

## Performance of American bison (*Bos bison*) in feedlots \*

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### ABSTRACT

The performance of bison finished on grain and forage was evaluated in summer and winter. In the first experiment, 58 bison bulls were finished for slaughter (90 day period beginning in late October 1993 and 1994). Half of the bulls fed with a feed-weigh station were compared to bulls fed with industry standard self-feeders. No significant differences ( $P>0.05$ ) were found in average daily gain between the two feed delivery methods. The feed-weigh station then was used to assess seasonal effects on average daily gain of 156 bison bulls. After correcting for initial body weight, average daily gain was higher in summer ( $1.1 \text{ kg/d} \pm 0.004$ ) than in winter ( $0.7 \text{ kg d}^{-1} \pm 0.005$ ). This was associated with higher average daily feed consumption in summer ( $14.3 \text{ kg d}^{-1} \pm 1.15$ ) than in winter ( $10.6 \text{ kg d}^{-1} \pm 1.15$ ). Although not as striking as in northern cervids, seasonal energetic cycles of bison are a significant consideration in commercial management.

KEY WORDS: bison, feedlot, weight gain, behaviour

### INTRODUCTION

The plains bison has been farmed and ranched since the last century when the species was rescued from extinction (Roe, 1970; Dary, 1974). At one time, con-

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siderable interest was shown in bison-cattle hybrids developed and evaluated by Agriculture Canada between 1917 and 1965 (Peters, 1958, 1984). Basic agricultural evaluations (Richmond et al., 1977; Christopherson et al., 1978, 1979a,b; Schaefer et al., 1978), and coincidental demand for lean red meat and search for more suitable forms of northern agriculture, renewed interest in the agricultural potential of bison and more generally in livestock diversification.

In response to strong regional, national and international markets, the Canadian bison industry has grown rapidly, especially in the Peace Country in north-eastern British Columbia and northwestern Alberta. In 1985, three Peace River region commercial herds farmed less than 150 head expanded to 54 producers ranching 8820 head (prior to calving) in 1992, while the Canadian bison herd increased to 18,400 by October 1992. The Canadian herd is expected to exceed 120,000 by the year 2000.

The issue of feedlot finishing has been widely debated. However, bison are increasingly fed on grain to promote evenness and proper fat cover and colour. A large North American cooperative stipulates at least 120 days of grain feeding before slaughter. However, bison may not perform well when confined and handled and they may finish less quickly and efficiently in some seasons. This study addresses these two influences on performance of bison bulls in feedlots. First, we evaluated two methods of offering feed and monitoring intake and gain. We then compared the relative importance of season and starting weight on average daily gain.

## MATERIAL AND METHODS

The performance of bison bulls in feedlots was conducted at the Bison Evaluation Unit at the Center for Agricultural Diversification, Northern Lights College, Dawson Creek, British Columbia. This program was developed in conjunction with the Peace Country Bison Association and involved animals from commercial herds. Two experiments were conducted relating to the method of feeding and the effects of season.

### *Feeding and handling system*

The first experiment was conducted to evaluate if electronic feed-weigh stations could be used to monitor performance of individual animals obviating the stress of handling for weighing (Corbin, 1976). The feed-weigh station (Ration Master) automatically recorded animal identity, liveweight, amount of grain dispensed (set at 0.5 kg min<sup>-1</sup>), and time of entry.

Commencing October 26, 1993 and October 28, 1994, bison bulls between 28 and 32 months of age and over 350 kg were weighed, tagged, injected with iver-

mectin (at recommended cattle dosage) and randomly assigned to pens equipped with either a self feeder or a four-unit feed-weigh station. Both groups were placed on a 90 day feeding period with free choice access to a standard ration of rolled and blended oats and barley (1:1), good quality forage (barley straw in 1993 and grass hay in 1994), mineral supplement and water.

The feeding period was divided into three intervals: Day 0 to Day 35/45 (Start to middle, SM), Day 35/45 to Day 90 (middle to end, ME), and Day 0 to Day 90 (start to end, SE). The middle period commenced at Day 35 in year 1993 and Day 45 in year 1994.

Consumption of grain and forage was determined for the same time intervals. Because forage was available from round bale feeders and there was no accounting of daily wastage, forage intake is more adequately described as average daily forage removal. Sample bales from each lot were weighed to determine average consumption on a group 84 basis.

Average daily grain intake by the self feeder group was determined by weighing the feed hoppers before entry and on exit from the pens. For the feed-weigh group, daily grain intake was the daily average of grain dispensed to each animal for the 24 h period.

Gain and intake were analyzed by repeated-measures analysis of variance (SuperANOVA, Abacus Concepts, Inc., Berkeley, CA, 1989). Season and pen were treated as independent variables in the general linear model, with initial body weight entered as a covariate to explore the effects of compensatory gain.

#### *Performance in winter and summer*

The second experiment evaluated seasonal effects. Performance of 156 bulls from approximately 20 herds was evaluated in two winter and two summer trials. Ninety-day feeding periods commenced in December 1992, June 1993, December 1993 and June 1994 (Table 1). The animals were weighed at Day 0 and again on Day 45 and Day 90. The bulls were 18-28 months of age and over 317 kg. At entry, the bulls were weighed, dehorned, injected with ivermectin and placed into one of two groups of approximately 20 bulls.

Bulls were held in four large pens (45 m<sup>2</sup>/animal) with packed sandstone shale for footing. Dividers between the pens were either planks or wire fence with plywood panels serving as a visual barrier. No additional shelter was provided. Rations differed between years (Table 2). Bison had free choice access to a standard ration of rolled and blended oats and barley (50:50 or 75:25), good quality fescue or barley straw (Table 3), cattle mineral and water.

Average daily gain (kg d<sup>-1</sup>) was determined for Day 0 to Day 45 (start to middle, SM), Day 45 to Day 90 (middle to end, ME) and Day 0 to Day 90 (start to end, SE). Average daily intake of grain, minerals and forage was determined by divi-

TABLE 1

Design of experiment to evaluate effects of season and diet on performance of bison bulls

Season	Start Dates	Bulls per replicate	Oats : barley	Forage
Winter 1992	9 Dec 92	28	75:25	Fescue straw
	3 Dec 92	15	75:25	Fescue straw
Summer 1993	29 Jun 93	24	75:25	Fescue straw
	7 Jun 93	15	75:25	Fescue straw
Winter 1993	22 Dec 93	11	50:50	Barley straw
	22 Dec 93	23	50:50	Barley straw
Summer 1994	6 Jun 94	19	50:50	Barley straw
	6 Jun 94	21	50:50	Barley straw

TABLE 2

Composition of 1992/3 and 1993/4 grain rations on dry matter basis

	1992/93	1993/94
Proportion oats/barley	75:25	50:50
Moisture, %	11.3	12.9
Crude protein, %	10.9	11.2
Calcium, %	0.06	0.06
Phosphorus, %	0.29	0.25
Potassium, %	0.43	0.44
Magnesium, %	0.11	0.10
Sodium, %	0.01	0.01
Salt, %	0.03	0.03
Acid Detergent Fiber, %	12.8	13.1
TDN, %	77.9	77.5
DE, MCal/kg	3.43	3.41

TABLE 3

Composition of fescue and barley straw

Percent dry matter	Fescue	Barley
Moisture	26.5	10.4
Crude protein	3.9	2.0
Acid Detergent Fiber	52.4	48.0
TDN	37.0	42.1
Calcium	0.21	0.25
Phosphorous	0.08	0.04

ding the average daily grain consumed (by the group) by the number of animals adjusted on a dry matter basis. Forage use included considerable wastage.

Weights and gains were analyzed by repeated-measures analysis of variance (Abacus concepts, Inc., Berkley, CA, 1989). Season, pen, and ration including year effects were entered as independent variables into the general linear model, with initial body weight as a covariate. In most analyses, an individual animal was the experimental unit. In analyses that involved either consumption or conversion, the pen served as the experimental unit as grain, forage and minerals were measured on a pen basis.

## RESULTS

### *Feeding and handling systems*

Average daily gain was comparable between pens within rations (Table 4). Average daily gain was significantly different between rations (1993 =  $0.59 \pm 0.04$  vs 1994 =  $0.89 \pm 0.04$  kg d<sup>-1</sup>,  $P < 0.05$ ) but not between pens ( $P < 0.05$ ). Animals in the feed weigh station group gained  $0.73 \pm 0.04$  kg d<sup>-1</sup>, whereas animals in the self feed group gained  $0.75 \pm 0.04$  kg d<sup>-1</sup>.

Animals with a lower initial body weight gained more rapidly, especially during the first half of the feeding period (Figure 1). Initial body weight was negatively correlated with gain in the first half ( $r = -0.90$ ) and over the whole feeding period ( $r = -0.89$ ) but not during the last half of the feeding period.

Total digestible energy consumption based on combined grain and forage intake was comparable between years and feeding methods (Table 4). Grain and forage consumption were reciprocally related so estimated energy consumption varied little among years and feeding systems.

### *Performance in winter and summer*

Gain and feed consumption during winter and summer are summarized in Table 5. Average daily gain was considerably greater ( $P < 0.05$ ) in summer ( $1.13 \pm 0.04$  kg d<sup>-1</sup>) than in winter ( $0.71 \pm 0.05$  kg d<sup>-1</sup>) when data were combined for both years of the study. Average daily gain was higher in 1992/3 when animals were fed a 75:25 ration with fescue straw compared to the following year when a 50:50 ration with barley straw was fed. Bulls on the 75:25 ration and fescue straw gained more rapidly ( $1.1 \pm 0.04$  kg d<sup>-1</sup>) than bulls on the 50:50 ration and barley straw ( $0.78 \pm 0.05$  kg d<sup>-1</sup>).

Overall, gain was greater in summer than in winter ( $0.94 \pm 0.04$  kg d<sup>-1</sup> vs  $0.77 \pm 0.05$  kg d<sup>-1</sup>). In summer 1994, animals gained significantly more during the first 45 days ( $1.2 \pm 0.06$  kg d<sup>-1</sup> vs  $0.6 \pm 0.07$  kg d<sup>-1</sup>).

Average daily gain, grain consumed, forage consumed, grain energy consumption and forage consumption by pen

TABLE 4

Year	Group	n	Average daily gain kg d <sup>-1</sup>			Grain consumed kg d <sup>-1</sup> , DM			Forage consumed kg d <sup>-1</sup> , DM basis			Estimated digestible energy consumption kg d <sup>-1</sup> , DM		
			SM	ME	SE	SM	ME	SE	SM	ME	SE	SM	ME	SE
1993	Feed-weigh station	15	0.63	0.62	0.62	4.1	6.7	5.6	5.0	3.8	4.4	1105	1349	1260
1993	Self feeder	14	0.18	0.72	0.51	5.5	6.5	6.0	4.3	2.3	3.0	1223	1171	1179
1994	Feed-weigh station	14	1.10	0.55	0.83	4.3	3.9	4.1	1.8	3.8	2.9	1246	932	
1994	Self feeder	15	1.25	0.82	1.03	5.5	7.8	6.6	1.8	2.8		??	1165	1256

S-Start (Day 0), M-Middle (Day 35 in 1993, Day 45 in 1994), E-End of trial (Day 90)

During the next 45 days, daily gain was not significantly different between summer and winter ( $0.64 \pm 0.06 \text{ kg d}^{-1}$  vs  $0.86 \pm 0.06 \text{ kg d}^{-1}$ ). Animals in Pen 2 gained significantly more during Day 0 to Day 45 than the animals in Pen 1. In experiment 2, animals in Pen 2 gained significantly more during the first 45 days of the trial ( $1.1 \text{ kg d}^{-1}$  vs  $0.75 \text{ kg d}^{-1}$ ) than Pen 1, during the next 45 days the gain was reversed with animals in Pen 1 gaining more than the animals in Pen 2 ( $0.90 \pm 0.06 \text{ kg d}^{-1}$ ). In this experiment, initial body weight was not an important determinant of total average daily gain ( $P < 0.05$ ).

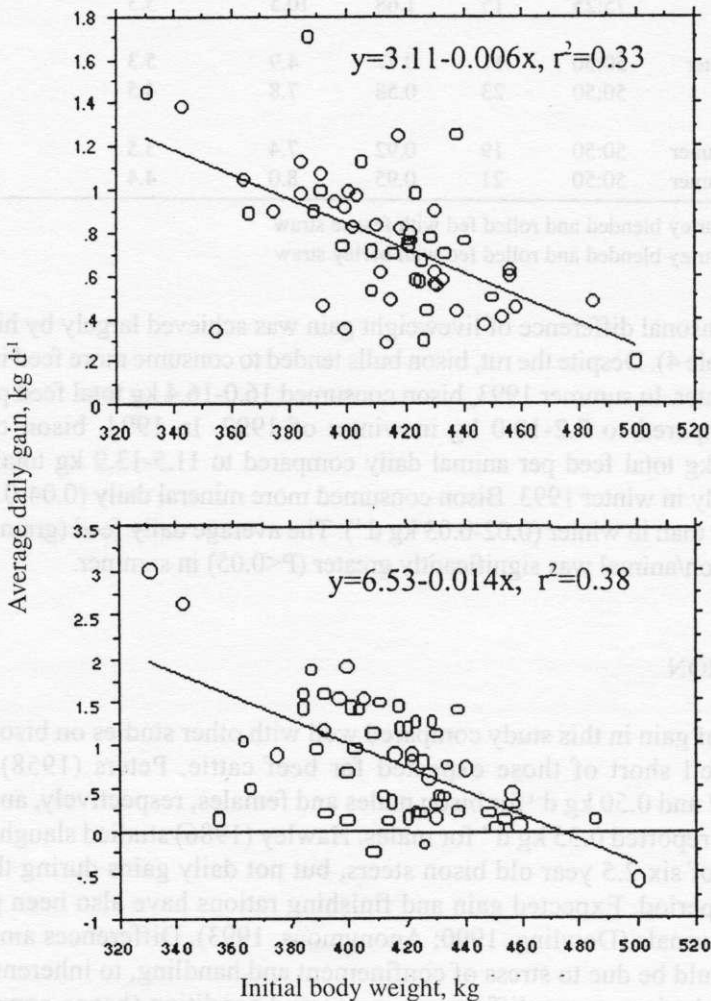


Figure 1. Relationship between average daily gain and initial body weight for 90 day feeding period and initial 45 day period

TABLE 5

Total average daily gain (kg) and average daily grain (kg), forage (kg), mineral (kg), and total feed consumed animal (kg) and total grain, and forage

Year	Season	Oats:barley	n	Gain kg d <sup>-1</sup>	Grain intake kg d <sup>-1</sup>	Forage intake kg d <sup>-1</sup>	Mineral intake kg d <sup>-1</sup>
1992	Winter	75:25	28	0.87	6.6	1.9	0.02
		75:25	15	0.59	5.3	1.0	0.02
1993	Summer	75:25	24	1.01	7.2	2.9	0.04
		75:25	15	1.68	10.5	3.3	0.04
1993	Winter	50:50	11	0.77	4.9	5.3	0.03
		50:50	23	0.58	7.8	4.5	0.03
1994	Summer	50:50	19	0.92	7.4	3.5	0.04
1994	Summer	50:50	21	0.95	8.0	4.4	0.06

75:25 oats:barley blended and rolled fed with fescue straw

50:50 oats:barley blended and rolled fed with barley straw

This seasonal difference of liveweight gain was achieved largely by higher feed intake (Table 4). Despite the rut, bison bulls tended to consume more feed in summer than in winter. In summer 1993, bison consumed 16.0-16.4 kg total feed per animal daily, compared to 7.2-10.0 kg in winter of 1992. In 1994, bison consumed 12.4-14.1 kg total feed per animal daily compared to 11.5-13.9 kg total feed per animal daily in winter 1993. Bison consumed more mineral daily (0.04-0.06 kg d<sup>-1</sup>) in summer than in winter (0.02-0.03 kg d<sup>-1</sup>). The average daily feed (grain plus hay) consumption/animal was significantly greater ( $P < 0.05$ ) in summer.

## DISCUSSION

Rates of gain in this study compared well with other studies on bison in feedlots but fell short of those expected for beef cattle. Peters (1958) reported 0.64 kg d<sup>-1</sup> and 0.50 kg d<sup>-1</sup> for bison males and females, respectively, and Koch et al. (1988) reported 0.35 kg d<sup>-1</sup> for males. Hawley (1986) studied slaughter characteristics of six 2.5 year old bison steers, but not daily gains during the 78 day finishing period. Expected gain and finishing rations have also been published in trade journals (Dowling, 1990; Anonymous, 1993). Differences among these studies could be due to stress of confinement and handling, to inherent seasonal energetic rhythms, or to differences in age and condition (hence compensatory gain) when animals enter the feedlot. This study attempted to explore possible causes of this variation.



This study demonstrated the importance of season. The superior feedlot performance of bison in summer was not unexpected from Christopherson et al. (1978, 1979a,b) who demonstrated seasonal effects on energy metabolism. This indicates an advantage to grain finishing bison on summer as opposed to winter seasons; however, the fact that the feed conversion ratio (grain, forage or combined) was the same between seasons serves to diminish the advantage.

Bison gained more in summer but they had a higher average daily feed consumption, resulting in similar feed conversion ratios between seasons. Because bison had higher ADG in summer compared to winter, this would reduce the amount of time that the animals would have to spend in the feedlot, and would subsequently reduce yardage fees.

Total feed conversion ratios and ADG in this study were similar to a smaller previous study (Koch et al., 1988) that compared the growth of 10 bison with 12 Hereford and 10 Brahman cattle (bison: 8.2 FCR food conversion ratio, 0.76 ADG kg d<sup>-1</sup>). Although Koch et al. (1988) found higher conversion ratios, their animals were fed a ration composed of %: maize silage 66, maize 22, soya-bean 12 and mineral supplement. Whereas the ADG was higher in bison fed the 75:25 ration with fescue straw compared to bison fed the 50:50 ration and barley straw, the diets were fed in successive years and therefore the effects of ration and year were confounded.

The contrast between summer and winter may differ from cows because of the rut. Social organization may have modified food selection of bison (Belovsky et al., 1983). Past observations indicate that social investment during the rut may limit the feeding time of bison (Fuller, 1960; Lumia, 1972; Lott, 1979, 1981; Rutberg, 1983). The rut certainly has the potential to negatively affect intake, relative to domestic cattle which exhibit weak social structuring compared to bison (Plumb and Dodd, 1993). The bulls used in this study were considered young at 18 to 28 months of age.

In conclusion, the performance of bison in feedlots is lower than cattle but current premium prices for bison meat ensure economic viability. Bison consume and grow more in summer than in winter but feedlot finishing may be necessary to ensure a year-round supply to sustain fresh meat markets.

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## STRESZCZENIE

**Użytkowość bizonów amerykańskich (*Bos bison*), utrzymywanych na wybiegu (system feedlot)**

Badania nad użytkowością bizonów, otrzymujących w końcowym okresie opasu ziarno i pasze objętościowe, przeprowadzono w porze letniej i zimowej. W doświadczeniu pierwszym przeprowadzonym na 58 buhajkach (90 dni przed ubojem) porównano system żywienia oraz kontroli spożycia paszy i masy ciała zwierząt przy pomocy elektronicznej stacji Ration Master z systemem żywienia z karmideł samoobsługowych. Nie stwierdzono istotnych różnic ( $P > 0,05$ ) w dziennych przyrostach pomiędzy zwierzętami obydwóch grup.

W drugim doświadczeniu, przeprowadzonym na 156 buhajkach, porównano wpływ pory roku na przyrosty, stosując system elektroniczny. Po uwzględnieniu poprawki na początkową masę ciała, przyrosty bizonów latem były większe ( $1,1 \text{ kg/d} \pm 0,004$ ) niż zimą ( $0,7 \text{ kg/d} \pm 0,005$ ), co było związane z pobraniem większej ilości paszy latem ( $14,3 \text{ kg/d} \pm 1,15$ ) niż zimą ( $10,6 \text{ kg/d} \pm 1,15$ ).

Cykliczność przemiany energii u bizonów, choć nie tak wyraźna jak u północnych jeleni, ma istotne znaczenie przy przemysłowym ich utrzymaniu.