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OBSERVED TRENDS IN ESTIMATED BREEDING VALUES IN RESPONSE TO SELECTION USING VISUAL MUSCLE SCORE IN BEEF CATTLE

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SUMMARY

Selection on the basis of visual muscle score has been proposed in strategies for increasing beef carcass yield. An experiment to examine the effect of selection for high or low muscle score on production traits was established, and demonstrated that significant divergence in the trait was achievable. Selection for high muscle score was shown to be associated with increasing BreedPLAN estimated breeding values (EBV) for eye muscle area while reducing those for rump fat depth and consequently increasing retail beef yield EBVs. The opposite responses have seen to selection for low muscle score. There was no apparent divergence in growth EBVs between muscle selection lines, confirming no antagonism between muscle score and growth rate.

INTRODUCTION

Weight and subcutaneous fat cover have been almost universally accepted by the Australian beef industry as determinants of animal and carcass value. However, the likely introduction of yield based payments has raised awareness among producers for the need to select animals that produce higher yielding carcasses. Muscle score has been proposed as a means of selecting animals that produce higher yielding carcasses (McKiernan 1990). However, the value of muscle score for predicting carcass attributes of live animals (Johnson 1980, Taylor *et al*. 1990, Perry *et al*. 1993a,b) and its usefulness for animal breeding (Johnson 1996, Koch *et al*. 1995) has attracted considerable debate. While some producers in the Australian commercial beef cattle industry have associated higher muscled animals with decreased growth rates, specific studies have demonstrated the independence of these traits (Tatum *et al*. 1986, McKiernan and Robards 1997).

This paper presents EBV trends observed in a research herd that was established to examine the effect selection for divergent visual muscle score of live animals would have on production traits in beef cattle.

MATERIALS AND METHODS

The base females used in this selection experiment were F1 progeny from an earlier selection experiment that commenced in 1991 to evaluate the effect of using high (11.4 or ~B - see below) and low (5.3 or ~D) visual muscle score Angus bulls that were pair mated within muscle score to a random selection of Hereford heifers and cows (average visual muscle score 4.6 or ~D, McKiernan and Robards 1996, 1997).

In 1997 females were selected from within sire mating groups based on yearling visual muscle score to form the first generation of high or low muscle score lines. In subsequent years (1998-2010) all matings involved Angus bulls selected from industry herds for either high (>=11 or >=B) or low (<=5 or <=D) visual muscle score. The bulls were single-sire mated within muscle score line to allow full pedigree to be recorded. i.e. high muscle bulls mated to high muscle cows. The inadvertent use of high muscled Angus bulls that carried the myostatin 821 del11 mutation (O'Rourke *et al*. 2009) in matings since 1998 resulted in a sub-selection line (high muscle myostatin) being formed in 2005. This line retains only females carrying a single copy of the myostatin mutation. Since this time reciprocal matings have occurred i.e. high muscle bulls mated to myostatin cows and heterozygous myostatin bulls to high muscle cows. Thus, progeny are able to move between the myostatin and high muscling lines based on their confirmed myostatin status.

The females from all muscle selection lines have been managed in mixed groups outside joining periods (Oct-Dec) with calving occurring primarily between September and November with weaning in March/April. Following DNA testing for all myostatin mutations (O'Rourke *et al*. 2009) selection of heifer replacements in the myostatin and high muscle lines is based only on yearling muscle score within line. Low muscle line heifer replacements are selected from those with the lowest yearling muscle scores. Following weaning all steer progeny have been managed as a single cohort until either sold or slaughtered while the selected female progeny have been managed as a single cohort until joining.

The muscle scoring system is based on a visual assessment of thickness and convexity of the body relative to skeletal size with adjustment for fat depth (McKiernan 1990). A 15-point scale is used, from A+ (15) to E- (1), with score A animals being the best muscled and score E animals being the lightest muscled (McKiernan 1990). As indicated above, female selection is based on yearling muscle scores (~ 1 year old) while bull selection is based on muscle score at the time of purchase (~ 2 years old). All muscle score assessments were conducted by a single assessor.

All progeny were regularly assessed for muscle score, height and other body dimensions, live weight, scanned fatness (P8 and rib sites) and eye muscle area. Progeny born since 2003 have been scanned by a BreedPLAN accredited scanner using real time ultrasound machines. In most years these assessments have been conducted at weaning and yearling ages for all progeny. The steers have also been assessed during backgrounding, prior to feedlot entry and prior to feedlot exit while replacement females have been assessed several times prior to first mating. Chilled steer carcasses have generally been assessed for subcutaneous fat depth at the P8 and rib sites as well as eye muscle area. Some steer cohorts have also had full commercial yield tests conducted (Cafe *et al*. 2006).

All pedigree information as well as live animal and carcass measurements excluding muscle scores have been submitted to the Angus group BreedPLAN database. All estimated breeding values for the muscling herd have been calculated by the national genetic evaluation system, BreedPLAN (Graser *et al*. 2005).

RESULTS AND DISCUSSION

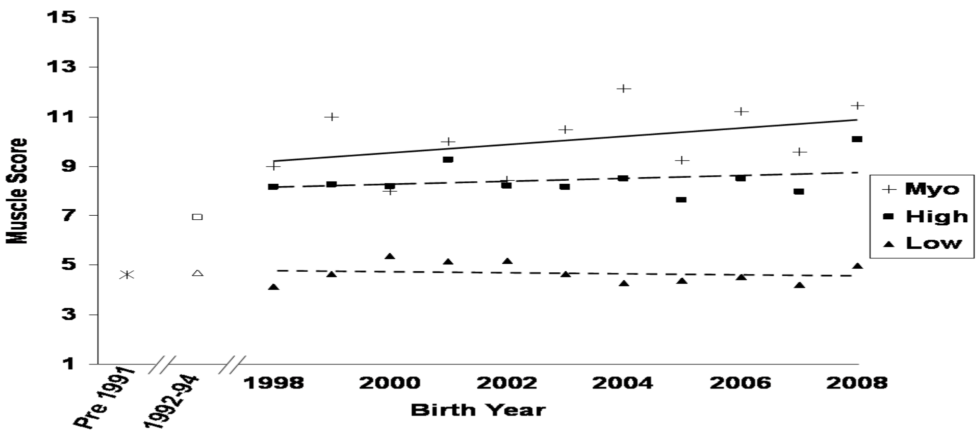

Figure 1. Average visual muscle scores for animals born in each year from base Hereford females (Pre 1991), F1 females (1992-94) and the low, high and myostatin muscle lines.

Animal selection based on visual muscle score has been successful in creating divergence in muscle score over an 11 year period (Figure 1). The mean muscle score of the high muscling line has increased from 4.6 in the Hereford females to 8.2 (~ C) in 1998 to 10 (B-) in 2008 with an overall upward trend evident while the low muscling line has remained relatively static at approximately 4.7 (just below D). Figure 1 also demonstrates the higher visual muscle scores associated with animals carrying the myostatin mutation. However, the myostatin line results need to be interpreted with caution as most myostatin cohorts contain less than 10 animals except the 2007 and 2008 cohorts which have more substantial numbers (>40). For this reason the observed EBV trends of the myostatin muscling line will not be presented in the remainder of this paper.

Table 1. Estimated breeding values (EBVs) for birth, 200 day, 400 day, 600 day and mature cow weight for animals born since 1998 from the high and low muscle selection lines.

	Birth Wt		200 Day Wt		400 Day Wt		600 Day Wt		Mature Cow Wt	
Year	High	Low	High	Low	High	Low	High	Low	High	Low
1998	3.08	3.59	16.3	16.7	35.4	35.0	39.3	47.3	34.7	46.9
1999	0.65	3.40	10.0	16.8	24.1	33.8	29.9	43.2	32.7	39.0
2000	2.83	3.27	15.0	14.2	30.9	28.7	40.6	37.5	41.6	42.8
2001	3.53	3.01	20.0	13.7	37.5	28.8	45.6	38.3	36.5	43.1
2002	3.27	3.92	15.2	19.1	29.7	38.6	38.4	49.2	39.9	48.0
2003	2.88	2.77	19.6	15.0	39.4	34.8	49.3	41.2	43.2	36.6
2004	3.23	1.85	23.1	11.2	45.4	27.7	56.4	34.1	46.8	30.9
2005	2.99	3.46	22.6	17.1	43.2	35.5	55.2	48.4	50.2	47.5
2006	3.01	4.13	22.6	18.8	44.0	40.8	53.0	56.2	50.6	61.3
2007	3.32	4.05	23.2	23.5	46.0	45.1	54.3	62.0	49.6	65.2
2008	3.26	3.65	22.2	27.3	44.5	50.7	54.3	65.8	55.5	62.3
2009	2.82	3.29	21.9	25.0	43.3	49.6	53.6	62.7	56.9	55.8

Birth, 200 day, 400 day, 600 day and mature cow weight observed EBV trends for the high and low muscling lines are presented in Table 1. These observed EBV trends demonstrate large amounts of variability both between lines and between years without clear divergence occurring between the muscling lines. This result suggests no positive or negative correlation when selecting for growth or muscling and is supported by previous experimental results demonstrating the independence of these traits (McKiernan and Robards 1997)

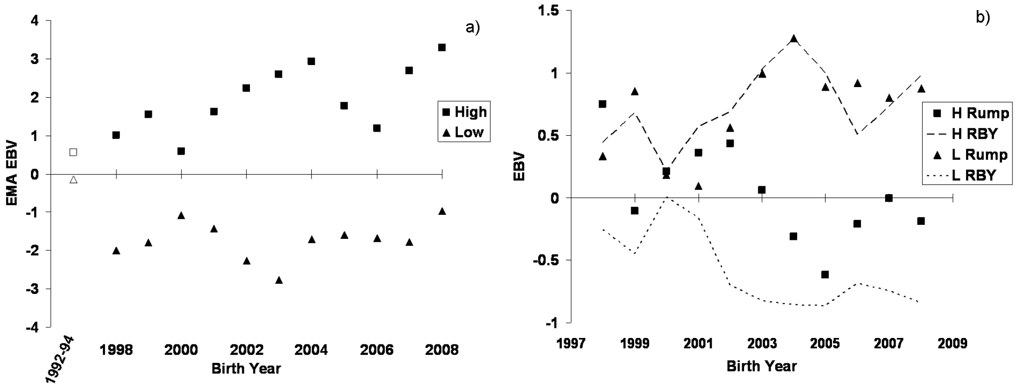

Figure 2. Estimated breeding values (EBVs) for eye muscle area (EMA) (a), rump fat and retail beef yield (RBY) (b) for animals born in each year from the muscle selection lines.

Figure 2 presents observed trends in EBVs for eye muscle area (EMA) and rump fat along with retail beef yield (RBY). Selection using muscle score has increased EMA EBV in the high muscle line while a static response has been seen in the low muscle line (Figure 2a). EBVs for rump fat have trended downward in the high muscling line and slightly upward in the low muscling line (Figure 2b). The changes in EMA and rump fat EBVs have seen corresponding changes occur in RBY EBV with a downward trend in the low muscling line and upward trend in the high muscling line (Figure 2b). These changes in EMA, fat and yield EBVs are logical and support previous experimental results demonstrating selection for muscling increases carcass yield (Tatum *et al*. 1986, McKiernan and Robards 1997).

CONCLUSIONS

This paper demonstrates that divergence in muscularity can be achieved in beef cattle by selection using visual muscle score at yearling age (females) and point of purchase (bulls). The observed trends in live weight and carcass EBVs seen in response to selection using visual muscle score demonstrate that this can be used to increase carcass yield with no detrimental impacts on animal growth. Although a slight decrease in fatness is evident it is postulated this decrease is less than would occur if selection for meat yield was based solely on reducing fatness. In the latter case a greater reduction in fatness may have negative effects on meat quality and maternal traits. On an individual animal basis it is quite often difficult to discern the relationship between EMA EBV and visual muscle score. McKiernan (1995) reported phenotypic correlations between muscle score and scanned EMA of 0.4 for females and 0.7 for males indicating the two assessments of muscling are moderately related which is supported at the genetic level by this data.

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