Management Systems That Increase Uniformity of the Forage Supply for Year-round Grazing by Spring Calving Herds

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Summary

A comparison was made between two different systems: a year-round grazing system and a minimal-land grazing system at the McNay Research Farm, Chariton IA. The winter component of a year-round grazing system used sequential grazing of corn crop residues and stockpiled grass legume forages. The winter component of a minimal land system consisted of cows maintaining in drylot. Following grain harvest, four 7.5-acre fields containing corn crop residues were stocked with cows at midgestation at an allowance of 1.5 acres per cow. After 2 months, cows in the year-round grazing system grazed stockpiled tall fescue-red clover or smooth bromegrass-red clover forage at 3 acres/cow for approximately 4 months. Forage organic yields at the initiation of grazing were 3,467 lb./acre for three years on corn crop reside fields and 2,473 and 1,968 for stockpiled tall fescue-red clover and smooth bromegrass-red clover fields. In all years, no seasonal differences in body weight or body condition scores were observed between cows sequentially grazing corn crop residues and stockpiled forage or cows maintained in drylot during winter. Grazing cows consumed less hay resulting in a 3-year average hay excess of 4,235 and 4,743 pounds of hay dry matter per cow in the year-round grazing systems while the minimal land system was deficient in hay by 4,529 pounds of hay dry mater per cow.

The summer component of a year-round grazing system involved rotational stocking of smooth bromegrass-orchardgrass-birdsfoot trefoil pastures with cow-calf pairs and stocker yearlings at .75 animal units/acre for 40 days, and hay harvest and grazing of tall fescue-red clover and smooth bromegrass-red clover pastures at .33 cow-calf pairs/acre for 57 days and 83 days grazing of smooth bromegrass-orchardgrass-birdsfoot trefoil pastures at .5 cow-calf units per are. The minimal land system involved the rotational stocking of smooth bromegrass-orchardgrass-birdsfoot trefoil pastures with cow-calf pairs grazing at .64 animal units/acre and hay removal from 40% of the pasture. Grazing system did not affect cow body weight, condition score, or calf daily gain in any of the three years. Growing animal production was affected by grazing system; the minimal land system 3-year average was 181 lb./acre compared with year-round system averages of 128.7 and 123.9 lb./acre. The year-round grazing systems also produced more net winter forage than did the minimal land system. Differences in forage quality were only observed between tall fescue-red clover, smooth bromegrass-red clover and smooth bromegrass-orchardgrass-birdsfoot trefoil pastures during summer.

Introduction

The need to optimize forage utilization and animal productivity at minimal cost in forage based cow-calf systems has led many producers to try to increase the length of the grazing season to reduce the amount of stored feeds necessary to maintain beef cows throughout the year. In order to compare a system that maximizes grazing through the use of summer rotational grazing and winter grazing of corn crop residues and stockpiled perennial forages to a more conventional system utilizing summer rotational grazing and drylot feeding of hay, two systems were developed and are being evaluated. In this project, a year-round grazing system, in which cows sequentially graze corn crop residues and stockpiled tall fescue-red clover or smooth bromegrass-red clover forage during the winter and rotationally graze smooth bromegrass-orchardgrass-birdsfoot trefoil pastures with seasonal grazing of yearling calves, is compared with a minimal land system, in which cows are fed hay produced from summer pastures in a drylot during winter and rotationally graze smooth bromegrass-orchardgrass-birdsfoot trefoil pastures in the summer (Table 1). Systems are evaluated for animal and forage production, utilization and economic returns. This project encompasses three years, year one (Yr1) occurred from fall of 1995 through 1996, year two (Yr2) occurred from fall of 1996 through 1997 and year three (Yr3) occurred from fall of 1997 through 1998.

Materials and Methods

Winter Components

In each year of this experiment, thirty-six crossbred cows in midgestation were used to compare sequential grazing corn crop residue and stockpiled hay

Table 1. Summary of forage-based beef production systems to be evaluated at the McNay Research Farm.

Month	System	
	Year-round grazing	Minimum land
November	Wean calves on hay until summer grazing. Cows strip-graze cornstalks at 1 ac/cow/mo.	Wean calves and finish in feedlot. Four cows in drylot and fed hay from summer pasture as necessary to maintain condition score 5.
January	Cows strip-graze stockpiled 15 ac tall fescue-alfalfa-red clover or smooth bromegrass-red clover at 1 ac/cow/mo. Hay offered to maintain condition score of 4.	
April	Cows and yearlings rotationally graze 10 ac smooth bromegrass-orchardgrass-birdsfoot trefoil pastures at .75 animal units[a]/ac. Cows will be rotated daily. Cows will calve in early May.	Cows to rotationally graze 6.25 ac smooth bromegrass-orchardgrass-birdsfoot trefoil at .64 animal units/ac with daily rotation. Grazing will begin after 10 cm growth. Cows will calve in early April.
June	First cutting hay baled on 15 ac tall fescue-alfalfa-red clover 15 ac smooth bromegrass-red clover. Cows with calves and yearlings will continue to rotationally graze after 50% removal.	Hay removed from ungrazed portion a minimum of 3.75 ac of a 10-acre pasture. Breeding of cows initiated. Cattle will be rotated after 50% removal.
July	Cows with calves and bull moved to strip-graze tall fescue-alfalfa-red clover or smooth bromegrass-red clover with stocker steers at .4 animal units/ac. Breeding of cows initiated. Yearlings continue to rotationally graze birdsfoot trefoil pastures at .25 animal units/ac.	Cows allowed to graze hayed area. Total stocking rate is .4 animal units/ac. If available forage is inadequate, hay will be fed in pastures.
August	Cows with calves moved back to smooth bromegrass-orchardgrass-birdsfoot trefoil pastures to rotationally graze at .5 animal units/ac. Cows will be rotated according to forage growth. Yearlings placed in feedlot to be finished.	
November	System is repeated.	System is repeated.

[a] An animal unit is defined as 1 cow with or without a calf, 2 stocker steers or 1 bull.

crop forages with maintaining cows by feeding hay in a drylot as winter management systems.

In the summer hay was harvested from stockpiled pastures for winter use. In the summer prior to Yr1, two cuttings were harvested from the entire pasture, one cutting was harvested from 11.25 acres in Yr1, and one cutting was harvested from the entire pasture in Yr2 in replicated fields containing endophtye-free tall fescue-red clover (TF-RC) or smooth bromegrass-red clover (SB-RC) forages. Hay yields from the TF-RC fields were 4,336, 2,144 and 1,289 lb. DM/acre in the summer before Yr1, Yr1 and Yr2. Hay yields from the SB-RC fields were 4,600, 2,202 and 1,485 lb. DM/acre in the summer before Yr1, Yr1 and Yr2. In Yr1, the 3.75 acres not harvested as hay and all of the second cutting forage in Yr2 and Yr3 was removed by grazing of cows, calves and bulls at .4 animal units/acre as part of the summer system. In Yr1 tall fescue-red clover and smooth bromegrass pastures were not fertilized before stockpiling. In Yr2 and Yr3, however, both TF-RC and SB-RC fields were fertilized at 40 lb. N/acre as ammonium nitrate in early August at the initiation of stockpiling.

Following corn harvest on October 26 of Yr1, November 1 of Yr2 and October 30 of Yr3, 20 cows were allotted to four 7.5-acre corn crop residue (CCR) fields to strip-graze (four paddocks) for 55 days (Period 1). After grazing corn crop residues, each group of cows in the year-round grazing system was allotted to one of four 15-acre pastures containing either stockpiled TF-RC or SB-RC forage. Cows strip-grazed (four paddocks) stockpiled forages from late December through the initiation of the calving season (Period 2) to the initiation of summer grazing (Period 3). Cows were supplemented with large round bales of hay as necessary to maintain a body condition score of five on a nine-point scale, or when forage availability was limited by weather conditions.

Simultaneous to the initiation of CCR grazing, 16 cows were allotted into replicated drylots where they remained throughout the winter and spring grazing season (minimal land system). Cows in the drylot were supplemented with large round bales as necessary to maintain a body condition score of five on a nine-point scale. All cows were weighed at the initiation and end of each grazing period. Cows calved in their respective locations beginning in late March. Body condition scores (1= very thin, 5=moderate, 9=very obese) were recorded biweekly. Additionally, 24 crossbred weaned calves from the previous summer were used to compare backgrounding on hay with a period of corn gluten feed supplementation followed by summer grazing (year-round system) with complete feedlot finishing of calves (minimal-land system) as finishing systems.

Samples for the determination of quantity and chemical composition of CCR and TF-RC and SB-RC were taken monthly. To determine quantity of hay harvested and fed large round bales were weighed at harvest and feeding. Dry matter concentration and recoveries were determined by core sampling six bales from each stockpiled pasture at harvest and three bales at mid and late winter.

Summer Components

On May 1,1996 (Yr1) and May 7, 1997 (Yr2), twenty cow-calf pairs (mean body weight 1,118 lb.; mean body condition score 5.1) in the year-round grazing system were allotted from winter stockpiled TF-RC and SB-RC pastures to four 10-acre, smooth bromegrass-orchardgrass-birdsfoot trefoil (SB-OG-BT) pastures divided into eight paddocks. Pastures were stocked with cow-calf pairs and yearling stockers at .75 animal units per acre. Yearling stockers were used as a management tool to control excess spring forage growth. Simultaneously, sixteen cow-calf pairs (mean body weight 1,123 lb.; mean body condition score 4.65) in the minimal land system were allotted from winter drylots to four 10-acre, SB-OG-BT pastures divided into eight paddocks and initially stocked at .64 animal units per acre. In Yr1, 3.75 acres and in Yr2 5.0 acres were reserved for hay harvest for management of excess spring forage growth. For the first 41 days in Yr1 and 34 days in Yr2 animals in both grazing systems were moved among paddocks to remove rapidly growing forage. On June 10 in Yr1, cow-calf pairs in the year-round grazing systems were moved back to the TF-RC or SB-RC pastures on which they had grazed during the winter because of insufficient forage on SB-OG-BT pastures. One of four 3.75-acre paddocks was strip-grazed for 34 days until hay was harvested from the remaining 11.25 acres of the pasture. After hay removal on July 1 in Yr1 and June 26 in Yr2, cow-calf pairs and bulls were allowed access to all 15 acres of the TF-RC and SB-RC pastures by strip-grazing four paddocks until August 6 in Yr1 and Yr2. Thereafter, cows and calves returned to summer SB-OG-BT pastures. Meanwhile, in Yr1 and Yr2 yearling stockers remained on summer SB-OG-BT pastures and were rotationally stocked between paddocks after 50% forage removal until August 6 when the yearlings were placed in a feedlot for finishing. In Yr1, cow-calf pairs in the minimal land system were confined to hay paddocks after hay removal on July 1 and offered hay because of insufficient forage. InYr2, minimal land system cow-calf pairs continued to be rotationally stocked on four unhayed paddocks until July 16. On August 6 in both years, all pastures were put on a grazing schedule to remove approximately 33% of the forage based on sward height for the remaining grazing season.

Cows, calves and yearling stockers were weighed and condition scored every 28 days during the grazing season. Sward heights of paddocks were taken with a falling plane meter (.98 lb./ft ^{2}) in two locations per paddock when cows entered and exited paddocks in the grazing cycle. Growth rates, feed efficiencies, and carcass characteristics of yearlings, which grazed in the year-round system, were compared to yearlings, which were placed in a feedlot directly as weaned calves. Pasture forage yields and chemical composition and hay yield and chemical composition were compared in the minimal land and year-round systems.

Results and Discussion

Winter Component

In all three years, organic matter yields of CCR were greater than those of TF-RC or SB-RC pastures at the initiation of CCR grazing (Table 2). Organic matter yields of stockpiled TF-RC or SB-RC were greater in Yr2 and Yr3 than those of Yr1. These increases in yields were caused by the application of N fertilization in the fall. In both Yr1 and Yr2, rates of loss of organic matter were greater in grazed CCR than ungrazed CCR. Grazed stockpiled forages lost more organic matter than did

Table 2. Initial and daily change in the yields of dry matter (DM yield), organic matter (OM yield) and digestible organic matter (IVOMD yield) from grazed and ungrazed portions of fields of corn crop residues (CCR), stockpiled tall fescue-red clover (TF-RC), or smooth bromegrass-red clover (SB-RC) as predicted by regression analysis.

		Initial lb./acre			Grazed lb./acre			Ungrazed lb./acre		
		CCR	TF-RC	SB-RC	CCR	TF-RC	SB-RC	CCR	TF-RC	SB-RC
DM Yield	Yr.1	3,757	1,747	1,880	-23.5	-9.2	-9.9	-2.8	-5.9	-7.5
	Yr.2	3,551	2,912	2,187	-28.8	-13.7	-8.6	-19.1	-1.5	-8.6
	Yr.3	5,394	3,982	2,911	-36.1	-8.1	-3.4	-8.0	-2.1	-4.6
	Avg.	4,234	2,880	2,326	-29.5	-10.3	-7.3	-10.0	-3.2	-6.9
OM Yield	Yr.1	2,981	1,466	1,487	-23.6	-10.3	-9.9	-2.4	-4.9	-5.5
	Yr.2	2,918	2,297	1,677	-26.4	-8.7	-4.7	-2.5	-1.9	-3.8
	Yr.3	4,501	3,657	2,740	-30.3	-8.1	-5.0	-10.5	-3.3	.23
	Avg.	3,467	2,473	1,968	-26.8	-9.0	-6.5	-5.1	-3.4	-3.2
IVOMD	Yr.1	1,755	1,105	1,069	-14.6	-6.3	-5.9	-3.5	-4.8	-4.7
Yield	Yr.2	1,893	1,586	1,088	-19.8	-8.3	-4.7	-5.6	-2.5	-4.8
	Yr.3	2,332	2,226	1,382	-19.4	-8.4	-3.6	-7.0	-6.9	.1
	Avg.	1,993	1,639	1180	-17.9	-7.7	-4.7	-5.4	-4.7	-3.1

Table 3. Initial concentrations and daily changes in concentrations of chemical components from grazed and ungrazed portions of fields containing corn crop residue (CCR), stockpiled tall fescue-red clover (TF-RC), or stockpiled smooth bromegrass-red clover (SB-RC) as predicted by regression analysis.

		Initial			Grazed			Ungrazed		
		CCR	TF-RC	SB-RC	CCR	TF-RC	SB-RC	CCR	TF-RC	SB-RC
% of OM					change, % unit / day					
IVOMD	Yr.1	53.2	67.7	67.9	-.15	-.13	-.14	-.05	-.06	-.09
	Yr.2	56.6	58.2	51.9	-.18	-.06	-.02	-.12	-.07	-.04
	Y r.3	49.8	61.7	49.9	-.12	-.14	-.01	-.04	-.16	-.01
	Avg.	53.2	62.5	56.6	-.15	-.11	.06	-.07	-.10	-.05
NDF	Yr.1	72.3	52.1	55.9	.11	.08	.06	-.02	.09	.05
	Yr.2	73.1	59.9	63.6	.10	.04	.00	.05	.05	.03
	Yr.3	75.5	61.4	59.4	.07	.01	.02	-.05	.01	.02
	Avg.	73.6	57.8	59.6	.09	.04	.03	-.007	.05	.03
ADF	Yr.1	45.1	31.9	37.1	.13	.05	.01	.004	.05	.01
	Yr.2	44.5	35.5	35.5	.07	.02	.004	.03	.03	.03
	Yr.3	47.6	35.1	37.5	.07	.02	-.01	-.03	.02	-.001
	Avg.	45.7	34.2	36.8	.09	.03	.001	.001	.03	.01
CP	Yr.1	6.3	14.5	13.9	-.02	-.02	-.01	0.0	-.01	-.01
	Yr.2	5.6	13.4	12.5	-.01	-.001	0.007	.01	-.01	-.01
	Yr.3	5.0	13.0	12.9	-.01	-.0003	-.001	.01	-.0004	-.001
	Avg.	5.6	13.6	13.1	-.01	-.007	-.001	.01	-.007	-.007

loss in IVOMD concentration between grazed and ungrazed forages of stockpiled TF-RC, SB-RC or CCR. Stockpiled forages of TF-RC and SB-RC had higher IVOMD at all times throughout the winter grazing period in Yr1. Crude protein concentration of stockpiled TF-RC and SB-RC forages were greater than CCR in both years. In Yr1, grazed CCR lost crude protein at a greater rate than did ungrazed CCR. In Yr2, there was no difference in the rate of loss of crude protein concentration between grazed and ungrazed forages. In both Yr1 and Yr2, CCR had greater levels of neutral detergent fiber (NDF) and acid detergent fiber (ADF) than stockpiled perennial forages. Rates of change in NDF and ADF were not different between grazed and ungrazed forages.

To examine the effects of N-fertilization on stockpiled TF-RC and SB-RC samples were taken from fertilized and eight locations in each pasture that were excluded from fertilization by covering with 8 x 8 foot tarps the day of application, samples were taken from these areas at the initiation of fall grazing. In both Yr2 and Yr3 N fertilization increased dry matter and organic matter in TF-RC and SB-RC compared to yields in Yr1 and unfertilized areas in Yr2 and Yr3 (Table 4). Crude protein concentrations were higher in fertilized pastures in Yr2 and Yr3 than in Yr1 and unfertilized areas.

Mean body weight gains of cows maintained on hay in drylots of the minimal land system, were greater than cows grazing CCR in Period 1 in all three years (Table 35. During period 2, minimal land system cows continued to have greater body weight gains than did cows grazing TF-RC, but not SB-RC in the year-round systems. In period 3, however, cows in both year-round systems gained more weight than did cows in the minimal land system. Therefore total body weight changes over winter were not different between the three systems.

Mean cow body condition score increases in period 1 of Yr1 and 2 of cows in the minimal land system were greater than either year-round system. During period 2 there was no difference in condition score change between cows in the minimal land or year-round systems in any year. However, during period 3 in every year cows in the minimal land system lost body condition while cows grazing either TF-RC or SB-RC in the year-round system did not lose or even gained body condition In all three years, there was no difference in total body condition score change over winter between minimal land and year-round system cows. Similar to weight changes during period 3, condition score changes during period 3 could be associated with calving stress. Maintenance or gains in body condition score by cows in the year-round system would imply that grazing TF-RC or SB-RC allows for recovery of body condition after calving and adverse weather conditions (like mud) that drylot maintenance of cows does not.

Cows in the year-round systems grazing CCR and stockpiled TF-RC or SB-RC consumed an average of 340 and 438 lb. hay DM /cow over three years in contrast to

Table 4. Fertilized and unfertilized stockpiled forage yield and quality of tall fescue-red clover and smooth bromegrass-red clover.

			Fertilized			Unfertilized		
		Yr1	Yr2	Yr3	Avg.	Yr2	Yr3	Avg.
TF-RC	DM Yield lb./ac	1,747	2,912	3,824	3,368	2,334	3,124	2,729
	OM Yield lb./ac	1,580	2,647[a]	3,505	3,076	2,101[b]	2,855	2,478
	IVOMD %	69.9	60.0	63.6[A]	61.8	55.9	49.5[B]	52.7
	CP %	11.9	14.1	13.4[a]	13.8	12.4	11.5[b]	12.0
	NDF %	52.1	57.6	59.8[A]	58.7	59.8	58.4[B]	59.1
	ADF%	32.0	33.7	34.5	34.1	35.6	33.7	34.7
SB-RC	DM Yield lb./ac	1,880	2,187	3,315	2,751	1,978	2,872	2,425
	OM Yield lb./ac	1,710	1,992	3,034	2,513	1,796	2,618	2,207
	IVOMD %	62.5	54.6	50.4[a]	52.5	54.9	60.6[b]	57.8
	CP %	11.5	13.1	13.4	13.3	12.1	13.4	12.8
	NDF %	56.0	62.6	58.5[A]	60.6	62.0	56.7[B]	59.4
	ADF %	37.1	34.0	39.6	36.8	34.5	32.9	33.7

[A B] Difference between means by years with different superscripts are significant P<. 05.
[a b] Difference between means by years with different superscripts are significant P< 1.0.

Table 5. Cow body weight and body condition score changes for three winter forage systems containing corn crop residues and tall fescue-red clover or smooth bromegrass-red clover or drylot.

	Forage System											
	Minimal land				Year-round /TF-RC				Year-round/ SB-RC			
	Yr1	Yr2	Yr3	Avg.	Yr1	Yr2	Yr3	Avg.	Yr1	Yr2	Yr3	Avg.
Body weight, lb.												
Initial	1,119	1,157	1,201	1,159	1,142	1,143	1,213	1,166	1,154	1,151	1,163	1,156
Period 1[g]	54[a]	47[c]	3[e]	35	37[a]	-47[d]	-86[f]	-32	-15[b]	-75[d]	-75[f]	-55
Period 2	42[a]	102	114	86	-59[b]	103	26	23	-63[b]	125	87	92
Period 3	-74[a]	-159	-163[e]	-132	18[b]	-121	15[f]	-29	51[b]	-115	-47[f]	-37
Total	22	-10	-46	-11	-4	-65	-45	-38	-27	-65	-35	42
Body Condition Score [h]												
Initial	4.5	5.1	5.8	5.1	4.9	5.2	5.7	5.3	4.9	5.3	5.8	5.3
Period 1	.5[a]	-.2	0[e]	.1	-.05[b]	-.4	-.9[f]	-.5	-.15[b]	-.8	-.7[f]	-.6
Period 2	-.1	.8	-.4	.1	.1	.2	-.7	-.1	-.2	.6	-.5	-.03
Period 3	-.6[a]	-1.0[c]	-.3[e]	-.6	0[b]	.2[d]	.8[f]	.3	0[b]	0[d]	.4[f]	-.13
Total	-.2	-.4	-.7	-.4	.05	0	-.8	-.3	-.35	-.2	-.8	-.45

[abcdef] Differences between means by years with different superscripts are significant P<. 05.
[g] Year 1 Period 1 = 10/26/95-12/20/95, Period 2 = 12/21/95-3/7/96, Period 3 = 3/8/96-5/1/96.
Year 2 Period 1 = 11/1/96-12/26/96, Period 2 = 12/27/96-3/10/97, Period3 = 3/11/97-5/7/97.
Year 3 Period 1 = 10/29/97-12/30/97, Period 2 = 12/31/97-3/25/98, Period = 3/26/98-4/29/98.
[h] 9 point scale.

the total three-year average of 6,375 lb. hay DM /cow required to maintain minimal land system cows in drylots(Table 6). In Yr1 cows in the year-round systems were supplemented with 241 and 245 lb. hay DM /cow in addition to grazing CCR due to weather during period 1. At the same time cows in the minimal land system in drylots consumed 2,024- lb. hay DM /cow. In Periods 2 and 3, the amount of hay supplemented to year-round system cows grazing TF-RC or SB-RC were not different and resulted in similar amount of total hay supplemented to the two systems. Minimal land system cows required a total of 6,201- lb. hay DM /cow for the entire winter. In Yr2 and Yr3, cows in the year-round systems required no hay supplementation during Period 1, and no supplementation of hay in Period 2 of Yr2. Total amounts of supplemental hay once again were not different between year-round systems of TF-RC or SB-RC in Yr2 and Yr3 and significantly less than that required in the minimal land system. Hay balance was significantly greater in the two year-round systems than the minimal land system in all three years. This large hay balance in the year-round system results from the summer hay production on the stockpiled TF-RC and SB-RC pastures that exceeds the supplemental needs of the cows. Hay balance in the two year-round systems was greater in Yr1 than Yr2 and Yr3 because of the two cuttings of hay taken in the summer prior to Yr1. Hay balance on a cow-calf basis was reduced in the year-round systems due to winter drylot management of weaned calves in this system.

The quality of the hay supplemented to both cows maintained on hay in drylots and supplemented to grazing cows was measured at various times during the three winters of the experiment. Currently data from Yr1 and Yr2 are available. In Yr1, hay bale core samples were collected to determine IVOMD, CP, NDF, and ADF in November, December and March. In Yr2, hay bale core samples were collected every month during the winter portion of the experiment. In vitro organic matter digestibility did not change greatly in either Yr1 or Yr2, but did exhibit slight numerical increases (Table 7). Crude protein concentration changes observed were also small, as were seasonal NDF and ADF concentration changes. Differences in chemical composition between hay that was fed and grazed forages of TF-RC and SB-RC during period 3 may not entirely explain the observed difference in condition scores between cows.

Table 6. Hay use and hay balance of different winter forage systems containing corn crop residues and tall fescue-red clover or smooth bromegrass or drylot.

	Forage System											
	Minimal land				Year-round/TF-RC				Year-round/SB-RC			
	Yr 1	Yr 2	Yr 3	Avg.	Yr 1	Yr 2	Yr 3	Avg.	Yr 1	Yr 2	Yr 3	Avg.
Hay fed lb. DM/cow [a]												
Summer		591		197								
Period 1	2,024	2,518	2,047	2,196	241			80	245			82
Period 2	2,477	2,169	2,643	2,430	391		39	143	392		63	152
Period 3	1,700	2,259	697	1,552	172	112	66	117	360	114	139	204
Total	6,201	7,537	5,387	6,375	804	112	105	340	997	114	202	438
Hay Balance [b]												
lb. DM/ cow	-3,125	-4,821	-2,863	-3,603	11,905	4,925	3,762	6,864	12,804	5,062	4,252	7,373
lb. DM/ cow-calf	-5,903	-4,821	-2,863	-4,529	9,127	2,263	1,314	4,235	10,026	2,400	1,804	4,743

[a] Differences between all means by year between minimal land and year-round systems are significant $P < .05$.
[b] Hay balance = lb. hay DM produced – lb. hay DM fed / number of cows.

Table 7. Monthly average chemical composition of hay fed to cows maintained in a drylot or supplemented to cows grazing corn crop residues and tall fescue-red clover or smooth bromegrass-red clover.

	Chemical Composition							
	IVOMD		CP		NDF		ADF	
	Yr 1	Yr 2	Yr 1	Yr 2	Yr 1	Yr 2	Yr 1	Yr 2
November	44.5	44.6	7.4	10.1	61.7	67.2	37.3	40.4
December	48.1	44.4	12.4	9.7	60.6	68.3	38.2	42.3
January		52.5		14.5		58.7		41.4
February		46.7		10.3		65.4		45.3
March	49.0	65.8	12.2	12.2	59.7	60.6	40.4	40.5
April		49.1		12.9		61.1		47.2

Summer Component

Grazing season had no effect on seasonal cow body weight gain in either Yr1, Yr2 or Yr3 (Table 6). In Yr2, cows in the minimal land system lost weight during the breeding season while cows in the year-round systems gained body weight. During the post-breeding season period of Yr2, however cows in the minimal land system and the year-round SB-RC systems gained weight while year-round TF-RC system cows lost weight. In Yr1, initial body condition score of cows in the minimal land grazing system were lower than those in the year-round grazing system. During the post-breeding season period, cows in the minimal land system gained in body weight while year-round system cows lost body condition score. Minimal land system cows then had greater seasonal body condition score increases than year-round TF-RC or SB-RC cows. In Yr2 and Yr3 there were no differences in body condition score change during the summer between grazing systems. The percentage of cows rebreeding in Yr1 was lower in the minimal land system than the year-round systems, but in Yr2 was lower in the year-round TF-RC than other systems. Calving interval was 14 days longer ($P < .10$) for the minimal land system in Yr1 than the year-round systems. No differences in calving interval occurred in Yr2 or Yr3. Calf daily gains were not different between minimal land and year-round system calves in any year (Table 9). Yearling animal daily gains averaged 2.31 and 2.05 lb./d in the year-round TF-RC and SB-RC systems. Two-year average seasonal calf weight gains ($P < .05$) were 170.4,84.6 and 79.2 lb./ac for the minimal land, year-round TF-RC and SB-RC systems. Seasonal calf gains are significantly different because the year-round systems 10 acres from summer SB-OG-BT and 15 acres from the stockpile TF-RC and SB-RC pastures for five cows, whereas the minimal land system utilizes just 10 acres from summer SB-OG-BT pastures for four cows. Although growing animal gains included weight gains of both calves and yearlings in the year-round system, the year-round system still had lower growing animal seasonal gains than the minimal land system.

Table 8. Cow body weight and body condition score changes for three summer forage systems: Minimal land, Year-round TF-RC or Year-round SB-RC.

	Forage System											
	Minimal land				Year-round/TF-RC				Year-round/SB-RC			
	Yr.1	Yr.2	Yr.3	Avg.	Yr.1	Yr.2	Yr.3	Avg.	Yr.1	Yr.2	Yr.3	Avg.
Cow body weight, lb.												
Initial	1,119	1,144	1,173	1,140	1,154	1,079	1,141	1,125	1,155	1,086	1,170	1,137
Pre-breeding	43	58	25	42	22	75	35	44	10	46	35	30
Breeding	15	-4[a]	-5	2	-9	41[b]	16	16	-20	29[b]	6	5
Post-breeding	39	42[b]	48	43	20	-13[a]	12	10	62	24[b]	30	39
Total	97	96	68	87	33	103	63	66	32	99	71	67
Body Condition Score[d]												
Initial	4.6[a]	4.7	5.1	4.8	5.3[b]	5.1	5.2	5.2	4.8[b]	5.1	4.9	4.9
Pre-breeding	.5	.7	.5	.6	.2	.4	.8	.5	.5	.6	.5	.5
Breeding	.1	-.1	.4	.1	.05	.2	.1	.1	.05	-.3	.8	.2
Post-breeding	.2[a]	.6	-.3	.2	-.3[b]	.1	-.6	-.1	-.35[b]	.3	-.3	-.1
Total	.8[a]	1.2	.6	.9	-.05[b]	.5	.3	.3	.15[b]	.6	1.0	.6
% Pregnant	88	100	94	94	100	80	90	90	100	100	100	100
Calving Interval	376	370	382	376	360	374	387	374	363	375	388	375

[ab] Differences between means by year are significant P<. 05.
[c] Year 1 Pre-breeding = 5/1/96-6/11/96, Breeding = 6/12/96-8/1/96, Post-breeding = 8/2/96-10/30/96.
Year 2 Pre-breeding = 5/7/97-6/26/97, Breeding = 6/27/97-8/7/97, Post-breeding = 8/8/97-10/29/97.
Year 3 Pre-breeding = 4/28/98-6/21/98, Breeding = 6/22/98-8/7/98, Post-breeding = 8/8/98-11/11/98.
[d] 9 point scale.

Table 9. Growing animal production on summer pasture for three summer forage systems; Minimal land, Year-round TF-RC or Year-round SB-RC.

	Forage System											
	Minimal land				Year-round/TF-RC				Year-round/SB-RC			
	Yr.1	Yr.2	Yr.3	Avg.	Yr.1	Yr.2	Yr.3	Avg.	Yr.1	Yr.2	Yr.3	Avg.
Daily gain lb./d												
Calf	2.27	2.31	2.31	2.30	2.24	2.33	2.25	2.27	2.16	2.13	2.01	2.1
Yrlg.	-	-	-	-	1.91	2.68	2.19	2.26	1.87	2.22	2.41	2.17
Seasonal gain lb./ac[e]												
Calf	167.7[a]	172.9[c]	202.5[e]	181.0	82.9[b]	86.3[d]	95.4[f]	88.2	79.0[b]	79.4[d]	90.3[f]	82.9
Yrlg.	-	-	-	-	37.8	40.3	43.4	40.5	37.4	37.9	47.8	41.0
Growing Animal	167.7[a]	172.9[c]	202.5[e]	181.0	120.7[b]	126.6[d]	138.8[f]	128.7	116.4[b]	117.3[d]	138.1[f]	123.9

[abcdef] Differences between means by year with different superscripts are significant P<.05.
[e] Minimal land = 10 acres, year-round = 25 acres.

Gross hay production was greater on the year-round systems than the minimal land system during all three summers of the experiment (Table 10). However, hay production from the SB-OG-BT pastures of the minimal land system yielded greater hay dry matter per acre from harvested acres and total system than from the TF-RC or SB-RC fields of the year-round systems. Hay production per cow was greater in the year-round TF-RC and SB-RC systems than the minimal land system. As shown previously from winter drylot management, the amount of hay produced per cow in every year was insufficient by approximately 3,603 lb. DM/cow over three winters. The shortfall in summer hay production in the minimal land system required the additional input of hay into the system for winter management.

During the first 30 days of summer grazing, DM masses of SB-OG-BT forage available for grazing were not different between the three grazing systems (Table 11). In Yr1cows were moved to TF-RC and SB-RC pastures in month 2 which had greater DM masses than SB-OG-BT summer pastures in both the minimal land and year-round systems. This greater amount of DM mass in TF-RC and SB-RC pastures was due to 40 days of growth from 25 % of the pasture area. In Yr2 pastures of TF-RC and SB-RC had significantly lower DM yields than SB-OG-BT pastures of the minimal land system in month 2. Thereafter, the only other time that DM yields were different between systems was in month 5 of Yr2. Monthly average live forage density as estimated by sward heights, did not differ between SB-OG-BT summer pastures of the minimal land and year-round

Table 10. Summer hay production from minimal land system smooth bromegrass-orchardgrass-birdsfoot trefoil, year-round tall fescue-red clover or smooth bromegrass-red clover pastures.

Forage System											
Minimal land [a]				Year-round/TF-RC [b]				Year-round/SB-RC [b]			
Yr.1	Yr.2	Yr.3	Avg.	Yr.1	Yr.2	Yr.3	Avg.	Yr.1	Yr.2	Yr.3	Avg.
Gross hay, lb. DM											
10,862	10,092	8,779	9,911	25,187	19,331	23,970	22,829	25,874	22,269	30,526	26,223
Harvested acres, lb. DM/acre											
$2,896^{c}$	$2,018^{e}$	$1,756^{g}$	2,223	$2,144^{d}$	$1,289^{f}$	$1,598^{h}$	1,677	$2,202^{d}$	$1,485^{f}$	$2,035^{h}$	1,907
Total system lb. DM/acre											
$1,086^{c}$	$1,092^{e}$	878^{g}	991	$1,006^{d}$	733^{f}	959^{h}	913	$1,035^{d}$	891^{f}	$1,221^{h}$	1,049
Hay lb. DM/cow											
$2,715^{c}$	$2,523^{e}$	$2,195^{g}$	2,478	$5,037^{d}$	$3,866^{f}$	$4,794^{h}$	4,566	$5,175^{d}$	$4,454^{f}$	$6,105^{h}$	5,245

[a] Yr1 = 3.75 acres harvested
Yr2,3 = 5.0 acres harvested
[b] Yr1 = 11.25 acres harvested
Yr2,3 = 15 acres harvested
[cdefgh] Differences between means by year with different superscripts are significant P<.05.

grazing systems in the first month of both Yr1 and Yr2. In Yr1, during the second and third months, forages of TF-RC and SB-RC had greater sward heights than did forages of SB-OG-BT in the minimal land and year-round systems. During Yr2 sward heights were not different between the three grazing systems throughout the year. Monthly summer forage growth was measured by using grazing exclosures that were moved within pastures monthly. Total seasonal forage growth was not different between the three grazing systems in Yr1 (Table 12). In Yr2, however, minimal land and year-round/SB-RC grazing systems had greater seasonal forage yields than did the year-round/TF-RC grazing system. Monthly utilization of forage estimated through the use of the grazing exclosures varied as much as 75 % in the minimal land grazing system during Yr1, and 67% in Yr2.

Monthly forage in vitro dry matter digestibility (IVDDM) of SB-OG-BT pastures in the minimal land, year-round/TF-RC and year-round/SB-RC were not different at any time during Yr1 (Table 13). Forages of TF-RC and SB-RC had lower IVDDM concentrations than did SB-OG-BT forages in the second and third months of the summer grazing season in Yr1. The lower digestibility of TF-RC and SB-RC forages resulted from the advanced maturity of those forages. In Yr2, SB-OG-BT forages in the year-round/TF-RC and year-round/SB-RC systems had greater IVDDM concentration than minimal land SB-OG-BT, TF-RC and SB-RC forages in the second month of the season. Monthly forage CP concentrations in Yr1 were initially greater for SB-OG-BT forages in the year-round/SB-RC system, than the year-round/TF-RC system. In the fifth month of Yr1, SB-OG-BT forages in the minimal land system had CP concentrations of 15.4 % compared with 12.5 % of SB-OG-BT forages in the year-round/TF-RC. In Yr2, SB-OG-BT forages of the minimal land system had lower CP concentrations than did TF-RC forages in that year-round system. Crude protein concentrations were not different between SB-OG-BT forages in the three systems during Yr2. Concentrations of NDF in SB-OG-BT forages of the three grazing systems were different during only the fourth month of Yr.1 (Table 14). Concentrations of ADF were only different between SB-OG-BT forages of the minimal land and year-round/TF-RC in the fourth month of Yr2. The few number of differences in forage quality of SB-OG-BT in the minimal land and year-round systems would imply that use of yearling animals for the

Table 11. Monthly summer average dry matter yields of smooth bromegrass-orchardgrass-birdsfoot trefoil and tall fescue-red clover or smooth bromegrass-red clover forage available for grazing.

		Month					
		1	2	3	4	5	6
Forage	Grazing System						
		Minimal land					
SB-OG-BT	Yr.1	473	1,145[a]	1,083	1,003	1,192	1,390
	Yr.2	1,233	3,140[a]	2,210	1,557	2,616[b]	2,477
	Yr.3	1,580	2,933	1,743	2,740	2,353	2,535
		Year-round/TF-RC					
SB-OG-BT	Yr.1	675	925[c]	1,377	1,168	1,542	1,334
	Yr.2	1,108	1,997	2,204	2,063	3,679[a]	2,469
	Yr.3	1,550	1,711	2,081	3,515	2,936	3,117
TF-RC	Yr.1		2,461[b]	959			
	Yr.2		1,628[b]	1,615			
	Yr.3		1,119	1,564			
		Year-round/SB-RC					
SB-OG-BT	Yr.1	440	899[c]	1,440	1,631	1,186	1,152
	Yr.2	1,047	1,359[c]	2,745	2,090	2,192[b]	2,264
	Yr.3	1,478	1,858	2,409	3,285	3,031	2,983
SB-RC	Yr.1		1,789[b]	713			
	Yr.2		1,115[b]	1,231			
	Yr.3		862	1,250			

[abc] Differences between means by year with different superscripts are significant P<.05.

Table 12. Summer forage growth and utilization of smooth bromegrass-orchardgrass-birdsfoot trefoil pastures.

	Forage System								
	Minimal Land			Year-round/TF-RC			Year-round/SB-RC		
	Yr.1	Yr.2	Yr.3	Yr.1	Yr.2	Yr.3	Yr.1	Yr.2	Yr.3
Monthly growth, lb./ac									
1	1,563	1,680	1,099	1,730	860	1,498	2,019	1,771	771
2	902	1,528	1,874	590	1,275	1,106	975	1,574	1,679
3	262	181	2,160[a]	175	-270	1,198[b]	425	672	2,131
4	605	1,152	901	1,022	1,375	1,915	374	1,524	580
5	394	1,099	1,082	314	53	860	-79	388	1,871
6	386	275	750	351	-404	403	689	-107	-158
Total	4,112	5,915	7,865	4,183	2,889	6,981	4,403	5,822	6,8373
Utilization, %									
1	-7.5	1.1[A]	10.0	41.3	20.9[B]	39.8	19.2	33.6[B]	19.8
2	67.5	52.9	54.4	61.1	33.5	32.7	60.2	25.9	11.0
3	62.3	68.7[a]	55.0[B]	69.6	61.6[b]	32.1[A]	49.6	62.9[b]	53.8[B]
4	54.8	35.4[A]	58.3	37.2[A]	12.1[B]	55.1	65.3[B]	53.7[C]	52.2
5	51.5	60.4	56.6[A]	64.9	63.8	52.1[B]	64.4	61.5	54.8
6	57.8	66.6	59.9	62.1	71.2	55.8	54.5	60.4	61.5

[ABC] Differences between means by year with different superscripts are significant P<.05.
[ab] Differences between means by year with different superscripts are significant P<.1.

Table 13. Summer monthly in vitro digestibility and crude protein of forage available for grazing.

	Grazing system									
	Minimal land		Year-round/TF-RC				Year-round/SB-RC			
	SB-OG-BT		SB-OG-BT		TF-RC		SB-OG-BT		SB-RC	
Month	Yr 1	Yr 2	Yr 1	Yr 2	Yr 1	Yr 2	Yr 1	Yr 2	Yr 1	Yr 2
IVDDM										
1	61.6	50.7	68.2	48.5			59.6	52.0		
2	63.4^{a}	56.0^{a}	65.7^{a}	68.0^{b}	49.4^{b}	53.0^{a}	72.3^{a}	76.1^{b}	49.5^{b}	57.2^{a}
3	74.3^{a}	75.0	68.3^{a}	73.6	49.7^{b}	69.3	67.3^{a}	72.4	52.4^{b}	70.3
4	58.1	77.5^{a}	64.5	66.2^{b}			58.3	68.7		
5	55.9	74.0	64.1	69.9			59.0	71.3		
6	52.0	83.6	49.6	79.3			54.9	83.3		
Crude Protein %										
1	15.4	15.5	14.1^{a}	14.6			17.6^{b}	16.3		
2	11.5	11.1	12.5	12.1	12.6	12.1	11.4	11.9	10.9	10.8
3	12.3	10.2^{a}	11.5	13.3	11.6	13.1^{b}	13.0	11.3	12.9	12.1
4	15.0	11.5	12.9	12.1			13.9	12.3		
5	15.4^{a}	12.6	12.5^{b}	17.7			12.0	12.5		
6	12.8	13.3	12.4	13.7			11.0	12.9		

^{ab} Differences between means by year with different superscripts are significant P<.05.

Table 14. Summer monthly neutral detergent fiber and acid detergent fiber of forage available for grazing.

	Grazing system									
	Minimal land		Year-round/TF-RC				Year-round/SB-RC			
	SB-OG-BT		SB-OG-BT		TF-RC		SB-OG-BT		SB-RC	
Month	Yr 1	Yr 2	Yr 1	Yr 2	Yr 1	Yr 2	Yr 1	Yr 2	Yr 1	Yr 2
NDF %										
1	61.6	50.7	68.2	48.5			59.6	52.0		
2	63.4^{a}	56.0^{a}	65.7^{a}	68.0^{b}	49.4^{b}	53.0^{a}	72.3^{a}	76.1^{b}	49.5^{b}	57.2^{a}
3	74.3^{a}	75.0	68.3^{a}	73.6	49.7^{b}	69.3	67.3^{a}	72.4	52.4^{b}	70.3
4	58.1	77.5^{a}	64.5	66.2^{b}			58.3	68.7		
5	55.9	74.0	64.1	69.9			59.0	71.3		
6	52.0	83.6	49.6	79.3			54.9	83.3		
ADF %										
1	15.4	15.5	14.1^{a}	14.6			17.6^{b}		16.3	
2	11.5	11.1	12.5	12.1	12.6	12.1	11.4	10.9	11.9	10.8
3	12.3	10.2^{a}	11.5	13.3	11.6	13.1^{b}	13.0	12.9	11.3	12.1
4	15.0	11.5	12.9	12.1			13.9		12.3	
5	15.4^{a}	12.6	12.5^{b}	17.7			12.0		12.5	
6	12.8	13.3	12.4	13.7			11.0		12.9	

^{ab} Differences between means by year with different superscripts are significant P<.05.

management of excess forage produced forage equal to that produced by hay harvest management.

Yearling animal data are to be collected over the three years of the project. Currently two years of results are available for review but have not been statistically analyzed. Total days on feed were not different between minimal land and year-round system animals (Table 15). The similarity in days on feed in Yr1 is due to the 180 days both groups spent in a winter drylot. In Yr2, minimal land animals' days on feed were only in the feedlot, whereas year-round animals days on feed were both in the winter drylot and feedlot. Daily stored feed use was not different between the two groups of animals in both years, and total feed use in Yr1 was similar. Daily gain for the entire time spent on feed was greater for animals in the minimal land system in both years. Year-round system animals seemed to make more efficient use of stored feeds in Yr1, whereas in Yr2 minimal land system animals seemed to be more efficient. Carcass data were collected on animals.

Year-round animals were evaluated by ultrasound each year approximately 90 days after entering the feedlot to estimate back fat in each year. Attempts were made to finish animals from minimal land and year-round systems to equal levels in each year. Year-round animals tended to have heavier carcasses, higher marbling scores, larger ribeye areas, and higher numbers of animals grading choice. Back fat differed by .07 inches in Yr1 and was equal in Yr2.

Table 15. Yearling animal feed use and feed efficiency and carcass characteristics.

	Grazing system			
	Minimal land		Year-round	
	Yr 1	Yr 2	Yr 1	Yr 2
Days on feed	330	211	320	295
Stored feed use lb./day	20.2	18.9	20.9	18.3
Total feed use, lb. DM	6,679	4,004	6,684	5,401
Daily gain, lb./day	2.05	2.99	1.89	2.46
Feed efficiency lb. DM fed/lb. gain	9.9	6.3	11.1	7.5
Carcass Wt, lb.	732	721	791	758
Marbling score [a]	990	1054	1037	1062
Ribeye area, sq. in.	13.25	13.29	14.86	15.09
Back fat, in	.36	.58	.43	.58
Yield grade	1.89	2.0	2.0	2.1
% Choice	44	83	75	80

[a] 900 = slight, 1000 = small, 1100 = modest, 1200 = moderate.

Implications

An outstanding feature of this experiment is that the year-round system utilizes more land than the minimal land system. The year-round system produces more hay than is consumed in the systems by cows and calves in winter drylot. The addition of the extra land also allows for winter grazing of cows that reduces the amount of supplemental feed required for winter management. The forage produced for winter grazing is in adequate amounts and of adequate quality to produce increased in cow body condition scores in the late winter after calving. The use of yearling animals in the year-round system as a method to control excess spring forage resulted in forages of equal quantity and quality to that of hay harvest. Calf daily gains were equal in each system, but because of the larger land area in the year-round system, seasonal gains were lower on the year-round system.

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