Improving carcase value by incorporating primal weights into beef breeding objectives

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Abstract

The impact selection for increased high-value primal cuts (HVC) has on improving beef profitability is important to explore. This study presented an approach that facilitates the extension of existing beef breeding objectives (BO) by including HVC. Economic values for HVC were derived for two different production systems: one pasture-based for the Australian domestic market (DPS) and the other grain-based for the Japanese market (JPS). The BO incorporated HVC on a percentage basis to maintain independence to carcase weight. The emphasis on HVC in the breeding objective was 8.78% and 10.77%, respectively, with annual predicted genetic gains from a mean of 0.10% and 0.18% in HVC for DPS and JPS, respectively. The addition of HVC increased the index response by 14.95% and 54.22% for DPS and JPS, respectively over the base scenario, which does not include primal cuts, indicating the potential of HVC to enhance selection for improved carcase value.

Introduction

In Australia, and most other countries, beef producers are currently paid on carcase weight, conformation and fat cover. These measurements provide the basis for payment to producers, with financial penalties for carcases that do not conform to desirable characteristics (Kenny *et al.*, 2020). The red meat yield, especially in primal cuts, dictates the economic and production efficiency at the processor level (Drennan *et al.*, 2009). Producing carcases with a higher proportion of red meat yield positively impacts beef processing profitability due to less fat and bone in the carcase. Overall, the proportion of primals, especially the high-value primals, is the main price determiner of a beef carcase for processors. The current beef breeding objectives do not include primal cuts. Therefore, the aim of this study was to derive economic values (EV) for high-value primal cuts (HVC) and predict responses to selection for HVC and other traits incorporated in current breeding objectives (BO) for Australian beef.

Materials & Methods

Animal and primal cuts. Primal weights were recorded on 1,014 Angus cattle (876 steers and 138 heifers), from NSW Department of Primary Industries research herds. The animals were slaughtered between 2017 and 2020 at around 600 days of age and in lots of 23 to 54 animals per day. The primal cuts were classified into two groups based on their retail value; the HVC composed of the cube roll, striploin, tenderloin, rump, topside, intercostal and thick flank, and the low-value cuts (LVC) composed of the thin flank, hindquarter shank, forequarter shank, brisket, inside skirt, silverside, blade, rib set, chuck tender and chuck.

The breeding objective. In addition to the current BO traits, the BO included HVC to determine the value of increasing HVC at a fixed carcase weight. Breeding objectives were constructed for two terminal production systems relevant to Australian beef. One system was based on finishing steers off pasture for the Australian domestic market (DPS) with steers slaughtered at a target live weight of 620 kg. Marbling was assumed to have low value in this market. The other system was based on feedlot finishing steers for the high-quality Japanese market (JPS), where marbling was of high importance. JPS steers were slaughtered at a target live weight of

800 kg. Carcase prices at the farm-gate level were assumed to be $AUD5.40/kg and $AUD6.20/kg for the DPS and JPS markets, respectively.

Derivation of economic values for high-value cuts at farm-gate level. The BO defined HVC on a percentage basis rather than a weight basis to maintain independence from carcase weight. Firstly, the wholesale prices of different primal cuts were converted to farm-gate prices using the conversion factor k, so the derived EV of HVC was also at the farm-gate level. The factor k was calculated with equation 1, where P_p was the total farm-gate value of a carcase adjusted to a fixed weight of 305 kg or 350 kg for DPS and JPS, respectively.

$$k = P_p \, / \text{ total weighted price of all primal cuts at the wholesale level} \qquad (1)$$

Based on the weighted average of the difference between HVC and LVC, EVs were calculated by multiplying the price difference at farm-gate by 3.05 and 3.50 since a 1% increase in HVC represents 3.05 kg and 3.50 kg increases in HVC for DPS and JPS, respectively.

Beef index description. The BOs were developed with BreedObject (Barwick *et al.*, 2005) and the selection criteria based around BREEDPLAN EBVs that align with terminal systems (Johnston *et al.*, 1999). The EVs and parameters for BO (Table 1) and selection criteria (Table 2) traits used in this study were assembled from published (Archer *et al.*, 2004; Wood *et al.*, 2004) and unpublished sources (pers. comm. Brad Walmsley, *2021*). It was assumed that the live animal traits were recorded for the selection candidate, sire, dam and 25 half-sibs, while carcase traits except HVC were recorded for 25 half-sibs only. To investigate the effect of including HVC in beef breeding programmes, two different scenarios were modelled: one in which HVC was not included in the BOs, and another in which HVC was incorporated in the BOs without any relatives information for HVC. The annual response for each trait was predicted assuming an average generation interval of four years. Trait EVs were multiplied by their genetic standard deviation to show the relative importance of traits in BO.

Table 1. Heritabilities (h^2), phenotypic standard deviations (PSD) and economic values for breeding objective traits for two Australian beef markets.

Traits	h^2	PSD	Economic value	
			Domestic	Japanese
Weaning Weight – Direct (kg)	0.10	25.10	0.02	0.09
Residual feed intake – pasture (kg/day)	0.40	1.10	-22.22	-16.33
Feedlot entry live weight (kg)	0.17	31.15	-	0.04
Residual feed intake – feedlot (kg/day)	0.35	1.32	-	-20.29
Sale Weight (kg)	0.31	34.64	0.76	0.61
Dressing percentage (%)	0.33	1.80	11.20	11.80
Saleable meat percentage (%)	0.56	2.00	8.63	9.69
Fat Depth at rump (mm)	0.41	1.97	2.79	1.13
Marbling score (score)	0.38	0.71	102.41	135.51
Calving Ease – Direct (%)	0.10	20.30	3.45	3.66
High-value primal cuts (%)	0.62	0.80	19.05	28.80

Table 2. Heritabilities (h^2) of selection criteria traits and genetic correlations with the breeding objective traits.

Traits[1]	BW	200d WT	400d WT	600d WT	CEMA	P8	RBY	CIMF
h^2	**0.39**	**0.18**	**0.25**	**0.31**	**0.26**	**0.36**	**0.58**	**0.25**
WWd	0.45	0.85	0.68	0.65	0.04	-0.11	0.06	0.00
RFI-p	-0.10	-0.30	-0.15	-0.15	-0.10	0.25	-0.07	0.20
EWT	0.40	0.65	0.80	0.65	0.00	-0.10	0.06	0.03
RFI-f	-0.10	-0.30	-0.15	-0.15	-0.10	0.25	-0.04	0.20
SW	0.49	0.62	0.72	0.88	0.36	0.05	0.03	-0.22
DP	-0.01	-0.19	-0.16	-0.18	-0.09	0.50	0.06	0.10
SMP	0.00	-0.06	-0.04	-0.04	0.34	-0.52	0.70	-0.27
FD	-0.05	0.04	0.06	0.06	0.28	0.85	-0.35	0.26
MS	0.00	-0.06	-0.14	-0.22	-0.15	0.23	-0.17	-0.14
CEd	-0.50	-0.20	-0.16	-0.17	-0.10	0.00	0.00	0.00
HVC	0.05	0.05	0.05	0.05	0.38	-0.30	0.71	-0.36

[1]Traits: Selection criteria traits, BW: Birth Weight (kg), 200d WT: 200-day Weight (kg), 400d WT: 400-day Weight (kg), 600d WT: 600-day weight (kg), CEMA: carcase eye muscle area (cm^2), CFD: P8 fat depth (mm), RBY: retail beef yield (%) and CIMF: carcase IMF (%). Breeding objective traits, WWd: weaning weight- direct (kg), RFI-p: residual feed intake- pasture (kg/day), EWT: feedlot entry live weight (kg), RFI-f: residual feed intake- feedlot (kg/day), SW: sale weight (kg), DP: dressing percentage (%), SMP: saleable meat percentage (%), FD: fat depth on the rump (mm), MS: marbling score (score), CEd: calving ease-direct (%) and HVC: high-value primal cuts (%)

Results

The HVC represented 8.78% and 10.77% of the BO emphasis for DPS and JPS, respectively (Table 3). This demonstrates that HVC could be important to include in future beef BOs. Inclusion of HVC in current beef BO produced additional responses of 0.10% and 0.18% for DPS and JPS, respectively. Total responses improved when HVC was added to the current BO. The inclusion of HVC improved overall predicted index responses by \$1.06 (\$7.09 to \$8.15) and \$4.37 (\$8.06 to \$12.43) per year, respectively for DPS and JPS and this equated to increases of 14.95% and 54.22%, respectively. Including HVC also changed the predicted responses of other BO traits favourably for both production systems. For instance, genetic gain for saleable meat percentage increased when HVC were included because of the positive genetic correlation between HVC and retail beef yield, which is one of the main profit drivers in beef terminal indexes. The response in marbling score was slightly decreased for the DPS. Another important trait in beef indexes was calving ease-direct, which also had a favourable response in the extended beef BOs. The inclusion of HVC in BOs trait could therefore be expected to be useful to improve overall selection response in both production systems in beef.

Discussion

Given current pricing systems, the findings of this study show that incorporating HVC into current breeding goals would benefit the beef industry. Selection for increased HVC resulted in increased responses for both production systems; however, in JPS, the relative importance of HVC was higher than DPS. If breeding values could be estimated by multi-trait animal models and made available, the EVs produced with the current model can be utilised to construct selection indices for beef in specific production systems. The model has a large number of traits, but it would be beneficial to include more carcase and meat quality traits. Broadening the breeding goal, particularly by including HVC, should result in more profitable animals; as a result, breeders' emphasis should include valuable primal cuts to increase the total market value of the carcase.

Table 3. Relative contribution of different breeding objective traits and predicted annual responses for different selection index strategies.

Traits[1]	Breeding objectives							
	DPS		JPS		DPS		JPS	
	Relative contribution				Response per year			
HVC	✗	✓	✗	✓	✗	✓	✗	✓
WWd (kg)	0.14	0.13	0.49	0.44	-0.18	-0.10	0.49	0.40
RFI-p (kg/day)	12.32	11.24	7.50	6.69	-0.06	-0.06	-0.01	-0.02
EWT (kg)	-	-	0.31	0.27	-	-	1.22	0.87
RFI-f (kg/day)	-	-	10.51	9.38	-	-	0.00	-0.02
SW (kg)	11.66	10.64	7.78	6.94	0.26	0.31	1.57	1.24
DP (%)	9.26	8.45	8.09	7.22	-0.01	0.00	0.11	0.10
SMP (%)	10.33	9.42	9.62	8.58	-0.06	0.16	0.26	0.36
FD (mm)	2.82	2.58	0.95	0.85	0.05	-0.02	-0.07	-0.10
MS (score)	35.72	32.58	39.18	34.96	0.05	0.03	0.01	0.01
CEd (%)	17.74	16.18	15.56	13.89	0.17	0.20	0.47	0.50
HVC (%)		8.78		10.77	-	0.10	-	0.18
Total response in BO $					7.09	8.15	8.06	12.43

[1]Traits: WWd: weaning weight- direct, RFI-p: residual feed intake- pasture, EWT: feedlot entry live weight, RFI-f: residual feed intake- feedlot, SW: sale weight, DP: dressing percentage, SMP: saleable meat percentage, FD: fat depth on the rump, MS: marbling score, CEd: calving ease-direct and HVC: high-value primal cuts
DPS: domestic production system and JPS: Japanese production system.
✗: without HVC and ✓: with HVC included in BO

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