Integration of Year-round Forage Management Systems for Spring-calving and Fall-calving Beef Cows (A Progress Report)

A. S. Leaflet R1778

N. A. Janovick, graduate assistant in animal science
J. R. Russell, professor of animal science
D. R. Strohbehn, professor of animal science
D. G. Morrical, professor of animal science
S. K. Barnhart, professor of agronomy
D. Maxwell, beef herdsman, McNay Research and Demonstration Farm
L. J. Secor, superintendent, McNay Research and Demonstration Farm

Summary

Animal production, hay production and feeding, winter forage composition changes, and summer pasture yields and nutrient composition of a year-round grazing system for spring-calving and fall-calving cows were compared to those of a conventional, minimal land system. Cows in the year-round and minimal land systems grazed forage from smooth bromegrass-orchardgrass-birdsfoot trefoil (SB-O-T) pastures at 1.67 and 3.33 acres, respectively, per cow in the summer. During the summer, SB-O-T pastures in the year-round grazing system also were grazed by stockers at 1.67 stockers per acre, and spring-calving and fall-calving cows grazed smooth bromegrass–red clover (SB-RC) and endophyte-free tall fescue–red clover (TF-RC) at 2.5 acres per cow for approximately 45 days in midsummer. In the year-round grazing system, spring-calving cows grazed corn crop residues at 2.5 acres per cow and stockpiled SB-RC pastures at 2.5 acres per cow; fall-calving cows grazed stockpiled TF-RC pastures at 2.5 acres per cow during winter. In the minimal land system, in winter, cows were maintained in a drylot on first-cutting hay harvested from 62.5–75% of the pasture acres during summer. Hay was fed to maintain a body condition score of 5 on a 9-point scale for spring-calving cows in both systems and a body condition score of 3 for fall-calving cows in the year-round system. Over 3 years, mean body weights of fall-calving cows in the year-round system did not differ from the body weights of spring-calving cows in either system, but fall-calving cows had higher ($P < .05$) body condition scores compared to spring-calving cows in either system. There were no differences among all groups of cows in body condition score changes over the winter grazing season ($P > .05$). During the summer grazing season, fall-calving cows in the year- round system and spring-calving cows in the minimal land system gained more body condition and more weight ($P < .05$) than spring-calving cows in the year-round grazing system. Fall calves in the year-round system had higher birth weights, lower weaning weights, and lower average pre-weaning daily gains compared to either group of spring calves ($P < .05$). However, there were no significant differences for birth weights, weaning weights, or average pre-weaning daily gains between spring calves in either system over the 3-year experiment ($P > .05$). The amount of total growing animal production (calves and stockers) per acre for each system did not differ in any year ($P > .05$). Over the 3-year experiment, 1.9 ton more hay was fed per cow and 1 ton more hay was fed per cow–calf pair in the minimal land system compared to the year-round grazing system ($P < .05$).

Introduction

Stored feeds comprise almost half of the production costs for beef cow–calf enterprises in Iowa. Therefore, any reduction in the amount of stored feeds used to maintain cows through the winter will impact the maintenance costs of a cow–calf herd. Two resources that may be used to reduce winter feed costs are corn crop residues and stockpiled perennial forage for grazing. Depending on the area of the state, farmers have variable amounts of corn crop residues or pasture that could be managed for winter grazing. Therefore, there is a need to design and evaluate grazing systems to integrate the use of each of these resources.

In a previous experiment, spring-calving cows grazing 1.5 acres per cow of corn crop residues and 3 acres per cow of stockpiled forage for winter grazing required 390 lbs. hay dry matter/cow compared to 6313 lbs. hay dry matter/cow for cows maintained in a drylot. Though the use of stockpiled forage reduces the amount of hay needed for the winter, it also results in production of excess forage during summer that must be managed to maintain forage quality. The use of stocker cattle to graze excess forage in early to mid-summer was proven effective in removing excess forage and maintaining pasture quality for the cows and calves in the system. Because stocker cattle must be maintained during the winter months, spring calves that are kept require more stored feeds compared to fall calves kept with their dams through the winter. Therefore, the addition of fall-calving cows to a year-round grazing system could prove to be a practical way to further reduce stored feed costs. Furthermore, fall-calving cows have lower nutritional requirements during the summer months and, therefore, can be used to graze areas of the pastures that animals with

higher nutrient requirements have previously grazed in a leader–follower stocking system.

The objectives of this experiment were to compare the amounts of stored feeds needed to maintain cows and calves during winter and the amounts of growing animal production from summer pasture between a year-round grazing system utilizing corn crop residue and stockpiled forages during winter and a minimal land system utilizing winter feeding of hay produced from summer pasture.

Materials and Methods

Forage Systems

Year-round and minimal land grazing systems were developed and evaluated (Table 1). A graphic illustration of grazing systems is found in the appendix immediately following this report. To initiate the experiment, first-cutting hay was harvested from replicate 15-acre endophyte-free tall fescue-redclover (TF-RC) and smooth bromegrass-red clover (SB-RC) pastures in the summer of 1998. Second-cutting forage in these pastures was grazed by 5 cow–calf pairs and 1 bull as part of a previous experiment. In early August, 40 lbs. N/acre was applied to each of these pastures, and the forage was allowed to stockpile until early November. First-cutting hay for cows to be maintained in the drylot was cut from 10 acres of replicate smooth bromegrass-orchardgrass-birdsfoot trefoil (SB-O-T) pastures. Second-cutting forage from these pastures was incorporated into a rotational stocking system for 8 cows.

On November 13, 1998, 24 spring-calving Angus-cross cows in midgestation were randomly assigned to one of two drylots in the minimal land system or to one of two CCR fields (2.5 acres/cow) in the year-round grazing system. At the same time, 12 Angus-cross cows with fall calves were randomly assigned to one of two TF-RC pastures in the year-round grazing system. One bull also was assigned to each of the TF-RC pastures. Eighty-five days after initiation of grazing, spring-calving cows grazing CCR were moved to SB-RC pastures to graze for the remainder of the winter grazing season (approximately 81 days). Because of heavy snow cover, hay was offered to the spring-calving cows and fall-calving cows in the year-round grazing system on the pastures to maintain condition scores of 5 and 3, respectively. Calves were weaned on March 3, 1999, and fed a hay-corn gluten feed diet until summer grazing was initiated. Additionally, 12 calves from the previous season's spring-calving cows were maintained on a hay-corn gluten feed diet over winter until summer grazing was initiated.

On April 22, 1999, both groups of 6 cows from the drylot in the minimal land system were assigned to one of two SB-O-T pastures and were rotationally stocked on 5 of the 20 acres. First-cutting hay was harvested from the remaining 15 acres of each pasture in June. This land was incorporated into the grazing system after a minimum of 28 days of regrowth, and the entire area of each pasture was rotationally grazed until October 28, 1999. In the year-round grazing system, spring-calving and fall-calving cows and stockers were assigned to one of two 20-acre SB-O-T pastures on April 22, 1999. Hay was harvested from the 15-acre SB-RC and TF-RC pastures in June. After a minimum of 28 days of regrowth, fall-calving cows were moved to the TF-RC pastures and spring-calving cows with calves and bulls were moved to the SB-RC pastures to graze until early August. Stockers remained on the SB-O-T pastures during this time. In August, cows grazing stockpiled pastures were then moved back to the SB-O-T pastures to graze until October 28, 1999, and stockers were removed and finished in a feedlot.

The experiment was repeated on October 28, 1999, when spring calves from the minimal land system were weaned and finished in the feedlot and spring calves from the year-round grazing system were placed on a hay-corn gluten feed diet in a drylot. Cows in the minimal land system were again placed in replicate drylots and fed hay to maintain a body condition score of 5 throughout the winter. Cows in the year-round grazing system were moved to their respective pastures to initiate winter grazing. Approximately 80 days after initiation of grazing, spring-calving cows on CCR pastures were moved to SB-RC pastures to continue to graze through the winter. Fall calves were weaned March 3, 2000, and placed on a hay-corn gluten feed diet for the remainder of the winter.

Summer grazing was initiated for cows in both systems on April 26, 2000. Because of lack of rain and resulting poor forage growth in both summer and stockpiled pastures, only 12.5 acres of the SB-O-T pastures in the minimal land system and 7.5 acres of the TF-RC and SB-RC pastures in the year-round grazing system were harvested as hay. Paddocks not cut for hay in the minimal land system were incorporated into the rotational stocking system to maintain adequate forage for grazing on the pastures. Cows in the year-round grazing system grazed 7.5 acres of the TF-RC and SB-RC pastures in May for two weeks and 15 acres of these pastures from late June to early August. Stockers were removed from SB-OG-T pastures on August 2, 2000, when spring-calving and fall-calving cows again were stocked in these pastures for the remainder of the summer grazing season.

On October 18, 2000, spring calves were weaned and the final winter grazing season was initiated by placing cows in their respective pastures or drylot. Spring calves from the minimal land system were finished in a feedlot and spring calves from the year-round grazing system were fed a hay-corn gluten feed diet in a drylot. Spring-calving cows in the year-round grazing system were moved from the CCR fields to the SB-RC pastures on January 17, 2001. Fall calves also were weaned at this time because of heavy snow and subsequent falling body condition scores of their dams. These calves were maintained in a drylot on a hay-corn gluten feed diet until initiation of the final summer grazing

Table 1. Summary of cow-calf movement though the year-round and minimal land grazing systems[a].

Winter Calendar	Forage System		
	Year Round Grazing		Minimal Land
Month	Fall Calving	Spring Calving	Spring Calving
November	Two groups of 6 fall calving cows with calves and 1 bull graze 7.5 acres of stockpiled endophyte-free tall fescue red clover (TF-RC) for 2 months (.54 ac/cow/mo).	Spring calves are weaned and fed hay in a drylot. Two groups of 6 spring calving cows graze 15 acres of corn crop residue per group for 2 to 3 months (.83 ac/cow/mo).	Spring calves are weaned and finished in a feedlot. Two groups of 6 cows are fed hay (summer production) in a drylot to maintain a body condition score of 5 (9-point scale).
January	Cows with calves graze an additional 7.5 acres of stockpiled TF-RC for 4 months (.62 ac/cow/mo). If needed, hay (summer production) fed to maintain body condition score greater than 3 (9 point scale).	Cows continue to graze corn crop residue.	Cows continue to be fed hay.
February	Cows continue to graze TF-RC pastures.	Cows are moved to graze 15 acres of stockpiled smooth bromegrass–red clover (SB-RC) per group for 3–4 months (.83 ac/cow/mo).	Cows continue to be fed hay.
March	Fall calves are weaned if not done previously (weaning criteria: calves weaned when 50% of cow's condition scores are 3 or lower). Cows continue to graze TFRC pastures.	Cows begin calving in late March and continue to early April.	Cows begin calving in late March and continue to early April.
Summer Calendar			
April	Cows moved to summer pastures as pasture growth permits. Cows will follow-graze behind spring-calving cows and stockers for 50% forage removal.	Cows moved to summer pastures as pasture growth permits. Cows and calves and stockers lead graze, for 34% forage removal, 20 acres of smooth brome-orchardgrass-birdsfoot trefoil (SB-O-T) per group.	Cows and calves rotationally graze 5 acres of a 20-acre smooth brome–orchardgrass-birdsfoot trefoil (SB-O-T) pasture per group (1.2 au/ac). Cows are rotated between paddocks daily.
May	First cutting hay baled on 15-acre TF-RC pastures. Cows continue follow grazing in SB-O-T pastures.	First cutting hay baled on 15-acre SBRC pastures. Cows and calves and stockers continue lead grazing in SB-O-T pastures.	First cutting hay baled from ungrazed portion of 20 acre pasture (15 acres). Cows and calves continue to graze 5 acres of SB-O-T pastures.
June	Cows moved to strip-graze 15-acre TF-RC pastures at .4 au/ac.	Breeding is initiated for cows. Cows and calves and 1 bull per group are moved to strip-graze 15 acres of SB-RC pastures at .47 au/ac. Stockers continue to graze in SB-O-T pastures at .3 au/ac at a 50% forage removal rate.	Breeding is initiated for cows. Cows and calves with 1 bull per group continue to graze 5 acres of SB-O-T pastures at 1.4 au/ac and at a 50% forage removal rate. If available forage becomes inadequate, hay will be fed *ad lib*.
July	Cows continue to graze TF-RC pastures.	Cows continue to graze SB-RC pastures.	The 15 hayed acres are incorporated into the rotational grazing system. Grazing is now over the entire 20 acres and is grazed at .35 au/ac.
August	Cows moved back to SB-O-T pastures to graze at .6 au/ac. Fall calving begins. TFRC pastures are fertilized.	Cows moved back to SB-O-T pastures to graze at .6 au/ac. Stockers are moved to the feedlot to be finished. SBRC pastures are fertilized.	Cows and calves and continue to grazed 20 acres of SB-O-T pastures at .3 au/ac. Calves are weaned before cows are placed in drylot for the winter.
November	System is repeated	System is repeated	System is repeated

[a]A graphic illustration of the grazing systems can be found in the appendix immediately following this report.

Notes:

1) An animal unit (au) is defined as 1 cow with or without a calf, 2 stockers, or 1 bull.
2) Stockers are defined as fall calves weaned in March and spring calves from the previous calving season (yearlings).
3) When not grazing in the summer pastures, stockers are maintained on a hay-corn gluten feed diet.
4) Groups of cows (i.e., year-round fall calving, year-round spring calving, minimal land spring calving) are replicated. Each cow group is 12 cows.
5) Pastures are replicated. Each system has two of each pasture described. (Eg., in January, the first set of 6 cows, with calves, grazes one 15-acre TF-RC pasture, and the second set of 6 cows, with calves, grazes another 15-acre TF-RC pasture.
   Exception: A summer pasture is "shared" by one group of year-round fall-calving cows, spring-calving cows, and stockers. There are two of these "shared" summer pastures.)

season. As in previous seasons, spring-calving and fall-calving cows were fed hay to maintain mean body condition scores of 5 and 3.

The final summer grazing season was initiated on May 2, 2001, when all cows were moved back to SB-OG-T pastures. Hay was harvested in June from 15 acres of these pastures in the minimal land system and from the 15-acre SB-RC and TF-RC pastures in the year-round grazing system. After regrowth, harvested paddocks were incorporated into the rotational stocking system for cows in the minimal land system. Fall-calving and spring-calving cows strip-grazed in the TF-RC and SB-RC in July, while stockers remained on the SB-OG-T pastures to control excess forage growth. On July 30, 2001, stockers were finished in a feedlot and fall-calving and spring-calving cows were stocked once again in the SB-OG-T pastures for the remainder of the summer. Summer grazing was terminated on October 26, 2001.

Measurements

Through the winter grazing season, cows were scored for body condition biweekly by one person. Cow and calf weights were measured at initiation of grazing, at transition from corn crop residue to stockpiled forage grazing, at weaning of fall calves, and at the end of the winter grazing period. In the summer, stocker, cow, and calf weights were measured and cows were condition-scored monthly. Reproductive performance was determined by rectal palpation at a minimum of 45 days post-breeding, and open cows were replaced at the time their calves were weaned.

During the fall and winter, corn crop residues were hand-sampled monthly in two 4-m^2 locations per paddock. Stockpiled forages were hand-clipped monthly in three .25-m^2 locations per paddock. To determine the effects of winter weather on forage quantity and quality, samples were collected monthly from four 1-m^2 and two 24-m^2 grazing cages in the stockpiled forage pasture and corn crop residue fields, respectively. To estimate live forage mass and regulate grazing intervals in summer pastures, sward heights were measured with a falling plate meter (4.8 kg/m^2) in four locations per paddock, when cows were moved into or out of a paddock. To measure forage quality and nutritive value of forages in pastures, forage samples were hand-clipped monthly in three .25 m^2 locations per paddock. Forage samples were weighed, dried, and analyzed for organic matter, digestibility, fiber, crude protein, and unavailable protein.

Results and Discussion

Animal Performance and Production

Body condition score changes for cows in both the minimal land and year-round grazing systems were compared on chronological and physiological bases (Tables 2 and 3). Over the three-year experiment, there were no differences in initial body condition score or seasonal change in body condition score among all groups of cows in both systems. However, when averaged, fall-calving cows in the year-round grazing system had higher body condition scores at the initiation of the winter grazing season. Both fall-calving cows in the year-round grazing system and spring-calving cows in the minimal land system lost less condition over the summer grazing season compared to the spring-calving cows in the year-round grazing system. Over all three years, fall-calving cows lost condition after calving

Table 2. Condition score changes (9-point scale) of spring-calving and fall-calving cows in the year-round grazing and minimal land systems for winter grazing seasons.

		System		
		Year round		Minimal land
	Date	Fall calving	Spring calving	Spring calving
Winter 1				
Initial score	11Nov98	5.2	4.9	5.0
Overall change	22Apr99	-0.5	-0.3	-0.2
Winter 2				
Initial score	28Oct99	5.9	5.0	5.2
Overall change	26Apr00	0.2	0.7	0.4
Winter 3				
Intial score	18Oct00	6.5	5.2	5.7
Overall change	2May01	-1.3	-0.4	-1.2
Average				
Initial Score	Late Oct	5.8[a]	5.0[b]	5.3[b]
Overall change	Late Apr	-0.2	0.2	-0.2

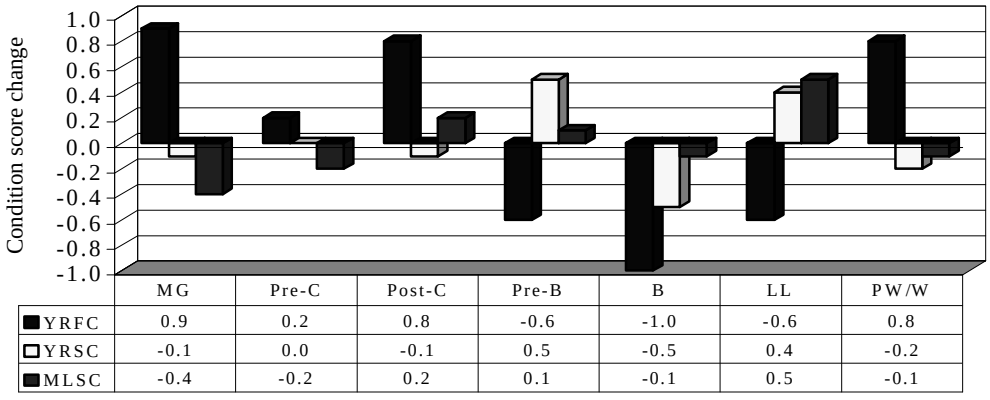
[abc]Differences between means among different cow groups with different superscripts are significant (P < .05).

Table 3. Condition score changes (9-point scale) of spring-calving and fall-calving cows in the year-round grazing and minimal land systems for summer grazing seasons.

		System		
		Year-round		Minimal land
	Date	Fall calving	Spring calving	Spring calving
Summer 1				
Initial score	22Apr99	4.8	4.7	4.6
Overall change	28Oct99	1.1	0.3	0.8
Summer 2				
Initial score	26Apr00	5.8	5.5	5.6
Overall change	18Oct00	1.0	-0.1	0.3
Summer 3				
Initial score	2May01	5.0	5.0	4.5
Overall change	26Oct01	1.0	-0.5	0.5
Average				
Initial score	Late Apr	5.2	5.0	4.9
Overall change	Late Oct	1.0[a]	-0.1[b]	0.5[a]

[ab]Differences between means among different cow groups with different superscripts are significant (P < .05).

Figure 1. Average condition score changes (9 pt scale) at different productions stages for spring-calving and fall-calving cows in the year round and minmal land grazing systems.



[a]Key to production stage abbreviations: MG = mid-gestation; Pre-C = pre-calving; Post-C = post-calving; Pre-B = pre-breeding; B = breeding; LL = late lactation; PW/W = post-weaning (fall cows)/weaning (spring cows).

and while nursing calves and grazing stockpiled forage; however, they were able to regain condition after weaning (Figure 1). Fall-calving cows lost more condition during the period from calving to the initiation of the breeding season compared to either group of spring-calving cows; however, this did not affect rebreeding rates.

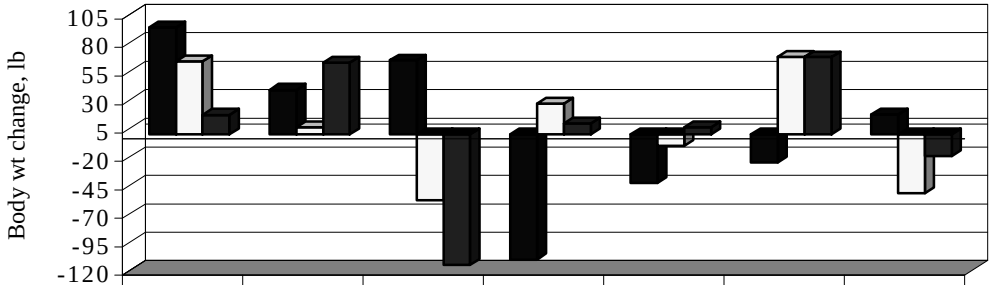
Trends in body weight changes for cows over the grazing seasons were similar to those observed for body condition score changes. Over the first winter, fall-calving cows had greater body weight losses than spring-calving cows in either system (Table 4). Body weight changes of cows in years 2 and 3 did not differ between treatments. Similarly, body weight changes of cows did not differ between treatments in any year (Table 5). On average, fall-calving cows in the year-round grazing system lost more weight over the winter grazing season compared to spring-calving cows in this system (Table 4); however, they gained more body weight over the summer grazing season than spring-calving cows in the year-round grazing system. On a comparable physiological basis, fall-calving cows in the year-round grazing system gained more body weight post-weaning compared to either group of spring-calving cows (Figure 2). Spring-calving cows in the minimal land system lost more body weight from calving to initiation of summer grazing than did spring-calving cows in the year-round grazing system over all of the winter grazing season. Body weight gains during the post-calving period from the pre-calving weight in early August to the post-calving weight in late September for fall-calving cows in the year-round grazing system were greater than those measured between early March and late April for spring-calving cows in either system. Spring-calving cows in both the minimal land and year-round grazing systems regained body weight while nursing calves on summer pastures during the pre-breeding and late lactation stages. Fall-calving cows lost body weight in similar physiological states.

Table 4. Body weight changes of spring-calving and fall-calving cows in the year-round grazing and minimal land systems for winter grazing seasons.

		System		
		Year round		Minimal land
	Date	Fall calving	Spring calving	Spring calving
Winter 1				
Initial score	11Nov98	1214.0	1157.5	1165.0
Overall change	22Apr99	-66.5[a]	12.5[b]	-20.5[a]
Winter 2				
Initial score	28Oct99	1237.5	1176.5	1231.5
Overall change	26Apr00	42.5	82.0	6.5
Winter 3				
Intial score	18Oct00	1340.5	1281.5	1285.5
Overall change	2May01	-126.0	-59.0	-90.0
Average				
Initial Score	Late Oct	1264.0	1205.2	1227.3
Overall change	Late Apr	-50.0[a]	11.8[b]	-34.7[ab]

[abc]Differences between means among different cow groups with different superscripts are significant ($P < .05$).

Figure 2. Average body weight changes at different productions stages for spring-calving and fall-calving cows in the year round and minmal land grazing systems.



	MG	Pre-C	Post-C	Pre-B	B	LL	PW/W
YRFC	94	39	65	-110	-43	-25	17
YRSC	64	6	-58	27	-10	68	-52
MLSC	17	63	-115	10	6	68	-19

Production stage[a]

[a]Key to production stage abbreviations: MG = mid-gestation; Pre-C = pre-calving; Post-C = post-calving; Pre-B = pre-breeding; B = breeding; LL = late lactation; PW/W = post-weaning (fall cows)/weaning (spring cows).

Table 5. Body weight changes of spring-calving and fall-calving cows in the year-round grazing and minimal land systems for summer grazing seasons.

		System		
		Year-round		Minimal land
	Date	Fall calving	Spring calving	Spring calving
Summer 1				
Initial score	22Apr99	1152.5	1173.0	1150.0
Overall change	28Oct99	84.5	3.0	99.5
Summer 2				
Initial score	26Apr00	1250.0	1225.5	1237.0
Overall change	18Oct00	90.0	68.5	99.0
Summer 3				
Initial score	2May01	1214.5	1190.5	1196.0
Overall change	26Oct01	48.0	-11.5	21.0
Average				
Initial score	Late Apr	1205.7	1196.3	1194.3
Overall change	Late Oct	74.2[a]	20.0[b]	73.2[a]

[ab]Differences between means among different cow groups with different superscripts are significant ($P < .05$).

Rebreeding rates for spring-calving cows in the year-round grazing system were greater than spring-calving cows in the minimal land system in year 1 (Table 6). In year 2, spring-calving cows in either system had lower rebreeding rates than fall-calving cows in the year-round grazing system. Despite harsh winter weather conditions in year 3, there were no differences between fall-calving cows in the year-round grazing systems and spring-calving cows in either system. Similarly, there were no differences in rebreeding rates between fall-calving cows in the year-round grazing system and spring-calving cows in either system.

Table 6. Rebreeding rates for spring-calving and fall-calving cows in the year-round grazing and minimal land systems.

Year	Cow group	Percent rebred
1	Year round fall-calving	83.5[a]
	Year round spring-calving	100[b]
	Minimal land spring-calving	83.0[a]
2	Year-round fall calving	100[a]
	Year-round spring calving	75.0[b]
	Minimal land spring calving	83.0[b]
3	Year-round fall calving	100
	Year-round spring calving	75.0
	Minimal land spring calving	91.5
Average	Year-round fall calving	94.5
	Year-round spring calving	83.3
	Minimal land spring calving	85.8

[ab]Differences between means among different cow groups with different superscripts are significant (P < .05).

Birth weights for fall calves in the year-round grazing system were greater than birth weights for spring calves in the minimal land system in year 2 (Table 7). Because fall calves entered the first winter grazing season in November, birth weights were not compared for that year. In each year, pre-weaning average daily gains and weaning weights of spring calves in either system did not differ. However, pre-weaning daily weight gains and weaning weights of fall-calves in the year-round grazing system were 21% lower than spring calves in either system.

Table 7. Birth weights, weaning weights, and average daily gains of calves in both the year-round and minimal land grazing systems.

	Summer grazing system		
	Year round		Minimal land
	Fall calves	Spring calves	Spring calves
Birth wts., lbs.			
Year 1	--	98.5	96.5
Year 2	100.0[a]	93.5[b]	91.0[b]
Year 3	93.0	85.5	84.5
Average	96.5[a]	89.5[b]	87.8[b]
Weaning wts., lbs.			
Year 1	415.5[a]	499.0[ab]	480.5[a]
Year 2	468.5[a]	545.0[ab]	549.0[b]
Year 3	346.0[a]	516.5[b]	514.0[b]
Average	410.0[a]	520.2[b]	514.5[b]
Average daily gain, lb/day			
Year 1	1.8[a]	2.6[b]	2.4[b]
Year 2	2.0[a]	2.4[b]	2.6[b]
Year 3	1.9	2.2	2.3
Average	1.9[a]	2.4[b]	2.4[b]

[ab]Differences between means among different calf groups with different superscripts are significant (P < .05).

Because of the difference in the area of perennial forage used in the two systems, calf production per unit of perennial forage from the year-round grazing system was 38% lower than the minimal land system (Table 8). However, after weights gains of grazing stockers are added to those of the calves in the year-round grazing system, total growing animal weight gains in the year-round grazing system were only 9% lower than in the minimal land system.

Hay Production and Feeding

In year 1, no differences in hay production were observed between the year-round grazing and minimal land systems expressed either on a per-acre or per-cow basis (Table 9). However, in year 2, hay yields per acre from the SB-O-BFT pastures in the minimal land system were greater than those from the TF-RC and SB-RC fields used in the year-round grazing system. Furthermore, since more area in the SB-O-BFT fields in the minimal land system was harvested as hay in year 2, hay production per cow in the minimal land system were greater than that from the year-round grazing system when expressed on a per-cow basis. Over the three years, spring-calving cows in the minimal land system required 3745 lbs. more hay per cow and 1974 lb more hay per cow–calf pair than did the mean of spring-calving and fall-calving cows grazing stockpiled pasture with or without corn crop residues in the year-round grazing system. Over the three years, fall-calving cows grazing stockpiled forages required a mean of 700 lbs. less hay dry matter per cow and 2376 lbs. less hay dry matter per cow–calf pair than did spring-calving cows sequentially grazing corn crop residues and stockpiled forages.

Table 8. Growing animal production from the year round and minimal land grazing systems.

			Summer grazing system	
	Calf group		Year round	Minimal land
Year	Pre-weaning production	Date	lb/ac perennial pasture	
	Fall calves			
1		11-Nov-98 to 3-Mar-99	24.2	--
2		28-Oct-00 to 2-Mar-00	44.2	--
3		18-Oct-00 to 17-Jan-01	30.4	--
Ave.			32.9	--
	Spring calves			
1		22-Apr-99 to 28-Oct-99	32.4	115.5
2		26-Apr-00 to 18-Oct-00	54.2	137.5
3		2-May-01 to 26-Oct-01	51.7	129.0
Ave.			46.1	127.3
	Post-weaning production[x]			
	Spring calves	22-Apr-99 to 5-Aug	16.3	--
1		26-Apr-00 to 2-Aug-00	20.5	--
2		2-May-01 to 30-Jul-01	13.7	--
3			16.8	--
Ave.				
	Fall calves		18.7	
1		22-Apr-99 to 5-Aug	15.6	--
2		26-Apr-00 to 2-Aug-00	9.5	--
3		2-May-01 to 30-Jul-01	14.6	--
Ave.				--
	Total production[y]			
1			107.5	115.5
2			134.5	137.5
3			105.5	129.0
Ave.			115.8[a]	127.3[b]

[ab]Differences between means among different calf groups with different superscripts are significant, $P < .05$.

[x]Designates stocker production on summer pastures.

[y]There was a significant effect of year on average total production, $P < .02$.

Because of the lack of difference in hay production and the differences in amounts of hay required, cows maintained in a drylot in the minimal land system required 1783 lbs. hay DM/cow more than was produced, while the year-round grazing system resulted in a positive hay balance of 3377 lbs/cow in year 1. In year 2, hay production from pastures in the minimal land system exceeded the amounts required by 2486 lbs. hay DM/cow compared to an excess of 4236 lbs/cow in the year-round grazing system. In year 3, even during poor winter weather conditions and early weaning of fall calves, cows in the minimal land system required approximately 3000 lbs. DM/cow and 1400 lbs. DM/cow–calf pair more than the mean for the year-round grazing system. Over the three years, the minimal land system produced 1000 more lbs. DM/ac and 1000 more lbs. DM/cow than did the year-round grazing system (Table 10). However, to maintain cows in the minimal land system required 3700 lbs. DM/cow more than the year-round grazing system; therefore, the hay balance for the minimal land was –690 lbs. hay DM/cow compared to 2070 hay DM/cow in the year-round grazing system. Maintaining spring stockers in the drylot resulted in 2300 lbs. DM/cow–calf pair more than did maintaining fall stockers within the year-round grazing system. After adding hay required for stockers, the difference between the amount of hay harvested and required was 298 lbs. hay DM/cow–calf pair.

Table 9. Years 1, 2, and 3 of hay production, feeding, and balance for year-round and minimal land systems.

	System			
	Year-round			Minimal land
	Fall calving	Spring calving	System mean	
Year 1				
Hay production,				
Lbs/harvested ac[c]	1598	2035	1817	1171
Lbs/cow	3995	5088	4541	2926
Hay fed,				
Lbs/cow	923	1373	1148[a]	4732[b]
Lbs/cow–calf	1303[x]	4110[y]	2706[a]	4732[b]
Hay balance,				
Lbs/cow	3071	3714	3393[a]	-1805[b]
Lbs/cow–calf	2692	978	1835	-1805
Year 2				
Hay production,				
Lbs/harvested ac[c]	1481	1907	1694[a]	2883[b]
Lbs/cow	3703	4768	4236[a]	7206[b]
Hay fed,				
Lbs/cow	0	0	0[a]	4720[b]
Lbs/cow–calf	550[x]	2483[y]	1517[a]	4720[b]
Hay balance,				
Lbs/cow	3703	4768	4236	2486
Lbs/cow–calf	3153	2285	2719	2486
Year 3				
Hay production,				
Lbs/harvested ac[c]	436[x]	1094[y]	765[a]	1224[b]
Lbs/cow	545[x]	1368[y]	957[a]	2549[b]
Hay fed,				
Lbs/cow	2338	2416	2375[a]	5307[b]
Lbs/cow–calf	3422[x]	5810[y]	4616[a]	5307[b]
Hay balance,				
Lbs/cow	-1792	-1048	-1420[a]	-2758[b]
Lbs/cow–calf	-2877[x]	-4442[y]	-3660[a]	-2758[b]

[ab]Differences between means of systems with different superscripts are significant ($P < .05$).

[c]Hay was harvested from tall fescue–red clover and smooth bromegrass–red clover fields from 2.5 ac/cow for fall-calving and spring-calving cows in the year-round grazing system and from smooth bromegrass–orchardgrass–birdsfoot trefoil pastures at 1.67 ac/cow for spring-calving cows in the ML system.

[xy]Differences between means within the year-round system with different superscripts are significant ($P < .05$).

Implications

When fall-calving cows are added to a year-round grazing system with spring-calving cows, a more economical source of stockers for summer pastures is achieved. In both winter grazing seasons, fall-calving cows and their calves were able to graze stockpiled pastures with little additional hay supplementation needed in year 1 and none needed in year 2 to maintain cow body condition scores until weaning, compared to an average of 4700 lbs. hay DM/cow required for cows maintained in a drylot. Whereas the previous season's spring calves are maintained throughout the entire winter, weaned fall calves are maintained for approximately 50 days before being turned out to summer pasture; therefore, less stored feed is required for maintenance. When 60% and 75%, respectively, of the 4.2 and 3.3 acres of perennial pasture per cow are harvested as hay, there is approximately 1 ton of excess hay produced per cow–calf pair, and the yields and nutritional quality of forage in the summer pastures do not differ. Even under harsh winter weather conditions, the amount of hay required to maintain both fall-calving and spring-calving cows in the year-round grazing system was significantly less than that required for the minimal land system.

Acknowledgements

This project was funded, in part, by a grant from the Leopold Center for Sustainable Agriculture, Iowa State University, Ames, Iowa. The authors gratefully acknowledge the assistance given by the animal caretakers at the McNay Research and Demonstration Farm, as well as by graduate and undergraduate research assistants in our research group.

Table 10. Average hay production, feeding, and balance for the year-round and minimal land grazing systems.

	System			
		Year-round		Minimal land
	Fall calving	Spring calving	System mean	
Hay production,				
Lbs/harvested ac[c]	1172	1677	1425[a]	2539[b]
Lbs/cow	2748	3741	3244[a]	4227[b]
Hay fed,				
Lbs/cow	1087	1263	1175[a]	4920[b]
Lbs/cow–calf	1758[x]	4134[y]	2946[a]	4920[b]
Hay balance,				
Lbs/cow	1660	2478	2070[a]	-692[b]
Lbs/cow–calf	989[x]	-393[y]	298[a]	-692[b]

[ab]Differences between means of systems with different superscripts are significant ($P < .05$).

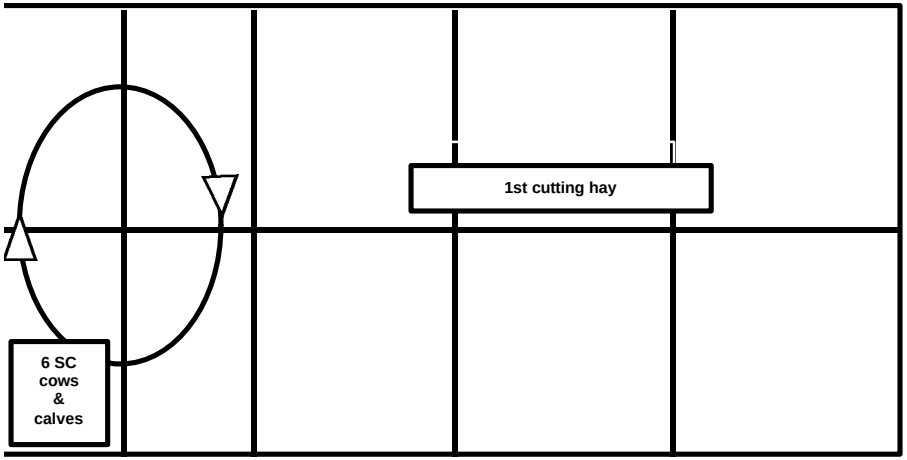
[c]Hay was harvested from tall fescue–red clover and smooth bromegrass–red clover fields from 2.5 ac/cow for fall-calving and spring-calving cows in the year-round grazing system and from smooth bromegrass–orchardgrass–birdsfoot trefoil pastures at 1.67 ac/cow for spring-calving cows in the ML system.

[xy]Differences between means within the year-round system with different superscripts are significant ($P < .05$).

Appendix I. Graphic illustrations of grazing systems.

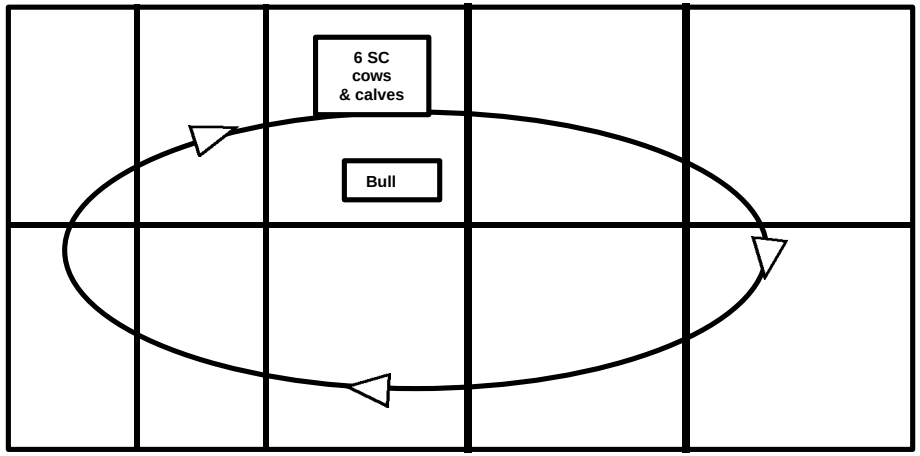
Minimal Land Grazing System
April to June

20-ac smooth bromegrass-orchardgrass-birdsfoot trefoil pasture



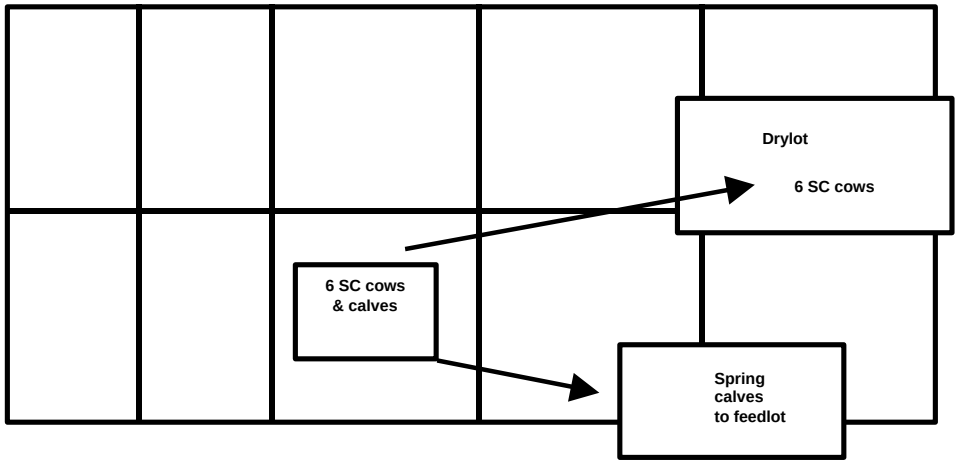
Minimal Land Grazing System
June to July

20-ac smooth bromegrass-orchardgrass-birdsfoot trefoil pasture



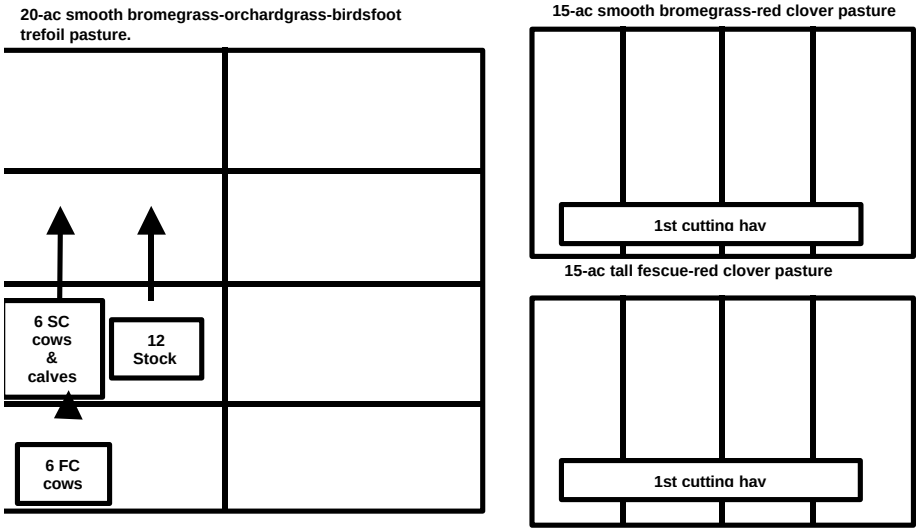
Minimal Land Grazing System
November to April

20-ac smooth bromegrass-orchardgrass-birdsfoot trefoil pasture

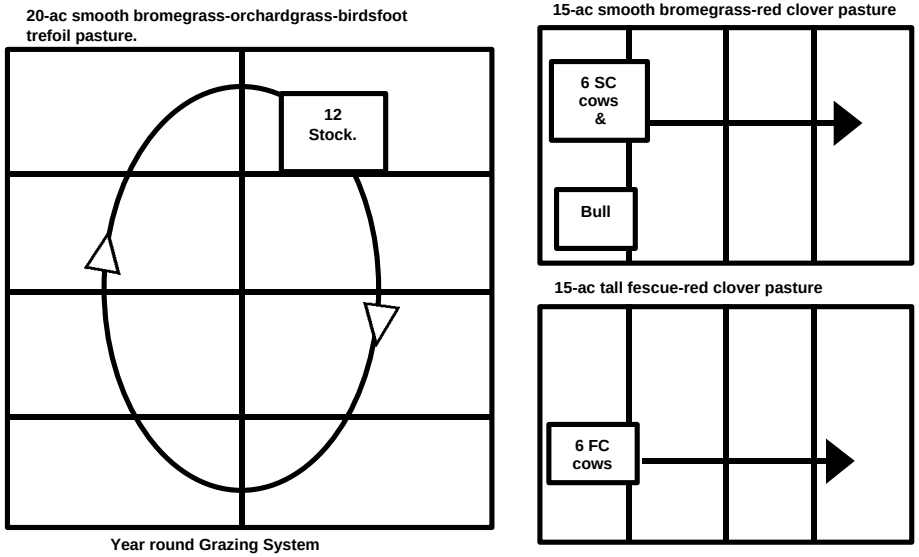


Key to abbreviations: SC = spring-calving

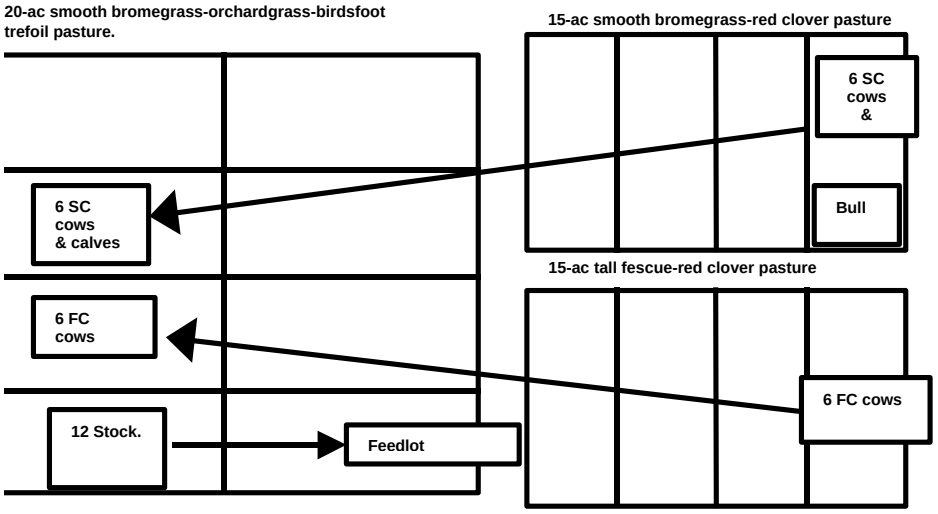
Year round Grazing System
April to June



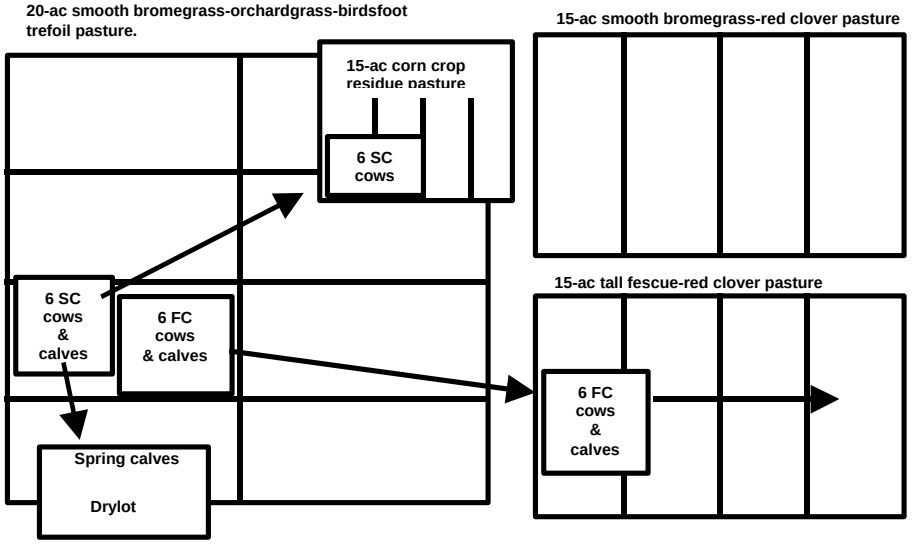
Year round Grazing System
June to July



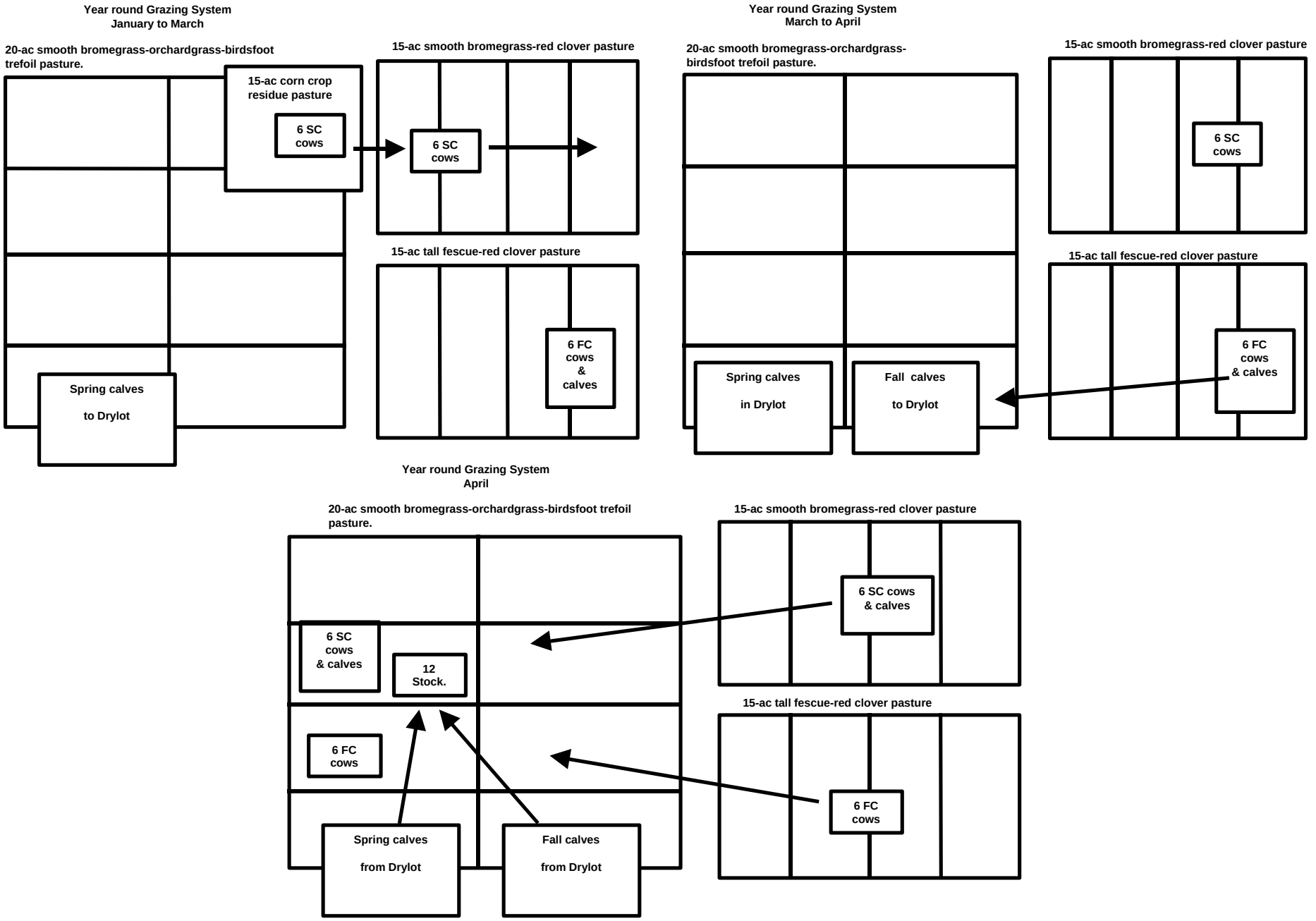
Year round Grazing System
late July



Year round Grazing System
November to January



Key to abbreviations: FC = fall-calving; SC = spring-calving; Stock. = stocker cattle



Key to abbreviations: FC = fall-calving; SC = spring-calving; Stock. = stocker cattle