Proc. Assoc. Advmt. Anim. Breed. Genet: 24: 353-356

IMPROVING CARCASE VALUE BY INCORPORATING PRIMAL WEIGHTS INTO PIG BREEDING OBJECTIVES

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SUMMARY

This study aimed to evaluate the benefits of including primal cut measures of pig carcases in the breeding objective by comparing the efficacy of two different approaches; a detailed approach and a simpler approach. The detailed approach included economic values for the loin and belly primals separately (\$1.54 and \$2.24/pig respectively), where the simpler approach included an economic value for the combination of these (the 'middle primal' at \$1.89/pig). Each approach was evaluated in two different scenarios by adding information on the primal cut(s). Inclusion of primal traits in the breeding objective increased the predicted response to selection by 2.47% and 3.20% for both approaches (I and II) and primals contributed 15% and 12% to the new breeding objectives. The predicted response to selection was greater for the approach that included the middle primal, which was consistent with moderate to high genetic correlations with other traits in breeding objectives.

INTRODUCTION

The current pig carcase payment system in Australia focuses on fat depth at a given carcase weight without giving any consideration to variation in primal cut weights. Moreover, selection pressure to change back fat has been substantially reduced over the last decade, and further reducing genetic carcase fatness presents little opportunity for economic benefit (Hermesch 2005). However, there are significant premiums in wholesale markets for the belly and the loin primals, which combined make up the middle portion of a pig carcase. According to Mérour et al. (2009), substantial economic differences in carcase value are connected to the variability in individual primal cut weights at a fixed carcase weight and fat depth. The aim of this study was to compare two different approaches for incorporating primal cuts into pig breeding objectives that either included economic values for the loin and belly primals or placed economic emphasis only on the middle portion of the carcase, which combined the loin and belly primals to produce a single trait.

MATERIALS AND METHODS

Data sets. Data describing primal traits were available for 2,198 pig carcases collected from March to September 2012. Pigs came from three different terminal sire lines, which were nested within five different grow-out facilities. Variance and covariance components were estimated with an animal model using ASReml 4.1 (Gilmour *et al.* 2015).

Estimation of primal price at the farm gate level. Firstly, the wholesale prices of different primals obtained from the Australian Pork Limited (APL) weekly reports were converted back to farm-gate-level price (FP). The farm-gate prices for loin (FP_{Ln}), belly (FP_B) and middle (FP_M) were obtained as follows,

$$FP_{Ln} = WP_{Ln}.\ k,\ FP_B = WP_B.\ k \text{ and } FP_M = (FP_{Ln} + FP_B)/2,$$

where k was a constant derived as $k = P_p / (WP_{Sh}*pCwt_{Sh} + WP_L*pCwt_L + WP_{Ln}*pCwt_{Ln} + WP_B*pCwt_B)$, where, P_p was the total price of the carcase adjusted to a fixed weight of 80 kg and a

[1] AGBU is a joint venture of NSW Department of Primary Industries and University of New England

price of $AU3.05/kg carcase weight. The wholesale prices for different primal cuts (shoulder, leg, loin and belly) were denoted by WP_{Sh}, WP_L, WP_{Ln} and WP_B, and $pCwt_{Sh}$, $pCwt_L$, $pCwt_{Ln}$ and $pCwt_B$ were the proportion that each primal represented of an 80kg carcase, respectively.

Estimation of the economic value of primals. The economic values for the loin and belly primals were considered to improve as a percentage basis rather than weight to look at the effect of changing proportions of the carcase to improve profitability. The economic values for either loin, belly or middle were the price difference between each of these primals and the average price of the shoulder and leg primals. This price difference was multiplied by 0.80, since a 1% increase of either loin, belly or middle represented 0.8 kg of a carcase (Table 1).

Index description. The existing pig breeding objective (I_0) includes six traits: average daily gain (ADG, g/d), back fat thickness (BFT, mm), feed conversion ratio (FCR, kg/kg), post-weaning survival (PWS, %), belly fat percentage (BFP, %), drip loss percentage (DLP, %) and two selection criteria traits; juvenile insulin-like growth factor-I (IGF1, ng/ml) and muscle depth (MD, mm). This study expanded the breeding objective to include primal cut traits (loin percentages, LnP and belly percentages, BP or middle percentages, MP), as shown in Table 1. The genetic parameters and economic values outlined in Table 1 were based on Hermesch *et al.* (2015) and Hermesch and Jones (2010). The heritabilities for primal percentages were estimated in this study and were corresponded to heritabilities for weights of primal cuts presented by Sarker *et al.* (2019) based on these data.

Table 1. Heritabilities (h^2), genetic standard deviations (GSD), economic values (EV), genetic (below diagonal) and phenotypic (above diagonal) correlations between traits

Trait[1]	h^2	GSD	EV	ADG	BFT	FCR	PWS	BFP	DLP	IGF1	MD	LnP	BP	MP
ADG	0.31	30.00	0.09		11	-2	0	-6	6	9	12	-1	27	21
BFT	0.33	1.00	-1.70	2		6	0	45	-8	6	8	-11	-7	-15
FCR	0.12	0.15	-27.4	-20	27		0	20	-8	15	1	-14	2	0
PWS	0.05	0.04	1.82	0	0	0		0	0	0	0	0	0	0
BFP	0.34	10.96	-0.20	16	63	21	0		-4	0	1	-20	20	0
DLP	0.23	0.84	-2.25	11	-18	-16	0	-4		0	-7	3	-10	0
IGF1	0.21	13.07	0.00	6	20	57	0	0	0		0	0	0	0
MD	0.30	1.93	0.00	35	16	-8	0	1	20	0		-1	-5	-5
LnP	0.13	0.57	1.54	-3	-4	-13	0	-37	1	0	-12		-27	70
BP	0.21	0.62	2.24	59	65	1	0	32	-8	0	19	6		56
MP	0.24	0.94	1.89	36	44	-17	0	0	-1	0	8	64	76	

*Traits in Italics represent referenced results. Genetic and phenotypic correlations were multiplied by 100. [1] Trait[1] abbreviations: ADG: average daily gain (g/day), BFT: back fat thickness (mm), FCR: feed conversion ratio (kg/kg), PWS: post-weaning survivability (%), BFP: belly fat percentage (%), DLP: drip loss percentage (%), IGF1: juvenile insulin-like growth factor-I (ng/ml), MD: muscle depth (mm), LnP: loin percentage (%), BP: belly percentage (%), MP: middle percentage. h^2: heritability, GSD: genetic standard deviation and EV: economic value

The information for ADG, BFT and MD was available for the selection candidates, sires, dams, 5 full sibs and 30 half sibs. For FCR, records were only available for the candidates, sires, 1 full sib and 5 half sibs because this trait is expensive and difficult to measure. For IGF1, the candidates, sires, dams, 2 full sibs and 10 half-sibs had records. For PWS, it was assumed that only the sires had information available. Carcase traits BFP, DLP, LnP, BP and MP were assumed to be available for 2 full sibs and 10 half sibs. Index calculations were performed using the MTIndex program of van der Werf (https://jvanderw.une.edu.au/software.htm).

Approaches to include primal cut percentages in pig breeding objectives. Approaches that included the loin and belly primals or fitted the combined (middle) term (Approaches I and II, respectively) were evaluated under two different scenarios (A and B). In the first scenario for both approaches (I_A and II_A), the economic values of different primal cuts were included in the breeding objective, while the second scenario (I_B and II_B) included information for different primals from relatives.

RESULTS AND DISCUSSION

Genetic correlations between primal cuts and breeding objective traits. Results presented in Table 1 show that the loin primal (LnP) had negative genetic correlations with BFT and BFP which were favourable for selection (r_g = -0.04 and -0.37), but the genetic association of LnP with FCR and MD were unfavourable (r_g = -0.13 and -0.12). In comparison, BP had favourable genetic correlations with ADG and MD and was highly positively correlated with BFT and BFP (r_g = 0.59, 0.19, 0.65, and 0.32 respectively). A favourable correlation existed between MP and ADG (r_g = 0.36), but MP had unfavourable correlations with FCR and BFT (r_g = -0.17 and 0.44). The genetic and phenotypic correlations between MP and LnP or BP were high because of the part-whole relationship between these traits. Overall, MP had favourable correlations with most other traits.

Comparisons of different scenarios for adding approaches. Adding primal cut traits to existing pig breeding objectives without including additional data in the analyses produced a positive correlated response in LnP, while BP had a negative response (I_0) (Table 2). In comparison, MP showed a negative response due to the genetic correlations with other breeding objective traits in the index (Table1).

Current breeding objectives do not usually take these correlated responses with primal weights into account. Adding economic values for different primal cuts to existing pig breeding objectives in the first scenario increased the overall response in the breeding objective. The individual responses of LnP, BP and MP were positive for both approaches (I and II). The economic implications can be calculated by multiplying each primal response by its economic weight (0.046 and 0.067 for loin and belly, respectively and 0.094 for middle cut). The overall response was $4.07 per pig in first scenario for both approaches (I_A and II_A) and an increase of 0.74% relative to the base index I_0. The addition of information describing loin and belly or middle primal cuts to the breeding objective both produced changes in the relative contribution of index components. The overall responses in the second scenario were highest for approach II (3.22%) compared to approach I (2.47%). The differences in response for the two approaches could be associated with inconsistencies in butchering practices of the loin and belly primals that affects genetic parameters as well.

In the first scenario, (I_A and II_A) index accuracies were lower for both approaches when compared to the base index (I_0) when adding primal cuts as breeding objectives trait without including any additional information. However, accuracies were increased in the second scenario where information from relatives for different primal cuts was added to the index.

Impact of primal cuts to other breeding objective traits. The responses for ADG and MD increased for the first approach in both scenarios when compared to the base index by including primals in breeding objectives. This change was due to the positive genetic correlation between muscle depth and growth rate. However, in the second approach, for ADG, responses were slightly lower when compared to first approach for both scenarios. In comparison, the MD responses were similar in both scenarios for approach I and II. The responses for BFT and BFP were reduced for both approaches and all scenarios when information on the middle primal (or loin and belly) were included in the breeding objectives due to the high genetic correlation between these fatness and primal traits.

The relative contribution of different traits to both existing and extended breeding objectives indicates that including information about the loin and belly or middle primals led to a decreased percent contribution of the original index traits. The relative contribution of LnP, BP and MP cuts were 6% and 9% or 12% of the relative emphasis in their respective approaches (I and II), respectively, demonstrating the importance of these traits in pig breeding objectives.

Based on the conducted research, it is worth mentioning that the inclusion of additional trait(s) is important in the estimation of the commercial value of pig carcases. These results show that the approach which fitted information about the combined middle primal was superior as it produced the highest genetic response in comparison to the approach which fitted the loin and belly primals separately. Moreover, the proposed approach effectively improves the total carcase value of pigs and reduces the costs as well as relative errors or biasness for the individual measurements of the loin and belly.

Table 2. Traits measured in indexes, the response in individual traits for different indexes, and resulting index value and accuracy

Traits	**Indices**					**Relative contribution of different traits in breeding objectives (%)**		
	I_0	I_A	I_B	II_A	II_B	Base index I_0	Index I_B	Index II_B
ADG	10.33	12.67	12.76	12.16	12.13	21	18	19
BFT	-0.50	-0.40	-0.38	-0.41	-0.38	13	11	12
FCR	-0.06	-0.06	-0.06	-0.06	-0.06	32	28	28
PWS	0.00	0.00	0.00	0.00	0.00	57	49	50
BFP	-3.51	-2.84	-2.93	-2.98	-3.06	17	15	15
DLP	0.07	0.05	0.05	0.06	0.06	15	13	13
IGF1	-3.79	-3.59	-3.58	-3.64	-3.60	0	0	0
MD	0.19	0.25	0.25	0.24	0.24	0	0	0
LnP	0.03*	0.03	0.06				6	
BP	-0.05*	0.03	0.05				9	
MP	-0.02*			0.05	0.11			12
$ Index	4.04	4.07	4.14	4.07	4.17			
Accuracy	0.60	0.58	0.59	0.57	0.58			

For trait[1] abbreviations and index descriptions see Table 1. Extended breeding objective includes both LnP and BP or MP.

*Correlated responses due to selection using the current breeding objective I_0

ACKNOWLEDGEMENTS

Data recording was funded by Australian Pork Limited (Project 1025). The first author was supported by an Australian Government RTP International Scholarship.

REFERENCES

Gilmour A., Gogel B., Cullis B., Welham S. and Thompson R. 2015. ASReml user guide release 4.1 structural specification. VSN international ltd, Hemel hempstead, UK.

Hermesch S. (2005) *Australasian Pig Science Association (APSA)* 99.

Hermesch S., Arnal M., Börner V. and Dominik S. (2015) *Proc. Assoc. Advmt. Anim. Breed. Genet.* **21:**1.

Hermesch S. and Jones R. M. (2010) *In Pig Genetics Workshop Notes* Armidale, Australia**:**39.

Mérour I., Hermesch S., Jones R. and Tribout T. (2009) *Proc. Assoc. Advmt. Anim. Breed. Genet* **18:**195.

Sarker N., Walmsley B. and Hermesch S. (2019) *Proc. Assoc. Advmt. Anim. Breed. Genet.* **23:**318.