ON THE CONSEQUENCES AND ECONOMICS OF FEEDING GRAIN AD LIBITUM TO CULLED BEEF COWS

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Thirty-five non-pregnant beef cows in three age classes (<4 yr, 4–5 yr, and >5 yr) were allocated at random to two treatments (fed, unfed) soon after weaning in November 1978. On day 1, the unfed group of 17 cows were marketed and the fed group of 18 cows were introduced to grain feeding. After 63 days, the fed cows were marketed and data were collected in a manner identical to those from the unfed cows. Feed consumption by the 18 cows in 63 days was 15 398 kg at a cost of $1 188.66. The cows gained a mean of 1.42 kg/day with an efficiency of 9.59 kg feed/kg gain. The <4 yr, 4–5 yr and >5 yr cows gained 1.59, 1.21 and 1.19 kg/day, respectively. Feeding produced significantly greater carcass weight, dressing percentage, fat depth and marbling scores ($P<0.01$) and significantly ($P<0.05$) greater rib-eye areas and brighter meat color. Carcass grade was also improved, resulting in a higher carcass price ($2.03/kg vs. $1.93/kg) and, combined with carcass weight, a significantly ($P<0.01$) greater total carcass value. Feeding caused a greater incidence of liver abscesses (50% vs. 29%), but reduced the incidence of yellow fat (0% vs. 29%). Under the economic conditions at the time of the study, it was profitable to feed all age classes of cows. The conditions under which grain feeding of cull cows would be profitable are discussed.

Trente-cinq vaches d'élevage à viande non gravides, appartenant à trois classes d'âge (< 4-5 ans et > 5 ans) ont été affectées au hasard à deux traitements, engraissés et non engraissées, peu après leur sevrage en novembre 1978. Au jour 1, le groupe "non engraissé" a été vendu pour la boucherie et l'autre groupe, composé de 18 vaches, était mis au grain. Au bout de 63 jours, ces vaches ont à leur tour été vendues à l'abattoir et on a consigné sur elles les mêmes données que sur les vaches non engraissées. Durant la phase d'engraisseement de 63 jours, les 18 vaches ont consommé 15 398 kg d'aliment au coût de $1188.66. Elles ont pris en moyenne 1.42 kg de poids par jour, pour un indice de consommation de 9.59. Les vaches de <4 ans, 4–5 ans et >5 ans ont gagné respectivement 1.59, 1.21 et 1.19 kg/jour. L'engraissement a produit, pour le poids de carcasse, le rendement à l'abattage, le gras de couverture et le persillé, des valeurs significativement supérieures au seuil de 1%, et pour la surface de la noix de côte et la couleur de la viande des valeurs supérieures au seuil de 5%. Le classement des carcasses s'en est trouvé amélioré; les prix moyens obtenus étaient de $2.03/kg contre $1.93, ce qui s'ajoutant au poids supérieur des bêtes s'est soldé par une meilleure valeur totale de la carcasse. Si l'engraissement a donné lieu à une plus forte fréquence d'apparition d'abcès hépatiques (50 contre 29%), il a en revanche abaissé le taux de fréquence de la graisse jaune (0 contre 29%). Dans les conditions économiques existant à l'époque de l'expérience, il s'est révélé rentable d'engraisser les vaches, de quelque groupe d'âge qu'elles soient. Les auteurs examinent les circonstances dans lesquelles l'alimentation au grain des vaches de réforme pourrait être avantageuse.

Commercial beef cows maintained under range conditions exhibit fluctuating body condition through each year. Some producers attempt to prevent this by supplementary feeding, but there appears to be little economic justification for doing so. Under Canadian conditions, cows generally carry the least amount of body fat at weaning, and this is when the greatest number of cows are culled and sold for slaughter. It is known that when cattle lose weight they lose approximately equal amounts of muscle and fat (Butterfield 1966; Price 1977a,b) and that during realimentation the catch-up growth is rapid and efficient, with some evidence of muscle weight recovering more rapidly than fat weight (Butterfield 1966). Meat quality is also thought to be able to recover to normal-for-age (Yeates 1964).

Range cows at weaning are the equivalent of cattle which have lost weight, and so may also be expected to exhibit catch-up growth when fed adequately. Feeding culled cows thus offers a marketing alternative to cow/calf producers who normally sell their culls directly off range; it could also provide a very large source of beef in times of reduced supply (Swingle et al. 1979).

The following study was conducted to establish the physical responses of culled cows to grain feeding in terms of both live animal and carcass changes. This would assist producers in predicting the profitability of feeding culled cows in a particular economic environment.

MATERIAL AND METHODS

A total of 35 cows of mixed breeding from the University of Alberta Beef Research Ranch at Kinsella was used in this experiment. They were all born in April and May and varied in age from about 2 yr 5 mo to about 13 yr 7 mo when the study began. Each cow had nursed a calf during 1978, but had not been bred during the summer because of such problems as dystocia and unsoundness of the mammary or reproductive systems.

Seventeen cows (unfed group) were selected at random and marketed directly off the range on 1 Nov. 1978, a month after weaning. The remaining 18 cows (fed group) were brought into a small field and introduced to a diet of long hay and a mixture of rolled barley, rolled oats and alfalfa pellets, supplemented with rapeseed meal and a vitamin/mineral concentrate (Table 1). The offering of grain was increased daily until the cows were feeding ad libitum. The hay was reduced to a minimum of 1.4 kg/head/day. No veterinary problems were experienced, and the cows were marketed as a group on 3 Jan. 1979, 63 days after the unfed group.

The procedure at marketing was identical in both groups: the cows were held overnight without feed or water and shipped 150 km to Edmonton the following morning. They were weighed on arrival at the packing plant and slaughtered as soon as possible. After an overnight chill, all carcasses were graded (Canada Beef Grading System) and appraised (Form ML107) in the normal manner by Agriculture Canada graders. Carcass length from the first thoracic vertebra to the pubic bone was measured as described by Yeates (1952). The cows were all sold to the packer on a rail-grade basis (payment based on actual weight and grade of the carcass).

Data from the unfed cows were used to estimate the carcass weight, grade and hence the value of the fed group at the beginning of the feeding period. The actual weight and grade of the fed group carcasses were combined with the November 1978 price schedule to obtain an adjusted carcass value at the end of the feeding period in January 1979. This procedure eliminated the effect of fluctuations in market price during the feeding period.

Table 1. Composition and cost of grain mixture fed to cows

Ingredient	kg/tonne	@ $/tonne	Feed cost ($)
Rolled barley	620	55.13	34.18
Rolled oats	200	64.82	12.96
Alfalfa pellets	100	93.00	9.30
Rapeseed meal	58	192.00	11.14
Calcium carbonate	10	59.00	0.59
Dicalcium phosphate	5.2	330.00	1.72
Vit. mash (A, D_3, E)	2.6	840.00	2.18
Trace-mineralized salt	2.6	123.00	0.32
Molasses	1.6	110.00	0.18
Processing	–	4.41	4.41
Total	1000.0		76.98

For statistical analysis, the cows were placed into three chronological age classes: less than four years (<4 yr), four to five years (4–5 yr) and greater than five years (>5 yr), and the data were analyzed using least-squares (Harvey 1960). One-way ANOVA was used to compare the performance of the three age groups during feeding, and two-way ANOVA was used to study the effects of age, feeding and the age × feeding interactions on carcass and economic traits. The Student Neuman Keuls procedure was used to separate means where a significant age effect was detected.

RESULTS AND DISCUSSION

It must be recognized that care needs to be taken in feeding cows grain, particularly during the first few weeks, to avoid rumen overload or bloat. Range beef cows seem to be particularly susceptible to these problems (Berg and Price, unpublished data).

The cost of the mixed feed was calculated to be $76.98 per tonne (Table 1). Feed consumption was high, averaging 13.58 kg/head/day (Table 2). The average ad libitum daily intake approached 4% of body weight, and so probably exceeded 20 kg/day for many cows. Feed consumption per kilogram of liveweight gained was 9.59 kg. This is higher than the figure found by Swingle et al. (1979), using an 80% concentrate diet, but their cows were lighter than those used in this study. Overall, the cows gained an average of 89.2 kg during the 63 days of feeding (Table 3). Although the differences in daily gain among the age classes were not significant, mean gain of the youngest (<4 yr) cows was 34% greater than that of the two older groups. This is anticipated, since the <4 yr cows, being immature, would presumably have a greater growth impetus. Since the cows were fed as a single group, nothing is known of individual differences in feed efficiency.

Analysis of the slaughter data showed no significant interaction of age × feed group (fed or unfed) for any of the carcass traits studied. There were striking differences, however, between the fed and unfed cows (Table 4). The fed cows had significantly heavier carcasses ($P<0.01$), greater dressing percent ($P<0.01$), more fat ($P<0.01$), and larger rib-eye areas ($P<0.05$) after 9 wk

Table 2. Feed consumption and cost for 18 cows fed for 63 days

	Grain mixture	Long hay	Mineral oil	Tallow	Total
Consumption					
Total (kg)	13237	2107	19	35	15 398
kg/cow/day	11.67	1.86	0.05		13.58
Feed/kg gain (kg)					9.59
@ $/kg	0.0770	0.0569	1.280	0.720	0.0772
Feed cost					
Total ($)	1019.25	119.89	24.32	25.20	1 188.66
$/cow/day	0.899	0.106	0.044		1.048

Table 3. Liveweight change (mean ± SE) in cows by age classes

	<4 yr	4–5 yr	>5 yr	Total
Number of cows:	10	3	5	18
Liveweight (kg)				
Day 1	449.8±20.44	474.5±56.20	531.2±16.61	476.5±70.4
Day 63	549.9±24.20	550.9±72.90	606.2±25.63	565.7±80.1
Gain, 63 days (kg)	100.1± 6.87	76.4±17.25	75.0±12.00	89.2±26.1
Daily gain (kg)	1.59± 0.11	1.21± 0.27	1.19± 0.19	1.42±0.41

Table 4. The effects of feeding and cow age† on carcass traits of culled, range beef cows

	Feed treatment				Cow age						
	Unfed		Fed		<4 yr		4–5 yr		>5 yr		
Carcass trait	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Sig.
No. of cows	17		18		19		6		10		
Plant wt (kg)	475.6	±17.40	533.8	±17.25	*	462.6*a*	±14.94	520.0*ab*	±26.54	531.5*b*	±20.56	*
Carcass wt (kg)	248.9	±10.41	295.8	±10.32	**	250.0	± 8.94	281.4	±15.89	284.1	±12.31	NS
Dressing (%)	52.2	± 0.57	55.2	± 0.57	**	53.8	± 0.49	54.0	± 0.87	53.3	± 0.67	NS
Fat depth (cm)	0.5	± 0.09	1.5	± 0.09	**	0.7*a*	± 0.08	1.1*b*	± 0.14	1.2*c*	± 0.10	**
Rib-eye area (cm^2)	61.2	± 3.13	71.2	± 31.0	*	68.6	± 2.68	67.2	± 4.77	62.7	± 3.70	NS
Meat color‡	1.3	± 0.08	1.0	± 0.08	*	1.1	± 0.07	1.2	± 0.13	1.2	± 0.10	NS
Marbling§	9.4	± 0.16	7.6	± 0.15	**	8.6	± 0.13	8.5	± 0.24	8.4	± 0.18	NS
Carcass length	133.2	± 1.31	130.4	± 1.30	NS	126.8*a*	± 1.13	134.3*b*	± 2.00	134.4*b*	± 1.55	**
Actual price ($/kg)	1.93	± 0.03	2.24	± 0.03	**	2.15*a*	± 0.03	2.08*ab*	± 0.05	2.01*b*	± 0.04	**
Actual value ($)	481.08	±22.75	655.91	±22.55	**	546.13	±19.53	583.38	±34.71	575.98	±26.89	NS
Adj. price ($/kg)//	1.93	± 0.05	2.03	± 0.05	NS	2.08	± 0.04	1.96	± 0.08	1.90	± 0.06	NS
Adj. value ($)	481.08	±23.12	593.34	±22.92	**	522.75	±19.85	547.60	±35.27	541.28	±27.32	NS
Abscessed livers	5(29%)		9(50%)			6(32%)		2(33%)		6(60%)		
Yellow fat	5(20%)		0(0%)			5(23%)		0(0%)		0(0%)		

†The feeding × age interaction effect was not significant ($P > 0.05$) in all cases.
‡1 = bright, 2 = medium, 3 = dark (subjective evaluation).
§Range 1–10 higher numbers indicate less visual marbling.
//Based on November 1978 prices.
NS = $P > 0.05$, *$P \leq 0.05$, **$P < 0.01$.
a-c Means bearing the same letter in the same row are not significantly different ($P > 0.05$).

of feeding. There were also improvements in meat color ($P<0.05$) and marbling score ($P<0.01$) after feeding (Table 4). However, the number of abscessed livers was greater in the fed than the unfed cows.

These feeding results are similar to those found by Wooten et al. (1979) and indicate an increase in both muscle and fat tissue during this period of feeding. There was no significant effect of feeding on carcass length, suggesting no skeletal growth during this period. It is more likely, however, that the small number of cows and large standard errors for this measurement were the true cause of this result. Skeletal growth would be anticipated in the <4 yr grup, though probably not in the 4–5 yr or >5 yr groups. The increased dressing percent was expected from the effects of muscle and fat deposition increasing the carcass percentage. In addition, concentrate feeding as opposed to range feeding would exaggerate this effect by reducing the gut contents.

Feeding caused carcass grade changes in all age classes (Table 5), but it was not considered useful to attempt a statistical analysis of these changes. Among the unfed group of 17 cows, 6 were placed in the highest grade possible for their carcass maturity class (2 C1 and 4 D1); the remaining 11 were downgraded for lack of fat, lack of muscle, yellow fat or some combination of these. Of the 18 fed cows, 17 were placed in the highest possible grade for their maturity class; the remaining cow was downgraded for lack of muscling.

It is clear from these results that since grain feeding improved liveweight, carcass weight, dressing percent and carcass grade, the monetary value of the cows would also increase. Table 6 indicates the estimated changes in carcass weight and value of the 18 cows during 63 days of grain feeding. The carcass weight, grade and value were estimated for day 1 (1 Nov. 1978) from the data collected on cows marketed that day. The mean estimated increase in carcass weight for all 18 fed cows was 44.8 kg (Table 6); this translates into an increase in value of $115.82 per carcass using day 1 rail-grade prices. The feed cost was $66.03/head, leaving a $49.79 margin to cover management costs and profit. Custom feed lots were charging 10–15¢/head/day for yardage at that time. This would remove a further $6.30–$9.45 from the margin, leaving $40.34–$43.49 per head for profit.

Table 6 also shows that the youngest (<4 yr) cows made more than twice the gain in value of the two older groups. This resulted from more rapid rates of carcass weight gain and the fact that after feeding, a large proportion of them graded A1, whereas before feeding none did. Although no

Table 5. Effect of 63 days of high-energy feeding on carcass grades of culled beef cows

		Carcass physiological maturity class†								
		I				II			III	
	n	A1‡	B1	C1	C2	C1‡	D1	D2	D1‡	D2
<4 yr										
Unfed	9	0	3	3	2	1	0	0	0	0
Fed	10	8	0	0	0	2	0	0	0	0
4–5 yr										
Unfed	3	0	0	0	0	1	0	0	1	1
Fed	3	1	0	0	0	1	0	0	1	0
>5 yr										
Unfed	5	0	0	0	0	0	0	0	3	2
Fed	5	0	0	0	0	0	0	0	4	1

†The Canadian beef carcass grading regulations define three physiological age classes: I (youthful), II (intermediate) and III (mature), based mainly on degree of skeletal ossification.
‡This is the highest grade that can be achieved by a carcass placed in the particular maturity class.

Table 6. Estimated mean changes in carcass weight and value of culled cows after 63 days of high-energy feeding

	<4 yr	4–5 yr	>5 yr	Total
Number of cows:	19	6	10	35
Carcass wt (kg)				
Est.† day 1	235.7	259.6	270.9	245.7
Actual day 63	285.5	283.4	315.5	293.5
Gain, 63 days	49.8	23.8	44.6	44.8
Carcass value ($)				
Est.‡ day 1	459.62	501.03	517.42	479.99
Adj.§ day 63	628.10	561.13	599.49	595.81
Gain, 63 days	168.49	60.10	82.03	115.82
Feed cost, 63 days ($)				66.03

†Estimated from day 1 liveweight of fed cows (Table 3), using dressing percent of unfed cows (Table 4).
‡Estimated from estimated carcass weight of fed cows (above) and actual mean carcass price ($/kg) obtained for unfed cows (Table 4).
§Adjusted by applying day 1 price schedule to actual carcass weights and grades of fed cows.

individual feed consumption data were available, it is possible that the youngest (<4 yr) cows consumed less than the larger, older cows, making their profit margins even greater than indicated in Table 6.

The important variables that will affect the profitability of feeding culled cows are the cost of feed and price spreads among carcass grades. Another important factor is seasonal fluctuation in carcass price. Prices are commonly low for cows in the fall and high during the winter and spring because of seasonal fluctuations in cow marketings (Agriculture Canada 1976).

This study shows that feeding culled range cows on grain rations can produce rapid weight gains and significant improvements in carcass grade. In the economic environment at the time this study was conducted, it was profitable to grain-feed all classes of culled beef cows for a period before marketing. However, at higher feed prices and/or in the absence of a substantial price increase between November and January, and/or in the presence of a larger price spread between A1 and D1 grades, the profitability of grain-feeding 4–5 yr or >5 yr classes of cows would be greatly reduced. Further studies will be conducted to clarify the limitations to feeding culled cows profitably.

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AGRICULTURE CANADA. 1976. The Canadian beef system. Food Systems Branch, Ottawa, Ont.

BUTTERFIELD, R.M. 1966. The effect of nutritional stress and recovery on the body composition of cattle. Res. Vet. Sci. **7**: 168–179.

HARVEY, W.R. 1960. Least-square analysis of data with unequal subclass numbers. U.S. Dep. Agric. Agric. Res. Serv. Bull. 20–28.

PRICE, M.A. 1977a. The effect of severe feed restriction on bulls and steers. I. Liveweight loss, behaviour and non-carcass body composition. Aust. J. Agric. Res. **28**: 521–528.

PRICE, M.A. 1977b. The effect of severe feed restriction on bulls and steers. II. Carcass composition. Aust. J. Agric. Res. **28**: 529–541.

SWINGLE, R.S., ROUBICEK, C.B., WOOTEN, R.A., MARCHELLO, J.A. and DRYDEN, F.D. 1979. Realimentation of cull range cows. 1. Effects of final body condition and dietary energy level on rate, efficiency and composition of gains. J. Anim. Sci. **48**: 913–918.

WOOTEN, R.A., ROUBICEK, C.B., MARCHELLO, J.A., DRYDEN, F.D. and SWINGLE, R.S. 1979. Realimentation of cull range cows. 2. Changes in carcass traits. J. Anim. Sci. **48**: 823–830.

YEATES, N.T.M. 1952. The quantitative definition of cattle carcasses. Aust. J. Agric. Res. **3**: 68–94.

YEATES, N.T.M. 1964. Starvation changes and subsequent recovery of adult beef muscles. J. Agric. Sci. **62**: 267–272.