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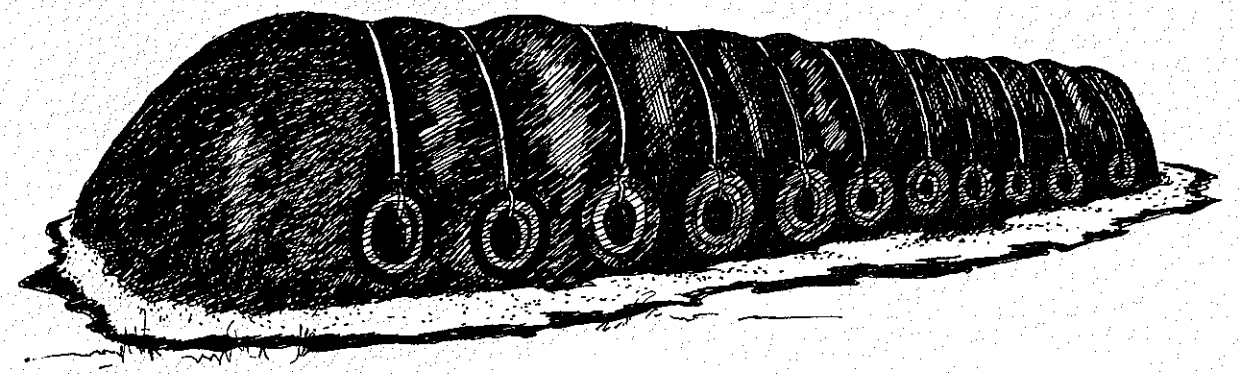

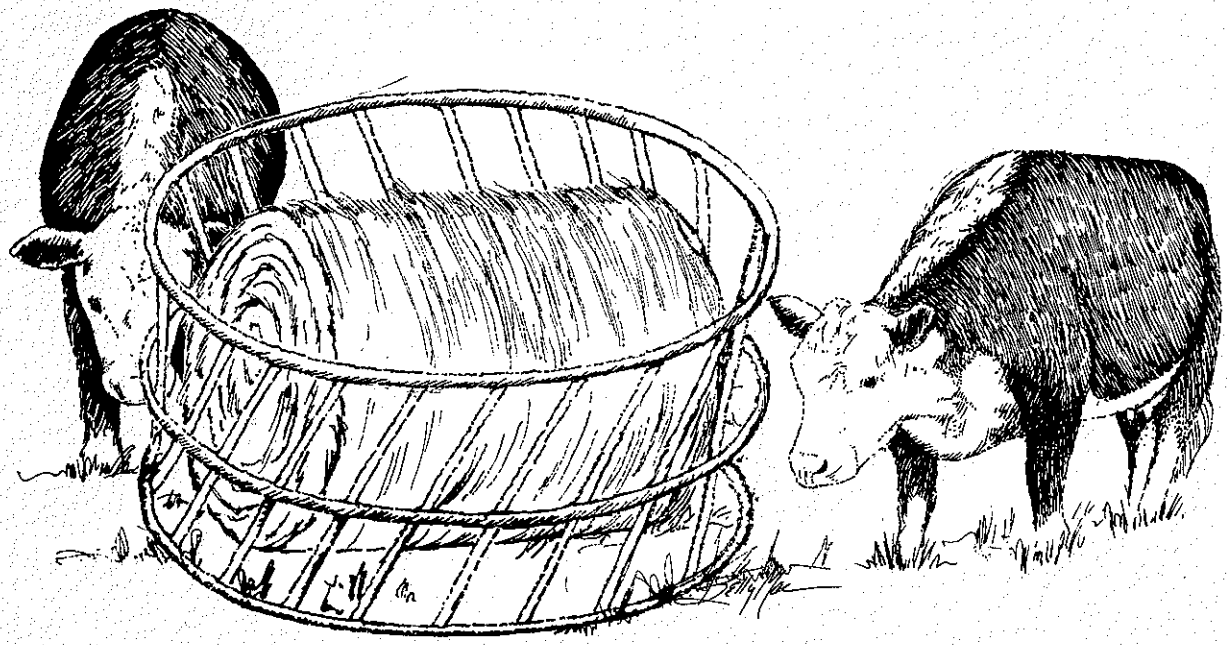

Ammoniated Hay
for Cow Wintering Diets

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Forages (pasture, hay, and silage) constitute the largest portion and the most important feedstuff consumed by beef cattle. Hay is the most common winter energy feedstuff used in Mississippi beef cattle operations. Nutrients provided in hay harvested at the proper stage of plant growth and undamaged by weather usually cost less and are easier to produce and feed than those in other forms. However, most hay harvested in Mississippi is from plants in advanced stages of maturity and baled at a moisture content above 20%. These conditions lead to a poor quality hay that spoils easily and loses dry matter during storage. This is particularly true if the hay is packaged in a large round bale and left exposed to weather.

Research at the Mississippi Agricultural and Forestry Experiment Station has shown that hay harvested at moisture levels of about 20% and stored unprotected outside may lose in excess of 40% of the dry matter that was placed in storage. Anhydrous ammonia acts as a preservative and its use with hay has been shown to increase crude protein and dry matter digestibility. The purpose of the study described in this bulletin was to compare a hay storage system whereby hay covered with black plastic and ammoniated with anhydrous ammonia was compared to the more conventional hay storage systems (in protected storage and outside) for cow wintering diets.

Methods and Materials

The experiment was conducted at four MAFES locations: the Brown Loam Branch Experiment Station at Raymond; the Pontotoc Ridge-Flatwoods Branch Experiment Station at Pontotoc; the Prairie Research Unit at Prairie; and at the Leveck Animal Research Center (LARC) at Mississippi State University (MSU). Spring calving cows were assigned to three groups based on breed, age, weight, and body condition at each location. The Pontotoc Branch used 45 cows divided into three groups of 15 cows each; the Brown Loam Branch used 63 cows divided into three groups of 21 cows each; the Prairie Unit used 75 cows divided into three groups of 25 cows each; and at the LARC, 104 cows were divided into four groups of 26 cows each.

Treatments used at each location were: (1) bermudagrass hay stored outside and uncovered, plus a protein supplement; (2) bermudagrass hay ammoniated at a rate of 3% of the dry matter and stored outside under black plastic; (3) bermudagrass hay stored under shelter, plus a protein supplement. The fourth group of 26 cows at MSU was given a diet of fescue hay ammoniated at a rate of 3% of the dry matter and stored outside under black plastic.

Protein supplement for animals not fed ammoniated hay consisted of 50% ground shelled corn, 36% cottonseed meal, 8% urea, and 6% dicalcium phosphate. The supplement was fed as a 2:1 (supplement:salt) mix for dry cows and a 3:1 mix for cows with calves fed nonammoniated hay, except at the Prairie Unit where no protein supplement was fed. All animals fed ammoniated hay were provided a mineral mix that contained 50% trace mineral salt, 25% dicalcium phosphate, and 25% magnesium oxide.

All locations used bermudagrass pasture as the hay source. Bermudagrass hay used at the Pontotoc Branch came from two sources. Hay stored inside came from the Northeast Mississippi Branch at Verona and hay stored outside under plastic was produced on the Pontotoc Station. Hay was baled in large round bales with about 20% moisture. Bales were immediately transported to the storage area and those to be ammoniated were placed in rows oriented in a north-south direction. There were three side by side rows, each with 13 bales placed end to end; two additional rows of bales were placed pyramid-style on top of these three rows. A row of conventional square bales was placed on top of the two rows of round bales to complete the pyramid and give a ridge effect preventing water puddles from forming on the plastic covering.

Two 55-gallon barrels were placed in the center row of the bottom three rows. Bottoms were cut out of these barrels and the 3/4-inch opening at the other end was connected with a 3/4-inch PVC pipe extending outside of the stack.

The barrels were inverted (open end up) and used as ammonia vaporization vessels. A cut-off valve was placed at the end of the 3/4-inch PVC pipe outside of the black plastic to allow cut-off of ammonia and hookup to the ammonia supply tank. Stacks were covered with a 40-foot by 100-foot sheet of 6-mil black plastic with the ends and sides of the plastic covered with dirt to provide a tight seal and prevent ammonia loss. A rope with an old car tire on each end was placed across each bale to help anchor the plastic cover. Ammonia flowed into the vaporization vessel and was allowed to infiltrate the bales of hay. The hay remained covered until it was fed the following winter.

Fescue hay at MSU was ammoniated June 22, 1984, and the bermudagrass hay was ammoniated August 30, 1984. The bermudagrass hay at Pontotoc was ammoniated September 26, 1984. The hay at Prairie was ammoniated September 4, 1984, and the hay at the Brown Loam Station was ammoniated October 12, 1984.

Core samples of hay were taken before winter feeding started. Hay cores were analyzed for dry matter (DM), crude protein (CP), and *in vitro* dry matter digestibility (IVDMD) values. Criteria for evaluation of animal performance were cow weight change, cow condition score, calf weight at the end of the hay feeding period, and subsequent cow rebreeding. Each animal served as an observation for animal performance analyses. The average of the groups on each treatment served as an observation for economic evaluation related to feeding cost.

Length of test varied among locations and ranged from 71 to 90 days. Budgets used in economic evaluation were generated using additional information from MAFES Agricultural Economics Report No. 17. Diets recorded in all tables were the diets actually fed at each location.

Results and Discussions

Chemical composition of hays by location varied considerably for dry matter, crude protein (dry matter basis and as-fed basis), and IVDMD percentages (Table 1). The DM percent varied from a low of 67% at Brown Loam to a high of 90% at Pontotoc. Crude protein content of hay at the Brown Loam Branch appeared to be lower than at the other locations, probably because the hay was cut in October at the Brown Loam Station. Hay at the Pontotoc Station tended to be higher in crude protein than at other locations. There was also a distinct difference at Pontotoc in DM, CP, and IVDMD values of hay stored inside (produced at Verona) and outside (produced at Pontotoc).

Ammoniation caused most hays to increase about five percentage points in crude protein (DM basis). The IVDMD values increased from about 8 to 13 percent as a result of ammoniation, indicating that ammoniation increased crude protein content and dry matter digestibility values of all hays.

The IVDMD values for both ammoniated bermudagrass and ammoniated fescue hays were higher at the Leveck Animal Research Center than hay at other locations. The IVDMD value of bermudagrass hay at the Pontotoc Station was also higher than IVDMD values for ammoniated hay at the Prairie and Brown Loam Stations. The IVDMD values suggest that bermudagrass hay at Pontotoc and bermudagrass and fescue hay at MSU were of better quality than hay at Prairie and Brown Loam. The crude protein and IVDMD values for hay at the Pontotoc Station suggest that hay stored outside (produced at Pontotoc) was of higher quality than hay stored inside (produced at Verona).

Performance data for cows fed the different wintering diets at all of the locations ranged from a loss of 6 pounds to a loss of 227 pounds (Tables 2, 3, 4, 5). A weight loss of about 125 pounds is normally expected of cows calving during this period of winter. At the Brown

Table 1. Chemical composition values of hays by location, 1984-1985.

Location	Chemical analyses			
	DM(%)[a]	CP[a] (DM basis)	CP[a] (as-fed)	IVDMD[b]
	(%)	(%)	(%)	(%)
BROWN LOAM				
Outside	66.97	5.62	3.76	50.93
Inside	84.29	5.57	4.69	53.53
Ammoniated	76.20	10.12	7.71	64.17
PRAIRIE				
Outside	74.42	8.17	6.08	55.35
Inside	88.58	8.36	7.41	54.90
Ammoniated	80.69	13.70	11.05	62.09
PONTOTOC				
Outside	81.47	13.24	10.79	61.99
Inside	90.23	8.99	8.11	55.02
Ammoniated	81.04	17.21	13.94	67.66
MSU-LARC				
Outside	83.31	7.42	6.18	60.39
Inside	87.25	6.82	5.95	56.01
Ammoniated	83.56	12.42	10.38	69.56
Ammoniated (fescue)	88.56	12.25	10.85	71.50

[a]Average of three analyses of three samples.
[b]Average of four analyses of three samples.

Loam Branch Station, weight losses ranged from 32 to 55 pounds for cows fed the different hays (Table 2). At Prairie, weight losses ranged from 131 to 209 pounds (Table 3). Weight loss ranged from 6 to 151 pounds at MSU. Weight loss ranged from 134 to 227 pounds at the Pontotoc Station. The lowest weight losses at all stations occurred in cows fed ammoniated hay. At the Brown Loam, Prairie, and MSU-LARC locations, the greatest weight loss occurred in cows fed hay that was stored outside. At Brown Loam and MSU, there was not a great deal of difference in cow condition score at the beginning and end of the experiment; however, in all cases, condition scores were lower at the end of the wintering period than they were at the beginning.

There appeared to be little difference in percent pregnancy of cows at the end of the breeding season as influenced by previous winter treatment. There were no calf deaths when cows were fed ammoniated hay at the Brown Loam and Prairie locations. Calf deaths for cows fed nonammoniated hay ranged from 4 to 10% at these two locations. At the Brown Loam Station, cows fed ammoniated hay consumed 35.4 tons (42.7 pounds daily) of ammoniated hay, 30.9 tons (37.2 pounds daily) of hay stored inside, and 32.5 tons (39.2 pounds daily) of nonammoniated hay stored outside. Hay consumption at Brown Loam was based on bale weights taken at harvest and did not consider losses that may have occurred during storage or feeding. Those cattle at the Prairie Unit were all fed the same quantity of hay (23 pounds daily).

The performance of cows fed nonammoniated hay or ammoniated fescue hay at the MSU-LARC location was similar to that of cows at the Brown Loam and Prairie Station (Table 4). Cow weight loss at MSU ranged from 6 to 151

Table 2. Performance of cows fed various hay wintering diets, Brown Loam Branch Experiment Station, 1984-85.

		Nonammoniated	
Item	**Ammoniated**	**Inside**	**Outside**
Start date	12/19/84	12/19/84	12/19/84
End date	3/8/85	3/8/85	3/8/85
Days on test	79	79	79
Number of cows	21	21	21
Cow I wt, lb	1,123	1,070	1,058
Cow F wt, lb	1,091	1,025	1,003
Cow wt change, lb	-32	-45	-55
Cow c.s. beginning[a]	5.52	5.05	5.33
Cow c.s. ending[a]	5.38	4.95	4.90
Change c.s. ending[a]	-0.14	-0.10	-0.43
Pregnancy, %			
(after wintering)	90	100	100
Born	21	21	21
Lost	0	2	1
Calf deaths, %	0	10	5
Calf birth wt, lb	60	64	64
Consumption			
Hay, tons	35.42	30.86	32.52
Hay, lb/day	42.7	37.2	39.2
Protein, lb	0	1,500	1,650
Salt, lb	0	750	825
Minerals, lb	140	30	30

[a]c.s. is a subjective condition score with 1 being the lowest and 10 the highest.

Table 3. Performance of cows fed various hay wintering diets, Prairie Research Unit, 1984-85.

		Nonammoniated	
Item	**Ammoniated**	**Inside**	**Outside**
Start date	1/29/85	1/29/85	1/29/85
End date	4/29/85	4/29/85	4/29/85
Days on test	90	90	90
Number of cows	25	25	25
Cow I wt, lb	1,099	1,146	1,158
Cow F wt, lb	968	957	949
Change in weight	-131	-189	-209
Cow c.s. beginning[a]	6.92	6.96	7.04
Cow c.s. ending[a]	5.28	4.98	4.88
Change in c.s.[a]	-1.64	-1.98	-2.16
Pregnancy, %			
(after wintering)	88	88	100
Number of calves			
Born	25	25	25
Lost	0	1	1
Calf deaths, %	0	4	4
Birth wt, lb	76.92	79.08	79.96
Calf final wt, lb	171.67	169.8	193.3
Gain, lb	94.75	90.72	113.34
Daily gain, lb	1.05	1.01	1.26
Consumption			
Hay, tons	25.85	25.85	25.85
Hay, lb/day	23.0	23.0	23.0
Salt, lb	0	0	0
Mineral, lb	550	550	550

[a]c.s. is a subjective condition score with 1 being the lowest and 10 being the highest.

Table 4. Performance of cows fed different hay wintering diets, Mississippi State University (LARC), 1984-85.

Item	Ammoniated	Nonammoniated		Ammoniated fescue
		Inside	Outside	
Start date	12/18/84	12/18/84	12/18/84	12/18/84
End date	3/7/85	3/7/85	3/7/85	3/7/85
Days fed	79	79	79	79
Number of cows	26	26	26	26
Cow I wt, lb	1,126	1,126	1,113	1,127
Cow F wt, lb	1,120	1,020	961	1,011
Cow wt change, lb	-6	-106	-151	-116
Cow beginning c.s.[a]	7.23	7.35	7.15	7.23
Cow ending c.s.[a]	6.69	6.50	6.42	6.37
Change in c.s.[a]	-0.54	-0.85	-0.73	-0.85
Pregnancy, % (after wintering)	72	80	92	88
Number of calves				
Born, total	26[b]	27	25	25
Born, 3/7/85	17	20	18	17
Dead, 3/7/85	10	0	0	1
Calf deaths, %	58.8	0	0	4
Birth wt, lb	78.82	73.23	74.08	75.25
Consumption				
Hay, tons	33.65	27.26	29.87	27.39
Hay, lb/day	32.8	26.5	29.1	26.7
Protein, lb	0	700	800	0
Minerals, lb	100	0	0	100
Mg blocks, lb	166	0	0	166

[a]c.s. is a subjective condition score with 1 being the lowest and 10 the highest.
[b]9 calves born and lived after 3/7/85 for a total of 26 calves born.

Table 5. Performance of cows fed different hay wintering diets, Pontotoc Branch Experiment Station, 1984-85.

Item	Ammoniated	Nonammoniated	
		Inside	Outside
Start date	1/8/85	1/8/85	1/8/85
End date	3/20/85	3/20/85	3/20/85
Days on test	71	71	71
Number of cows	15	15	15
Cow I wt, lb	1,144	1,192	1,163
Cow F wt, lb	1,010	965	945
Cow wt change, lb	-134	-227	-218
Cow c.s. beginning[a]	6.87	7.27	7.07
Cow c.s ending[a]	5.27	4.73	5.33
Change in c.s.[a]	-1.6	-2.54	-1.74
Pregnancy, % (after wintering)	100	100	100
Number of calves born	14	14	13
Number of calves lost	12	1	1
Calf death, %	86	7	8
Calf birth wt, lb	62	70	67
Calf end wt, lb[b]	97.5	163	160
Gain, lb	36.5	92.4	93.31
Daily gain, lb	0.51	1.30	1.31
Consumption			
Hay, tons	15.4	17.05	17.05
Hay, lb/day	28.9	32.0	32.0
Protein, lb	0	600	900
Salt, lb	20	216	316
Minerals, lb	10	0	0

[a]c.s. is a subjective condition score with 1 being the lowest and 10 the highest.
[b]Calf weight at end of the winter feeding period.

pounds and cows fed nonammoniated bermudagrass hay stored outside had the largest weight loss. There were no calf deaths in the group of cows fed nonammoniated bermudagrass hay (Table 4). There was one calf death in the group of cows fed ammoniated fescue hay; however, this calf died from hypothermia due to extremely cold weather at the time of calving (-2°F).

When cows were fed ammoniated bermudagrass hay at the MSU-LARC location, the cows consumed the hay very readily (32.8 pounds daily). Cows were weighed on January 15, and at this time, two cows fed ammoniated bermudagrass hay exhibited a staggering gait and circling pattern upon being returned to their respective pastures. These symptoms were similar to those associated with magnesium deficiency. Therefore, due to poor consumption of the loose mineral mixture containing magnesium oxide, the mineral supplement was changed to a commercial molasses block containing magnesium (Table 6).

One of the two cows that exhibited symptoms of hyperexcitability on January 15, calved on February 3, and the calf was dead on arrival. The other cow that exhibited symptoms on January 15, produced a calf on march 6, and it survived. Between January 18 and March 6, 17 calves were born (Table 7). Of these, six were dead on arrival, four died within 2 to 8 days after birth, and seven lived. The study was terminated on

Table 6. LARC-MSU cow mineral supplementation schedule.

Date	Amount	Ingredient
12/12/85	50 lb	50% TM Salt
2/20/85	50 lb	25% DiCaP
		25% MgO
1/15/85	3 HI-MAG Blocks	
1/21/85	2 HI-MAG Blocks	
2/27/85	52 lb/D	87.5%
3/7/85		12.5% MgO

Table 7. LARC-MSU calf mortality data.

Birth date	Remark
1/18/85	OK
1/21/85	OK
2/3/85	DOA[a]
2/3/85	DOA[b]
2/4/85	Died 2/12
2/10/85	Died 2/12
2/10/85	DOA
2/10/85	Died 2/12
2/18/85	OK
2/19/85	OK
2/21/85	DOA
2/22/85	DOA
2/25/85	Died 3/2
2/28/85	OK
3/2/85	DOA
3/4/85	OK
3/6/85	OK[b]

Summary: 7 lived, 6 DOA, and 4 died (2-8D)

[a]DOA–Calf dead on arrival

[b]Cow exhibited symptoms of hyperexcitability 1/15/85.

March 7. Nine calves born after the cows were no longer fed the ammoniated bermudagrass hay all lived. As a result of feeding ammoniated bermudagrass hay, 59% of the first 17 calves born died. If the total calf crop is considered, 39% of the total calves born, died. But nine calves were born after ammoniated hay was removed from the cow's diet.

Feeding high magnesium blocks was discontinued on February 27 and a mixture of 87.5% corn and 12.5% magnesium oxide was fed at the rate of 2 pounds per cow daily until March 7, when the study was terminated. Feeding magnesium oxide did not appear to have any influence on calf mortality.

Similarly, very severe calf losses were experienced at the Pontotoc Station from cows fed ammoniated bermudagrass hay. Cows started calving on January 19 and of the 14 calves that were born, six were dead on arrival, six died within 1 to 24 days after birth, and two lived (Table 8). This represents a death loss of 86% for calves from cows that were fed ammoniated bermudagrass hay; whereas, in cows fed nonammoniated bermudagrass hay, there was a death loss of one calf in each of the treatment groups (Table 5). Cows fed nonammoniated hay stored either inside or outside at the Pontotoc location had the largest weight loss and largest change in condition score for cows at all locations. Cows fed ammoniated bermudagrass hay at the Pontotoc station did not consume as much (28.9 pounds daily) as those fed nonammoniated hay (32 pounds daily) and did not lose as much weight or have as large a condition score change as those fed nonammoniated bermudagrass hay.

Blood and milk samples were taken from all cows at the Pontotoc and MSU-LARC locations. These samples were analyzed for 4-methylimidazole, calcium, phosphorus, magnesium, and plasma-urea-nitrogen; and a complete blood profile scan was conducted. Blood and milk contained normal levels of calcium, phosphorus, and magnesium. Plasma-urea-nitrogen levels were below the toxicity level, which is considered to be 2,000 mg/100 ml of blood. There were traces of 4-methylimidazole in both the milk and hay and these levels were considerably lower than the 200 mg/kg body weight considered to be toxic to 3-day old calves. These chemical analyses indicated no differences for the blood and milk profile of animals fed either ammoniated or nonammoniated bermudagrass hay.

Table 8. Pontotoc calf mortality data.

Birth date	Remark
1/19	Died 1/22
1/20	DOA[a]
1/22	DOA
1/23	Died 2/16
1/28	DOA
1/28	Died 1/29
1/28	DOA
1/29	Died 2/2
1/30	Died 2/17
2/2	DOA
2/19	DOA
2/22	Died 2/23
3/6	Lived
3/15	Lived

Summary: 2 Lived, 6 DOA, and 6 Died (1 - 24D).

[a]DOA–Calf dead on arrival.

One of the cows fed ammoniated bermudagrass hay produced a calf that was dead on arrival and this cow was used in a case study at the Leveck Animal Research Center. Milk was collected for 3 days and analyzed for 4-methylimidazole, calcium, phosphorus, and magnesium. Some of the milk was fed to day-old chickens for 4 days without apparent problems. At the end of 3 days, a 3-day-old dairy calf was grafted to the cow. This dairy calf exhibited symptoms of hyperexcitability after nursing for 7 days. The calf started trembling, let out a bellow, started running, ran into the corral fencing, and then exhibited a circular movement pattern. The calf was given thiamin intramuscularly at the rate of 1 g/100 lb body weight and no signs of hyperexcitability were exhibited for 6 days. On day 7 after the thiamin injection, the calf again exhibited the symptoms of hyperexcitability. Thiamin was again administered and no symptoms of hyperexcitability observed for another 7 days.

Economics

Budgets for hay harvest and storage were developed and are presented in Tables 9 through 11. These budgets suggest that there was a cost of $54.81 to produce a ton of bermudagrass pasture hay and transport it to a central storage location. If the hay was stacked under an open shed, there was a cost of $57.71 per ton. When hay was stacked, covered with black plastic, and ammoniated, there costs were $64.26 per ton–an additional cost of $9.45 per ton for plastic, anhydrous ammonia, labor, and machinery. The outside storage was the lowest cost per ton

Table 9. Summary of estimated costs per acre, pasture hay, Mississippi, 1984.

Item	Unit	Price	Quantity	Cost
		($)		($)
DIRECT EXPENSES[a]				
Preharvest				
Fertilizer				
Nitrate (34% N)	Cwt	8.85	2.00	17.70
Phosphate (46% P_2O_5)	Cwt	10.03	1.00	10.03
Potash (60% K_2O)	Cwt	8.07	1.00	8.07
Lime (spread)	Ton	22.00	0.33	7.26
Miscellaneous				
Custom spread (truck)	Appl.	3.75	2.00	6.50
Interest on operating capital	Acre	6.07	1.00	6.07
Subtotal preharvest direct expense				56.63
Harvest				
Twine	Bundle	26.68	0.20	5.34
Tractors	Acre	25.77	1.00	25.77
Harvest equipment	Acre	14.58	1.00	14.58
Special labor	Hour	4.45	5.00	22.25
Subtotal harvest direct expenses				67.93
Total direct expenses				124.56
FIXED EXPENSES				
Tractors	Acre	22.48	1.00	22.48
Harvest equipment	Acre	24.27	1.00	24.27
Prorated estimated cost	Acre	12.32	1.00	12.32
Total fixed expenses				59.07
Total specified expenses				183.63
Total specified expenses/ton[b]				54.81

[a]Production of 3,000 lb in June, 2,500 lb in August, and 1,200 lb in September. Total production 6,700 lb (3.35 tons) in a year.
[b]Includes all costs, except land, of producing hay and transporting to storage location.

of the three storage treatments, whereas, ammoniated hay was the most costly.

Cost per cow for wintering diets is presented in Tables 12 through 15. Table 16 provides a summary of wintering costs for each treatment by location. Wintering cost per head for cows fed ammoniated hay was higher than for cows fed nonammoniated hay stored either inside or outside at Brown Loam, Prairie or MSU-LARC. Cost per head varied from a high of $108.39 to a low of $66.12 for cows fed ammoniated bermudagrass hay; from $93.20 to $62.31 for cows fed bermudagrass hay stored inside; and from $94.08 to $59.31 for cows fed bermudagrass hay stored outside. The major difference in cost per head can be attributed to different levels of hay consumed by cows. Wintering costs at the Brown Loam Station were about $30 per cow more than at the other three locations. Feeding ammoniated hay at all locations, except for Pontotoc inside storage, cost more than

Table 10. Summary of estimated costs per ton, ammoniated storage for common pasture hay, Mississippi, 1984.

Item	Unit	Price	Quantity	Amount
		($)		($)
DIRECT EXPENSES				
Hay	Ton	54.81[a]	1	54.81
Front loader	Hour	2.18[b]	0.06[c]	0.13
Tractor	Hour	3.88[b]	0.06	0.23
Labor	$	1.29[d]	1	1.29
Plastic (6 mil)	Sq ft	0.025	120	0.87
Anhy. ammonia (82%)	Cwt	10.62	0.6	6.37
Total direct expenses				63.70
FIXED EXPENSES				
Front loader	Hour	5.81[b]	0.06	0.35
Tractor	Hour	3.51[b]	0.06	0.21
Total fixed expenses				0.56
Total specified expenses/ton				64.26

[a]Total cost of hay per ton from Table 9.
[b]Expense per hour for operating machine from MAFES/MCES publication 1485, Department of Ag. Economics, Miss. State University, 1985.
[c]Tractor and front loader used to stack bales were assumed to run 20% of the time that hay is being moved from the field to the storage location as obtained from MAFES/MCES publication 1485, Department of Ag. Economics, Miss. State University, 1985.
[d]Prorated share of total cost of hay ammoniation expressed on a per ton basis.

Table 11. Summary of estimated costs per ton, common pasture hay, inside storage, Mississippi, 1984.

Item	Unit	Price	Quantity	Amount
		($)		($)
DIRECT EXPENSES				
Hay	Ton	54.81[a]	1	54.81
Front loader	Hour	2.18[b]	0.06[c]	0.13
Tractor	Hour	3.88[a]	0.06	0.23
Total direct expenses				55.17
FIXED EXPENSES				
Front loader	Hour	5.81[b]	0.06	0.35
Tractor	Hour	3.51[b]	0.06	0.21
Pole type shed[b]	Sq ft	2.20[d]	18	1.98
Total fixed expenses				2.54
Total specified expenses/ton				57.71

[a]Total cost of hay per ton from Table 9.
[b]Expense per hour for operating machine from MAFES/MCES publication 1485, Department of Ag. Economics, Miss. State University, 1985.
[c]Tractor and front loader used to stack bales were assumed to run 20% of the time that hay is being moved from the field to the storage location as obtained from MAFES/MCES publication 1485, Department of Ag. Economics, Miss. State, 1985.
[d]Shed requirement based on production of 2 bales per ton, and bale having diameter of 6 feet, and a length of 6 feet. Hay stored stacked 2 bales high. Cost of shed was $2.20 per square foot. This cost of $39.60 per bale of storage area was ammortized over 20 years at 10% interest to get an annual storage charge.

Table 12. Cost per cow for the wintering diet, Mississippi State University, 1984-85.

Diet ingredient	Unit	Amount	Cost/unit	Total cost	Head	Cost/head
			($)	($)		($)
Ammoniated hay						
Hay	ton	33.65	64.26	2,162.35	26	83.17
Protein	pound	520	0.09	46.80	26	1.80
Mineral	pound	100	0.12	12.00	26	0.46
Salt	pound	0	0	0	26	0
TOTAL						85.43
Inside stored hay						
Hay	ton	27.26	57.71	1,513.17	26	60.51
Protein	pound	700	0.09	63	26	2.42
Mineral	pound	100	0.12	12	26	0.46
Salt	pound	0	0	0	26	0
TOTAL						63.39
Outside stored hay						
Hay	ton	29.87	54.81	1,637.17	26	62.97
Protein	ton	800	0.09	72.00	26	2.77
Mineral	pound	100	0.12	12.00	26	0.46
Salt	pound	0	0	0	26	0
TOTAL						66.20
Ammoniated fescue						
Hay	ton	29.89	64.26	1,920.73	26	73.87
Protein	pound	0	0	0	26	0
Mineral	pound	100	0.12	12.00	26	0.46
Salt	pound	0	0	0	26	0
TOTAL						74.33

Table 13. Cost per cow for the wintering diet, Brown Loam Branch Experiment Station, Raymond, Mississippi, 1984-85.

Diet ingredient	Unit	Amount	Cost/unit	Total cost	Head	Cost/head
			($)	($)		($)
Ammoniated hay						
Hay	ton	35.42	64.26	2,276.09	21	108.39
Protein	pound	0	0	0	21	0
Mineral	pound	140	0.12	16.80	21	0.80
Salt	pound	0	0	0	21	0
TOTAL						109.19
Inside stored hay						
Hay	ton	30.86	57.71	1,780.93	21	84.81
Protein	pound	1,500	0.09	135.00	21	6.43
Mineral	pound	30	0.12	3.60	21	0.17
Salt	pound	750	0.05	37.5	21	1.79
TOTAL						93.20
Outside stored hay						
Hay	ton	32.52	54.81	1,782.42	21	84.88
Protein	pound	1,650	0.09	148.5	21	7.07
Mineral	pound	30	0.12	3.60	21	0.17
Salt	pound	825	0.05	41.25	21	1.96
TOTAL						94.08

Table 14. Cost per cow for the wintering diet, Pontotoc Ridge-Flatwoods Branch Experiment Station, Pontotoc, Mississippi, 1984-85.

Diet ingredient	Unit	Amount	Cost/unit	Total cost	Head	Cost/head
			($)	($)		($)
Ammoniated hay						
Hay	ton	15.4	64.26	989.60	15	65.97
Protein	pound	0	0	0	15	
Mineral	pound	10	0.12	1.20	15	0.08
Salt	pound	20	0.05	1.00	15	0.07
TOTAL						66.12
Inside stored hay						
Hay	ton	17.05	57.71	983.96	15	65.60
Protein	pound	600	0.09	54.00	15	3.60
Mineral	pound	0	0	0	15	
Salt	pound	216	0.05	10.80	15	0.72
TOTAL						69.92
Outside stored hay						
Hay	ton	17.05	54.81	934.51	15	62.30
Protein	pound	900	0.09	81.00	15	5.40
Mineral	pound	0	0	0	15	
Salt	pound	316	0.05	15.80	15	1.05
TOTAL						68.75

Table 15. Cost per cow for the wintering diet, Prairie Research Unit, Prairie, Mississippi, 1984-85.

Diet ingredient	Unit	Amount	Cost/unit	Total cost	Head	Cost/head
			($)	($)		($)
Ammoniated hay						
Hay	ton	25.88	64.26	1,663.05	25	66.52
Protein	pound	0	0	0	25	0
Mineral	pound	550	0.12	66.00	25	2.64
Salt	pound	0	0	0	25	0
TOTAL						69.16
Inside stored hay						
Hay	ton	25.85	57.71	1,491.80	25	59.67
Protein	pound	0	0	0	25	0
Mineral	pound	550	0.12	66.00	25	2.64
Salt	pound	0	0	0	25	0
TOTAL						62.31
Outside stored hay						
Hay	ton	25.85	54.81	1,416.83	25	56.67
Protein	pound	0	0	0	25	0
Mineral	pound	550	0.12	66.00	25	2.64
Salt	pound	0	0	0	25	0
TOTAL						59.31

feeding hay that was stored either inside or outside (Table 16).

Summary

Because of the high death rate of calves from cows fed ammoniated bermudagrass hay at the Leveck Animal Research Center and at the Pontotoc Branch, it is recommended that ammoniated hay **not be fed to cows 30 days prior to calving or 30 days after calving.** Analyses of blood, milk and hay suggest that 4-methylimidazole, calcium, phosphorus, magnesium, and plasma-urea-nitrogen were not involved in the hyperexcitability syndrome. In every location where ammoniated hay was used, cows had the lowest weight loss and the lowest condition score change. In general, cows fed ammoniated hay consumed more hay than those fed hay that was stored either inside or outside. Performance of calves that survived, appeared to be equal to that of calves from cows fed nonammoniated hay. Generally, ammoniated hay was the highest in quality as measured by CP and IVDMD values and cow performance, but it also was the highest in cost.

Table 16. Summary cost of wintering diet per head, by location, Mississippi, 1984-85.

Location	Ammoniated	Nonammoniated		Ammoniated fescue
		Inside	Outside	
	($)	($)	($)	($)
MSU	85.43	63.39	66.20	74.33
Brown Loam	108.39	93.20	94.08	0
Pontotoc	66.12	69.92	62.30	0
Prairie	69.16	62.31	59.31	0

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