Managing extensive winter grazing systems in arid/semi-arid environments

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Introduction

The most expensive aspect of a beef cow operation is the wintering of dry pregnant cows. Reducing the feeding of conserved forage while maintaining or increasing cow performance utilizing alternative forage systems could lower overall costs of production (Volesky et al. 2002). Greater reliance on the cow rather than equipment for forage harvesting is one method for reducing feed costs (D'Souza et al. 1990). The cost of wintering beef cows in the prairie region of Canada and United States is the single largest cost of beef production, accounting for 60-65% of the total cost of production in a cow-calf operation (Larson 2008). Providing wintering beef cows enough feed to meet their nutrient requirements while avoiding waste resulting from over-feeding provides a means of controlling and reducing these costs.

Extensive grazing systems to be discussed include stockpile grazing perennials (Hitz and Russell, 1998; Meyer et al., 2009;Kulathunga et al., 2018), swath grazing annuals (Kelln et al., 2011; Kumar et al. 2012), and grazing cereal crop residues (McCartney et al., 2006; Van De Kerckhove et al., 2011; Krause et al., 2013). Bale grazing (Kelln et al., 2011; Lardner et al., 2018), and grazing whole plant corn (Lardner, 2012; Jose et al. 2020) will also be discussed. Using cool or warm season annuals for in-field grazing may allow producers to reduce winter feeding costs, while animal activity and deposition of manure nutrients (Jungnitsch et al. 2011) directly on the land may be beneficial to soils and subsequent crop production (Kelln et al. 2012). There has been considerable research conducted on nutrient management associated with extensive winter grazing systems (Schoenau and Davis, 2006; Jungnitsch et al., 2011; Smith et al., 2011). Finally, extensive grazing systems can decrease costs for harvesting, transportation, labor, yardage and manure removal relative to the conventional drylot system (Nayigihugu et al., 2007).

Annual Forages

Several annual forage crops, including barley (*Hordeum vulgare* L.), oat (*Avena sativa* L.), golden German foxtail millet (*Setaria italica*), kale (*Brassica oleracea*), turnip (*Brassica rapa*) and corn (*Zea mays*) have shown promise in cow-calf grazing systems (Lardner, 2003; McCartney et al. 2008). However, the economic use of these crops should be compared to other annual cereals (May et al. 2007; McCartney et al. 2009). In warm and moister regions, corn is traditionally grown as either a grain crop or silage. The remaining stover or crop residue is usually grazed during late fall or winter with weaned beef calves or dry pregnant beef cows (Klopfenstein et al. 1987; Poland et al. 2003). Recently in western Canada and some northwest US states, there has been interest in grazing standing whole plant corn to avoid the costs of conventional harvesting and storage. However, corn production has been limited to areas receiving a minimum of 2000-2400 corn heat units (Aasen and Bjorge 2009).

Stockpile Grazing

Stockpiling forage is the practice of accumulating forage biomass during summer and fall and grazing it after the growing season (Hitz and Russel, 1998; Riesterer et al., 2000). Grazing stockpiled perennial forages can be an excellent alternative to more expensive hay or silage feeding in drylot pens. However, stockpiled forages are usually mature and due to leaf senescence, can be moderate to poor in nutritive value. Yet, stockpiled forage can meet dry cow nutrient requirements in early to mid-gestation (Table 1) when requirements are less compared to lactating cows (Poore and Drewnoski, 2010; Kulathunga et al., 2016). Stockpiled forage can be grazed from October to early December, or until weather and snow conditions prevent grazing, or can be used in early spring, before new pasture growth (Kulathunga et al., 2016). Stockpiling perennial forage species for fall and winter grazing has been shown to be a cost effective alternative to traditional drylot feeding (Baron et al., 2005). Costs are reduced through the minimization of harvesting, hauling, feeding and manure removal (Kulathunga et al., 2016). Labor can be reduced by 25 percent in comparison to conventional wintering of beef cows (Riesterer et al. 2000). The efficacy of a stockpile system depends on species selection, accumulation period, soil nutrition management and weather (Baron 2004). Depending on the forage quality, it can be grazed any time after pasture ceases to be productive, usually in September, and graze well into December, possibly longer if weather conditions such as ice and snow do not prevent grazing (Riesterer et al. 2000), with no effect on cow condition (Table 2).

Swath Grazing

Swath grazing is a method of extending the grazing season, where an annual cereal crop is swathed at a defined stage, left in windrows in field for grazing (Aasen et al., 2004; Kelln et al., 2011). For swath grazing of annual cereals, the producer needs to balance yield with the potential weathering (May et al., 2007). In a study by May et al. (2007), later seeding dates resulted in higher quality forage, although the yield was reduced. Suggestion is that ideally oat and barley be seeded from May 20-25, to optimize utilization of soil moisture and cool temperatures (May et al., 2007). If swaths are large enough, cattle can access the feed through up to 45 cm (1.5 ft) of snow. The cows then graze the swaths in fall and winter and sometimes in the following spring (Aasen et al., 2004). These swathed annuals generally meet the nutritional requirements of the cow in mid-gestation (NASEM, 2016) when the temperature is in the thermo-neutral zone (Aasen at al. 2004). Access to the swaths should be controlled with portable electric fence, allocating 3 to 4 day supply of forage (Karn et al. 2005). McCartney et al. (2004) explains that pregnant beef cows can be managed using swath grazing and can result in savings of 50% through decreasing or eliminating the expenses of harvesting, hauling and feeding the forage as well as reduced manure removal costs. Kumar et al. (2012) reported that backgrounding calves on quality swathed barley or millet forage (Table 3) in field paddocks did not adversely affect performance compared with backgrounding calves in a traditional DL pen system (Table 4).

Bale Grazing

Bale grazing is another method to extend the grazing season and optimize nutrient management. Smith et al. (2011) describes bale grazing as a system to optimize the benefits of manure nutrients, by placing round bales on a field site and grazing at a higher stocking density. Bale grazing systems can be managed either as intensive where baled forage is hauled out to the bale grazing site and placed in a grid pattern or more extensively where bales are left where they are ejected from the baler (SMA 2008). With bale grazing there is a need to restrict forage access, using portable electric fence, and 3 to 4 d allocation of forage made available, which reduces wastage and facilitates manure deposition throughout the field (Lardner, 2018). Management of the site is required, as Kelln et al. (2011) explains that bale grazing has the least uniform distribution of manure nutrients of the winter grazing systems.

Cattle have poor N retention and most of the N is excreted in the feces and urine (Kelln et al. 2012). Erickson and Klopfenstein (2001) reported that feedlot yearlings retained only approximately 10 percent N and excreted the remaining 90 percent. Another advantage of cattle directly depositing manure in the field is that manure that is deposited in a drylot feeding pen can be subjected to nutrient losses due to volatilization, making it less valuable (Kelln et al. 2012). Nutrient benefits are accessible through this system as bale grazing at a density of 63 bales/ha (25 bales/acre) can equate to about 34 kg of N available to the plant in the following season (SMA 2008). Jungnitsch et al. (2011) reported significant improvement in soil fertility and greater pasture growth where manure and urine were deposited during winter in-field bale grazing.

Highlights from Jungnitsch et al. (2011) reported soil inorganic N amounts, measured in spring following winter grazing, were 3 times greater on bale graze sites compared to unfertilized sites. Forage DM yields were 3 to 4 fold greater on winter feeding sites compared to unfertilized sites. Recovery of N and P in pasture forage was approximately 30-40% of original feed N and 20-30% of original feed P on beef cattle winter feeding sites. Finally, recovery of N and P in pasture forage was only 1% of original feed N and 3% of original feed P from pen manure applied sites. In addition, Lardner et al. (2018) backgrounded weaned steers on supplemented bale grazing systems, showing an alternative to drylot backgrounding (Table 5). Kelln et al. (2011) reported costs averaged 10% lower for bale grazing compared to drylot feeding over a 3-year study. With a reduction in cost and a reduction of labor associated with overwintering cows, bale grazing is a viable alternative to drylot pen feeding.

Grazing Crop Residues

There has been renewed interest in the use of crop residues in beef-cow diets because of their potential to reduce winter feed costs (Krause et al. 2013). Cereal crop residues such as barley, wheat, oat and triticale grown in the western prairies are potential sources of feed for overwintering beef cows (McCartney et al. 2006). Costs can be reduced by leaving crop residues in the field and having cows graze it (McCartney et al. 2006). Cereal chaff consists of smaller particles than straw and includes glumes, hulls, seed heads, short straw, leaf materials, weed seeds, and whole or cracked kernels that were separated from harvest grain (McCartney et al. 2006; (Figure 1). These fractions vary in palatability and digestibility depending on the crop variety and the time at harvest, harvest method and weathering of the residue (Van De Kerckhove et al. 2011).

Because of the low protein and high fiber content of cereal crop residues, a study by Krause et al. (2013) compared the effects of grazing either oat or pea residues versus drylot pen-feeding grass-legume hay on cow performance, reproductive efficiency, estimated dry matter intake (DMI), and winter system costs. The CP level of the pea residue was higher than oat residue and the pea residue had similar CP and TDN as the mixed hay (Krause et al. 2013). But despite this, the cows consuming the pea crop residue had lower DM intake and reduced nutrient intake and found that this was likely due to the lower palatability of the crop (Krause et al. 2013). Cows grazing pea residues for 63 days had lower body weight change than cows grazing oat residues or drylot hay fed cows. On average, total costs for the oat and pea residue grazing strategies were $0.77 and $0.59 cow/d less than drylot ($2.13 cow/d), respectively. Grazing crop residue for part of a cow's winter feeding program has cost advantages over pen feeding hay; however, environmental conditions (snowfall, temperature) dictate forage accessibility.

In the northern Great Plains, wintering cows on cornstalk residue is a common practice. With the adaptation of low heat unit corn varieties there is great potential to graze corn residues in beef cow wintering systems. Fernandez-Rivera and Klopfenstein (1989) demonstrated cornstalk residue is of adequate quality for growing cattle immediately following harvest. The nutrient profile of cornstalks is well established, with crude protein (CP) levels reported to be from 3.3 to 5.5%, which does not meet the requirements for a gestating cow or heifer (NASEM, 2016). Protein supplementation may be required to increase intake and digestibility of low-quality forages during winter (DelCurto et al., 1990; Bowman and Sanson 2000). Research in Nebraska reported that although cornstalk residue is typically low in CP, the relatively low CP requirement of early gestation beef cows may be met due to selective grazing of crop residue components, provided the cow has the ability to selectively graze (Warner et al. 2011).

Grazing corn residues also offer an opportunity to lower feed costs and extend the grazing season (Wilson et al. 2004). Although, the main concern when grazing corn residues is that protein content and energy digestibility are low because the plant is harvested at late maturity (Klopfenstein et al. 1987). Cows grazing corn residues may need to be provided a supplement earlier than cows grazing stockpile forages. Digestibility of the diet is high initially, but declines with time due to selection of the more digestible parts early (Wilson et al. 2004). Access to the corn residue should be controlled to minimize wastage and improve utilization (McGeough et al. 2018).

Grazing Whole Plant Corn

Grazing standing whole plant corn is a management system that makes sense to many western US and Canadian cow-calf producers, to extend the grazing season and reduce feed costs per cow per day. However, the equipment, seed, fertilizer cost, and unfamiliarity with growing corn for grazing often deters producers from trying it themselves. Early grazing corn research in western Canada, evaluated several corn varieties for beef cows (Lardner, 2002) and backgrounding programs for weaned beef calves (Lardner, 2003a). Corn should be seeded early as with an early frost, there is an appropriate amount of leaf and grain on the plants to optimize cow nutrition (May et al. 2007). In central Saskatchewan, corn grazing studies showed that early maturing varieties provided excellent late-season grazing either grazed in a swath or as standing crop during the winter (Lardner 2003a; Jose 2020). Strip grazing is highly recommended when grazing the field with allocation of enough grazing corn for a 3 to 4 day supply. By limiting the grazing area, animals are forced to consume both high- [cobs] and low-quality [stalk, husk, leaves] structures of the corn plant (Lardner et al. 2012). Ensure a balanced mineral program is provided and a good supply of high quality drinking water is also available to the grazing animals.

There are several concerns when managing grazing corn with beef cows. Excessive cob intake may lead to digestive disturbances such as acidosis and founder due to potential grain overload. Adapting cows to grain supplementation for 7 to 10 days before turning into cornfields can minimize this concern. Recent work by Jose et al. (2020) is evaluating ruminal pH of ruminally cannulated heifers fitted with indwelling ruminal pH probes. Cow were field grazing either whole plant corn or swathed whole plant barley or drylot fed barley hay in pens in a 3x3 Latin Square design. Forage was allocated on a 3 d basis and pH values were summarized. Data suggests that in yr 1, beef cows grazing barley swaths faced maximum acidic challenge compared to cows grazing standing corn or fed barley hay. However, in yr 2, SARA conditions were observed for cows grazing whole plant corn (Jose et al. 2020).

Additional strategies to transition animals to grazing corn include supplying extra roughage in the form of supplemented hay/forage bales, or limiting the daily cornfield grazing time and ensuring cows are full prior to accessing the crop. It will take 7 to 10 days for the rumen to adjust to the new diet. Another issue can be nitrate toxicity; however the highest level of nitrate concentration in the plant is the lowest part of the stalk. This plant structure is typically consumed last by the grazing animal; therefore the potential for nitrate issues is unlikely. Finally, animals should be monitored daily to evaluate body condition and remaining crop material and managed for 90-95 percent utilization of available forage.

A recent study was conducted in east central Saskatchewan to evaluate several corn varieties for extended grazing with beef cows (Lardner et al. 2012). Five different corn varieties were seeded with a corn planter June 1, at 65,500 seeds/ha (26,200 seeds/acre) with a row spacing of 750 mm (30 inches) and depth of 37 mm (1.5 inches). The field was sprayed with glyphosate 11 June at 3.8 L/ha (1.5 L/ac). Corn varieties included five varieties, ranging in crop heat units of 2050 to 2250. Total CHU's at the site from 1 April to 31 October 2011 were 2417 CHU. Dry matter yield in September 2011 ranged from 10.8 to 11.8 tonne/ha (4.1 to 5.7 ton/acre) (Table 7).

Forage quality in corn will vary according to cultivar and seeding date with early-maturing cultivars having higher CP (11 to 12 %) than later maturing cultivars. May et al. (2007) noted in their study that corn was marginal in meeting the CP requirements of third trimester pregnant beef cows. Energy and protein requirements for a 680 kg (1500 lb) pregnant beef cow in second trimester are 7.8% CP and 50% TDN (NASEM 2016). Corn quality was determined at two different times, in September at the end of the growing season and again in November, coinciding with the start of grazing with beef cows (Lardner et al. 2012). September samples included submission of whole plant, leaf and grain+cob from each variety and November samples were only whole plant. Crude protein content of the whole plant for all varieties ranged from 6.4 to 8.1 percent (Table 8). Corn leaf CP levels ranged from 7.4% for P7443R to 13.6% for HLSR06. Grain+cob CP levels ranged from 10.9% for DKC2754 to 12.9% for HLSR06 (Table 4). Total digestible nutrient (TDN) content of whole plant for all varieties ranged from 68.6 to 70.8 percent. Corn leaf TDN levels ranged from 49.7% for P7443R to 60.6% for DKC2754. Grain+cob TDN levels ranged from 89.3% for P7443R to 90.8% for P7213R (Table 4). At start of grazing in November, CP levels ranged from 6.7 to 9.7%, while TDN levels ranges from 57.1 to 66.5 percent (Table 8). Overall, energy levels of most corn varieties would meet nutrient requirements of grazing dry, pregnant beef cows, however CP may be limiting for late gestation cows, suggesting the need for supplementation.

Producers are encouraged to calculate costs according to their own individual situation. The cost per cow per day is calculated by dividing the crop production costs per acre by the grazing days per acre. Crop production costs should be calculated for each variety and compared to alternative grazing systems. Lardner (2012) reported total crop expenses ranged from $205 to $223/acre (Table 5). In addition, $/cow/day ranged from $0.70 to $1.42/day and averaged $0.94/day (Table 5). It is important to note that costs will vary from operation to operation.

Conclusion

With the need for beef producers to find alternative methods for managing cattle in economically challenging times, extensive systems appear to be valuable options in terms of improved economics and nutrient management. Through the reduction in feed costs and returns from manure excretion directly in the field, winter management of beef cattle can be more efficient. However, caution should be observed when choosing the system that best fits an individual's beef cattle operation.

This type of extensive grazing strategy demands a well-managed program, starting with forage crop choice and continuing with close monitoring of animals during the grazing period. For more on extensive grazing systems, several videos are available at: https://www.youtube.com/user/WSTRNBEEF/videos.

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Table 1. Chemical composition of stockpiled forage and round bale hay (%, DM) (Kulathunga et al., 2016)

	Forage system[1]			
Item	SPF	HAY	SEM	*P*-value
October				
OM	92.1	90.3	2.13	<0.01
CP	10.7	10.0	0.47	0.24
ADF	42.0	41.6	0.53	0.64
NDF	61.8	60.0	0.53	0.02
P	0.21	0.22	0.005	0.06
Ca	0.70	0.70	0.000	0.88
TDN[2]	52.5	52.7	0.74	0.76
DE	2.33	2.35	0.026	0.53
December[3]				
OM	91.1	90.8	0.34	0.66
CP	9.5	8.7	0.34	0.16
ADF	45.6	44.5	0.99	0.46
NDF	66.8	64.0	0.87	0.04
P	0.13	0.10	0.013	0.17
Ca	0.62	0.66	0.040	0.46
TDN	50.5	51.8	1.12	0.46
DE	2.2	2.25	0.04	0.45

[1]SPF = stockpiled perennial grass-legume forage grazed in field paddocks; HAY = round bale grass-legume hay fed in drylot pens.
[2]Calculated using Penn State equations (Adams, 1995).
[3]December forage samples in yr 1 were considered unreliable due to laboratory problems; therefore only yr 2 and 3 December samples analyzed.

Table 2. Cow performance grazing either stockpile forage or drylot fed hay bales over 3 yr (Kulathunga et al., 2016)

	Forage system[1]			
Item	SPF	HAY	SEM	*P*-value
Body weight[2], kg				
Initial	651.3	645.3	2.80	0.10
Final	674.9	677.3	4.85	0.69
Change	23.6	32.0	5.17	0.20
Rib fat, mm				
Initial	3.4	3.3	0.27	0.74
Final	4.9	4.2	0.31	0.18
Change	1.5	0.9	0.20	0.22
Rump fat, mm				
Initial	3.6	3.3	0.42	0.63
Final	4.5	4.1	0.34	0.38
Change	0.9	1.0	0.16	0.96
BCS[3]				
Initial	2.6	2.6	0.06	0.47
Final	2.7	2.7	0.06	0.42
Change	0.1	0.1	0.05	0.37

[1]SPF = stockpiled perennial grass-legume forage grazed in field paddocks; HAY = round bale grass-legume hay fed in drylot pens.
[2]Cow BW adjusted for conceptus growth.
[3]BCS = body condition score (1 = emaciated; 5 = obese; Lowman et al., 1976).

Table 3. Effect of backgrounding system on DMI and consumed nutrients over 3 yr (Kumar et al., 2012)

	Backgrounding system[1]				
Item	BAR	MILL	DL	SEM	*P*-value
DMI, kg/d	7.76	6.81	7.53	0.447	0.32
CP, kg/d	0.92	0.90	0.75	0.105	0.19
NDF, kg/d	3.25	3.16	3.84	0.286	0.23
TDN, kg/d	4.28	3.51	3.89	0.518	0.27

[1]BAR = swathed barley grazing; MILL = swathed millet grazing; DL = drylot pen feeding.

Table 4. Effect of backgrounding system on beef calf performance over 3 yr (Kumar et al., 2012)

	Backgrounding system[1]				
Item	BAR	MILL	DL	SEM	*P*-value
Performance					
Initial BW, kg	207.1	207.3	207.7	8.46	0.96
Final BW, kg	288.1[a]	269.4[b]	290.7[a]	7.65	0.01
ADG, kg/d	0.8[a]	0.6[b]	0.8[a]	0.03	0.01
BW change, kg	77.9[a]	59.0[b]	79.9[a]	4.39	0.01

[a,b]Means within a row with different superscripts differ ($P < 0.05$).

[1]BAR = swathed barley grazing; MILL = swathed millet grazing; DL = drylot pen feeding.

Table 5. Effect of supplementation on beef steer performance while winter bale grazing over 2 yr (Lardner et al., 2018)

Item	BARL[1]	DDGS	50:50	SEM	*P*-value
Initial BW[2], kg	228	228	230	7.7	0.79
Final BW[2], kg	322	331	329	7.3	0.10
Gain, kg	94	103	99	2.4	0.07
ADG, kg/d	0.87	0.97	0.92	0.02	0.07

[1]BARL = steers supplemented with 100% barley; DDGS = steers supplemented with 100% wheat DDGS; 50:50 = steers supplemented with 50% wheat DDGS + 50% barley.

[2]Shrunken BW calculated as 96% of liveweight according to NASEM (2016).

Table 6. Effect of wintering system on beef cow performance over 3 yr (Krause et al., 2012)

Item	Treatment[1]			SEM	*P*-value
	DLPF	OATG	PEAG		
BW, kg					
Initial	650.3	660.9	648.0	6.67	0.39
Final	707.1[a]	683.3[a]	651.7[b]	7.56	0.01
BW change, kg					
Final	65.9[a]	26.5[b]	3.7[c]	3.92	0.01
BCS[2]					
Initial	2.6	2.8	2.8	0.07	0.23
Final	2.8	2.7	2.6	0.08	0.16
Change	0.2[a]	-0.1[ab]	-0.2[b]	0.05	0.01
Rib fat, mm					
Initial	3.8	4.9	4.7	0.40	0.14
Final	5.5[a]	5.0[ab]	3.6[b]	0.45	0.03
Change	1.6[a]	0.1[b]	-1.1[c]	0.25	<0.01
Rump fat, mm					
Initial	3.8	5.4	4.9	0.55	0.14
Final	7.0[a]	5.8[ab]	4.2[b]	0.58	0.01
Change	3.2[a]	0.4[b]	-0.8[b]	0.41	<0.01

[1]DLPF = drylot pen feeding; OATG = grazing oat residue in field paddocks; PEAG = grazing pea residue in field paddocks.
[2]BCS = Body condition score (1 = emaciated to 5 = grossy fat; Lowman et al., 1976).
[a-b]Means (*n* = 9) within a row and with different letters differ ($P < 0.05$).

Table 7. Dry matter yield of corn varieties (Lardner et al., 2012)

Item	P7443R	DKC 27-54	P7535R	HLSR06	P7213R
Crop Heat Unit	2100	2175	2100	2250	2050
Dry matter, %	40.1	50.3	37.0	38.1	49.4
t/acre, wet	11.8	11.4	10.9	10.8	11.4
t/acre, DM	4.75	5.74	4.04	4.13	5.64

Table 8. Nutrient composition of corn varieties (Lardner et al., 2012)

Item [z]	P7443R	DKC 27-54	P7535R	HL SR06	P7213R
September					
CP, %					
Whole plant	7.8	7.7	6.4	8.1	7.0
Leaves	7.4	13.1	12.0	13.6	13.0
Grain+Cob	12.3	10.9	11.4	12.9	11.2
TDN, %					
Whole plant	69.7	70.8	68.6	69.2	68.7
Leaves	49.7	60.6	60.5	59.7	55.1
Grain+Cob	89.3	90.3	90.1	89.8	90.8
November[z]					
CP, %	7.7	8.5	8.7	9.7	6.7
TDN, %	62.1	63.0	64.7	66.5	57.1

[z]whole plant

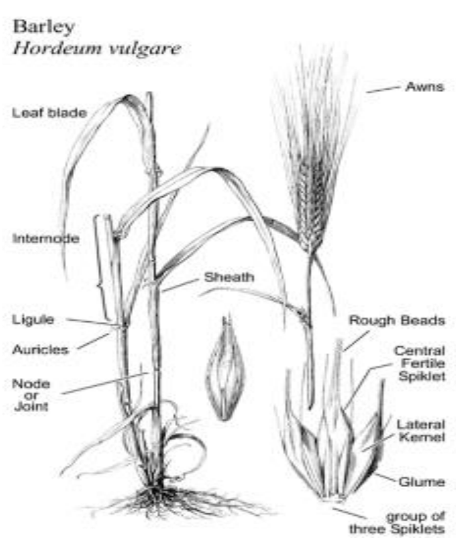

Figure 1. Parts of a cereal plant (McCartney et al. 2006).