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Effect of cow body condition score on inter-calving interval, pregnancy diagnosis, weaning rate and calf weaning weight in beef cattle

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Abstract

The aim of this study was to describe the effect of cow body condition score (BCS) on pregnancy rate, inter-calving interval, weaning rate and birth and weaning weights of calves. Measurements of BCS in a herd of mixed age (2-10 years), predominantly Angus, beef cows were recorded annually four times between November 2012 and March 2015, at joining/rebreeding (November), weaning/pregnancy diagnosis (PD, March), winter (June) and calving (August). Year influenced BCS ($P<0.05$) and BCS was greatest at weaning 2014. Two-year-old cows had greater BCS ($P<0.05$) than three-year-old and the mixed age cows. Pregnancy rate was no different ($P>0.05$) between BCS at calving, joining and PD. Cows that increased BCS from joining to PD had lower pregnancy rate than cows that maintained or decreased BCS during this period, although it is unclear whether this association reflects an influence of BCS on pregnancy rate, or whether the BCS change was a result of differing pregnancy status. Greater BCS at joining was associated with lower calf birth weights. Body condition score at each event was not associated with inter-calving interval or calf weaning weight. Further research is still required to determine the optimum BCS at each stage of the production cycle.

Keywords: beef cattle; body condition score; pregnancy rate; calf weaning weights

Introduction

Body condition score (BCS) in beef cattle is a visual assessment tool used in New Zealand. Body condition score is assessed using a numeric 1-5 (Morris et al. 2002) or 1-10 point scale (Hickson et al. 2017), in which 1 is emaciated and either 5 or 10 respectively, are obese. Body condition score is a good indicator of the animals' body energy reserves (Wagner et al. 1988; Bishop et al. 1994), and a better indicator of nutritional status than live weight (Russel et al. 1969). Body condition score and change in BCS of beef cows have been reported to influence pregnancy rates and inter-calving interval (ICI) (Osoro & Wright 1992; Ciccioli et al. 2003). Milk production and subsequent calf growth to weaning have also been reported to be influenced by BCS (Renquist et al. 2006). Pregnancy rates are affected by BCS at calving and joining (Richards et al. 1986; Houghton et al. 1990; Renquist et al. 2006). Lower BCS at calving resulted in a lesser proportion of first-calving cows returning to oestrus early in the breeding period, increasing ICI (Dziuk & Bellows 1983).

Ciccioli et al. (2003) found that BCS at calving did not affect birth weight, however, a greater live weight and BCS between calving and weaning was associated with higher calf weaning weights. Renquist et al. (2006) reported that cows with either high or low BCS at weaning tended to wean lighter calves than did cows of moderate BCS. No similar study has been completed in New Zealand using the 1-10 point beef BCS scale.

To date, New Zealand studies have looked at the effect of different feed intakes (e.g. Nicoll 1979) or live weight (e.g., Smeaton et al. 2000) on the production of beef breeding cows over a short period of time. These two studies focused on BCS resulting from different experimental groups. In contrast the study, undertaken by Morris et al. (2006), considered the effect of live weight, BCS and age of dam across periods of the production cycle, on beef-breeding-cow productivity. They reported no effect of calving BCS or live weight on pregnancy rate. From these studies it is unclear which period(s) of the production cycle are important for meeting BCS targets, to ensure greater pregnancy rates, ICI and calf weaning weights. The current beef industry targets outlined by Hickson et al. (2017) are a BCS of six at joining, five throughout winter to calving, and seven at weaning. Therefore, the purpose of the study was to examine BCS at different periods throughout the production cycle and describe the ICI, pregnancy diagnosis (PD), birth and weaning weights of calves over two successive calving seasons in a commercial beef-breeding-cow herd in New Zealand.

Materials and methods

Animals

The study utilised the commercial cow herd at Taratahi Agricultural Training Centre's Koromiko Farm in the Wairarapa. Records from November 2012-March 2015 were included. At the start of the experimental period the herd consisted of 199 cows, including 46 first-calving two-year-olds. A further 47 first-calving two-year-old animals entered the herd in 2013. Cows aged 2-10 years at calving were Angus or Angus crossbred cattle. All cows were commercially managed with heifers bred at 15 months of age. Non-pregnant cows were culled after PD. Heifers calving in 2013, previously being managed in a separate herd, joined the 3-10 year olds at PD in March 2013, whereas the heifers calving in 2014 entered the herd at joining in November 2013. Body condition score was not recorded for calving in 2012.

Measurements

Body condition score on a scale of 1-10 (0.5 increments), where 1 is emaciated and 10 is obese (Hickson et al. 2017), were measured with corresponding live weights four times annually (Table 1) between November 2012 and March 2015, at joining/rebreeding (November), PD/weaning (March), winter (June) and before calving, which will be referred to as calving (August), for two pregnancies. Date of birth, PD and calving dates were recorded. Joining and PD coincided with rebreeding and weaning of the current calf at foot, respectively, therefore, these measurements overlapped across calving seasons (Table 1). Sex of calf, calving date and birth weight were recorded for all calves. Weaning weights were recorded for all calves that survived to weaning. Calving dates for 2012, 2013 and 2014 were recorded allowing for ICI to be calculated twice. Birth weight was recorded within 24 hours of birth, and weaning occurred at a fixed date for all calves in each year.

Data manipulation

Weaning age was calculated as time in days from birth to weaning. Average daily liveweight gain (ADG) was calculated as weaning weight less birth weight divided by age at weaning. Inter-calving interval was calculated as the time in days between each successive calving for each cow. Weaning rate was recorded as either 0 (calf not present at weaning) or 1 (calf present at weaning) for cows which were present at the winter BCS measurement. Body condition scores ranged from 3.5 to 9 (0.5 increments) which, after rounding up to the nearest integer, were subsequently grouped into four BCS groups, ≤5, 6, 7 and ≥8. These groups were chosen based on distribution of BCS in the herd and to reflect the range of scores in the industry BCS targets (Hickson et al. 2017). Change in BCS was calculated as difference among the four BCS groups. Cow ages were grouped into two-year-old, three-year-old and mixed-age (4-10 years old, MA) categories.

Table 1 Cow measurement events with corresponding dates and number of body condition score (BCS) records for 2013 and 2014 calving seasons.

Event	Date	Number of BCS records
2013 Season		
Joining	22 November 2012	151
Pregnancy diagnosis	20 March 2013	214
Winter	20 June 2013	183
Calving	29 August 2013	180
Rebreeding	21 November 2013	155
Weaning	3 April 2014	160
2014 Season		
Joining	21 November 2013	202
Pregnancy diagnosis	3 April 2014	207
Winter	19 June 2014	175
Calving	22 August 2014	172
Joining	27 November 2014	169
Weaning	25 March 2015	168

Statistical analysis

Statistical analyses were conducted using SAS 9.4 (SAS Institute Inc, Cary NC, USA). Least square means for BCS, live weight, ICI, pregnancy rate, weaning rate, calf birth weight, calf weaning weight, calf weaning age and calf ADG were calculated using a GLM procedure with age of cow (2 vs. 3 vs. MA) and year of calving (2013 vs. 2014 calving) as class effects. Pregnancy and weaning rates were analysed using PROC GENMOD with a binomial distribution and a logit transformation. Fixed effects included age of cow (2 vs. 3 vs. MA), year of calving (2013 vs 2014 calving) and BCS or live weight as covariates. Inter-calving interval, calf birth weight and weaning weight were analysed using a general linear model with fixed effects of age of cow, year of calving and BCS or live weight as covariates. Sex of calf and weaning age were used as fixed effects in the weaning weight models only.

Results

BCS differed among years ($P<0.05$) and was greatest at pregnancy diagnosis in 2014 (Table 2). Body condition scores were greatest ($P<0.05$) in two-year-old cows and lowest in three-year-old cows. ICI and calf birth weight were not different among years ($P>0.05$), however, the three-year-old cows had longer ($P<0.05$) ICI than MA cows and calves with lower ($P<0.05$) birth weights, than the calves of MA cows (Table 2). Two-year-old cows had calves with lower ($P<0.05$) birth weight than those of the calves of both three-year-old and MA cows. Weaning weight, weaning age and ADG were greatest in 2013-born calves. Two-year-old cows had calves with the greatest weaning age, the lowest ADG, and had calves with lower ($P<0.05$) weaning weights than MA cows, but did not differ ($P>0.05$) in weaning weight compared to calves born to three-year-old cows.

The pregnancy rates for cows in 2013 and 2014 were 0.88 (95% CI 0.82-0.92) and 0.86 (0.80-0.90), respectively (Table 2). Body condition score at calving (data not shown) and joining did not affect ($P>0.05$) pregnancy rates, but BCS at PD tended ($P=0.05$) to influence pregnancy rate, and a lower pregnancy rate was observed for cows with a BCS of ≥8 compared with lower BCS (Table 3). Cows in BCS ≥8 at PD had a weaning rate of 0.26 and 0.12 greater ($P<0.05$) than cows with BCS of 6 and 7, respectively. Cows which had a decrease or no change in BCS from joining to PD had greater pregnancy rates ($P<0.05$) compared with cows that experienced an increase in BCS (Table 4). Cows with a BCS of 7 or ≥8 at joining had 3 kg greater ($P<0.05$) calf birth weight than did cows with a BCS of 6 (Table 3).

A decrease in BCS from winter to calving resulted in cows with a shorter ($P<0.05$) ICI than that of cows which increased in BCS or exhibited no change in BCS (Table 4). Weaning rate and birth weight were not influenced ($P>0.05$) by change in BCS. A decrease or no change in BCS from joining to PD resulted in 18 kg greater ($P<0.05$) calf weaning weights compared with those of cows that had increased BCS.

Table 2 Effect of year of calf birth and age of cow at calving on the mean (95% CI) body condition score (BCS), pregnancy rate (cows pregnant per cow joined, %), weaning rate (calves per cow wintered, %) and mean (±SEM) live weight (kg), inter-calving interval (days) of the cow and birth weight (kg), weaning weight (kg), weaning age (days) and average daily liveweight gain (ADG, kg/day) of the calf.

		Year of calving		Age of cow		
Parameter		2013	2014	2	3	MA
Cow	n	199	246	93	93	259
BCS						
Joining	332	5.8(5.5-6.3)^{b}	7.5(7.2-7.9)^{a}	8.5(7.7-9.3)^{a}	6.5(6.0-7.1)^{b}	6.5(6.2-6.9)^{b}
PD	375	5.6(5.2-5.9)^{b}	7.5(7.1-7.9)^{a}	7.1(6.6-7.7)^{a}	6.1(5.6-6.6)^{c}	6.6(6.2-6.9)^{b}
Winter	344	6.3(5.9-6.6)^{b}	7.5(7.1-7.9)^{a}	7.9(7.4-8.5)^{a}	6.2(5.7-6.8)^{c}	6.6(6.2-7.0)^{b}
Calving	339	6.3(6.5-7.3)^{b}	6.9(6.5-7.3)^{a}	7.2(6.6-7.8)^{a}	5.9(5.4-6.5)^{c}	6.6(6.3-7.0)^{b}
Rebreeding	317	7.2(6.8-7.6)	7.1(6.7-7.5)	7.2(6.7-7.9)^{a}	6.9(6.3-7.5)^{b}	7.2(6.8-7.6)^{a}
Weaning	321	7.3(6.9-7.7)^{a}	7.0(6.6-7.4)^{b}	7.3(6.7-7.9)^{a}	6.8(6.2-7.5)^{b}	7.2(6.8-7.6)^{a}
Live weight (kg)						
Joining	332	527±7	520±5	401±8^{c}	484±6^{b}	560±4^{a}
PD	375	492±5^{b}	521±5^{a}	443±5^{c}	468±6^{b}	549±3^{a}
Winter	344	508±5^{b}	547±5^{a}	480±5^{b}	489±6^{b}	565±4^{a}
Calving	339	513±5^{b}	543±5^{a}	484±5^{b}	488±6^{b}	565±4^{a}
Rebreeding	317	553±5^{a}	537±5^{b}	494±6^{c}	526±6^{b}	574±4^{a}
Weaning	321	538±5^{a}	522±5^{b}	480±6^{c}	511±6^{b}	560±4^{a}
Inter-calving interval (d)	226	366±2	368±2		371±2^{a}	365±1^{b}
Pregnancy rate (%)	381	0.88(0.82-0.92)	0.86(0.80-0.90)	0.98(0.91-0.99)^{a}	0.88(0.79-0.94)^{b}	0.82(0.76-0.87)^{b}
Weaning rate (%)	409	0.85(0.79-0.90)	0.85(0.79-0.90)	0.78(0.68-0.85)^{b}	0.81(0.70-0.89)^{b}	0.91(0.86-0.94)^{a}
Calf						
Birth weight (kg)	308	35.8±0.5	36.3±0.5	32.2±0.7^{c}	35.4±0.8^{b}	37.9±0.5^{a}
Weaning weight (kg)	284	218.8±2.3^{a}	203.3±2.2^{b}	197.8±3.2^{b}	201.0±3.5^{b}	219.7±2.1^{a}
Weaning age (d)	284	184±1^{a}	175±1^{b}	187±2^{a}	177±2^{b}	176±1^{b}
ADG (kg/d)	284	1.00±0.01^{a}	0.96±0.01^{b}	0.88±0.01^{c}	0.93±0.02^{b}	1.03±0.01^{a}

$^{a, b, c}$ Means with different superscripts horizontally differ ($P<0.05$) between main effects within rows.

Discussion

The average BCS achieved in the present study were at or above target (Hickson et al. 2017) for each measurement period. McFadden et al. (2005) reported an average of 90% for pregnancy rates from 1005 beef cow herds distributed across New Zealand. The range of the duration of mating was 67-87 (McFadden et al. 2005). The pregnancy rates and in the current study were 88% and 86% in 2013 and 2014, respectively, with length of mating of 71 and 70 days, respectively.

Body condition score at calving or joining had no effect on pregnancy rates in the current study which agrees with the findings of both Ciccioli et al. (2003) and Morris et al. (2006). The cows in the previous two studies were in moderate condition. In contrast, Renquist et al. (2006) reported BCS at calving and joining had an effect on pregnancy rates, however, BCS ranged from 3-6 on a 1-9 point scale, whereas in the present study the BCS of all cows were ≥6 (1-10 point scale). Therefore, in the present study most cows may have had an adequate BCS to conceive, which explains the insignificant effect. Pregnancy rate was negatively associated with change in BCS from joining to PD ($P<0.05$), whereas Renquist et al. (2006) reported no relationship between BCS change and pregnancy rate. It is not clear in the present study, whether this association reflects an influence of change in BCS on pregnancy rate, or whether the BCS change was a result of differing pregnancy status. Metabolisable energy requirements for pregnant cows in early pregnancy are not markedly greater than those for non-pregnant cows (Nicol & Brookes 2007), so this relationship is unlikely to reflect difference in nutrient requirements.

In the current study, the two-year-old calving cows had the greatest BCS throughout the year as they were managed separately from the cow herd to ensure their continued growth. This conflicts with the findings of Smeaton et al. (2000), who reported that younger cows had lower BCS which could have been a result of managing all age groups together within their treatment groups. In the present study, three-year-old cows had the lowest BCS, which could be a result of them being grazed with the MA cows in spite of their higher metabolisable energy requirements for maternal growth compared with MA cows. In addition, social heirachy within the herd is likely to be to the detriment of the lighter, younger cows, potentially affecting the feed intake of the three-year-olds. Two-year-old cows had greater pregnancy rates than did three-year-old and MA cows which could be a result of being separately managed prior to breeding resulting in greater BCS in two-year-old cows, as well as because they were not suckling calves at the time of mating.

Table 3 Least-squares means (95% CI) for pregnancy rate (cows pregnant per cow joined, %) and weaning rate (calves per cow wintered, %), Least-squares means (±SEM) for inter-calving interval (ICI, days), birth weight (BWT, kg) and weaning weight (WWT, kg) of cows that were body condition score ≤5, 6, 7 and ≥8 at joining, pregnancy diagnosis (PD), winter, calving, rebreeding and weaning.

	n	Pregnancy rate	n	ICI	n	BWT	n	WWT	n	Weaning rate
Joining										
≤5	42	0.93(0.79-0.98)	36	376±3	35	33.6±1.2[ab]	34	192.5 ±5.5	37	0.87(0.63-0.96)
6	62	0.89(0.76-0.95)	50	367±3	50	32.3±1.0[b]	44	202.1 ±4.8	52	0.81(0.63-0.92)
7	87	0.96(0.90-0.99)	73	366±2	76	35.7±0.8[a]	72	202.8 ±3.9	79	0.96(0.89-0.98)
≥8	133	0.93(0.86-0.97)	63	366±2	108	35.7±0.7[a]	102	208.4 ±3.4	116	0.94(0.87-0.97)
P Value		0.15		0.07		0.03		0.13		0.11
PD										
≤5	52	0.94(0.84-0.98)	43	372±3	44	34.2±1.1	43	208.2±4.2	47	0.82(0.58-0.94)[ab]
6	105	0.93(0.86-0.97)	64	366±2	90	34.2±0.8	77	205.6±3.9	98	0.69(0.55-0.81)[b]
7	86	0.94(0.87-0.97)	60	369±2	71	36.2±0.8	65	198.4±3.4	78	0.83(0.71-0.90)[b]
≥8	129	0.87(0.75-0.94)	58	368±3	101	36.2±0.9	98	205.2±4.2	108	0.95(0.89-0.98)[a]
P Value		0.05		0.24		0.40		0.23		<0.01
Winter										
≤5			30	374±3	29	33.9±1.3	28	206.9±5.9	31	0.91(0.73-0.98)
6			68	369±2	69	33.4±0.9	65	206.9±4.3	71	0.92(0.81-0.97)
7			67	366±2	75	36.0±0.8	68	203.0±3.6	79	0.83(0.71-0.91)
≥8			60	367±3	133	36.1±0.7	122	202.8±3.2	149	0.79(0.68-0.87)
P Value				0.29		0.10		0.86		0.30
Calving										
≤5			16	368±4	16	34.5±1.5	15	202.8±6.5	18	0.83(0.57-0.95)
6			81	368±2	86	34.7±0.7	83	204.2±3.1	93	0.89(0.79-0.94)
7			87	369±2	125	35.6±0.6	114	204.1±2.8	132	0.85(0.77-0.90)
≥8			39	372±3	75	36.0±0.8	69	203.8±3.6	83	0.81(0.68-0.90)
P Value				0.73		0.61		0.99		0.73
Rebreeding										
≤5							6	200.4±9.5	7	0.82(0.35-0.98)
6							33	210.7±4.3	40	0.82(0.66-0.91)
7							104	202.4±2.6	114	0.91(0.83-0.95)
≥8							135	203.7±2.4	148	0.90(0.84-0.94)
P Value								0.34		0.52
Weaning										
≤5							9	206.4±8.0	11	0.83(0.50-0.96)
6							41	208.0±3.9	44	0.93(0.81-0.98)
7							87	205.2±2.7	99	0.87(0.79-0.93)
≥8							144	201.6±2.3	159	0.90(0.83-0.94)
P Value								0.41		0.63

[a, b] means with different superscripts vertically differ (P<0.05) between main effects within columns.

Greater BCS at joining is associated with greater calf birth weights which aligns with the findings of both Spitzer et al. (1995) and Renquist et al. (2006), in which greater BCS at joining and calving resulted in greater calf birth weights. Renquist et al. (2006) reported a BCS range of large range of 2-8.5 on a nine-point scale and Spitzer et al. (1995) reported a smaller BCS range of 4-6 on a nine-point scale. Greater BCS at calving in the current study followed the same trend but was not significant.

The change in BCS throughout the production cycle did not significantly influence calf birth weight which is in agreement with the findings of Ciccioli et al. (2003). Restricted feeding of 15-month-old heifers in early pregnancy reduced calf birth weight in the experiment by Hickson et al. (2009a), but not in two further experiments (Hickson et al. 2008; Hickson et al. 2009b). This could be due to cows being of adequate condition and able to utilise their own reserves to buffer the nutrient supply to the calf. In support of this, Long et al. (2010) restricted feed intake of cows in moderate condition during early gestation, resulting in different BCS and live weight but reported no effect on calf birth weight or post-natal liveweight gain.

In conclusion, this study indicated that cows of BCS ≥8 at PD tended to have a lower pregnancy rate than did cows with lower BCS, but weaned more calves per cow wintered at the following weaning, possibly indicating that they were in a better position to over-winter carrying the calf. The experiment highlighted that joining and PD are key periods when BCS may influence subsequent productivity. The cows in this experiment were

Table 4 Least-squares means (95% CI) for pregnancy rate (cows pregnant per cow joined, %) and weaning rate (calves per cow wintered, %), Least-squares means (±SEM) for inter-calving interval (ICI, days), birth weight (BWT, kg) and weaning weight (WWT, kg) of cows which had a body condition score (BCS) change that increased, had no change or decreased from joining to pregnancy diagnosis (PD), PD to winter, winter to calving, calving to rebreeding and rebreeding to weaning.

	n	Pregnancy rate	n	ICI	n	BWT	n	WWT	n	Weaning rate
Joining to PD										
Increase BCS	73	0.75(0.61-0.85)[b]	53	373±3	54	32.5±2.5	51	193.6±9.0[b]	58	0.79(0.63-0.89)
No change	117	0.88(0.82-0.92)[a]	68	369±2	95	34.1±2.2	91	208.8±8.0[a]	100	0.84(0.78-0.90)
Decrease BCS	136	0.92(0.82-0.97)[a]	101	366±2	120	34.1±2.3	110	214.3±8.8[a]	126	0.79(0.67-0.87)
P value		0.03		0.21		0.45		<0.01		0.48
PD to winter										
Increase BCS			89	366±3	128	36.0±0.8	114	205.7±3.4	140	0.73(0.59-0.83)
No change			95	369±1	123	35.1±0.6	117	202.9±2.5	132	0.86(0.79-0.91)
Decrease BCS			41	367±4	55	35.6±1.6	52	203.1±6.0	58	0.94(0.66-0.99)
P value				0.45		0.59		0.79		0.09
Winter to calving										
Increase BCS			72	374±3[a]	72	36.0±1.0	66	208.1±4.3	74	0.86(0.69-0.95)
No change			66	371±2[a]	80	34.8±0.6	75	204.45±2.6	86	0.84(0.76-0.90)
Decrease BCS			84	363±2[b]	149	35.8±0.6	139	201.5±2.79	165	0.82(0.74-0.89)
P value				0.02		0.34		0.44		0.90
Calving to rebreeding										
Increase BCS					181	34.7±0.6	175	202.4±2.4	193	0.91(0.84-0.95)
No change					59	36.5±0.6	57	206.5±2.7	63	0.89(0.80-0.94)
Decrease BCS					45	36.7±1.2	44	209.0±4.9	50	0.81(0.61-0.92)
P value						0.08		0.38		0.39
Rebreeding to weaning										
Increase BCS					90	35.6±0.9	85	203.7±3.8	96	0.85(0.71-0.93)
No change					101	35.5±0.5	98	203.7±2.1	110	0.90(0.84-0.94)
Decrease BCS					96	36.1±0.8	95	208.9±3.6	103	0.92(0.81-0.97)
P value						0.84		0.42		0.55

[a, b] means with different superscripts vertically differ (P<0.05) between main effects within columns.

predominantly at or above recommended industry targets, and therefore, the absence of many relationships between BCS and productivity indicates that the industry targets are appropriate as few further improvements in productivity were achieved by increasing BCS above the targets. Future work should involve using feeding to manipulate BCS during a production cycle to better understand the relationship between BCS and production.

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