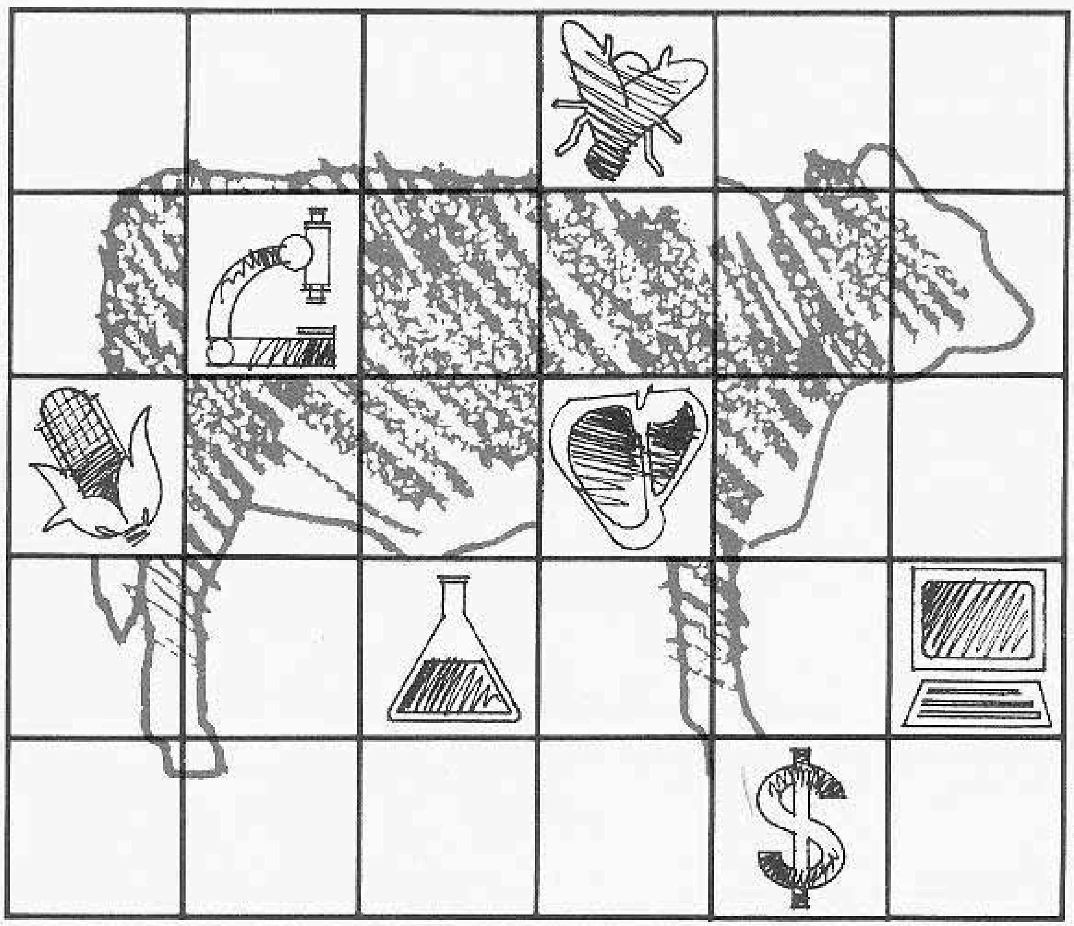
CATTLEMEN'S DAY 1986



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Contribution No. 86-320-S from the Kansas Agricultural Experiment Station.

KSU

Effect of Variety, Location, and Irrigation on Selected Criteria for Evaluating Wheat as a Feed for Ruminants

Gary Goldy, Jack Riley, Gerry Posler,[1]
Andy Lenssen,[1] and Ted Walters[1]

Summary

There were no significant differences in in vitro digestibility between wheat varieties, but there was a trend for differences due to locations. Location differences were much wider for test weight, 1000 kernel weight, hardness score and crude protein level than variety differences. Wheat from irrigated plots had higher grain yields and crude protein content, but lower test weights, 1000 kernel weights, and hardness values than wheat from fallow plots at the same location. There were no differences in digestibilites between fallow and irrigated wheat.

Introduction

A better understanding of wheat as a feed is needed to increase its potential use in livestock rations. This study was designed to identify wheat varieties that might have superior feeding qualities and to find improved methods of screening wheat for potential feeding value.

Experimental Procedures

In 1984, a total of 347 individual samples representing 32 hard red winter wheat varieties were grown in Agronomy Department test plots across Kansas. From those 32 varieties, 15 common varieties were selected from each of the 11 different locations. A least squares statistical analysis was done to determine differences caused by variety, location, and fallow vs. irrigated. A 48-hour, first stage, in vitro dry matter disappearance (IVDMD) method was used to estimate digestibility of the 32 varieties. Data for crude protein, test weight, 1000 kernel weight, and hardness were provided by the Grain Marketing Research Laboratory and the Agronomy Department.

Results and Discussion

In vitro digestibilities were not statistically different between the 15 selected varieties, ranging from 77.4 to 80.1%, but IVDMD values ranged from 76.1 to 81.4% for the 11 locations. Crude protein values (dry matter basis) ranged from 11.8 to 12.8% among varieties and from 10.7 to 14.8% among locations. Bushel weights ranged from 56.0 to 59.2 lb for the 15 selected varieties and from 53.2 to 62.4 lb across the 11 locations. Weight of 1000 kernels varied from 22.4 to 26.7 gm. among varieties and from 18.5 to 28.0 gm. among the locations. Hardness indexes of the 15 varieties ranged from 206 to 240 between varieties and from 210

[1]Department of Agronomy.

to 248 between locations. Soft red winter wheats have hardness indexes of around 150. Yields ranged from 56.6 to 71.3 bushels per acre among the varieties and from 44.6 to 92.0 bushels per acre between locations. Irrigated plots were compared with fallow plots at three locations for the 15 selected varieties, and IVDMD values were similar. However, irrigated plots had higher yields (79.2 vs. 60.5 bu/acre) and crude protein levels (12.0% vs. 11.3%). Irrigated plots had lower test weights, 1000 kernel weights, and hardness values (Table 1.1). Further research is needed to determine how these differences affect wheat's feeding value.

Table 1.1. Effect of Variety, Location, and Irrigation on Selected Criteria for Evaluating Wheat as a Feed for Ruminants

Criteria:	15 Varieties		14 Locations	Fallow	Irrigated
	Average[1]	(Range)	(Range)	Average	Average
Yield bu/ac.	61.1	(56.8-71.3)	(44.8-92.0)	60.5	79.2
Bushel Wt., lb	58.0	(56.0-59.2)	(53.2-62.4)	59.6	57.6
1000 Kernal Wt., gm	24.7	(22.3-26.7)	(18.5-28.0)	25.7	23.0
Hardness Index	227	(206-240)	(210-248)	238	223
IVDMD, %[2]	78.0	(77.4-80.1)	(76.0-81.4)	79.0	79.0
Crude Protein, %	12.3	(11.8-12.8)	(10.7-14.8)	11.3	12.0

[1] Least Squares Means.
[2] In Vitro Dry Matter Disappearance.

Table 2.2. Comparative Nutritional Composition of 15 Selected Wheat Varieties From 14 Locations[1]

Variety	Crude Protein (%)	IVDMD[2] (%)	1000 Kernel Wt. (gm.)	Test Wt. (lb/bu)	Yield/ Acre (Bu.)	Hardness Index
Mustang	11.8	78.8	26.7	58.5	59.6	233
Hawk	12.2	79.6	25.3	57.5	56.6	232
Arkan	12.6	79.1	24.3	58.7	60.6	223
Bounty 203	12.5	79.4	26.4	58.5	71.3	214
Bounty 310	12.8	79.0	25.2	58.0	65.6	240
Garst HR64	12.5	79.1	22.3	57.1	59.5	231
Garst 428402	12.4	78.8	25.0	57.1	59.0	231
Hybrex HW1010	12.0	78.9	24.3	58.8	61.0	221
Hybrex HW1019	12.7	79.4	25.7	59.2	58.9	231
Hybrex HW1030	12.3	79.6	24.3	58.2	59.8	232
Newton	12.1	77.4	24.2	58.5	57.5	226
Tam 105	12.2	80.1	24.6	57.5	61.8	229
Tam 107	12.1	78.8	25.8	58.0	67.1	239
Tam 108	11.8	77.5	23.8	56.0	62.0	206
Vona	12.0	79.1	22.4	58.0	56.7	221

[1] Least Squares Means.
[2] In Vitro Dry Matter Disappearance.

Table 3.3. Average Nutritional Composition of Wheat Varieties at 14 Locations[1]

Variety	Crude Protein (%)	IVDMD[2] (%)	1000 Kernel Wt. (gm.)	Test Wt. (lb/bu)	Yield/ Acre (Bu.)	Hardness Index
Manhattan	12.6	80.6	24.7	56.8	71.2	210
Ottawa	11.8	78.6	23.3	53.2	50.7	220
Parsons	12.3	79.1	26.5	58.0	59.4	245
Ft. Hays	13.6	79.1	26.6	59.4	44.6	229
Belleville	13.4	76.5	26.1	56.4	55.1	238
Heston	12.2	79.9	24.0	58.1	44.8	225
Hutchinson	11.2	80.4	28.0	60.4	48.4	212
St. John (Fal)	10.7	79.2	27.7	62.4	67.8	229
St. John (Irr)	11.8	81.4	27.4	61.4	92.0	223
Colby (Fal)	11.5	78.9	22.4	57.8	50.4	236
Colby (Irr)	12.0	79.4	18.5	55.9	66.4	230
Tribune (Irr)	14.8	77.7	20.4	57.8	62.5	222
Garden City (Fal)	11.6	78.9	26.9	58.7	63.4	248
Garden City (Irr)	12.1	76.1	23.2	55.6	79.3	214

[1] Least Squares Means.

[2] In Vitro Dry Matter Disappearance.

Adding Fat and/or Sodium Bicarbonate to Steer Finishing Rations That Contain Wheat

John R. Brethour[1], Jack Riley, and Bob Lee[2]

Summary

Adding .6 pound fat or .22 pound sodium bicarbonate (soda) to finishing rations containing rolled wheat significantly improved performance and appeared to increase the substitution value of wheat. Both fat and soda increased feed intake. The improved gains from adding fat corresponded to increased energy intake. However, soda seemed to enhance nutrient utilization. There was more response to fat when we fed 100 percent vs. 50 percent wheat, but feeding 100 percent wheat depressed performance, with or without fat, to unsatisfactory levels.

Introduction

In Kansas, wheat is often priced competitively with other ingredients for feeding cattle. However, feeding wheat may involve extra management and special ration formulation. Past research has indicated that adding fat and sodium bicarbonate (soda) may be especially beneficial when wheat is fed. We conducted four trials at Hays to evaluate those ingredients. This project is a joint effort by scientists from the Department of Animal Sciences and Industry and the Hays and Garden City Branch Experiment Stations.

Experimental Procedures

Four feeding trials were conducted with heavy yearling steers that were mostly Angus x Hereford. Cattle were fed in groups of 16 to 27 head. The tables include details of rations and performance for each trial. The first two trials evaluated adding fat to milo, milo and wheat, and all-wheat finishing rations. We dropped the all-wheat rations and tested soda additions in trials 3 and 4.

Both milo and wheat were finely rolled. Forage sorghum silage and prairie hay were used as roughage. When fat was fed, we added .3 lb per head per day the first few days, then fat was increased to .6 lb per day. The fat was a mixture of soybean oil and beef tallow that melted at about 100° F. The soda level was .22 lb (100 g) per day. Milo rations were supplemented with soybean meal and urea but no supplemental protein was needed (except for the first few days) when wheat was fed. Rumensin® and Tylan® were fed with a premix that contained Vitamin A, niacin, zinc methionine, and trace minerals. Rations also contained ammonium sulfate and ground limestone.

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[1]Fort Hays Branch Experiment Station.

[2]Formerly Garden City Branch Experiment Station.

Implanting experiments were superimposed on the feeding trials, so most cattle were implanted. The remarkable gains in Trial 4 partially resulted from research with an experimental implant combination. All cattle were followed through a packing plant and carcass data were obtained. Initial weights were adjusted to actual "pay weight" and final weights were adjusted to a constant 62 dressing percentage.

In order to calculate individual energy gains, we estimated body composition at the end of each trial using equation 1:

$$C = 4.0525 - .002048\ X + .1292\ Y + 1.8214\ Z \qquad (1)$$

C = Caloric density of soft tissue (C/gram)
X = Carcass weight (pounds)
Y = Marbling score (small amount = 5; modest = 6)
Z = Backfat thickness (inches)

Equation 2 expresses individual energy gains as a function of both relative rate of gain and body fatness.

$$E = X\ (.1244 + .8756\ G/g)\ (.11 + .8\ C/c) \qquad (2)$$

E = Energy gain for each individual (Mcal/day).
X = Standard energy gain for the group (energy gain calculated from intake of a standard ration or average energy gain for the set calculated from national Research Council equations that estimate net energy gain from metabolic weight and live weight gain).
G/g = Ratio of average daily gain for each indivdual to group average daily gain.
C/c = Ratio of individual caloric density to the group or a standard set average.
(The constants adjust live weight gain for gain that is gut fill and for tissues that do not change composition).

We calculated net energy gain with this procedure to compare with net energy gain estimated from feed intake. That enabled us to determine if differences in feed intake accounted for differences in performance. The ratios are included in the tables. We interpreted a ratio above 1 as an indication that the ration was utilized better than expected.

Cost of gain used to determine relative value of wheat included both feed and fixed costs. We assigned $0.50 per day to cover interest, yardage, and miscellaneous. The difference in total cost per 100 pounds gain between the wheat-containing ration and the standard milo ration was divided by the pounds of wheat per 100 pounds gain to calculate the effective substitution price for wheat. We did not try to economically evaluate possible differences in carcass quality. Our procedure penalized reductions in animal performance (sometimes seen with wheat rations) severely, but more accurately reflected feedlot closeouts than comparisons that used only feed efficiency or feed costs.

Results and Discussion

Tables 2.1 to 2.4 contain the detailed results of each trial. However, Tables 2.5 to 2.7 condense the most important indications. Adding fat (Table 2.5) significantly increased feed intake and gain. Since a pound of fat contained more net energy than 2.5 pounds of milo, the small increases in total feed intake accounted for all the weight gain increase. There was a significant trend for fat addition to improve feed efficiency more as the proportion of wheat increased. Also, fat improved carcass grade when we fed 100 percent wheat (Table 2.1). Feed intake was consistently reduced when rations contained wheat; fat may have restored net energy intake to the level needed for maximum performance.

Soda also significantly increased feed intake and gain (Table 2.6). The response to soda was the same whether or not fat was included. However, soda differed from fat by apparently improving energy utilization. It might create a more favorable rumen environment or it might increase rumen turnover rates and cause more nutrients to be absorbed in the lower digestive tract.

In Table 2.7 we have attempted to estimate the relative substitution values of wheat. These values may differ from those published elsewhere, because our values are based on actual performance data. When the standard ration was fed in these four trials, wheat had to be priced 5 percent less per pound than milo to result in cheaper gain. A possible reason why the equivalent value of wheat was so low may have been our penalty for reduced rate of gain (gains averaged 10 percent less when wheat was fed). Also, our other research suggests that improved processing and feeding Rumensin® or Bovatec® may benefit milo more than wheat. Protein prices were low during those tests, so the ability to substitute wheat for soybean meal was relatively unimportant. Price relationships vary with cattle requirements and costs of other ingredients. They should be recalculated for each situation.

Average daily gain (adjusted to a constant dressing percent) was about 200 percent less when wheat was the only grain fed. While cattle can be fed a ration containing wheat as the only grain, it appears that wheat would have to be very cheap in relation to other grains for that to be feasible. It is possible that steam flaking results in substantially better relative performance when high-wheat levels are fed.

Both fat and soda increased the relative value of wheat (Table 2.7) by significantly improving animal performance. In one test, feeding both soda and fat enabled a 40 percent premium for wheat over milo; however, that large a response needs confirmation. Also, the design of our tests did not completely evaluate responses to fat and soda in rations that contained only milo.

Table 2.1. Adding Fat to Milo, Milo-wheat, and Wheat Rations. October 1, 1984, to January 12, 1985, 105 days. Trial 1

Item	Milo	Milo-fat	Milo-wheat	Milo-wheat fat	Wheat	Wheat fat
Number of head	25	25	25	24	25	25
Initial weight	777.6	782.4	780.6	776.9	782.9	779.1
Final weight[1]	1204.7	1220.7	1169.7	1201.6	1115.7	1150.7
Average gain	427.1	438.3	389.1	424.7	332.8	371.6
Average daily gain, lb	4.07	4.17	3.71	4.04	3.17	3.54
Average daily ration, lb:						
Sorghum silage	11.50	11.47	11.26	11.35	10.97	11.20
Prairie hay	.45	.52	.37	.35	.30	.30
Rolled milo	24.57	24.18	10.91	11.02	—	—
Rolled wheat	—	—	10.91	11.02	18.94	19.11
Soybean meal	.60	.60	.05	.05	.03	.03
Urea	.05	.05	.01	.01	—	—
Fat	—	.58	—	.58	—	.55
Premix[2]	.55	.55	.55	.55	.55	.55
Dry matter total	25.14	25.45	22.67	23.45	20.45	21.24
Carcass data:						
Dressing percent	62.05	61.81	60.88	61.62	60.49	61.09
Backfat, in	.46	.52	.41	.44	.37	.41
Marbling score	4.82	5.21	5.05	4.99	4.54	4.88
Percent choice	80.%	84.%	88.%	83.%	52.%	80.%
Lb D M/100 lb gain	618.0	609.6	611.7	579.6	645.0	600.1
Feed cost/cwt gain[3]	$28.34	$29.08	$29.08	$29.17	$32.12	$31.66
Total cost/cwt gain	$40.63	$41.49	$42.57	$41.53	$47.89	$45.79
Value of wheat (cwt) equal to milo @ $3.80	—	—	$3.84	$4.17	$3.28	$3.54
Caloric density, C/g	3.98	4.11	3.98	3.98	3.92	3.97
Energy gain, Mcal/day	9.76	10.31	9.04	9.72	7.81	8.74
Ratio of observed to predicted gain	1.00	.99	1.02	.99	.98	.98
Net energy values	(milo)	(milo)	(wheat)	(wheat)	(wheat)	(wheat)
NE gain (Mcal/kg DM)	1.40	1.39	1.53	1.50	1.48	1.49
NE maintenance	2.12	2.10	2.40	2.33	2.29	2.31

[1] Final weights and gains adjusted to dressing percent of 62. Initial weights adjusted to pay weights.

[2] Premix included .11 lb ammonium sulfate, .22 lb ground limestone, niacin, zinc methionine, Rumensin, Tylan, vitamin A, and trace minerals.

[3] Costs based on milo, $3.80/cwt; wheat, $4.50/cwt; silage, $16/ton; soybean meal, $140/ton; 50 cents per day for interest, yardage, and miscellaneous costs (fat and sodium bicarbonate priced at 17 cents per pound).

Table 2.2. Adding Fat to Milo, Milo-wheat, and Wheat Rations. January 18, 1985, to May 4, 1985, 107 days. Trial 2

Item	Milo	Milo-fat	Milo-wheat	Milo-wheat fat	Wheat	Wheat fat
Number of head	27	26	27	27	27	26
Initial weight[1]	858.3	868.3	862.8	859.9	862.5	864.7
Final weight	1198.2	1246.5	1182.7	1211.4	1132.4	1189.4
Average gain	339.9	378.2	319.9	351.5	269.9	324.7
Average daily gain, lb	3.18	3.53	2.99	3.28	2.52	3.04
Average daily ration, lb:						
Sorghum silage	11.00	10.96	10.52	10.94	10.54	10.70
Prairie hay	.48	.51	.46	.34	.36	.39
Rolled milo	21.15	21.87	9.97	9.40	—	—
Rolled wheat	—	—	9.97	9.40	17.42	17.32
Soybean meal	.60	.60	.05	.05	.05	.05
Urea	.05	.05	.01	.01	.01	.01
Fat	—	.58	—	.58	—	.58
Premix[2]	.55	.55	.55	.55	.55	.55
Dry matter total	22.36	23.58	21.06	20.70	19.15	19.73
Carcass data:						
Dressing percent	61.92	62.68	61.52	62.66	60.76	61.86
Backfat, in	.40	.48	.42	.46	.36	.43
Marbling score	5.10	5.09	4.93	4.83	4.65	4.72
Percent choice	89.%	88.%	74.%	74.%	63.%	65.%
Lb D M/100 lb gain	703.9	667.0	704.4	630.2	759.5	650.0
Feed cost/cwt gain[3]	$32.10	$32.35	$33.32	$31.82	$37.68	$34.37
Total cost/cwt gain	$47.84	$46.40	$50.04	$46.94	$57.51	$50.74
Value of wheat (cwt) equal to milo @ $3.80	—	—	$3.84	$4.81	$3.10	$3.99
Caloric density, C/g	3.93	4.03	3.94	3.97	3.88	3.94
Energy gain, Mcal/day	8.01	9.00	7.73	8.34	6.51	7.75
Ratio of observed to predicted gain	1.00	.98	.99	1.04	.93	1.00
Net energy values	(milo)	(milo)	(wheat)	(wheat)	(wheat)	(wheat)
NE gain (Mcal/kg DM)	1.40	1.38	1.49	1.57	1.43	1.50
NE maintenance	2.12	2.08	2.30	2.48	2.18	2.32

[1]...Footnotes in Table 1.

Table 2.3. Fat and Sodium Bicarbonate in Steer Finishing Rations Containing Wheat. May 21, 1985, to October 8, 1985, 141 days. Trial 3

Item	Milo	Milo-fat	Milo-wheat	Milo-wheat fat	Milo-wheat soda	Milo-wheat soda fat
Number of head	18	18	17	17	17	17
Initial weight[1]	728.3	726.9	722.9	728.6	731.3	728.8
Final weight[1]	1162.4	1158.2	1119.5	1192.8	1174.3	1246.4
Average gain	434.1	531.3	396.6	464.2	443.0	517.4
Average daily gain, lb	3.08	3.77	2.81	3.29	3.14	3.67
Average daily ration, lb:						
Sorghum silage	10.02	10.39	10.10	10.29	10.27	10.45
Prairie hay	.14	.22	.11	.12	.12	.09
Rolled milo	20.02	22.28	9.10	9.86	9.82	10.44
Rolled wheat	—	—	9.10	9.86	9.82	10.44
Soybean meal	.60	.60	.03	.03	.03	.03
Urea	.05	.05	—	—	—	—
Fat	—	.59	—	.59	—	.59
Sodium bicarbonate	—	—	—	—	.22	.22
Premix[2]	.55	.55	.55	.55	.55	.55
Dry matter total	21.26	23.95	19.49	21.45	20.79	22.50
Carcass data:						
Dressing percent	62.57	64.46	61.86	62.82	62.35	63.64
Backfat, in	.41	.55	.33	.45	.40	.49
Marbling score	4.23	4.71	3.85	4.32	4.11	4.28
Percent choice	28.%	72.%	24.%	29.%	35.%	41.%
Lb D M/100 lb gain	690.5	635.7	692.9	651.5	661.7	613.1
Feed cost/cwt gain[3]	$31.19	$30.39	$32.34	$32.73	$32.06	$31.45
Total cost/cwt gain	$47.42	$43.66	$50.12	$47.62	$48.00	$45.09
Value of wheat (cwt) equal to milo @ $3.80	—	—	$3.68	$4.43	$4.32	$5.32
Caloric density, C/g	3.85	4.03	3.71	3.91	3.83	3.91
Energy gain, Mcal/day	7.83	9.82	6.99	8.48	7.89	9.31
Energy gain predicted from feed intake	7.83	9.88	7.30	8.97	8.04	9.58
Ratio of observed to predicted gain	1.00	.99	.96	.95	.98	.97

[1]...Footnotes in Table 1.

Table 2.4. Fat and Sodium Bicarbonate in Steer Finishing Rations Containing Wheat. September 18, 1985, to December 17, 1985, 91 days. Trial 4

Item	Milo	Milo-fat	Milo-wheat	Milo-wheat fat	Milo-wheat soda	Milo-wheat soda fat
Number of head	18	18	17	16	17	18
Initial weight[1]	851.5	850.6	854.2	849.3	849.6	846.2
Final weight	1265.5	1267.5	1203.8	1230.6	1248.6	1269.4
Average gain	414.0	416.9	349.6	381.3	399.0	423.2
Average daily gain, lb	4.55	4.58	3.84	4.19	4.38	4.65
Average daily ration, lb:						
Sorghum silage	14.38	14.26	12.42	12.21	12.70	12.83
Prairie hay	.21	.21	.14	.05	.14	.09
Rolled milo	24.94	24.70	11.16	10.98	11.56	11.63
Rolled wheat	—	—	11.16	10.98	11.56	11.63
Soybean meal	.60	.60	.06	.06	.06	.06
Urea	.06	.06	.01	.01	.01	.01
Fat	—	.57	—	.57	—	.57
Sodium bicarbonate	—	—	—	—	.22	.22
Premix[2]	.55	.55	.55	.55	.55	.55
Dry matter total	26.26	26.62	23.43	23.55	24.42	25.10
Carcass data:						
Dressing percent	63.40	63.51	61.87	62.50	62.84	63.29
Backfat, in	.41	.48	.40	.45	.39	.50
Marbling score	4.70	4.82	4.84	4.59	4.62	4.71
Percent choice	72.2%	66.7%	88.2%	68.8%	58.8%	66.7%
Lb D M/100 lb gain	577.1	581.0	609.8	562.1	556.9	539.5
Feed cost/cwt gain[3]	$26.00	$27.62	$28.69	$28.04	$26.80	$27.34
Total cost/cwt gain	$36.99	$38.60	$41.14	$39.48	$37.88	$37.90
Value of wheat (cwt) equal to milo @ $3.80	—	—	$3.07	$3.55	$4.16	$4.14
Caloric density, C/g	3.79	3.94	3.86	3.91	3.77	3.97
Energy gain, Mcal/day	10.28	10.65	8.97	9.70	9.83	10.88
Energy gain predicted from feed intake	10.22	10.97	9.24	9.84	9.67	10.61
Ratio of observed to predicted gain	1.01	.97	.97	.99	1.02	1.03

[1]...Footnotes in Table 1.

Table 2.5. Adding .6 lb Fat to Milo, Milo-wheat, or Wheat Rations for Finishing Steers. Summary of Four Trials

Item	Milo	Milo-fat	Milo-wheat	Milo-wheat-fat	Wheat	Wheat-fat
Average daily gain, lb	3.72	4.01	3.34	3.70	2.92	3.36
Average DM intake, lb	23.75	24.90	21.66	22.28	19.89	20.58
Lb DM/100 lb gain	643.1	621.7	651.7	603.7	687.8	616.2
Ratio of observed net energy gain to predicted net energy gain	100.00	97.97	98.37	98.90	94.03	97.68

Table 2.6. Adding 100 Grams Sodium Bicarbonate to Milo-wheat Rations for Finishing Steers. Summary of Two Trials

Item	Control	Fat	Soda	Soda + Fat
Average daily gain, lb	3.32	3.74	3.76	4.16
Average DM intake, lb	21.46	22.50	22.60	23.80
Lb DM/100 lb gain	648.7	603.5	604.8	574.0
Ratio of observed net energy gain to predicted net energy gain	96.11	96.30	99.63	99.57

Table 2.7. Effect of Adding Fat or Sodium Bicarbonate on the Relative Value of Wheat. Summary of Four Trials

	Substitution Value of Wheat as Percent of Milo Price					
Trial	Milo-wheat	Milo-wheat-fat	Wheat	Wheat-fat	Milo-wheat-soda	Milo-wheat-soda-fat
Trial 1	101	110	86	93	—	—
Trial 2	101	127	76	98	—	—
Trial 3	97	117	—	—	114	140
Trial 4	81	93	—	—	109	109
Average	94.9	111.6	81.2	95.8	111.6	124.5

Comparative Nutritional Composition Of Selected Grain Sorghum Varieties

Gary Goldy, Jack Riley, Ted Walters,[1]
Gerry Posler,[1] and Andy Lenssen[1]

Summary

For the 188 grain sorghum varieties studied, in vitro digestibilites were statistically similar, but there was a significant difference between the 12 production locations. Crude protein, calcium, and phosphorus levels indicated slight varietal differences; however, strong locational effects were evident.

Introduction

Grain sorghums appear to vary widely in their nutritional characteristics. The differences may be due to such factors as variety, rainfall, and cultural practices. This study was designed to identify the sources of variation in sorghum grain and to find ways to predict sorghum's nutritional characteristics.

Experimental Procedures

First stage (48 hr) IVDMD was used to estimate digestibility of 188 varieties of grain sorghum grown in Department of Agronomy test plots at 12 locations across Kansas. Fourteen varieties were selected from each of the 10 locations. Selected varieties were analyzed for crude protein, calcium, and phosphorus. Data were analysed by variety and location.

Results and Discussion

Digestibilities were not statistically different among the 14 varieties. However, there were several significant differences because of locations. The data are for the 1984 crop only, so location differences may actually reflect variation in growing conditions. Several locations were wet during the spring, but dry in July and August. An early frost (about September 30) occurred at many locations.

Crude protein values ranged from 9.05 to 10.01% among varieties and from 6.7 to 11.3% among locations (dry matter basis). Calcium ranged from 296 to 360 ppm for the 14 varieties and from 281 to 412 ppm across the 10 locations. Phosphorus varied from 3277 to 4198 ppm among the varieties and from 2699 to 4240 ppm among locations. Yields ranged from 79.6 to 91.9 bushels per acre among varieties and from 34.0 to 156.1 bushels per acre among locations. Data for varieties are shown in Table 3.1, and for locations in Table 3.2.

[1]Department of Agronomy.

Table 3.1. Average Nutritional Composition of 14 Grain Sorghum Varieties from 10 Locations[1]

Variety	Crude Protein (%)	Calcium (PPM)	Phos. (PPM)	IVDMD[2] (%)	Yield/Acre Bu.
Cargill-70	9.10	336	3480	74.3	83.3
DeKalb 42Y	9.05	340	4198	75.2	79.6
FB 301	9.46	324	3823	75.3	83.5
Funk's G550	10.01	296	3400	75.3	90.7
Jacques 408	9.72	354	3575	74.8	75.0
Oro GXTRA	9.21	343	3255	74.0	84.5
KSU RS610	9.54	296	3643	75.5	NA
Triumph 270D	9.68	323	3590	75.5	91.9
Triumph 264yG	10.37	360	3621	74.3	84.2
WAC D701G	9.36	305	3362	74.0	88.8
WAC 686	9.13	304	3341	74.6	89.7
Wheatland X TX2536	9.55	323	3426	75.2	82.7
TX3042 X TX2737	9.23	330	3277	75.9	84.2
TX2752 X TX430	9.30	325	3353	74.1	89.8

[1]Values are least squares means.
[2]In vitro dry matter digestibility.

Table 3.2. Average Nutritional Composition of Sorghum Varieties at 10 Locations[1]

Location (county)	Crude Protein (%)	Ca (PPM)	Phos (PPM)	IVDMD[2] (%)	Yield/ Acre Bu.	Rainfall (Inches) Apr	May	June	July	Aug	Sept
Brown	10.6	330	3205	74.8	94.4	7.18	2.58	15.97	1.69	1.97	1.66
Franklin	8.6	326	4240	74.2	107.5	5.72	5.23	11.39	3.20	0.5	1.29
Republic	10.3	276	3500	70.0	84.4	7.55	4.28	7.25	0.60	2.92	0.93
Stafford	10.7	351	3600	76.9	46.2	4.18	1.61	2.74	0.21	1.34	0.85
Ellis	11.3	303	3639	75.6	64.9	5.29	1.37	4.43	1.16	2.18	0.94
Greeley (Irr)	8.0	412	2908	74.9	82.5	—	—	—	—	—	—
Finney (Fal)	6.7	330	2689	76.7	34.0	4.11	1.44	0.93	2.43	0.30	0.37
Finney (Irr)	9.6	315	4058	72.6	103.1	—	—	—	—	—	—
Thomas (Fal)	9.9	333	3427	76.7	79.3	3.46	2.85	2.37	0.63	2.88	0.39
Thomas (Irr)	8.5	281	3978	75.8	156.1	—	—	—	—	—	—

[1]Values are least squares means of 14 varieties
[2]In vitro dry matter digestibility

The Feeding Value of Wheat and High Moisture Sorghum Grain Fed Singly and in Combination to Finishing Steers

Dirk Axe, Keith Bolsen,
Robert Lee,[1] and George Herron[2]

Summary

Wheat and high moisture sorghum grain were fed singly and in two combinations in a 121-day feedlot trial at the Garden City Branch Experiment Station. Feed efficiency improved with increasing proportions of wheat in the ration. However, rates of gain were similar for the three wheat-containing rations. Results showed that at least 33% sorghum grain can be substituted for wheat in finishing rations with little influence on performance.

The combination rations produced rates of gain that were above predicted values, indicating positive associative effects.

Introduction

The narrow margin of profit with which the cattle feeder has to work has stimulated careful study of the relative values of feeds available and their most effective use.

Sorghum grain's drought resistence and crop rotation potential makes it important to the cattle industry, but it has a low fermentability in the rumen, and is considered less valuable than corn because of its highly variable chemical composition.

Favorable pricing and availability have made wheat an attractive feed grain. Numerous trials have been conducted to determine the feeding value of wheat (Report of Progress 470), but there is little information on its value when fed in combination with other grains.

In some cases, the feeding value of a combination of two grains has been higher than either grain alone, an example of associative effects. Wheat is rapidly and extensively fermented in the rumen. Sorghum grain's low fermentability allows a large portion of its nutrients to be digested in the small intestine. A combination of the two may optimize cattle performance.

This trial was conducted to determine how varying the proportion of wheat and high moisture sorghum grain in beef rations would influence cattle performance.

[1]Formerly Garden City Branch Experiment Station.

[2]Garden City Branch Experiment Station.

Experimental Procedures

A 121-day feedlot trial involving 196 Charolais and Simmental crossbred steers (avg. initial wt. of 750 lb) was conducted at the Garden City Branch Experiment Station. Each treatment was randomly allotted to six pens, at least eight steers per pen, in a randomized complete block design. In the four ration treatments, the grain portion was: 1) all wheat ; 2) 67:33 combination of wheat (W) and sorghum grain (SG) (67W:33SG); 3) 33:67 combination of wheat and sorghum grain (33W:67SG); and 4) and all sorghum grain.

The wheat variety was TAM 105, harvested at 12 to 14% moisture and dry rolled prior to feeding. The sorghum grain was DeKalb DK-42Y, harvested at 25 to 27% moisture and processed in a tub grinder through a .3 inch screen prior to ensiling in a bunker silo. The composition of the rations on a DM basis was: 80% of the appropriate grain or grain combination, 7.8% supplement, 2.2% blended cane molasses, and 10% chopped alfalfa hay. Rations were formulated to contain 14% crude protein and met NRC (1984) mineral and vitamin requirements.

Steers were fed once daily and full weights were taken to establish initial and final weights, with the overall average dressing percent used to adjust final weights. Steers were weighed every 28 days. The feeding period was from February 25 to June 26, 1985.

Results and Discussion

Results for steer performance and carcass traits are shown in Table 4.1. Rates of gain for the wheat and combination rations were similar, with the sorghum grain ration producing 12.9% slower ($P<.05$) gains. Feed intake was 14.9% lower ($P<.05$) for the wheat and 67W:33SG rations compared with the 33W:67SG and sorghum grain rations. However, the wheat and 67W:33SG rations were utilized 32.5% and the 33W:67SG ration 14.1% more efficiently ($P<.05$) than the sorghum grain ration. Carcass characteristics were similar among treatments, except for dressing percent and quality grade. Steers receiving the 33W:67SG ration had a higher ($P<.05$) dressing percent than those receiving the wheat ration, and quality grade was greater ($P<.05$) for steers fed the 67W:33SG ration compared with those fed the wheat and 33W:67SG rations.

The performance data of the wheat vs. sorghum grain rations were plotted and a straight line drawn between them (Figures 4.1. and 4.2). The plots showed that rate of gain was 5.0% ($P=.17$) and 6.3% ($P=.08$) greater (Figure 4.1) and feed efficiency was 6.7% ($P=.10$) and 3.9% ($P=.27$) better (Figure 4.2) for the 67W:33SG and 33W:67SG rations, respectively, compared with predicted values calculated from the plots. These differences represent positive associative effects, whereby the values of the combination rations were higher than that predicted from the grains fed singly.

Table 4.1. Effect of Ration on Feedlot Performance and Carcass Traits of Finishing Steers

Item	Wheat	67W:33SG	33W:67SG	Sorghum Grain
	Ration			
No. of Steers	48	48	48	52
Initial Wt., lb	750	735	759	757
Final Wt., lb	1100	1089	1104	1067
	Feedlot Performance			
Avg. Daily Gain, lb	2.91[a]	2.93[a]	2.85[a]	2.56[b]
Daily Feed Intake, lb[1]	16.74[a]	17.56[a]	19.47[b]	19.95[b]
Feed/lb of Gain, lb[1]	5.78[a]	6.03[a]	6.86[b]	7.83[c]
	Carcass Traits			
Dressing, %	62.6[b]	63.3[ab]	63.6[a]	63.2[ab]
Quality Grade[2]	8.8[b]	9.6[a]	8.6[b]	9.2[ab]
Yield Grade	2.29	2.27	2.22	2.22
Fat Thickness, in	.32	.31	.31	.28
Ribeye Area, in	12.1	11.9	12.4	11.9

[a,b,c]Values in the same row with different superscripts differ (P<.05).

[1]100% dry matter basis.

[2]Average good = 8.0, high good = 9.0.

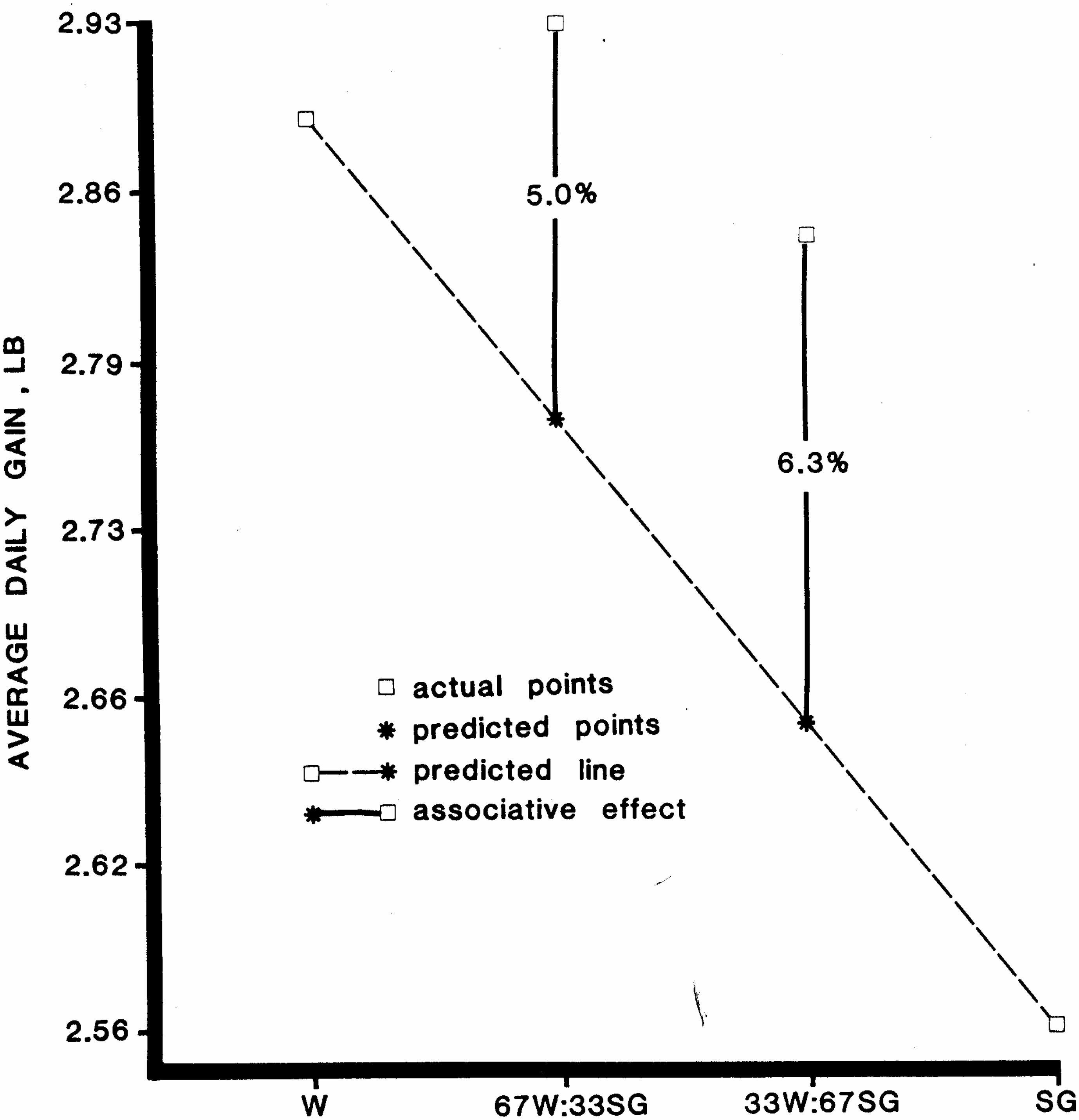

Figure 4.1. Average Daily Gain for Steers Fed the Four Rations.

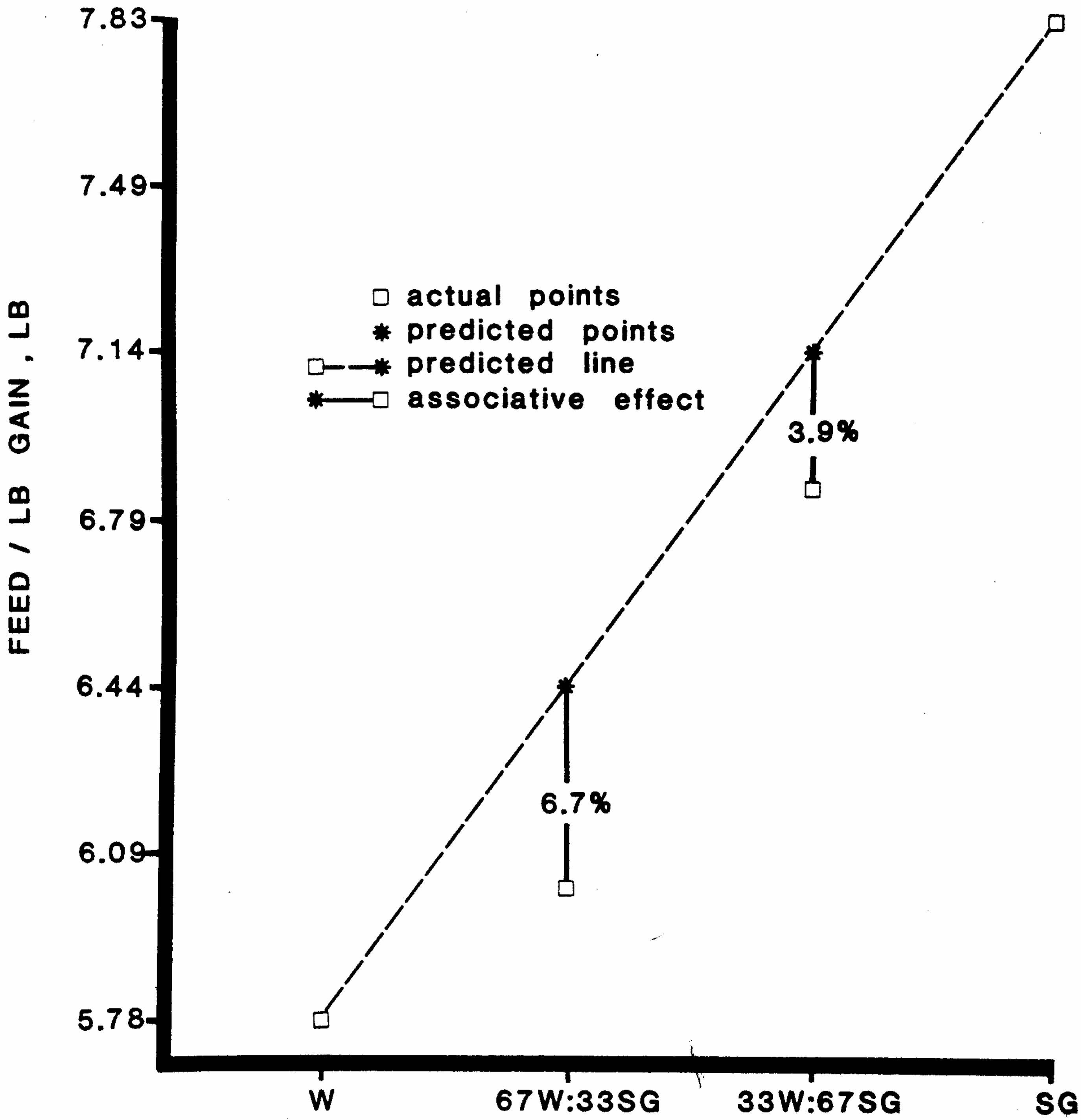

Figure 4.2. Feed/lb Gain for Steers Fed the Four Rations.

Effects of Monensin and Sodium Propionate on Net Nutrient Absorption in Steers Fed High-grain Diets

D. L. Harmon and T. B. Avery[1]

Summary

Adding either monensin or sodium propionate alone or in combination to the diet of steers fed high-grain diets resulted in increased net absorption of glucose. Monensin reduced ammonia output and gut uptake of urea. We propose that increased propionate availability reduces the utilization of glucose by gut tissues, allowing more glucose to reach the portal system. These changes may contribute to the increased feed effeciency seen when monensin is fed.

Introduction

Ionophore antibiotics like monensin (Rumensin®) shift ruminal fermentation to increased production of propionic acid. This may be a major contributor to the increased feed effeciency seen when these compounds are fed. The previous paper investigated how this change in fermentation was reflected in the nutrients absorbed into the portal blood stream. One of the changes we noted was an increase in the net absorption of glucose. The present study was conducted to separate the effects of increased propionic acid production from the direct effects of ionophores.

Experimental Procedures

Four Holstein steers (464 lbs) surgically fitted with catheters in the hepatic portal vein, a mesenteric vein, and a carotid artery were utilized to study how addition of monensin (300 mg/head/day) and/or sodium propionate (1 lb/head/day) to a high-grain diet influenced the pattern of absorbed nutrients. The diet consisted of 15% chopped alfalfa with the remainder of the diet made up of cracked corn and supplement to supply 11.5% crude protein, .62% calcium, and .4% phosphorous. Animals were fed in 12 portions daily every 2 hours using an automatic feeding system. Three samples of portal and arterial blood were taken at hourly intervals for 3 consecutive days during each sampling period. Blood flow was determined by continuous infusion of p-aminohippuric acid.

Results and Discussion

Dry matter intakes (Table 5.1) were not affected by addition of either monensin or propionate, nor was portal blood flow. Adding monensin tended to decrease the net gut uptake of glucose (P=.16), whereas adding propionate increased (P<.05) net glucose uptake. No differences were seen in the net absorption of lactate or beta-hydroxybutyrate, but adding monensin decreased net

[1]Department of Surgery and Medicine.

ammonia absorption and decreased the transport of urea back into the gut. Both of these changes are consistant with the antibiotic activitiy of monensin. It decreases ruminal protein and urea hydrolysis because rumen microbial activity is decreased. However, the decreased proteolytic activity was not reflected in the net absorption of alpha-amino-nitrogen. Adding propionate, however, decreased (P<.05) the net absorption of alpha-amino-nitrogen. No significant changes in the net absorption of glutamate, glutamine, or alanine were seen in either treatment.

It appears that increased propionate availability, whether achieved by altering ruminal fermentation with ionophores or by adding propionate directly to the diet, may reduce the utilization of glucose by gut tissues. This, in turn, would make more glucose available for absorption, which may be one reason why feed efficiency improves when ionophores are added to the diet.

Table 5.1. Main Effects of Dry Matter Intake, Blood Flow, and Net Nutrient Absorption in Steers Receiving Monensin and Sodium Propionate

Item	- Monensin	+	- Propionate	+
Intake (lbs. dry matter)	11.1	10.9	11.1	11.0
Portal blood flow, liter/h	651.1	668.7	681.2	638.6
	Net absorption, mmol/h			
Glucose[b]	-22.6	-3.8	-31.9	5.5
L-lactate	40.1	84.2	51.5	72.9
ß-hydroxybutyrate	46.3	26.6	26.1	46.8
Ammonia[a]	120.9	93.8	111.7	103.0
Urea-N[a]	-45.8	-11.4	-29.2	-29.1
Alpha-amino-N[b]	136.2	131.9	170.6	97.5
Glutamate	-6.0	-5.4	-7.5	-3.9
Glutamine	-9.7	-12.1	-7.7	-14.1
Alanine	16.4	20.3	20.1	16.6

[a]Significant Monensin effect (P<.05)

[b]Significant Propionate effect (P<.05)

Influence of Ionophore Addition to High-grain Diets on Net Nutrient Absorption

D. L. Harmon and T. B. Avery[1]

Summary

Adding ionophores to a high grain diet increased glucose absorption and decreased the transport of urea back into the gut. These changes are consistent with the antibiotic effects of these compounds. Decreased microbial activity in the gut and shifts in the pattern of absorbed nutrients may help explain the improvements in feed efficiency seen with ionophore addition.

Introduction

Ionophore antibiotics play a central role in U.S. beef production. The ionophores, Rumensin® (monensin) and Bovatec® (lasalocid), are added to diets of the majority of the feedlot cattle in this country. Their main effect is to increase feed efficiency. Recently, the effectiveness of a new ionophore, salinomycin, has been investigated. Ionophores affect the pattern of nutrients produced by ruminal microbial fermentation. Our objective was to evaluate how these changes in ruminal fermentation translated into nutrients absorbed into the portal blood system.

Experimental Procedures

Three Hereford heifers (770 lbs) were surgically fitted with catheters in the hepatic portal vein, a mesenteric vein, and the abdominal aorta, as well as with a permanent rumen fistula. The diet was 85% cracked corn and 15% alfalfa, with and without ionophore addition. Animals were fed at 2-hour intervals with 12 sets of blood samples taken per sampling period. Treatments were control, monensin (300 mg/head/day), or salinomycin (100 mg/head/day). Blood flow was determined by continuous infusion of p-aminohippuric acid, and net nutrient absorption into the portal system was calculated.

Results and Discussion

Dry matter intake (Table 6.1) was slightly less ($P>.10$) for animals receiving the control diet, as was blood flow ($P=.11$). Adding monensin increased net glucose absorption ($P<.05$) but lactate, betahydroxybutyrate, and ammonia were unaffected. Both ionophores decreased the transport of urea back into the gut ($P<.10$) and tended to increase the absorption of alpha-amino-nitrogen. Both ionophores increased the net absorption of glutamate ($P<.10$). The amount of a nutrient flowing to the portal system can increase because 1) more of the nutrient is being absorbed or 2) less of the nutrient is being utilized by gut tissue itself. A

[1]Department of Surgery and Medicine.

negative flow of portal nutrients means that either 1) the nutrient is flowing back into the gut (urea is an example) or 2) the gut wall is utilizing more of the nutrient than is being absorbed. As ruminal fermentation was altered by the ionophores, there was an increase in the net absorption of glucose and an increased gut uptake of glutamine with an increase in the appearance of glutamate and alanine. The increased glucose absorption may have been caused by more starch entering the small intestine because of decreased ruminal microbial activity, or by decreased utilization of glucose by gut tissues.

Table 6.1. Dry Matter Intake, Blood Flow, and Net Nutrient Absorption in Heifers Fed a High Concentrate Diet

	Treatment		
Item	Control	Salinomycin	Monensin
Intake (lbs dry matter)	9.6	11.4	11.2
Portal blood flow, liter/h	564.2	747.6	701.9
Net absorption, mmol/h			
Glucose[a,b]	-27.7	-20.5	14.0
L-lactate	89.5	59.4	69.6
ß-hydroxybutyrate	94.5	72.1	91.8
Ammonia	150.6	199.6	117.7
Urea-N[a]	-126.8	-51.3	-21.1
Alpha-amino-N	138.3	228.8	193.3
Glutamate[a,b]	-4.14	-2.55	-.24
Glutamine	-1.15	-11.74	-18.33
Alanine	11.90	29.20	41.25

[a]Control vs. ionophores (P<.10).

[b]Salinomycin vs. Monensin (P<.10).

Effect of Combinations of Rumen-Protected Methionine Plus Rumen-Protected Lysine on Performance of Finishing Steers

Jack Riley, Gary Goldy,
and Ron Pope

Summary

Feed efficiency for finishing steers was significantly improved (7.4%) when rumen-protected methionine and lysine were added to a finishing ration.

Introduction

Basic ruminant nutrition research has demonstrated improved performance with postruminal infusion of amino acids. This has led to the development of rumen protected amino acids by Eastman Kodak. Research is currently limited to investigating various ratios and levels of methionine and lysine coated with a polymeric substance that survives the rumen environment, but is swollen and dispersed in the abomasum, releasing the amino acids. The polymer is not absorbed but is excreted unchanged in the feces.

Experimental Procedures

One hundred and eighty crossbred steers averaging 720 lbs. were randomly allotted to 30 pens of six steers each. All steers were vaccinated for IBR, BVD, leptospirosis and 7-way clostridium and were wormed with injectable levamisole. Individual shrunk weights were taken initially and at the end of the 122 day trial. Interum weights at 28 day intervals were taken prior to the morning feeding. All steers were implanted initially and re-implanted at 56 days. Six pens (36 steers) were fed a basal diet containing (as fed basis) 70% sorghum grain, 25% sorghum silage and 5% supplement. The diets were formulated to meet 1984 NRC recommendations (crude protein, 10.8%).

The trial was designed to test a control and four levels of rumen-protected methionine (RPMET) + rumen protected lysine (RPLys) (Table 7.1). Individual jugular blood samples were obtained from two steers within each pen on days 7 and 56 to determine level of plasma amino acids. Individual identity was maintained at slaughter and carcass weight, quality grade, yield grade, and liver abscess data collected. Composition of the basal diet is shown in Table 7.2.

Table 7.1. Supplemental Dietary Amino Acid Levels

Treatment	Methionine[1]	Lysine[1]
Control	0.00	0.00
A	0.05	0.04
B	0.10	0.08
C	0.15	0.12
D	0.20	0.16

[1] Actual dosage (percent of diet dry matter) of supplemental active amino acids.

Table 7.2. Composition of Basal Diet[1]

Ingredient	% (as fed basis)
Sorghum grain	72.5
Sorghum silage	25.0
Dried molasses	0.8
Urea	0.4
Calcium carbonate	0.6
Salt	0.3
Dicalcium phosphate	0.2
Potassium chloride	0.15
Trace mineral	0.02
Vitamin A (30,000 I.U./g)	0.01
Rumensin - 60	0.02

[1] RPMet + RPLys were mixed at 2.5% of sorghum grain to provide dietary levels shown in Table 7.1.

Results and Discussion

Results are shown in Table 7.3. Steers consuming the control diet ate the most daily feed and gained the slowest. Even though dry matter intake did not differ significantly, all treatments with RPMet + RPLys showed lower average daily consumption. Daily gains for treatment B(3.47 lb) and D(3.48 lb) were significantly higher ($P<.10$) than for the control (3.27 lb). Feed efficiencies for all supplemental amino acid treatments were better than for the control ($P<.05$).

The average improvement in feed utilization was 7.4%, with treatment B being the most efficient. There were no significant differences for any of the carcass traits evaluated in this study.

Table 7.3 Effect of Combinations of Rumen-Protected Methionine Plus Rumen-Protected Lysine on Performance of Finishing Steers

Item	Control	A .05%RPmet .04%RPLys	B .10%RPmet .08%RPLys	C .15%RPmet .12%RPLys	D .20%RPmet .16%RPLys
No. Steers	36.0	36.0	36.0	36.0	36.0
Initial wt, lb.	720.3	719.4	720.2	720.7	719.5
Final wt, lb.	1119.2	1139.1	1144.8	1137.9	1144.1
Gain, lb.	398.9	419.7	424.6	417.2	424.6
ADG, lb.	3.27^{a}	3.44^{ab}	3.48^{b}	3.42^{ab}	3.48^{b}
Daily intake, lb. D.M.	23.48	23.07	22.93	22.61	23.16
Feed/gain, lb. D.M.	7.17^{c}	6.72^{d}	6.59^{d}	6.62^{d}	6.66^{d}

[a,b]Means in same row with different superscripts differ ($P<.10$).

[c,d]Means in same row with different superscripts differ ($P<.05$).

Bacteriological and Histopathological Investigations of Liver Abscesses

K.F. Lechtenberg, T.G. Nagaraja, and H.W. Leipold[1]

Summary

Fusobacterium necrophorum was the predominant bacterial isolate from 49 liver abscesses. Biotype A tended to occur in pure infections and produced a more severe tissue reaction than biotype B, which tended to occur as a mixed infection.

Introduction

Abscessed livers in feedlot cattle are a constant concern to both producers and packers. Without feeding of an antibiotic, the incidence of abscesses is approximately 30% and ranges from 5% to 90% depending on management and ration. Adding an antibiotic, such as tylosin (Tylan®, 10g/ton), to the feed significantly reduces the incidence of abscesses. Most liver abscesses in cattle cannot be diagnosed by observation. Cattle with severely abscessed livers have decreased daily gain (3.5-7%) and feed efficiency (7%). Abscessed livers are a direct cost to the packer, since any liver with an active abscess is condemned. The liver accounts for approximately 2% of the live weight of cattle. The packer either passes this cost along to the consumer or discounts the price paid for live cattle. Some packing houses are taking the incidence of abscessed livers into account for individual feedlots that consistently send cattle with a higher than normal abscess rate.

Experimental Procedure

Twenty-eight abscessed livers from feedlot steers and heifers fed in north central Kansas and northwestern Missouri were collected at Iowa Beef Processors Inc., Emporia, KS. Forty-nine abscesses from these livers were evaluated for facultative and anaerobic bacterial involvement and histopathological changes. Facultative bacteria were isolated and characterized with the assistance of the Dept. of Laboratory Medicine, College of Veterinary Medicine. Anaerobic bacteria were isolated, characterized, biotyped, and tested for antimicrobial sensitivity using the anaerobic equipment in the Rumen Microbiology Laboratory, Dept. of Animal Sciences. Histology sections were prepared, stained, and evaluated with the assistance of the Dept. of Pathology, College of Veterinary Medicine.

Results and Discussion

Facultative bacteria were isolated from 44% of the abscesses, with the predominate isolate being Corynebacterium pyogenes. Facultative bacterial counts ranged from 1.0×10^4 to 9.2×10^9 colony forming units (CFU) per gram of purulent

[1]Department of Pathology.

material with a mean of 8.0×10^8. Fusobacterium necrophorum, the predominant anaerobic isolate, was found in 100% of the lesions. Viable anaerobic counts ranged from 1.1×10^6 to 2.5×10^{10} with a mean of 3.0×10^8 CFU/g. Biotyping of F. necrophorum revealed that biotype A was isolated from 51% of the abscesses; 76% of it was in pure culture. Biotype B was isolated from 53% of the abscesses; 88% of this biotype was in mixed infections, usually with C. pyogenes.

Histologic evaluation revealed that both biotypes of F. necrophorum formed typical abscess lesions. However, infections with biotype A tended to cause more severe effects. We found more cellular infiltration, more extensive capsule formation, and more extensive peri-abscess portal triad fibrosis and bile duct proliferation in abscesses containing biotype A than in those containing biotype B alone. Mixed infections of biotype B had a tissue response similar to that of a pure biotype A.

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Why do Liver Abscesses Form?

While ruminants are adapting to grain, or whenever they over-consume grain, the pH of the rumen fluid is lowered by acids from the rumen's bacterial fermentation. The low pH irritates the rumen wall and may cause ulcers and abscesses. The blood draining the rumen wall flows toward the liver via the portal vein, carrying absorbed nutrients. If the rumen wall has become ulcerated, the blood may also carry Fusobacterium necrophorum, a normal inhabitant of the rumen. Once in the liver, the bacteria can grow rapidly, causing inflammation and killing a large number of liver cells. In an attempt to keep the bacteria from spreading to the rest of the liver, the animal's body walls off the area of damaged tissue, thus forming a liver abscess. Abscesses tend to get larger with time, and will eventually cause the formation of fibrous scar tissue.

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A Comparison of Synovex-S® and STEER-oid® Implants for Finishing Cattle

Jack Riley, Gary Goldy, and Ron Pope

Summary

There were no significant differences in performance or carcass traits for finishing cattle implanted with either Synovex-S® or STEER-oid®. The 122-day trial used 180 steers, with each treatment having 15 replicates.

Introduction

Synovex-S® and STEER-oid® are generic equivalents which both contain 200 mg progesterone and 20 mg estradiol benzoate per implant of eight pellets. Since the implants are produced by different companies, there continue to be questions regarding apparent differences in hardness, release rate, length of effectiveness, and comparative responses. Recent studies from Texas, Minnesota, and Kansas reported no significant differences between the two implants.

Experimental Procedure

One hundred eighty Angus x Hereford crossbred yearling steers were blocked by weight and randomly allotted to 30 feeding pens. Steers in 15 pens were implanted with Synovex-S and steers in the other 15 pens received STEER-oid. All steers were reimplanted with their respective implants on day 56 of the trial. All steers were eartagged, vaccinated for IBR, BVD, Leptospirosis, and 7-way clostridium, and wormed with injectable Tramisol®.

Individual initial and final weights were taken after a 16-hour removal from feed. The diet contained (D.M. basis) 84% dry rolled milo, 10% sorghum silage, and 6% supplement. Calculated analysis was 10.8% crude protein and 75.0% dry matter. The diet also contained 30 grams/ton of Rumensin.

Results and Discussion

The results of the trial are shown in Table 9.1. There were no significant differences in average feedlot performance nor in carcass characteristics between the two implants for the 122-day trial. Individual full weights taken at 28-day intervals also were not significantly different, which further indicates similar activity and response.

Table 9.1. Effect of Synovex-S or STEER-oid Implants on Performance and Carcass Characteristics of Finishing Steers.

Item	Synovex-S	STEER-oid
Pens	15	15
No. steers	90	89
Days on feed	122	122
Initial wt., lb.	721.2	726.6
Final wt., lb.	1141.2	1141.9
Gain, lb.	420.0	415.3
Daily gain, lb.	3.44	3.40
Intake, as fed, lb.	30.77	30.67
Feed/Gain, as fed, lb.	8.94	9.02
Carcass wt., lb.	696.1	693.2
Yield grade	2.88	2.88
Quality grade:		
No. prime	3	1
No. choice	80	84
No. good	7	4
Abscessed livers	15	8

Weight Changes and Estrous Cycles After Abortion in Beef Heifers

J.M. Wright and G.H. Kiracofe

Summary

Ninety-one pregnant, crossbred Angus heifers aborted after receiving an injection of a prostaglandin analog at an average of 50, 75, 100, or 122 days of gestation. Weight change in the first 3 weeks after abortion and subsequent estrous cycles were observed. No detrimental effects were noted in those heifers aborting at 50 or 75 days of gestation, and growth rate was not altered. Those heifers aborting at 100 days of gestation exhibited a decreased growth rate; those aborted at 122 days lost weight. There was more udder development, vaginal discharge, and retained membranes in heifers aborted later in gestation. Typically, heifers exhibited estrus within 5 days after abortion, then had 8- to 12-day cycles until a normal cycle occurred. Heifers aborted at 50 days of gestation required an average of 7.5 days prior to the estrus of their first normal cycle, 13.2 days if aborted at 75 days, 16.7 days if aborted at 100 days, and 24.7 days if aborted at 122 days.

Introduction

Prostaglandin F_2 alpha (PGF) and its analogs are abortifacients in several species. Injection of PGF will terminate pregnancy in cattle up to 150 days of gestation. Stage of pregnancy influences the effectiveness of PGF in inducing abortion, weight change after abortion, and time required for return of normal estrous cycles. These are factors to be considered by both feedlot and ranch managers.

The current study was designed to determine weight loss and time required for return of normal estrous cycles after abortion with PGF at various stages of gestation.

Experimental Procedure

One hundred three pregnant crossbred Angus heifers (average weight, 890 lb) were injected with a prostaglandin analog at either at 50, 75, 100, or 122 days of gestation. The range in days pregnant at injection for each group was 45-60 for the 50-day group, 71-79 for the 75-day group, 94-101 for the 100-day group, and 117-132 for the 122-day group. All heifers were being fed to gain about 2.5 lb/day. The initial weight was taken at time of treatment. A second weight was taken 1 week after treatment, and a third weight was taken 3 weeks after treatment. Heifers were observed twice daily for estrus and complications arising from the treatment. Heifers were also palpated weekly to detect other possible complications, and to follow changes in uterine tone and size. Cycles of less than 13 days were classified as "short", those of 16 to 24 days as "normal", and those more than 24 days as "long".

Results and Discussion

There was no difference in weight change between the 50-day and 75-day abortion groups, and their average daily gains were similar to heifers that were injected and did not abort (2.52, 3.1, and 2.76 lb/day respectively; Table 10.1). However, heifers treated at 100 days of gestation gained only 1.2 lb/day; and those treated at 122 days lost .24 lb/day for the 3 weeks following treatment.

Generally, membranes or fetuses were expelled 3 to 6 days after treatment. There were retained membranes (26.5%) and infection (8%) in heifers treated at 122 days of gestation; these problems did not occur in heifers aborted earlier. Heifers treated at 122 days also exhibited some udder development (20 of 49), vaginal discharge, and appeared uncomfortable and nervous during the first week after injection.

As days of pregnancy at treatment increased, time required for return of normal estrous cycles also increased (Table 10.2). The interval from injection to estrus ranged from 2.5 to 49 days, and averaged 5 days. The first cycle after treatment was typically short (8 to 12 days). A second short cycle or a normal cycle (16 to 24 days) then occurred. In general, heifers aborted at 50 or 75 days had no more than two short cycles prior to a normal cycle. Heifers treated at 100 or 122 days exhibited two or three short cycles, with a few heifers having five short cycles. The cycling pattern in heifers aborted at 50, 75, or 100 days appeared more predictable than those aborted after 100 days (Table 10.2).

Table 10.1. Comparison of Weight Change in Heifers Aborted at 50, 75, 100, or 122 days of Gestation.

Item	Average Day of Gestation at Treatment				Heifers Not
	50	75	100	122	Aborting
No. of Heifers	15[1]	14	13	49	12[2]
Initial Weight (lb)	830	839	885	943	878
Weight, 1 Week Post-treatment (lb)	850	858	898	916	901
Weight Change (lb)	20	19	13	-27	23
Weight, 3 Weeks Post-treatment (lb)	883	904	912	938	936
Total Weight Change (lb)	53	65	27	-5	58
Avg. Daily Gain (lb/day)	2.52	3.1	1.29	-0.24	2.76

[1] Weights not collected for one heifer that did abort; therefore, data are based on 14 heifers.

[2] Two heifers did not abort in the 50-day group, 4 in the 75-day group, 4 in the 100-day group, and 2 in the 122-day group.

These data indicate that heifers can be aborted up to 75 days of pregnancy without weight losses or serious effects on their ability to return to normal estrous cycles. However, reduction in weight gain, lengthened intervals to normal cycling, and complications such as udder development, retained placentas, and uterine infections can be expected after 100 days.

Table 10.2. Estrous Cycles in Heifers That Were Aborted at an Average of 50, 75, 100, or 122 Days of Gestation.

Item	Average Day of Gestation at Treatment			
	50	75	100	122
No. Heifers	15	14	13	49
Interval From Injection to Estrus (days)	3.6	4.2	3.7	6.7
Days to Estrus of First Normal Cycle	7.5	13.2	16.7	24.7[1]
First Cycle Length (days)	14.4	11.8	8.8	13.09[2]
Second Cycle Length (days)	17.7	20.7	15.6	13.15[3]
Number of Heifers With:				
Short First Cycles	7 (46.7%)	11 (78.6%)	12 (92.3%)	31 (63.3%)
Normal First Cyles	8 (53.3%)	2 (14.3%)[4]	1 (7.7%)	13 (26.5%)[5]
Repeated Short Cycles[6]	1 (14.3%)	3 (27.3%)	7 (58.3%)	25 (80.6%)

[1,2,3]Value does not include those heifers not exhibiting estrus.

[4]One heifer exhibited a long cycle (28.5 days).

[5]Two heifers exhibited long cycles (25 days, 32.5 days), and three heifers never exhibited a second estrus.

[6]Number represents those exhibiting a second short cycle following an initial short cycle.

Aborting Feedlot Heifers with Alfavet® or Bovilene®[1]

Scott Laudert,[2] Garth Boyd, and Gerry Kuhl

Summary

Alfavet® (alfaprostol), an experimental prostaglandin analog for inducing abortion in feedlot heifers, was evaluated for efficacy. Abortion was induced within 8 days following injection of 5 mg alfaprostol in 45 of 51 heifers (88.2%) ranging from 40 to 150 days in gestation. Bovilene® (fenprostalene), injected at 1 mg per head resulted in abortion in 45 of 49 heifers (91.8%) of similar pregnancy status. Both products were 95-100% effective from 40 to 120 days of pregnancy, but only 75% effective from 121 to 150 days.

Introduction

Pregnant feedlot heifers continue to be a serious economic problem. In the past few years, several drugs have been introduced that induce abortion. This trial was conducted to measure the safety and efficacy of a new abortion-inducing drug for feedlot heifers.

Experimental Procedures

One hundred yearling heifers from 40 to 150 days pregnant were used to compare the efficacy of Alfavet® (alfaprostol) and Bovilene® (fenprostalene) as abortifacients. Each product was administered to alternate heifers found by rectal palpation to be within the following gestation-day ranges: less than 90 days, 91 to 120 days, and 121 to 150 days. Dosage and injection routes were 5 ml (5 mg) alfaprostol, intermuscularly or 2 ml (1 mg) fenprostalene, subcutaneously. All heifers were penned together and observed for complications. Eight days following injection, each heifer was repalpated to determine pregnancy status.

Results

No differences in abortion percentages were detected between the two products (Table 11.1). Both products displayed excellent efficacy on fetuses less than 120 days old. Both products were about 75% effective on fetuses from 121 to 150 days old. The results of this trial agree with other published work on the efficacy of Bovilene®.

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[1]Appreciation is expressed to Grant County Feeders, Ulysses, KS for supplying cattle and facilities and to Hoffmann-LaRoche, Inc., Nutley, NJ for support. Alfavet® is not yet approved for use.

[2]Extension Livestock Specialist, Southwest Kansas.

Table 11.1. Efficacy of Alfavet® and Bovilene® as Abortifacients for Feedlot Heifers 150 or Fewer Days Pregnant

Item	Alfavet®				Bovilene®			
	121-150	91-120	40-90	40-150	121-150	91-120	40-90	40-150
	days				days			
No. Heifers	18	13	20	51	17	13	19	49
Avg. Days Preg.	142	110	74	107	142	103	75	106
No. Aborted	13	13	19	45	13	13	19	45
% Aborted	72.2	100	95.0	88.2	76.5	100	100	91.8

The pregnant feedlot heifer is more than just a nuisance; she's an economic liability to both the feeder and the packer. If she calves in the lot, she loses valuable pounds, and runs a serious risk of health problems. If she's still pregnant at slaughter, she's a dressing percent disaster, so she sells grade-and-yield, or at a severe discount. Either way, she spells red ink for the entire cattle industry.

Reproductive Performance of Angus x Hereford and Brahman x Hereford Heifers Fed to Prebreeding Target Weights

D.J. Patterson, L.R. Corah, D.D. Simms,[1]
J.R. Brethour[2], and W.R. Negus[2]

Summary

Heifer development as effected by nutrition was evaluated in 148 F_1 Angus x Hereford (A x H) and 148 F_1 Brahman x Hereford (B x H) heifers. Heifers within each breed cross were assigned to one of two energy levels and weight groups. Heifers on the low and high energy-level diets were fed to reach 55 or 65%, respectively, of their projected mature body weights by the start of spring breeding.

A higher (P<.05) percentage of A x H heifers had reached puberty by the start of spring breeding; however, their average age at puberty was greater (P<.05) than that of B x H heifers. Weight at puberty, for heifers that cycled prior to the start of spring breeding, did not differ between breed groups. Weight of heifers at puberty was greater with the high-energy than with the low-energy diets. Prebreeding body condition scores of heifers on the two energy levels differed (P<.05) more among the A x H females.

The A x H heifers had higher (P<.05) fall pregnancy rates than the B x H heifers (89.2 vs 71.9%). Energy level had no significant effect on fall pregnancy rate of A x H heifers, but B x H heifers on the high-energy level had a higher (P<.05) pregnancy rate than those on the low-energy diet.

Introduction

Attainment of puberty in beef heifers depends largely on age and weight; however, the influence of these two factors differs with breed. Sorting heifers and feeding heavy and light weight groups separately effectively reduces age at puberty and increases pregnancy rate.

This study was conducted to evaluate reproductive performance in the first and subsequent calvings of two different biological types of beef females fed to reach target percentages of their projected mature body weight by the start of spring breeding.

[1]Extension Livestock Specialist, Northeast Kansas.

[2]Fort Hays Branch Experiment Station.

Experimental Procedures

This project was designed to measure the effects of breed cross and heifer development as affected by nutrition and breeding scheme on lifetime productivity and reproductive performance. We used 148 F_1 Angus x Hereford (A x H) heifers and 148 F_1 Brahman x Hereford (B x H) heifers obtained from 17 ranches throughout Kansas, east central Colorado, and northeastern Oklahoma. All heifers purchased for the study were known F_1's with a recorded birth date.

At the start of the trial, heifers within each breed group were randomly allotted to one of two nutritional treatments based on origin and birth date. Within each treatment, heifers were then divided into light (below average) and heavy weight (above average) groups based on initial weight.

Nutritional treatments consisted of either low or high-energy feeding programs designed to allow both light and heavy heifers to reach 55% or 65%, respectively, of their projected mature body weight by the start of spring breeding. Frame measurements were used to predict mature weights. Nutritional treatments were started on December 5, 1984 and continued through June 29, 1985. Diets consisted of prairie hay, ground milo, and a soybean meal-based supplement. Heifers were weighed every 28 days and gains were compared with the desired gain for each treatment group. Based on monthly gains, diets were adjusted to attain the following month's desired weight change.

Prior to the breeding season, heifers were observed twice daily for visible estrus. In addition, the eight groups of heifers were exposed to either marker bulls or androgenized cows to aid in estrus detection. Criteria used to determine age at puberty included:

1) marked by a bull or androgenized cow, or seen standing in estrus

2) presence of a palpable corpus luteum

3) progesterone levels $\geq$ 1 ng/ml of serum 6 to 10 days following observed estrus

At the start of the breeding season, heifers were classed as either cycling or prepuberal based on these criteria. Beginning on May 12, heifers were observed continuously during the daylight hours to detect signs of visible estrus and the use of marker bulls was continued. Heifers were inseminated 12 hr following the onset of estrus by one of two AI technicians, using semen from a single sire. At the end of the 45-day AI period, heifers were transferred to the Fort Hays Branch Experiment Station and exposed to a clean-up bull for 35-days.

Results and Discussion

Heifer weights are summarized in Table 12.1. Actual prebreeding weights of both breed groups closely matched the targeted weights. The one exception was the light weight, B x H heifers on the high energy diet, which gained slower than anticipated. Average daily gains across all treatments ranged from .49 to 1.59 lb per day. Daily gains do not reflect actual gain potential, since all heifers were fed to prebreeding target weights.

Age and weight at puberty, prebreeding body conditon score and weight, and fall pregnancy status of the respective breed groups are summarized in Table 12.2. A higher percentage ($P<.05$) of the A x H heifers had reached puberty by the start of spring breeding compared to the B x H heifers (92.6 vs. 66.8%). This difference may be explained in part by the fact that the A x H heifers were about a month older.

Of the heifers that reached puberty before spring breeding, average age at puberty was greater ($P<.05$) for the A x H heifers (361 vs. 338 days), but a smaller percentage of the B X H heifers had cycled. No significant difference was observed between breed groups for weight at puberty. Weight at puberty was heavier ($P<.05$) in both breed groups for heifers on the high-energy level.

Prebreeding body condition scores for the two breed groups differed ($P<.05$) among the energy levels and weight groups. Body condition scores increased with increasing weight in the A x H heifers, but not in the B x H heifers.

Fall pregnancy rates were higher ($P<.05$) among the A x H heifers compared to the B x H heifers (89.2 vs. 71.9%). No major differences in pregnancy rates were seen in the A x H heifers because of energy level or weight grouping. However, in the B x H heifers, fall pregnancy rates were higher ($P<.05$) on the high-energy level. This may represent an important difference between the breed groups that warrants further consideration.

We will continue to measure subsequent reproductive performance of these heifers to examine the long-term effects of nutritional treatments imposed during the early development period.

Table 12.1. Prebreeding Heifer Weight and Body Condition Score Summary

	Breed, Treatment, and Weight Group							
	Angus x Hereford				Brahman x Hereford			
	Low energy[1]		High energy		Low energy		High energy	
Item	Light	Heavy	Light	Heavy	Light	Heavy	Light	Heavy
No. Heifers	37	37	37	37	37	37	37	37
Initial Wt., lb[2]	442	516	436	504	426	502	431	505
Estimated Mature Wt., lb[3]	1050	1050	1050	1050	1125	1125	1125	1125
Target Prebreeding Wt., lb	578	578	682	682	619	619	731	731
Actual Prebreeding Wt., lb	609	590	677	690	621	640	662	727
Average Daily Gain, lb (12/5/84 to 5/6/85)	1.09	.49	1.59	1.22	1.28	.91	1.52	1.46

[1]Energy level: heifers were fed to weigh 55% (low level) or 65% (high level) of projected mature body weight by the start of spring breeding.

[2]Initial wt. obtained on Dec. 5, 1984.

[3]Mature wt. estimates were based on age, frame size, and weight.

Table 12.2. F_1 Angus x Hereford and F_1 Brahman x Hereford Yearling Prebreeding and Fall Pregnancy Summary

	Low Energy						High Energy					
	Light		Heavy		Total		Light		Heavy		Total	
Item	Cycling	Prepuberal	Cycling	Prepuberal	Cycling	Prepuberal	Cycling	Prepuberal	Cycling	Prepuberal	Cycling	Prepuberal
						F_1 Angus x Hereford						
No. heifers,	36/37	1/37	33/37	4/37	69/74	5/74	35/37	2/37	33/37	4/37	68/74	6/74
%	97.3	2.7	89.2	10.8	93.2	6.8	94.6	5.4	89.2	10.8	91.9	8.1
Age at puberty,												
days[1]	365^{abd}	—	358^{ac}	—	361	—	376^{b}	—	348^{cd}	—	362	—
Wt at puberty, lb[1]	543^{a}	—	564^{a}	—	553	—	592^{b}	—	590^{b}	—	591	—
Prebreeding body												
condition score[2]	4.7^{b}	5.0	4.3^{a}	4.4	4.5	4.5	5.5^{c}	5.0	5.5^{c}	5.8	5.5	5.5
Prebreeding wt, lb	610	580	591	580	600	580	675	712	687	715	684	714
No. pregnant,	32/36	0/1	31/33	3/4	63/69	3/5	32/35	2/2	28/33	4/4	60/68	6/6
%	88.8^{a}	0.0	9.39^{a}	33.3	91.3	60.0	91.4^{a}	100.0	84.8^{a}	100.0	88.2	100.0
						F_1 Brahman x Hereford						
No. heifers,	32/37	5/37	24/37	13/37	56/74	18/74	22/37	15/37	21/37	16/37	43/74	31/74
%	86.5	13.5	64.9	35.1	75.7	24.3	59.5	40.5	56.8	43.2	58.1	41.9
Age at puberty,												
days[1]	328^{a}	—	348^{b}	—	338	—	340^{ab}	—	338^{ab}	—	339	—
Wt at puberty, lb[1]	540^{c}	—	571^{a}	—	555	—	598^{ab}	—	613^{b}	—	606	—
Prebreeding body												
condition score[2]	5.6^{b}	5.3	5.3^{a}	5.3	5.5	5.3	5.7^{a}	5.6	6.0^{c}	6.1	5.9	5.9
Prebreeding wt, lb	622	615	642	643	630	635	670	650	716	742	694	698
No. pregnant	21/32	4/5	14/24	11/13	35/56	15/18	15/21	12/15	17/20	11/16	32/41	23/31
%	68.8^{a}	80.0	58.3^{a}	84.6	62.5	83.3	71.4^{ab}	80.0	85.0^{b}	68.8	78.0	74.2

[1]Least squares means.

[2]Body condition score statistical comparisons reflect only differences among cycling heifers.

[a,b,c,d]Means with different superscripts within rows differ (P<.05).

The Effect of GnRH on Pregnancy Rates in Estrus-Synchronized Beef Heifers

Mary Ferguson and Larry Corah

Summary

Injecting 100 mcg of GnRH into cycling heifers at artificial insemination following estrus synchronization with either prostaglandin or Syncro-Mate-B® did not improve first service conception rate. However, GnRH improved first service conception in Syncro-Mate-B®-treated heifers that did not exhibit estrus prior to breeding and were bred by appointment.

Introduction

Use of artificial insemination in beef cattle is still limited, partially because of low first service conception rates. Injecting gonadotropin-releasing hormone (GnRH) or related gonadotropins at artificial insemination has had varying effects on conception rate. Research at Kansas State University using GnRH on lactating Holstein cows did not improve first service conception rate, but conception rates on second and third services were improved by nearly 21%.

This study was designed to determine the effect of GnRH on conception rates in yearling beef heifers, estrus synchronized with Syncro-Mate-B®[1] (SMB) or prostaglandin[2] (PGF).

Experimental Procedures

Spring trials with Syncro-Mate-B®

Three field trials were conducted in 1984 on 169 spring-born, yearling beef heifers. All received the SMB treatment (6 mg norgestomet implanted subcutaneously in the ear for 9 days and an intramuscular injection of 5 mg estradiol valerate and 3 mg norgestomet on the day of implant insertion).

The heifers were observed for estrus beginning 24 hr after implant removal. Those showing heat 24 to 36 hr after implant removal were artifically inseminated 12 hr after estrus was first detected. Those that did not show heat by 36 hr were inseminated 48 hr after implant removal. All heifers were allotted at breeding to either an untreated control group or a treated group that received 100 mcg of GnRH (2 ml Cystorelin®[1]) subcutaneously at insemination. Calving dates were used to determine conception rate.

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[1] CEVA Laboratories, Overland Park, Kansas.

[2] Lutalyse is a Prostaglandin developed and marketed by the Upjohn Co., Kalamazoo, Michigan.

Fall trial with Syncro-Mate-B®

Two additional field trials with SMB and GnRH were conducted on 268 fall-born yearling beef heifers. Procedures were the same as in the spring trials. At first service, all heifers were inseminated by the same A.I. sire 48 hr after implant removal.

Trial with Prostaglandin

At another commercial ranch in Southwest Kansas, 184 fall-born yearling Angus heifers were observed 5 days for estrus. Heifers showing estrus were artificially inseminated 12 hr after the onset of estrus. On day 6, 25 mg PGF (5 ml Lutalyse) was given intramuscularly to heifers that had not shown estrus. Heifers that exhibited estrus by 12 days after PGF injection were inseminated 12 hr after the onset of estrus. Those that did not exhibit estrus after PFG were given a second injection on day 12, and were inseminated by estrus. All heifers were allotted to either an untreated control group or a GnRH-treated group at insemination. Over a 65-day breeding season, heifers that returned to estrus were reinseminated and about 70% of the treated heifers received GnRH again. Pregnancy was determined by rectal palpation 40 days after the last insemination.

Results and Discussion

Trials with SMB

Injecting GnRH at breeding following synchronization with SMB did not significiantly affect first or second service conception rates (Table 13.1). We cannot explain the extremely low first service conception rate, except for the fact that a high percentage of the heifers were not cycling.

Those heifers not observed in estrus before insemination had higher conception rates if injected with GnRH at first service (Table 13.2). GnRH may have induced follicle rupture, which would correlate time of insemination and ovulation.

Table 13.1. Effect of GnRH on First and Second Service Conception Rates of SMB-Synchronized Heifers

Item	GnRH	Control
First service conception rate, %	20.71	17.79
No. heifers	41/198	37/208
Second service conception rate, %	28.57	33.33
No. heifers	4/14	7/21

Table 13.2. Effect of GnRH on First Service Conception Rates in SMB-Synchronized Heifers Bred by Appointment or by Estrus

Item	GnRH			Control		
	Bred by Estrus	Bred by Appointment	Total	Bred by Estrus	Bred by Appointment	Total
Estrus observed						
First service conception rate, %	22.4	25.9	23.2	21.6	28.2	23.5
No. heifers	19/85	7/27	26/112	21/97	11/39	32/136
No estrus observed						
First service conception rate, %		17.4[a]	17.4[a]		6.9[b]	6.9[b]
No. heifers		15/86	15/86		5/72	5/72
Total, %		19.5			14.4	

[a,b]Values on the same line with different superscripts differ ($P<.05$).

Trial with PGF

In this trial, all heifers were bred approximately 12 hr after observed estrus. Injecting GnRH at breeding had no significant effect on first service conception rate. GnRH treatment of the same heifers at the second service decreased ($P<.10$) conception rate (Table 13.3).

Table 13.3. Effect of GnRH on First and Second Service Conception Rates Following PGF Synchronization

Item	GnRH	Control
First service conception rate, %	47.7	51.0
No. heifers	41/86	50/98
Second service conception rate, %	45.2[a]	65.4[b]
No. heifers	14/31	34/52

[a,b]Values on the same line with different superscripts differ ($P<.10$).

Effects of MGA[1] and PGF on Estrus Induction and Synchronization in Cows and Heifers[2]

G.W. Boyd, D.J. Patterson, L.R Corah, and J.R. Brethour[3]

Summary

Three trials were conducted in the spring of 1985 to evaluate the effectiveness of MGA feeding and Prostaglandin (PGF) injection on estrus induction and synchronization. Trials 1 and 2 were both done on a Kansas ranch and involved 70 heifers and 86 cows, respectively. In both trials, all cycling and non-cycling females were fed MGA (7 days in trial 1, 9 days in trial 2) and half of the cows and heifers received a PGF injection. The estrus response was higher (P<.01) for the cycling heifers with the combination treatment. Both treatments resulted in similar first service conception rates and both were effective in inducing estrus in noncycling heifers. Only a small percentage of the cows in trial 2 were cycling prior to the treatments and only a small percentage of the non-cycling cows responded to the MGA.

In trial 3, half of the cycling heifers were fed MGA for 7 days and PGF was injected on day 7. Response to synchronization peaked 96 to 120 hr following MGA withdrawal. Among F_1 Angus X Hereford heifers, the MGA-PGF treatment reduced (P<.01) first service conception rates as compared to controls (55 vs 80%), although a reduction was not seen with F_1 Brahman X Hereford heifers. Conversely, 45-day pregnancy rates tended to be higher among both groups of synchronized heifers (P>.05). The MGA treatment also initiated cyclicity in prepuberal females of both crosses.

Introduction

Estrus synchronization increases the number of females showing heat within a short time span, thus making artificial insemination more practical. Synchronization also contributes to older and heavier calves at weaning and allows genetic improvement through the use of AI sires. However, most available synchronization products are costly, they do not work on non-cycling females, and they require large amounts of labor. Because of this, there has been renewed interest in using Melengestrol Acetate (MGA) to synchronize estrus in breeding cattle. MGA is a widely available oral progestin that has traditionally been used for suppressing estrus and increasing rate and efficiency of gain in feedlot heifers. Because MGA is inexpensive (2 to 3¢ per day), easy to administer, and effective in some non-cycling females, it appears to be a practical way to synchronize heat.

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[1]MGA is a progestational steroid that is approved for use in rations for feedlot heifers and is marketed by the Upjohn Company.

[2]Sincere appreciation is expressed to Joe Thielen, Dorrance, Kansas for providing cattle, facilities, and management for Trials 1 and 2.

[3]Fort Hays Branch Experiment Station.

We conducted three trials to determine the effectiveness of short duration MGA feeding combined with Prostaglandin (PGF) injection for estrus synchronization, to compare conception rates of synchronized vs. control heifers and to determine estrus response and subsequent conception rate following MGA feeding in non-cycling heifers.

Experimental Procedures

Trial 1: The objective was to compare the effect of MGA alone (MGA) or MGA + PGF (MGA-PGF) on rates of estrus synchronization and fertility of cycling and non-cycling heifers. The PGF injection (2 ml Bovilene®[4]) was given on the last day of MGA feeding. Reproductive status (cycling vs non-cycling) of the 70 crossbred heifers was determined by serum progesterone analysis of blood samples taken 10 days before and on the first day of treatment.

Heifers with less than 1 ng/ml serum progesterone at both bleedings were considered non-cycling. MGA was fed for 7 days to both groups at 0.5 mg per head daily, incorporated into 1 lb of ground milo.

A 6-day AI breeding period was initiated the day after the last MGA feeding and was followed by a 40 day clean-up with bulls. Heifers were heat-checked three times daily and those detected in estrus were inseminated approximately 12 hours later. Pregnancy was determined by rectal palpation.

Trial 2: The objective of this study was the same as in trial 1, except 86 crossbred nursing cows were utilized. The reproductive status was determined as outlined in trial 1. The MGA-feeding period was 9 days for both MGA and MGA-PGF groups. A daily dosage of 0.75 mg MGA per head was incorporated into 1.5 lb of range cubes and fed on pasture.

The cows averaged 66 days postpartum on the first day of MGA feeding. A 6-day AI breeding period was initiated after MGA withdrawal, followed by 70 days of clean-up with bulls. Cows were heat-checked three times daily and those detected in estrus were inseminated approximately 12 hours later. Pregnancy was determined by rectal palpation.

Trial 3: A project comparing two different biological types of beef cattle was initiated during the fall of 1984 by the Fort Hays Experiment Station. The project involved 148 F_1 Angus x Hereford heifers and 148 F_1 Brahman x Hereford heifers obtained from 17 ranches in Kansas, Colorado and Oklahoma. All heifers were known F_1's with recorded birth dates.

[4]Bovilene® is a prostaglandin analog manufactured by Syntex Animal Health Inc. which provided partial financial assistance for this trial.

Androgenized cows or marker bulls were used to aid in estrus detection. Criteria used to determine puberty were:

1) marked by a bull or androgenized cow, or seen in standing heat

2) presence of a palpable corpus luteum

3) progesterone levels $\geq$ 1 ng/ml of serum 6 to 10 days after observed estrus

At the start of the spring breeding season, heifers were classed as cycling or prepuberal based on the above criteria. All cycling heifers were randomly assigned to control or synchronized groups. Synchronized heifers were separated from controls and fed 0.5 mg MGA in 1 lb milo daily for 7 days. On day 7, all heifers in the synchronized group received 2 ml of Bovilene®. Heifers classed as prepuberal were treated the same as synchronized heifers, but received no Bovilene®. During the AI period, heifers were observed continuously during the daylight hours to detect visible signs of estrus and the use of marker bulls was continued. Heifers were inseminated 12 hours following the onset of estrus by one of two AI technicians using semen from a single sire.

Results and Discussion

Trial 1: Results shown in Table 14.1 indicate that the estrus response was higher ($P<.05$) and the degree of synchronization tended to be greater for the MGA-PGF group than the MGA-only group. Conception rates were similar between the groups. Both treatments were successful in inducing estrus in non-cycling heifers. Overall pregnancy rate was higher in non-cycling MGA-PGF heifers than in non-cycling MGA heifers.

Table 14.1. Reproductive Response of Cycling and Non-cycling Heifers Treated with MGA only or MGA and PGF

Treatment	Cycling Status	No. Heifers, %	Estrus Response[1]	Degree of Synchrony[2]	1st Service Conception Rate[3]	Overall Pregnancy Rate[4]
MGA	Yes	28/35=80%	12/28=46%[a]	4/13=31%	8/13=62%	24/28=86%
	No	7/35=20%	4/7=57%	2/4=50%	3/4=75%	3/7=43%
MGA-PGF	Yes	25/35=71%	21/25=84%[b]	11/21=52%	13/21=62%	22/25=88%
	No	10/35=29%	7/10=70%	3/7=43%	5/7=71%	7/9=78%
Overall	Yes	53/70=76%	34/53=64%	15/34=44%	21/34=62%	46/53=87%
	No	17/70=24%	11/17=65%	5/11=45%	8/11=73%	10/16=63%

[ab] Values with different superscripts within a column differ ($P<.01$).

[1] Estrus Response = Females in estrus/number treated

[2] Degree of Synchrony = Number in estrus in peak 24/hr/number in estrus

[3] Conception rate = Conceived to AI/number inseminated.

[4] Overall Pregnancy Rate= Number conceived during the total breeding season/number treated

Trial 2: The results shown in Table 14.2 indicate that relatively few of the cows in either group were cycling prior to treatment. Although there were no significant differences for any of the variables among treatment groups, the average days postpartum were higher for the cycling cows in both groups compared to non-cycling cows. A low percentage of the non-cycling cows responded to either treatment.

The poor results in this trial might have related to inadequate MGA dosage, since daily cube consumption by the cows was irregular because of ready access to lush spring forage.

Table 14.2. Reproductive Response of Cycling and Non-cycling Cows Treated with MGA only or MGA and PGF

Treatment	Cycling Status	No. Cows, %	Days postpartum 5/18/85	Estrus Response[1]	Degree of Synchrony[2]	1st Service Conception Rate[3]	Overall Pregnancy Rate[4]
MGA	Yes	9/49=18%	71.3	6/9=67%	2/6=33%	2/6=33%	9/9=100%
	No	40/49=82%	63.2	9/40=23%	3/9=33%	3/9=33%	35/4=88%
MGA-PGF	Yes	11/37=30%	68.9	9/11=82%	5/9=56%	4/9=44%	11/11=100%
	No	26/37=70%	63.8	6/26=23%	2/6=33%	1/6=17%	24/26=92%
Overall	Yes	20/86=23%	70.0	15/20=75%	7/15=47%	6/15=40%	20/20=100%
	No	66/86=77%	63.4	15/66=23%	5/15=33%	4/15=27%	59/66=89%

1,2,3,4 - Same as Table 1.

Trial 3: First service conception rate of the synchronized Angus X Hereford heifers was lower (P<.01) than that of controls, however, this difference disappeared at second service (Table 14.3). There was no significant reduction in first service conception rate because of synchronization among the F_1 Brahman x Hereford heifers, but, in general, their first service conception rates were low.

A trend was seen in both synchronized breed groups toward higher pregnancy rates than the controls at the end of the 45-day breeding period. This difference, although not statistically significant, probably occurred because the synchronized heifers had three chances at AI vs. two for the controls.

The prepuberal or non-cycling heifers' response to MGA is also shown in Table 14.3. Response to MGA, as measured by observable estrus, was favorable; 60 to 70% cycled. In addition, their pregnancy rates were comparable to cycling heifers over the 45-day AI period.

Table 14.3. Effect of MGA on Reproductive Parameters of Heifers

Angus X Hereford F_1 Females				Conception Rate[2]						Pregnancy Rate[3]	
				1st Service		Overall 1st Service[6]		45 Day		45 Day	
Treatment[4]	Exposed (No.)	Estrus (No.)	Response[5] (%)	(No.)	(%)	(No.)	(%)	(No.)	(%)	(No.)	(%)
Control	69	—	—	51/64[a]	79.7	—	—	56/64[a]	87.5	56/69[a]	81.2
Synchronized	68	62/68	91.2	34/62[b]	54.8	35/64	54.6	59/64[a]	92.2	59/68[a]	86.8
Prepuberal	11	7/11	63.6	3/7[b]	42.9	4/9	44.4	9/9[a]	100.0	9/11[a]	81.8

Brahman X Hereford F_1 Females				Conception Rate						Pregnancy Rate	
				1st Service		Overall 1st Service		45 Day		45 Day	
Treatment[4]	Exposed (No.)	Estrus (No.)	Response (%)	(No.)	(%)	(No.)	(%)	(No.)	(%)	(No.)	(%)
Control	47	—	—	8/42[a]	19.0	—	—	28/42[a]	66.7	26/47[a]	59.6
Synchronized	50	34/50	68.0	4/34[b]	11.7	9/44	20.1	36/44[a]	81.8	36/50[a]	72.0
Prepuberal	49	33/49	67.3	3/33[a]	9.1	7/48	14.6	26/48[a]	54.2	26/49[a]	53.1

[1] Breeding season began May 12, 1985. Results based on rectal palpation on August 30, 1985.

[2] Conception rate = Number pregnant/number inseminated

[3] Pregnancy rate = Number pregnant/number inseminated

[4] Treatment groups= Control = cycling heifers inseminated 12 hours following onset of spontaneous estrus.
Synchronized = cycling heifers fed .5 mg MGA/hd/d for 7 days, followed by 2 ml Bovilene® on day 7.
Prepuberal = noncycling heifers fed .5 mg MGA/hd/d for 7 days.

[5] Estrus response = Number of heifers observed in estrus within 120 hours after MGA withdrawal/number treated. (pertains only to sychronized and prepuberal treatment groups)

[6] Includes heifers conceiving to a first insemination that failed to exhibit estrus within the synchronized time period.

[a,b] Numbers with different superscripts differ ($P<.05$).

KSU

Beef Cattle Systems Analysis

R.R. Schalles[1]

Summary

For cattle producers to stay in business, they must apply the business management techniques used by sophisticated non-agricultural enterprises. Among these techniques is systems analysis, in which formulas representing interrelationships between various inputs are built into a computer program. The program simulates expected results, based on available information.

Introduction

During the last few years, it has been difficult to make a profit from beef cattle operations. This trend may continue. To stay in business, producers must use all management techniques at their disposal, such as systems analysis. But systems analysis for beef cattle is difficult because of the complex interactions among the biological and economic characteristics of the business. The simulation program is a library of research intregrated into a complete production system. The linear programming model simultaneously considers all the characteristics of the operation to find optimum combinations to produce maximum profit or minimum cost solution. Presented here are examples generated from a successful computer model of cow herds developed and verified at Colorado State University.

Procedures

A complete record of all biological and economic inputs and outputs under the current system is the first step in these analyses. The biological inputs include the genetic capabilities of the cattle (estimated breeding values and breed means), production capabilities (harvested and grazed forage) of the land resource, feed value of harvested feedstuffs and human inputs. Fixed economic inputs include costs of land, labor, management, taxes, and general farm overhead. Variable costs include feed, breeding fees, veterinary and medicine cost, transportation, marketing, interest on variable items, seasonal labor, yardage, etc. Ownership cost may also be involved.

With the use of the simulation program, biological inputs can be varied to generate new estimates of biological outputs. Thus, a variety of strategies can be examined as a means of maximizing profits.

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[1]The author recently completed a 6-month sabbatical leave at Colorado State University, where he studied computer modeling and systems analysis.

Example 1

This example shows a simulation of the economic potential of starting to breed heifers a month before cows. All other inputs were held constant. Cows were bred during June and July. Results are shown in Table 15.1.

According to the assumption, dystocia and calf death would be slightly higher. However, over-all conception rate would be considerably greater, lowering the need for replacement heifers. That made more high-value heifer calves and fewer low-value cull cows available for sale, resulting in a net return of about $900.

Table 15.1. Comparison of Starting to Breed Heifers a Month before Cows vs the Same Breeding Season as Cows

	Heifer Breeding Season[1]	
Traits	May-July	June-July
Dystocia 2 year olds	25.9%	24.5%
Newborn death - 2 year olds	7.6%	6.1%
% of herd 2 years old	20.5%	22.3%
% of 2 yr. olds pregnant	84.7%	77.8%
Cow herd size (11,660A Ranch)	247 head	244 head
Replacement heifers	59 head	66 head
Total calves weaned	228 head	226 head
Steer calves sold @ 60¢	(114 head) 624 lb	(113 head) 612 lb
Heifer calves sold @ 52¢	(54 head) 563 lb	(47 head) 553 lb
Long ylg. heifers sold @ 40¢	(8 head) 1019 lb	(10 head) 1010 lb
Cull cows sold @ 34¢	(46 head) 1049 lb	(50 head) 1148 lb
Income from sales	$79,721.80	$78,564.92
Expenses	$74,899.00	$74,638.34
Return for labor, mangement and investment	$ 4,822.80	$ 3,926.58
Difference	$896.22	

[1]Cows were bred in June-July.

From these data, the producer must determine if he is willing to provide the extra labor and management for the month longer calving and breeding season for an expected return of $900.

Example 2

An 11,600 acre ranch that was all grass ran 458 head of crossbred cows. Fall pasture was available on the ranch, but protein supplement was necessary during November, December, and January. Corn stocks could be leased at $15 per animal unit month (AUM), which covered the cost of transportation, fencing, water, etc. The price per unit of feed energy was cheaper using the leased corn stocks. However, certain fixed cost are incurred whether the home ranch is used or not. A linear programming model determined that the combination that maximized profit was leasing 662 AUM of corn stocks for 221 head during November, December, and January. The remaining 237 head were kept at the home ranch and supplemented with 4 lbs of a range cube that was 3/4 cottonseed meal and 1/4 milo, at a cost of $140 per ton.

With the aid of a computer and appropriate programs, all of the interrelationships of a cattle operation can be considered and accurate business decisions can be made.

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Why Systems Analysis?

Changing one part of a beef cattle production system affects most of its other parts. Nutrition level effects cull cow weights, reproduction, dystocia, calf survival, replacement heifer rate, etc., all of which influence the profitability of the operation. Alternative uses of labor, land and capital must be considered. But the interrelationships are too complex to handle with paper and pencil. That's where computer modeling comes in.

The heart of systems analysis is the information that goes into it. Commodity futures prices can be used as an estimate for advance pricing. Land carrying capacity, cattle performance data, historical weather data, and financial information must be supplied to the system. For an ongoing operation, that information can best come from a good set of performance and financial records. It's no longer good enough to be a good cattleman. Today's successful operator must be a skillful business man.

Research conducted at land-grant universities like Kansas State is an important input to cattle systems analysis. Much of that research is described in mathmatical form. Because systems analysis is such an essential tool for profitable beef cattle management, Kansas State University is making a concerted thrust in the area.

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Cow Size and Milk Level: Results of a Simulation Program

R.R. Schalles and R.M. Bourdon[1]

Summary

A simulation program was used to evaluate nine genotypes of cattle based on cow size and milk production. Return per cow unit using current economics is given. The larger, heavy milking cows were more than twice as profitable on a ranch basis than the small, low milking cows.

Introduction

A breeding program can alter cow size and milk production over a wide range. The impact of these changes is of major concern. Using a simulation program, which combines results from many research studies, the profitability of nine genetic types of cattle were compared.

Procedures

Small, medium, and large-type cows, each producing low, medium, and high milk levels were compared. All simulated herds used a two-breed rotational crossbreeding program. Bulls used were of comparable size to the cows to provide constant size replacement heifers. Breeding season was June and July. Calves were weaned October 1, fed grain and alfalfa hay, and sold November 1. Replacement heifers were fed grain and alfalfa hay through April. Cows grazed native short-grass range year around (grass data came from a Northeast Colorado Range research study) and were supplemented from December 1 through April with alfalfa hay. Enough supplemental winter feed was allowed so that cows and yearling heifers were condition score 5 early in the breeding season, but were not excessively fat at the end of the grazing season. All open cows, plus a number that were unsound, were culled in October. No cows were kept past 11 years of age. Gestation period was 282, 285, and 288 days for the small, medium, and large size cows, respectively.

On-farm costs were compiled by Dr. Kerry Gee (USDA-ERS) for 1982 in midsized herds (average 305 cows) in eastern Colorado. Prices of feed and cattle are approximately those received in the fall of 1985. All alfalfa hay and grass was produced on the ranch. The actual values of the expenses may vary with different size operations; however, the relative comparisons should remain the same. Operating capital was borrowed at 12% interest and surplus cash returned 10% from short-term investments.

[1]Dept. of Animal Science, Colorado State University, Fort Collins.

Results

All heifers had similar pregnancy rates (Table 16.1). Pregnancy rate decreased slightly as cow size increased because of longer gestation and higher dystocia rate (Table 16.2). This necessitated a slightly higher heifer replacement rate. Milk production was similar among different cow sizes (Table 16.3). Cows with low milk production tended to get fat during the summer, allowing less winter supplemental feeding. Heavy milking cows maintained rather constant condition throughout the year but required more supplemental feeding (Table 16.4). Yearly TDN consumption increased with both size and milk production.

Calf weights increased with increasing milk production and increasing cow size (Table 16.5). Calf prices were higher for the larger frame calves and decreased for fatter calves. Pounds of cull cows sold increased with increased cow size because of both greater numbers and heavier weights.

Fixed costs are associated with the ranch operation and not with number or kind of animals. Variable costs are associated with an animal unit (Table 16.6). There were no additional costs associated with increased milk production. Total cost increased with increased cow size, but production increased faster, making the high milking, large cow the most profitable. This is partly because the variable cost were approximately the same for all cows and there were 14% fewer large cows. The total pounds of product produced per year were considerably higher for the large cow with high milk production (112 lb per cow unit).

Table 16.1. Pregnancy Rate of Genotypes by Age

Genotype	% Heifers[1]		% 2-yr olds[1]		% Cows[1]	
Size Milk	Bred July 1	Bred Aug. 1	Bred July 1	Bred Aug 1	Bred July 1	Bred Aug 1
SM-LO	69.2	92.6	51.2	84.8	42.0	85.7
SM-ME	69.6	92.5	50.1	84.1	44.0	85.8
SM-HI	69.0	91.7	50.0	83.2	48.5	87.1
ME-LO	68.8	92.5	49.3	82.4	36.4	83.9
ME-ME	73.4	93.9	51.5	83.4	39.4	84.5
ME-HI	70.6	92.5	48.0	81.8	41.1	85.1
LG-LO	69.1	92.5	49.4	79.8	37.4	82.4
LG-ME	73.9	94.1	50.8	80.5	39.9	83.1
LG-HI	71.2	92.9	44.4	78.3	36.4	82.0

[1] 60 day breeding season ended Aug. 1.

Table 16.2. Calving and Replacement Rate by Genotypes

Genotype Size Milk	% Heifers Dystocia	% Heifers Calving Loss	% Overall Dystocia	% Overall Calving Loss	% Calf Crop Weaned of Pregnant Cows	Heifer Replacement Per Cow
SM-LO	18.7	5.5	5.7	4.0	92.8	.243
SM-ME	18.9	5.5	5.8	4.0	92.8	.244
SM-HI	19.3	5.6	5.8	4.0	92.8	.240
ME-LO	23.7	6.0	7.8	4.1	92.6	.262
ME-ME	23.5	6.0	7.6	4.1	92.6	.251
ME-HI	24.3	6.1	7.8	4.2	92.6	.257
LG-LO	30.7	6.7	13.0	4.7	91.5	.283
LG-ME	30.3	6.8	12.8	4.7	92.1	.271
LG-HI	31.1	6.8	13.4	4.7	92.0	.290

Table 16.3. Cow Weights, Condition Score, and Milk Production.

Genotype Size Milk	Avg. Milk Production	Minimum Wt	Minimum Date	Minimum Cond Score	Maximum Wt	Maximum Date	Maximum Cond Score
SM-LO	12.4	964	May 1	4.1	1088	Dec 1	5.9
SM-ME	18.5	979	May 1	4.5	1049	Jan 1	5.4
SM-HI	23.2	1006	Jun 1	4.8	1028	Feb 1	5.1
ME-LO	12.4	1102	May 1	4.3	1246	Nov 1	5.8
ME-ME	18.3	1120	May 1	4.5	1208	Oct 1	5.4
ME-HI	23.6	1140	May 1	4.7	1201	Sep 1	5.2
LG-LO	12.4	1271	May 1	4.5	1415	Nov 1	5.8
LG-ME	18.4	1297	May 1	4.7	1393	Sep 1	5.6
LG-HI	23.8	1298	May 1	4.8	1357	Sep 1	5.3

Table 16.4. Per Head Feed Consumption By Genotypes

Genotype Size Milk	Winter Grass DM	Winter Grass Cost	Winter Hay DM	Winter Hay Cost	Winter Grain DM	Winter Grain Cost	Summer Grass DM	Summer Grass Cost	Yearly TDN Consumed	Yearly TDN Cost
	lb	$	lb	$	lb	$	lb	$	lb	$
SM-LO	2066	12.40	1889	62.34	211	16.46	7191	79.10	6036	170.30
SM-ME	2114	12.68	1891	62.40	179	13.96	7031	77.34	6100	166.38
SM-HI	1894	11.36	2445	80.69	150	11.70	6924	76.16	6230	179.91
ME-LO	2106	12.64	1982	65.41	245	19.11	8089	88.98	6795	186.14
ME-ME	2170	13.02	2206	72.80	220	17.16	7862	86.48	6802	189.46
ME-HI	2226	13.36	2511	82.86	182	14.20	7772	85.49	6923	195.91
LG-LO	2143	12.86	2550	84.15	278	21.68	8804	96.84	7552	215.53
LG-ME	2219	13.31	2761	91.11	256	19.97	8559	94.15	7545	218.54
LG-HI	2320	13.92	3005	99.16	214	16.69	8491	93.40	7664	223.17
Price/ ton DM		$12.00		$66.00		$156.00		$22.00		

Table 16.5. Sale Cattle Weights, Number, and Value Per Cow by Genotypes

Genotype Size Milk	Steer Calves Wt	Steer Calves Number	Steer Calves Value	Heifer Calves Wt	Heifer Calves Number	Heifer Calves Value	Yearling Heifers Wt	Yearling Heifers Number	Yearling Heifers Value	Cull Cows Wt	Cull Cows Number	Cull Cows Value
	lb		$	lb		$	lb		$	lb	$	
SM-LO	455	.464	.64	411	.221	.53	872	.039	.42	1069	.183	.36
SM-ME	509	.464	.62	460	.220	.52	870	.039	.42	1026	.183	.35
SM-HI	563	.464	.60	508	.224	.51	867	.041	.42	989	.178	.34
ME-LO	507	.463	.66	458	.201	.55	1001	.044	.40	1238	.197	.36
ME-ME	561	.463	.65	507	.212	.54	1019	.038	.40	1199	.191	.35
ME-HI	615	.463	.64	555	.206	.53	1004	.042	.40	1156	.193	.34
LG-LO	563	.458	.67	508	.175	.56	1136	.048	.38	1410	.211	.36
LG-ME	618	.460	.66	558	.189	.55	1157	.041	.38	1370	.206	.35
LG-HI	667	.460	.65	602	.170	.54	1140	.047	.38	1313	.218	.34

Table 16.6. Income and Expenses Per Cow by Genotype.

Genotype Size Milk	Fixed Cost	Grain[1] Cost	Variable Cost	Operating Interest	Total Cost	Gross Income	Return for Labor Management and Investment	Relative[2] Carrying Capacity	Return[2] Per Cow Unit
SM-LO	$146.53	$16.46	$50.39	$12.17	$225.55	$267.88	$42.33	1.00	$42.33
SM-ME	146.53	13.96	47.85	12.25	220.59	279.01	58.42	1.00	58.42
SM-HI	140.48	11.70	48.23	12.22	212.53	289.54	76.91	1.04	79.99
ME-LO	158.38	19.11	48.90	13.27	239.66	310.82	71.16	0.92	65.47
ME-ME	157.28	17.16	49.11	13.29	236.84	322.46	86.62	0.93	76.63
ME-HI	158.38	14.20	49.65	13.40	235.63	335.53	99.90	0.92	91.91
LG-LO	168.12	21.68	50.56	14.39	254.75	350.10	95.35	0.87	82.95
LG-ME	167.18	19.97	50.79	14.42	252.36	362.60	110.24	0.88	97.01
LG-HI	169.52	16.69	51.49	14.54	252.24	372.53	120.29	0.86	103.45

[1]Home grown hay is used and production expenses are included in other costs.

[2]A cow unit is assumed to be a 1000 lb cow of low milk production with the necessary replacements and calf.

Comparison of 36 mg and 72 mg[1] Ralgro® for Suckling Steer Calves[2]

D.D. Simms[3]

Summary

In a study in which 525 Simmental-cross steer calves were assigned to five implant treatments in four trials, 72 mg Ralgro® implants failed to increase performance significantly over conventional 36 mg implants.

Introduction

Some researchers and producers have questioned the adequacy of the standard 36 mg dosage of Ralgro® for high growth-potential, suckling steer calves. Consequently, these trials were conducted to evaluate a 72 mg dosage® either at branding or at reimplanting time.

Experimental Procedures

Simmental-cross suckling steer calves were randomly assigned to the following treatments: 1) Control (no implant), 2) 36 mg Ralgro® at branding (1-3 mo), 3) 72 mg Ralgro® at branding, 4) 36 mg Ralgro® at branding and 36 mg Ralgro® at 5 to 6 mo of age, or 5) 36 mg Ralgro® at branding and 72 mg Ralgro® at 5 to 6 mo of age. Individual, non-shrunk weights were taken at branding in May, at re-implanting in August, and at weaning in October.

Two trials were conducted in 1984 and two in 1985. The 1984 trials were summarized in the 1985 Cattlemen's Day Report. Least Square Means Procedures were used to analyze the data.

Results and Discussion

Results of these trials are shown in Table 17.1.

1985 Trials. When both 1985 trials were considered, all implant treatments significantly increased gain over controls, but there was no difference in rate of gain among Ralgro® treatments.

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[1] 72 mg Ralgro® is not an approved dosage. It was used in these trials under authorization of the FDA in conjunction with International Minerals and Chemical Co.

[2] Appreciation is expressed to Norman Rohleder, Russell and Roger Wilson, Oberlin for providing cattle and assisting with data collection, and to County Extension Agricultural Agents, Allen Dinkel, Rooks Co. and Del Jepsen, Russell Co.

[3] Extension Livestock Specialist, Northeast Kansas.

Combined 1984 and 1985 Trials. When the data from all four trials were combined, all implant treatments significantly increased gain over controls. Implanting with 36 mg of Ralgro® at branding and 72 mg at 5-6 mo of age gave the greatest gain, but the improvement was not statistically significant. Thus, there does not appear to be an advantage to increasing the dosage of Ralgro® from the approved dosage of 36 mg to 72 mg, even in high growth-rate, suckling steer calves.

Table 17.1. Results of Four Trials Comparing Various Dosages of Ralgro® for Suckling Steer Calves

	Implant Treatment				
Item	Control	36 mg	72 mg	36 mg + 36 mg	36 mg + 72 mg
No. Calves - 1985 Trials:					
Trial 1	28	26	25	27	26
Trial 2	25	26	28	28	27
Combined	53	52	53	53	53
Daily Gain, 1985 Trials, lb:					
Trial 1	1.89^{a}	1.93^{ab}	2.04^{b}	1.95^{ab}	1.97^{ab}
Trial 2	2.08^{a}	2.25^{b}	2.14^{a}	2.21^{ab}	2.33^{b}
Combined	1.98^{a}	2.09^{b}	2.09^{b}	2.08^{b}	2.15^{b}
Combined 1984 and 1985 Trials:					
No. Calves	105	106	105	105	104
Daily Gain, lb	1.93^{a}	2.02^{b}	2.03^{b}	2.01^{b}	2.07^{b}
Increase over Controls - Combined 1984 and 1985 Trials:					
Percent		4.7	5.2	4.1	7.3
Total Gain, lb[1]		13.5	15.0	12.0	21.0

[ab]Values in the same row with different superscripts differ significantly (P<.05).

[1]Based on 150 days from initial implant to weaning.

Effect of Various Dosages of Ralgro® in the Suckling Period on Weight Gain During the Growing Period[1]

D.D. Simms,[2] G. Boyd, and J. Higgins[3]

Summary

We studied how implanting with various dosages of Ralgro® during the suckling period affected gains in the growing period. Preweaning performance was reported in the 1985 Cattlemen's Day Report. All calves, regardless of suckling period treatment, received 36 mg Ralgro® at the start of the growing period. Average daily gains during the growing period were similar for all treatments. Consequently, the added weight obtained from the suckling-period implants was still present at the end of the growing period.

Introduction

Some producers and researchers have questioned the use of implants during the suckling period, believing that the faster growth obtained might result in slower gain during the growing phase. Furthermore, there has been considerable interest in using a 72 mg dosage[4] of Ralgro® for calves with high growth potential.

Experimental Procedures

Approximately 100 suckling steer calves on two Kansas ranches were assigned at branding (1-2 mo of age) to the following treatments: 1) Control - no implant, 2) 36 mg Ralgro® at branding (36), 3) 36 mg Ralgro® at branding and reimplanted at 4-5 mo (36-36), 4) 36 mg Ralgro® at branding and reimplanted with 72 mg Ralgro® at 4-5 mo (36-72), or 5) 72 mg Ralgro® at branding (72). At the first ranch, calves were weaned and backgrounded for approximately 1 month before initiating the growing trial. At the second location, calves were weaned and started directly on the growing trial. Non-shrunk individual weights were used throughout the trial. The growing periods lasted 101 and 144 days for ranch 1 and

[1]Appreciation is expressed to Norman Rohleder, Russell and Roger Wilson, Oberlin for providing cattle and assisting with data collection, and to County Extension Agricultural Agents Allen Dinkel, Rooks Co. and Del Jepsen, Russell Co., and to Pat Burton, International Minerals and Chemicals Corp.

[2]Extension Livestock Specialist, Northeast, Kansas.

[3]Department of Statistics.

[4]72 mg Ralgro® is not an approved dosage. It was used in these trials under authorization of the FDA in conjunction with International Minerals and Chemical Corp.

2, respectively. Least Squares Means Procedures were used to analyze the data. Data from both locations were pooled, since the location by implant treatment interaction was not statistically significant.

Results and Discussion

As can be seen in Table 18.1, only the 36-36 implant treatment significantly increased gain over controls prior to the start of the growing period, although all implant treatments tended to increase suckling gain.

Average daily gain during the growing period was similar for all suckling implant treatments. Consequently, the increased weight resulting from suckling period implants remained at the end of the growing period.

This trial indicates that cattle producers who grow their cattle after weaning should use implants in the suckling period, since growing-phase gains are not reduced by suckling implants, even when used at twice the recommended dosage.

Table 18.1. Effect of Implanting with Various Dosages of Ralgro® During the Suckling Phase on Growing Steer Performance

	Suckling Phase Implant Treatment				
Item	Control	36 mg	36 mg + 36 mg	36 mg + 72 mg	72 mg
No. Steer	44	50	45	45	47
Average Daily Gain, lb:					
Branding to Start of Growing Period	1.78^{a}	1.83^{ab}	1.87^{b}	1.86^{ab}	1.83^{ab}
Growing Period	1.93	1.92	1.93	1.90	1.99
Average Weight, lb:					
Start of Growing	522.9^{a}	531.3^{ab}	540.2^{b}	538.5^{ab}	533.0^{ab}
End of Growing	769.5	777.4	786.2	781.4	785.4

^{ab}Values in the same row with different superscripts differ signficantly (P<.05).

Effects of Preweaning and Postweaning Implants on Suckling, Growing, and Finishing Steer Performance[1]

D.D. Simms,[2] R.W. Lee,[3]
S.B. Laudert,[4] and J. Higgins[5]

Summary

One hundred and ninety-five crossbred steers were used to compare lifetime implant strategies and study the effects of implanting during the suckling period on performance in the growing and finishing periods. There were no differences in growing period gains when both groups were implanted in the suckling period and the growing period. However, steers implanted in the suckling period but not implanted in the growing period had significantly lower gains than all other treatments including controls. Steers implanted only in the growing period had better feed efficiency in the growing period than both controls and steers implanted only in the suckling period.

Steers reimplanted during the finishing period had similar finishing gains regardless of prior implant treatment, and all implanted cattle gained faster than controls in the finishing period. Steers not reimplanted during the finishing period had lower gains than those reimplanted. Implanting in the finishing period resulted in better feed efficiency.

All implanted cattle that were reimplanted in the finishing period had higher lifetime gains than controls, but there was no difference between implant combinations. The only carcass characteristic changed by implanting was quality grade, which was reduced by all implant combinations with the exception of implanting only in the finishing period.

Implanting during the suckling period did not reduce cattle performance during the growing and finishing periods when the steers were also implanted during these periods. This study emphasizes the importance of implanting twice in the finishing period to maximize finishing gain and final weight.

[1]Appreciation is expressed to International Minerals and Chemical Corp. for funding support of this research, to Tom Stewart, Weskan and Joe Thielen, Dorrance for providing cattle and assisting in data collection, to County Extension Agricultural Agents Keith VanSkike, Norton, and Del Jepsen, Russell, and to Pat Burton, IMC, for their assistance.

[2]Extension Livestock Specialist, Northeast Kansas.

[3]Formerly Garden City Branch Experiment Station.

[4]Extension Livestock Specialist, Southwest Kansas.

[5]Department of Statistics.

Introduction

While numerous implanting trials have been conducted, very few have studied the long-term effects of implanting during the suckling and growing periods on performance in the finishing period. Some research has indicated that implanting in the suckling period reduces performance during the finishing phase. The present trial was conducted to help answer this critical question.

Experimental Procedures

Approximately 100 exotic crossbred, suckling, steer calves on each of two Kansas ranches were assigned at branding (1-2 mo old) to receive either no implant (Control) or a 36 mg Ralgro® implant. Non-shrunk weights were taken at branding and weaning.

Calves at one ranch were weaned and backgrounded for approximately 1 month before being transported to the feedlot. Calves at the other ranch were weaned and shipped directly to the lot. All calves were grown and finished at the Garden City Experiment Station. The cattle were at the experiment station about 30 days before the growing period started. Calves were then allotted to implant treatments shown in Table 19.1.

Table 19.1. Experimental Design of the Long-Term Implant Trial

Treatment No.	No. Steers	Phase		
		Suckling	Growing	Finishing
1	32	-[1]	-	-
2	33	-	-	+ +
3	32	-	+	+ +
4	32	+	-	+ +
5	32	+	+	+
6	34	+	+	+ +

[1] - = no implant, + = implanted, + + = implanted twice during the finishing period.

Cattle in each treatment group were allotted to four pens of approximately 8 head each. Non-shrunk beginning and ending weights were the average of two weights taken on consecutive days at the start and end of the growing and finishing periods.

The growing and finishing periods lasted 59 and 121 days, respectively. All Ralgro® implants were 36 mg. Reimplanting occurred on day 57 of the finishing period. Least Squares Means Procedures were used to analyze the data.

Results and Discussion

Suckling Period

As can be seen in Table 19.2, implanting at branding time tended to increase average daily gain during the suckling period, increasing weaning weight at both ranches about 7 lb. However, this increase was not statistically significant. Implanted suckling calves also had slightly higher average daily gains up to the start of the growing trial.

Growing Period

Calves not implanted in the suckling phase but implanted in the growing phase (Trt. 3) gained faster ($P<.05$) than control calves (Trt. 1 and 2) and calves implanted in the suckling period but not in the growing period (Trt. 4). Calves implanted in both suckling and growing periods had intermediate gains between controls and calves implanted only in the growing period. Calves implanted in the suckling period but not in the growing period gained significantly slower in the growing period than all other treatments, including controls (Trt. 1). It appears that once an animal has been implanted, implanting must be repeated to avoid marked performance decreases.

Calves implanted in the growing period, but not in the suckling period, were more efficient than controls (Trt. 1 and 2) and calves implanted only in the suckling phase (Trt. 4), but performed similarly to calves receiving implants in both periods (Trt. 5 and 6).

Finishing Phase

All implanted cattle gained significantly faster in the finishing period; however, steers not implanted twice during finishing (Trt. 5) gained significantly slower than treatments 2, 3, and 4. This emphasizes the importance of implanting twice during a long finishing period. Steers implanted twice prior to the finishing period (Trt. 6) gained essentially the same as steers that had never been implanted until the finishing phase or those implanted only once prior to the finishing period. In addition, all implanted cattle tended to have better feed conversions than controls, but only in treatments 2 and 5 were the differences significant ($P<.05$).

Lifetime Performance

Lifetime average gain was increased by all implant combinations. Furthermore, final weight was increased ($P<.05$) over controls in all treatments implanted twice during finishing. There were no differences in cattle gains from birth to slaughter or in final weights among any of the implant combinations.

Carcass Characteristics

Quality grade was the only carcass characteristic influenced ($P<.05$) by implanting. Implanting reduced the quality grade in all treatments except implanting only in the finishing period.

According to our data, implanting during the suckling phase does not reduce subsequent performance if implanting is repeated. Moreover, this trial indicates the importance of implanting twice during finishing.

Table 19.2. Effects of Implant Combinations on Steer Performance During the Suckling, Growing, and Finishing Periods, and on Lifetime Performance and Carcass Characteristics

Item	Treatment No. 1	2	3	4	5	6
Average Daily Gain, lb:						
Branding to Weaning	1.77	1.78	1.78	1.85	1.82	1.83
Branding to Start of Growing Period	2.20	2.19	2.15	2.30	2.21	2.25
Growing Period	2.20[a]	2.17[a]	2.43[b]	1.95[c]	2.30[ab]	2.34[ab]
Branding to End of Growing Period	2.19	2.18	2.21	2.22	2.22	2.26
Finishing Period	2.61[a]	3.07[c]	3.06[c]	3.07[c]	2.86[b]	2.98[bc]
Branding to Slaughter	2.32[a]	2.45[b]	2.47[b]	2.48[b]	2.42[b]	2.48[b]
Feed/Gain, lb:						
Growing Period	8.01[a]		6.99[b]	8.83[a]	7.48[ab]	
Finishing Period	7.22[a]	6.44[b]	6.50[ab]	6.53[ab]	6.47[b]	6.61[ab]
Final Weight, lb	1094.6[a]	1147.7[b]	1152.3[b]	1154.1[b]	1132.3[ab]	1157.5[b]
Total Gain, lb	921.4[a]	974.5[b]	979.1[b]	980.9[b]	959.1[ab]	984.3[b]
Gain Over Controls, lb		53.1	57.7	59.5	37.7	62.9
Carcass Characteristics:						
Dressing %[1]	63.1	62.9	63.2	63.2	63.6	62.9
Quality Grade[2]	9.8[a]	9.1[ab]	9.1[ab]	9.0[b]	9.0[b]	8.6[b]
Yield Grade	2.32	2.33	2.25	2.32	2.21	2.42
Fat Thickness, in	.31	.30	.30	.30	.30	.33
Ribeye Area, sq in	11.7	12.0	12.2	12.1	12.0	12.0

[abc]Values with different superscripts in the same row differ significantly (P<.05).

[1]Calculated after shrinking final weights 4%.

[2]8 = Average Good, 9 = High Good, 10 = Low Choice.

Effect of a Single Ralgro® Implant During the Suckling Period on Reproductive Performance of Replacement Heifers[1]

T. B. Goehring, L. R. Corah, and D. D. Simms

Summary

One hundred and seven spring-born, crossbred heifers were used to determine the effect of a single Ralgro® implant on their reproductive performance. Three implant treatments were used: 1) Non-implanted controls, 2) 36 mg Ralgro® at birth, or 3) 36 mg Ralgro® at 2 to 3 months of age.

Heifers implanted at birth had significantly lower first service conception rates and overall pregnancy rates than non-implanted controls or those implanted at 2 to 3 months of age. Pelvic areas of yearlings were increased by implanting at birth or 2 to 3 months of age. Age at puberty and the percentage of heifers cycling prior to the 22nd day of the 60-day breeding period were not influenced by treatment.

Introduction

Several studies have found that implanting with Ralgro® during the suckling period or at weaning does not reduce reproductive performance of replacement heifers bred as yearlings. However, implanting at birth appears to reduce conception and pregnancy rates. This study was designed to further evaluate the effect of Ralgro® implants on age of puberty, pelvic area, and breeding performance of replacement heifers.

Experimental Procedures

One hundred and seven spring-born, crossbred heifers were allotted at birth to three implant treatments: 1) control (no implant), 2) implanted at birth, or 3) implanted at 2 to 3 months of age. Following weaning, the heifers were allotted by implant treatment and weight to one of four levels of energy. Weight, frame, and pelvic measurements (Rice pelvimeter) were taken at the start and end of a 130-day feeding trial. To determine onset of puberty, heifers were checked visually twice daily for estrus activity. Heifers were artificially inseminated for a 60-day period, and subsequent pregnancy was confirmed by rectal palpation. Reproductive variables measured included first service conception rate, overall pregnancy rate, initial and final pelvic area, age at puberty, and the percentage of heifers cycling up to and including the first 21 days of the breeding period.

[1]Appreciation is expressed to International Minerals and Chemical Company for providing Ralgro® (zeranol) implants and partial financial support.

Results and Discussion

Implanting heifers with 36 mg of Ralgro® at birth or 2 to 3 months of age increased adjusted 205-day weaning weight by an average of 19.5 lb over non-implanted controls (Table 20.1). The heifers averaged 471 lb at the beginning of the 130-day feeding phase and their average daily gain ranged from 1.12 to 1.74 lb during this phase. Average daily gain had no effect on first service conception rate. Implanting heifers at birth significantly lowered first service conception and overall pregnancy rates compared to controls and heifers implanted at 2 to 3 months of age (Table 20.1). This finding agrees with earlier research.

Onset of puberty was not influenced by implant treatment. Age at puberty and the percentage of heifers cycling up to and including the 21st day of the breeding period were not different among treatments (Table 20.1). Cycling activity was lower than expected in this study, with no obvious explanation. This study was conducted in 1983-84, which had a severe winter followed by a wet spring. This may have influenced cycling activity. Four control (7.4%), four birth-implanted (11.4%), and one suckling-implanted (5.6%) heifer did not show estrus during the study. Pelvic area at the start of the feeding trial was greater for heifers implanted at 2 to 3 months of age than for controls. At the end of the trial, pelvic area was greater for both implant groups than for controls (Table 20.1). This observation agrees with results of previous studies. This study indicates that implanting at birth does not affect onset of puberty, but does reduce first service conception and overall pregnancy rates, and, therefore, is strongly discouraged. In contrast, results of this and previous studies indicate that implanting heifers at 2 to 3 months of age does not lower fertility.

Table 20.1. Effect of Ralgro® on Heifer Reproductive Performance

Item	Control	Implanted at Birth	Implanted at 2 to 3 Months of Age
Number of Heifers	54	35	18
Adjusted 205 Day Wt., lb	418^{ae}	441^{b}	437^{f}
1st Service Conception Rate, %	58^{e}	39^{fc}	74^{d}
Overall Pregnancy Rate, %	78^{d}	48^{c}	79^{d}
Age at Puberty, Days	414	412	422
Cycling Activity, %[1]	64	62	77
Initial Pelvic Area, cm^2	130.6^{c}	132.9	137.7^{d}
Final Pelvic Area, cm^2	168.6^{c}	175.0^{d}	178.8^{d}

[ab] Values in the same row not sharing the same superscript are significantly different (P<.01).

[cd] Values in the same row not sharing the same superscript are significantly different (P<.05).

[ef] Values in the same row not sharing the same superscript are significantly different (P<.01).

[1] Percentage of heifers cycling up to and including the first 21 days of the breeding period.

Effects of Castration, Dehorning, Frame Size, and Gut Fill on the Long-term Performance of Feeder Calves[1]

Frank K. Brazle[2] and Robert R. Schalles

Summary

In two experiments, calves purchased as steers gained substantially faster than calves purchased as bulls and then castrated, during both the starting period and the subsequent growing period. Large-framed calves gained .22 lb per day faster, and small-framed calves .21 lb per day slower, than medium-framed calves. Cattle appearing gaunt at the start of the trial gained 1.33 lb per day less than those with average gut fill.

Introduction

Research shows that castrating 400 to 500 lb bull calves reduces their gain about .5 lb per day for the first 21 to 28 days. It has been assumed that after this initial period, bulls castrated at arrival performed as well as steers. However, research by Brazle and coworkers (Cattlemen's Day Report, 1985) showed that 525 lb castrated bulls gained 27 lb per head less during a 28-day starting period and 18 lb less during a subsequent 77-day growing period compared to calves purchased as steers. Recent California research also found that castrated bull calves gained .54 lb per day less than calves purchased as steers during the first 29 days and .25 lb per day less from 30 to 169 days in the finishing period.

The objective of this research was to further clarify the long-term effects of purchasing and castrating bull calves compared to steers. The effects of dehorning, frame size, and gut fill on performance were also evaluated.

Experimental Procedures

In Experiment I, 155 steer and bull calves of mixed breeds were purchased and shipped to a backgrounding lot in southeast Kansas. The calves were vaccinated at arrival for infectious bovine rhinotracheitis (IBR), bovine virus diarrhea (BVD), parainfluenza$_3$ (PI$_3$), and blackleg (7-way), and dewormed with Tramisol®. In late December, 60 days after arrival, the cattle were individually weighed, horns were removed at the base of the head, and bulls were castrated with a knife. All calves were visually scored for condition, fill, frame, and breed at that time. Individual weights were recorded after 29 and 71 days on a corn silage-based growing ration.

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[1]Appreciation is extended to Richard Potter, Reading, Kansas; Herb and Clair Niles, Lebo, Kansas; and Warren Bell, Coffey County Extension Agricultural Agent, for their help and support with these trials.

[2]Extension Livestock Specialist, Southeast Kansas.

In Experiment II, 1000 bull and steer calves of mixed breeds were purchased over a 60-day period in the fall from local sale barns in southeast Kansas. The calves were processed within 4 h of arrival at the lot; they were vaccinated for IBR, BVD, PI_3, 7-way blackleg, and hemophilus somnus, given an injection of vitamin A, dewormed with Tramisol®, and treated with Tiguvon®. The horned calves were tipped back 3 to 4 in. and bulls were castrated with a knife. All calves were weighed individually and visually evaluated for condition and breed. The calves were started on a forage sorghum silage-based ration with 3 to 4 lb of long-stem prairie hay and 3 lb of a pelleted protein, mineral, vitamin, and Bovetc® supplement per head daily.

During the receiving period, calves were pulled and treated when they appeared sick. Treatment was continued until visual appearance improved or body temperature returned to normal. The choice of drugs was determined by the local veterinarian and producer.

Calves were weighed individually at the end of the 22-day receiving period and 285 head were placed on wheat pasture, while the rest remained on the silage-based growing ration. At the end of the 74-day growing period, the calves were reweighed. Least Squares Analysis of Variance was used to evaluate the data.

Results and Discussion

In Experiment I, calves purchased as steers gained .35 lb per day faster ($P<.05$) than castrated bulls during the 29-day starting period. The steers continued to gain .18 lb per day faster ($P<.10$) than castrated bulls during the 71-day growing period. Over the 100-day period, this resulted in a .21 lb per head per day advantage ($P<.05$) in favor of the calves purchased as steers.

In Experiment II, calves purchased as steers gained .64 lb per day faster ($P<.001$) than castrated bulls in the first 22 days. Of those fed silage for 74 days, steers gained .23 lb per day faster ($P<.001$) than castrated bulls. Of those placed on wheat pasture, steers out-gained ($P<.001$) castrated bulls by .59 lb per head daily. Over the entire 94-day period, and considering calves on both wheat pasture and silage, this resulted in calves purchased as steers gaining .35 lb per day more than bulls castrated on arrival (Table 21.2).

In Experiment II, steer calves required fewer treatments per animal (.65 vs. 1.66) and fewer became sick (15 vs. 36%) compared to castrated bulls (Table 21.3).

These trials suggest that 550 lb bull calves must be discounted enough to account for increased health problems and the reduced gains over an extended period after castration. The bull calves in Experiment II cost $2.46/cwt less than steer calves. That discount did not cover the extra costs and poorer performance. Earlier findings by Brazle and coworkers (Cattlemen's Day, 1985) suggested that highly stressed, long hauled, 525 lb bulls needed to be discounted $8.70/cwt below steers. Locally puchased bull calves could probably be discounted less.

In both experiments, calves that were dehorned or tipped tended to gain slower, but not significantly so ($P>.10$), as shown in Table 21.4.

In Experiment I, large-framed calves gained significantly faster (P<.05) and small-framed calves gained slower (P<.05) than medium-framed calves (Table 21.5).

The effect on performance of gut fill, evaluated at the start of Experiment I, is shown in Table 21.6. Calves that were guant gained the slowest (P<.05). Calves with average fill had the best (P<.05) gains during the first 29 days. Calves that were full or "tanked" gained poorer than those with average fill, but considerably better than the gaunt calves. The number of guant calves in the study was small, and apparently they were either not completely healthy or had poor appetites.

There were no significant effects of either starting body condition or breed type on daily gains in the two experiments.

Many factors affect the performance and, therefore, the value of stocker calves. The data summarized in this article can be used to calculate the discounts appropriate for several of these factors.

Table 21.1. Performance of Castrated Bull Calves Compared to Steers -- Experiment I

Item	Steers	Castrated Bulls
Starting Wt., lb	592	591
Average Daily Gain, lb:		
29-Day Starting Period	1.40^{a}	1.05^{b}
71-Day Growing Period	1.68^{c}	1.50^{d}
100-Day Combined Periods	1.58^{a}	1.37^{b}

[ab] Means in the same row with different superscripts are significantly different (P<.05).

[cd] Means in the same row with different superscripts are significantly different (P<.10).

Table 21.2. Performance of Calves Purchased as Steers, or Bulls and Castrated on Arrival — Experiment II

Item	Steers	Castrated Bulls
Starting Wt., lb	550	549
Average Daily Gain, lb:		
22-Day Starting Periods (all calves)	2.19[a]	1.55[b]
74-Day Silage Growing Period (811 head)	1.32[a]	1.09[b]
74-Day Wheat Grazing Period (285 head)	1.60[a]	.81[b]
96-Day Combined Periods (all calves)	1.43[a]	1.08[b]

[ab]Means in the same row with different superscripts are significantly different ($P<.001$).

Table 21.3. Sickness and Mortality of Calves Purchased as Steers Compared to Bulls Castrated on Arrival — Experiment II

Item	Steers	Castrated Bulls
Treatments Required per Head	.65[a]	1.66[b]
Percent of Calves Treated	15[a]	36[b]
Percent Mortality	1.1	2.4

[ab]Means in the same row with different superscripts are significantly different ($P<.05$).

Table 21.4. Effect of Dehorning Calves on Average Daily Gain

Average Daily Gain	No Horns	Dehorned
Experiment I:		
29-Day Starting Period	1.26	1.19
71-Day Growing Period	1.66	1.52
100-Day Combined Periods	1.53	1.41
Experiment II:		
22-Day Starting Period	1.98	1.75
74-Day Growing Period	1.20	1.21
96-Day Combined Periods	1.30	1.20

Table 21.5. Effect of Frame Size on Calf Gains — Experiment I

Average Daily Gain, lb	Large	Medium	Small
29-Day Starting Period	1.51^{a}	1.01^{b}	1.16^{b}
71-Day Growing Period	1.74^{a}	1.67^{a}	1.35^{b}
100-Day Combined Periods	1.69^{a}	1.47^{b}	1.26^{c}

[abc]Means in the same row not sharing the same superscript are significantly different (P<.05).

Table 21.6. Effect of Visual Gut Fill at Start of Trial on Calf Gains — Experiment I

Average Daily Gain, lb	Gaunt	Average	Full	Tanked
29-Day Starting Period	$.07^{a}$	2.10^{d}	1.52^{c}	1.20^{b}
71-Day Growing Period	$.90^{e}$	1.79^{f}	1.79^{f}	1.85^{f}
100-Day Combined Periods	$.60^{e}$	1.93^{f}	1.79^{f}	1.66^{f}

[abcd]Means in the same row not sharing the same superscript are significantly different (P<.05).

[ef]Means in the same row not sharing the same superscript are significantly different (P<.10).

Effects of Decoquinate on Gain and Health of Newly-arrived Stocker Cattle

Frank Brazle[1]

Summary

Decoquinate (Deccox®), when added to the diet of newly-arrived calves, reduced ($P<.05$) the number of treatments required per animal in three experiments involving 551 cattle. Feed conversion was improved in two of the three experiments and average daily gain was increased ($P<.05$) in one experiment when Deccox® was fed. Steer calves gained faster ($P<.001$) and required fewer ($P<.01$) treatments per head than bull calves castrated on arrival. Black, medium-framed calves required fewer ($P<.05$) treatments than other breed types.

Introduction

Feeder calves undergo numerous stresses when they are marketed, transported, and placed into a feedlot environment. Normally, as stressors increase, the incidence of clinical and subclinical coccidiosis increases. This weakens calves and allows for more problems from bovine respiratory disease (BRD).

We evaluated the gain and health benefits of feeding Deccox®[2], a highly effective coccidiostat, to calves during the first month after arrival.

Experimental Procedures

In January and February of 1985, 551 bull and steer calves of mixed breeds were purchased at auction markets (experiments 1 and 2) or off farms (experiment 3) in Southeast Kansas. They were shipped to a backgrounding lot, processed on arrival, and the bull calves were castrated with a knife. The calves were vaccinated for Infectious Bovine Rhinotracheitis (IBR), Bovine Virus Diarrhea (BVD), Parainfluenza$_3$ (PI_3), Leptospirosis pomona, Clostridum chauovei and septicum, and Pasteurella, dewormed with Fenbendazole (Safe-Guard®) and given two sulfamethazine (Sulfa-span®) boluses per animal, then randomly allotted to either control or Deccox® treatments. Calves were breed typed into six groups: red, medium frame; black, medium frame; black white face, medium frame; exotic-cross, large frame; Brahman-cross, medium and large frame; and red white face, feather necked, medium frame.

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[1] Extension Livestock Specialist, Southeast Kansas.

[2] Rhone-Poulonc, Inc., Atlanta, Georgia.

Experiments 1 and 2. The calves were fed a silage-based growing ration containing 71% dry matter and 46 Mcal/cwt NEg (dry basis), with AS-700® being fed the first 14 days of each experiment. Those on the Deccox® treatment were fed 24 to 25 mg of decoquinate per 100 lb body weight daily. In experiment 2, a high percentage of the calves were affected with BRD.

Experiment 3. The calves were fed an alfalfa-based growing ration containing 86% dry matter and 46 Mcal/cwt NEg (dry basis), with AS 700® being fed the first 14 days. A high percentage of the calves were bought in the country without going through an auction. The calves on the Deccox® treatment were inadvertently underdosed and received only 11 mg per 100 lb body weight daily. In all three experiments, calves were treated if rectal temperature was above 104°F or there were visual signs of sickness. The data were evaluated by Analysis of Variance Procedures with Least Squares Means Procedures.

Results and Discussion

The calves fed Deccox® in experiment 1 showed an improvements in daily gain (P<.05), feed efficiency, and the number of treatments required per animal (P<.05). The Deccox®-treated calves in experiments 2 and 3 required fewer treatments per animal and in experiment 3, had better feed efficiency. There was no significant improvement in gain in experiments 2 and 3. Results are shown in Table 22.1.

Table 22.1. Effects of Deccox® on Performance and Health of Newly-arrived Stocker Calves.

	Least Squares Means[1]	
Item	Deccox®	Control
Experiment 1--28 Days:		
No. Calves	77	78
Daily Gain, lb	$1.66^b \pm .22$[2]	$.99^a \pm .23$
No. Treatments/Animal	$.49^a \pm .53$	$1.76^b \pm .54$
Feed DM/Gain, lb	8.39	11.35
No. Deads	2	2
Experiment 2--31 Days:		
No. Calves	113	112
Daily Gain, lb	$1.36 \pm .24$	$1.38 \pm .24$
No. Treatment/Animal	$4.06^a \pm .50$	$5.31^b \pm .50$
Feed DM/Gain, lb	10.08	10.18
No. Deads	16	18
Experiment 3--28 Days:		
No. Calves	85	86
Daily Gain, lb	$2.16 \pm .29$	$2.08 \pm .24$
No. Treatments/Animal	$.77^a \pm .64$	$2.27^b \pm .55$
Feed DM/Gain, lb	6.68	7.10
No. Deads	2	3

[1]The least squares model accounted for trial, treatment, sex, breed, trial x sex, trial x treatment, treatment x sex, and starting weight.

[2]Standard error.

[ab]Means in the same row with different superscripts are significantly different (P<.05).

A large percentage of the calves in experiment 2 were sick from BRD. In experiment 3, the calves were underdosed with Deccox®, but were country fresh and exposed to less stress, which may explain their lack of gain response.

The largest responses in the three experiments from Deccox® were obtained in bulls castrated on arrival. They out-gained ($P<.10$) the control bulls by .38 lb per head daily, and required 3.2 fewer ($P<.001$) treatments per animal (Table 22.2).

Table 22.2. Effects of Deccox® on Gain and Health of Bull and Steer Calves

	Least Squares Means[1]	
Item	Deccox® Bulls[2]	Control Bulls
Daily Gain, lb	$1.36^{b} \pm .32$[3]	$.98^{a} \pm .27$
No. Treatments/Animal	$1.63^{c} \pm .70$	$4.87^{d} \pm .58$
	Deccox® Steers	Control Steers
Daily Gain, lb	$2.09 \pm .10$	$1.99 \pm .11$
No. Treatments/Animal	$1.91 \pm .24$	$1.76 \pm .25$

[1]The least squares model accounted for trial, treatment, sex, breed, trial x sex, trial x treatment, treatment x sex, and starting weight.

[2]Purchased as bulls and castrated on arrival.

[3]Standard error.

[a,b]Means in same row with different superscripts are significantly different ($P<.10$).

[c,d]Means in the same row with different superscripts are significantly different ($P<.001$).

These data strongly suggest that Deccox® helps reduce health problems of newly-arrived calves by reducing the stress of sub-clinical coccidiosis, resulting in better gains and feed conversion. No clinical cases of coccidiosis developed in the calves. Each time an animal was treated, it was correlated with a daily gain reduction of .14 lb. Steers out-gained ($P<.001$) bulls castrated on arrival by .87 lb per day and required 1.2 fewer ($P<.01$) treatments per animal (Table 22.3).

The black, medium-framed calves required fewer ($P<.05$) treatments than other breed types; they may have more natural immunity than some other breed types (Table 22.4). These data agree with earlier findings by the author (Cattlemen's Day, 1985). The Brahman cross calves gained slower ($P<.05$) than the red white face calves.

Table 22.3. Effects of Sex Status on Gain and Health of Newly-arrived Stocker Calves

	Least Squares Means[1]	
Item	Bulls[2]	Steers
Starting Weight, lb	493.7 ± 7.8[3]	494.8 ± 3.0
Daily Gain, lb	1.17[a] ± .21	2.04[b] ± .08
No. Treatments/Animal	3.047[d] ± .46	1.84[c] ± .18

[1]The least squares model accounted for trial, treatment, sex, breed, trial x sex, trial x treatment, treatment x sex, and starting weight.

[2]Purchased as bulls and castrated on arrival.

[3]Standard error.

[a,b]Means in the same row with different superscripts are significantly differ (P<.001).

[c,d]Means in same row with different superscripts are significantly differ (P<.01).

Table 22.4. Effects of Breed-type on Gain and Health of Newly-arrived Stocker Calves.

	Least Squares Means[1]					
Item	Red Medium-Frame	Black Medium-Frame	Black White Face	Brahman Cross	Exotic Cross	Red White Face
Starting Wt., lb	489.4	476.8	501.2	509.2	505.4	483.5
Daily Gain, lb	1.58[ab] ± .22[a]	1.56[ab] ± .19	1.59[ab] ± .16	1.44[a] ± .21	1.51[a] ± .23	1.93[b] ± .18
No. Treatments/ Animal	2.28[b] ± .50	1.45[a] ± .43	2.35[b] ± .35	3.06[b] ± .48	2.77[b] ± .53	2.75[b] ± .40

[1]The least squares model accounted for trial, treatment, sex, breed, trial x sex, trial x treatment, treatment x sex, and starting weight.

[2]Standard error.

[a,b]Means in the same row not sharing the same superscript are significantly different (P<.05).

Kansas Bull Test
15-Year Summary

R.R. Schalles, K.O. Zoellner,
and Willard Olson

Summary

Bulls placed in Kansas Bull Tests have increased in weight, gain, frame, and scrotal circumference, while decreasing in fat thickness over the past 15 years. Bull buyers have been willing to pay for increased performance, with changes in bull prices generally reflecting changes in other cattle prices.

Introduction

The first Kansas Bull Test started at Beloit in June, 1971. A test was added at Yates Center in 1975 and moved to Potwin in 1982. In the 43 tests completed through spring 1985, 732 herds were represented by the 9946 bulls, whose 2195 sires represented 32 breeds. Bulls had been consigned from 13 states.

Procedure

Bulls 7-8 months old are delivered to the test stations each fall and spring, approximately 3 weeks before the test officially starts. They are weighed on 2 consecutive days at both the start and end of the 140-day test. Intermediate weights are obtained at 56 and 112 days. Since 1974, height has been measured at the 112-day weighing to calculate frame score. Loin eye area and backfat are measured by ultrasonic imaging at the 140-day weighing. Since 1975, scrotal circumference has been measured on all bulls eligible for sale. The rations have remained a constant 83 and 52 Mcal/cwt in NEm and NEg, respectively, for the final ration. Bulls in the upper two-thirds of the index, which is an average of the 140-day ADG ratio and end of test weight per day of age ratio, were eligible to sell through 1982. After 1982, bulls with our index of 100 or above were eligible to sell.

Results

The average daily gain of all bulls over all the 140-day tests was 3.18 lb, weight per day of age was 2.75 lb, and frame score has averaged 5.0 (Table 23.1). The adjusted weaning weight furnished by the consignor was 577 lb with an average starting test weight of 611 lb. The average loin eye area was 12.1 sq in; backfat has averaged 0.22 in. The average price of the 5122 bulls sold was $1072.

Average daily gain on test increased from 2.79 lb in 1971 to 3.46 lb in 1985, while weight per day of age increased from 2.48 lb. Adjusted 365-day weight increased from 931 to 1054 lb.

Frame score increased from 4.0 in 1973 to 5.2 in 1979, and has held steady at 5.2 to 5.4 since. Fat thickness decreased from 0.30 in (1974) to 0.21 in. (1978) and has remained constant since. Scrotal circumference of sale bulls has steadily increased from 31.5 cm in 1974 to 36.0 cm in 1985. Considerable variation was present between breeds; however, the number of bulls was too small to adequately compare some breeds.

Adjusted weaning weight and starting weight were correlated with later performance but weaning weight ratio was not. Correlations between loin eye area and growth traits and between frame score and growth traits were positive. Backfat and growth traits had negative correlations.

Seven breeds totaling 4854 bulls were used in a price analysis (Table 23.2). Gelbvieh and Simmental were the high selling breeds. Buyers paid for performance; they paid $86.84 for each 0.1 lb increase in weight per day of age at the end of the test. Each 0.1 lb increase in average daily gain on test brought $8.72 more. An increase of one frame score was worth $274.43. An increase of 0.1 lb in adjusted weaning weight was worth $1.19 and a 1 cm increase in scrotal circumference brought $8.21. The average price paid for bulls started at $553 in 1971, increased to a high $1391 in 1979, and decreased through 1985 to $1060 (Table 23.3).

Table 23.1. Average Performance by Breeds, 1971-1985

Breed	No.	Adj. Weaning Wt.	Test ADG	Final Wt/Day	Frame	365-day Wt	Scrotal Circum-ference
Amerifax	10	518	3.25	2.67	4.4	979	32.9
Angus	2006	523	2.98	2.57	3.9	954	34.3
Beefalo	4	544	2.68	2.51	4.3	957	30.9
Beefmaster	3	538	2.96	2.72	5.5	1005	NA
Blonde D'Aqutane	18	521	2.79	2.52	4.9	918	26.8
Brangus	40	519	2.62	2.44	4.5	903	33.4
Charolais	611	603	3.35	2.94	5.6	1075	33.2
Chianina	143	568	3.26	2.83	6.8	1041	32.2
Friesian	15	542	3.05	2.73	4.8	1001	34.4
Galloway	10	481	2.53	2.31	NA	864	NA
Gelbray	7	526	2.87	2.44	4.1	936	30.4
Gelbvieh	225	583	3.11	2.75	5.1	1024	34.5
Hereford	914	529	2.92	2.55	3.8	952	33.3
Herfex	6	456	3.04	2.31	4.2	846	33.6
Lemousin	374	544	3.04	2.63	4.6	970	31.0
Maine Anjou	122	558	3.41	2.83	5.3	1042	34.1
Marchigania	19	566	2.94	2.63	6.1	991	30.6
Milking Shorthorn	3	556	2.85	2.77	5.3	1011	34.6
Murry Gray	30	510	3.00	2.47	3.9	925	35.0
Norwegian Red	23	613	3.14	2.80	5.3	1040	32.4
Polled Hereford	718	499	2.89	2.50	3.6	920	32.7
Polled Shorthorn	3	525	2.69	2.66	4.7	937	NA
Romagnola	7	NA	3.22	2.69	5.4	NA	NA
Red Angus	28	500	3.03	2.51	3.4	925	34.2
Red Polled	9	540	2.63	2.59	5.1	954	32.2
Saler	10	474	2.82	2.44	4.6	878	30.3
Santa Gertrude	16	607	2.64	2.60	5.7	1013	35.4
Shorthorn	19	499	2.96	2.57	4.4	941	33.7
Simbra	3	538	2.47	2.48	6.0	919	32.4
Simmental	4510	580	3.36	2.87	5.7	1063	35.3
South Devon	20	548	3.28	2.87	5.6	1023	31.1
Tarentaise	20	517	3.11	2.62	4.3	926	34.4
Total	9946	577	3.18	2.75	5.0	1028	34.9

Table 23.2. Bull Prices by Breed, 1975-1985

Breed	Price
Angus	$876
Charolais	850
Gelbvieh	1178
Hereford	769
Limousin	845
Polled Hereford	702
Simmental	1025

Table 23.3. Bull Prices by Year

Year	Price
1971	$533
1972	612
1973	728
1974	778
1975	412
1976	615
1977	624
1978	941
1979	1391
1980	1197
1981	1170
1982	1126
1983	1123
1984	1052
1985	1060

Survey of Northwest Kansas Cow-Calf Producers[1]

D.D. Simms,[2] G. Boyd, and L.R. Corah

Summary

An in-depth survey of reproductive performance and management practice was conducted on 169 cow/calf operations in Northwest Kansas.

Introduction

A survey of cow/calf management practices was conducted to gain a better knowledge of the management techniques being used by producers and to aid in extension program planning and evaluation.

Procedure

One hundred and sixty-nine cow-calf producers in northwest Kansas were surveyed by county extension agricultural agents. While we recommended that agents select a random sample of cow-calf producers, those active in extension programs were sometimes given priority in interview selection. Most of the surveys were completed "one on one" to increase the accuracy of information collected. Data represent either the 1984 or 1985 calf crop. The 169 herds surveyed had 24,359 breeding age females for an average of 144 per herd.

Results

The responses of cow-calf producers to a variety of management oriented questions is summarized below.

Reproduction

Average length of the breeding season in days	105
% of cows exposed that calved	91.0
% of cows exposed that weaned a calf	85.7
% of calves born in 1st 20 days of the calving season	38.0
% of calves born in 1st 40 days of the calving season	66.0
% of calves born in 1st 60 days of the calving season	84.0
% of heifers assisted at calving	25.2
% of cows assisted at calving	2.7
% of calves dying within 5 days of birth	3.8
% of calves dying from birth to weaning	5.8

[1]Appreciation is expressed to the County Extension Agricultural Agents in northwest Kansas for their assistance in conducting this survey.

[2]Extension Livestock Specialist, Northeast Kansas.

Reproduction (cont.)

% of open mature cows in herds that are pregnancy checked	4.2
% of open yearling heifers in herds that are pregnancy checked	8.4
% of open 1st calf heifers in herds that are pregnancy checked	9.9
% of herds that are pregnancy checked	47.3
% of producers breeding heifers prior to cows	46.7
% breeding heifers to calve at 24 mo of age	94.0
% breeding heifers to calve at 30 mo of age	5.6
Average number of cows per bull	25.0
% semen checking bulls	59.6

Production

Average weaning weight of steer calves, lb	513.7
Average weaning weight of heifer calves, lb	473.1

Breeding and Selection

% of producers not crossbreeding	12.9
% of producers utilizing straightbred cows	21.2
% of producers with a systematic crossbreeding plan	60.3

% of producers using the following traits as the primary selection trait:

Trait	Heifers	Bulls
Type or Conformation	24.3	20.4
Performance of Dam	17.7	1.2
Weaning Weight	15.8	4.3
Frame	7.9	11.2
Weight-For-Age	7.9	5.6
Disposition	6.7	1.2
Size	6.1	—
Yearling Weight	6.1	5.6
Conception	1.2	—
Breeder Reputation	0.6	7.4
Performance of Sire	0.6	5.6
Pedigree	0.6	1.2
Birth Weight	—	21.7
Breeding Value	—	4.9
Individual Performance	—	6.2
Scrotal Circumference	—	1.2
Cost	—	1.2

Management

% of producers identifying calves at birth	84.0
% buying 1 year old bulls	26.6
% buying 1.5 year old bulls	22.0
% buying 2 year old bulls	51.2
Average cash costs per cow per year	$257

Nutrition

Average summer acreage allotted per cow-calf pair	7.9
% of producers with range in poor condition	2.2
% with range in fair condition	15.5
% with range in good condition	74.8
% with range in excellent condition	7.4
% with poor grazing distribution	5.9
% with good grazing distribution	94.0
% separating pregnant cows from cows that have calves	43.3
% implanting steer calves	88.4
% implanting heifer calves	38.6
% creep feeding calves	17.6

Marketing

Average number of groups into which calves were sorted at sale	3.8
% of producers that have at one time wintered their calves	89.4
% that have finished calves at home or in a commercial feedlot	24.2
% selling calves at auction	85.8
% selling directly off the farm	11.4

Health

% of producers that vaccinate for the following items:

Item	Cows	Heifers	Calves
None	31.3	28.4	9.5
Vibriosis	55.6	44.4	4.1
Leptospirosis	62.1	53.2	19.5
Blackleg	5.3	23.6	85.2
Brucellosis	—	20.7	—
Infectious Bovine Rhinotracheitis (IBR)	11.2	19.5	32.5
Bovine Virus Diarrhea (BVD)	11.2	13.6	14.8
Parainfluenza-3 (PI_3)	2.9	9.5	17.7
Scours	10.6	5.9	—
Hemophilus Somnus	1.2	1.2	5.3

% reporting these specific disease problems:

Scours	33.1
Respiratory Disease	17.2
Pinkeye	8.9
Footrot	6.5
Coccidiosis	1.8
Cancer eye	1.8
Blackleg	1.2
Bangs	1.2

% worming cows or calves	44.9
% treating for external parasites	85.2
% without a fly control program	11.2

Heterosis in Simmental Angus Rotational-Cross Calves

Lisa A. Kriese, Robert R. Schalles,
and Lyle W. Lomas[1]

Summary

Heterosis estimates were determined for gestation length, birth weight, and yearling weight using a two-breed rotational crossbreeding system with Angus and Simmental cattle. Heterosis for gestation length was -.3%; birth weight, 8.31%; weaning weight 5.05%, and yearling weight, 5.39%. Angus-sired calves from Simmental dams were significantly heavier at weaning and as yearlings than the reciprocal cross.

Introduction

Systematic crossbreeding of beef cattle is a useful tool for commercial cattlemen, resulting in an efficient, autonomous breeding program with a minimal loss in heterosis.

It has been well documented that heterosis can be utilized well by the cow-calf producer, since the greatest amounts of heterosis are expressed in pre-weaning traits. The established cow herd should be crossed with a different bull breed. This first cross allows for maximum heterosis. However, if there is no breeding system, large losses in heterosis can occur after crossbred replacement heifers are placed into the herd.

Some type of crossbreeding system should be used to produce maximum obtainable heterosis in the offspring. Rotational crossbreeding is such a system. In a rotational system, all replacement heifers are produced and only purebred sires need to be purchased. The rotational system should be developed to match the management of the operation.

A two-breed, rotational crossbreeding system was initiated in southeast Kansas utilizing Angus and Simmental cattle. Reproductive, pre-weaning, postweaning, and carcass data were collected and heterosis values determined for gestation length, birth weight, weaning weight, and yearling weight.

[1]Director, Southeast Kansas Experiment Station, Parsons, KS.

Procedures

Data were collected on 425 cows and their progeny at the Southeast Kansas Agricultural Experiment Station, Parsons, from 1979 to 1985. Hereford cows, present at the station in 1979, were gradually eliminated and replaced with Simmental and Angus straightbred and crossbred cows. A two-breed, rotational crossbreeding system was initiated in 1980. Twenty females each were maintained in purebred Simmental and purebred Angus herd to use as comparisons. Forty cows were maintained in a two-breed, rotational crossbreeding herd. The existing cows were divided into three groups; two were housed at Parsons and one approximately 15 miles southwest at Mound Valley. Average cow weights were 1054.82 $\pm$ 83.24 lbs for purebred Simmental, 986.83 $\pm$ 101.58 lbs for purebred Angus, and 1008.81 $\pm$ 92.43 lbs for the crossbred cows. The cows were pastured primarily on fescue and native grass and supplemented with hay and concentrate when needed during the winter months.

From 1979 to 1983, two groups calved in the fall and one group in the spring. Fall-calving cows began calving in late August or early September and continued through November. Spring calves were born in late February through May. All groups were synchronized and bred AI with Angus and Simmental bulls. Angus and Simmental bulls also were used as cleanup bulls.

The breeding season lasted 60 to 90 days. In 1984, the spring-calving herd was eliminated and switched to fall calving. Calves were weaned at approximately 205 days of age. Replacement heifers were selected from offspring or bought from producers, and steer calves were placed in the feedlot or sold. First calf heifers were bred to Angus bulls and then placed into the rotation. All calves received creep feed, except in 1979 when spring-born calves and half of Parsons, fall-born calves did not receive creep feed.

Data were collected on calving ease, gestation length, birth weight, weaning weight, and yearling weight. All records that were used in developing models for gestation length, birth weight, weaning weight, and yearling weight also were used in calculating heterosis values. From 1980 on, steers were placed in a feedlot and carcass data were collected. Traits measured included days on feed, average daily gain, final weight, carcass weight, quality grade, yield grade, ribeye area, and backfat thickness.

Heterosis was calculated using least squares means for gestation length, birth weight, weaning weight, and yearling weight (Table 25.1). Only 82 observations were used in calculating heterosis estimates, since other observations included Hereford blood, and a base Hereford population was not maintained after 1979.

Reciprocal cross means were also calculated. Sire and dam breeds were taken into account in calculating least squares means and standard errors for birth weight, weaning weight, and yearling weight. Least squares means for dam breeds were an indication of maternal heterosis.

Results and Discussion

Simmental calves were sired by Abricot, Eagle, Mr. PR, Alpine Polled Proto, Cezon, Bar 5 Fantastic, Formula 10, CPS, Lightning, AR Extra 8J, and sons of these bulls. The 8 purebred calves comprising the basis for comparison had an average gestation length of 292 $\pm$ 2.1 days and birth weight of 77.4 $\pm$ 5.8 lb. Adjusted weaning weight average was 538.2 $\pm$ 26.9 lb and average for yearling weight was 683.1 $\pm$ 35.6 lb.

Forty-one Angus calves sired by PS Power Play, Dalebanks Rito 9144, Dalebanks Barometer 0829, Dalebanks Skymere 9238, Benchmark 0505, Thomas Chaps, and Ken Caryl Mr. Angus characterized the purebred Angus population. Average gestation length for purebred Angus was 284 $\pm$ 2.95 days, with an average birth weight of 70.34$\pm$ 2.95 lb. Average adjusted weaning weight was 537.5 $\pm$ 15.41 lb and yearling weight was 672.97 $\pm$ 19.82 lb.

The crossbred population was sired by bulls used in the purebred Simmental and Angus populations. The results are based primarily on the F_1 generation. Six F_2 calves have been produced thus far in the study. Twenty-six 50% Simmental, 50% Angus calves were born. Of the 26 F_1 calves, 15 were sired by Simmental bulls and 11 were sired by Angus bulls.

Average gestation length was 287 $\pm$ 2.69 days and birth weight average was 80.0 $\pm$ 4.21 lb for the 50% Angus, 50% Simmental calves. Weaning weight average was 565.1 $\pm$ 18.37 lb and yearling weight average was 714.4 $\pm$ 47.65 lb.

Table 25.2 gives heterosis for birth weight, gestation length, weaning, weight and yearling weight by percentage of breeding in the calves. The most reliable heterosis values are associated with 50% Angus-50% Simmental calves, which included most of the calves in the heterosis analysis. All heterosis values in that group are very similair to previously published reports.

The reciprocal F_1 crosses favor the Angus-sired calves raised by Simmental dams. Those calves were 4.76 lbs heavier at birth, 72.63 lbs heavier at weaning, and 52.23 lbs heavier as yearlings compared to the reciprocal. In the parent populations, purebred Simmental calves outweighted purebred Angus calves at birth, weaning, and as yearlings. The differences between the reciprocal cross calves cannot be totally explained by differences in milk production between the two dam breeds.

Studies of rotational crossbreeding systems indicate that high levels of heterosis are sustained in successive generations. The F_1 crosses produced thus far should express maximum individual heterosis. As F_1 females are retained in the herds, subsequent generations in the two-breed, rotational crossbreeding system should show decreased individual and maternal heterosis.

Previous studies have shown that both individual and maternal heterosis will stabilize to two-thirds of the maximum heterosis in seven generations using a two-breed, rotational crossbreeding system.

Table 25.1. Least Squares Means and Standard Errors by Trait and Percentage of Angus and Simmental in Calves Used to Calculate Heterosis Values

% breeding of calf			Trait			
Simmental	Angus	No. born	Birth weight (kg)	Gestation length (d)	Weaning weight (kg)	Yearling weight (kg)
0	1	41	31.9 (1.34)[1]	283.9 (2.52)	243.8 (6.99)	305.2 (8.99)
1/8	7/8	2	37.8 (4.65)	293.0 (3.48)	270.7 (16.54)	338.5 (23.31)
1/4	3/4	2	30.9 (4.81)	-	222.0 (18.85)	286.8 (26.71)
1/2	1/2	27	36.3 (1.91)	287.0 (2.69)	256.3 (8.33)	324.0 (12.61)
5/8	3/8	2	39.0 (4.72)	303.7 (4.53)	280.8 (22.54)	364.3 (31.26)
1	0	8	35.1 (2.60)	292.1 (2.07)	244.1 (12.18)	309.8 (16.58)

[1]Standard errors are in parentheses.

Table 25.2. Percent Heterosis for Birth Weight, Weaning Weight, Yearling Weight, and Gestation Length

	Heterosis (%)[1]			
Simmental % in Calf	Birth Wt.	Weaning Wt.	Yearling Wt.	Gestation Length
1/2	8.31 (27)[2]	5.05 (26)	5.39 (13)	-.30 (10)

[1]Heterosis = ((Crossbred Avg. - Weighted Purebred Avg.)/ Weighted Purebred Avg.) * 100. Weighted purebred average = (Angus mean * % Angus in calf) + (Simmental mean * % Simmntal in calf).

[2]Numbers in parentheses indicate number of observations.

Effects of Compudose® Implants from Birth to Slaughter on Carcass and Meat Traits of Young Bulls and Steers

T.D. Hopkins and M.E. Dikeman

Summary

Implanting young bulls with Compudose® three times from birth to slaughter resulted in performance similar to that of nonimplanted bulls, but decreased masculinity development. Implanted bulls tended to have higher marbling scores, more tender meat, more youthful carcasses, and lighter lean color than nonimplanted bulls. Although both implanted and nonimplanted bulls were more efficient and gained faster in the feedlot than implanted steers, the steers showed very little carcass masculinity and had finer-textured lean. Implanted steers had more youthful carcasses and lower Warner-Bratzler shear values than nonimplanted bulls. However, nonimplanted bulls grew faster, were more efficient, had larger ribeyes and lower yield grade numbers than implanted steers.

For large-framed cattle, castration and implanting with Compudose® near birth result in the most desirable combination of performance, carcass, and meat quality traits.

Introduction

Increased concern about fat in the American diet has prompted consumer preference for leaner beef. Consequently, the beef industry has renewed its interest in feeding non-castrated males in an effort to produce meat more efficiently and meet the consumers' desire for a leaner product. Some of the problems in the use of bulls for beef include dark and coarsely textured lean, excessive fullness and thickness of the neck, and management problems. In addition, meat may be less tender, and have lower marbling and/or quality grades. Implanting young bulls with "estrogen-like" substances has reduced some of these problems, while retaining many of the advantages that young bulls have. Implanting young bulls with Compudose® - a natural rather than synthetic estrogen - may improve carcass and meat traits without sacrificing their performance advantages.

Experimental Procedure

Twenty-eight Simmental bulls were randomly assigned to one of three treatments at birth. Ten calves remained intact and were implanted (IB) with Compudose®. Nine calves were castrated at birth and implanted (IS) with Compudose®. The remaining nine calves were intact, nonimplanted controls (CB). Calves were implanted near birth, at weaning and at approximately 200 days after weaning. Calves were weaned at 7.5 months of age and fed an 85% concentrate diet at the Kansas State University Beef Cattle Research Unit until slaughter at the university meat laboratory. Hip heights, masculinity scores, and scrotal circumferences were measured at 8.5 months of age and again just prior to slaughter.

Cattle were slaughtered at an average age of 14.8 months. Testicular weights were determined at slaughter. Carcass masculinity (size of crest, jump muscle, and pizzle eye), marbling scores, and USDA yield grade data were obtained at 24 hr postmortem. The wholesale rib section was removed at 48 hr postmortem, vacuum packaged and aged in a cooler for 10 days. Two 1 inch-thick steaks from the 12th rib region were cooked to 156°F for Warner-Bratzler shear force determinations and trained taste panel evaluations.

Results

Implanting bulls and steers with Compudose® from near birth to slaughter did not affect hip height at 8.5 or 14.8 months of age. However, masculinity scores were lowest ($P<.05$) for IS, and IB were less ($P<.05$) masculine than CB. Scrotal circumferences were lower ($P<.05$) for IB than for CB at both 8.5 and 14.8 months of age (Table 26.1).

Average daily gains were greater ($P<.05$) for CB than for IS, whereas IB were intermediate to CB and IS (Table 26.2). Feed per pound of gain was similar for CB and IB, but IS were less efficient than either CB or IB. Although slaughter and carcass weights were not significantly different, CB tended ($P<.10$) to be heavier than IS, and IB were intermediate (Table 26.3). Dressing percentages were not different among treatments. Implanted steer carcasses were more ($P<.05$) youthful than CB carcasses, and IB tended to be more youthful than CB. Marbling scores among treatments were not significantly different, although CB tended to be lowest. Similar marbling scores for IS and IB were unexpected because IB had significantly less ($P<.05$) fat thickness than IS. Ribeye areas were smaller and yield grades were higher for IS than for CB. Yield grades for IB and CB were equal, although CB tended ($P<.10$) to have larger ribeye areas. Although testical weights were similar for IB and CB, the variability was much greater for IB. Carcass masculinity was lowest ($P<.05$) for IS, and IB were less ($P<.05$) masculine than CB. Consequently, implanting young bulls with Compudose® effectively retarded masculinity and made bull carcasses more acceptable.

Lean color and firmness were not significantly different among treatments, but CB tended ($P<.10$) to be darker than IS and IB. Implanted steers had finer ($P<.05$) textured ribeyes than IB and CB. The incidence of heat ring (dark, coarse band in the ribeye) was higher ($P<.05$) for IB than IS, whereas CB were intermediate (Table 26.4). The higher incidence of heat ring in IB was likely due to less insulation (less fat cover) of the ribeye muscle during chilling.

A trained taste panel found no significant differences in flavor intensity, connective tissue amount, or myofibrillar or overall tenderness among treatments (Table 26.5). However, IB tended to be more tender than CB, whereas IS were intermediate. In addition, IB were more ($P<.05$) juicy than CB and IS were intermediate in juiciness. Warner-Bratzler shear-force values were lower ($P<.05$) (more tender) for IS than for CB, whereas IB were intermediate.

Implanting young bulls from birth to slaughter reduced their masculinity and scrotal circumferences both at 8.5 mo and at slaughter, resulting in carcasses that would be more acceptable to meat packers.

Implanted bulls tended to have more youthful carcasses, higher marbling scores, lighter lean color, and more tender meat than CB. In addition, IB were more efficient and tended to gain faster than IS. Furthermore, IB had lower yield grades than IS.

In spite of the improvements from implanting bulls, IS still were superior to both IB and CB for live and carcass masculinity and texture of lean. Although IS had a higher yield grade (2.4) than IB and CB (both 1.9), and had more fat thickness (.32 in) than IB (.20 in), IS carcasses were more desirable. This would compensate for their less efficient gains.

For large-framed cattle like these, the IS treatment resulted in the most desirable combination of performance, carcass, and meat quality traits.

Table 26.1. Hip Heights and Masculinity Characteristics for Control Bulls and Compudose®-Implanted Bulls and Steers.

Item	Implanted steers	Implanted bulls	Control bulls
Hip Height at 8.5 months, in.	46.5	45.8	46.7
Hip Height at slaughter, in.	54.6	53.7	53.9
Masculinity score at 8.5 months[1]	1.2[a]	2.2[b]	3.9[c]
Masculinity score at slaughter[1]	1.4[a]	3.6[b]	4.6[c]
Scrotal circumference at 8.5 months, cm.	—	19.5[a]	27.0[b]
Scrotal circumference at slaughter,cm.	—	38.7[a]	42.4[b]

[1]Scores of 1 to 5: 2 = slightly masculine, 3 = moderately masculine, 4 = masculine.

[a,b,c]Means in the same row with different superscript letters differ ($P<.05$).

Table 26.2. Performance Characteristics for Control Bulls and Compudose® - Implanted Bulls and Steers.

Item	Implanted steers	Implanted bulls	Control bulls
Weaning wt., lb	624^{ab}	595^{a}	643^{b}
Slaughter wt., lb	1334	1357	1427
Average daily gain, lb	3.40^{a}	3.64^{ab}	3.79^{b}
Feed/lb of gain (DM basis)	6.80^{a}	5.96^{b}	6.12^{b}

[a,b]Means in the same row with different superscript letters differ (P<.05).

Table 26.3. Carcass Characteristics of Control Bulls and Compudose®-Implanted Bulls and Steers.

Item	Implanted steers	Implanted bulls	Control bulls
No. of animals	9	10	9
Slaughter wt., lb	1334	1357	1427
Hot Carcass wt., lb	835	854	911
Dressing percentage	62.6	62.9	63.8
Carcass maturity	A^{62a}	A^{66ab}	A^{76b}
Marbling score	$Slight^{90}$	$Slight^{94}$	$Slight^{62}$
Fat thickness, in	$.32^{a}$	$.20^{b}$	$.28^{ab}$
Ribeye area, in^2	14.1^{a}	14.9^{ab}	16.1^{b}
Yield grade	2.4^{a}	1.9^{b}	1.9^{b}
Testicular wt., gram	—	623	693
Jump muscle and crest[1]	1.4^{a}	3.4^{b}	5.0^{c}
Pizzle eye size[2]	1.8^{a}	3.0^{b}	4.2^{c}

[1]Scores of 1 to 6: 2 = barely evident, 3 = slightly prominent and 4 = moderately prominent.

[2]Scores of 1 to 7: 2 = moderately small, 3 = slightly small and 4 = slightly large.

[a,b,c]Means in the same row with different superscript letters differ (P<.05).

Table 26.4. Ribeye (Longissimus) Quality Characteristics for Control Bulls and Compudose®-Implanted Bulls and Steers.

Item	Implanted steers	Implanted bulls	Control bulls
Lean firmness[1]	6.2	6.3	6.4
Lean texture[2]	5.4[a]	4.1[b]	4.0[b]
Lean color[3]	3.7	3.7	4.5
Heat ring (Dark coarse band)[4]	1.0[a]	1.8[b]	1.3[ab]

[1]Scores of 1 to 8: 5 = slightly firm, 7 = firm.

[2]Scores of 1 to 8: 4 = slightly coarse, 5 = slightly fine, 6 = moderately fine.

[3]Scores of 1 to 9: 3 = light cherry red, 4 = cherry red, 5 = slightly dark red.

[4]Scores of 1 to 5: 1 = none, 2 = slight.

[a,b]Means in the same row with different superscript letters differ ($P<.05$).

Table 26.5. Taste Panel Evaluation and Warner-Brazler Shear Values of the Ribeye (Longissimus) for Control Bulls and Compudose®-Implanted Bulls and Steers.

Item	Implanted steers	Implanted bulls	Control bulls
Flavor intensity[1]	5.8	5.8	5.4
Juiciness[1]	5.4[ab]	5.8[a]	5.2[b]
Connective tissue amount[1]	6.5	6.4	6.0
Myofibrillar tenderness[2]	5.4	5.8	5.2
Overall tenderness[2]	5.6	5.8	5.4
Warner-Bratzler shear, lb	8.7[a]	9.7[ab]	11.4[b]

[1]6 = slightly intense, slightly juicy or slight amount, 7 = very intense, very juicy or practically none.

[2]Scores of 1 to 8: 5 = slightly tender, 6 = moderately tender and 7 = very tender.

[a,b]Means in the same row with different superscript letters differ ($P<.05$).

Methods of Tenderization for Value-Added, Hot-boned, Restructured, Pre-cooked Roasts from Cows

H.A. Flores, C.L. Kastner,
D.H. Kropf, and M.C. Hunt

Summary

Restructured, pre-cooked roasts were prepared from four hot-boned USDA Utility grade cow carcasses. Before forming the roasts, meat was either blade tenderized, manually trimmed of large connective tissue deposits, or both blade tenderized and trimmed. Control roasts received neither treatment. Although trimming minimized the negative effects of connective tissue, blade tenderization was frequently as effective, and sometimes superior, and minimized the high labor costs and shrink losses associated with manual trimming.

Introduction

As a consequence of age-associated problems with tenderness, much of the beef from older animals is currently used as ground beef or raw material for sausage. If the palatability of beef from older animals could be improved to a level comparable to that from younger carcasses, it could be marketed more flexibly.

Blade tenderization is one of the most effective mechanical meat tenderization methods. It reduces the effects of connective tissue and may make cuts from older animals comparable in tenderness to those from younger animals.

There are economic pressures to minimize processing cost, maximize product palatability, and develop new high quality meat products using less valuable carcasses and carcass portions. The overall concept of restructured meat includes the utilization of less expensive beef cuts to manufacture a product that provides satisfactory roast- or steak-like eating qualities at a low unit cost.

Improving the energy, labor, and yield efficiencies of beef processing are major goals of hot boning. Some potential advantages of hot boning include: 1) facilitating centralized processing, 2) reducing cooler space and energy needs, 3) improving yields, 4) reducing labor, and 5) improving the emulsifying properties of the product.

This investigation was designed to evaluate the effects of blade tenderization and manual trimming of large connective tissue deposits on restructured, pre-cooked roasts from hot-boned cow carcasses.

Experimental Procedures

Sample preparation

Muscles were removed from both sides of four USDA Utility grade cow carcasses within 1 hr postmortem. All muscles from one side were trimmed of exterior fat, blade tenderized three times, cut into pieces (approximately 8.0 x 10.0 cm), mixed, and divided into two batches. One batch was manually trimmed of large connective tissue deposits, whereas the companion batch was not trimmed. Muscles from the other side were treated identically, except they were not blade tenderized. This resulted in four treatment batches: 1) blade tenderized and trimmed, 2) blade tenderized and non-trimmed, 3) trimmed only, and 4) a non-trimmed control. The pieces from each batch were coarsely ground through a three-hole kidney plate yielding irregular chunks of approximately 4.0 x 1.9 cm. Ten percent by weight of each batch was reground through a 0.64 cm plate. Fat content was standardized at 10%.

The individual batches were placed immediately into a mixer with 1.5% salt and 0.25% sodium tripolyphosphate for 6 min of pre-blending at 1°C. After pre-blending, the individual treatment batches were placed in a vacuum paddle mixer and mixed under vacuum (686 mm Hg) for 7 min. Then, the ground fat component was added to each batch to achieve a final fat content of 10%, and vacuum mixing continued for an additional 7 min. The order of pre-blending and vacuum mixing of product from each treatment was randomized to eliminate variation in the time postmortem before blending and mixing. To form the restructured roasts, the product was stuffed through a 5.1 cm horn into 20.4 x 81.6 cm fibrous pre-stuck casings. Casings were compressed and clipped using a Polyclip device, and the resulting roasts were individually weighed.

Cooking procedures

Roasts were steam cooked in a smokehouse to an internal temperature of 62.8°C (145°F) during a three-stage heating cycle. Roasts were weighed, chilled for 24 hr at 1°C, and reweighed prior to being frozen. Maximum frozen storage time was 1 mo before taste panel evaluation. Subsequent analyses were performed after an overnight thawing period at 1°C.

Analyses

Samples were evaluated for pH, taste panel traits, connective tissue content, and Instron textural measures.

Results

Roasts from beef trimmed of large deposits of connective tissue were more palatable and more tender as measured by an Instron tester, had smaller cooking losses and less connective tissue, and were less variable compared with treatments involving no trimming. However, the treatment involving blade tenderization and no trimming was frequently equal, and in some cases superior, to trimmed treatments, considering taste panel traits, peak yield, and product uniformity. As Instron measures increased, taste panel scores for tenderness became less desirable and total connective tissue content increased. Greater cooking losses and total connective tissue values were associated with less desirable perceptions by the taste panel of tenderness, juiciness, and overall acceptability.

Even though blade tenderization was less effective than trimming of connective tissue, for some restructured, value-added products, it may be a viable alternative to trimming, since it is much less labor intensive and does not reduce product yield.

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Restructured, Value-Added Meat Products

Restructuring meat isn't new. Sausage is a good example of a restructured product, and it's been around for years! To make a restructured product, meat is ground, chunked, flaked, sliced, or treated in some other way to subdivide it into smaller particles. Then the particles are physically re-formed into items that resemble steaks, roasts, bacon -- items that the customer can identify. But why take meat apart and put it back together? The subdivision process tenderizes the meat, allowing use of less tender carcass parts, or parts of older, less tender carcasses. In the process, value is added. What would have been sold as hamburger can be sold at a higher price. Generally, a small amount of salt is added to extract protein and bind the product together. But for customers that should minimize their salt intake, new techniques are being developed to allow restructuring without adding salt. Product composition can also be changed. For example, the fat content can be adjusted to satisfy today's calorie-concious consumer.

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A Comparison of Selected Breed Crosses on Growth Rate During Long-Term Grazing

Jack Riley and Ron Pope

Summary

Brahman crossbred and Simmental crossbred calves gained similarly during a 312-day, native range grazing study. Longhorn crossbreds gained less than the Brahman or Simmental crosses but more than the British crossbreds, which served as controls. Most of the gain advantage was obtained during the summer portion (April 30 - September 20) of the project.

Introduction

The use of Brahman, Simmental, and Longhorn bloodlines in crossbreeding programs has increased in recent years, primarily in an attempt to increase growth rate or influence calving ease. A large number of calves are still dry-wintered on native range and continued through the following spring and summer grazing season, although this practice is decreasing in popularity. It is difficult to find direct comparisons between crossbreds, especially those involving Longhorn and Brahman, when grazed under the same conditions. This trial was an initial attempt to determine the comparative performance for these selected breed crosses.

Experimental Procedure

A total of 119 steer calves (12 Longhorn X, 12 Simmental X, 12 Brahman X, and 83 British or British X) were used in a 312-day grazing trial (November 13, 1984 to September 20, 1985). Six experimental pastures were used with each breed group equally represented in each pasture. All calves were individually identified, processed and determined healthy prior to allocation to pasture groups. Individual shrunk weights (overnight without feed and water) were taken initially, at end of winter phase, and at end of summer phase.

Results and Discussion

Results are shown in Table 28.1. The average daily winter gain for the 119 calves was 0.58 lb. This level of performance would be considered too low to be economically justified unless substantial compensatory growth occurred during the following summer grazing phase. The average daily gain for the 143-day summer period was 2.39 lb; an excellent rate of gain indicating that compensatory gain probably occurred. The average daily gain for the 312 days was 1.43. The straight bred British and British crossbred calves (predominantely Angus X Hereford) gained slowest during the winter and for the total grazing period. The Brahman cross calves gained the most during the winter and for the entire trial but only slightly more than the Simmental crosses. The Longhorn cross calves' gains were intermediate during the winter and overall.

Based upon the limited numbers in this trial, there was no indication that Brahman, Simmental, or Longhorn crossbreeding results in depressed grazing performance when compared to straightbred British or British crossbreds.

Table 28.1. Influence of Breed Type on Growth Rate During Long-Term Grazing

Breed:	British or British X	Longhorn X	Simmental X	Brahman X
Grazing Phase 1:				
No. steers	83	12	12	12
Winter: (Nov. 13 - April 30)				
No. days	169	169	169	169
Initial wt., lb	395	385	443	344
Gain, lb	90	117	107	125
ADG, lb	.53	.69	.63	.74
Grazing Phase 2:				
Summer: (April 30 - Sept. 20)				
No. days	143	143	143	143
Initial wt., lb	485	502	550	469
Gain, lb	333	331	386	372
ADG, lb	2.33	2.31	2.70	2.60
Total:				
No. days	312	312	312	312
Gain	423	448	493	497
ADG	1.36	1.44	1.58	1.59

Effect of Salinomycin[1] on Performance of Grazing Stocker Heifers

Lyle Lomas[2]

Summary

The effect of feeding 0, 25, 50, 100, or 150 mg of salinomycin per head daily on performance of stocker heifers grazing smooth bromegrass pasture was evaluated in a 126-day trial. Feeding 100 or 150 mg of salinomycin per head daily produced the fastest gain.

Introduction

Salinomycin, an experimental feed additive, is a polyether ionophore that alters rumen microbial population and fermentation patterns. Although it improves the performance of finishing cattle, only limited data are available concerning its use in grazing stocker cattle.

Experimental Procedures

Eighty Charolais crossbred yearling heifers were used to evaluate the effect of salinomycin on the performance of grazing stocker cattle. Salinomycin was fed at 0, 25, 50, 100, or 150 mg per head daily in 2 lb of ground corn. The five treatments were replicated twice, using ten 10-acre smooth bromegrass pastures, with eight heifers per pasture. The study began on April 17, 1985 and was terminated on August 21 (126 days). Both initial and final weights were the average the average of two nonshrunk weights taken on consecutive days. Treatment groups were rotated among pasture plots at 14-day intervals to minimize effects of differences in forage availability and/or quality.

Results

Heifers that received 100 or 150 mg of salinomycin per head daily had the highest average daily gains and gained significantly more weight ($P<.01$) than those fed 25 mg of salinomycin per head daily (Table 29.1). There were no significant differences ($P>.05$) in rate of gain between any of the other salinomycin levels.

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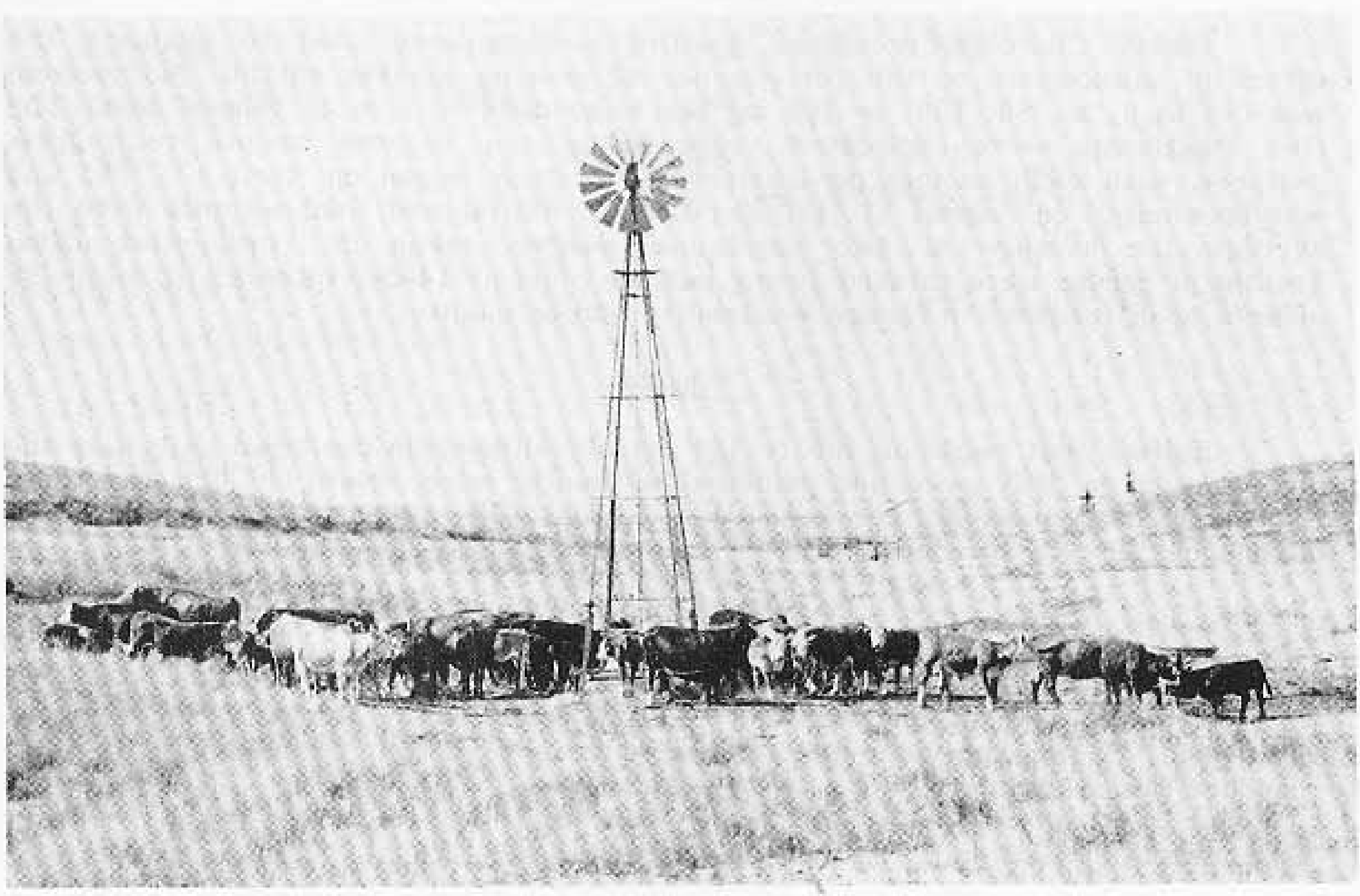
[1]Salinomycin is an experimental feed additive produced by the A. H. Robins Co., Richmond, VA who provided the feed additive and partial financial assistance to conduct this study.

[2]Southeast Kansas Branch Experiment Station.

Table 29.1. Effect of Salinomycin on Performance of Grazing Heifers (126 days)

Item	Salinomycin Level (mg/hd/day)				
	0	25	50	100	150
Initial Wt., lb	574	573	575	573	574
Final Wt., lb	753	731	751	766	762
Total Gain, lb	179[ab]	158[a]	176[ab]	193[b]	188[b]
Average Daily Gain, lb	1.42[ab]	1.25[a]	1.40[ab]	1.53[b]	1.49[b]

[ab]Means with different superscripts differ significantly ($P<.01$).



Evaluation of Rumensin® in Late Season, Salt-Limited, Protein Supplements Fed to Grazing Steers and Heifers[1,2]

Larry R. Corah and Frank K. Brazle[3]

Summary

Even though an average daily Rumensin® consumpton of over 100 mg per was achieved in all three trials, it did not significantly improve daily gains of steers or heifers grazing late-season native range. Late-season protein supplementation improved average daily gain by over .2 lb per head.

Introduction

Research has consistently shown that adding Rumensin® to a hand-fed supplement on grass will improve stocker gains by .15 to .2 lb daily. But, the concept has not been well accepted by producers because of the difficulty of feeding Rumensin®. Most producers would prefer some method of self feeding. These trials were designed to evaluate the use of free-choice, salt-limited, supplements as a method of supplying Rumensin®.

Experimental Procedures

Three trials were conducted with cooperating producers in 1985, involving late-season protein supplementation of grazing cattle. All of the trials were conducted on native range with the cattle rotated every 25-40 days to eliminate pasture effects. The trials ran 90 to 120 days with the trials starting in late July-early August. Cattle were weighed individually at the start and end of the trials.

The cattle were fed supplements consisting of 68-85% soybean meal, and 2% dicalcium phosphate, with the remainder being salt. The salt content was adjusted to achieve the desired 1 to 1 1/4 lb consumption of supplement per head daily. Rumensin® was added at the rate of 100 mg/lb to one of the supplements.

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[1]Rumensin® is a feed additive developed and marketed by Elanco Products Co., Division of Eli Lilly Co. Appreciation is expressed to Elanco for partial funding of this project.

[2]Appreciation is expressed to cooperating producers: Jack and Alan Grothusen, Ellsworth; Kimbell Ranch, Yates Center; Buck Gehrt, Manhattan; Eugene Beachner, St. Paul; David Holbrook, Washington; and Bill McLaughlin, Chapman; and to Kirk Roe, Ellsworth County Agricultural Agent for his assistance.

[3]Extension Livestock Specialist, Southeast Kansas.

Trial 1

One hundred forty-nine crossbred heifers were randomly allotted to three treatments: 1) control - no supplementation other than salt, 2) salt-limited protein supplement, and 3) salt-limited protein supplement plus Rumensin®. The supplements were fed free-choice in large self-feeders for the 106-day trial.

Trial 2

Fifty-eight crossbred steers were randomly allotted to two treatments: 1) salt-limited protein supplement, or 2) salt-limited protein supplement plus Rumensin®. The supplements were fed in wind-vane mineral feeders for the 91-day trial.

Trial 3

Sixty-three fall-born, crossbred heifers were allotted following late summer weaning to two treatments: 1) salt-limited protein supplement, or 2) salt-limited protein supplement plus Rumensin®. Supplements were fed in wind-vane feeders for the 114-day trial.

Results and Discussion

In trial 1, the use of a late-season protein supplement, with or without Rumensin®, improved gain by 25 and 21 lb, respectively (Table 30.1). The amount of supplement required for each additional lb of gain was 5.1 and 6.25 lb for the two respective treatments. When Rumensin® was added to the supplement, the salt level in the supplement was reduced by 7.5 percent. Although average daily Rumensin® intake was 138 mg per head, it had no effect on gain.

Table 30.1. Effect of Late-Season Protein and Rumensin® Supplementation on Performance of Grazing Heifers—Trial 1

Treatment	No. Heifers	Starting Wt., lb	Avg. Daily Gain, lb	Avg. Daily Supplement Intake, lb	Avg. % Salt In Suppl.	Avg. Daily Rumensin Intake, mg
Control-No Supplement	49	605.0	.89[a]	—	—	—
Salt-Limited Supplement	50	596.8	1.12[b]	1.18	20.0	—
Salt-Limited Supplement + Rumensin®	50	601.8	1.09[b]	1.25	12.5	138

[a,b]Means with varying superscripts are significantly different ($P<.05$).

In trials 2 and 3, adding Rumensin® to the supplement had no effect on average daily gain. Rumensin® reduced the salt level needed by 5-6% to achieve daily supplement intakes of 1 to 1 1/4 lb per head.

The fact that Rumensin® did not improve gain does not completely agree with other research results that have evaluated the inclusion of Rumensin in self-fed supplements. A few studies have shown no response to Rumensin® in self-fed supplements, but most have been positive. We do not have an explanation as to why so little response was noted in our three trials.

Table 30.2. Effect of Rumensin® in Late-Season, Salt-Limited, Protein Supplements on Performance of Grazing Steers and Heifers

Treatment	No. Head	Starting Wt., lb	Daily Gain, lb	Avg. Daily Supplement Intake, lb	Avg. % Salt In Suppl.	Avg. Daily Rumensin® Intake, mg
Trial 2 with Steers:						
Salt-Limited Supplement	32	780.6	.88	1.18	27.4	—
Salt-Limited Supplement + Rumensin®	26	743.8	.95	1.18	22.8	118
Trial 3 with Heifers:						
Salt-Limited Supplement	32	514.8	1.02	1.25	19.1	—
Salt-Limited Supplement + Rumensin®	31	531.6	1.08	1.14	12.5	114

Bovatec® vs. Rumensin® Fed in Free-Choice Mineral-Grain Mixtures on Early Intensively Grazed, Native Grass

Frank Brazle[1] and Gerry Kuhl

Summary

The performance of grazing heifers offered a free-choice mineral or two mineral-grain-ionophore mixtures was evaluated in a 3-year study. Heifers ate more of the supplement containing Bovatec® than that containing Rumensin® (P<.05). Heifers fed Bovatec® gained faster (P<.10) than those fed Rumensin® or the control mineral mixture.

Introduction

Responses have been excellent when ionophore-containing supplements are hand-fed on grass. Results with ionophores in free-choice mineral mixtures have been less consistent, probably because of inadequate or irregular daily ionophore intakes. The objectives of this trial were to compare the intakes of Rumensin® and Bovatec® in mineral-grain mixtures, and the subsequent stocker cattle gains.

Experimental Procedures

One 60-acre and two 40-acre native grass pastures were used to evaluate heifer gains and intakes of a mineral (control) and two mineral-grain-ionophore supplements. The study was conducted over a 3-year period with supplement treatments assigned to a different pasture each year. Eighty yearling heifers were randomly allotted, condition scored and weighed on May 5 of each year, and early-intensively grazed on native grass for 60 days, allowing 1.8 acres per heifer. The control mineral and two mineral-grain-ionophore supplements shown in Table 31.1 were fed in wind-vane mineral feeders. The feeders were monitored and replenished weekly. The heifers were gathered and weighed off trial July 5 each year.

Table 31.1. Composition of Mineral and Mineral-Grain-Ionophore Mixtures

Ingredient	Control Mixture	Bovatec® Mixture	Rumensin® Mixture
White Salt, lb	1000	700	700
Dicalcium Phosphate, lb	1000	100	100
Bovatec® (68 g/lb), lb		17.5	
Rumensin® (60 g/lb), lb			20
Ground Milo, lb		1182.5	1180

[1]Extension Livestock Specialist, Southeast Kansas.

Analysis of Variance was used to analyze the data, and the results are reported as least squares means.

Results and Discussion

The average starting weight of the heifers was 453 lb, but ranged from 295 to 650 lb. The correlation between starting weight and daily gain was -.243; a low correlation but favoring the lighter weight heifers. The correlation between body condition and gain was -.309; also low but favoring the thinner heifers. Since the heifers were wintered together and condition differences were small, greater variation in condition would probably make the correlations higher.

Supplement intakes and animal performance are shown in Table 31.2. The Bovatec®-containing supplement was more readily consumed ($P<.05$) than that containing Rumensin®. Consequently, Bovatec® intake was higher than that of Rumensin® ($P<.05$). The daily intakes of 160 mg per head daily for Bovatec® and 103 mg for Rumensin® compare to recommended intakes of 150-200 mg on lush grass. The ionophore supplements contained about 59% grain, and both were consumed more readily ($P<.05$) than the control supplement that contained only minerals. Bovatec®-fed heifers gained faster ($P<.10$) than either Rumensin®-fed heifers or controls.

Table 31.2. Effects of Mineral and Mineral-Grain-Ionophore Mixtures on Intake and Gain of Heifers Grazing Native Grass

Item	Control Mineral	Mineral-Grain-Bovatec®	Mineral-Grain-Rumensin®
No. Heifers	80	80	80
Starting Wt., lb	452	455	443
Daily Supplement Intake, lb	$.072^{a}$	$.267^{c}$	$.172^{b}$
Daily Ionophore Intake, mg	—	160.2^{b}	102.9^{a}
Average Daily Gain, lb	2.28^{d}	2.48^{e}	2.30^{d}

[abc]Means in the same row with different superscripts are significantly different ($P<.05$).
[de]Means in the same rows with different superscripts are significantly different ($P<.10$).

This study confirms that Bovatec® is more palatable than Rumensin®. Thus, the extra intake of Bovatec® could account for the difference in gain resulting from the two ionophores. Bovatec®, because of its palatability advantage, is preferrable for use in free-choice, mineral-based supplementation systems.

Experimental Implant Evaluated in Grazing Yearling Steers[1]

Scott Laudert[2] and Charles Sauerwein[3]

Summary

An experimental implant containing Beta-estradiol increased (P<.05) daily gain of grazing yearling steers by 15.5% compared to controls. Compudose implants increased (P<.01) daily gain by 13.5%. There was no gain difference between the experimental implant and Compudose.

Introduction

Commercial companies continue to develop new products, which must be tested for efficacy and safety prior to clearance. This trial was conducted to evaluate a new implant being developed by Hoffmann-LaRoche, Inc.

Experimental Procedures

One hundred and eighteen yearling steers averaging 642 lb were randomly allotted to three implant treatment groups as follows: (1) control (no implant); (2) Compudose; and (3) an experimental implant, identified as VJR, and containing Beta-estradiol as the active ingredient. All steers were individually weighed at the beginning and end of the 126-day trial. The implants were inserted subcutaneously in the middle of the backside of the ear at the onset of the trial. All cattle were handled similarly and grazed native pasture along the banks of the Arkansas River in Gray County. Implanted steers were checked for implant loss at the end of the trial. Data were analyzed by analysis of covariance with initial weight as a covariate. Duncan's multiple range test was used to determine statistical differences among treatments.

Results

Both implants improved (P<.01) average daily gain over that of controls. There was no significant difference between the Hoffmann-LaRoche experimental implant and Compudose. Implant loss in the Compudose-implanted steers was 2.3% (1 out of 43), vs. 5.0% (2 out of 40) in the experimental implant group.

[1] Appreciation is expressed to Wiley McFarland, Cimarron, KS, for supplying cattle and facilities and to Hoffmann-LaRoche, Inc. for support.

[2] Extension Livestock Specialist, Southwest Kansas.

[3] Gray County Extension Agricultural Agent.

Table 32.1. Implant Response in Grazing Yearling Steers

Item	Control	Compudose	Roche Implant VJR
No. of Steers	35	43	40
Begin. Wt., lb	644	639	643
Final Wt., lb	876	904	913
Daily Gain, lb	1.85[a]	2.10[b]	2.14[b]

[a,b]Values within the same row with different superscripts are significantly different (P<.01).

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Livestock Drugs and Human Safety

The U. S. Food and Drug Administration (FDA) is responsible for approving the license and sale of human and animal drugs and for monitoring their use once they are approved. Drugs used for cattle include implants, antibiotics, and ionophores like Rumensin® and Bovatec®. The regulations state that a new product must be proven both safe and effective. The process of obtaining that proof can take 7 to 10 years and cost millions of dollars.

The safety requirement states that the product must be safe for the animal receiving it, safe people handling it, and safe for people consuming the food. The food safety regulation is especially costly. The application for approval must include analytical procedures that are sensitive and specific enough to satisfy FDA that the product would be found even if present in extremely small amounts. In addition, the product must generally be given in large quantities to the target animal, then the carcasses destroyed after residue testing.

The efficacy requirement means that the drug must meet the claims on the label. For example, if growth promotion is claimed, then that must be demonstrated in carefully controlled experiments. Much of the efficacy testing is done at land-grant institutions such as Kansas State University.

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Effect of Sodium Bicarbonate on Gains of Stocker Cattle Fed Grain on Tall Fescue Pastures[1]

Frank Brazle[2]

Summary

Adding sodium bicarbonate to the grain supplement of steers grazing lush, low endophyte, tall fescue pasture had no effect on cattle performance.

Introduction

Sodium bicarbonate supplementation of sorghum silage rations has resulted in improved intake and average daily gain. Research conducted at the Fort Hays Branch Experiment Station (Kansas Agric. Exp. Sta. Bull. 556) showed that steers fed sorghum silage rations supplemented with 100 gm of sodium bicarbonate daily consumed 4% more dry matter and gained 8% faster than controls. However, research at Manhattan (Kansas Agric. Exp. Sta. Bull. 448) showed no differences in feed intake or gain on forage sorghum silage when sodium bicarbonate was supplemented at 112 gm per head daily.

When grain is fed at a high level on lush grass, the forage to grain ratio is similar to that of a silage diet. The objective of this trial was to evaluate the effect of adding sodium bicarbonate to a grain supplement fed on lush spring fescue.

Experimental Procedures

On April 8, 1985, 44 steers were randomly allotted to either a sodium bicarbonate or a control group. The two groups were rotated between two 25-acre fescue pastures (10% infestation of endophyte fungus). The control supplement consisted of wheat, milo, and soybean meal, and contained 14% crude protein. The bicarbonate group received the same supplement plus 103 gm of sodium bicarbonate per head daily. The cattle were hand-fed 4 lb of supplement per head each morning. The steers were gathered June 10, mixed together, and then weighed the morning of June 11. The data were evaluated by Analysis of Variance with Least-Squares Means Procedures.

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[1]Appreciation is extended to John McClintick, Walnut, KS for providing cattle and facilities and to Dean Stites, Crawford Extension Agricultural Agent, for assistance in data collection.

[2]Extension Livestock Specialist, Southeast Kansas.

Results and Discussion

The results of feeding sodium bicarbonate to steers on tall fescue pasture are shown in Table 33.1. There was no significant difference in gain. The steers weighed 800 lb when the trial started; therefore, the 4 lb of grain would be only 15 to 25% of the steer's daily dry matter intake. This low percentage of grain in the diet may not have been enough to reduce rumen pH to the point of affecting fiber digestibility, thus explaining why sodium bicarbonate was without benefit.

However, lighter cattle or higher levels of supplementation could give a different response. Additional research or sodium bicarbonate is needed with 400 to 500 lb calves supplemented with 4 to 5 lb of grain on lush grass.

Table 33.1. Effect of Adding Sodium Bicarbonate to a Grain Supplement on Gains on Steers Grazing Tall Fescue Pasture

Item	Control	Sodium Bicarbonate (103 g/day)
No. Steers	22	22
Starting Wt., lb (April 8)	796	803
Ending Wt., lb (June 11)	924	927
Daily Gain, lb (64 Days)	2.00 ± .08[1]	1.94 ± .08[1]

[1]Standard Error.

Effect of Thiabendazole on Gains of Stockers Grazing 50% Endophyte Fungus-Infected, Tall Fescue Pastures[1]

Frank Brazle[2]

Summary

Thiabendazole (TBZ®) wormer pellets were added to either a mineral or grain mix in two experiments with steers grazing 50% endophyte fungus-infected, tall fescue pastures. Research from other stations has suggested that TBZ® partially overcomes the toxicity of endophyte fungus. In our experiments, steers received .2 g of TBZ® per 100 lb body weight per day, but daily gain was not improved during the grazing period.

Introduction

Thiabendazole (TBZ®[2]) has been suggested to relieve the effects of endophyte fungus in tall fescue. Unpublished research at Alabama showed a .4 lb daily gain improvement in steers grazing greater than 80% endophyte fungus-infected tall fescue pasture when supplemented with TBZ® at .7 g per 100 lb body weight per day.

When TBZ® was fed in a receiving ration at Illinois for 42 days at .35 or .7 g per 100 lb body weight daily to calves or yearlings coming off endophyte fungus-infected, tall fescue pastures, the results were inconsistent. Although differences were not statistically significant, there was a trend toward lower body temperatures in calves treated with TBZ®. Also, treated calves gained .5 lb more per day than controls and showed improved feed conversion. There was no gain difference between treatments with yearling steers. The purpose of our experiments was to evaluate the effect of TBZ® at a lower dosage level on yearling steers grazing endophyte fungus-infected, tall fescue pastures.

Experimental Procedures

Two experiments were conducted using TBZ® on 50% endophyte-infected, tall fescue pastures. In experiment 1, 6.6% TBZ® pellets were added to a mineral-grain-Rumensin®[3] mixture (Table 34.1). The steers were randomly allotted to treatment and weighed individually on April 1. All steers were injected with ivermectin (Ivomec®[4]) on day 1 to remove any deworming effect of TBZ®. The

[1]Appreciation is extended to Merck and Co., Inc., Rahway, NJ for support of these trials, to 3-G Farms and Owen O'Brien for supplying cattle and facilities, and to Glenn Newcomber and Ted Wary, County Extension Agricultural Agents, for their assistance with these trials.

[2,4]MSD Agriet, Division of Merck and Co., Inc.

[3]Elanco Products, Division of Eli Lilly Co., Indianapolis, IN.

steers were rotated in 30-acre pastures to remove pasture effects. The steers were weighed off trial on June 20.

In experiment 2, steers were self-fed a 14% crude protein, salt-limited supplement with either 0 or 15 lb of TBZ® per ton, added as 6.6% TBZ® pellets. The steers were randomly allotted, weighed, and injected with Ivomec® on April 2. The steers were grazed in two, 160-acre tall fescue pastures (50% endophyte fungus-infected), and were weighed off July 13.

Table 34.1. Mineral - Grain - Rumensin® Mixtures Used in Experiment 1.

TBZ®	Control
500 lb (6.6%) TBZ®	1180 lb ground milo
680 lb ground milo	700 lb salt
700 lb salt	100 lb dicalcium phosphate
100 lb dicalcium phosphate	20 lb Rumensin® (60 g/lb)
20 lb Rumensin® (60 g/lb)	

Data were treated by Analysis of Variance with Least Squares Means Procedures.

Results and Discussion

In experiment 1, the steers supplemented with the mineral-grain-Rumensin® mixture plus TBZ® consumed .21 lb of supplement per day compared to .19 lb for the controls. This resulted in a daily TBZ® intake of 1.6 g per head or .20 g per 100 lb of body weight. Daily Rumensin® intake was 127 mg for the TBZ® group and 112 mg for the controls. However, there was no difference (P>.05) in gain as shown in Table 34.2.

The year 1985 was cooler than most, with only two days above 80°F during the experiment, and the fescue was lush and growing rapidly. These factors may have reduced the effects of the endophyte fungus on gains. The level of endophyte fungus infection also was lower in our pastures than in those cited earlier. Our dosage rate of TBZ® was considerably lower as well. The cattle were yearling steers, which in the Illinois research also showed no response to TBZ®.

In experiment 2 (Table 34.3), the steers consumed 6 lb of grain per day resulting in 1.35 g of TBZ® per head or .2 g per 100 lb of body weight per day, the same as in Experiment 1. These steers grazed longer into the summer when the environmental temperature was higher. Higher temperatures, in combination with high endophyte fungus-infected fescue pastures, normally result in reduced gains.

The yearling steers in Experiment 2 were receiving 6 lb of grain daily, which should have reduced forage dry matter intake, and consequently the amount of the endophyte fungus or toxins consumed.

At this level and under these conditions, TBZ® would not be recommended as an aid in reducing the effect of endophyte fungus on grazing yearling steers.

Table 34.2. Effect of TBZ® in a Mineral-Grain-Rumensin® Mixture on Gains of Stocker Steers Grazing 50% Endophyte-Infected, Tall Fescue Pastures

Item	TBZ®	Control
No. Steers	25	25
Starting Wt., lb	735	714
Days on Trial	80	80
Ending Wt., lb	913	889
Daily Gain, lb	2.22 ± .13[1]	2.19 ± .12

[1]Standard error.

Table 34.3. Effect of TBZ® When Self-fed in a Grain Mixture on Gains of Steers Grazing 50% Endophyte-Infected, Tall Fescue Pastures

Item	TBZ®	Control
No. Steers	52	51
Starting Wt., lb	549	560
Days on Trial	102	102
Ending Wt., lb	762	780
Daily Gain, lb	2.09 ± .06[1]	2.16 ± .06

[a]Standard error.

KSU

Effect of Rotational Grazing by Yearlings on Early-Intensive, Double-Stocked, Native Grass[1]

Frank Brazle[2] and Gerry Kuhl

Summary

Continuous, early - intensive (double-stocked) grazing vs. early-intensive grazing using a two-pasture, 16 to 18-day rotation were compared in three experiments. No significant differences were found (P>.15) in daily gains of stockers or forage remaining after the 2 1/2 month grazing season.

Introduction

In recent years, producers have become interested in various rotational grazing systems. Early intensive grazing, where stocking rate is doubled and grass is used for only the first half of the normal grazing season, increases stocker gains per acre and improves grass vigor. However, little is known about the impact of combining rotational grazing with early-intensive, double stocking.

Experimental Procedures

Three experiments were conducted to evaluate stocker gains and residual forage after rotational grazing of early-intensive, double-stocked, native grass pastures. The first two experiments were done on native tall grass prairie (big and little bluestem, etc.) and the third was on a mixed prairie of tall and short native grasses. On about May 3, the cattle were weighed and allotted to either a continuous, double-stocked grazing system (1.8 to 2.0 acres per head), or a 16 to 18-day rotation system between two pastures stocked at that same rate. The cattle were weighed off trial about July 14. Then residual forage was estimated by clippling samples of remaining herbage. Analysis of Variance was used to analyze the data, pooled across the three locations, and the results are reported as least squares means.

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[1]Appreciaton is expressed to Richard Porter, Reading, KS; Walter Poor, Chanute, KS; and Dan Bird, Anthony, KS for providing cattle, facilities, and assistance in data collection.

[2]Extension Livestock Specialist, Southeast Kansas.

Results and Discussion

Stocker gains on the two systems are shown in Table 35.1. Gains were almost identical, and there was no significant difference (P>.15) in the amount of forage left at the end of the early intensive grazing season. The experiment was run in the spring and early summer of 1985, a period of above average rainfall. Although one year is far too short a time to measure changes in vegetation or seasonal weather effects, these three experiments suggest that under the conditions that prevailed in 1985, there was no advantage to rotational grazing.

Table 35.1. Effects of Rotational vs. Continuous Grazing of Double-Stocked, Early Intensively Grazed Native Range (May 3 to July 14)

Item	Rotationally Grazed every 16 to 18 days	Continuously Grazed
No. Cattle	150	150
Starting Wt., lb	531	545
Ending Wt., lb	655	670
Daily Gain, lb	1.72 ±.05[1]	1.73 ±.05[1]

[1]Standard error.

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Early-Intensive Grazing on Kansas Ranges

Early-intensive grazing means doubling the normal stocking rate on native range, but grazing only during the first half of the season, typically May 1 to July 15. The system concentrates cattle on the grass when it is lush, growing rapidly, and highly nutritious. Gains are fast and efficient, and generally, the result is more beef per acre. Grazing distribution is improved and soil moisture is conserved. The grass has an opportunity to rest and store nutrients. Late spring burning and early intensive stocking make an excellent combination. As an added benefit, feeder prices may be higher in July than in the fall.

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Effect of Inoculants on the Fermentation of Wheat, Alfalfa, and Sorghum Silages[1]

Keith Bolsen, Russell Smith,
Harvey Ilg, and Daniel Y.C. Fung

Summary

Results from three laboratory silo experiments showed that four commercial silage inoculants increased fermentation rate, particularly during the first 4 days of the ensiling process. The effects of the additives on pH drop and lactic acid production were greater in wheat and alfalfa than in forage sorghum.

Introduction

Silage additives are receiving fairly widespread acceptance in the U.S. As farmers learn more about the ensiling process and improve their silage-making techniques, the risk of producing a bad smelling, poor quality, unpalatable silage has decreased. Thus, most farmers today are fine-tuning their silage management to make good silage superior—not bad silage acceptable.

Recently, Bolsen and Heidker (1985)[2] published a guide to over 150 silage additive products marketed in the U.S. Those additives contained over 120 different active ingredients. Microbial inoculants were the most numerous. Generally, inoculants are combinations of several bacterial species selected to rapidly convert part of the crop's soluble carbohydrates to lactic acid, thus improving silage preservation and reducing dry matter loss. Silage additives are usually formulated for low volume usage rates (.5 to 2.0 lb per ton of fresh crop) and most are available in either dry or liquid form. In Europe, most forage harvesters are equipped to apply additives in the field. In the U.S., most farmers prefer to use the additive at the silo.

Over 40 claims are made by the 91 manufacturers or distributors cited in the guide. These include increased dry matter recovery, greater aerobic stability, faster ensiling rate, increased lactic acid, greater nutrient retention, and increased palatability—all characteristics of improved silage. With so many products and claims, how does the silage-maker assess the value of a silage additive? Efficacy is the first consideration. Does it work? Will it work under all farm conditions? What evidence does the manufacturer or distributor have to document efficacy? The buyer should look for good evidence that the product improves the fermentation and conservation processes. Results from laboratory-scale experiments are helpful, especially if the crops used are similar to the buyer's. Under laboratory conditions, effective silage inoculants should speed the drop in pH through a faster and greater production of lactic acid.

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[1]Partial financial assistance was provided by Moorman Manufacturing Company, Quincy, Illinois.

[2]Bolsen, K.K. and J.I. Heidker. 1985. Silage Additives USA. Chalcombe Publications, Box 1222, Manhattan, Kansas 66502.

The objective of these experiments was to determine the effects of commercial silage inoculants on the rate and efficiency of fermentation of wheat, alfalfa, and forage sorghum.

Experimental Procedures

The laboratory silos used were 4 x 14 inch PVC pipes closed with a Jim-Cap on each end. One cap was fitted with a Bunsen valve to allow gases to escape. For filling, 125 lb of fresh crop was placed on a plastic sheet and the inoculant applied and mixed thoroughly. After all silage treatments were prepared, the silos were filled on an alternating schedule which distributed the time from harvest through silo filling equally across the treatments. The silos were packed with a hydraulic press, which excluded air and filled all silages to similar densities.

Experiment 1. Silages were made from heading-stage, hard red winter wheat (Centurk variety), with the crop field-wilted to approximately 35% dry matter (DM) prior to ensiling. The five treatments were:

1) H/M Plus Liquid (from Triple "F" Feeds, Des Moines, Iowa and containing Streptococcus faecium M-74, Lactobacillus plantarum, and Pediococcus sp.).
2) Kem Lac (from Kemin Industries, Inc., Des Moines, Iowa and containing Lactobacillus plantarum, Lactobacillus bulgaricus, and Lactobacillus acidophilus).
3) Biomate Lab Concentrate (from Chr. Hansen's Laboratory, Inc., Milwaukee, Wisconsin and containing Lactobacillus plantarum and Pedicoccus cerevisiae).
4) SI Concentrate 40 A/F (from Great Lakes Biochemical Co., Inc., Milwaukee, Wisconsin and containing Lactobacillus plantarum, Lactobacillus brevis, Pediococcus acidolactici, Streptococcus cremoris, and Streptococcus diacetylactis).
5) Control (no additive).

Silos were stored at approximately 85 F and three silos per treatment were opened at 12, 24, and 48 hours and 4, 7, and 42 days post-filling.

Experiment 2. Silages were made from second cutting alfalfa, with the crop field-wilted to approximately 42% dry matter. All other procedures and inoculant treatments were the same as those described in Expt. 1.

Experiment 3. Silages were made from dough-stage forage sorghum (DeKalb 25E variety) and the crop contained approximately 25% DM at harvest. All other procedures and inoculant treatments were the same as those described in Expt. 1.

In all three experiments, the pre-ensiled crops were analyzed for DM, pH, buffer capacity (BC), water soluble carbohydrates (WSC), and numbers of lactic acid bacteria (LAB). Silages were analyzed for DM, pH, and lactic, acetic, and total fermentation acids.

Results

The fresh, pre-ensiled wheat and alfalfa had less than 10^3 colony-forming units of LAB per gram, whereas the forage sorghum contained 10^4 per gram--10 times more. The wheat and alfalfa had relatively low WSC values (5.4 and 4.9% of the DM, respectively) and the forage sorghum, a high WSC value (24.0%). Only the alfalfa had a high BC (56.3 millequivalents of NaOH per 100 gram of DM).

Experiment 1 (Table 36.1). All five wheat silages underwent a rapid drop in pH (from approximately 6.15 down to 4.6 in 24 hours) and all were well-preserved, as evidenced by a low terminal pH (4.26 or lower) and a sufficiently high lactic acid value (6.70% of the DM or above). All four inoculated silages had a lower (P<.05) pH value than control silage at days 4, 7, and 42 and a numerically higher lactic acid content at days 4 and 7. Only Biomate silage contained more (P<.05) lactic acid than the control after 42 days.

Experiment 2 (Table 36.2). All four inoculants significantly increased the rate of pH drop and the rate of lactic acid production in the alfalfa silages. Biomate silages had the lowest (P<.05) pH at each opening time during the first 4 days and the highest (P<.05) lactic acid content at hours 12, 24, and 48 post-filling. All four inoculated silages had a significantly lower pH and higher lactic acid content than control silage at days 7 and 42.

Experiment 3 (Table 36.3). All five forage sorghum silages reached pH 4.0 by hour 48. Only the H/M Plus silage had more (P<.05) lactic acid than control at hour 24. At day 4, the Biomate and SI Concentrate silages had a lower (P<.05) pH and a higher (P<.05) lactic acid content than control silage. All silages had similar pH and lactic acid values at 42 days post-filling; however, Biomate silage had the lowest (P<.05) acetic acid content.

Table 36.3. pH and Lactic Acid Over Time for the Five Forage Sorghum Silages in Expt. 3

Time Post-filling and Item		Control	Inoculant Treatment: H/M Plus	Kem Lac	Biomate	SI Conc	SE
Initial:	pH	5.78	5.81	5.78	5.80	5.80	—
Hour 12:	pH	5.75	5.79	5.78	5.79	5.80	.014
	Lactic Acid[1]	.19	.41	.30	.41	.35	.054
Hour 24:	pH	4.54^{b}	4.51^{ab}	4.71^{c}	4.73^{c}	4.47^{a}	.013
	Lactic Acid	$.85^{bc}$	1.95^{a}	$.55^{bc}$	$.60^{bc}$	1.04^{b}	.176
Hour 48:	pH	4.00^{c}	3.99^{bc}	4.01^{c}	3.86^{a}	3.95^{b}	.018
	Lactic Acid	2.35^{b}	2.79^{b}	2.51^{b}	3.57^{a}	3.06^{ab}	.247
Day 4:	pH	3.96^{d}	3.88^{c}	3.94^{d}	3.77^{a}	3.82^{b}	.149
	Lactic Acid	5.00^{b}	6.35^{b}	6.08^{b}	8.49^{a}	8.26^{a}	.470
Day 7:	pH	3.71^{b}	3.68^{b}	3.72^{b}	3.65^{a}	3.65^{a}	.011
	Lactic Acid	5.76	5.95	5.76	6.66	6.53	.364
Day 42:	pH	3.64^{a}	3.69^{c}	3.67^{b}	3.70^{d}	3.66^{b}	.004
	Lactic Acid	6.24	7.06	6.94	6.26	6.42	.394
	Acetic Acid	2.45^{cd}	2.26^{bc}	2.26^{bc}	1.75^{a}	2.14^{b}	.098

[a,b,c,d,e] Values on the same line differ (P<.05).

[1] Acids are expressed as a % of the silage dry matter.

Table 36.1. pH and Lactic Acid Over Time for the Five Wheat Silages in Expt. 1

Time Post-filling and Item		Control	Inoculant Treatment: H/M Plus	Kem Lac	Biomate	SI Conc	SE
Initial:	pH	6.11	6.18	6.13	6.14	6.09	—
Hour 12:	pH	5.10^{d}	5.07^{cd}	5.01^{b}	4.93^{a}	5.03^{bc}	.015
	Lactic Acid[1]	1.80^{c}	2.25^{a}	1.69^{c}	2.13^{ab}	1.86^{bc}	.095
Hour 24:	pH	4.67^{c}	4.69^{c}	4.59^{b}	4.45^{a}	4.65^{c}	.016
	Lactic Acid	3.24^{b}	3.12^{b}	3.40^{b}	4.17^{a}	3.23^{b}	.096
Hour 48:	pH	4.65^{d}	4.59^{bc}	4.58^{bc}	4.31^{a}	4.62^{cd}	.022
	Lactic Acid	3.40^{c}	3.20^{c}	5.29^{a}	5.28^{a}	3.14^{c}	.264
Day 4:	pH	4.58^{e}	4.33^{b}	4.38^{c}	4.12^{a}	4.50^{d}	.013
	Lactic Acid	3.90^{c}	5.31^{a}	4.93^{ab}	5.21^{a}	4.02^{bc}	.329
Day 7:	pH	4.55^{d}	4.22^{b}	4.27^{b}	4.09^{a}	4.38^{c}	.022
	Lactic Acid	3.77^{b}	8.05^{a}	5.22^{b}	7.82^{a}	4.33^{b}	.764
Day 42:	pH	4.26^{b}	4.06^{a}	4.07^{a}	4.00^{a}	4.05^{a}	.023
	Lactic Acid	7.59^{bc}	8.39^{b}	7.44^{bc}	10.64^{a}	8.45^{b}	.515
	Acetic Acid	.56^{d}	.34^{bc}	.27^{b}	.17^{a}	.46^{d}	.042

^{a,b,c,d,e}Values on the same line differ ($P<.05$).

[1]Acids are expressed as a % of the silage dry matter.

Table 36.2. pH and Lactic Acid Over Time for the Five Alfalfa Silages in Expt. 2

Time Post-filling and Item		Control	Inoculant Treatment: H/M Plus	Kem Lac	Biomate	SI Conc	SE
Initial:	pH	5.94	5.95	5.94	5.95	5.95	—
Hour 12:	pH	5.81^{c}	5.78^{c}	5.77^{bc}	5.65^{a}	5.73^{b}	.017
	Lactic Acid[1]	.33^{b}	.27^{b}	.42^{b}	.75^{a}	.65^{a}	.048
Hour 24:	pH	5.73^{d}	5.62^{c}	5.64^{c}	4.88^{a}	5.49^{b}	.230
	Lactic Acid	.81^{c}	1.67^{b}	1.88^{b}	4.28^{a}	2.15^{b}	.211
Hour 48:	pH	5.43^{d}	4.89^{c}	4.88^{bc}	4.62^{a}	4.81^{b}	.024
	Lactic Acid	2.00^{c}	5.62^{b}	5.14^{b}	7.85^{a}	6.24^{b}	.447
Day 4:	pH	5.11^{d}	4.74^{c}	4.65^{b}	4.54^{a}	4.65^{b}	.014
	Lactic Acid	3.38^{d}	7.35^{b}	7.15^{bc}	10.14^{a}	9.41^{a}	.631
Day 7:	pH	4.97^{d}	4.74^{c}	4.58^{b}	4.49^{a}	4.60^{b}	.020
	Lactic Acid	4.74^{b}	8.56^{a}	7.93^{a}	8.22^{a}	8.54^{a}	.441
Day 42:	pH	4.61^{e}	4.54^{cd}	4.47^{ab}	4.40^{a}	4.51^{bc}	.022
	Lactic Acid	7.13^{b}	11.67^{a}	9.94^{a}	11.26^{a}	9.36^{a}	.549
	Acetic Acid	2.78	2.57	2.03	1.97	2.27	.097

^{a,b,c,d,e}Values on the same line differ ($P<.05$).

[1]Acids are expressed as a % of the silage dry matter.

Evaluation of an Experimental Silage Inoculant in Laboratory and Farm Silos Using Alfalfa and Forage Sorghum[1,2]

Keith Bolsen, Russell Smith,
Harvey Ilg, and Daniel Y.C. Fung

Summary

An experimental microbial inoculant dramatically increased the speed of pH drop and rate and amount of lactic acid production in alfalfa at both 60 and 90 F storage temperatures. In two trials with forage sorghums, the inoculant did not affect the silage fermentation at 60 F but it did produce small improvements in silages at 90 F. In general, sorghum silages at 60 F fermented slower and had higher pH values, lower lactic acid, and higher acetic acid contents than silages at 90 F. The response to the additive in a farm silo trial was not consistent for the criteria measured. Ensiling temperatures, chemical compositions, and dry matter recoveries were similar for control and inoculated silages. However, calves fed treated silage had a 5.9% better feed conversion, which resulted in 4.4 lb more gain per ton of ensiled crop.

Introduction

The primary objective of the four trials reported here was to determine how an experimental silage inoculant affected the rate and efficiency of fermentation and nutritive value of alfalfa and forage sorghum silages. A secondary objective was to measure the effect of storage temperature on the ensiling process.

Experimental Procedures

The laboratory silo used in Trials 1, 2, and 3, and the silo filling techniques were similar to those described on page 110 of this report. The experimental inoculant (USO_3M) from Sanofi Sante Animale was applied in dry form in all four trials. Chemical composition and microbiology of the fresh crop materials are presented in Table 37.1.

Trial 1. Silages were made from 2nd-cutting alfalfa on July 5, 1984 and the crop was field-wilted to approximately 35% dry matter (DM) prior to ensiling. Four treatments were compared: (1) control (no additive), with laboratory silos stored at 60° F (control-60); (2) control (no additive), with silos stored at 90° F (control-90); (3) USO_3M inoculant, with silos stored at 60° F (inoculant-60); and (4) USO_3M inoculant, with silos stored at 90° F (inoculant-90). Twenty-four silos were filled for each treatment, with three silos per treatment opened at 12, 24, 36, and 48 hours and 4, 7, 21, and 56 days post-filling.

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[1] The experimental inoculant contained Lactobacillus plantarum and Lactobacillus casei and was provided by Sanofi Sante Animale, 37 Avenue George V, 75008 Paris, France.

[2] Partial financial assistance was provided by Sanofi Sante Animale.

Trial 2. Silages were made from early-dough stage forage sorghum (DeKalb 25E variety) on September 29, 1984; the crop contained approximately 25% dry matter. The four treatments were the same as in Trial 1. There were 21 laboratory silos filled for each treatment, with three silos per treatment opened at 12, 24, and 48 hours and 4, 7, 14, and 42 days post-filling.

Trial 3. Silages were made from late-dough stage forage sorghum (Acco 351 variety) on October 10, 1984; the crop contained approximately 36% dry matter. All other treatments and procedures were the same as those described in Trial 2.

Trial 4. Two whole-plant forage sorghum silages were compared in farm silos: (1) control (no additive) and (2) inoculated with USO_3M at the silage blower. The harvested crop was ensiled using the alternate load method in 10 x 50 ft concrete stave silos on October 9, 1984 from DeKalb FS 1A forage sorghum harvested in the hard-dough stage at about 33% dry matter. Ensiling temperatures were monitored for the first 5 weeks and nylon bags (nine per silo) were buried for additional observations of silage DM recoveries. The silos were opened on November 16, 1984 and emptied at a uniform rate during the following 8 weeks.

Each silage was fed to 16 crossbred steer and heifer calves in a 56-day growing trial that began November 16, 1984. The calves (average initial wt., 476 lb) were randomly allotted to four pens of four calves per silage. Silages were full-fed and all calves received 2.0 lb of supplement daily (as-fed basis). Rations were formulated to provide 12.25% crude protein (DM basis), 200 mg of Rumensin® per calf daily, and equal amounts of calcium, phosphorus, and vitamins A, D, and E.

One week before the trial began, all calves were fed a limited ration of grass hay and sorghum grain to provide a daily DM intake of 1.75% of body weight. Calves were weighed individually on two consecutive days after 16 hr without feed or water at the start and end of the trial. Three days before the final weighing, the calves were fed their respective silage ration at a restricted daily DM intake of 1.75% of body weight.

Feed intake was recorded daily for each of the eight pens and the quantity of silage fed adjusted daily to ensure that fresh feed was always in the bunks. Feed not consumed was removed, weighed, and discarded as necessary. Samples of each silage were taken twice weekly.

Results and Discussion

Trial 1. Presented in Table 37.2 are the fermentation dynamics of the four alfalfa silages. At hour 24 post-filling, inoculant-90 silage had a dramatically lower pH and higher lactic acid content than the other three silages. At day 4, both inoculated silages had lower pH and higher lactic acid contents than the two control silages and these differences were maintained through day 56 post-filling. These rapid lactic acid fermentations in the inoculated silages likely reflect the low lactic acid bacteria count for the pre-ensiled alfalfa (Table 37.1) and demonstrate the efficacy of the inoculant under these crop and environmental conditions.

Silages made at 60 F underwent very little fermentation during the first 24 hours; however, the inoculant-60 silage had a rapid drop in pH and an increase in lactic acid content between hour 36 and day 4 post-filling. The inoculant-60 silage reached a lower ($P<.05$) pH than control-90 silage at hour 48.

Trial 2. Presented in Table 37.3 are the fermentation dynamics of the four DeKalb 25E forage sorghum silages. The fresh crop had a low DM (24%), high WSC content (24.3%), low crude protein (5.31%), and 10^4 lactic acid bacteria per gram. The crop was harvested at 8:30 a.m. after a heavy frost and had an initial ambient temperature of 30 F. The ensiled material did not reach the 60 and 90 F storage temperatures until about 12 to 14 hours post-filling.

The inoculant had only small effects on pH and lactic acid values throughout the 42 day test. However, four observations can be made: 1) the control-90 silage fermented very rapidly and reached a pH of 4.00 at hour 48; 2) the 60 F storage temperature delayed fermentation until after hour 48 post-filling; 3) the inoculant-60 silage was nearly identical to the control-60 silage at each time; and 4) only at day 42 did inoculant-90 silage have a higher ($P<.05$) lactic acid content than control-90 silage.

Trial 3. Presented in Table 37.4 are the fermentation dynamics of the four Acco 351 forage sorghum silages. The fresh crop had a higher DM (36%) and lower WSC content (12.2%) than the 25E forage sorghum used in Trial 2 and the initial ambient temperature was warmer at harvest (62 F). As was observed in Trial 2, the inoculant had very little influence on the rate of the ensiling process at 60 F. However, at 90 F the inoculant-treated silages had lower pH and higher lactic acid values on days 7, 14, and 42 post-filling.

Trial 4. Visual appraisal indicated that both silages were well preserved. Chemical analyses showed similar compositions for the two silages; both had undergone a normal lactic acid fermentation (Table 37.5). Ensiling temperatures were nearly identical for the two silages. Both silages were unstable during the first 3 weeks of unloading and feeding; they heated after less than 24 hours of exposure to air. But as the feeding trial progressed, the inoculated silage became more stable in air than the control.

Silage DM recoveries and losses were similar for the control and inoculated silages (Table 37.6). The average loss from the buried bags was 6.7% of the DM ensiled, which is within the range observed in numerous other trials. The 15.4% average loss from the concrete stave silos was somewhat higher than expected and likely reflected the rather unstable nature of both silages.

Performance of the calves during the 56-day feeding trial was excellent, with daily DM intake being approximately 2.6% of body weight (Table 37.7). Although average daily gains were similar, calves receiving the inoculated silage were 5.9% more efficient (6.90 vs. 7.33 lb of DM per lb of gain). Also shown in Table 37.7 are calf gains per ton of forage sorghum ensiled, which combines farm-silo recovery and cattle performance results. Inoculated silage produced 4.4 lb more gain per ton of ensiled crop than the control.

Table 37.1. Composition of the Fresh Crops

Item	Trial 1 Alfalfa	Trial and Forage Sorghum Variety: Trial 2 25E	Trial 3 351	Trial 4 FS 1A
Dry Matter, %	36.0	24.3	35.5	32.8
pH	6.1	5.8	5.8	5.9
Water Soluble Carbohydrates[1]	4.9	24.0	12.2	9.4
Crude Protein[1]	18.75	5.31	5.63	9.06
Buffer Capacity[2]	56.3	26.3	19.9	36.5
Microbiology (colony-forming units per gram):				
Mesophilic	4×10^5	6×10^5	9×10^6	4×10^7
Lactic Acid Bacteria	$< 10^3$	1×10^4	$< 10^3$	7×10^4
Yeasts and Molds	$< 10^3$	$< 10^3$	6×10^4	3×10^5

[1]Expressed as a % of the dry matter.

[2]Milliequivalents NaOH per 100 grams of dry matter.

Table 37.2. Effect of Temperature and Inoculation on pH and Lactic Acid Over Time for the Four Alfalfa Silages in Trial 1

Time Post-filling and Item	Ensiling Temperature and Inoculant Treatment: 60 F Control	60 F Inoculant	90 F Control	90 F Inoculant	SE
Time 0					
pH	6.17	6.17	6.17	6.17	—
Hour 12					
pH	6.00^a	6.01^a	6.16^b	6.03^a	.020
Lactic Acid[1]	$<.01^b$	$.04^b$	$<.01^b$	$.20^a$	.038
Hour 24					
pH	6.06^b	6.12^c	6.14^c	4.95^a	.017
Lactic acid	$.06^b$	$.06^b$	$.56^b$	4.75^a	.180
Hour 36					
pH	6.07^c	5.98^b	5.90^b	4.88^a	.027
Lactic Acid	$.05^d$	$.82^c$	1.77^b	4.97^a	.134
Hour 48					
pH	6.10^d	5.34^b	5.78^c	4.87^a	.054
Lactic Acid	$.40^c$	2.36^b	2.27^b	6.59^a	.404
Day 4					
pH	5.49^c	4.71^a	5.58^c	4.84^b	.027
Lactic Acid	2.46^c	6.55^b	3.04^c	7.64^a	.304
Day 7					
pH	5.28^c	4.66^a	5.48^d	4.77^b	.019
Lactic Acid	3.87^b	6.69^a	3.79^b	7.78^a	.340
Day 21					
pH	5.07^b	4.57^a	5.23^c	4.66^a	.048
Lactic Acid	5.60^b	7.93^a	4.95^b	8.66^a	.407
Day 56					
pH	4.87^b	4.44^a	5.15^c	4.54^a	.037
Lactic Acid	7.06^b	9.17^a	3.83^b	9.17^a	.700
Acetic Acid	4.27^{ab}	3.75^a	4.41^b	4.24^{ab}	.200

[a,b,c,d]Values on the same line differ (P<.05).

[1]Acids are expressed as a % of the silage dry matter.

Table 37.3. Effect of Temperature and Inoculation on pH and Lactic Acid Over Time for the Four Forage Sorghum Silages in Trial 2

Time Post-filling and Item	Ensiling Temperature and Inoculant Treatment				
	60 F		90 F		
	Control	Inoculant	Control	Inoculant	SE
Time 0					
pH	5.78	5.82	5.78	5.82	—
Hour 12					
pH	5.81^{b}	5.88^{c}	5.75^{a}	5.83^{b}	.012
Lactic Acid[1]	.39^{a}	.38^{a}	.19^{b}	.41^{a}	.050
Hour 24					
pH	5.82^{c}	5.89^{d}	4.54^{b}	4.49^{a}	.013
Lactic acid	.06^{b}	.10^{b}	.85^{a}	1.33^{a}	.010
Hour 48					
pH	5.29^{b}	5.39^{b}	4.00^{a}	4.03^{a}	.054
Lactic Acid	.21^{c}	.71^{b}	2.35^{a}	2.14^{a}	.147
Day 4					
pH	4.14^{c}	4.17^{c}	3.96^{b}	3.92^{a}	.008
Lactic Acid	2.85^{b}	2.08^{b}	5.00^{a}	5.33^{a}	.380
Day 7					
pH	4.00^{b}	4.02^{b}	3.71^{a}	3.70^{a}	.008
Lactic Acid	2.39^{b}	2.22^{b}	4.76^{a}	4.55^{a}	.140
Day 14					
pH	3.78^{b}	3.80^{b}	3.59^{a}	3.62^{a}	.006
Lactic Acid	4.47^{b}	5.07^{b}	6.97^{a}	6.53^{a}	.299
Day 42					
pH	3.70^{b}	3.72^{b}	3.64^{a}	3.66^{a}	.004
Lactic Acid	4.99^{d}	5.58^{c}	6.24^{b}	6.63^{a}	.308
Acetic Acid	2.70^{b}	2.67^{b}	2.45^{a}	2.42^{a}	.059

^{a,b,c,d}Values on the same line differ ($P<.05$).

[1]Acids are expressed as a % of the silage dry matter.

Table 37.4. Effect of Temperature and Inoculation on pH and Lactic Acid Over Time for the Four Forage Sorghum Silages in Trial 3.

Time Post-filling and Item	Ensiling Temperature and Inoculant Treatment				
	60 F		90 F		
	Control	Inoculant	Control	Inoculant	SE
Time 0					
pH	5.74	5.75	5.74	5.75	—
Hour 12					
pH	5.70^{b}	5.72^{b}	4.63^{a}	4.65^{a}	.034
Lactic Acid[1]	.21^{c}	.05^{d}	.52^{a}	.45^{b}	.021
Hour 24					
pH	4.91^{b}	4.91^{b}	4.20^{a}	4.22^{a}	.011
Lactic Acid	.26^{c}	.36^{c}	1.54^{b}	1.69^{a}	.035
Hour 48					
pH	4.15^{b}	4.25^{c}	4.05^{a}	4.14^{b}	.018
Lactic Acid	1.63^{b}	1.27^{c}	2.47^{a}	1.78^{b}	.104
Day 4					
pH	4.20^{b}	4.21^{b}	4.19^{b}	4.14^{a}	.009
Lactic Acid	1.89^{bc}	1.67^{c}	2.16^{a}	1.97^{ab}	.074
Day 7					
pH	4.21^{c}	4.27^{d}	4.04^{b}	3.95^{a}	.010
Lactic Acid	2.52^{c}	2.18^{c}	3.33^{b}	4.34^{a}	.201
Day 14					
pH	4.22^{c}	4.23^{c}	4.00^{b}	3.87^{a}	.014
Lactic Acid	2.29^{c}	2.51^{c}	3.36^{b}	4.87^{a}	.165
Day 42					
pH	3.96^{b}	3.92^{ab}	3.86^{a}	3.83^{a}	.029
Lactic Acid	3.64^{b}	3.72^{b}	4.09^{b}	4.83^{a}	.332
Acetic Acid	2.64^{a}	2.72^{a}	2.23^{b}	2.32^{b}	.165

^{a,b,c,d}Values on the same line differ ($P<.05$).

[1]Acids are expressed as a % of the silage dry matter.

Table 37.5. Chemical Composition of the Control and Inoculated Forage Sorghum Silages From the Concrete Stave Silos and From Buried Bags in Trial 4

Item	Control		Inoculant	
	Silos	Buried Bags	Silos	Buried Bags
Silage DM, %	30.79	31.52	31.25	31.42
pH	3.78	3.95	3.78	3.90
	% of the Silage DM			
Total Fermentation Acids	10.0	9.1	9.4	8.4
Lactic Acid	7.35	6.39	6.95	6.29
Acetic Acid	2.52	2.68	2.41	1.99
Ammonia-nitrogen	.18	.18	.18	.19
Lactic:Acetic	3.6	2.4	3.3	3.2

Table 37.6 Dry Matter Recoveries and Losses From the Concrete Stave Silos and From Buried Bags for Control and Inoculated Forage Sorghum Silages in Trial 4

Item	DM Recovery		DM Lost During Fermentation, Storage, and Feedout
	Feedable	Non-feedable (Spoilage)	
	% of the DM Ensiled		
Concrete Stave Silos:			
Control	81.42	3.11	15.47
Inoculant	81.60	3.07	15.33
Buried Bags:			
Control	93.50	—	6.50
Inoculant	93.05	—	6.95

Table 37.7. Performance by Calves Fed the Control and Inoculated Forage Sorghum Silages in Trial 4

Item	Control	Inoculant
No. of Calves	16	16
Initial Wt., lb	216	216
Avg. Daily Gain, lb	1.94	1.96
Daily Feed Intake, lb[1]	14.13	13.64
Feed/lb of Gain, lb[1]	7.33	6.90
Silage fed, lb/Ton Ensiled[2]	1,628,4	1,632.0
Silage/lb of Gain, lb[2]	21.2	20.1
Calf Gain/Ton of Ensiled Crop, lb[2]	76.8	81.2

[1] 100% dry matter basis.

[2] Values are adjusted to the same silage DM, 30 percent.

Additive-treated Corn Silage for Growing Cattle[1]

Keith Bolsen, Russell Smith,
Harvey Ilg, and Dirk Axe

Summary

The response of corn silage to the additive, Silo-Best Soluble®, was not consistent for the farm silo criteria measured. Ensiling temperatures and chemical compositions were similar for control and treated silages, except for ethanol, which was lower in the treated silage. Dry matter recovery favored the treated silage in both the top and bottom halves of the silos and in buried bags. Although daily gains were similar for calves fed control and treated silages, feed conversion was slightly better for those fed control silage.

Introduction

The objective of this trial was to determine the efficacy of a microbial inoculant additive, Silo-Best Soluble®, for whole-plant corn silage using farm silo evalution techniques. The effect of the additive on the rate and efficiency of fermentation of wheat, alfalfa, and forage sorghum silages using laboratory silos is reported on page 110 of this report.

Experimental Procedures

Two whole-plant corn silages were compared: (1) control (no additive) and (2) with Silo-Best Soluble® applied at the blower, at the manufacturer's recommended rate. The silages were made in the 10 x 50 ft concrete stave silos on August 24, 25, and 27, 1984. The irrigated corn (Pioneer 3183) was in the early-dent stage and contained about 67% whole-plant moisture at the time of harvest.

The silos were filled by the alternate load method on each of the 3 filling days. Each silo was partitioned vertically into halves as it was filled, with approximately 34 tons per half. The partitions were separated by plastic mesh fencing. Four thermocouple wires and 12 nylon bags filled with 4.5 to 5.5 lb of fresh crop, were placed in the vertical center of each half. The silos were opened on November 15, 1984 and emptied at a uniform rate over a 13-week period. Silage samples were taken twice weekly.

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[1]Silo-Best Soluble® contains Streptococcus faecium, Lactobacillus acidophilus, Lactobacillus plantarum, and Pediococcus sp. fermentation products and is marketed by Cadco, Inc., Des Moines, Iowa, which provided partial financial assistance.

The silages were fed to steer and heifer calves (four pens of four calves per silage) in an 84-day growing trial, which began on November 16. Silages were full-fed and all calves received 2.0 lb of supplement daily (as-fed basis). Rations were formulated to provide 12.25% crude protein (DM basis), 200 mg of Rumensin® per calf daily, and equal amounts of calcium, phosphorus, and vitamins A, D, and E. Supplements were top-dressed and partially mixed with the silages in the bunk. Feed offered was recorded daily for each of the pens and the quantity of silage fed was adjusted daily to assure that feed was always available. Feed not consumed was removed, weighed, and discarded every 7 days or as necessary.

All calves were weighed individually on two consecutive days at the start and at the end of the trial. Intermediate weights were taken before the a.m. feeding at 28 and 56 days.

Results and Discussion

Actual and adjusted ensiling temperatures are shown in Table 38.1. Both silages reached maximum temperature on day 4 post-filling. Although the average temperatures were nearly identical for the two silages, control silage had the greatest temperature rise in the bottom half of the silo (83.0 to 97.7 F) and Silo-Best Soluble® silage in the top half (90.0 to 105.2 F).

Chemical analyses are shown in Table 38.2. Both silages had very low pH values, high total fermentation acids (predominantly lactic acid), and low ammonia-nitrogen contents, all characteristics of well preserved, high moisture corn silage. The Silo-Best Soluble® silage had approximately one-half as much ethanol as the control, an indication of slightly better preservation of the treated silage.

Silage recovery and loss data are shown in Table 38.3. In the concrete stave silos, DM lost during fermentation, storage, and feedout was 24.6% less for the Silo-Best Soluble® silage (10.1%) than for the control silage (13.4%). The data from the buried nylon bags were similar—treated bags had 12.2% less DM loss than control bags (6.5 vs. 7.4%). Results of five previous trials have shown consistent improvements in DM recovery for Silo-Best silages (Report of Progress 448).

Performance by calves fed the two corn silages is shown in Table 38.4. Throughout the 84-day trial, calves fed Silo-Best silage consistently consumed more feed than those fed control silage. Since daily gains were the same for calves fed the two silages, feed efficiency was slightly in favor of the control silage.

Also shown in Table 38.4 are calf gains per ton of crop ensiled. These data combine silage recovery (Table 38.3) and calf performance. The two silages were similar (only a .7 lb advantage for Silo-Best Soluble®). In four of five previous trials, gains produced per ton of whole-plant corn, sorghum, or high-moisture corn ensiled with Silo-Best were increased by an average of over 6.0 lb when compared with control silages (Reports of Progress 377, 413, and 448).

Table 38.1. Ensiling Temperatures for the Two Corn Silages[1,2]

Days Post-filling	Location in the Silo	Control		Silo-Best Soluble®	
		Actual °F			
Initial:	Top	91.0		90.0	
	Bottom	83.0		83.0	
	Avg.	87.0		86.5	
Day 4:	Top	102.7		105.2	
	Bottom	97.7		96.0	
	Avg.	100.2	(+13.2)	100.6	(+14.1)
Day 7:	Top	101.2		102.3	
	Bottom	97.0		94.5	
	Avg.	99.1	(+12.1)	98.4	(+11.9)
Day 14:	Top	99.25		100.5	
	Bottom	96.0		92.3	
	Avg.	97.6	(+10.6)	96.4	(+9.9)
Day 21:	Top	95.2		97.0	
	Bottom	93.0		89.0	
	Avg.	94.1	(+7.1)	93.0	(+6.5)
Day 35:	Top	85.5		86.5	
	Bottom	84.7		82.4	
	Avg.	85.1	(-1.9)	84.5	(-2.0)

[1]Top and bottom values are the mean of four thermocouple wires. Bottom wires were buried in the crop at about 8 p.m. on August 24th and top wires, at about 4 p.m. on August 25th.

[2]In parenthesis are the changes from the initial crop temperature for each silage.

Table 38.2. Chemical Analyses for the Two Corn Silages

Item	Concrete Stave Silos		Buried Bags	
	Control	Silo-Best Soluble®	Control	Silo-Best Soluble®
Dry Matter:				
Pre-ensiled	33.3	33.0	32.6	32.5
Silage	32.0	31.5	32.6	32.5
pH	3.73	3.67	3.69	3.61
	% of the Silage DM			
Lactic Acid	6.54	6.33	6.21	7.50
Acetic Acid	2.89	2.83	3.73	3.09
Propionic Acid	.06	.03	.11	.06
Butyric Acid	.23	.12	.23	.16
Total Fermentation Acids	9.86	10.15	10.39	11.32
Ethanol	2.53	.93	1.34	.92
Ammonia-nitrogen	.105	.103	.083	.088
Ratio (Lactic:Acetic)	2.26	2.24	1.66	2.43

Table 38.3. Dry Matter Recoveries and Losses From the Concrete Stave Silos and Buried Bags for the Two Corn Silages

Item		DM Recovery: Feedable	DM Recovery: Non-feedable (Spoilage)	DM Lost During Fermentation, Storage, and Feedout
		— % of the DM Ensiled —		
Concrete Stave Silos:				
Control:	Top	85.9	2.1	12.0
	Bottom	85.1	—	14.9
	Avg.	85.5	1.1	13.4
Silo-Best Soluble®:	Top	88.9	2.4	8.7
	Bottom	88.2	—	11.8
	Avg.	88.6	1.3	10.1
Buried Bags:				
Control:	Top	93.2	—	6.8
	Bottom	92.1	—	8.0
	Avg.	92.6	—	7.4
Silo-Best Soluble®:	Top	93.3	—	6.7
	Bottom	93.8	—	6.2
	Avg.	93.5	—	6.5

Table 38.4. Performance by Calves Fed the Two Corn Silages and Calf Gain per Ton of Crop Ensiled

Item	Control	Silo-Best Soluble®
No. of Calves	16	16
Initial Wt., lb	472	474
Final Wt., lb	664	667
Avg. Daily Gain, lb	2.29	2.30
Daily Feed Intake, lb[1]	14.67	15.11
Feed/lb. of Gain, lb[1]	6.43	6.53
Silage Fed, lb/Ton Ensiled[2]	1710	1772
Silage/lb of Gain, lb[2]	16.06	16.53
Calf Gain/Ton of Crop Ensiled, lb[2]	106.5	107.2

[1]100% dry matter basis.

[2]Values are adjusted to the same silage DM content, 35 percent.

Whole-plant Grain Sorghum Silages for Growing Cattle

Russell Smith, Keith Bolsen,
and Jim Hoover

Summary

Four trials were conducted to determine the effects of processing (rolling before feeding, with rolls set to break 95% of the kernels) and stage of maturity at harvest on the nutritive value of whole-crop grain sorghum silages for growing cattle. Rolling mid-dough silages did not improve feeding value. However, rolling at later maturity stages increased cattle gains and feed efficiencies, with the more mature, hard-grain silages giving the greatest response. Only starch digestibility was consistently affected (increased) by processing. Silage dry matter (DM) intake tended to increase, but feed efficiences tended to decrease with advancing maturity. Neither average daily gains nor DM digestibilities were affected by stage of maturity at harvest. However, starch and crude protein (CP) digestibilities were highest for the late-dough silage in one trial and for the early-dough silage in another. Dry matter content and DM recovery from the silos increased and silage CP content decreased with advancing maturity.

Introduction

Work at Texas A and M has shown that feeding whole-plant grain sorghum silage can increase beef production per acre by almost 28% compared with feeding only the grain. However, if the silage is fed straight from the silo, much of the grain may escape digestion. The effect of processing (rolling) the silage to break the kernel has been studied at Kansas State University in each of the past three years (Reports of Progress 427, 448, and 470), but results have been inconsistent. Last year's report (470) showed that the benefit from processing probably depended on the amount and maturity of the grain; higher grain yielding, more mature grain sorghum silages responded most to processing.

This trial measured the response to processing grain sorghum silages harvested at early- and late-dough and hard-grain stages of maturity. The results from our first three trials are also presented for comparison.

Experimental Procedures

Summarized in Table 39.1 are the harvest dates, maturities, and dry matter contents at harvest for the grain sorghum hybrid used in this year's trial (Trial 4) as well as those used in the three previous years (Trials 1, 2, and 3).

All hybrids were direct-cut using a Field Queen forage harvester, and about 80 to 85% of the sorghum kernels were whole when ensiled. The mid-dough silages in Trials 1 and 2 were made in 16 x 50 ft concrete stave silos. In Trial 3, the late-dough material was ensiled in a 14 x 60 ft concrete stave and the hard-grain stage in a 14 x 40 ft Harvestore®. Storage structures used in Trial 4 were the 14 x

60 ft concrete stave silos for the early- and late-dough stage materials and the 14 x 40 ft Harvestore® for the hard-grain stage.

Trial 1. The whole-plant silage made in 1981 was either processed through a roller mill prior to feeding to break 95% of the kernels or fed without processing. Sixteen steer and heifer calves (four pens of four calves per ration) were allotted by weight to the two silage rations. Silages were full-fed with 2.0 lb of supplement per calf daily (as-fed basis). Rations were formulated to provide 12.5% crude protein (CP) on a DM basis, 150 mg of monensin per calf daily, and equal amounts of calcium, phosphorus, and vitamin A. The growing trial was 84 days (January 20 to April 20, 1982).

Trial 2. The whole-plant silage made in 1982 was fed with or without processing (as described in Trial 1) to 16 steer calves, four pens of four calves per ration. Rations were formulated and fed as presented in Trial 1. The growing trial was 56 days, November 20, 1982 to January 15, 1983.

Trial 3. Each of the two whole-plant silages made in 1983 was fed with and without processing as described in Trial 1. In the growth trial, the four silage rations were fed to 20 steers, four pens of five steers per ration. Silages were full-fed with 2.0 lb of supplement per steer daily (as-fed basis). Rations were formulated to provide 12.0% CP (DM basis), 200 mg monensin per calf daily, and equal amounts of calcium, phosphorus, and vitamin A. The growing trial lasted 84 days, December 15, 1983 to March 9, 1984.

Twenty steers, similar to those used in the growth trial, were individually fed the same four silage rations in a digestion trial, using chromic oxide as a marker. The trial consisted of a 14-day adaptation period followed by a 7-day fecal collection period.

Dry matter losses during fermentation, storage, and feedout were measured by accurately weighing and sampling all loads of fresh crop ensiled and subsequently weighing and sampling all silage removed.

Further details of procedures for Trials 1, 2, and 3 are in the Reports of Progress 427, 448, and 470, respectively.

Trial 4. In 1984, DeKalb DK-42Y, a homozygous, yellow endosperm, grain sorghum, was harvested for whole-plant silage at three stages of kernel development: early-dough, late-dough, and hard-grain. The sorghum was from fields with two planting dates (May 25 and June 19), so approximately the same amount of material for each stage of maturity was harvested from plots of each planting date. In-silo DM losses were determined for each silage.

Six silage rations were compared. Each of the three silages was processed through a roller mill prior to feeding and also fed without processing. The roller mill was a Roskamp® model K, with two 9 x 18 inch rolls, each having 10 corregations per inch. Forty-eight heifer and 48 steer calves (avg. initial wt., 553 and 623 lb, respectively) were allotted by weight and previous rate of gain to the six rations (two pens of four heifers and two pens of four steers per ration). Silages were full-fed twice daily with 2.0 lb of supplement per calf daily (as-fed basis). Rations were formulated to provide 12.0% CP for heifers or 11.0% CP for steers (DM basis), 200 mg of Rumensin® per calf daily, and equal amounts of calcium, phosphorus, and vitamin A. All calves received hormonal implants at the start of the 84-day growing trial (February 15 to May 10, 1985).

Calves were weighed on two consecutive days at the beginning and end of the trial, after 16 hr without feed or water. To minimize fill effects, all calves were fed a forage sorghum silage ration at 1.75% of body weight (DM basis) for 1 week before the trial began.

Samples of each silage were taken twice weekly. Feed intake was recorded daily for each pen and the quantity of silage fed adjusted daily to assure that fresh feed was always in the bunks. Feed not consumed was removed, weighed, and discarded as necessary.

After completion of the growing trial, 30 of the steers were individually fed the same six silage rations to determine apparent digestibility. Other digestion trial procedures were similar to those used in Trial 3.

Results and Discussion

Chemical analyses and DM recoveries of the five silages fed in Trials 3 and 4 are shown in Table 39.2. Good preservation was obtained for silages at all stages of maturity. In Trial 3, DM recovery was higher for the hard-grain stage silage than for the late-dough silage. Likewise, DM recovery in Trial 4 increased from the early-dough to the hard-grain stage silage. As maturity advanced, DM content increased and the extent of fermentation decreased, as indicated by the increasing pH values and decreasing fermentation acids. There was a decrease in CP, ammonia-nitrogen, and cellulose and an increase in hot water insoluble-nitrogen as maturity increased. No consistent trends were observed in other fiber constituents, indicating that variation among years might have more effect on silage composition than stage of maturity at harvest.

Trials 1 and 2. Performance by calves fed the processed and nonprocessed mid-dough grain sorghum silages is shown in Table 39.3. Processing the silages prior to feeding did not significantly improve cattle performance in either trial. In Trial 1, calves receiving processed silage consumed 4% more DM and gained 6% faster, but in Trial 2 processing gave just the opposite response, with calves receiving nonprocessed silage consuming 4% more DM and gaining slightly faster.

Trial 3. Performance by steers fed the two grain sorghum silages is shown in Table 39.4. For the late-dough harvested silage, processing increased gain by 11% ($P<.05$) and improved feed efficiency by 12% ($P<.10$), but did not affect DM intake. For the hard-grain harvested silage, processing increased gain by 16% ($P<.05$) and improved feed efficiency by 9.6% ($P<.10$). Although not statistically significant, DM intake was increased from 19.86 to 20.82 pounds from processing the later harvested silage.

Apparent digestibility coefficients of the four silage rations are shown in Table 39.5. For the late-dough silage, processing increased DM digestibility by 15% ($P<.05$) and starch digestibility by 22% ($P<.05$). For the hard-grain silage, DM digestibility was increased by only 5%, but starch digestibility was improved by 22% (P<.05). Fiber digestibility were not affected by processing.

Trial 4. Performance by steers and heifers fed the six grain sorghum silage rations is shown in Table 39.6. Both stage of maturity and processing significantly affected cattle performance. For the unprocessed silages, gain and feed efficiency tended to decrease but DM intake increased as maturity advanced. The responses to processing increased with increasing maturity. Processing improved gain by only 4.5% and feed efficiency by only 3% in the early-dough silage, gain by 12% and efficiency by 7% in the late-dough silage, and gain by 23% and efficiency by 12% in the hard-grain silage.

Results from the digestion trial are shown in Table 39.7. The effect of processing on apparent digestibilities was not as pronounced as in Trial 3, with only starch digestibility being significantly affected by processing. Dry matter digestibility was not significantly affected by stage of maturity at harvest, although it tended to decrease with advancing maturity. Digestibilities of starch and CP were highest (P<.05) for the early-dough stage silages, but similar for the late-dough and hard-grain stage silages. Fiber digestibilities generally increased from the early- to late-dough stage silages, then declined at the hard-grain stage.

Table 39.1. Grain Sorghum Hybrids, Harvest Dates, and Maturities and Dry Matter Contents at Harvest

Year, Trial, and Hybrid	Harvest Date	Maturity at Harvest	% DM at Harvest
1981 (Trial 1)			
Ferry-Morse 81	Sept. 16-17	Mid-dough	37.0
1982 (Trial 2)			
DeKalb E 67	Sept. 20	Mid-dough	36.6
1983 (Trial 3)			
DeKalb DK-42Y	Aug. 28-30	Late-dough	42.1
DeKalb DK-42Y	Sept. 15-16	Hard-grain	50.8
1984 (Trial 4)			
DeKalb DK-42Y	Aug. 23 & Sept. 17	Early-dough	32.6
DeKalb DK-42Y	Sept. 4 & Sept. 26	Late-dough	41.3
DeKalb DK-42Y	Sept. 12 & Oct. 12	Hard-grain	54.2

Table 39.2. Chemical Analyses and Dry Matter Recoveries for the Grain Sorghum Silages Fed in Trials 3 and 4

Item	Trial 3 Late-dough	Trial 3 Hard-grain	Trial 4 Early-dough	Trial 4 Late-dough	Trial 4 Hard-grain
Silage DM,%	42.3	50.9	31.9	42.3	56.2
DM Recovery, % of the DM Ensiled	96.7	97.9	87.0	92.2	94.1
pH	4.19	4.34	3.85	4.13	4.39
	% of the Silage DM				
Lactic Acid	5.92	4.56	5.49	3.58	2.57
Acetic Acid	1.54	1.22	3.00	2.04	1.42
Butyric Acid	<.01	<.01	.07	.08	.05
Total Fermentation Acids	7.48	5.81	8.7	5.8	4.2
Acid Detergent Fiber	23.3	23.1	26.6	26.5	21.9
Neutral Detergent Fiber	40.1	45.2	44.8	41.7	41.9
Lignin	3.8	4.0	4.3	4.4	3.6
Cellulose	17.3	16.6	19.6	18.7	16.2
Crude Protein	10.9	10.1	10.6	9.8	9.9
	% of the Total Nitrogen				
Ammonia-nitrogen	6.5	5.0	9.8	6.1	5.2
Hot Water Insoluble-nitrogen	46.7	56.3	33.4	47.3	62.4
Acid Detergent-nitrogen	11.1	13.3	—	—	—

Table 39.3. Performance by Calves Fed the Grain Sorghum Silage Rations in Trials 1 and 2

Item	Trial 1 Nonproc	Trial 1 Proc	Trial 2 Nonproc	Trial 2 Proc
Silage DM, %	36.3		35.9	
Silage CP, %	9.3		9.5	
No. of Calves	16	16	16	16
Initial Wt., lb	412	416	453	452
Avg. Daily Gain, lb	2.19	2.32	2.12	2.07
Avg. Daily Feed, lb[1]	15.11	15.75	15.01	14.45
Feed/lb of Gain	6.88	6.80	7.09	7.02

[1] 100% dry matter basis.

Table 39.4. Performance by Steers Fed the Four Grain Sorghum Silage Rations in Trial 3

Item	Late-dough		Hard-grain	
	Nonproc	Proc	Nonproc	Proc
No. of Calves	20	20	20	20
Initial Wt., lb	573	570	569	570
Avg. Daily Gain, lb	2.25[b]	2.50[a]	2.11[b]	2.45[a]
Avg. Daily Feed, lb[1]	19.41[d]	19.37[d]	19.86[cd]	20.82[c]
Feed/lb of Gain	8.68[d]	7.75[c]	9.44[e]	8.53[d]

[a,b]Means with different superscripts differ (P<.05).
[c,d,e]Means with different superscripts differ (P<.10).
[1]100% dry matter basis.

Table 39.5. Dry Matter Intake and Apparent Nutrient Digestibility of the Four Grain Sorghum Silage Rations in Trial 3

Item	Late-dough		Hard-grain	
	Nonproc	Proc	Nonproc	Proc
No. of Steers	5	5	5	5
Initial Wt., lb	572	554	557	576
Avg. Daily Feed, lb[1]	18.7	20.3	17.3	18.0
	Digestibility, %			
Dry Matter	53.8[b]	61.9[a]	55.1[ab]	57.9[ab]
Starch	65.0[b]	79.0[a]	50.8[c]	65.5[b]
Crude Protein	42.8[ab]	51.6[a]	38.3[b]	42.6[ab]
Neutral Detergent Fiber	52.5	55.1	60.6	60.2
Acid Detergent Fiber	49.5	50.0	55.9	56.1
Hemicellulose	56.6	61.0	66.2	65.1
Cellulose	60.2	59.0	62.5	63.0
Crude Fiber	58.9	58.6	65.4	64.4

[a,b,c]Means with different superscripts differ (P<.05).

[1]100% dry matter basis.

Table 39.6. Performance by Heifers and Steers Fed the Six Grain Sorghum Silage Rations in Trial 4

Item	Early-dough		Late-dough		Hard-grain	
	Nonproc	Proc	Nonproc	Proc	Nonproc	Proc
No. of Calves	16	16	16	16	16	16
Initial Wt., lb	579	595	593	584	596	580
Avg Daily Gain, lb	2.40^{bc}	2.51^{abc}	2.37^{bc}	2.66^{ab}	2.27^{c}	2.79^{a}
Avg. Daily Feed, lb[1]	18.4^{b}	18.6^{b}	18.5^{b}	19.3^{b}	19.5^{b}	21.3^{a}
Feed/lb of Gain[1]	7.75^{a}	7.52^{a}	7.98^{a}	7.42^{a}	8.78^{b}	7.76^{a}

a,b,c Means with different superscripts differ (P<.05).

1 100% dry matter basis.

Table 39.7. Dry Matter Intake and Apparent Nutrient Digestibility of the Six Grain Sorghum Silage Rations in Trial 4

Item	Early-dough		Late-dough		Hard-grain	
	Nonproc	Proc	Nonproc	Proc	Nonproc	Proc
No. of Steers	4	4	4	4	4	4
Initial Wt., lb	891	876	884	878	869	856
Avg. Daily Feed, lb[1]	19.6	18.4	19.2	20.0	21.9	21.0
	Digestibility, %					
Dry Matter	54.3	55.9	53.7_{f}	53.9	51.6_{f}	54.3
Starch	86.1^{cd}	91.5^{c}	71.4^{f}	76.7^{e}	68.2^{f}	82.3^{de}
Crude Protein	49.1^{cd}	50.8^{c}	39.7^{e}	39.6^{e}	43.0^{de}	39.3^{e}
Neutral Detergent Fiber	39.7^{cd}	40.8^{cd}	49.6^{c}	45.6^{cd}	41.2^{cd}	$38.^{d}$
Acid Detergent Fiber	36.5^{cd}	39.5^{cd}	44.2^{c}	41.0^{cd}	38.4^{cd}	33.0^{d}
Hemicellulose	44.1^{cd}	42.8^{d}	55.9^{c}	51.0^{cd}	44.6^{cd}	45.7^{cd}
Cellulose	47.0^{cd}	51.0^{cd}	58.1^{c}	55.0^{c}	50.3^{cd}	42.8^{d}
Crude Fiber	46.4^{d}	49.2^{cd}	57.1^{c}	49.5^{cd}	52.6^{cd}	44.9^{d}

a,b Means with different superscripts differ (P<.10).

c,d,e,f Means with different superscripts differ (P<.05).

1 100% dry matter basis.

Effect of Maturity at Harvest on Yield and Composition of Hybrid Grain and Forage Sorghum Silages

Russell Smith, Keith Bolsen,
Ted Walter[1], and Brett Kirch

Summary

Results from two trials indicate that grain sorghums can produce high, whole-crop dry matter yields in a short time. Although grain sorghum whole-crop silage may yield less tonnage than forage sorghum, its higher crude protein and grain-to-forage ratio could more than compensate for the difference. Maximum yields, both whole-crop and grain, were obtained at late-dough maturity in both years. However, since high quality silages were made at each harvest stage, grain sorghums had a relatively long harvest season. Grain sorghums had a dry matter content suitable for ensiling over the range of maturities studied. In addition, their yield and nutrient content reached a plateau at the late-dough and hard-grain stages.

Introduction

The importance of sorghum as a feed grain and silage crop in the High Plains region has increased steadily during the past 25 years. Sorghums have more drought resistance or avoidance and better drought recovery than corn. However, there is wide diversity among sorghum types and among hybrids within types for both quantity and quality of silage.

The objective of these experiments was to determine how stage of maturity influences yield, composition, and quality of sorghum hybrids harvested for silage.

Experimental Procedures

Trial 1. Preliminary results were presented last year (Report of Progress 470). Field plots were established on June 1, 1984 under dryland conditions near Manhattan. Treatments were arranged in a split-plot design with four replications. Main plots were three stages of kernel development at harvest: late-milk to early-dough, late-dough, and hard-grain. Subplots were five grain sorghum hybrids: Asgrow Colt, DeKalb DK-42Y, Funk's G-522DR, Northrup-King 2778, TX 2752 x TX 430, and one forage sorghum hybrid (Pioneer 947) for comparison. Procedures for the selection of hybrids, seeding rates, thinning of plots, and collection of agronomic data were similar to those in Trial 2. The chopped material from each subplot was collected and ensiled in a 5-gallon, plastic laboratory silo, using the procedures described on page 110 of this report. Silos were opened about 100 days post-filling and samples were taken for analyses.

[1]Department of Agronomy.

Trial 2. Dryland grain sorghum field plots were established in the summer of 1985. One early- (WAC 652G), two intermediate- (DeKalb DK-42Y and NC+ 174), and one late-maturity (Asgrow Colt) hybrids were used. They were chosen to represent a range of sorghum pedigrees, which included variation in maturity, plant height, and forage and grain yields. Each hybrid was harvested at three stages of kernel development: late-milk to early-dough, late-dough, and hard-grain. Treatments were arranged in a split-plot design with stages of harvest as main plots and hybrids as subplots, with four replications.

About 100 lb per acre of anhydrous ammonia and a broadcast pre-emergence herbicide (Ramrod-Atrazine) were applied before planting. All plots were planted on June 13. Two to 3 weeks after emergence, the plots were thinned to 34,848 plants per acre (6 inches between plants). On July 24, Lorsban insecticide spray was applied for greenbug control. Each plot had six rows, 30 inches apart and 30 ft long.

Agronomic data collected for each plot included days to half bloom, plant height, lodging, whole-plant dry matter (DM), and grain yields. Days to half bloom was used to measure maturity. This is defined as the number of days between planting and the date half the main heads exhibited some florets. Plant height was measured to the tallest point of the head immediately prior to harvest. Whole-crop DM yields were determined by harvesting 20 ft from each of the two center rows. All rows were harvested using a modified one-row forage harvester. Chopped forage from each plot was weighed, sampled, and collected for making silage. Grain yields were determined by hand-cutting the heads from 20 ft of one of the remaining rows. The heads were dried and threshed in a stationary thresher.

Results

Trial 1. Differences among grain sorghum hybrids in days to half bloom and plant height were smaller than expected (Table 40.1). This probably resulted from drought and heat during the early part of the growing season. Hot weather during the late growing season accelerated maturity for all the hybrids. On the average, only 9 days elapsed between successive harvest stages. The forage sorghum (Pioneer 947) was significantly later maturing and taller than the grain sorghums. Data for the five grain sorghum hybrids were pooled for statistical analyses and presentation since they responded similarly.

The effect of harvest stage on yields is presented in Table 40.2. The highest ($P<.05$) whole-crop DM and grain yields for the grain sorghums occurred at the late-dough stage. Whole-crop DM yields for all five hybrids and grain yields for three of the five hybrids decreased at the hard-grain stage. This was due, in part, to leaf loss prior to the third harvest and severe bird damage in some plots. The DM yield for the forage sorghum tended to decrease and grain yield increase as maturity advanced. Grain-to-forage ratios increased with advancing maturity for both sorghum types. However, this increase was significant only for the grain sorghums.

The effect of harvest stage on silage composition is shown in Table 40.3. For the grain sorghums, pre-ensiling and silage DM contents were significantly higher with each advancing stage of maturity. Crude protein (CP) was highest

(10.5%) at the early-dough stage (P<.05). None of the grain sorghum hybrids dropped below 9.0% CP at any stage of maturity. Acid detergent fiber decreased with advancing maturity; however, only the difference between the early-dough and hard-grain stages was significant. Cellulose also decreased with advancing maturity, with the early-dough silage containing significantly more cellulose than silages made at the other two stages. For the forage sorghum, silage DM content followed a pattern similar to the pre-ensiled forage, with the early-dough silage having less (P<.05) DM than silages made at the two later stages.

The effect of harvest stage on silage fermentation characteristics is shown in Table 40.4. Silages made at all three stages were well preserved and lactic acid was predominant. For the grain sorghum silages, lactic, acetic, and total fermentation acids decreased and pH values increased (P<.05) as maturity advanced. The lactic to acetic ratio decreased (P<.05) from the early-dough to the hard-grain stage. Ammonia-nitrogen was highest (P<.05) in the early-dough stage silages. For the forage sorghum silage, lactic acid was significantly higher in the early-dough stage silage than in the late-dough or hard-grain silages. The late-dough stage silage had the highest pH value (P<.05). The lactic to acetic ratio decreased (P<.05) with advancing maturity for the forage sorghum.

Trial 2. Differences in days to half bloom and plant height among the four grain sorghum hybrids were greater than among the five hybrids in Trial 1 (Table 40.5).

The results for harvest dates, compositions, and yields are also presented in Table 40.5. An average of 29 days elapsed between the first and third harvest dates. The initial harvest was made on September 7 for WAC 652G (late-milk to early-dough stage) and the last harvest made on October 24 for Asgrow Colt (hard-grain stage). Whole-crop DM content was significantly higher at each successive harvest stage for all four hybrids. Crude protein was highest (P<.05) at the first harvest stage for three of the four hybrids. Whole-crop DM yield was affected by stage of maturity only for WAC 652G, with the late-milk to early-dough stage having a lower yield (P<.05) than the hard-grain. Grain yield was lowest (P<.05) at the first harvest for all hybrids.

Table 40.1. Maturity and Plant Height for the Six Sorghum Hybrids in Trial 1

Hybrid	Sorghum Type	Days to Half Bloom	Plant Height, Inches
DeKalb DK-42Y	Grain	61.1^{a}	43^{ab}
Northrup-King 2778	Grain	61.3^{a}	43^{ab}
TX 2752 x TX 430	Grain	62.1^{b}	43^{ab}
Funk's G-522DR	Grain	63.1^{c}	42^{a}
Asgrow Colt	Grain	65.2^{d}	44^{b}
Pioneer 947	Forage	71.7^{e}	78^{c}

a,b,c,d,e Means with different superscripts differ (P<.05).

Table 40.2. Effect of Harvest Stage on Yield of the Grain and Forage Sorghums in Trial 1

Sorghum Type and Item	Harvest Stage			
	Early-dough	Late-dough	Hard-grain	SE
Grain Sorghums[1]				
Whole-crop DM Yield, Tons/Acre	5.09^{b}	5.64^{a}	5.08^{b}	.18
Grain Yield, Bu/Acre[2]	68.2^{c}	101.9^{a}	93.8^{b}	.15
Grain:Forage	.48^{b}	.79^{a}	.82^{a}	.04
Forage Sorghum				
Whole-crop DM Yield, Tons/Acre	6.06	5.96	5.70	.53
Grain Yield, Bu/Acre[2]	83.4	85.5	91.2	.39
Grain:Forage	.50	.53	.62	.05

[1]Average of five hybrids.
[2]Adjusted to 12.5% moisture.
[a,b,c]Means in the same row with different superscripts differ ($P<.05$).

Table 40.3. Effect of Harvest Stage on Silage Composition of the Grain and Forage Sorgums in Trial 1

Sorghum Type and Item	Harvest Stage			
	Early-dough	Late-dough	Hard-grain	SE
Grain Sorghums[1]				
Dry matter:				
Pre-ensiled Crop, %	32.9^{a}	41.8^{b}	51.3^{c}	.01
Silage, %	32.2^{a}	40.0^{b}	50.5^{c}	.34
	—— % of the Silage DM ——			
Crude Protein	10.5^{a}	9.7^{b}	9.5^{b}	.10
Neutral Detergent Fiber	48.8	47.1	49.3	.57
Acid Detergent Fiber	27.8^{b}	26.2^{ab}	25.5^{a}	.40
Cellulose	20.5^{b}	18.8^{a}	18.0^{a}	.24
Lignin	4.4	4.5	4.6	.11
Forage Sorghum				
Dry matter:				
Pre-ensiled Crop, %	39.1^{a}	45.2^{b}	45.5^{b}	.01
Silage, %	37.4^{a}	43.6^{b}	44.8^{b}	1.06
	—— % of the Silage DM ——			
Crude Protein	8.2	8.1	7.9	.18
Neutral Detergent Fiber	55.5	52.1	54.1	1.07
Acid Detergent Fiber	31.9	31.1	32.6	.81
Cellulose	22.8	22.5	23.3	.87
Lignin	5.7	6.1	6.0	.21

[1]Average of five hybrids.
[a,b,c]Means in the same row with different superscripts differ ($P<.05$).

Table 40.4. Effect of Harvest Stage on Silage Fermentation Characteristics of the Grain and Forage Sorghums in Trial 1

Sorghum Type and Item	Harvest Stage			SE
	Early-dough	Late-dough	Hard-grain	
Grain Sorghums[1]	------- % of the Silage DM --------			
Lactic Acid	5.72[a]	3.97[b]	2.92[c]	.18
Acetic Acid	2.22[a]	1.66[ab]	1.32[b]	.08
Butyric Acid	.07[a]	.23[ab]	.59[b]	.12
Total Fermentation Acids	8.01[a]	5.87[b]	4.86[b]	.19
pH	4.08[a]	4.34[b]	4.78[c]	.03
Lactic:Acetic	2.72[a]	2.44[ab]	2.16[b]	.14
Ammonia-nitrogen[2]	8.75[a]	6.92[b]	6.78[b]	.09
Forage Sorghum	------- % of the Silage DM --------			
Lactic Acid	5.06[a]	3.00[b]	3.22[b]	.41
Acetic Acid	1.78	1.49	2.36	.36
Butyric Acid	.08	<.01	.02	.04
Total Fermentation Acids	6.93[a]	4.50[b]	5.61[ab]	.60
pH	4.26[a]	4.60[b]	4.21[a]	.03
Lactic:Acetic	2.84[a]	2.01[ab]	1.55[b]	.25
Ammonia-nitrogen[2]	5.68	5.62	5.70	.004

[1]Average of five hybrids.

[2]Expressed as a % of the total nitrogen.

[a,b,c]Means in the same row with different superscripts differ (P<.05).

Table 40.5. Maturities, Plant Heights, Harvest Dates, Compositions, and Whole-crop Forage and Grain Yields for the Four Grain Sorghum Hybrids in Trial 2

Hybrid	Harvest Stage[1]	Harvest Date	Whole-crop[2] DM	Whole-crop[2] CP	Whole-crop DM Yield	Grain Yield[3]	Grain: Forage
			%	%	Tons/Acre	Bu/Acre	
WAC 652G	1	Sept. 7	29.0[a]	11.6[a]	4.4[b]	64.6[c]	.59[b]
(63[4], 51[5])	2	Sept. 17	32.9[b]	10.7[b]	4.9[ab]	88.1[b]	.82[a]
	3	Oct. 4	40.2[c]	10.2[b]	5.3[a]	100.8[a]	.91[a]
DeKalb DK-42Y	1	Sept. 9	27.9[a]	11.7[a]	4.8	46.1[c]	.32[b]
(69, 47)	2	Sept. 19	31.0[b]	10.6[b]	5.1	78.5[b]	.63[a]
	3	Oct. 14	41.3[c]	10.1[b]	5.1	94.6[a]	.83[a]
NC+ 174	1	Sept. 16	28.2[a]	10.4[a]	5.1	83.8[b]	.70[b]
(71, 53)	2	Sept. 24	30.8[b]	9.7[b]	5.8	102.7[a]	.81[b]
	3	Oct. 15	41.2[c]	9.2[b]	5.2	111.6[a]	1.20[a]
Asgrow Colt	1	Sept. 24	26.9[a]	10.0	5.4	85.4[b]	.66
(78, 52)	2	Oct. 2	30.9[b]	10.0	5.7	97.4[a]	.75
	3	Oct. 24	42.2[c]	9.4	5.1	86.9[ab]	.74

[1]Harvest stage 1, late-milk to early-dough; stage 2, late-dough; and stage 3, hard-grain.

[2]100% dry matter basis.

[3]Adjusted to 12.5% moisture basis.

[4]Days to half bloom.

[5]Plant height, inches.

[a,b,c]Means within a hybrid with different superscripts differ (P<.05).

Effect of Maturity at Harvest on Yield, Composition, and Feeding Value of Hybrid Forage Sorghum Silages

John Dickerson, Keith Bolsen,
Susan Hamma, and Jim Hoover

Summary

Results from three trials showed the diversity among forage sorghum hybrids for both agronomic and nutritive characteristics. Later maturing and nonheading hybrids produced silages with low dry matter (DM) contents, low pH values, high levels of fermentation acids, and low voluntary intakes. Earlier maturing and moderate grain-producing hybrids had whole-crop DM yields similar to the later hybrids, but their silages had higher DM contents and higher voluntary intakes. Stage of maturity at harvest had surprisingly little influence on silage chemical composition, intake, or digestibility.

Introduction

In 1984, Kansas produced nearly 200,000 acres of forage sorghum, yielding almost 2 millon tons of silage. Little information is available concerning how stage of maturity at harvest affects composition and digestibility of forage sorghum hybrids. Several researchers have reported decreased digestibility of dry matter, crude protein, and fiber components with advancing maturity. However, others suggest that the effects of maturity might vary among hybrids.

The objective of these three experiments was to measure how stage of maturity at harvest influences yield, composition, and nutritive value of silage from several forage sorghum hybrids.

Experimental Procedures

Trial 1. Two forage sorghums, DeKalb FS-25A+ (a late maturing, moderate grain producing hybrid) and Funk's G-1990 (a late maturing, nonheading hybrid), were seeded on June 9, 1983 and grown under dryland conditions near Manhattan. Harvests were made at six stages of maturity for the FS-25A: boot (stage 1), anthesis (stage 2), early-milk (stage 3), late-milk to early-dough (stage 4), late-dough (stage 5), and post-freeze, hard-grain (stage 6). Since G-1990 does not head, it was harvested on the same days as FS-25A. Days post-emergence (DPE) for the six harvests were: 81, 93, 100, 110, 114, and 160 for stages 1 through 6, respectively. Whole-crop yield was determined by harvesting two rows, each 450 ft long.

At each harvest six, 55-gallon, metal drum, pilot silos lined with 4 ml plastic were filled with approximately 225 lb of fresh material from each hybrid. Silos were stored at ambient temperature (60 to 75 F) for at least 100 days prior to opening. Silage samples were taken at three levels from the geometric center as the pilot silos were emptied.

Chemical analyses of the silages included DM, crude protein (CP), ash, fiber constituents, pH, lactic acid, volatile fatty acids, and hot water insoluble nitrogen.

Twenty-four crossbred wether lambs (average wt., 80 lb) were allotted by weight to the 12 silages (two lambs per silage) for three digestion trial periods. All rations were 90% of the appropriate silage and 10% supplement (DM basis). Rations were formulated to 11.5% CP and supplied equal amounts of minerals and vitamins (Table 41.1). Between periods, all lambs were weighed and randomly re-assigned to the 12 silage rations.

Each 24-day period was divided into a 10-day preliminary phase, a 5-day voluntary intake, a 2-day ration intake adjustment, and 7-day fecal collection phases. During the intake adjustment and collection phases, all lambs received 85% of their previously established ad libitum intake.

Trial 2. Three forage sorghum hybrids were seeded on June 14, 1984 and grown under dryland conditions near Manhattan. Hybrids were: Acco Paymaster 351 (a middle maturing, high grain producing hybrid), DeKalb FS-25E (a late maturing, low to moderate grain producing hybrid similar to FS-25A in Trial 1), and Funk's G-1990, also described in Trial 1. Harvests were made at three stages of maturity for the Acco 351 and FS-25E: late-milk to early-dough (stage 4, described in Trial 1), late-dough (stage 5), and post-freeze, hard-grain (stage 6). The G-1990 was harvested on the same day as FS-25E, which was at 102, 116, and 127 DPE for stages 4, 5, and 6, respectively. Whole-crop yield was determined by harvesting three rows, each 400 ft long.

At each harvest for each hybrid, fresh material was ensiled, stored, weighed, and sampled as described in Trial 1. Silos were opened at about 75 day post-filling. Preparation and analyses of samples were identical to Trial 1.

Twenty-seven crossbred wether lambs (avgerage wt., 73 lb) were allotted by weight to the nine silages (three lambs per silage) for two digestion trial periods. All rations were 90% of the appropriate silage and 10% supplement (DM basis). Rations were formulated to 11.5% CP and supplied equal amounts of vitamins and minerals (Table 41.1). Period and phase length, re-assignment between periods, preparation of samples, and chemical analyses were similar to Trial 1.

Trial 3. Three forage sorghum hybrids, Pioneer 947, Acco Paymaster 351, and DeKalb FS-25E, were selected to represent a range of maturities, plant heights, and forage and grain yields. Harvests were made at four stages of crop maturity: late-milk to early-dough (stage 4), late-dough (stage 5), post-frost, hard-grain (stage 6), and 2 to 4 weeks after hard-grain (stage 7).

Field plots were seeded on June 8, 1985 under dryland conditions near Manhattan. About 100 lb per acre of anhydrous ammonia was applied 1 month before planting. Furadan 15 G insecticide was placed in the furrows at planting and the following day, pre-emergence herbicide (Ramrod) was broadcast. On July 24, the plots were sprayed with Cygon 400 for greenbug control.

The hybrids were assigned in a randomized complete block design to three replicate plots each. Single plots had 18 rows, 30 inches apart and 200 ft long. Whole-crop yield for each plot at each stage of maturity was determined by harvesting three rows with a Field Queen forage harvester. One row was left as a border from which the heads were clipped from a random 40 ft to determine grain yield. The heads were dried and threshed in a stationary thresher.

Results and Discussion

Trial 1. Harvest dates, dry matters, and whole-crop yields for the two hybrids are shown in Table 41.2. The increase in DM content with advancing maturity was similar for the two hybrids. FS-25A reached maximum DM yield at stage 3, and G-1990 at stage four. FS-25A outyielded G-1990 at the three earlier stages, but at stages 4 and 5, DM yields were similar. A freeze on September 25 hastened leaf loss in both hybrids, so subsequent DM yields were reduced. The yield reduction was greatest for FS-25A.

Chemical analyses for the 12 forage sorghum silages are shown in Table 41.3. The CP content was similar for both hybrids, with the lowest CP at harvest stage six. The fiber fractions (neutral detergent fiber, acid detergent fiber, and hemicellulose) were higher at all harvest stages for G-1990 silages than FS-25A. Harvest stage did not affect the fiber fractions of either hybrid at stages 1 through five. At stage 6, all fractions except cellulose decreased.

Fermentation characteristics for the 12 forage sorghum silages are presented in Table 41.4. All silages were well preserved and had undergone lactic acid fermentations. They had very low pH values, high lactic acid contents, and negligible amounts of buytric acid. The lactic acid content did not appear to be related to harvest stage in either hybrid. Acetic and total fermentation acids increased with advancing maturity in G-1990 silages, but not in FS-25A. The G-1990 silages had consistently lower hot water insoluble nitrogen values than FS-25A.

Results for voluntary intakes and apparent digestibilities are shown in Table 41.5. Since there were no significant hybrid x harvest stage interactions, only data for the main effects are given. Hybrid did not affect intakes or digestibilities of DM, organic matter (OM), or crude protein. Only NDF and ADF digestibilities were significantly affected by hybrid; G-1990 silages were more digestible. Voluntary intakes were highest for the stage 5 silages and lowest for stage 1 silages ($P<.05$). The DM and OM digestibilities were highest for the stages 2 and 3 silages ($P<.05$). Crude protein digestibilities were lowest ($P<.05$) for the stage 1 silages. The NDF and ADF digestibilities were highest ($P<.05$) for the stage 2 silages, but lowest ($P<.05$) for stage 6 silages.

Trial 2. Harvest dates, dry matters, and whole-crop yields for the three hybrids are shown in Table 41.6. All three hybrids increased in DM content as maturity advanced, with Acco 351 being consistently highest at each harvest stage. The DM yield was lowest for all three hybrids at harvest stage 4; Acco 351 and G-1990 reached maximum yields at stage 6 and FS-25E, at stage five.

Chemical analyses of the nine forage sorghum silages are shown in Table 41.7. The CP contents were unusually low for all three hybrids and were not influenced by harvest stage. The fiber fractions followed very consistent patterns. Acco 351 silages had the lowest NDF, ADF, and cellulose values; G-1990 silages had the highest values. Most fiber fractions decreased at the last harvest stage, particularly for Acco 351 and FS-25E silages.

Fermentation characteristics for the nine forage sorghum silages are presented in Table 41.8. All silages were well preserved and had undergone lactic acid fermentations. Differences because of hybrid or harvest stage were small. Acco 351 silages, which had higher DM contents than silages from FS-25E or G-1990, also had the highest pH values, lowest total fermentation acids, and highest hot water insoluble nitrogen levels. The FS-25E silages had the lowest pH values and the highest total acids. Acetic acid content increased and lactic:acetic acid ratios decreased with advancing maturity for all three hybrids.

Results for voluntary intakes and apparent digestibilities are shown in Table 41.9. Since no significant hybrid x harvest stage interactions occurred, only main effects are given. The higher DM, Acco 351 silages were consumed in greater amounts ($P<.05$) than FS-25E or G-1990 silages. The hybrids had similar DM and OM digestibilities. Crude protein and ADF digestibilities were highest ($P<.05$) for the G-1990 silages; ADF digestibility was lowest ($P<.05$) for the Acco 351 silages. Harvest stage did not influence voluntary intakes or digestibilities of DM, OM, and crude protein.

Trial 3. Plant heights, harvest dates, compositions, and yields for the three hybrids are shown in Table 41.10. Pioneer 947 required only 28 days to advance from stage 4 to stage 6; Acco 351 required 35 days, and FS-25E required 44 days.

Whole-crop DM content increased ($P<.05$) at each successive harvest stage for Pioneer 947, ranging from 29.6% at stage 4 to 44.0% at stage seven. For Acco 351, DM content increased with advancing maturity after stage 5 and reached 40.4% at stage seven. The DM content of FS-25E did not change after stage four. That agrees with results obtained in Trial 2. Crude protein generally decreased with advancing maturity, but only in Pioneer 947 and FS-25E was the change statistically significant.

Whole-crop DM yield of Acco 351 was influenced less than the other two hybrids by stage of maturity (Table 41.10). The highest yields ($P<.05$) were at harvest stages 4 or 5 for Pioneer 947 and FS-25E, and their lowest yields ($P<.05$) were at stage seven. Grain yield for Pioneer 947 was not affected by harvest stage, but the lowest yield ($P<.05$) for Acco 351 occurred at stage 1 and the lowest yield ($P<.05$) for FS-25E was at the first two stages.

Table 41.1. Composition of Supplements Fed in Trials 1 and 2

Ingredient	Trial 1 A[1]	Trial 1 B[2]	Trial 1 C[3]	Trial 1 D[4]	Trial 2 E[5]	Trial 2 F[6]
	% on a DM Basis					
Rolled Grain Sorghum	—	10.0	26.0	75.0	—	—
Soybean Meal	78.3	67.0	51.0	1.0	75.1	73.4
Urea	8.7	8.8	8.8	8.8	10.5	12.0
Limestone	5.3	6.5	6.3	5.4	6.0	6.1
Dicalcium Phosphate	3.5	3.8	4.1	5.6	3.8	3.9
Salt	2.5	2.5	2.5	2.5	2.5	2.5
Soybean Oil	1.0	1.0	1.0	1.0	1.0	1.0
Trace Mineral Premix	.3	.3	.3	.3	.3	.3
Vitamin and Antibiotic Premix[7]	.4	.4	.4	.4	.8	.8

[1]Fed with FS-25A stage 4, 5, and 6 silages.
[2]Fed with FS-25A stage 2 and 3 and G-1990 stage 6 silages.
[3]Fed with FS-25A stage 1 and G-1990 stage 2, 3, 4 and 5 silages.
[4]Fed with G-1990 stage 1 silage.
[5]Fed with all Acco 351 and FS-25E silages.
[6]Fed with all G-1990 silages.
[7]Formulated to supply 3,000 IU of vitamin A, 300 IU of vitamin D, 3 IU of vitamin E, and 20 mg of aureomycin per lamb day.

Table 41.2. Harvest Dates, Dry Matters, and Whole-Crop Yields for the Two Forage Sorghum Hybrids in Trial 1

Hybrid and Harvest Stage[1]	Harvest Date	DM at Harvest	Whole-crop DM Yield
	1983	%	Tons/Acre
FS-25A			
1	Aug. 29	20.4	5.0
2	Sept. 9	25.1	5.4
3	Sept. 16	26.2	5.8
4	Sept. 26	28.7	5.5
5	Sept. 30	28.8	5.4
6	Nov. 15	29.1	4.8
G-1990			
1	Aug. 29	20.2	4.4
2	Sept. 9	23.4	4.4
3	Sept. 16	24.1	5.2
4	Sept. 26	27.6	5.5
5	Sept. 30	27.6	5.3
6	Nov. 15	29.2	5.4

[1]Harvest stage 1, boot; stage 2, anthesis; stage 3, early-milk; stage 4, late-milk to early-dough; stage 5, late-dough; and stage 6, post-freeze and hard-grain.

Table 41.3. Dry Matter and Chemical Composition for the 12 Forage Sorghum Silages in Trial 1

Hybrid and Harvest Stage	DM	Chemical Component[1]							
		CP	Ash	EE	NDF	ADF	Hemi-cellulose	Cellulose	Lignin
	%	% of the Silage DM							
FS-25A									
1	19.1	7.2	7.9	2.6	64.2	39.6	24.7	31.4	5.3
2	23.0	7.2	8.0	2.3	67.9	38.8	29.1	29.6	5.5
3	23.4	7.4	8.7	3.4	63.1	37.3	25.9	27.5	5.9
4	25.5	7.1	8.8	4.3	64.0	38.0	25.4	28.0	6.1
5	26.5	6.6	8.8	2.5	62.7	38.2	24.5	30.6	3.8
6	28.0	6.2	8.2	2.5	56.5	38.1	18.5	33.2	3.8
G-1990									
1	21.1	7.3	8.5	2.7	67.4	41.3	26.1	33.8	4.9
2	22.1	6.8	8.3	3.6	68.9	41.5	27.2	32.3	5.6
3	23.6	6.8	7.9	3.0	70.5	40.8	29.8	26.9	6.7
4	25.7	7.2	8.7	3.1	67.4	39.6	27.7	30.3	5.1
5	25.7	6.8	8.9	2.8	67.2	41.4	25.8	31.5	5.4
6	26.8	6.2	9.0	2.4	62.6	40.9	21.7	32.7	3.8

[1]CP = crude protein, EE = ether extract, NDF = neutral detergent fiber, and ADF = acid detergent fiber.

Table 41.4. Fermentation Characteristics for the 12 Forage Sorghum Silages in Trial 1

Hybrid and Harvest Stage	DM	pH	Fermentation Acids			Lactic: Acetic	Hot Water Insoluble Nitrogen[1]
			Lactic	Acetic	Total		
	%		% of the Silage DM				
FS-25A							
1	19.1	3.71	8.7	2.5	11.2	3.6	43.5
2	23.0	3.90	6.8	1.4	8.2	4.9	50.0
3	23.4	3.75	8.4	2.4	10.6	4.0	50.8
4	25.5	3.89	6.6	2.5	9.2	2.7	59.6
5	26.5	3.82	7.5	2.7	10.3	2.7	59.4
6	28.0	3.95	5.3	2.4	7.7	2.2	51.5
G-1990							
1	21.1	3.79	6.8	1.3	8.1	5.4	44.4
2	22.1	3.85	7.2	1.4	8.6	5.2	43.1
3	23.6	3.81	5.7	2.5	8.1	2.3	39.8
4	25.7	3.88	6.3	3.7	9.9	1.7	51.3
5	25.7	3.75	7.0	3.2	10.2	2.2	55.0
6	26.8	3.77	7.0	3.2	10.2	2.2	42.9

[1]Expressed as a % of the silage total nitrogen.

Table 41.5. Effects of Forage Sorghum Hybrid and Stage of Maturity on Ration Voluntary Intakes and Apparent Digestibilities in Trial 1*

Hybrid and Harvest Stage	VI		Digestibility, %				
	g DM/Day	g DM/kg Body Wt$^{.75}$	DM	OM	CP	NDF	ADF
Hybrid							
FS-25A	581	40.0	58.8	51.1	68.8	48.4^{b}	44.7^{b}
G-1990	578	42.3	56.7	52.1	70.2	52.2^{a}	49.9^{a}
Harvest Stage							
1	510^{d}	34.3^{e}	55.5^{cd}	51.3^{cd}	64.5^{d}	51.8^{d}	49.6^{cd}
2	601^{cd}	39.5^{de}	57.8^{cd}	53.4^{c}	70.3^{c}	58.2^{c}	55.2^{c}
3	605^{cd}	44.0^{cd}	58.1^{c}	53.5^{c}	69.3^{c}	50.1^{de}	49.0^{cde}
4	580^{cd}	41.8^{cd}	56.5^{cd}	51.7^{cd}	71.0^{c}	48.8^{de}	44.6^{de}
5	625^{c}	47.1^{c}	55.0^{cd}	50.1^{cd}	69.7^{c}	48.9^{de}	43.3^{de}
6	557^{cd}	39.9^{de}	54.6^{d}	49.6^{d}	72.1^{c}	44.1^{e}	42.1^{e}

*VI = voluntary intake, DM = dry matter, OM = organic matter, CP = crude protein, NDF = neutral detergent fiber, and ADF = acid detergent fiber.

[a,b]Means in the same column with different superscripts differ ($P<.05$).

[c,d,e]Means in the same column with different superscripts differ ($P<.05$).

Table 41.6. Harvest Dates, Dry Matters, and Whole-Crop Yields for the Three Forage Sorghum Hybrids in Trial 2

Hybrid and Harvest Stage[1]	Harvest Date	DM at Harvest	Whole-crop DM Yield
	1984	%	Tons/Acre
Acco 351			
4	Sept. 21	29.2	4.6
5	Oct. 4	33.1	4.7
6	Oct. 19	36.7	5.0
FS-25E			
4	Sept. 24	23.3	5.2
5	Oct. 8	26.2	6.1
6	Oct. 19	26.5	5.6
G-1990			
4	Sept. 24	24.9	5.0
5	Oct. 8	25.2	4.5
6	Oct. 19	25.3	5.4

[1]Harvest stage 4, late-milk to early-dough; stage 5, late-dough; and stage 6, post-freeze, hard-grain.

Table 41.7. Dry Matter and Chemical Composition for the Nine Forage Sorghum Silages in Trial 2

Hybrid and Harvest Stage	DM	CP	Ash	EE	NDF	ADF	Hemi-cellulose	Cellulose	Lignin
		Chemical Component[1]							
	%	% of the Silage DM							
Acco 351									
4	27.8	5.6	8.7	2.3	60.0	38.2	21.8	27.2	5.9
5	32.5	5.6	8.6	1.9	59.8	36.9	22.5	24.4	7.1
6	35.3	5.9	8.6	1.8	53.5	38.1	15.5	27.1	6.1
FS-25E									
4	22.7	6.3	8.3	2.9	63.0	41.1	23.0	30.5	6.0
5	24.6	6.1	8.1	2.0	66.7	41.5	25.7	31.3	6.4
6	24.4	6.4	8.6	1.9	56.8	39.7	17.1	28.3	7.1
G-1990									
4	23.4	4.6	8.6	2.1	68.1	45.0	23.2	34.5	6.7
5	24.6	4.4	8.8	1.8	68.3	45.8	22.5	35.8	6.5
6	24.6	4.3	9.1	1.8	65.2	48.4	16.8	35.6	8.6

[1]CP = crude protein, EE = ether extract, NDF = neutral detergent fiber, and ADF = acid detergent fiber.

Table 41.8. Fermentation Characteristics for the Nine Forage Sorghum Silages in Trial 2

Hybrid and Harvest Stage	DM	pH	Fermentation Acids: Lactic	Fermentation Acids: Acetic	Fermentation Acids: Total	Lactic: Acetic	Hot Water Insoluble Nitrogen[1]
	%		% of the Silage DM				
Acco 351							
4	27.8	3.95	6.0	2.2	8.2	2.8	56.8
5	32.5	3.99	6.1	2.4	8.5	2.6	55.6
6	35.3	4.08	5.6	2.8	8.4	2.1	52.1
FS-25E							
4	22.7	3.81	7.9	2.3	10.1	3.7	46.5
5	24.6	3.84	7.4	3.0	10.4	2.5	49.0
6	24.4	3.79	6.7	3.2	9.9	2.1	40.8
G-1990							
4	23.4	3.85	6.7	2.9	9.5	2.4	45.2
5	24.6	3.94	5.9	3.5	9.4	1.8	47.9
6	24.6	3.92	6.0	3.3	9.4	1.9	80.9

[1]Expressed as a % of the silage total nitrogen.

Table 41.9. Effects of Sorghum Hybrid and Stage of Maturity on Ration Voluntary Intakes and Apparent Digestibilities in Trial 2*

Hybrid and Harvest Stage	VI g DM/Day	VI g DM/kg Body Wt$^{.75}$	Digestibility, % DM	OM	CP	NDF	ADF
Hybrid							
Acco 351	639^{a}	48.0^{a}	57.1	55.9	68.1^{b}	53.2	34.2^{c}
FS-25E	547^{b}	42.7^{b}	55.9	54.3	67.3^{b}	50.2	41.7^{b}
G-1990	527^{b}	40.8^{b}	56.7	55.3	70.5^{a}	55.2	48.7^{a}
Harvest Stage							
4	584	44.0	56.9	55.8	68.0	58.2^{d}	42.8^{d}
5	552	42.9	56.3	54.8	68.2	51.5^{de}	38.7^{e}
6	577	44.6	56.6	55.0	69.6	48.9^{e}	43.0^{d}

*VI = voluntary intake, DM = dry matter, OM = organic matter, CP = crude protein, NDF = neutral detergent fiber, and ADF = acid detergent fiber.

a,b,c Means in the same column with different superscripts differ (P<.05).

d,e Means in the same column with different superscripts differ (P<.05).

Table 41.10. Plant Heights, Harvest Dates, Dry Matters, Crude Proteins (CP), and Whole-crop Forage and Grain Yields for the Three Forage Sorghum Hybrids in Trial 3

Hybrid and Harvest Stage	Harvest Date	Whole-crop DM	Whole-crop CP[2]	Whole-crop DM Yield	Grain Yield[3]
	1985	%	%	Tons/Acre	Bu/Acre
Pioneer 947					
4 (116)[1]	Sept. 16	29.6^{d}	9.1^{a}	6.32^{b}	64
5	Sept. 25	32.3^{c}	9.2^{a}	7.04^{a}	77
6	Oct. 14	37.6^{b}	8.6^{ab}	5.02^{c}	62
7	Nov. 18	44.0^{a}	7.8^{b}	4.00^{d}	70
Acco 351					
4 (74)	Sept. 19	24.4^{c}	9.6	6.26^{ab}	38^{b}
5	Oct. 1	26.4^{c}	9.2	6.82^{a}	71^{a}
6	Oct. 24	36.3^{b}	9.1	6.64^{ab}	64^{a}
7	Nov. 19	40.4^{a}	9.0	6.12^{b}	74^{a}
FS-25E					
4 (128)	Sept. 24	22.8^{b}	8.8^{a}	7.09^{a}	32^{b}
5	Oct. 7	25.7^{a}	8.2^{ab}	6.44^{ab}	33^{b}
6	Nov. 7	27.8^{a}	8.3^{ab}	6.36^{b}	40^{ab}
7	Nov. 19	27.2^{a}	7.5^{b}	4.70^{c}	50^{a}

1 Plant height at harvest stage 4, inches.
2 100% dry matter basis.
3 Adusted to 12.5% moisture.

a,b,c,d Means within a hybrid with different superscripts differ (P<.05).

How Stems of Sorghum Silage are Digested

L.H. Harbers and R.A. Schweitzer

Summary

Upper and lower portions of stem from three sorghum cultivars were ensiled and then subjected to rumen fermentation. The lower stems were readily digested, whereas the upper sections were poorly utilized. Several microscopic techniques were used to help explain the difference.

Introduction

Forage sorghums are popular for silage because of their adaptability to different climates and their high dry matter yield. Sorghums are generally considered inferior to corn as a silage. Grain yield accounts for part of the difference. However, another factor may be the lower digestibility of the stem portion of the sorghum plant.

We investigated the differences in the upper and lower parts of stems of three cultivars at two stages of maturity to try to identify differences in plant structure that might affect utilization by cattle.

Procedures

Three sorghum cultivars — a full-season, non-heading type (Funks G-1990); a mid-season, heavy-heading cultivar (Acco 351); and a late-season, moderate-heading sorghum (DeKalb FS-25E) — were harvested at two stages of maturity — milk and mature.

Stalks selected at random were cut into half-inch sections and ensiled 90 days. Samples were taken within the first two internodes of the top and within the fourth and sixth internodes of the bottom of the stem. Ensiled samples were then digested in nylon bags inside rumens of fistulated steers for up to 48 hours and observed with a scanning electron microscope. Frozen samples of fresh stalks collected when the plants were cut for silage were sectioned for microscopic studies of lignin and starch location.

Results and Discussion

All sorghum stems appear to have the same tissue arrangement. The rind, composed of sclerenchyma cells and vascular bundles, forms the outer layer of the stem, the bulk of which is composed of parenchyma cells and scattered vascular bundles. Structural differences between the upper and lower internodes appear to be mainly cell size.

The major tissue digested in the rumen was the parenchyma or thin-walled cells in the lower portion of the stems. That digestion is exemplified in Fig. 42.1. The picture shows that after 18 hours of rumen digestion, lignified vascular bundles remain intact except for a small portion at the center of the bundles (phloem). Many of the thin-walled cells around those bundles have been removed. The rind area in the upper right hand corner is intact. The fermentation sequence has virtually reached its end point at this stage.

Fig. 42.2 is a photograph of the upper portion of the stem as it was removed from the silo. Note the small, irregular line of tissue breakdown around the inside of the rind. Rumen microorganisms attack this same area, but even after 48 hours, there is very little other tissue digested as shown in Fig. 42.3.

Using a light microscope and special stains, we found large amounts of lignin in the vascular bundles and in the rind of the upper stem where parenchymal cells were not digested. In the lower stem, the rumen microbes digested mainly the non-lignified, thin-walled cells.

Variations between cultivars were found when sections were stained for starch. The location of starch was apparently unrelated to either microbial fermentation patterns or entrance into tissues, except that starch might have encouraged digestion of the parenchyma adjacent to vascular bundles.

Differences between parenchymal cell walls of upper and lower internodes were found with fluorescence microscopy. We found a consistently greenish fluorescence in the parenchyma of the lower internodes, indicating a lack of lignification. On the contrary, a consistent blue fluorescence was present in parenchymal cells walls in the upper part of the stalk, indicating lignification or presence of lignin-type compounds.

The presence of some sort of lignin derivatives, as shown by fluorescence (but not staining) could explain why the parenchyma cells in the upper portion of the stem are not digested.

Figure 42.1. Photomicrograph of the lower stem after 18 hours of rumen fermentation, showing disappearance of thin-walled parenchyma with rind and vascular bundles remaining.

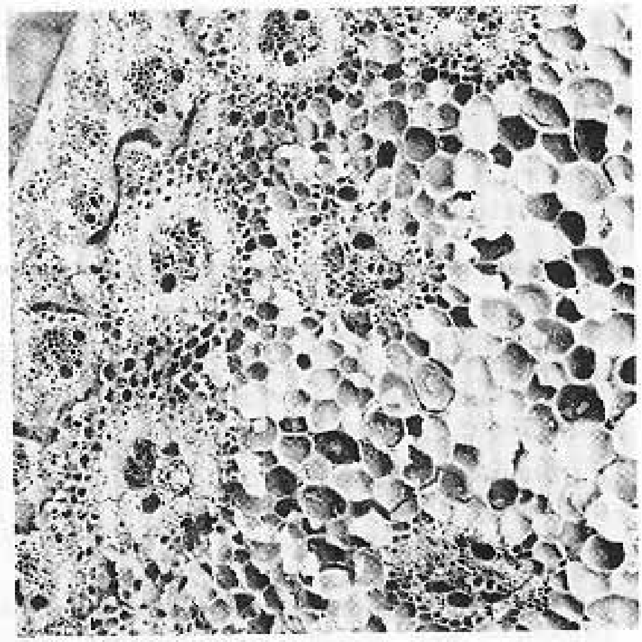

Figure 42.2. Ensiled upper internode (25E, milk stage), demonstrating erosion of inter-intercellular material near the stem periphery during ensiling.

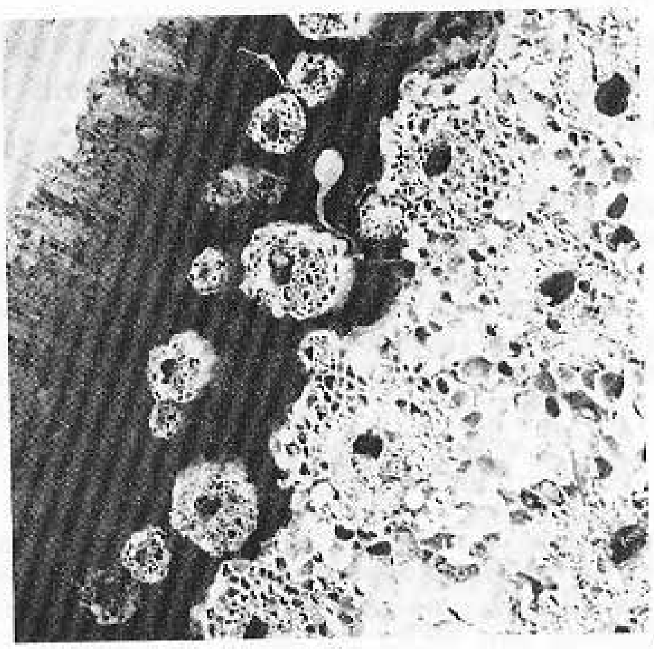

Figure 42.3. Upper stem after 24 hours of rumen fermentation, showing little digestion except of peripheral sclerenchyma. That tissue was also partially digested during ensiling (see Fig. 42.2).

Effect of Sodium Bicarbonate and Sodium Bentonite on Digestion and Ruminal Fermentation of Forage Sorghum Silage-based Rations Fed to Growing Steers[1]

Kate Jacques, Dirk Axe, Theodore Harris[2], Dave Harmon, Keith Bolsen, and Dallas Johnson[2]

Summary

One percent sodium bicarbonate increased intake of a 50% silage - 50% grain ration, but had no effect on intake of an 84% sorghum silage ration. Adding concentrate (rolled sorghum grain) lowered rumen pH slightly and decreased acid detergent fiber and starch digestion. The bicarbonate had no effect on digestibility, but 2% bentonite lowered digestibility of neutral and acid detergent fiber. Neither compound affected ruminal fermentation characteristics.

Introduction

Silages present a dietary lactic acid load to the rumen and their high moisture content and low pH are thought to be responsible for decreased intake. Bicarbonate, a natural component of the rumen buffering system, has proven beneficial in high concentrate rations, but performance results with growing cattle fed high silage rations have been inconclusive (Reports of Progress 448 and 470). Bentonite, an aluminum silicate clay used in the feed industry as a pellet binder, has also been shown to aid in the transition to high concentrate rations. The following experiment was conducted to test the effects of sodium bicarbonate and bentonite on intake, digestibility, and ruminal fermentation when added to either 50% or 84% forage sorghum silage rations.

Experimental Procedures

Six rations were offered ad libitum to six ruminally-fistulated steers. Three rations were 84% silage and 16% supplement and three included rolled sorghum grain and supplement such that grain comprised 50% of the dry matter (DM) intake. Two rations, one at each silage level, included sodium bicarbonate (1% of the DM) or bentonite (2% of the DM), and two rations served as controls. Rations were formulated to provide 12% crude protein (DM basis) and meet vitamin and mineral recommendations (NRC, 1984).

Results and Discussion

Sodium bicarbonate increased intake (Table 43.1) of the 50% silage ration but not the 84% silage ration. Steers fed the 50% silage and bicarbonate ration reached peak intake levels quickly. Bentonite had no effect on the intake of either

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[1]The sodium bicarbonate and partial financial assistance were provided by Church and Dwight Co., Inc., Piscataway, NJ.

[2]Department of Statistics.

ration. Bicarbonate had no effect on digestibility of either ration, but bentonite lowered neutral and acid detergent fiber digestibility in both rations. Adding sorghum grain increased total DM intake, but lowered digestibilities of acid detergent fiber and starch. Ruminal fermentation characteristics (Table 43.2) were unchanged by bicarbonate or bentonite additions. Lactate concentrations were at low levels. Rumen pH values were high for all six rations, which indicated that the rumens were well-buffered. Volatile fatty acid concentrations, while higher for the three 50% silage rations, were lower than expected for all six rations.

Conclusions

Bentonite did not improve intake or digestion of the rations studied. Sodium bicarbonate improved intake of the 50% silage ration, but had no effect on digestibility or rumen fermentation characteristics. Because rumen measurements indicated that the silage did not create excess acid in the rumen, it was concluded that the increased intake with bicarbonate may have been due to increased palatability.

Table 43.1. Effect of Sodium Bicarbonate and Bentonite on Intake and Digestibility of Forage Sorghum Silage-based Rations for Steers

Item	50% Silage			84 % Silage		
	Control	Sodium Bicarbonate	Bentonite	Control	Sodium Bicarbonate	Bentonite
Dry Matter Intake, lb/day[a]	16.9[b]	18.3[c]	16.5[b]	13.6	13.9	13.9
	Digestibility, %					
Dry Matter	57.0	56.8	55.1	57.6	56.8	53.6
Organic Matter	61.0	60.7	61.4	61.9	61.7	58.7
NDF[h]	51.5[d]	49.3[d]	45.4[e]	52.2[f]	49.9[f]	50.0[g]
ADF[h]	43.4[d]	41.1[d]	36.1[e]	48.6[f]	47.2[f]	43.5[g]
Starch[h]	78.8	78.0	76.0	84.1	82.8	87.5

[a] 50% silage rations >84% silage rations (P<.001).

[b,c] 50% silage - bicarbonate > 50% silage-control (P<.001).

[d,e,f,g] Rations including bentonite < controls (P<.05).

[h] 50% silage rations < 84% silage rations (P<.05).

Table 43.2. Effect of Sodium Bicarbonate and Bentonite on Ruminal Fermentation Characteristics for Steers Fed Forage Sorghum Silage-based Rations

Characteristic	50% Silage			84% Silage		
	Control	Sodium Bicarbonate	Bentonite	Control	Sodium Bicarbonate	Bentonite
Rumen pH [a]	6.66	6.62	6.66	6.76	6.80	6.73
L (+) Lactate (mM)	0.66	0.44	0.48	0.36	0.43	0.54
D (-) Lactate (mM)	0.42	0.13	0.48	0.12	0.28	0.38
Total Volatile Fatty Acids (mM)	71.0	76.7	71.6	70.0	71.1	68.1

[a]50% silage rations < 84% silage rations (P<.05).

[b]50% silage rations > 84% silage rations (P<.05).

Effect of Moisture and Bale Type on Alfalfa Hay Quality and Digestibility

Ahmed Laytimi, Chuck Grimes, and Keith Bolsen

Summary

Third cutting alfalfa was baled in large rectangular bales (1,400 to 1,800 lb) and in small conventional bales (70 to 90 lb) at three moisture levels: low (10%), medium (16%), and high (22%). During 120 days of storage under a roof, the high moisture, large bales heated the most, reaching 128° F by 2 days post-baling in a first peak and 133° F in a second peak by the 11th day. Moderate heating occurred in the high moisture, small bales (108° F) and medium moisture, large bales (103° F). Only the high moisture bales, either small or large, had significant dry matter loss during storage. Also, heating decreased water soluble carbohydrates and increased the concentration of cell wall contents by the end of storage. A three-period collection and digestion trial with lambs showed higher voluntary intakes of small bale hays than of large bale hays and higher intakes of high moisture hays than of low moisture hays. Also, the dry matter and crude protein digestibilities were lowest for the high moisture, large bales. Storing alfalfa hay in large bales at 22% moisture resulted in extensive heating, which increased storage loss and decreased nutrient content and digestibility.

Introduction

Under unfavorable weather conditions, making alfalfa hay can result in nutrient losses of 50 or 60% of the original forage. The losses start in the field and continue through storage, processing, and feeding. Plant respiration after cutting, mechanical damage, and leaching contribute to field losses, whereas continued respiration, microbial activity, and chemical oxidation, which all lead to heating, contribute to storage losses.

Hay-making aims at rapid moisture loss from the cut forage and baling with minimum physical losses. However, the optimum moisture level for efficient handling and safe storage of alfalfa hay has not yet been well established. The optimum moisture might vary, depending on such factors as: forage species, climatic conditions, bale types, bale sizes, bale densities, methods of storage, and length of storage. The objectives of this experiment were to study the effects of high, medium, or low moisture levels and conventional or large bale types on alfalfa hay composition and digestibility.

Experimental Procedures

The alfalfa for this experiment was provided by Slentz-McAllister, Inc., and was baled near Lewis, Kansas on August 17 to 19, 1983.

Irrigated, third cutting alfalfa was baled at 10, 16, or 22% moisture using either a model 336 John Deere baler to produce 15 x 19 x 37 inch small rectangular bales or a model 4800 Hesston baler to produce large rectangular bales of 4 x 4 x 8 foot. There were 12 small bales and three large bales per treatment. The initial moisture of the windrows at baling was determined arbitrarily. The two balers ran simultaneously, side by side in adjacent windrows. As the bales came out of the balers, they were identified and thermocouple wires inserted for temperature measurement. Two thermocouple wires were placed into each small bale and four into each large bale. Initial temperatures were recorded within 1 hour after baling. Thereafter, temperatures were taken twice daily for the first 7 days and then once daily until each bale returned to its initial temperature.

All bales were weighed and core-sampled using a Pennsylvania State University sampler within 1 hour after baling and after 4 months of storage under a roof. Samples were immediately frozen in liquid nitrogen until analyzed. After storage, all bales were opened, flakes were separated, and they were visually appraised from end to end for color, aroma, mold, mildew, and dust.

Hay from each treatment was ground and fed to 24 lambs (four lambs per hay) in a three-period, collection and digestion trial. Total feed offered, feed refused, and daily urine and fecal outputs were recorded.

Results and Discussion

Only three bale treatments showed any temperature rise above ambient: 1) the high moisture, large bales, 2) the high moisture, small bales; and 3) the medium moisture, large bales. Two temperature peak were observed in the high and medium moisture, large bales. The first peaks occurred in the first 2 days of storage. The high moisture, large bales heated the most, reaching 128° F in the first peak and 133° F in the second peak, which lasted from the 11th to the 20th day. The high moisture, small bales followed a similar trend, reaching 117° F in the first peak in the first 2 days and 108° F in the second peak on day 11. The temperature change of the medium moisture, large bales followed a similar pattern, but the peak temperatures were lower.

There was no visible discoloration or mold growth in any of the low moisture hays or in the medium moisture, small bales. There was very little discoloration or mold growth in the high moisture, small bales or the medium moisture, large bales. However, in the high moisture, large bales, the discoloration and mold growth were more apparent, very extensive, and heaviest in the fore, center, and butt portions, respectively.

Shown in Table 44.1 are the dry weights initially and after storage. For both bale types, initial dry matter per bale increased with increasing moisture. Significant dry matter loss during storage occurred in the treatments that heated, ranging from 1.5% in the medium moisture, large bales to 11.0% in the high moisture, large bales. The heating and the subsequent dry matter loss reflect the activity of thermophilic microbes.

Also shown in Table 44.1 is the chemical composition change of the hay from initial to the 120th day of storage. In the small bales, initial crude protein (CP) content decreased from 18.5 to 16.5% as moisture level decreased, indicating higher field loss of leaves at the low moisture level. In general, the initial CP was lower in the large than in the small bales at each moisture level. This is not surprising, considering the difference in ground speed between the 4800 Hesston and the 336 John Deere balers. Initial acid detergent insoluble nitrogen (ADIN) values were very high.

Powering the core sampler with an electric drill caused the probe to heat from friction, and might have increased the amount of ADIN in the initial samples. This demonstrates the difficulty of obtaining representative samples from cores.

For water soluble carbohydrates (WSC), the initial content of the hay was not affected by moisture level or bale size. The content ranged from 6.5 to 7.0 percent. However, WSC loss during 120 days of storage was closely related to the amount of heating and bale size. At each moisture level, large bales lost more WSC than small bales and the loss increased to approximately 62% in the high moisture, large bales.

Initial acid detergent fiber (ADF) (mostly cellulose and lignin) and cell wall (CW) contents (mostly cellulose, hemicellulose, and lignin) were not affected by moisture level or bale type. The values were nearly identical (35.2 to 35.9% for ADF and 43.9 to 44.9% for CW), except for high moisture, small bales (31.1% ADF and 38.2% CW). These figures were unexpected and may represent sampling or analytical error. Both ADF and CW concentrations increased, probably because of heating in the medium moisture, large and in the high moisture, small and large bales.

Shown in Table 44.2 are voluntary intakes and digestibility coefficients of the six alfalfa hays. Although the voluntary intakes were statistically similar, two trends were observed. First, intake was always higher for the small bales than for the large bales. Second, intake increased with increasing moisture level in both bale types.

The high moisture, large bales had the lowest dry matter (57.0%) and crude protein (64.5%) digestibilities, indicating nutrient damage as a result of heating during storage. The other five hays had similar dry matter and crude protein digestibilities, ranging from 60.5 to 61.9% and 73.9 to 78.9%, respectively. Neither ADF nor CW digestibilities were affected by bale moisture or size.

Table 44.1. Effect of Moisture and Bale Type on Alfalfa Hay Storage Losses and Change in Chemical Composition

Bale Characteristics[1]	Moisture 10% Post-baling	10% Post-storage	16% Post-baling	16% Post-storage	22% Post-baling	22% Post-storage
Large Bales:						
Wt., lb of DM	1098.0	1098.0	1376.3	1355.2	1560.0	1388.2
Wt. Change, %	—	0	—	-1.5	—	-11.0
	% of the Hay DM					
CP	15.9	15.4	15.8	16.0	16.2	17.0
ADIN	.306	.215	.183	.208	.209	.320
WSC	7.0	5.3	6.5	4.6	6.8	2.6
CW	44.6	42.1	44.9	45.2	43.9	47.1
ADF	35.2	34.2	35.5	36.2	35.9	38.2
Small Bales:						
Wt., lb of DM	50.8	50.4	56.0	55.4	70.6	66.9
Wt. Change, %	—	-.8	—	-1.1	—	-5.2
	% of the Hay DM					
CP	16.5	15.7	16.8	16.5	18.5	18.3
ADIN	.306	.177	.326	.173	.307	.184
WSC	6.7	6.6	6.7	6.1	6.8	5.4
CW	44.9	44.9	44.9	44.7	38.2	47.7
ADF	35.5	34.1	35.7	34.2	31.1	32.3

[1]CP = crude protein, ADIN = acid detergent insoluble nitrogen, WSC = water soluble carbohydrates, CW = cell wall contents, and ADF = acid detergent fiber.

Table 44.2. Effect of Moisture and Bale Type on Alfalfa Hay Voluntary Intakes and Digestibilities by Lambs

Item[1]	Moisture and Bale Type 10% Small	10% Large	16% Small	16% Large	22% Small	22% Large
Voluntary Intake, lb of DM/Day	3.80	3.63	3.85	3.74	3.90	3.83
	Digestibility, %					
DM	61.9^a	60.6^a	60.5^a	60.7^a	60.9^a	57.0^b
CP	78.9^a	75.1^a	73.9^a	74.8^a	74.6^a	64.5^b
CW	41.9	40.3	44.1	45.3	47.2	43.0
ADF	42.9	40.3	42.5	45.9	47.5	41.6

[1]CP = crude protein, CW = cell wall contents, and ADF = acid detergent fiber.

[a,b]Values with different superscripts differ (P<.05).

Effect of Moisture, Bale Type, and a Preservative on Alfalfa Hay Quality and Feeding Value[1,2]

Ahmed Laytimi, John Arledge,[3]
Chuck Grimes, and Keith Bolsen

Summary

In the first of two alfalfa hay experiments, lambs fed small bale hays averaged 16% better gains and feed conversions than those fed large bale hays; Fresh Cut®-treated hay gave 9% better performance than untreated hays; and medium-moisture hays produced 12% faster and more efficient gains than low-moisture hays. In the second experiment, hay baled above 30% moisture had excessive heating, more discoloration and mold growth, higher storage losses, and lower dry matter and protein digestibilities compared with 15% moisture hay.

Introduction

In spite of new hay-making equipment and techniques, the process continues to be greatly affected by weather. Preservatives could minimize weather risk by allowing hay to be baled at higher moisture levels, thereby reducing the time from cutting to baling. This would decrease field losses, such as nutrients leached and leaves shattered, and increase the potential for higher quality hay.

The success or failure of a hay preservative will be influenced by many factors including, but not limited to, hay moisture, bale size, bale type, and bale density. The objectives of these experiments were to determine the effects of moisture levels at baling, conventional or large bale types, and commercial preservatives on alfalfa hay quality, chemical composition, and feeding value for growing lambs.

Experimental Procedures

The alfalfa for these experiments was obtained from farmers' fields near the Agricultural Science Center at Artesia, New Mexico.

Experiment 1. Single windrow alfalfa plots approximately 1280 feet long were swathed on July 19, 1984 using a 14-foot swather with a mower-conditioner-crimper, which facilitated uniform dry down of the crop. A Massey Ferguson Model 126 baler was used to produce 14 x 18 x 36 inch bales (small bales), and a model 4800 Hesston baler was used to produce 4 x 4 x 8 foot bales

[1]These experiments were part of a cooperative project between the Agricultural Science Center at Artesia, New Mexico State University and the Animal Sciences and Industry Dept., Kansas State University.

[2]Partial financial assistance was provided by Kemin Industries, Inc., Des Moines, Iowa and International Stock Food, Inc., Waverly, N.Y.

[3]Assistant Professor of Agronomy, New Mexico State University.

(large bales). For each bale type, the alfalfa was baled at two moisture levels: approximately 15% (low) or 17% (medium) for the small bales and approximately 12% (low) or 14% (medium) for the large bales. The medium moisture hay was baled on July 22, and the low moisture, on July 24. The initial moisture of the windrows at baling was determined arbitrarily. Ninety-six small bales were made at the medium moisture and 48 at the low moisture. Eight large bales were made at the medium moisture and four at the low moisture. One-half of the medium moisture, small and large bales were treated at the bale chamber with Fresh Cut®, a commercial hay preservative from Kemin Industries, Inc. Small bales received 4 lb (2 quarts) per ton and large bales 6 lb (3 quarts) per ton. Fresh Cut® is a non-corrosive, non-volatile chemical hay stabilizer, which contains 20% propionic acid.

The two balers ran simultaneously, side by side in adjacent windrows. As the small bales came out of the baler, they were identified, weighed, and randomly assigned within each treatment to the following: 1) initial, pre-storage core sampling, or 2) thermocoupling for temperature measurement and post-storage core sampling and feeding. As the large bales came out of the baler, they were randomly assigned within each treatment to the following: 1) initial, pre-storage core sampling, or 2) thermocoupling and post-storage core sampling and feeding. For temperature measurement, two thermocouple wires were inserted into each small bale and four into each large bale. Initial temperatures were recorded within 1 hour post-baling. Thereafter, temperatures were recorded twice daily for the first 7 days and then once daily for 1 month.

All pre-storage bales were core-sampled within 1 hour post-baling, using a Pennsylvania State University sampler. Post-storage bales were weighed and core-sampled after 5 months of storage under a roof. All samples were frozen immediately in liquid nitrogen until analyzed for moisture and chemical constituents. All thermocoupled and post-storage bales were transported from Artesia to Manhattan, where they were flaked and visually appraised for color, aroma, mold, mildew, and dust.

The flaked hay from each treatment was ground, stored in boxes, and fed to 72 crossbred feeder lambs (three pens of four lambs per treatment) in a 46-day growing trial. The rations contained 90% of the appropriate hay and 10% supplement (Table 45.1). The lambs were fed twice daily and feed refusals were recorded weekly.

Experiment 2. Single windrow alfalfa plots approximately 600 feet long were swathed on August 25, 1984 using a 14-foot swather with a mower-conditioner-crimper. The following nine hay treatments (20 bales each) were made using a Massey Ferguson Model 126 baler: high and medium moisture, baled without preservative (control) and with Silo Guard II at .5 and 1.0 lb per ton; normal moisture, control and with Silo Guard II at .5 lb per ton; and low moisture control. Silo Guard II, a commercial hay preservative from International Stock Food, Inc., was applied at the bale chamber. For the .5 lb rate, 1 lb of preservative was mixed with 1 gallon of water and the solution applied at 2 quarts per ton. For the 1.0 lb rate, 2 lb of preservative was mixed with 1 gallon of water and the solution applied at 2 quarts per ton. The high-moisture hays were baled on August 26; the medium moisture, on August 27; the normal-moisture, on August 28; and the low-moisture, on August 29.

As the bales came out of the baler, they were identified, weighed, and assigned in a randomized block design within each treatment to four groups: 1) initial, pre-storage core sampling only; 2) thermocoupling for temperature measurement only; 3) thermocoupling, post-storage core sampling, and feeding; and 4) feeding only. Procedures for thermocouple wires, temperatures, core samples, storage, transport, and visual appraisal were similar to Expt. 1.

The flaked hay from treatments 1, 2, 3, 4, 5, and 7 (Table 45.5) was ground, stored in boxes, and fed to 24 crossbred wether lambs (four lambs per treatment) in a two-period voluntary intake and digestion trial. The lambs each received 15 grams of a mineral, vitamin, and aureomycin premix daily.

Results

Experiment 1. Shown in Table 45.2 are storage losses for the six alfalfa hay treatments. Small bales had an average DM weight loss of less than 1.0% during storage. The low-moisture, large bales lost slightly over 4.0% of the initial DM, but the control and Fresh Cut® medium-moisture, large bales gained DM weight during storage. A net gain in dry weight is impossible; a weighing or analytical error(s) must have been involved. For example, a 10 lb error in initial or final bale weight would give nearly a 1.0% change in storage loss. Underestimate of initial bale DM content and/or overestimate of final bale DM content from the core samples would also cause storage losses to be incorrect.

There was no heating in any of the hay and all bale temperatures declined from the initial, post-baling readings. Visual appraisals showed no evidence of mold growth or excessive dust in any of the bales. There were no signs of discoloration (or browning) in the hays, although all medium moisture bales were somewhat greener and less stemmy than the low moisture bales.

Shown in Table 45.3 is chemical composition of the six alfalfa hay treatments. Results for the post-baling samples showed that crude protein (CP) was slightly higher in the small than in the large bales and also slightly higher in the medium-moisture than in the low-moisture bales. Similar trends occurred for cell wall (CW) contents and acid detergent fiber (ADF). The data indicate that the small bales had somewhat higher initial quality than large bales and that medium-moisture bales had somewhat higher initial quality than low-moisture bales.

Performance by lambs fed the six alfalfa hay rations is presented in Table 45.4. Lambs receiving the low-moisture, large bale hay gained slower ($P<.05$) and less efficiently ($P<.05$) than lambs receiving any of the other five hays. These results are consistent with the chemical analyses data. In general, the three small bale hay rations supported faster gains and better feed conversions than their large bale counterparts.

The medium-moisture hays treated with Fresh Cut® were consumed in greater amounts and gave better lamb performance than medium-moisture, control hays. These differences were not statistically significant. On a percentage basis, the advantage to using Fresh Cut® was greater with small bales than with large bales.

Experiment 2. The intended hay moistures at baling were 12, 20, 28, and 35% for low, normal, medium, and high moisture treatments, respectively. Core samples taken immediately post-baling showed actual moistures to be 8, 15, 33, and 39 percent.

Shown in Figure 45.1 are hay temperature changes post-baling for the nine hay treatments. Extensive heating occurred in the high and medium moisture bales. The high-moisture bale temperatures rose from a 92 F average initial to 143 F after 6 days of storage. Temperatures of the medium-moisture control and 1.0 lb Silo Guard II bales rose from a 93.8 F average initial reading to 121 F at 9 days post-baling, whereas the 2.0 lb Silo Guard II bales rose from an 89.7 F average initial to 124 F at 6 days post-baling. There was no heating above the average initial temperature in any of the normal and low-moisture hay.

Visual appraisals of the bales showed the following: 1) very extensive discoloration with heavy mold growth throughout all high-moisture bales; 2) extensive discoloration, moderate mold growth, and light dustiness throughout all medium-moisture bales; and 3) bright green color, pleasant aroma, and no mold or dust for the control and .5 lb Silo Guard II normal-moisture and control low-moisture bales. All normal moisture hay appeared to have better leaf retention than the low moisture hay. Although handling and processing (grinding) losses were not measured, the low-moisture bales were observed to have the highest leaf-shattering losses.

Shown in Table 45.5 are storage losses for the nine alfalfa hay treatments. The high-moisture bales had an average DM weight loss of 19.0% during storage, while medium-moisture bales lost an average of 3.4 percent. Although Silo Guard II did reduce losses by about 20% in the high-moisture hay, all of these bales were of unacceptable quality for livestock feed. The 2.1% DM loss in the low-moisture hay was likely the result of shattering losses, which occurred during handling and transport. Chemical composition of the six alfalfa hay treatments fed to the lambs is shown in Table 45.5. The heating that occurred in the high-and medium-moisture hays resulted in higher fiber constituents than in the normal-moisture hays. The low-moisture hay had the lowest CP, which was likely due to excessive leaf shatter during baling, handling, and processing.

Shown in Table 45.7 are voluntary intakes and digestibilities of the six alfalfa hay treatments. Normal-moisture, Silo Guard II hay had the highest ($P<.05$) intake and high-moisture control hay had the lowest ($P<.05$). Normal- and low-moisture hays had the highest ($P<.05$) dry matter and CP digestibilities. The lower dry matter and CP digestibilities for the medium-and high-moisture hays reflect the nutritive value damage that was caused by heating during storage. Silo Guard II did not affect dry matter or CP digestibilities in the medium- and normal-moisture hays. None of the hay treatments consistently affected CW or ADF digestibilities. These results show the negative effects on hay quality caused by baling alfalfa when it is too wet or too dry. It was unfortunate that intended and actual hay moistures were not in closer agreement. The preservative was not intended or recommended for 33 or 39% moisture hay. The poor quality hay obtained at these moisture levels certainly does not imply that the Silo Guard II would not have improved hay quality in 20 to 28% moisture hay.

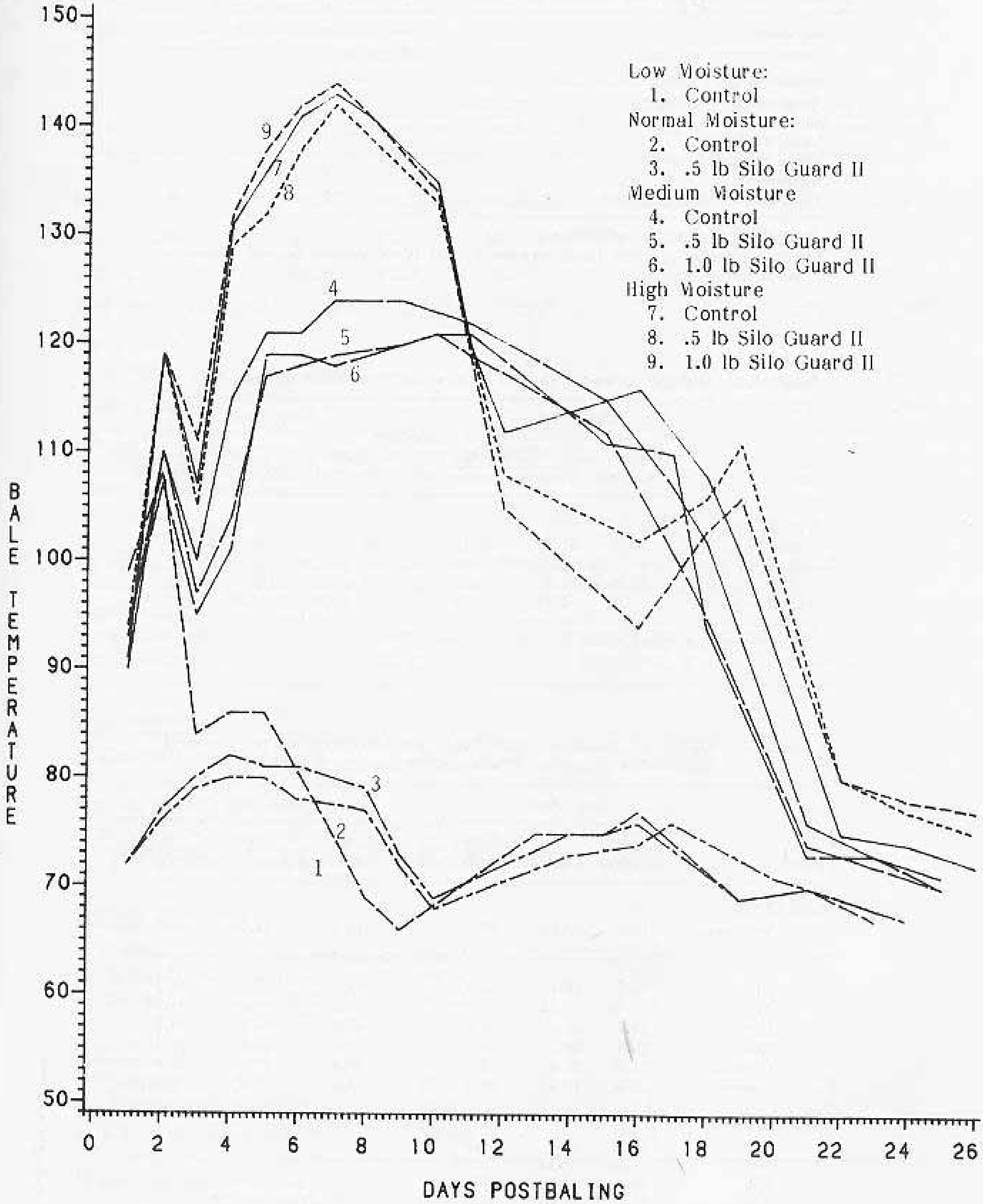


Figure 45.1. Temperature Changes for the Nine Alfalfa Hay Treatments in Expt. 2.

Table 45.1. Composition of the Supplement Fed to the Lambs in Expt. 1

Ingredient	% (as-mixed basis)
Rolled Sorghum Grain	88.2
Monosodium Phosphate	6.7
Salt	2.5
Cane Molasses	2.0
Trace Mineral Premix	.5
Aureomycin	*
Vitamin A, D, and E Premix	**

*Added to provide 20 mg/lamb/day.
**Added to provide 3,000 IU of vitamin A, 300 IU of vitamin D, and vitamin E per lamb per day.

Table 45.2. Storage Losses for the Six Alfalfa Hay Treatments in Expt. 1

	Small Bale			Large Bale		
	Moisture					
	Low	Medium		Low	Medium	
Item	Control	Control	Fresh Cut®	Control	Control	Fresh Cut®
Avg. Initial Bale Wt., lb[1]	66.1	52.1	54.2	1607	1360	1331
Avg. Final Bale Wt., lb[1]	65.8	51.5	53.9	1540	1376	1359
Wt. Change, %	-.45	-1.15	-.55	-4.18	+1.18	+2.10

[1]100% dry matter basis.

Table 45.3. Effect of Moisture, Bale Type, and Preservative on Chemical Composition of the Six Alfalfa Hay Treatments in Expt. 1

	Small Bale			Large Bale		
	Moisture					
	Low	Medium		Low	Medium	
Item[1]	Control	Control	Fresh Cut®	Control	Control	Fresh Cut®
Post-baling:						
Moisture, %	15.1	16.8	17.1	12.2	14.1	14.4
	% of the hay DM					
CP	16.2	16.4	16.8	15.9	15.9	16.2
ADIN	.16	.14	.15	.18	.18	.17
CW	43.9	42.4	38.9	47.9	46.0	44.3
ADF	37.4	36.3	34.5	39.5	38.9	37.3
Cellulose	27.0	25.0	23.7	29.9	29.8	27.4
Lignin	9.6	10.8	10.4	8.0	7.0	7.9
Post-storage:						
CP	16.1	16.6	16.4	Analyses are not completed		
ADIN	.20	.15	.16			
CW	46.2	45.2	46.5			
ADF	36.7	35.0	36.5			
Cellulose	24.2	25.4	24.5			
Lignin	12.4	10.8	11.6			

[1]CP = crude protein, ADIN = acid detergent insoluble nitrogen, CW = cell wall contents, and ADF = acid detergent fiber.

Table 45.4. Performance by Lambs Fed the Six Alfalfa Hay Rations in Expt. 1

Item	Small Bale, Low Moisture, Control	Small Bale, Medium Moisture, Control	Small Bale, Medium Moisture, Fresh Cut®	Large Bale, Low Moisture, Control	Large Bale, Medium Moisture, Control	Large Bale, Medium Moisture, Fresh Cut®
Hay DM, %	88.8	89.1	87.5	89.0	88.5	88.8
No. of Lambs	12	12	12	12	12	12
Initial Wt., lb	61.4	62.4	59.8	61.8	65.1	62.7
Avg. Daily Gain, lb	.298[a]	.288[a]	.337[a]	.213[b]	.276[a]	.298[a]
Daily Feed Intake, lb[1]	2.80	2.62	2.82	2.55	2.66	2.77
Feed/lb of Gain, lb[1]	9.46[a]	9.27[a]	8.37[a]	12.54[b]	9.75[a]	9.49[a]

[a,b]Values with different superscripts differ (P<.05).

[1]100% dry matter basis.

Table 45.5. Storage Losses for the Nine Alfalfa Hay Treatments in Expt. 2

Moisture, Treatment No., and Preservative	Avg. Intial Bale Wt., lb[1]	Avg. Final Bale Wt., lb[1]	Wt Change, %
Low Moisture:			
1. Control	28.4	27.9	-2.1
Normal Moisture:			
2. Control	62.5	63.0	+.8
3. .5 lb of Silo Guard II	61.4	61.2	-.3
Medium Moisture:			
4. Control	58.5	56.4	-3.6
5. .5 lb of Silo Guard II	58.6	56.7	-3.2
6. 1.0 lb of Silo Guard II	59.4	57.4	-3.4
High Moisture:			
7. Control	60.7	47.2	-22.2
8. .5 lb of Silo Guard II	57.0	47.6	-16.5
9. 1.0 lb of Silo Guard II	54.9	44.9	-18.2

[1]100% dry matter basis.

Table 45.6. Chemical Composition of the Six Alfalfa Hay Treatments in Expt. 2

Item[2,3]	Moisture and Preservative[1]					
		Normal		Medium		
	Low Control	Control	.5 lb of SG II	Control	.5 lb of SG II	High Control
Post-baling:						
Moisture, %	8.1	15.6	14.8	33.4	32.8	39.3
Post-storage:						
Moisture, %	10.3	11.6	12.1	13.9	14.3	16.7
	% of the Hay DM					
CP	22.1	23.5	23.4	23.4	23.9	23.7
CW	38.4	34.2	38.3	43.4	43.7	45.4
ADF	33.0	27.4	27.6	34.7	32.2	36.7
Cellulose	23.6	19.4	21.5	25.8	24.0	25.7
Lignin	8.0	7.0	7.4	8.7	7.8	8.5

[1]SG II means Silo Guard II.

[2]Post-baling analyses are not completed.

[3]CP = crude protein, CW = cell wall contents, and ADF = acid detergent fiber.

Table 45.7. Voluntary Intakes and Apparent Digestibilities of the Six Alalfa Hay Treatments Fed to the Lambs in Expt. 2

Item[2]	Moisture and Preservative[1]					
		Normal		Medium		
	Low Control	Control	.5 lb of SG II	Control	.5 lb of SG II	High Control
Voluntary Intake, lb of DM/Day	2.42^{ab}	2.39^{ab}	2.63^{a}	2.45^{ab}	2.45^{ab}	2.29^{b}
	Digestibility, %					
DM	64.4^{b}	67.7^{a}	66.2^{ab}	60.0^{c}	60.1^{c}	54.7^{d}
CP	77.2^{a}	76.8^{a}	78.4^{a}	69.3^{b}	70.7^{b}	52.5^{c}
CW	45.9^{bc}	47.5^{b}	51.3^{abc}	53.8^{a}	51.3^{abc}	53.9^{a}
ADF	51.4^{b}	50.1^{c}	50.7^{bc}	54.9^{a}	48.8^{c}	53.6^{a}

[1]SG II means Silo Guard II.

[2]CP = crude protein, CW = cell wall contents, and ADF = acid detergent fiber.

[a,b,c,d]Values with different superscripts differ ($P<.05$).

The Manhattan Weather in 1984 and 1985

L. Dean Bark[1]

The charts that follow show graphically the daily weather in Manhattan during the last 2 years. Each chart has three smooth curves to represent the average weather conditions at Manhattan based on 70 years of records from the Experiment Station files. The two smooth curves near the top of the charts show the average maximum and minimum temperatures that occur throughout the year. They reach a low point in mid-January and climb to a peak in mid-July.

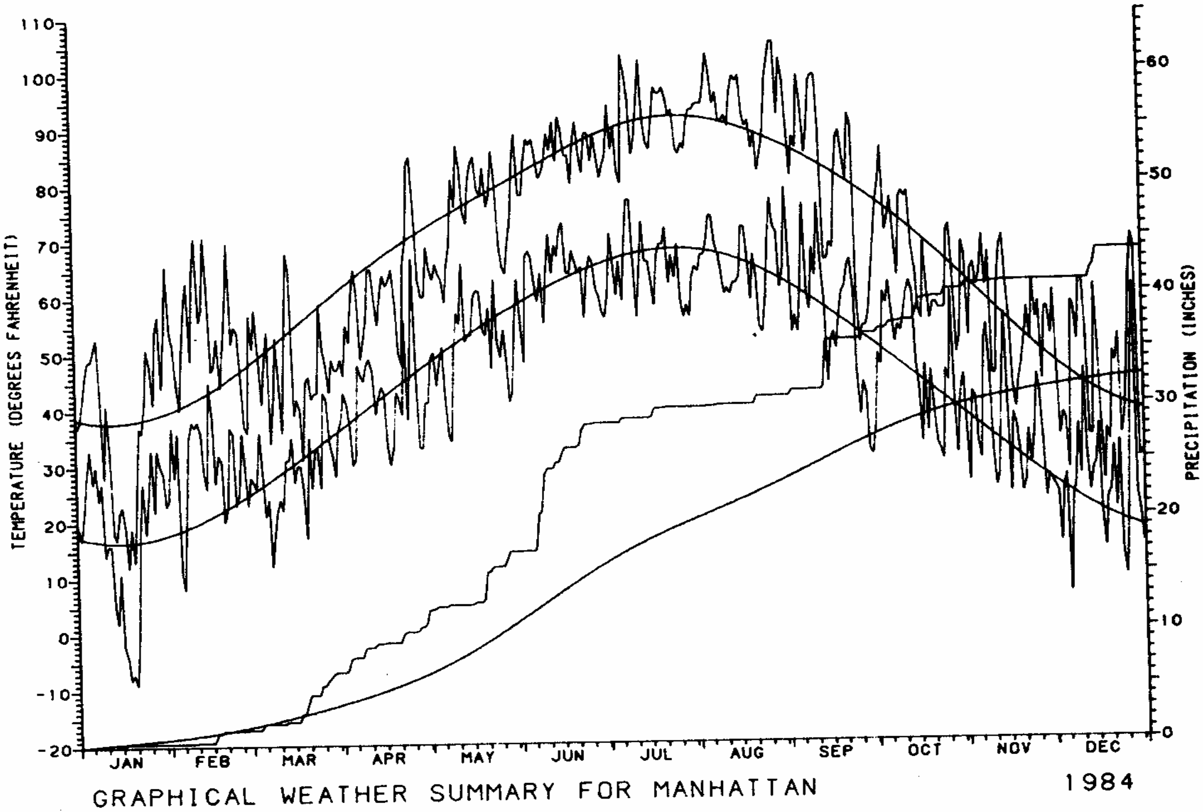
The smooth curve in the lower part of the chart indicates the average accumulative precipitation during the year. Starting at zero on January 1, it gradually increases throughout the year until it reaches the average annual total precipitation on December 31. This curve climbs quite steeply during mid-year, when considerable rain occurs in Kansas, and less steeply at the beginning and end of the year, when only small amounts of snow or rain are received.

The actual temperature and accumulated precipitation totals that occurred throughout 1984 and 1985 are also plotted on these charts so that the "weather" can be compared with the climatic averages. Note that on the actual precipitation curve, a horizontal section indicates no rain in that period, and a vertical section means that rain occurred that day.

The 1985 temperature curves show a very cold beginning to the year and a similar finish, when November mean temperatures reached a record low. In fact, above normal temperatures occurred only during March, April, and May, making the mean temperature for 1985 the third lowest since 1890. The cool temperatures during the crop-growing season kept water stress to reasonable levels. At the same time, these low temperatures slowed growth and maturation, reducing grass and forage production in mid-summer. Yields for some late-planted, or slow-maturing crops were reduced by the earlier than average freeze occurring on September 30th. In 1984, the first freeze was one day earlier, September 29.

Precipitation for 1985 was more than 5 inches above the average, but more than 5 inches below that received in 1984. Precipitation distribution was better in 1985 than in 1984, when there were many heavy rains followed by long dry periods—note June to September, 1984. Frequent rains and cloudy skies often made it difficult to perform field operations because of wet soils. Substantial rains that occurred late in September and October should have recharged the soil moisture used during the growing season.

[1]Climatologist for the Agricultural Experiment Station, Department of Physics.



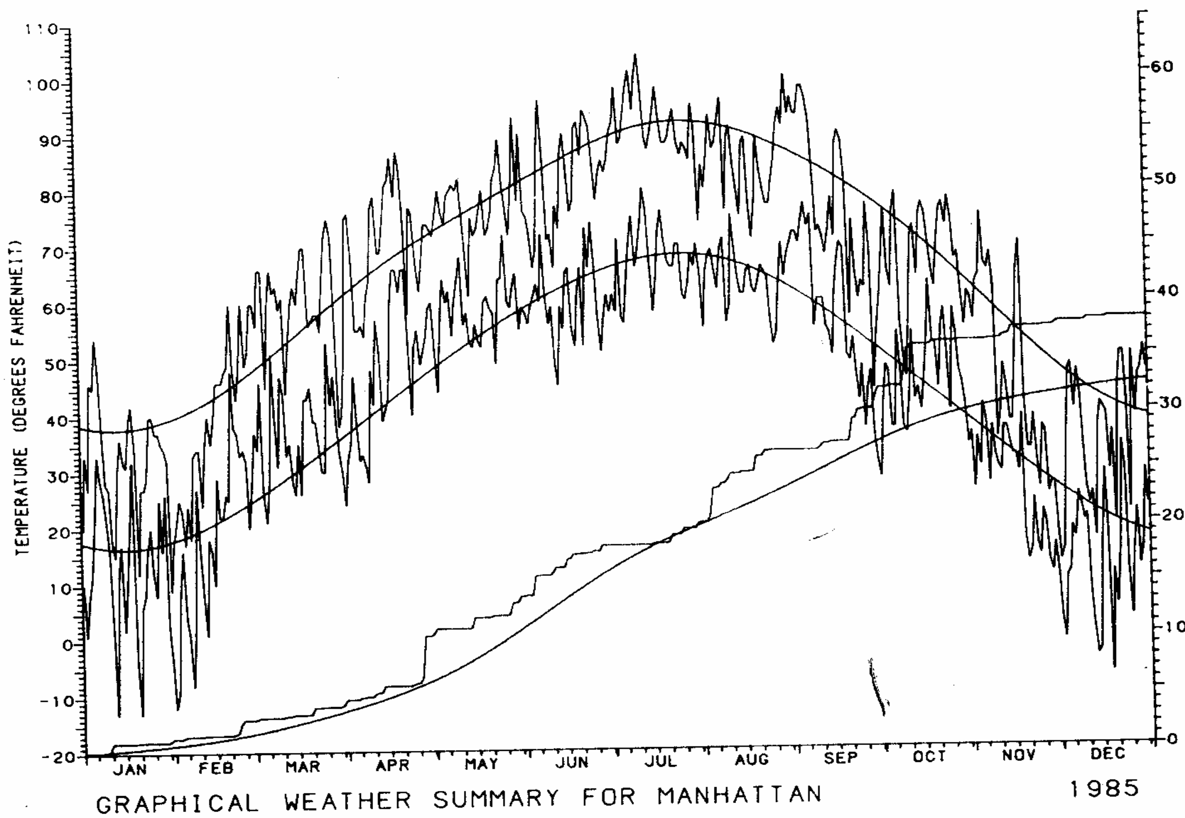


Figure 46.1. 1984 and 1985 graphical weather summary of Manhattan, Kansas. From the Kansas Agricultural Experiment Station Weather Data Library.

ACKNOWLEDGMENTS

Listed below are individuals, organizations and firms that have contributed to this year's beef research programs through financial support, product donations or services. We appreciate your help!

A. H. Robins Co.,	Richmond, Virginia
A.O. Smith harvestore Products, Inc.	Barrington, Illinois
American Hereford Association	Kansas City, Missouri
Archer Daniels Midland Company	Chicago, Illinois
David Briener	Alma, Kansas
Cadco, Inc.	Des Moines, Iowa
Center for Regulatory Services Acting for Roussel-UCLAF Corp.	Reston, Virginia
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Finnish Sugar Co., LTD	Espoo, Finland
Fourth National Bank	Wichita, Kansas
Grant County Feeders	Ulysses, Kansas
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Jorgensen Ranch	Ideal, South Dakota
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Livestock & Meat Industry Council, Inc. (LMIC)	Manhattan, Kansas
Merck & Company, Inc.	Rahway, New Jersey
New Breeds Industry Inc.	Manhattan, Kansas
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O'Neill Angus Farm	Logan, Iowa
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Ray Plumb III	Briggs, Texas
R. & J. Ranch	Briggs, Texas
Rhone-Poulenc, Inc.	Atlanta, Georgia
Roode Packing Co.	Fairbury, Nebraska
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Sanoti Sante Animale	Paris, France
Select Sires	Plain City, Ohio
Silopress, Inc.	Sioux City, Iowa
Sleutz - McAllister	Lewis, Kansas
Stauffer's Chemical Co.	Washington, Pennsylvania
Syntex Animal Health, Inc.	Des Moines, Iowa
The Upjohn Company	Kalamazoo, Michigan
Val-Agri Corp.	Wichita, Kansas
Viskase Corp.	Chicago, Illinois

Biological Variability and Chances of Error

The variability among individual animals in an experiment leads to problems in interpreting the results. Although the cattle on treatment X may have had a larger average daily gain than those on treatment Y, variability within treatments may mean that the difference was not the result of the treatment alone. Statistical analysis lets researchers calculate the probability that such differences were from chance rather than the treatment.

In some of the articles that follow, you will see the notation "$P<.05$". That means the probability of the differences resulting from chance is less than 5%. If two averages are said to be "significantly different", the probability is less than 5% that the difference is from chance -- the probability exceeds 95% that the difference results from the treatment.

Some papers report correlations; measures of the relationship between traits. The relationship may be positive (both traits tend to get bigger or small together) or negative (as one traits gets bigger, the other gets smaller). A perfect correlation is one (+1 or -1). If there is no relationship, the correlation is zero.

In other papers, you may see a mean given as $2.50 \pm .10$. The 2.50 is the mean; .10 is the "standard error". The standard error is calculated to be 68% certain that the real mean (with unlimit number of animals) would fall within one standard error from the mean, in this case between 2.40 and 2.60.

Many animals per treatment, replicating treatments several times, and using uniform animals increases the probability of finding real differences when they exist. Statistical analysis allows more valid interpretation of the results regardless of the number of animals. In nearly all the research reported here, statistical analyses are included to increase the confidence you can place in the results.

NOTICE

The Livestock & Meat Industry Council, Inc.

Dear Friends:

The Livestock and Meat Industry Council, Inc., is a unique way to promote the growth and development of our industry. One way to help yourself and the LMIC is through a "Charitable Remainder Trust." Frequently an individual or couple wishes to make a gift of property, but feels unable to give up the income produced by the property. In the case of agricultural land, income can vary with weather and markets. There is little opportunity to diversify risks, and the return can represent a relatively low percentage of the land's value--particularly when the owner's share is reduced by management fees and tenant shares. At the same time, such owners may hesitate to sell because the proceeds will be reduced by taxation of past appreciation and these proceeds unavailable for reinvestment. These problems can be overcome by making a gift of the property itself, to fund a trust that pays income for the lifetime of one or two recipients--usually including the donor. At the death of the last beneficiary, the assets remaining in the trust are used for the charitable purpose chosen by the donor. The following simplified example will explain how it works.

640 acres with an appraised value of $500/acre is given to the LMIC to establish a trust.

640 acres X $500/acre = $320,000 charitable gift for tax purposes.

Assume the donors ages are 67 and 65 years respectively and the trust will pay 8 percent.

Year 1: $320,000 X 8% = $25,600 paid to the donors.

Any money the trust earns in excess of 8 percent is added to the principal of $320,000 and the process continues.

If the farm had been earning 3 percent of its sale value the donor has more than doubled the income from the property and has derived large tax advantages.

Other types of trust are available. Many times the income from the trust is greater than the earning power of the property. For more information, contact Calvin Drake at the Department of Animal Sciences, Kansas State University.

Sincerely,

Calvin L. Drake

Calvin L. Drake
Executive Vice President

Weber Hall • Kansas State University • Manhattan, Kansas 66506

Agricultural Experiment Station, Kansas State University, Manhattan 66506

Report of Progress 494 March 1986

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