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CURRENT PROGRESS ON DEVELOPING A SELECTION INDEX FOR AUSTRALIAN MEAT GOATS

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SUMMARY

Previously meat goat breeders in Australia have used the Carcase Plus (CPLUS) index to make genetic selections. CPLUS is an index focused on lean meat production which used sheep parameter estimates and economic values. It was recommended that a new dual purpose index be developed for increased weaning rate and meat production of goats. The new index "Kid Plus" (K+) uses parameter estimates and economic values calculated for goats and places an economic value on reproductive traits, including kid survival. The dollar value response for each doe joined was higher for K+ ($16.56) compared to CPLUS ($9.53).

INTRODUCTION

Australian goat breeders using the national performance recording scheme (KIDPLAN) use the Carcase Plus selection index which was designed for Australian terminal sire sheep (Sheep Genetics 2016). The CPLUS index puts a large emphasis on increasing growth and eye muscle depth while maintaining leanness. There are several issues with this index when applied to KIDPLAN. Currently there are insufficient breeders consistently recording and submitting data for eye muscle depth or fat depth to justify the emphasis placed on these traits. The CPLUS index places a negative economic value on fat depth, but goats are already very lean and have a small amount of variation in fat depth. Another issue is the economic values used in CPLUS are based on lamb and not representative of the Australian meat goat market. Lastly, the genetic and phenotypic covariance matrices rely on values estimated from Terminal sheep breeds, which have been somewhat modified to suit the KIDPLAN dataset. Australian goat producers have a growing demand for an index built specifically for Australian meat goats (BCS Agribusiness 2012). The aim of this project was to develop the first Australian meat goat specific index.

MATERIALS AND METHODS

There were nine traits of interest used in the analysis; birth weight (BWT), weaning weight (WWT), post-weaning weight (PWT), maternal weaning weight (MWWT), number of kids born (NKB), number of kids weaned (NKW), kid survival (KSV), eye muscle depth (EMD), fat depth (FAT), and worm egg count (WEC). Parameter estimates were made with bivariate animal models in ASReml (Gilmour *et al*. 2009) using KIDPLAN data (Table 1). Body weight was defined as 50% emphasis of WWT and PWT. Kid survival was defined as a trait of the kid, between birth and weaning, it was corrected for birth weight and number of kids born. For EMD and FAT parameter estimates were combined post-weaning and yearling traits, due to limited records, and the low phenotypic variation of fat traits. There was insufficient data in KIDPLAN or published literature for genetic and phenotypic correlations of maternal weaning weight or worm egg count, any analysis that included these traits used the previous covariance estimates from CPLUS (these traits are only included in CPLUS to

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monitor trait changes and are not included in selection).

Table 1. Summary of parameter estimates. Genetic variance (σ_A^2), residual variance (σ_e^2) and maternal permanent environmental variance (MPE). The heritabilities are on the diagonal, genetic correlations are below the diagonal, and the phenotypic correlations above

	BWT	WWT	PWT	MWWT	EMD	FAT	WEC	NKB	NKW	KSV
σ_A^2	0.21	1.17	2.45	1.00	0.25	0.014	1.40	0.012	0.013	0.013
σ_e^2	0.12	8.28	15.56	9.20	2.01	0.206	5.39	0.300	0.307	0.133
MPE	0.07	1.56	2.42	1.00	0.09	0.005	7.00	0.030	*0.321	0.007
BWT	0.53	0.35	0.32	0.20	0.01	-0.02	-0.03	0.00	0.00	0.01
WWT	0.53	**0.11**	0.81	0.11	0.03	-0.06	0.00	0.00	0.00	0.00
PWT	0.50	0.88	**0.12**	0.08	0.06	-0.04	0.03	0.08	0.06	0.00
MWWT	0.48	0.50	0.50	**0.09**	0.00	0.00	0.00	0.00	0.00	0.00
EMD	-0.22	-0.21	-0.26	-0.38	**0.11**	0.27	-0.06	-0.07	0.01	0.00
FAT	-0.27	-0.24	-0.19	-0.27	0.26	**0.06**	-0.11	-0.29	0.01	0.00
WEC	0.11	-0.03	-0.24	-0.12	<0.01	<0.01	**0.10**	-0.02	0.04	0.00
NKB	0.10	0.08	0.12	0.15	<0.01	<0.01	<0.01	**0.04**	0.41	0.00
NKW	0.01	0.18	0.29	0.33	<0.01	<0.01	<0.01	0.90	**0.04**	0.00
KSV	0.19	0.05	0.03	-0.06	0.05	0.05	<0.01	0.57	0.63	**0.08**

*Animal permanent environmental variance

Table 2. Summary of economic values used for each index based on survey results and Sheep-Object2 (values in $AUD per trait unit)

Trait	Units	CPLUS	LP2020	SRC	LMG	MMG	K+
BWT	kg	0.00	-0.21	-0.21	0.00	0.00	0.00
WWT	kg	2.33	0.32	0.40	2.53	2.53	2.53
PWT	kg	3.50	0.47	1.48	2.53	2.53	2.53
MWWT	kg	0.00	0.00	1.88	0.00	0.00	0.00
EMD	mm	11.40	1.54	2.40	11.40	11.40	11.40
FAT	mm	-4.07	-0.55	0.00	-4.07	-4.07	-4.07
WEC	%	0.00	-1.71	-1.71	-1.71	-1.71	-1.71
NKB	Number	0.00	0.00	0.00	0.00	11.00	11.00
NKW	Number	0.00	0.00	75.00	0.00	30.00	30.00
KSV	Number	0.00	0.00	0.00	0.00	0.00	87.00

Surveys from key industry stakeholders were used to determine breeding objectives, herd structures and economic values were calculated with SheepObject2, a breeding objective software program developed by Andrew Swan (AGBU). There were six indexes of interest; including the CPLUS index. The Lamb 2020 (LP2020) index, designed to increase worm resistance as producers identified internal parasites as an industry issue. The maternal sheep index, Self-replacing Carcase (SRC). The first new KIDPLAN index is a Lean Meat Goat index (LMG) that included economic weights for the body weights and carcase traits. The second KIDPLAN index was a Maternal Meat Goat index (MMG), which added values for NKB and NKW. The final KIDPLAN index Kid Plus (K+), was a dual purpose index for lean meat production and reproduction which included a weight for KSV. The economic values are summarised in Table 2.

A herd of 280 does was used to model the indexes as per the calculations for the average herd size of commercial and seedstock producers. The proportion of males selected was 5%, and 50% for females. Generation intervals of 3 and 4 years were used for males and females respectively. The selection emphasis for EBVs was 65%. To address the Bulmer effect (Bulmer 1971) for a reduction in genetic variance caused by genetic selection, an adjustment for males and females was calculated using Normal distribution theory.

The index calculations were done using R (R Core Team 2016). The index selection theory of Hazel (1943) was used with the variances and covariances in Table 1. The economic values of Table 2 were used for an economic weights vector (a). The index weights ($\boldsymbol{b} = \boldsymbol{P}^{-1}\boldsymbol{Ga}$) were then calculated. The genetic gain ($\boldsymbol{R} = \boldsymbol{b}'\boldsymbol{G}(\boldsymbol{b}'\boldsymbol{Pb})^{-0.5}$) and the total economic gain ($\boldsymbol{\sigma_I} = (\boldsymbol{b}'\boldsymbol{Pb})^{0.5}$) of the index response for one standard deviation of selection was calculated for each of the indexes under different recording scenarios. The recording scenarios were for growth (only BWT, WWT, and YWT recorded), carcass (adds EMD and FAT records), reproduction (no carcass traits but NLB, NLW, and KSV added), standard practice (includes growth traits and reproductive traits but limited carcass traits recorded), best practice (standard practice with full carcass trait records), and gold standard (best practice with WEC recorded).

RESULTS AND DISCUSSION

The index dollar value is the $AUD of additional income per doe joined, per generation, with 5% of males selected and 50% of females, and using the index for the Australian market (Figure 1). The CPLUS index had an index dollar value of between $6.86 and $9.53 across recording scenarios, and was similar to the LMG, which was between $5.67 and $8.84. Both indexes had an increasing value under the following recording scenarios; Growth, Reproduction, Standard practice, Carcase, Best practice, and Gold standard. The maternal index SRC had index dollar values of between $5.99 and $8.33. In comparison, MMG had a value of between $6.64 and $9.86 and K+ had the highest values of between $9.39 and $16.27. Indexes SRC, MMG and K+ increased for the recording scenarios from Growth, Carcase, Standard practice, Reproduction, Best practice to Gold standard. LP2020 had the lowest index dollar values of $2.34 for the recording scenario Gold standard and between $1.25 and $1.35 for the remaining recording scenarios.

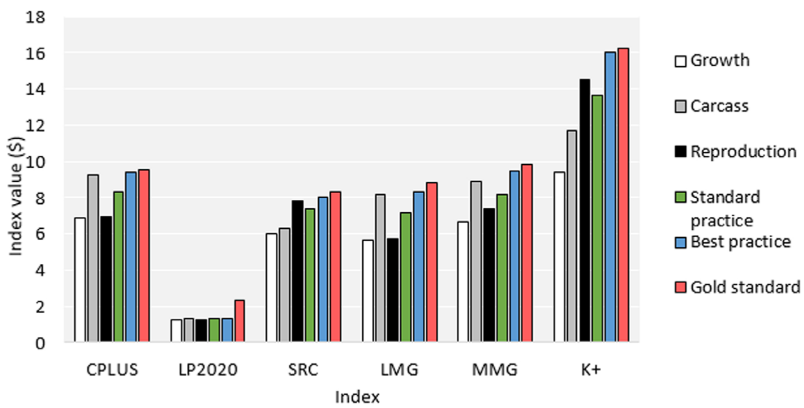

Figure 1. Summary of index response values ($ / doe joined / generation) for each index type and under Growth (white), Carcase (grey), Reproduction (black), Standard practice (green), Best practice (blue) and Gold standard (red) recording scenarios

There are a number of reasons why the index K+ should replace the current CPLUS for KIDPLAN users. Most importantly, it better described profit for the breeding objective of Australian meat goat producers. This was illustrated by the higher index dollar value responses for all recording scenarios. This was primarily due to the inclusion of KSV and the high economic value calculated with SheepObject2. Even under the Growth and Carcase recording scenarios, K+ was similar to CPLUS due to the high economic value placed on body weight and the positive genetic correlations those traits have between each other and KSV. The higher heritability and variation of survival compared to sheep was another reason why KSV is a suitable trait to be included in a KIDPLAN index. The fact that producers must submit the required birth type and rearing types for the KSV calculation improves the accuracy of estimates. Both NKB and NKW are traits of the doe, including both in the index could encourage breeders to better record birth and rearing type which has historically been an issue with the CPLUS index. The high genetic correlation between NKB and NKW could make reducing the index to NKW beneficial as it is easier to record. However, it is also important to monitor the direction of changes for both traits as larger litters resulting from increasing NKB, could result in higher rates of dystocia. Most importantly producers need to have further education on the importance of accurate pedigree and birth type recording.

CONCLUSIONS

Goats differ to sheep in higher heritabilities for kid survival, even with similar trait definitions. These differences include a higher genetic correlated between kid survival and birth weight, greater variation in number of kids born and weaned, less variation for eye muscle and fat depth, and genetic correlations between production traits were significantly different from sheep. The differences in genetic and phenotypic parameters, recording practices, economic values, and breeding objectives of goat breeders led to the creation of new Australian meat goat indexes for KIDPLAN users. The K+ index is based on the best defined breeding objective. This places selection pressure on growth and reproductive traits, especially kid survival calculated from existing birth and rearing type data. Before the K+ index is adopted by KIDPLAN users, further investigation is needed, including; predicted trait changes, differences in economic selection emphasis, selection differential of sires selected between different indexes, and a sensitivity analysis of the economic values used. Future testing of the indexes is recommended to compare the theoretical response to the real world and to demonstrate to producers that a index designed for meat goats is better than the current CPLUS index. Producers are also strongly recommended to record key traits for WEC and carcase traits.

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