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MILK AND WEIGHT EBVS ARE ASSOCIATED WITH COW AND CALF GAIN DURING LACTATION BUT CARCASS EBVS ARE NOT

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SUMMARY

In a series of in-depth interviews with seed-stock producers in southern Australia many breeders spoke about the importance of the ability of cows to gain energy reserves post-calving within their on-farm management system. Moreover, several breeders believed maternal, carcass and weight EBVs to influence a cow's ability to gain weight and energy reserves during lactation. This paper reports on heritability of cow weight change and body composition change traits during lactation, calf weaning weight (CalfWt), and total Cow+calf weight gain from calving to weaning for Angus cows. In addition, significant regressions of cow change traits, CalfWt and Cow+calf weight gain on current Breedplan EBVs are reported. Heritability estimates for CalfWt, cow weight change, rib fat depth change and eye muscle area (EMA) change during lactation and Cow+calf weight gain were low, ranging from 0.07 to 0.13. Cow EBVs with significant effect on CalfWt were 200 day weight (Wt200) (0.38±0.09kg/kg EBV) and 200 day maternal (MILK) EBV (1.00±0.15kg/kg EBV). Increased mature cow weight (MCWt) EBV was associated with greater gain in cow weight and rib fat depth during lactation whilst increased MILK EBV was associated with cow weight, rib fat and EMA loss during lactation. MILK EBV was not associated with the combined weight gain of the Cow+calf during lactation. Rib and EMA EBVs of the cow were not associated with CalfWt, change in cow weight, rib fat or EMA during lactation, or Cow+calf weight gain.

INTRODUCTION

The role of maternal productivity in beef production is becoming increasingly important as breeding operations migrate to more varied and challenging production environments. Analysis from a series of in-depth interviews with seed-stock breeders based in southern Australia found many breeders perceived high importance of cows being able to fluctuate in weight and energy reserves whilst still maintaining an annual production cycle (Lee *et al.* 2009). Some breeders perceived significant differences in a cow's ability to fluctuate in energy reserves within the constraints of their production system. Specifically, some breeders perceived that a cows ability to gain weight and energy reserves from calving to weaning was related to genetic merit for MCWt, MILK and subcutaneous fat EBVs (e.g. Rib EBV). This paper reports heritability of CalfWt as a trait of the cow, cow weight change during lactation, and Cow+calf weight gain to weaning. Heritability estimates of cow tissue change traits during lactation for ultrasound Rib fat depth and EMA are also presented.

The effect of the cow's genetic merit as measured by current Breedplan EBVs on traits including CalfWt, cow weight change during lactation and total Cow+calf weight gain is also quantified at first and second parity. Understanding and quantifying how cow EBVs impact these traits will enable breeders to be better informed as to how changing genetic merit affects CalfWt, cow weight change and tissue change during lactation and can therefore seek to optimise cow genetic merit accordingly.

METHODS

Animal performance data. Cow body composition traits including weight (kg) and ultrasound Rib fat depth (mm), and loin eye muscle area (EMA, cm^2) were collected on Breedplan performance recorded Angus cows at pre-calving and weaning over the first two parities. In total, 4070 records were available for CalfWt and 2840 for cow weight and tissue change traits and Cow+calf weight gain from 2449 individual cows. The same data was used for both genetic parameter estimation and for regression of traits on EBVs. Cow change traits for lactation were computed for weight, EMA and Rib fat depth by calculating the difference between the pre-calving observation and subsequent weaning observation. Contemporary group (CG) was based on year of birth, parity, calving season, pregnancy status, lactation status and breeder assigned management group. Summary statistics by calving season and parity are reported in Table 1.

Table 1. Summary statistics of calf weaning weight (kg), cow body composition change traits and Cow+calf weight gain from pre-calving (PC) to weaning (W) (SD in parentheses)

Parity		1		2	
Season		Autumn	Spring	Autumn	Spring
CalfWt	n records	405	2059	161	1445
	Wean age (days)	207 (31)	165 (41)	197 (53)	157 (37)
	Wean wt (kg)	259 (45)	194 (46)	268 (64)	200 (42)
Cow traits	n records	265	1468	77	1031
	Days PC to W	254 (37)	206 (37)	262 (35)	205 (32)
	Wt **Δ** (kg)	-15 (67)	36 (44)	9 (43)	28 (55)
	Rib **Δ** (mm)	-0.8 (3.0)	0.9 (2.0)	2.1 (2.5)	1.6 (2.8)
	EMA **Δ** (cm^2)	-1.1(11.7)	4.6 (9.0)	0.7 (8.0)	1.1 (9.8)
Cow+calf	Unit output (kg)	264.6 (71.4)	239.8 (63.8)	296.1 (79.5)	233.0 (64.4)

Animal performance data analysis. Univariate models were fitted using ASReml (Gilmour *et al*. 2006) to estimate variance components for CalfWt, all cow change traits and Cow+calf weight gain as a trait of the cow. Cow pedigree, sire of calf and contemporary group terms were fitted as random effects. For CalfWt, between-cow residual was fitted to account for repeat records. Between-cow residual was not fitted in other models due to low number of repeat records creating insufficient variance for components to be estimated. The variance components were similar when repeat records were included or excluded. Fixed effects and interaction terms were retained in the fixed model where significant ($P \leq 0.05$). Specifically, fixed effects fitted for CalfWt, cow change traits, and Cow+calf unit weight gain are detailed below. EBVs were added as additional fixed effects for each trait and retained where significant.

Calf Wt = parity + season + calf wean age + calf sex + calf sex.parity + calf wean age.parity
Cow change trait = parity + season + calf wean age + calf birth weight + calf weaning age.parity
Cow+calf = parity + season + calf wean age + cow days PC to W + calf sex + calf sex.season

RESULTS

Heritability and variance components of output and cow change traits from during lactation are presented (Table 2). When analysed as a trait of the cow, the heritability of CalfWt, cow weight change and Cow+calf weight gain were 0.13, 0.11 and 0.07 respectively. Cow heritability for CalfWt includes both direct genetic and maternal components because sire of calf was fitted instead of calf pedigree. The heritability of cow Rib fat depth change and EMA change during lactation were 0.13 and 0.08 respectively.

Table 2. Variance components and heritability for calf weaning weight, cow change traits and Cow+calf weight gain from during lactation

	CalfWt	Cow Wt **Δ**	Cow+calf	Cow Rib **Δ**	Cow EMA **Δ**
CG	600.3	2111.4	3206.2	5.09	68.2
Animal (cow)	58.0	133.8	92.3	0.35	2.96
Sire of calf	23.2	4.7	1.5	0.13	0.58
Between animal resid.	32.2				
Residual	399.9	1045.9	1277.5	2.31	36.5
V_p	457.9	1179.7	1369.8	2.66	39.46
Heritability	0.13	0.11	0.07	0.13	0.08

Significant EBV regressions are displayed in Table 3 for all traits. For CalfWt, cow EBVs for Wt200 and MILK had significant regressions of 0.33±0.08kg/kg EBV and 0.89±0.13kg/kg EBV respectively with no significant interactions with season, parity or calf sex. When adjusted to weaning at 200 days (from 168 days), the regression for MILK (1.00±0.15kg/kg) was exactly as expected (1.0kg/kg) whilst the regression for Wt200 (0.38±0.09kg/kg) did not significantly differ from expectation (0.5kg/kg). Increased cow MILK was associated with cow tissue loss during lactation for weight (-0.71±0.25kg/kg EBV), Rib (-0.05±0.01mm/kg EBV), and EMA (-0.17±0.04 cm^2/kg EBV). Cow MILK EBV (P= 0.39) and carcass EBVs for Rib (P= 0.53) and EMA (P= 0.82) did not significantly affect Cow+calf weight gain. Increasing cow MCWt was associated with cow weight and rib fat gain during lactation, but not gain in EMA. Only MCWt had a significant effect on Cow+calf gain, with varying size of effect depending on calving season and parity (Table 3).

Table 3. EBV regressions for CalfWt, cow weight change, Cow+calf output and ultrasound scan cow body composition change traits from pre-calving to weaning (n.s. = EBV or interaction not significant and thus not reported)

		CalfWt	Cow Wt **Δ**	Cow+calf	Cow Rib Δ	Cow EMA Δ
Wt200		0.33±0.07	n.s.	n.s.	n.s.	n.s.
Milk		0.89±0.13	-0.71±0.25	n.s.	-0.05±0.01	-0.17±0.04
MCWt	Parity 1	n.s.	0.21±0.06	0.18±0.06	0.01±0.003	n.s.
	Parity 2	n.s.	0.39±0.07	0.40±0.09	0.02±0.003	n.s.
MCWt	Autumn	n.s.	n.s.	0.52±0.16	n.s.	n.s.
	Spring	n.s.	n.s.	0.18±0.06	n.s.	n.s.

DISCUSSION

Published estimates of heritability for body weight and composition change traits in beef cattle are sparse. However, the heritability estimates presented are similar to those reported for change traits in dairy cattle and young sows. Berry *et al.* (2002) reported heritability estimates for weight change traits in dairy cows during lactation ranging from 0.02-0.10. Bunter *et al.* (2010) reported heritability of sow change traits during the first two lactations and found moderate heritability (0.23) for sow weight change but very low (0.01 to 0.10) heritability for fat change.

Phenotypically, the favourable effects of positive energy balance and weight gain post calving have been widely documented. However, genetic correlations for cow tissue change during lactation and from pre-calving to joining are yet to be fully elucidated. Recording cow body composition change traits is costly given the need to ultrasound scan cows at both pre-calving and weaning to be able to record the trait. Economic value of change traits for different periods over the production cycle need to be determined for beef cattle. If tissue change traits have impacts on economically important traits, selection to improve cow change traits may be beneficial.

In contrast to some breeder's perceptions (Lee *et al*. 2009), EBVs for Rib and EMA had no effect on CalfWt, cow change traits, or Cow+calf gain to weaning. This is important as it shows selection on current Breedplan carcass traits is not expected to confer change in the weight gain traits investigated.

Breeder's observations of the effect of MILK and MCWt EBVs on cow change traits during lactation were confirmed. Results suggest that increased MILK is associated with transfer of energy from cow to calf but no significant increase in total Cow+calf weight gain during lactation.

Similar to this study, across a range of purebred and cross bred *Bos taurus* Miller *et al.* (1999) found increased milk yield was associated with a reduction in rib fat depth through lactation of -0.22mm per 1kg/day increase in milk yield. However, there was not a significant trend for greater cow weight loss during lactation with increased milk yield. In addition Miller *et al.* (1999) found cow milk yield influenced calf pre-weaning growth such that every additional kilogram of milk during lactation resulted in 21.5g additional calf weight gain. The average lactation length for cows in this study was 167.6 days over which period a 1kg increase in MILK EBV resulted in gain in CalfWt of 0.89±0.13 kg (Table 3). Based on the results of Miller *et al.* (1999), to achieve the additional CalfWt, milk yield from the cow would have to increase by 0.25kg/day over a 167.6 day lactation. Using regressions reported by Miller *et al*. (1999), rib fat loss during lactation caused by the additional milk yield would be expected to be -0.05mm/kg increase in MILK EBV, nearly identical to the Rib fat loss reported (Table 3).

MCWt EBV appears to be related to gain in cow weight and fat tissue during lactation and also greater total Cow+calf unit gain during lactation. Therefore, selection to increase Cow+calf gain during lactation and cow weight gain post-calving could be facilitated through selection to increase MCWt EBV. However this strategy would also result in substantial increases in energy requirements, meaning overall economic benefit to the production system could be questionable.

It is important to note that CalfWt, cow weight change during lactation and Cow+calf gain to weaning appear lowly heritable. Moreover this study has demonstrated that EBVs for Rib and EMA are not associated with calf weight gain and cow weight change during lactation. Selection for increased Milk EBV should therefore be carefully considered. In production systems with high feed availability, increased MILK EBV may be economically advantageous but in production systems with low feed availability increased MILK EBV may inhibit the cow's ability to maintain an annual production cycle. Relationships between cow composition and fertility are currently being investigated as part of CRC research.

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