ROUNDUP 1996

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Marc A. Johnson, Director

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Statement of Purpose

Roundup is the major beef cattle educational event sponsored by the Agricultural Research Center–Hays. The 1996 program is the 83rd staging of Roundup. The purpose is to communicate timely research information to producers and extension personnel.

The research program of the Agricultural Research Center–Hays is dedicated to serving the people of Kansas by developing new knowledge and technology to stabilize and sustain long-term production of food and fiber in a manner consistent with conservation of natural resources, protection of the environment, and assurance of food safety. Primary emphasis is on production efficiency through optimization of inputs in order to increase profit margins for producers in the long term.

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Reimplanting Strategies Compliant with Precision Marketing of Feedlot Cattle[1]

John R. Brethour
Beef Cattle Scientist

Introduction

Ultrasound technology provides a method to precisely predict the optimal number of days to continue to feed feedlot cattle after reimplanting time. The technology also can be used to cluster cattle into outcome groups that will be marketed typically at monthly intervals. This has provoked a need to prescribe appropriate implanting treatments that allow for differences among response durations of different implants and interactions involving both increase in weight gain and effect on carcass quality.

Methods

In this study, 401 steers were evaluated with ultrasound at reimplanting time and clustered into three sets to be marketed in about 40, 70, and 100 days. Those steers had been on feed for about 80 days at reimplanting time and averaged about 1050 lbs. Fifty three percent were Angus, and the others were Charolais crossbreds; they were about 14 months old. They had been implanted with Ralgro at weaning and Synovex-S when placed on full feed.

Each set was divided into six groups (18 total) and assigned to one of three implant treatments (Control- no implant, Revalor-S, Synovex-S) at reimplanting on May 15. Two pen replications of 22 or 23 steers per treatment per marketing group were used. Cattle were fed a high energy ration comprised principally of rolled milo. They were slaughtered in a commercial plant, and individual carcass data were collected.

Results and Discussion

Table 1 presents the performance data. Because variability in fill drastically affects live weight gains in short-duration experiments, carcass weight (corrected for initial weight, cattle source, and initial ultrasound values) may provide the best measure of treatment response. The carcass weight response in Table 1 can be converted to live weight response by dividing by .635 (33.2 lb overall response for Revalor-S; 8.3 lb response for Synovex-S). No statistical differences occurred among total weight responses of the different marketing groups. This suggests that much of the response to implanting occurs within a few weeks. The response to Revalor-S was significantly greater ($P < .01$) than the

[1]The support from Hoechst-Roussel Agri-Vet, Somerville, New Jersey, for this study is appreciated.

response to Synovex-S. The amount of response to Revalor-S was greater than observed in many implanting trials. Possibly our cattle were at a stage of growth where they would have been most likely to benefit from implanting with trenbolone acetate. Implanted cattle ate slightly more feed, but relative improvements in feed efficiency were similar to the gain responses.

The only statistically significant ($P < .05$) treatment effects on carcass attributes were reductions in marbling score and quality grade among implanted cattle (Table 2). These analyses were performed with a statistical model that included cattle breed, initial ultrasound values, and initial weight. Animals were considered Choice if the adjusted marbling score was Small 00 or higher (our scale for marbling is 4.0 = Slight 00 and 5.0 = Small 00). The average reductions from scores of unimplanted cattle were 20 percentage points when Revalor-S was used and 8 percentage points with Synovex. The bottom two items in Table 2 summarize the final USDA grades for the cattle. Many of the Revalor-S carcasses were borderline, held for regrading, and eventually rolled Choice. The difference between the prices of Select and Choice carcasses would have to be about $12/cwt to offset the value of the 33-lb gain response from implanting (@$0.60/lb).

Components of carcass cutability (rib eye area, backfat thickness, and percent kidney heart and pelvic fat) were improved numerically by implanting, but none of those differences were statistically significant. Differences in calculated yield grade were very small. However, about 8% more carcasses were marked YG#1 and YG#2 by federal graders among the implanted cattle; that difference was not statistically significant, either.

Using ultrasound to sort the cattle into outcome groups successfully minimized YG#4 carcasses; only two occurred among the 401 cattle. Figure 1 depicts the accuracy in estimating future marbling score with ultrasound. The figure includes all cattle in the study because little difference occurred in accuracy for projections made 42, 73, or 105 days before slaughter (respective errors averaged .41, .45, and .42 marbling score units). Projections correctly classified 75% of the animals into the Select or Choice grades. If borderline (marbling scores between 4.9 and 5.1) cattle were omitted, accuracy was 83%.

Ultrasound might be used in a strategy that improves percent Choice, while still optimizing weight gain response. Table 3 shows that reduction in the likelihood of grading Choice was most prevalent among cattle that had been in the middle triad of the ultrasound marbling estimates. There seems to be a contingent of cattle that probably will never grade Choice whether they are implanted or not. Also, there is another group that will have sufficient marbling to grade Choice, even if implanted aggressively. Possibly, the ultrasound technology might be used to identify borderline candidates where implanting may be decisive in whether marbling will be sufficient by slaughter time to be in the Choice grade. A strategy might have been to refrain from implanting with Revalor-S those cattle that were in the middle ultrasound marbling groups and also in the early or middle marketing groups. Retrospectively, that would have increased Choice among the Revalor-S-implanted cattle by 9 percentage points, while reducing overall gain response by 7 lbs. In this scenario, the difference between the prices of Select and Choice carcasses would have to be $18 before the depression in carcass grade offset the advantage in gain.

Table 1. Performance response to implanting with Revalor-S or Synovex-S for 42-, 73-, or 105-day intervals from reimplanting to slaughter.

Item	Control	Revalor-S		Synovex-S	
Carcass weight, lb		Response, lb		Response, lb	
Group 1, 42 days	777.7	795.8	18.0	784.6	6.8
Group 2, 73 days	801.2	824.1	22.9	799.6	-1.6
Group 3, 105 day	793.9	816.4	22.5	804.4	10.5
Combined	790.9	812.1	21.1	796.2	5.3
Average daily gain, lb		Response, %		Response, %	
Group 1, 42 days	2.25	3.24	44.0%	2.52	11.8%
Group 2, 73 days	2.40	2.96	23.3%	2.36	-1.9%
Group 3, 105 day	2.30	2.66	15.4%	2.48	7.8%
Combined	2.32	2.95	27.4%	2.45	5.8%
Average dry matter intake, lb		Response, %		Response, %	
Group 1, 42 days	26.60	27.34	2.8%	27.10	1.9%
Group 2, 73 days	25.44	25.66	0.8%	24.89	-2.2%
Group 3, 105 day	23.21	24.00	3.4%	23.90	3.0%
Combined	25.08	25.67	2.3%	25.30	0.9%
Average lb gain/ 100 lb feed		Response, %		Response, %	
Group 1, 42 days	8.39	11.84	41.2%	9.28	10.6%
Group 2, 73 days	9.43	11.52	22.2%	9.46	0.4%
Group 3, 105 day	9.90	11.06	11.7%	10.37	4.7%
Combined	9.24	11.47	24.2%	9.70	5.0%

Table 2. Carcass response to implanting with Revalor-S or Synovex S for 42-, 73-, or 105-day intervals from reimplanting to slaughter.

Item	Control	Revalor-S		Synovex-S	
Marbling score		Response, %		Response, %	
Group 1, 42 days	5.22	5.04	-3.5%	5.20	-0.3%
Group 2, 73 days	5.57	5.13	-7.9%	5.29	-5.1%
Group 3, 105 day	5.23	5.12	-2.2%	5.24	0.2%
Combined	5.34	5.09	-4.6%	5.24	-1.8%
Percent Choice before regrading		Response, %		Response, %	
Group 1, 42 days	71.25	53.36	-25.1%	70.91	-0.5%
Group 2, 73 days	97.62	64.95	-33.5%	67.55	-30.8%
Group 3, 105 day	68.54	57.79	-15.7%	74.85	9.2%
Combined	79.13	58.70	-25.8%	71.10	-10.2%
Final USDA Choice, %		Response, %		Response, %	
Group 1, 42 days	77.85	66.40	-14.7%	82.40	5.8%
Group 2, 73 days	93.10	75.00	-19.4%	68.55	-26.4%
Group 3, 105 day	86.70	75.30	-13.1%	81.80	-5.7%
Combined	85.88	72.23	-15.9%	77.58	-9.7%
Backfat thickness, in		Response, %		Response, %	
Group 1, 42 days	0.48	0.47	-2.1%	0.45	-6.3%
Group 2, 73 days	0.45	0.43	-4.4%	0.44	-2.2%
Group 3, 105 day	0.40	0.40	-1.3%	0.41	2.5%
Combined	0.44	0.43	-2.6%	0.43	-2.3%
Rib eye area, sq in		Response, %		Response, %	
Group 1, 42 days	12.21	12.70	4.1%	12.32	0.9%
Group 2, 73 days	12.51	12.92	3.3%	12.55	0.3%
Group 3, 105 day	12.90	13.02	0.9%	13.11	1.7%
Combined	12.54	12.88	2.7%	12.66	1.0%
Kidney, heart, and pelvic fat, %		Response, %		Response, %	
Group 1, 42 days	2.15	2.10	-2.3%	2.08	-3.3%
Group 2, 73 days	2.49	2.54	1.8%	2.47	-1.0%
Group 3, 105 day	2.89	2.83	-2.1%	2.74	-5.0%
Combined	2.51	2.49	-0.9%	2.43	-3.2%
Calculated yield grade		Response, %		Response, %	
Group 1, 42 days	3.16	3.02	-4.4%	3.09	-2.2%
Group 2, 73 days	3.19	3.08	-3.6%	3.18	-0.5%
Group 3, 105 day	2.96	2.95	-0.3%	2.91	-1.5%
Combined	3.10	3.01	-2.8%	3.06	-1.4%
USDA YG#1 and YG#2, %		Response, %		Response, %	
Group 1, 42 days	46.85	58.15	24.1%	46.70	-0.3%
Group 2, 73 days	40.75	56.80	39.4%	57.05	40.0%
Group 3, 105 day	59.75	57.30	-4.1%	64.60	8.1%
Combined	49.12	57.42	16.9%	56.12	14.3%

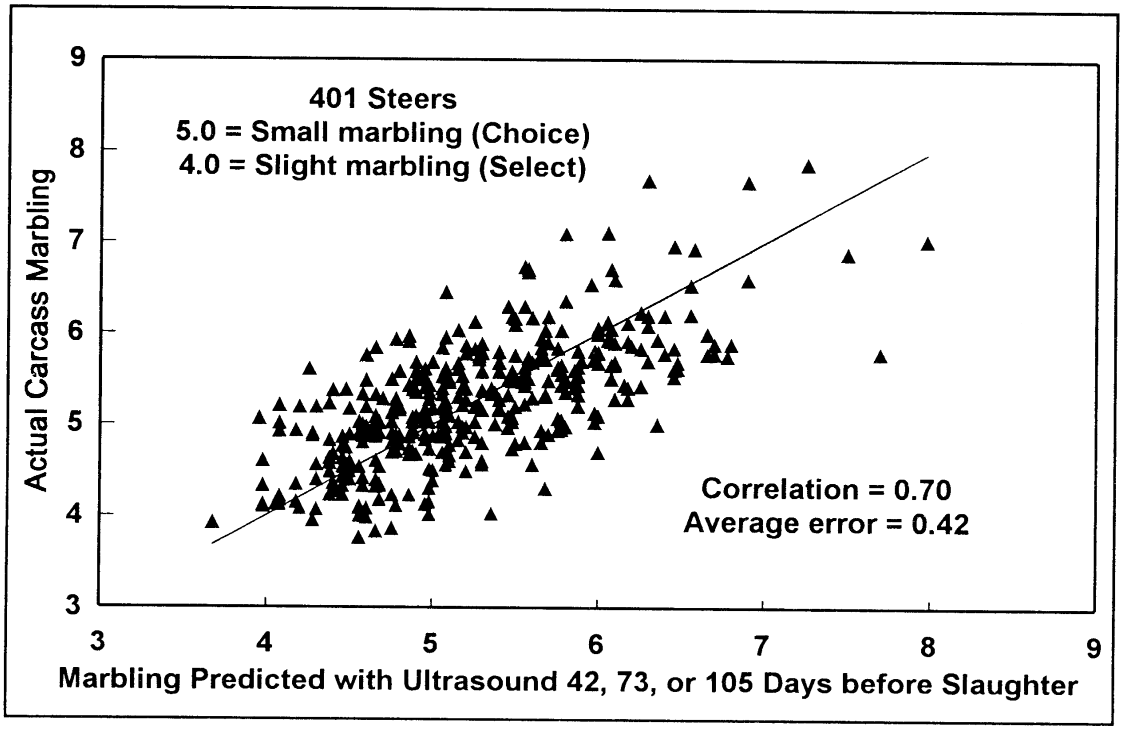

Figure 1. Accuracy of ultrasound to predict marbling 42, 73, or 105 days before slaughter.

Table 3. Percent USDA Choice by implant treatment and ultrasound marbling estimate at reimplanting time.

Ultrasound Marbling Estimate	Control	Revalor-S	Synovex-S	Average
Group 1, 42 days				
Low, < 4.6 [1]	38.5	25.0	41.2	34.9
Middle, 4.6 - 5.1	83.3	40.0	90.0	71.1
High, > 5.1	100.0	78.9	100.0	93.0
Group 2, 73 days				
Low, < 4.4	64.3	33.3	50.0	49.2
Middle, 4.4 - 4.9	100.0	61.5	57.1	72.9
High, > 4.9	100.0	92.3	100.0	97.4
Group 3, 105 days				
Low, < 4.2	46.7	47.1	43.7	45.8
Middle, 4.2 - 4.7	86.7	83.3	76.9	82.3
High, 4.7	100.0	92.9	100.0	97.6

[1] 5.0 = Small marbling (Choice); 4.0 = slight marbling (Select)

Comparison of Antibiotic Feed Additives for Stocker Cattle in West-Central Kansas

Eric S. Vanzant
Range Scientist

Introduction

Antimicrobial feed additives are used in ruminant feeds because of their ability to improve animal gain and feed efficiency. These antimicrobials can be categorized into ionophore and non-ionophore antibiotics based on their mode of action. Rumensin® and Bovatec® are ionophore antibiotics that have enjoyed widespread use in ruminant feeding. Gainpro™ is a relatively new antibiotic to the ruminant market in the U.S. and is classified as a nonionophore antibiotic. However, it has some ruminal effects similar to those of ionophores and, thus, might be expected to exert similar effects on animal performance. Although considerable amounts of research have been conducted to evaluate the effects of Rumensin® and Bovatec® on grazing cattle performance, relatively little information is available to document the efficacy of these products for cattle grazing shortgrass range. Furthermore, published research evaluating the effects of Gainpro™ on the performance of grazing cattle is very limited. This experiment was conducted to determine the influence of these three antibiotics on gains of stocker cattle grazing native shortgrass range during the summer.

Methods

Eighty yearling, crossbred, steer calves were used in this study. All steers had received vaccinations for clostridia (7-way), IBR, BVD, PI_3, and BRSV in the previous fall. In mid-April, each steer was weighed, vaccinated for *Haemophilus somnus* and *Pasturella haemolytica*, and treated with a wormer (5 mg fenbendazole/kg BW) and fly-control bolus (4.75 g diflubenzuron/steer). Steers were sorted into eight experimental groups (10 steers per group) which were balanced for weight, winter gain, and source. Groups were assigned randomly to receive one of four supplemental treatments for the duration of a 140-day grazing season. All supplements included 30% soybean meal and 70% sorghum grain (as-fed basis) to provide a final crude protein concentration of 20% and were fed daily at 2 lb per steer. Treatments were: 1) no additive (control), 2) 20 mg of Gainpro™ per steer daily, 3) 200 mg of Bovatec® per steer daily, and 4) 150 mg of Rumensin® per steer daily.

Dominant grass species in the experimental pastures included buffalograss (*Buchloe dactyloides*), blue grama (*Bothriochloa gracilis*), and western wheatgrass (*Agropyron smithii*). Other species present included various forbs, sedges (*Carex* spp.), and miscellaneous grasses that were predominantly cool-season annuals.

Steers were implanted with Synovex-S®, and initial weights for the experiment were obtained on 3 May, 1995, after steers had been grazing the experimental pastures (without supplementation) for a period of 13 days to minimize effects of previous diet on shrunk weight. Subsequent weight measurements were obtained at 28-day intervals. All weights were taken following an overnight stand (approximately 17 h) without access to feed or water. Steer groups were rotated through the pastures (31 to 36 acres each) every 2 weeks, in order to minimize pasture effects on steer gains. During the first two rotations, corresponding to 27 and 55 days after the initial wormer treatment, all steers received additional treatment with fenbendazole.

Results and Discussion

Despite an abundance of rainfall during May, the remainder of the summer was very dry (Figure 1), necessitating termination of the study after 112 days, at which time steers were removed from pastures. The precipitation pattern resulted in large production of cool-season grasses in the spring (including western wheatgrass and annual grasses) and less than normal production of warm-season grasses, creating a shortage of available forage in late summer. No sickness was observed in any of the steers throughout the experiment. Gains across the experimental period were somewhat erratic. Rotating groups through the pastures every 14 days exposed each group to two pastures during each 28-day weighing interval. Although patterns of weight gain across periods were partly functions of pasture, no consistent effects of pasture could be detected. Additionally, each group was exposed to all pastures by the end of the experiment, so that pasture effects on 112-day weight gains were minimal. Both the Bovatec®- and Rumensin®-supplemented groups experienced a trend for lower weight gains in the second 28-day period, as compared with the other two groups. Unusually low gains by the Bovatec®-fed steers during the second 28-day period were compensated for during the third period, when gains tended (P = .11) to be greater for all groups receiving feed additives than for the control group. By the end of the third 28-day period, cumulative gains tended (P = .16) to be greater for Rumensin®- and Gainpro™-supplemented steers than for control steers, whereas gains by Bovatec®-supplemented steers tended to be intermediate between these two extremes. No differences (P = .50) in gains were noted during the final 28-day period, so that cumulative weight gains across the 112-day study displayed the same trends as gains at the end of the third period. Average daily gains for treatment groups across the 112 days of the experiment were 1.74, 2.09, 1.90, and 2.12 lb per day for control, Gainpro™, Bovatec®, and Rumensin®, respectively.

Conclusions

For steers grazing native shortgrass prairie in west-central Kansas during the summer, a daily supplement with addition of an antibiotic feed additive tended to improve gains by .3 lb/day relative to a supplement with no feed additive. Gains by steers supplemented with 200 mg/d of Bovatec® were intermediate between those of control steers and those of steers supplemented with either 20 mg/d of Gainpro™ or 150 mg/d of Rumensin®.

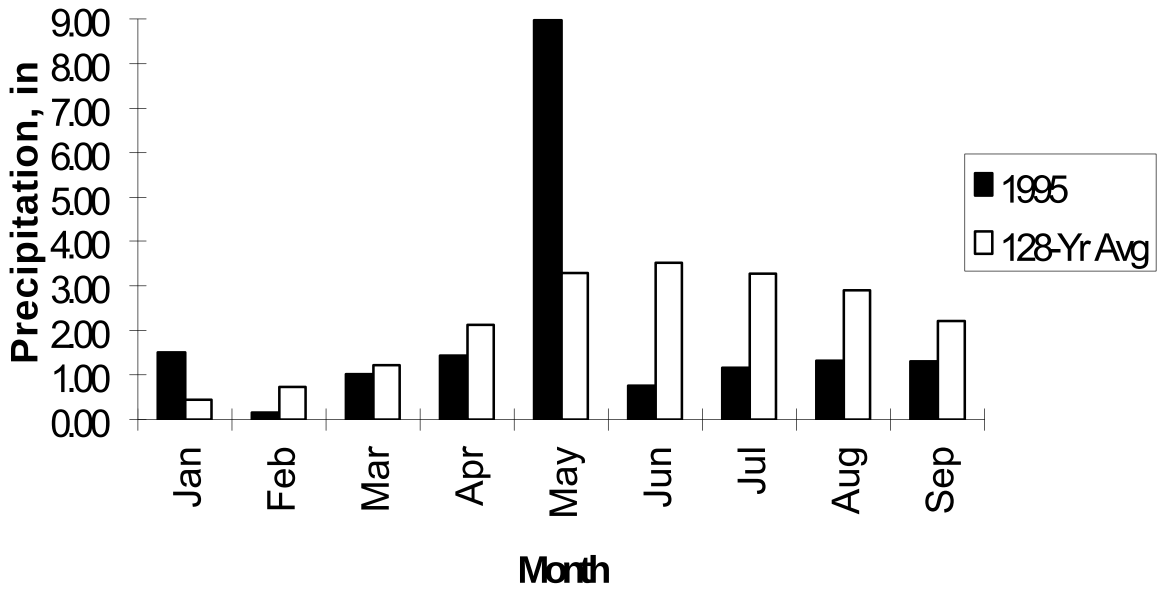

Figure 1. Monthly precipitation at Hays, KS during 1995 compared with 128-yr average monthly precipitation.

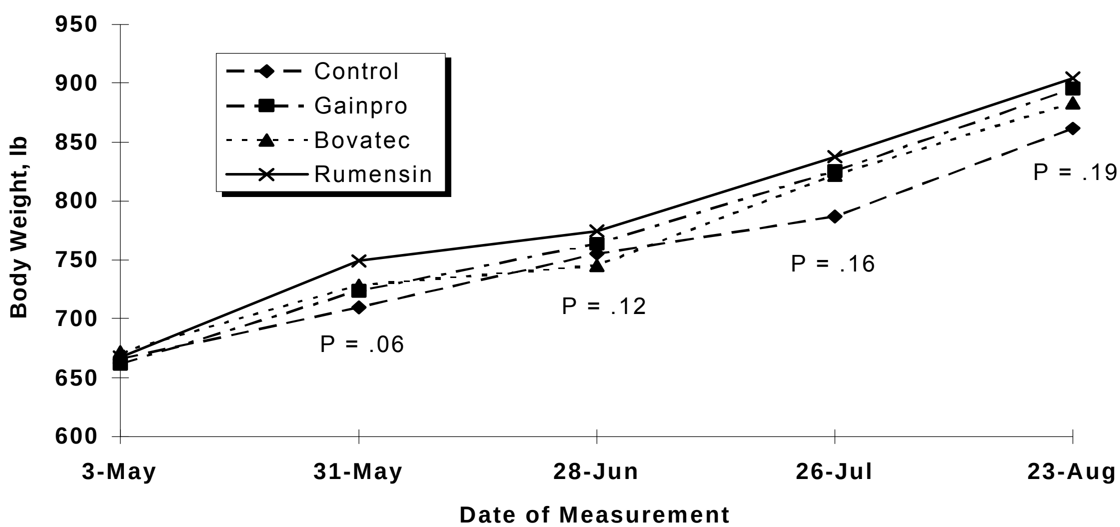

Figure 2. Growth of steers consuming 2 lb/day of supplement containing no additive (control) or one of three antibiotic feed additives.

Effect of Urea Level in Protein Supplements on Performance of Cows Consuming Low-Quality Forage Sorghum Hay

Eric S. Vanzant
Range Scientist

Introduction

Recent research from Kansas State University has demonstrated the importance of ruminally degradable intake protein (DIP) for stimulating intake and digestion of low-quality forages. Because of various environmental and management factors, forage sorghum hay is often deficient in DIP, as well as total crude protein (CP), for beef cows. Provision of DIP can increase the efficiency with which these low-quality forages are converted into animal products. Nonprotein nitrogen sources (e.g., urea) offer inexpensive alternatives to DIP. Early research indicated that nonprotein nitrogen was utilized inefficiently when fed with poor-quality forages. However, recent ruminal-infusion studies conducted at KSU have indicated that up to half of the supplemental DIP can be replaced by urea for cattle consuming low-quality forages, with minimal influence on forage intake, ruminal fermentation, or digestion. However, these studies did not address potential effects of urea on supplement acceptability or animal performance. Therefore, in this experiment, we examined effects of increasing amounts of urea provided during the prepartum phase on supplement consumption and performance of spring-calving beef cows consuming low-quality forage sorghum hay.

Methods

On December 2, 1994, 120 spring-calving, crossbred, beef cows (average initial weight = 1098 lb; average initial body condition = 4.6 on a 1 to 9 scale) were assigned to eight groups of 15 cows each. Groups were balanced for average weight and body condition, genotype, previous experimental treatment, and age. These groups were assigned randomly to one of four treatments: 1) no supplemental urea, 2) urea to provide 20% of supplemental DIP (15% of supplemental CP), 3) urea to provide 40% of supplemental DIP (30% of supplemental CP), and 4) urea to provide 60% of supplemental DIP (45% of supplemental CP). All supplements were formulated to contain 30% CP and a nitrogen:sulfur ratio of 10:1 (Table 1). The amount of DIP provided by the supplements had been determined in a previous study to maximize digestible organic matter (OM) intake of low-quality forage (11% or greater of projected digestible OM intake). In order to provide these levels of DIP, supplements were fed to provide 1.4 lb CP and a minimum of 1.0 lb DIP. Cows were placed in drylot pens and consumed large round bales of forage sorghum hay from bale feeders on an ad libitum basis. Chemical composition, intake, and digestibility of the forage sorghum hay were determined previously in a confinement digestion study with steers (Table 2). Cows were fed supplements in concrete bunks once daily from December 3 until February 1. No problems were noted with consumption of any of the supplements, all of which were consumed completely within approximately 30 min. On February 1, all cows were moved to a single calving pasture, and all groups were treated similarly thereafter. Postpartum diets included ad libitum forage sorghum hay and sufficient supplemental protein and energy to meet NRC (1984) requirements for postpartum cows.

Cows were weighed and scored for body condition (1 - 9 scale; average score of two trained individuals) at the beginning of the experiment, at monthly intervals during the supplementation period, just after calving, at the beginning of the breeding season, at the time of pregnancy diagnosis in mid-August, and at weaning in early October. All weights were obtained following an overnight stand (approximately 17 h) without access to feed or water. Calves were weighed at birth and at weaning.

A two-shot $PGF2_{\alpha}$ system was used to synchronize estrus in the cows. Cows displaying standing heat following either injection (given across an 11-d interval) were bred by artificial insemination. Cows then were moved to one of two summer pastures (groups within each pasture were represented evenly by each experimental group) and were pasture-mated to two bulls within each pasture for the remainder of the 60-day breeding season.

Results and Discussion

Although treatments were discontinued after calving, treatment effects on body weight (Figure 1) were evident through weaning. Linear depressions ($P \leq .06$) in weight gain in response to increasing urea level were evident after 2 months of receiving the treatment supplements, at the beginning of the breeding season, and at the time of pregnancy diagnosis in mid-August. By weaning time, a quadratic effect ($P = .01$) was apparent, resulting from approximately 20 lb less weight gain by cows receiving the 60% treatment, compared to cows on the other three treatments. Body condition changes were somewhat erratic (Figure 2) across the duration of this experiment. However, a consistent trend was evident, in which the high level of urea (60% of DIP) promoted less body condition increase than the other treatments. By mid-August, treatment effects were still evident (linear, $P = .07$), with cows from the 60% treatment displaying an average of about .25 units less cumulative condition gain than cows on the other three treatments. Treatments did not significantly affect calf performance or reproductive performance of the cows (Table 3).

Although supplements were consumed readily by cows in this experiment, in a similar experiment conducted on beef cows grazing dormant, tallgrass-prairie forage, many cows would not eat the 60% supplement. Small differences in ingredient composition of the supplements could explain differences between the experiments, although drylotting the cows in the present experiment may have promoted complete supplement consumption. Although reproductive performance was not depressed significantly, the lower weight and condition gains observed through late summer raise concerns with high levels of urea (60% of supplement DIP) in precalving supplements.

Conclusions

Results from this study and a companion study conducted with cows grazing in the Flint Hills suggest that levels of urea in precalving supplements for cows consuming low-quality forages should not exceed 40% of the supplemental DIP. Because of potential for excessive levels of ruminally degradable protein to adversely affect reproduction during the postcalving period, these results should not be extrapolated to that situation.

Table 1. Amount of supplemental ingredients (grams of DM) fed per cow daily

	Supplemental DIP from Urea, %			
Ingredient	0	20	40	60
44% Soybean meal	1181	948	710	477
Sorghum grain	813	1010	1214	1411
Cane molasses	113	113	113	113
Sodium chloride	34	34	34	34
Dicalcium phosphate	23	23	23	23
TM premix	4.5	4.5	4.5	4.5
Sulfur	4.5	5.3	6.0	6.8
Urea	0	35	70	104

Table 2. Quality and composition of forage sorghum hay.

Item	Amount
Voluntary intake, % of body weight[a]	1.65
Dry matter digestibility, %[a]	53.5
Dry matter, %	90.0
---% of Dry Matter---	
Organic matter	90.1
Crude protein	4.0
Acid detergent fiber	36.2
Neutral detergent fiber[b]	61.3
Acid detergent lignin	4.5

[a]Measured in previous experiment, using 310 kg steers fed forage sorghum hay and mineral supplement, and no protein or energy supplements.
[b]Ash-free.

Table 3. Calf performance and reproductive performance of cows as affected by increasing amount of supplemental urea.

	Supplemental DIP from Urea, %					Effects[b]	
Item	0	20	40	60	SE[a]	L	Q
Calf birth wt, lb	85.5	82.2	87.7	81.1	1.46	.31	.31
Calf weaning wt, lb	550	530	555	539	12.8	.91	.87
Calf ADG, birth-weaning, lb	2.20	2.12	2.18	2.12	.055	.45	.89
Standing heat, %[c]	65.5	71.4	60.0	62.1	-	.35	.63
Conception to AI, %[d]	38.1	40.1	28.1	33.2	-	.59	.83
Total pregnancy rate, %	96.4	96.4	96.4	92.6	-	.48	.59

[a] Standard error of the mean (n=2).
[b] Probability of a greater F-value, L = linear effect, Q = quadratic effect, C = cubic effect of supplemental urea level.
[c] Cumulative percentage displaying standing heat and bred by artificial insemination within 6 d following each of the two injections of PGF2 $_{\alpha}$.
[d] Percentage of all cows within a treatment conceiving to artificial insemination.

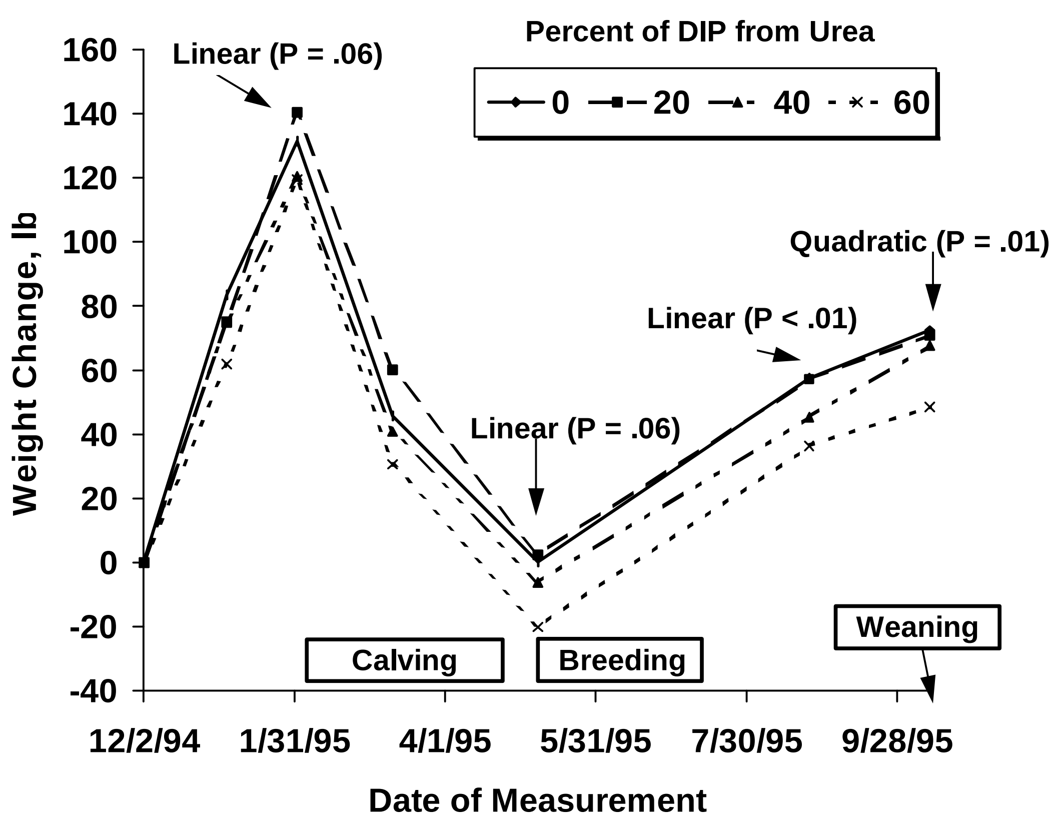

Figure 3. Influence of level of urea on body weight change of cows. Initial weight = 1099 lb.

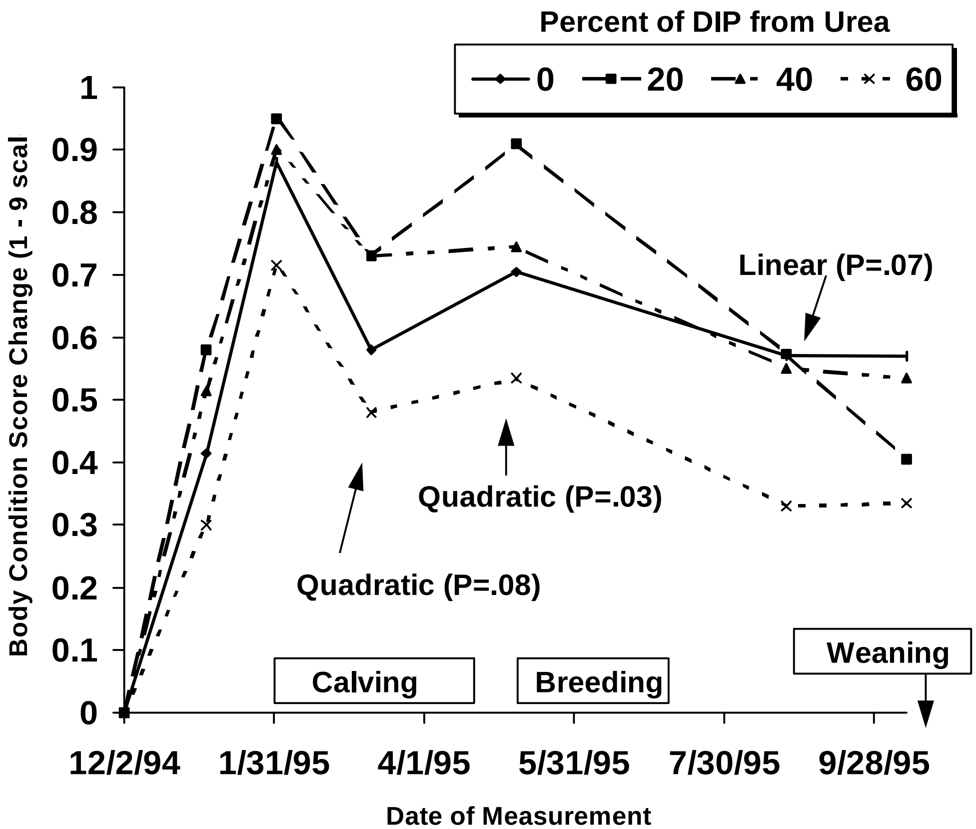

Figure 4. Influence of level of supplemental urea on body condition changes in cows. Initial body condition = 4.6.

Effect of Increasing Level of Wheat Middlings on Intake and Utilization of Forage Sorghum Hay

Brian L. Miller, Eric S. Vanzant, Danny D. Simms, K.C. Olson, and Bob Cochran
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Introduction

At particular times in the production cycle of beef cows, increasing dietary energy supply while providing the bulk of the diet from relatively inexpensive forage sources may be necessary. Traditionally, we have looked to grain-based supplements to provide this additional energy. However, grains possess the majority of their energy as starch, and high levels of starch can interfere with ruminal digestion of forage. Thus, supplemental energy sources that are comprised predominantly of fiber may offer benefits when the energy needs of cows cannot be met by forage alone. Wheat middlings generally contain much of their energy as highly digestible fiber and have ample protein concentrations to serve as sources of supplemental protein, as well. However, they also may have substantial amounts of starch, making it difficult to predict how they will interact with ruminal microorganisms to affect forage utilization. This experiment was conducted to evaluate the influence of increasing levels of wheat middlings on the intake and utilization of forage sorghum hay by beef cattle.

Methods

Sixteen ruminally fistulated steers (average weight = 937 lb.) were used in this experiment. The steers were housed in a partially enclosed barn and fed in individual pens with free access to water and a salt/trace mineral mix. Steers were stratified by weight and allotted to one of four treatments, such that treatments were represented equally by the four weight blocks. Treatments included 0, 4, 8, or 12 lb of wheat middlings (WM) daily. Forage sorghum hay and WM (composition of feedstuffs shown in Table 1) each were fed once daily at 0600. To allow ample opportunity for selective feeding, steers were offered hay at 150% of their average intake over the last 5 days of the adaptation period. After 12 days of adaptation to the dietary treatments, voluntary forage intake was measured for 7 days. The following 6 days were used to measure total fecal output using fecal bags fitted to the steers. After the fecal collection period, ruminal fermentation profiles were determined by sampling ruminal fluid at 3-hour intervals for 12 hours. These samples were analyzed for pH, volatile fatty acid (VFA) concentrations, and concentrations of ammonia.

Results and Discussion

Forage intake (Table 2) by the control group (those receiving 0 lb WM) was lower than expected, based on a previous study with forage sorghum hay of much lower protein content than that used in the present experiment. In the previous experiment, forage sorghum containing 4% crude protein was consumed at 1.65% of body weight compared to 1.66% of body weight in the present study. Previous research would lead us to expect greater voluntary intake of forage containing 9% as opposed to 4% crude protein. Ruminal fermentation characteristics, discussed below, may offer some insight into the relatively low intakes in this experiment. Increasing the level of WM from 0 to 12 lb resulted in a linear depression ($P < .01$) in forage intake. The trend ($P = .10$) toward a cubic response for forage intake is indicative of the tendency of the response to remain fairly level from 0 to 4 pounds of WM and to drop precipitously with additional increments of supplement. For each pound of WM consumed above 4 lb, forage intake declined by 1 lb. This 1 to 1 trade-off of forage intake for WM intake resulted in a fairly constant intake of total dry matter (DM) when 4 or more pounds of WM were fed. Because the WM were more digestible than the forage, apparent DM digestibility and intake of digestible DM increased linearly ($P \leq .02$) with increasing WM. Digestibility of NDF was unaffected by level of WM. Whereas we would expect dilution of the diet with a highly digestible fiber source to increase NDF digestibility, the decreasing ruminal pH (Linear, $P = .03$; Table 3) with increasing level of WM likely inhibited ruminal fiber digestion. Ruminal pH values were surprisingly low on all treatments. Typically, we would expect pH values on a 100% forage diet to be in the range of 6.5 to 7.0, rather than 6.0 as measured for the control treatment in this experiment. However, these pH values are in agreement with the high ruminal VFA concentrations measured for all treatments. Whether the high acid concentrations were functions of rapid fermentability or compromised ruminal buffering or absorption cannot be determined from these data and warrants further investigation. Neither total VFA concentrations nor the proportion of acetate to propionate was affected by level of WM ($P > .11$). Molar proportions of acetate declined with increasing WM, whereas proportions of C-4 and C-5 VFA increased. This pattern has been observed in studies in which protein supplements were added to forage diets, and is likely a response to the increased levels of protein provided by the WM.

Conclusions

Although increasing the amount of WM offered with moderate-quality forage sorghum hay stimulated consumption of digestible DM, incremental increases in WM above 4 lb resulted in substantial reductions in forage intake. Thus, although we would expect improvements in animal performance with increases in WM supplementation up to 12 lb, these benefits come at the expense of hay consumption. The relatively low ruminal pH and high VFA concentrations in this experiment likely exacerbated the intake and digestibility responses and warrant further evaluation.

Table 1. Composition of forage sorghum hay and wheat middlings.

Component	Forage Sorghum Hay	Wheat Middlings
	--------------------% of dry matter---------------------	
Crude protein	9.2	15.3
Acid detergent fiber	41.4	10.7
Neutral detergent fiber [a]	63.1	39.2
Starch	-	28.1

[a]Ash-free.

Table 2. Influence of increasing levels of wheat middlings on DM intake and digestibility.

	Level of Wheat Middlings, lb/day					Effects[a]		
Item	0	4	8	12	SEM[b]	L	Q	C
DM intake, % of body weight								
Forage	1.66	1.71	1.13	.88	.12	<.01	.23	.10
Supplement	-	.35	.74	1.15	-	-	-	-
Total	1.66	2.06	1.87	2.03	.12	.12	.35	.11
Digestible DM	.85	1.18	1.19	1.28	.08	<.01	.15	.32
Digestibility, %								
DM	50.6	57.9	64.8	62.6	3.4	.02	.19	.57
NDF	56.7	60.7	59.9	55.4	4.1	.80	.32	.96

[a] Probability of a greater F-value. L = linear response; Q = quadratic response; C = cubic response to increasing level of wheat middlings.
[b] SEM = standard error of the mean (n = 4).

Table 3. Influence of increasing levels of wheat middlings on ruminal fermentation.

	Level of Wheat Middlings, lb/day					Effects[a]		
Item	0	4	8	12	SEM[b]	L	Q	C
pH	6.01	5.94	5.63	5.68	.11	.03	.61	.26
NH_3, mM	1.69	1.92	3.97	4.48	.46	<.01	.77	.13
VFA, mM	120.2	119.9	126.2	130.2	7.43	.30	.77	.80
Acetate:Propionate	4.15	3.93	4.28	3.95	.16	.73	.76	.11
---------------------------------------moles/100 moles---------------------------------------								
Acetate	73.0	70.8	69.0	67.3	.9	<.01	.79	.97
Propionate	17.6	18.1	16.2	17.2	.5	.18	.63	.04
Butyrate	6.7	8.7	11.5	11.8	.7	<.01	.29	.32
Isobutyrate	.8	.6	.8	.9	.08	.37	.13	.23
Valerate	.5	1.0	1.1	1.3	.09	<.01	.80	.91
Isovalerate	1.0	.8	1.5	1.6	.1	<.01	.40	.05

[a] Probability of a greater F-value. L = linear response; Q = quadratic response; C = cubic response to increasing level of wheat middlings.
[b] SEM = standard error of the mean (n = 4).

Influence of Dietary Flushing Using Wheat Middlings on Performance of Thin Postpartum Beef Cows

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Introduction

Previous research has shown that cows in poor body condition (BC) at calving exhibit poor reproductive performance in the subsequent breeding season. Furthermore, it is difficult for a cow to gain condition during the interval from calving to the beginning of breeding because of the energy demands of lactation. Little research has been done to evaluate the ability of dietary flushing before breeding to improve reproductive performance of thin (BC $\leq$ 4) beef cows, and most of the available research has focused on the use of grain- based diets.

The state of Kansas produces a significant amount of wheat middlings as by-products of the flour milling process. Wheat middlings possess a substantial amount of energy in the form of highly digestible fiber, in contrast to grains, in which the majority of the energy comes from starch. Because starch-based supplements can depress forage utilization in ruminants, wheat middlings may provide an opportunity to increase the energy supply to beef cows consuming forage-based diets.

The purpose of this study was to evaluate reproductive performance, weight gain, and body condition changes in thin postpartum beef cows fed wheat middlings at two levels beginning thirty days before the start of the breeding season.

Methods

Fifty-two crossbred cows (average initial weight = 924 lb; average initial body condition = 4.2 on a 1 to 9 scale) were allotted to four groups (13 cows/group) equalized for calving date, calf sex , body weight, and body condition score. Each group was assigned to one of four, 40-acre, native grass pastures after calving. Each group had ad libitum access to forage sorghum hay (11.5 % crude protein; 39.1 % acid detergent fiber), water, and a salt/mineral mix. After calving, all groups were given 6 lb of wheat middlings (WM; 15.3 % crude protein; 39.2% neutral detergent fiber; 28.1% starch) in a pelleted form once daily in the morning. Beginning 30 days before the start of artificial insemination (AI), two of the four groups received 12 lb of WM per head per day (FLUSH). The remaining two groups continued to receive 6 lb of WM per head per day (CONTROL). Supplementation was continued for 6 days after the initiation of AI. Cows were weighed and scored for BC at calving, 30 days before and at the start of AI, at the time of pregnancy determination, and at weaning. At 10-day intervals beginning 50 days after calving, blood samples were taken to determine cyclicity in cows. Cows with serum progesterone levels $\geq$ .5 ng/mL were considered to be cycling. Prostaglandin ($PGF_{2\alpha}$) was used to synchronize estrus. Cows that did not display standing estrus following the first injection received a second injection 10 days later. Cows displaying standing estrus following either injection were bred by AI 12 h after observation of standing estrus. Following the AI period, cows were placed in a single, native-grass pasture with other, similar cows (stocking rate of approximately 8 acres/pair) and serviced by mature bulls at a ratio of one bull/32 cows. The breeding season (AI + natural service) lasted 60 days. Pregnancy rates were determined by rectal palpation in late August. Milk production data were collected by the weigh-suckle-weigh technique at 30, 70, and 150 days after calving.

Results and Discussion

Feeding high levels of WM did not influence weight gain ($P \geq = .32$; Fig. 1) or BC score changes ($P \geq .96$; Fig. 2) at any time during the experiment. Numerical trends in weight change followed the expected patterns, with cows receiving the FLUSH treatment losing about 17 lb less body weight by the beginning of the breeding season compared with cows receiving the CONTROL treatment. If the energy from the additional 6 lb of WM had been supplied in an additive manner, we should have obtained a larger weight response than measured in this experiment. These data suggest that forage intake and(or) digestibility were supressed when WM were fed at a high level. During the period from weaning to breeding, all cows were treated similarly; thus, minor differences noted in weight responses diminished following breeding.

Despite the numerical trends in weight changes, BC and reproductive performance (Table 1) of the cows did not benefit from the FLUSH treatment. The percentage of cows cycling at the start of breeding was less ($P < .05$) for FLUSH than for CONTROL, and first service conception rate was lower ($P \leq .10$) for cows receiving the FLUSH treatment. Only one of six cows exposed to AI on the FLUSH treatment conceived to first AI compared to five of eight cows exposed in the CONTROL group. Total pregnancy rate (AI + natural service) was not affected by treatment ($P = .55$). Research with dairy cows has implicated high levels of ruminally degradable protein as a potential cause of diminished reproductive performance. The relatively high levels of protein consumed by the cows on the FLUSH treatment could have had an adverse effect on reproductive performance, although further investigations are necessary to substantiate this possibility.

Previous research has demonstrated a tendency for increased dietary energy during the early postpartum period to result in increased milk production. This response was seen at 30 days after calving, when cows from the FLUSH treatment were producing about 3 lb/day more milk ($P = .06$) than those from CONTROL. However, this difference was fairly short-lived and had dissipated by 70 days postcalving when average milk production was actually slightly lower, numerically, for cows on the FLUSH treatment than for CONTROL cows. The minor differences in milk production were not sufficient to translate into calf gain response, because no treatment effects ($P \geq .62$) were found for calf weaning weights or average daily gains.

Conclusions

Beef cows that were thin at calving and 30 days before the start of breeding did not respond to supplementation with high levels of WM. Cows consuming forage sorghum hay on an ad libitum basis and receiving 12 lb of WM for 30 days before breeding exhibited similar weight and BC changes and somewhat poorer reproductive performance compared to cows recei ving 6 lb of WM during the same time period.

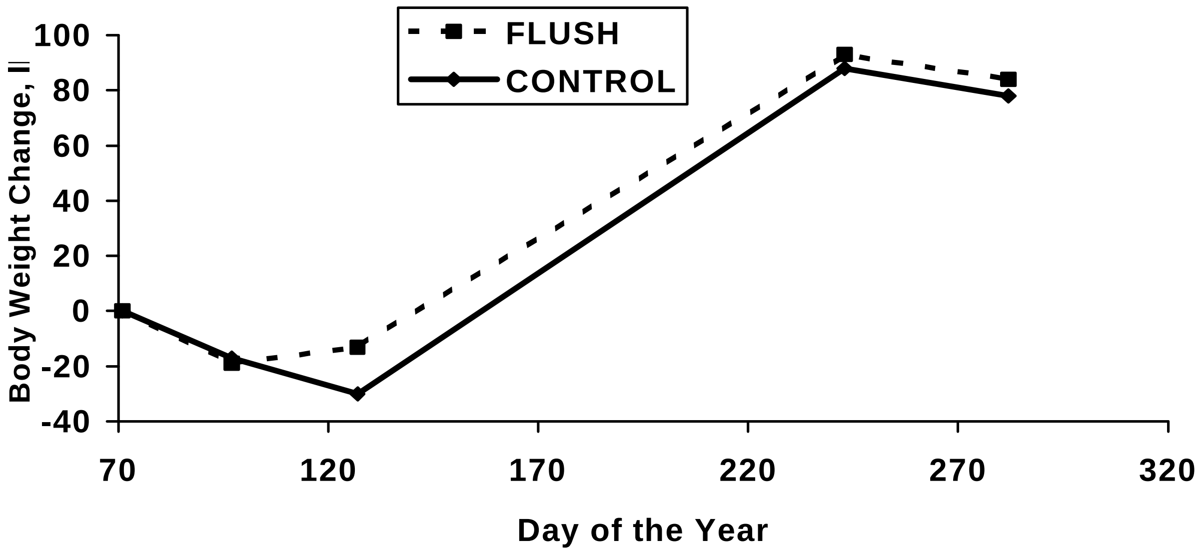

Figure 1. Influence of prebreeding supplementation with wheat middlings on cow body weight change. Average initial body weight = 924 lb. CONTROL = 6 lb WM per cow per day; FLUSH = 12 lb WM per cow per day. Calving = d 71, beginning of FLUSH treatment = d 97, start of breeding season = d 127, pregnancy checking = d 243, weaning = d 282.

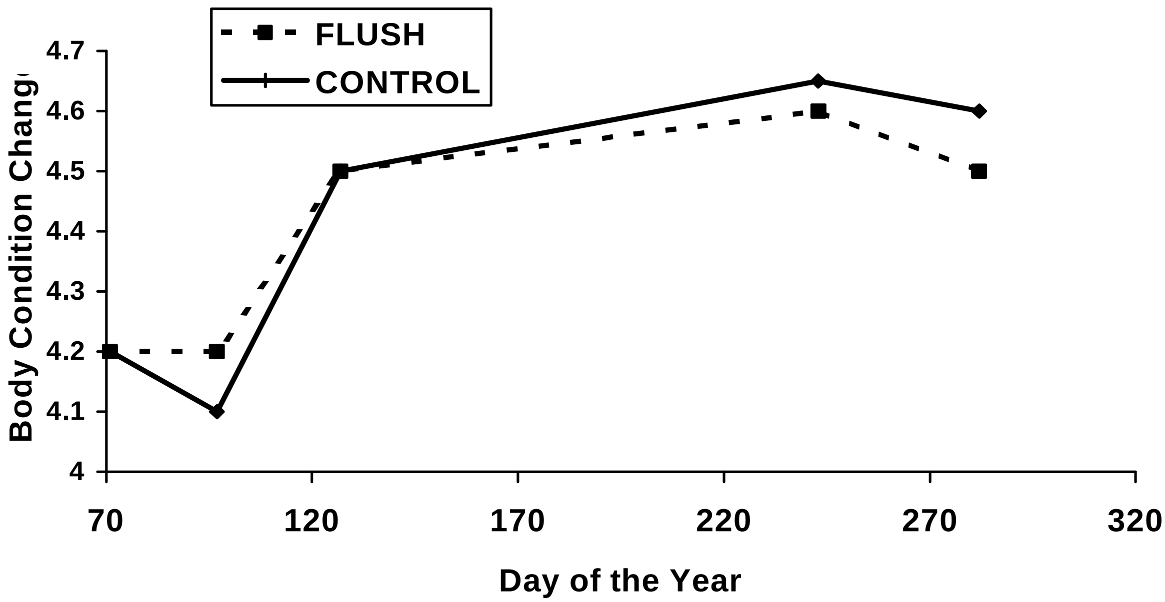

Figure 2. Influence of prebreeding supplementation with wheat middlings on cow body condition change (1 to 9 scale). Average initial body condition = 4.2. CONTROL = 6 lb WM per cow per day; FLUSH = 12 lb WM per cow per day. Calving = d 71, beginning of FLUSH treatment = d 97, start of breeding season = d 127, pregnancy checking = d 243, weaning = d 282.

Table 1. Influence of level of wheat middlings on reproductive performance and milk production of cows, and on calf weaning weight and average daily gain.

	Treatment[a]			
Item	CONTROL	FLUSH	SEM[b]	Probability of a Greater F-value
Cycling by beginning of AI, %	65	35	-	.03
First service conception[c], %	62	17	-	.09
Pregnant, %	96	92	-	.55
Milk production, lb/day				
30 days postpartum	16	19	1.2	.06
70 days postpartum	16	14	1.2	.41
150 days postpartum	14	15	1.9	.81
Calf birth wt, lb	78	81	-	-
Calf weaning wt, lb	503	493	14.0	.68
Calf ADG, lb	1.98	1.92	.069	.62

[a] CONTROL = 6 lb WM/cow daily for 30 days before beginning of AI; FLUSH = 12 lb WM daily for 30 days before beginning of AI.
[b] SEM = standard error of the mean (n = 2).
[c] First service conception = percentage of cows exposed to single AI service that co nceived to AI.

Agronomic Performance and Quality Traits of Small Grain Forages

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Introduction

Several recent economic studies have demonstrated that decreased dependence on harvested forages has great potential to increase the profitability of beef cattle operations. In the Great Plains, forages that are capable of supplying high-quality feed in the fall and early spring can greatly extend the grazing season for beef cattle. Little information is available on forage potential of contemporary cultivars of small grain cereals. Plant breeders in private, state, and federal agencies have released new small grain cereals that show more potential in forage and grain production than some of the earlier lines. Because of renewed interest, some growers are planting small grain forages for grazing or hay, and others are interested in the grain for feeding purposes or for selling to forage producers in their area. This study, established in the 22.5-inch precipitation area of west-central Kansas, was designed to address the forage and grain yields and forage quality of forage-type cereal grains. Forage agronomic results are reported for the 1992 to 1995 period, but forage quality results are reported only for 1993.

Methods

Seed was obtained from eight states, Canada, and Poland. Upland (Harney silt loam) and bottomland (Roxbury silt loam) reduced-till sites were established on the KSU Agricultural Research Center–Hays. Fall planting ranged from September 22 to October 7. Planting of spring small grains ranged from February 17 to March 25. Fall-planted triticale and rye were seeded at 90 lb/acre, and wheat at 60 lb/acre. Spring cereals were seeded at 120 lb/acre to help compensate for reduced tillering. Fall and spring cereals were seeded in 12-inch rows using a double-disc or hoe-type opener. Sixty pounds of actual nitrogen per acre, using ammonium nitrate, was surface broadcast in the fall before planting. Starter fertilizer (18-46-0) was applied with the seed at planting. Each entry was replicated four times, in a randomized complete block design, at each location in each year. Forage production was determined at the boot stage by clipping 40 sq ft of the whole-plant material from inside rows of each plot with a 2-row binder. Plant material was cut about 4 inches above the ground. Percent dry matter (DM) was determined on a sample from each plot. In 1993, the plant material was analyzed for crude protein (CP) and acid detergent fiber (ADF).

Results and Discussion

General. Over the 1992 to 1995 period, stands of planted cereals were generally good. On the bottomland site, planting of spring cereals was delayed in 1993 and 1994 by wet soil.

Consequently, plant height and forage production for the spring-planted crops on the bottomland site in these 2 years was less than expected. Damaging late spring freezes in 1992 and 1995 resulted in weakened nodes and lodged plants. In 1992, 10 to 35 % head damage occurred in the taller entries. In 1993, the fall-planted triticale variety Pika had measurable snow mold, which did not appear to depress forage production. In March 1994, dead leaves were the result of a hard freeze occurring after the plants had broken dormancy. A positive correlation (r=.71) was found between percent dead leaves and forage yields on the bottomland site. This points out the vigor and recovery potential of the fall-planted cereals.

Agronomic Performance-Upland. The relative differences in harvest date, plant height, and percent DM were similar across the 4 years of the study. Thus, only 1995 data are shown (Table 1). Only winter triticale varieties had significant differences in maturity. Newcale, Presto, and Roughrider were early maturing; Jenkins 10 and Pika late maturing; and the remainder intermediate in maturity. Of the fall-planted cereals, winter rye matured the earliest. Winter rye's fall growth, regardless of variety, was significantly more than that of any of the fall-planted triticale or winter wheat varieties. However, the spring growth of all winter triticale entries exceeded the vegetative growth of winter rye or winter wheat. Dry matter yields correlated reasonably well (r=.79) with plant height. Spring-planted cereals generally had lower DM percentages, which could translate into more time required for drying in the windrow. The four top-yielding small grain cultivars were all winter triticales: Pika, Jenkins 10, Trit I, and Trical 102. Dry matter of winter wheat averaged about 67% of that of these winter triticale varieties. Forage production of Troy oats exceeded that of other spring-seeded cereals, as well as that of winter wheat.

Agronomic Performance-Bottomland. The winter triticale variety Newcale and the three rye varieties matured significantly earlier when grown in the bottomland than on the upland site (Table 2). Otherwise, the maturity comparisons were similar for each site. Plant height at the harvested boot stage was generally taller on the bottomland site than on the upland site. Correlation of plant height with DM yield was the same as on the upland site. The low DM percentage of the spring-planted cereals is a concern when trying to achieve a rapid dry-down after swathing. Rapid early growth of the rye varieties over triticale and wheat offers an excellent fall grazing opportunity. The same four winter triticale varieties that yielded well on the upland site, responded similarly on the bottomland site. The experimental Gro-Green variety looked promising in the 1995 trials. Winter wheat varieties averaged about 15% less DM yield than the four top-yielding winter triticale varieties. Of all the spring-planted entries, Trical 2700 yielded the most DM.

Quality Traits. Newcale winter triticale and Trical 2700 spring triticale had the highest CP and the lowest ADF on both upland and bottomland sites (Table 3). As expected, the higher yielding cereals had the lowest CP and the highest ADF. Forage quality of winter rye was greater than that of winter wheat.

Conclusions

Because Hessian fly and wheat diseases are not problems with fall-planted winter rye or triticale, these crops could be planted from mid-August to mid-September, thus providing substantial fall grazing. A blend of winter rye and winter triticale should provide good fall grazing (primarily from the rye) and substantial spring grazing (primarily from the triticale). If winter rye or triticale is included in a blend, high intensity grazing or removal as hay in the boot stage is recommended, so that field contamination of succeeding crops is reduced. Destroying the crop soon after haying or grazing in the spring also is recommended. Depending on the rainfall area of the livestock producer, destroying the crop in May and planting a fall small grain cereal in mid- to late-August are quite possible. Fall-planted cereals will produce more DM than spring-planted cereals. Previous trials have shown that grazing of small grain cereals often delays maturity. Thus, late spring freezes occurring on fields that have been grazed should not be as great a problem when putting up hay in May or early June. The choice of cereal grain for grazing or hay will depend on the quality required for a particular cattle feeding operation. Additional costs for protein supplementation need to be considered when selecting a high-yield, low-protein variety. Additionally, higher ADF values generally will be associated with lower average daily gain of cattle consuming the forages.

Table 1. Agronomic performance of winter and spring cereal grains cut at the boot stage on upland site, 1992 to 1995, KSU Agricultural Research Center–Hays.

Small Grain Cultivar	Seed Source	1995 Harvest Date	1995 Plant Ht, in	1995 DM, %	Dry Matter Yield, lbs/a 1995	Dry Matter Yield, lbs/a 2-Yr Avg	Dry Matter Yield, lbs/a 3-Yr Avg	Dry Matter Yield, lbs/a 4-Yr Avg
Winter triticale								
Cowhand	KS	May 16	36	19.4	4819	3516		
Enduro	WI	May 16	30	19.4	5049	3575	4582	
Gro-Green	TX	May 15	32	21.4	5020			
Gro-Green-Ex	TX	May 16	40	19.0	5487			
Jenkins 10	TX	May 30	45	23.1	6447	5004		
Newcale	NE	May 12	30	24.2	5191	3724	4078	4372
Pika	Canada	May 30	45	23.1	7439	5475	6092	5506
Presto	Poland	May 12	28	21.0	5639	4020	4227	4544
Roughrider	KS	May 12	31	22.2	5504	3733	4160	
Trical 102	CA	May 16	39	20.3	5510	4243	5196	5240
Trit I	TX	May 16	38	19.0	5840	4609	5983	
Spring triticale								
Marvel	SD	May 30	26	16.6	2569	2044	2614	
Trical 2700	CA	May 30	30	15.3	2954	2705	3191	3072
Trical Grace	CA	May 30	28	17.4	3144	2745	3081	2931
Wapiti	Canada	May 30	29	15.7	3632	2796	3363	2993
Winter wheat								
Larned	KS	May 16	27	25.0	4039	3168	3927	4036
Longhorn	CO	May 16	28	22.6	4246	3311		
Winter rye								
Wrens	OK	Apr 24	24	24.7	2501			
Elbon	OK	Apr 24	26	23.0	2946	2241	3808	3701
Maton	OK	Apr 24	27	24.2	3473	2675	3906	4173
Spring barley								
Otis	CO	May 30	28	21.3	4642			
Robust	SD	May 30	28	17.4	2596			
Spring oats								
Hi-test	SD	June 8	37	18.8	4456			
Troy	SD	June 8	38	15.7	5714			
Least sig. diff. (P<.05)		1 day	3	1.4	128	71	327	299

Table 2. Agronomic performance of winter and spring cereal grains cut at the boot stage on bottomland site, 1992 to 1995, KSU Agricultural Research Center–Hays.

Small Grain Cultivar	Seed Source	1995 Harvest Date	1995 Plant Ht, in	1995 DM, %	Dry Matter Yield, lbs/a 1995	2-Yr Avg	3-Yr Avg	4-Yr Avg
Winter triticale								
Cowhand	KS	May 16	42	18.1	8906	6855		
Enduro	WI	May 16	38	18.4	8273	6612	7591	
Gro-Green	TX	May 15	40	18.8	7827			
Gro-Green-Ex	TX	May 30	46	21.4	9509			
Jenkins 10	TX	May 30	47	20.2	10430	8705		
Newcale	NE	May 5	28	18.8	7038	5996	6044	5966
Pika	Canada	May 30	47	19.4	9623	8419	9826	8914
Presto	Poland	May 12	37	18.6	9268	7365	6837	6571
Roughrider	KS	May 12	38	19.5	7738	6304	6269	
Trical 102	CA	May 30	45	21.5	10390	8238	9170	8265
Trit I	TX	May 30	46	19.3	9631	7827	9636	
Spring triticale								
Marvel	SD	May 30	30	13.8	4452	3200	3660	
Trical 2700	CA	June 2	38	13.8	6503	4629	5049	4426
Trical Grace	CA	June 2	34	14.6	5257	3725	3935	3505
Wapiti	Canada	May 20	33	14.6	5273	3633	4013	3465
Winter wheat								
Larned	KS	May 16	36	22.6	8940	7383	8392	7252
Longhorn	CO	May 16	33	20.0	8238	6696		
Winter rye								
Wrens	OK	Apr 17	30	24.4	4030			
Elbon	OK	Apr 17	30	20.3	4610	4184	5596	5242
Maton	OK	Apr 17	30	20.5	4816	4644	5817	5456
Spring barley								
Otis	CO	May 30	31	17.2	5796			
Robust	SD	May 30	34	16.6	5909			
Spring oats								
Hi-test	SD	June 2	37	15.7	5197			
Troy	SD	June 2	38	12.7	5792			
Least sig. diff. (P<.05)		1 day	2.2	2.4	251	152	438	460

Table 3. Agronomic performance and quality traits of seven small grain cultivars cut at the boot stage. 1993 results from a Harney silt loam and Roxbury silt loam soils on the KSU Agricultural Research Center–Hays.

Small Grain Cultivar	Seed Source	UPLAND SITE Harvest Date	UPLAND SITE DM Yield, lbs/a	UPLAND SITE CP, %	UPLAND SITE ADF, %	BOTTOMLAND SITE Harvest date	BOTTOMLAND SITE DM Yield, lbs/a	BOTTOMLAND SITE CP, %	BOTTOMLAND SITE ADF, %
Winter triticale									
Newcale	NE	May 10	4785	11.1	32.0	May 10	6141	16.9	34.5
Pika	Canada	May 28	7328	7.2	46.1	May 28	12641	14.0	40.5
Trical 102	CA	May 22	7100	7.6	44.7	May 22	11034	14.0	41.6
Trit I	TX	May 28	8731	6.4	46.8	May 28	13253	13.4	40.8
Spring triticale									
Trical 2700	CA	June 4	4162	12.8	38.8	June 7	5889	16.2	37.4
Winter wheat									
Larned	KS	May 22	5445	8.8	42.8	May 22	10410	12.0	44.1
Winter rye									
Elbon	OK	May 10	6944	8.9	39.9	May 10	8419	14.0	38.3
Least sig. diff. (P<.05)		1 day	1171	1.6	1.8	1 day	1265	2.7	2.3

Agronomic Performance and Quality Traits of Summer Annual Forages

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Introduction

Livestock production has become an integral part of most farming communities' income. Producing an adequate amount of quality hay or silage has become an important phase of farmers' management strategies. Summer-grown forage sorghum has been a traditional hay crop in the west-central Great Plains to satisfy the forage needs. However, other hay types offer promise to meet the forage demand from single to multiple cuttings. New hybrids, flex-acres, and improved management inputs have renewed research interest in a wide array of summer annual forages that are adapted to our 22.5-inch precipitation area. This study was conducted to compare agronomic and quality characteristics of several summer annuals produced on both upland and bottomland sites on the KSU Agricultural Research Center–Hays.

Methods

Forages were evaluated in a small grain-summer annual forage-fallow crop rotation (2 crops in 3 years). Except for areas planted to sunflower, each test site received 1 lb/acre preplant-applied atrazine. Each test site also received 60 lb N/acre (as urea) incorporated before planting. For evaluation of hay crops, six forage sorghums, two pearl millet hybrids, one foxtail millet, six sorghum-sudangrass hybrids, and two sudangrass hybrids were planted in 12-inch rows in June on an upland, Harney silt loam soil and a bottomland, Roxbury silt loam soil. Also evaluated were six silage types, including three forage sorghums, one grain sorghum, one corn hybrid, and one sunflower hybrid. All silage types were planted in 30-inch rows on both upland and bottomland sites. DeKalb hybrids FS5 and FS25E were planted for both hay and silage. Seed was prepackaged and metered through a cone/spinner mechanism mounted on the planter into double-disc openers using dual-type side press wheels. Two rows of each entry were harvested from 12-inch row plots and one row of each entry from 30-inch row plots. Hay types were cut at the boot stage, and a second cutting was obtained when regrowth was sufficient. Silage types were cut one time at the soft dough stage. Hay and silage yields were measured on an oven-dry basis (dry matter = DM). In 1993, the oven-dry samples were analyzed for crude protein (CP) and acid detergent fiber (ADF). Both sites had four replications in randomized complete block designs.

Results and Discussion

<u>General</u>. There were 6 ft of moist soil at planting time in each of the 3 years. Summer precipitation was above average in 1993 and significantly below average in 1994 and 1995. Initial stands

over the 3-year period were generally good. Because sunflower stands were damaged severely by jackrabbits, the upland plots were not harvested in any of the 3 years. In 1993, of the hay-types at both sites, only German millet and DeKalb FS25E did not receive a second cutting. In 1994, a second cutting was done only on the bottomland site; all the sorghum-sudangrass and sudangrass entries were cut twice. Because of extreme drought, no second cutting was possible at either site in 1995.

Agronomic Performance Upland. Extreme drought in 1995 delayed harvest, reduced plant height, and raised percent DM on several entries when compared to the 3- year average (Table 1). Plant height did not correlate well with DM yields. This is probably because of variations in leaf mass per plant, stem diameter, and plants per acre. Percent DM was lowest for TE Horsepower pearl millet and Trudan sudangrass. As expected, percent DM was higher for the silage types than on the hay types. Except in 1995, silage types produced more DM than hay types. Forage sorghum types generally produced more DM yield than the other hay types.

Agronomic Performance Bottomland. As on the upland site, extreme drought in 1995 delayed harvest, reduced plant height, and raised percent DM of several entries when compared to the 3- year average (Table 2). Plant height did not correlate well with DM yields. Low DM percent means high moisture in the plant in the windrow, which may delay the haying process. Because of a high-yielding second cutting for the sorghum-sudangrass entries, many of these had significantly more total DM than the forage sorghum entries. In 1995, DM yields from silage types were nearly the same or slightly below the yields from the forage sorghum hay types. However, silage yields of the top three producers, DeKalb FS5, DeKalb FS25E, and Cargill FS 466, averaged over 3 years, were significantly greater than yields of any of the hay-type entries.

Quality Traits - Upland. Crude protein decreased (Table 3) when harvest was delayed (r = -.68). Also, CP was lowest when DM yields were the highest (r = -.67). DeKalb FS25E had the highest DM yield (hay- and silage-types), but the lowest CP. Canex had the second highest CP and the lowest ADF.

Quality Traits - Bottomland. Only in the bottomland site did enough regrowth occur to merit a second cutting and then only with the sorghum-sudangrass and sudangrass entries (Table 4). DeKalb SX 15 was the highest yielding of all hay- and silage-type entries. Crude protein was consistently lower and ADF was consistently higher for the second cutting than for the first. CP was higher in the sorghum-sudangrass and sudangrass entries than all other hay or silage types. Canex had the lowest ADF value of the hay-types, and DeKalb FS5 had the lowest ADF value of the silage-types.

Conclusions

Storing soil moisture prior to planting of summer-grown crops (forage or grain) is critical because 2 weeks or more of drought often is experienced during the summer in the west central Great Plains. Relying on a second cutting on upland soils is risky, because drought often limits cuttings to one. Therefore, producers should plan to maximize their DM tonnage from one cutting. However, the possibility of a second cutting is higher on bottomland Roxbury-type soils. Thus, flexibility as to the type of forage crop grown is also greater. If adequate equipment and labor are available and if the livestock operation lends itself to silage feeding, forage sorghum silage-types are recommended. If forage sorghums are used, as compared with sorghum-sudangrass or sudangrass, the need for a protein supplement in the ration is greater.

Table 1. Agronomic performance of summer annual forages on upland site. 1993 to 1995, KSU Agricultural Research Center–Hays.

Summer Annual Hybrid or Cultivar	First Cutting[1] Harvest Date 1995	Harvest Date 3-yr avg	Plant Ht, inch 1995	Plant Ht, inch 3-yr avg	DM, % 1995	DM, % 3-yr avg	DM Yield, lbs/a 1995	DM Yield, lbs/a 3-yr avg	Total DM Yield, lbs/a 3-yr avg
Boot stage for hay: 12-inch rows									
Forage sorghum									
DeKalb FS5	Sept 25	Sept 4	36	52	28.0	23.4	3663	5356	5356
DeKalb FS25E	Sept 25	Sept 25	37	54	29.5	27.8	3924	8201	8201
Cargill Morcane II	Sept 25	Sept 2	36	51	27.6	22.0	3083	5152	5152
Canex	Sept 25	Aug 30	36	52	28.3	22.0	3986	4779	4779
TE Goldmaker	Sept 25	Aug 31	35	50	27.5	23.1	4272	5096	5096
Star Hybrid	Sept 25	Aug 31	33	50	27.5	21.7	3019	4706	4706
Pearl millet									
PP102M	Aug 17	Aug 12	32	38	28.3	23.9	2363	2045	2045
TE Horsepower	Aug 11	Aug 11	30	46	21.4	20.6	1742	2729	2729
Foxtail millet									
German millet	Aug 21	Aug 17	23	32	43.4	33.1	2037	2742	2742
Sorghum-sudangrass									
DeKalb ST 6E	Aug 28	Aug 18	40	63	33.7	24.0	4598	4511	5058
DeKalb SX 15	Aug 30	Aug 19	36	60	37.2	24.9	3842	4445	4888
Cargill Sweet Sioux	Aug 28	Aug 19	40	58	31.2	23.1	4180	4333	4868
Cattlegrazer	Aug 21	Aug 15	42	59	30.7	23.4	3310	3770	4358
TE Haygrazer	Aug 17	Aug 13	41	59	29.8	23.4	3361	3960	4426
Go-Man-Go II	Aug 30	Aug 18	35	59	43.3	28.0	3615	4041	4556
Sudangrass									
Piper	Aug 8	Aug 10	46	60	24.0	24.1	2658	3569	4166
Trudan	Aug 8	Aug 6	44	57	19.4	19.2	2732	2705	2705
Soft dough stage for silage: 30-inch rows									
DeKalb FS5	Sept 25	Sept 26	46	68	27.4	29.3	3395	7164	7164
DeKalb FS25E	Sept 25	Oct 6	44	63	27.9	27.2	3076	7736	7736
DeKalb DK56	Sept 25	Sept 29	32	42	30.4	35.9	3548	6535	6535
Cargill FS 466	Sept 25	Oct 6	46	59	28.9	28.3	3481	7009	7009
Corn, Pioneer 3563	Sept 25	Sept 18	56	72	41.7	31.7	1357	3620	3620
Least sig. diff. (P<.05)									
Hay	1 day	1 day	6	2	1.5	0.7	156	148	---
Silage	NS	1 day	4	2	1.3	0.9	153	154	---
Combination	1 day	1 day	5	2	1.4	0.8	151	146	152

[1] In 1993 all the sorghum-sudangrass entries and Piper sudangrass had a second cutting. Harvest was October 5, plant height ranged from 13 to 23 inches, and DM% ranged from 19 to 35.9%,.

Table 2. Agronomic performance of summer annual forages on bottomland site. 1993 to 1995, KSU Agricultural Research Center–Hays.

Summer Annual Hybrid or Cultivar	First Cutting[1] Harvest Date 1995	Harvest Date 3-yr avg	Plant Ht, inch 1995	Plant Ht, inch 3-yr avg	DM, % 1995	DM, % 3-yr avg	DM Yield, lbs/a 1995	DM Yield, lbs/a 3-yr avg	Total DM Yield, lbs/a 3-yr avg
Boot stage for hay: 12-inch rows									
Forage sorghum									
DeKalb FS5	Sept 18	Aug 29	46	64	24.5	20.6	6368	6254	6776
DeKalb FS25E	Sept 25	Sept 10	46	62	25.7	22.7	5867	7654	7654
Cargill Morcane II	Sept 18	Aug 26	46	62	24.5	18.7	6041	6039	6576
Canex	Sept 5	Aug 21	43	62	23.8	18.6	4854	5663	6237
TE Goldmaker	Sept 11	Aug 31	35	50	27.5	23.1	4272	5096	5096
Star Hybrid	Aug 30	Aug 19	38	61	30.2	21.4	5736	6453	6982
Pearl millet									
PP102M	Aug 25	Aug 15	32	48	25.2	20.7	3578	3144	3144
TE Horsepower	Aug 11	Aug 11	34	59	19.2	19.3	2085	4450	4801
Foxtail millet									
German millet	Aug 24	Aug 18	20	35	32.0	27.8	1941	3450	3450
Sorghum-sudangrass									
DeKalb ST 6E	Aug 28	Aug 12	44	66	27.8	19.8	4999	4587	8665
DeKalb SX 15	Aug 30	Aug 12	46	67	27.4	20.0	5620	5244	8951
Cargill Sweet Sioux	Aug 28	Aug 13	44	63	29.1	20.8	5461	4797	8808
Cattlegrazer	Aug 17	Aug 7	45	61	25.8	19.2	3697	3844	7587
TE Haygrazer	Aug 17	Aug 7	45	63	26.2	19.2	3747	2919	7876
Go-Man-Go II	Aug 22	Aug 9	46	62	32.7	21.3	4457	4251	8811
Sudangrass									
Piper	Aug 8	Aug 4	46	61	22.0	19.1	2676	3419	7365
Trudan	Aug 8	Aug 6	44	61	19.3	18.0	3010	3207	4987
Soft dough stage for silage: 30-inch rows									
DeKalb FS5	Sept 25	Sept 23	52	73	27.4	26.8	5934	9316	9316
DeKalb FS25E	Sept 25	Oct 3	56	78	24.6	25.4	5824	10516	10516
DeKalb DK56	Sept 25	Sept 23	33	44	30.1	28.7	5225	6606	6606
Cargill FS 466	Sept 25	Sept 23	53	72	25.1	26.1	5405	9627	9627
Corn, Pioneer 3563	Sept 25	Sept 14	57	76	41.5	30.8	1827	4354	4354
Sunflower, Cargill 187	Sept 25	Sept 10	42	52	29.8	20.3	2602	4694	4694
Least sig. diff. (P<.05)									
Hay	1 day	1 day	3	1	1.0	0.8	106	120	---
Silage	NS	1 day	3	1	1.4	1.0	143	216	---
Combination	1 day	1 day	3	1	1.1	0.8	115	168	226

[1] In 1993 and 1994 all the sorghum-sudangrass entries and Piper sudangrass had a second cutting. Harvest averaged Sept 25th, plant height ranged from 46 to 55 inches, DM% ranged from 20.8 to 25.3%, and DM yield ranged from 5561 to 6840 lbs/a.

Table 3. Agronomic performance and quality traits of 11 summer annual forages on upland site, cultivars. 1993, KSU Agricultural Research Center–Hays.

Summer Annual Hybrid or Cultivar	Harvest Date	Plant Ht, inch	DM, %	DM Yield, lb/a	CP, %	ADF, %
Boot stage for hay: 12-inch rows						
Forage sorghum						
DeKalb FS5	Aug 25	57	19.9	8219	4.9	40.7
DeKalb FS25E	Oct 1	64	23.8	11712	4.2	44.1
Canex	Aug 16	57	18.8	6453	6.1	36.6
Pearl millet						
TE Horsepower	Aug 16	57	20.2	4631	6.3	42.8
Sorghum-sudangrass						
DeKalb SX 15	Aug 16	68	17.6	5799	5.5	41.0
Cargill Sweet Sioux	Aug 16	65	17.6	5475	6.0	39.9
TE Haygrazer	Aug 16	66	19.7	5426	5.5	41.8
Sudangrass						
Piper	Aug 16	64	23.7	5222	5.3	43.4
Soft dough stage for silage: 30-inch rows						
DeKalb FS5	Oct 4	88	26.8	9030	4.4	41.0
DeKalb FS25E	Oct 20	82	27.7	11906	3.6	37.8
Cargill FS 466	Oct 20	72	27.1	9341	4.0	41.4
Least sig. diff. (P<.05)						
Hay	1 day	3.6	1.2	372	1.2	1.7
Silage	1 day	6.2	NS	452	NS	NS
Combination	1 day	3.7	2.0	380	1.2	2.0

Table 4. Agronomic performance and quality traits of 11 summer annual forages on bottomland site, 1993, KSU Agricultural Research Center–Hays.

Summer Annual Hybrid or Cultivar	Cutting	Harvest Date	Plant Ht, in	DM, %	DM Yield,	CP, %	ADF, %
			Boot stage for hay: 12-inch rows				
Forage sorghum							
DeKalb FS5	1st cutting	Aug 18	76	17.5	8049	6.8	43.4
DeKalb FS25E	1st cutting	Sept 7	69	19.4	11403	5.6	48.4
Canex	1st cutting	Aug 18	72	18.2	8418	5.8	39.7
Pearl millet							
TE Horsepower	1st cutting	Aug 16	75	22.4	8370	6.8	44.0
Sorghum-sudangrass							
DeKalb SX 15	1st cutting	July 30	65	17.7	6678	9.8	41.8
	2nd cutting	Oct 1	68	15.3	9452	7.3	47.7
	Total				16130		
Cargill Sweet Sioux	1st cutting	July 30	62	15.1	4544	9.4	41.4
	2nd cutting	Oct 1	66	15.8	10382	7.8	47.7
	Total				14926		
TE Haygrazer	1st cutting	July 30	63	14.7	4586	9.6	41.7
	2nd cutting	Oct 1	62	19.2	9149	6.9	48.0
	Total				13735		
Sudangrass							
Piper	1st cutting	July 30	59	14.3	4190	11.8	40.9
	2nd cutting	Oct 1	62	21.5	8970	7.3	50.1
	Total				13160		
			Soft dough stage for silage: 30-inch rows				
DeKalb FS5	1st cutting	Oct 12	88	26.1	11741	6.8	38.0
DeKalb FS25E	1st cutting	Oct 12	103	24.7	14865	5.9	41.1
Cargill FS 466	1st cutting	Oct 12	89	23.3	12405	6.6	42.4
Least sig. diff. (P<.05)							
1st cutting:							
Hay		1 day	3.3	2.0	215	1.7	2.0
Silage		1 day	4.6	2.0	729	NS	2.8
Combination		1 day	3.6	1.8	481	1.7	2.5
2nd cutting:							
Hay		1 day	NS	1.2	665	NS	NS
Total:		---	---	---	643	---	---

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