, it should be checked for holes usually caused by hay stems puncturing the plastic during covering.

The hose from the ammonia tank is placed under the plastic. Anhydrous ammonia tanks have a capacity gauge to meter the proper quantity of ammonia into the stack. Ammonia leaves the tank as a liquid and then turns into a gas and fills the area under the plastic. Depending upon how fast the ammonia is allowed to flow into the stack, the plastic can balloon out and become very tight. It usually takes three to five hours to apply the proper amount of ammonia to the stack. When ammonia is being applied, the stack should be checked about every hour to make sure the process is proceeding normally.

After 1 to 2 days, the ammonia will be absorbed into the hay. Treatment time depends upon environmental temperature; the warmer the temperature the faster the reaction time. As a general rule, hay should remain sealed under the plastic for about 30 days before feeding. When the hay is ready to feed, the plastic can be cut at ground level to expose only the number of bales to be removed from the stack. Plastic remains over the rest of the hay to help keep it dry.

Tropical grass hay should be ammoniated at 4% of the forage dry matter. In most cases, bale weight and dry matter percentage will be estimates. For the above example, 86 bales X 800 lbs each X 85% dry matter X 4% ammonia = 2339 lbs ammonia to treat the hay. Approximate costs are as follows:

Plastic	(40 X 100, 6-mil)	$100.00
Ammonia	(2339 lbs X $.13/lb)	304.07
Labor	(10 hrs X $5.00/hr)	50.00
Tractor	(1 hr X $20.00/hr)	20.00
Misc.		20.00
Total		$494.07

These costs result in a price of approximately $14.50 per ton on an as-fed basis, or approximately $5.75 per bale.

NUTRITIONAL BENEFITS OF AMMONIATION

Results from several research trials conducted in Florida comparing nontreated and ammoniated tropical grass hay are summarized in Table 1. Nontreated hays were low in quality and typical of most hay produced in Florida. Ammoniation increased CP concentration of the hays. Increased CP concentration of ammoniated hay is due to non-protein-nitrogen addition from ammonia, which is similar to the protein contribution from urea. For young growing cattle, utilization of this non-protein-nitrogen may not be as good as that from a natural protein source such as cottonseed meal or soybean meal. Although CP concentration of hay is increased by ammoniation, other nutritional effects are usually more important. However, from an economical standpoint, the increased CP concentration is important because standard molasses at approximately $80.00 per ton can be fed rather than a urea fortified molasses product at approximately $120.00 per ton. Because of the non-protein-nitrogen contribution from ammoniated hay, supplemental feeds containing urea should not be used when ammoniated hay is fed.

Ammoniation improves forage feeding value by a chemical breakdown and swelling of plant fibers resulting in a better opportunity for rumen bacteria to attach to the fiber and digest the ammoniated hay. Neutral detergent fiber concentration, which is a measure of forage cell wall content, was reduced by ammoniation (Table 1). This contributed to the greater in vitro organic matter digestion of ammoniated compared to nontreated hay.

Supplementation or Ammoniation A practical question arises as to whether an energy-protein supplement should be purchased and fed with nontreated hay, or nontreated hay should be ammoniated. To answer this question, a trial was conducted to evaluate ammoniation or molasses supplementation of mature limpograss hay. Brahman crossbred steers (500 lbs, 8 months old) were housed in drylot, and fed one of the following three treatments: (1) nontreated hay, (2) nontreated hay plus molasses, or (3) ammoniated hay. Cattle on all treatments were fed 1.0 lb supplement/head/day which contained natural protein, and steers fed nontreated hay plus molasses received 4.0 lbs molasses/head/day.

Steers fed ammoniated hay ate 20% more hay than those fed nontreated hay (Table 2). Steers in this trial performed better than expected. Steers fed ammoniated hay gained more weight and had a less expensive cost of gain than steers fed nontreated hay. Steers fed nontreated hay plus molasses had reduced hay intake compared to steers fed nontreated hay alone. This response is termed a substitution effect, and must be considered when supplementing forage-based diets. Steers fed nontreated hay plus molasses gained more weight and had a less expensive cost of gain compared to steers fed nontreated hay alone.

Contrasting the performance obtained from nontreated hay plus molasses to that obtained from ammoniated hay fed alone is important (Table 2). Steers fed ammoniated hay had a greater daily gain and a less expensive cost of gain than steers fed nontreated hay plus molasses. This indicates that cattle fed ammoniated hay perform at least as well as cattle fed nontreated hay plus molasses. Steers fed nontreated hay plus molasses consumed 4.0 lbs of molasses per day which is typical for cattle of that age and weight. If additional daily gain is desired from cattle fed nontreated hay plus molasses, then additional supplement or another type of supplement would have to be consumed. Steers fed ammoniated hay were not supplemented with additional energy. Ammoniated hay may provide a basal diet upon which energy and/or protein supplementation programs can be applied.

Supplementation Of Ammoniated Hay Ammoniated hay fed alone provides a level of animal performance similar to that of the respective nontreated hay supplemented with molasses. But daily gain obtained from nontreated hay plus molasses or from ammoniated hay alone is probably not adequate to develop a heifer during her first winter following weaning so that she can be bred as a yearling. Animal performance may be increased by energy and/or protein supplementation of ammoniated hay. To evaluate this, a growth trial was conducted to evaluate molasses and cottonseed meal supplementation of ammoniated hay. Brahman crossbred steers (480 lbs; 8 months of age) were placed on bahiagrass pasture from October through February and fed ammoniated stargrass hay plus the following four supplementation treatments: (1) control - no supplement, (2) ad libitum quantities of standard molasses, (3) 1.0 lb cottonseed meal (CSM)/head/day and (4) ad libitum quantities of standard molasses plus 1.0 lb CSM/head/day. Supplements were fed on Monday, Wednesday and Friday.

Steers supplemented with molasses or molasses-CSM had reduced hay intake compared to steers fed ammoniated hay alone (Table 3). Molasses intake was increased when CSM was added (5.9 vs 7.0 lbs). Steers fed ammoniated hay alone gained .46 lbs/day. This hay was adequate to meet maintenance requirements plus provide a small amount of gain, and formed a base to which supplementation programs could be applied. Both molasses and CSM supplementation improved daily gain and cost of gain, but the response to protein (CSM) was greater than the response to energy (molasses). Crude protein content of the hay before ammoniation was 6%, and after treatment was 11%. The increase was due to non-protein-nitrogen addition from ammonia which is similar to nitrogen from urea. This demonstrates the importance of feeding natural protein (cottonseed meal, soybean meal, feather meal) to cattle with high nutrient requirements such as developing heifers. Steers fed ammoniated hay plus molasses-CSM slurry gained 1.67 lbs/day. The cost of gain ($.55/lb) is attractive in today's markets for either developing heifers or backgrounding steers. Even though the research was conducted with steers, this feeding program (ammoniated hay plus molasses-natural protein slurry) can provide the level of performance necessary to develop a weaned heifer so that she can be bred as a yearling.

PRECAUTIONS FOR THE USE OF AMMONIATED HAY

Recently reports have surfaced concerning toxic effects in cattle fed ammoniated hay. Symptoms include restlessness, impaired vision, loss of balance, sudden stampeding and running in circles. Some deaths have been reported, primarily in young calves (less than 1 month old) nursing cows that were fed ammoniated hay. Recent research shows that this toxicity problem is not dependent on ammoniation level, moisture level, kind or quality of hay, but is dependent upon prolonged high heat during the ammoniation process. It appears that high temperatures in the hay stack at the time of treatment sometimes causes a toxic compound to be formed. This compound is not always produced during ammoniation. If the toxic compound is produced, in most cases it is not present in large enough quantities to produce symptoms in yearling cattle or mature cows, but can be transferred through the milk to negatively affect the calf.

At this time, limited information is known about this syndrome or the compound that is responsible. Because of the possibility of toxicity symptoms in young calves, we recommend not feeding ammoniated hay to lactating cows. Ammoniated hay should be reserved for feeding to developing heifers, herd bulls or cull cows that are held over the winter to obtain a greater price in the spring market.

Table 1. Chemical Composition and in Vitro Digestion of Nontreated and Ammoniated Hay			
	Crude Protein, %	**Neutral Detergent Fiber, %**	**In Vitro Organic Matter Digestion, %**
Trial 1: Limpograss			
Nontreated	3.2	88.9	46.2
Ammoniated	10.3	80.9	62.5
Trial 2: Stargrass hay			
Nontreated	4.4	87.4	30.8
Ammoniated	8.1	82.2	50.6
Trial 3: Bermudagrass hay			
Nontreated	7.5	83.3	40.5
Ammoniated	14.1	79.3	57.2
Trial 4: Bermuda-Bahiagrass hay			
Nontreated	4.2	81.9	42.2
Ammoniated	12.7	81.8	53.3

Table 2. Performance of Steers Fed Limpograss Hay Either Ammoniated or Supplemented with Cane Molasses			
Trial 1	**Treatment**		
	Nontreated	**Nontreated + Molasses**	Ammoniated
Daily feed, lbs as-is			
Hay	9.7	8.4	11.7
Supplement	1.0	1.0	1.0
Molasses		4.0	
Daily gain, lbs	.6	.9	1.2
Feed costs, $/day	.30	.44	.42
Yardage, $/day	.15	.15	.15
Total, $/day	.45	.59	.57
Cost of gain, $/lb	.75	.66	.48

Costs are based on $35.00/ton for nontreated forage, $50.00/ton for ammoniated forage, $250/ton for supplement, $80.00/ton for molasses.

Table 3. Performance of Steers Fed Ammoniated Stargrass Hay Alone or Supplemented with Molasses and/or Cottonseed Meal				
	Treatment			
	Ammoniated hay alone	Ammoniated **hay + molasses**	Ammoniated **Hay + CSM**	**Ammoniated hay + molasses + CSM**
Intake, lbs as-is				
Hay	14.4	10.0	13.4	12.2
Molasses		5.9		7.0
CSM			1.2	1.2
Daily gain, lbs	.46	.77	1.03	1.67
Feed costs, $/day	.36	.49	.52	.77
Yardage, $/day	.15	.15	.15	.15
Total, $/day	.51	.64	.67	.92
Cost of gain, $/day	1.11	.83	.65	.55

Costs are based on $50.00/ton for ammoniated hay, $80.00/ton for molasses, $300.00/ton for cottonseed meal.

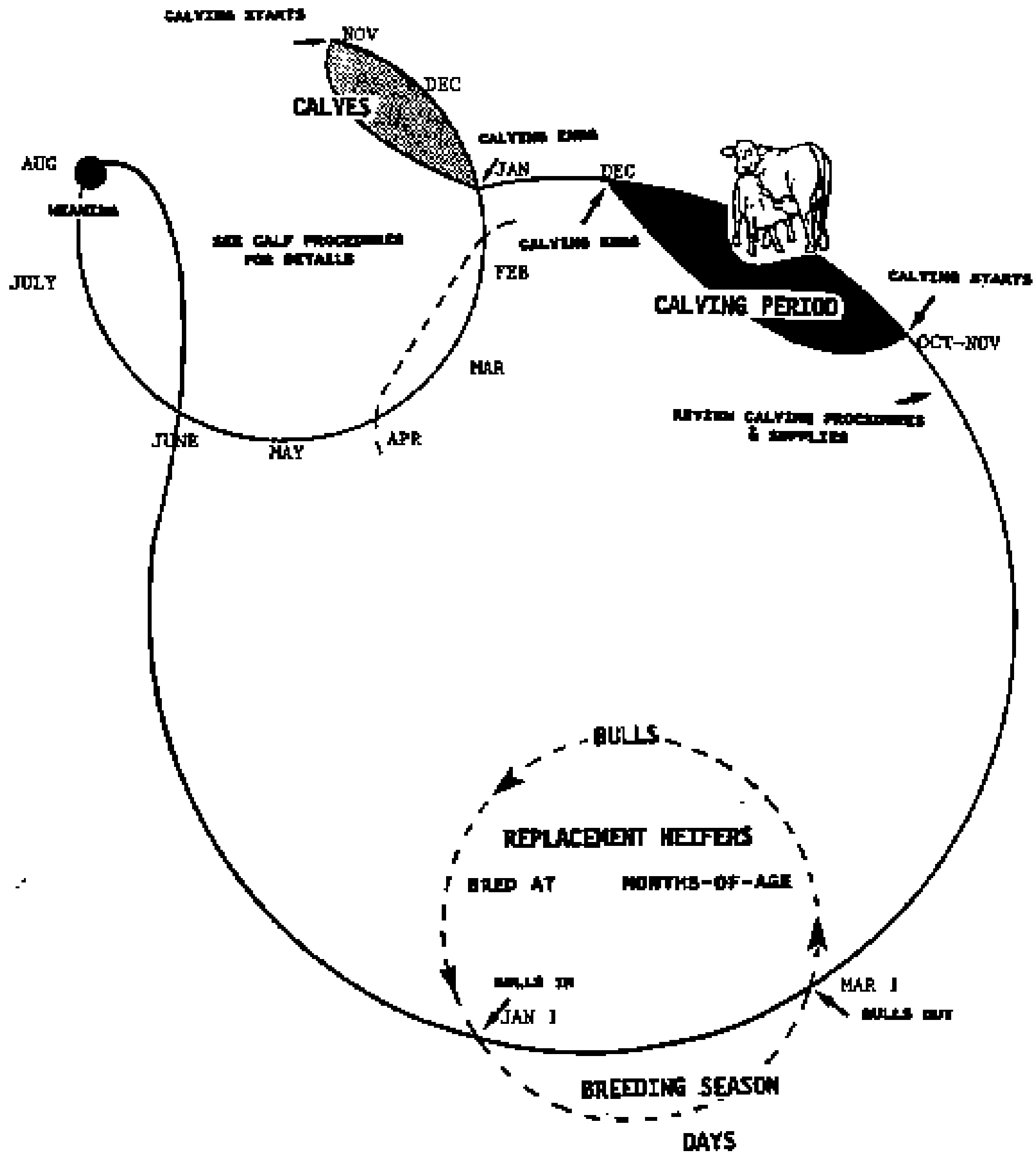

Figure 1. Replacement Heifer Cycle.