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AGE AT FIRST OESTRUS. A USEFUL TRAIT FOR EARLY REPRODUCTIVE PERFORMANCE?

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SUMMARY

An increasing number of Australian sheep breeders are joining ewes at 6-8 months of age, which is 6-12 months earlier than ewes are traditionally first joined. When joining at a young age, additional factors such as the attainment of sexual maturity must be considered. The age of sexual maturity is a challenging trait to measure with limited data currently available in sheep. This study explored several methods of analyzing age of first oestrus (AFO) data, an indicator trait for sexual maturity, and explored the relationship between AFO and early reproductive performance. Lambing records from 2218 Maternal-cross ewes joined naturally at 7-10 months were used, a subset of 906 ewes had AFO information collected through the use of teaser wethers. Heritability estimates for AFO were low (0.03 – 0.09) whilst estimates for number of lambs born and weaned at yearling age were 0.20 and 0.16 respectively. Genetic correlation between AFO and number of lambs born and weaned at yearling age were 0.45 and 0.51, respectively, but had high standard errors. Improving reproductive performance through the use of teasers to record AFO is not recommended, thus a need exists to find reliable measures for early reproductive traits including sexual maturity.

INTRODUCTION

Under traditional sheep operations ewes are first mated at 18 months of age. However there is increased uptake from industry in joining ewes at 6-9 months of age. Early joining of ewes is currently characterized by highly variable success rates (Fogarty *et al.* 2007) and the underlying causes of poor reproductive rates in yearling ewes have not been fully quantified. Age of first oestrus (AFO) is important as an indicator for the identification of earlier maturing animals. Measuring pubertal traits is a challenge that was tackled in the Australian beef industry with a high degree of success. Moderate-highly heritable traits for pubertal development in tropical cattle such as mean age at first corpus luteum have been identified (Johnston *et al.* 2009). This study aims to identify factors influencing AFO and yearling reproductive performance and to estimate the relationship between these traits.

MATERIALS AND METHODS

Experimental Design. Information on AFO was collected on 906 Maternal-cross ewes as part of the Sheep CRC Information Nucleus Flock (van der Werf *et al.* 2010) data collection. Ewes were run with harnessed teaser wethers after weaning until joining in 2008, 2009 and 2010. The timing of exposure to teasers post-weaning and the length of time of exposure to teasers differed between years and sites and was not recorded. AFO (in days) was recorded when ewes were first marked by a raddle worn by a teaser, raddle marks were checked weekly. Live weight was also recorded when AFO was recorded. For animals missing this live weight, the live weight closest to this date (usually within 14 days) was used in the analysis. Maternal sire breeds represented were: Border Leicester, Corriedale, Bond, Coopworth, East Friesian, Booroola, PRIME SAMM and

Dohne. Lambing data was recorded for 2218 Maternal-cross ewes, naturally mated at 7-10 months from 2008-2012. All animals were assigned a contemporary group based on site and year of birth. All ewes that were alive at one year of age that were within a contemporary group that was exposed to teasers and/or joined were assumed to have also been exposed to teasers and had the opportunity to join to the ram. Ewes that met this criterion and had no lambs were assumed to have been dry for yearling number of lambs born (YNLB) and yearling number of lambs weaned (YNLW). A synthetic AFO trait was created (AFO2) for which ewes exposed to the teasers, but not marked were assigned an AFO measurement equal to the maximum for the contemporary group plus 17 days, which represented a penalty equivalent to one full oestrous cycle. In total 621 maternal crossbred ewes that had no AFO measurement were assigned a value for AFO2 according to this method.

Statistical Analysis. Traits were first analysed using animal models in univariate analyses in ASReml (Gilmour *et al. 2009*). Animal and genetic groups were fitted as random effects. Genetic groups reflected breed proportions, thus sire breed was not fitted in models. Models fitted for all traits included contemporary group (flock/drop) and age of dam (2-8 and unknown). AFO models were run with and without weight at first oestrus fitted as a covariate. Models for YNLB and YNLW were tested for the covariates age at joining and joining length. Bivariate analysis was then conducted to estimate phenotypic and genetic correlations. Due to low record numbers, a unique pedigree was generated for each analysis. The number of records retained for analysis, number of sires, number of genetic groups and number of animals in the pedigree is outlined in Table 1.

RESULTS AND DISCUSSION

Data Summaries and Fixed Effect Analyses. A summary of the traits analysed and the covariates fitted is given in Table 1. Only 40% of young ewes joined to lamb as yearlings gave birth to a lamb, whilst only 30% of these ewes weaned a lamb. Joining length ranged from 21-56 days whilst age at commencement of joining varied from 189-273 days.

Table 1. Summary of reproductive traits analysed in INF Maternal-Cross Ewes: Age at first oestrus (AFO) in days and a synthetic version of the trait (AFO2), Yearling no. lambs born (YNLB) and weaned (YNLW)

Trait	No. of Records	No. of Sires	No. in Pedigree	No. genetic groups	Mean *(st. dev)*	Range
AFO ***(days)***	906	90	5007	47	202.8 *(36.5)*	130- 282
AFO2 ***(days)***	1527	91	6587	51	220.3 *(38.4)*	130-299
YNLB ***(no. lambs)***	2218	116	8062	54	0.40 *(0.65)*	0-4
YNLW ***(no. lambs)***	2218	116	8062	54	0.31 *(0.59)*	0-4
Weight at first oestrus ***(kg)***	906	-	-	-	40.8 *(8.61)*	19.4-67.0
Age at joining ***(days)***	2218	-	-	-	230.6 *(19.1)*	189-273
Length of Joining ***(days)***	2218	-	-	-	38.8 *(6.6)*	21-56

For all traits contemporary group was significant (P<0.01) whilst age of dam was not significant. Despite a difference in joining length of 35 days (Table 1.), the length of time the ewes were left with the rams was not significant for either YNLB or YNLW, most likely because this was accounted for by contemporary group. Joining length and joining age were excluded from the final models for YNLB and YNLW. Where fitted weight at AFO was highly significant (P<0.01).

Univariate and Bivariate Analyses. Heritability estimates for all traits were low to moderate, which was expected given the low heritability of reproductive traits in sheep reported elsewhere

(Safari and Fogarty 2003) (Table 2). Heritability estimates for both variations of AFO did not differ significantly with and without weight fitted as a covariate, 0.04 ± 0.07 and 0.03 ± 0.07 for AFO and 0.04 ± 0.07 and 0.09 ± 0.05 for AFO2. Although lower, this is similar to preliminary heritability estimates for the same trait in the New Zealand Central Progeny Test (CPT) flock of 0.09 ± 0.04 with weight and 0.10 ± 0.04 without weight fitted as a covariate (Jopson and Young pers. comm). The CPT results are from maternal sheep breeds not dissimilar from those used in the INF i.e. Corriedale, Coopworth and Romney. Higher heritability estimates for age at first corpus lutea have been reported in tropical cattle breeds, ranging from 0.52 to 0.57y (Johnston *et al.* 2011). However, age at first corpus lutea is a direct measure of sexual maturity whereas AFO in this study is an indirect measure of pubertal development. This may explain to some extent the lower heritabilities reported here.

Table 2. Phenotypic (V_p) and genetic group (V_{gg}) variances, heritabilities (on the diagonal) and genetic (above) and phenotypic (below) correlations for AFO, AFO2, YNLB, YNLW.* Standard errors in brackets.

	AFO	AFOnwt	AFO2	AFO2nwt	YNLB	YNLW
V_p	205.53 (9.97)	220.80 (10.68)	205.53 (9.97)	538.14 (20.00)	0.35 (0.01)	0.29 (0.01)
V_{gg}	30.78 (21.73)	24.08 (19.35)	30.78 (21.73)	26.16 (21.19)	0.04 (0.03)	0.02 (0.02)
AFO	**0.04 *(0.07)***	--	--	--	0.38 *(0.26)*	0.46 *(0.27)*
AFOnwt	--	**0.04 *(0.06)***	--	--	0.70 *(0.36)*	0.80 *(0.36)*
AFO2	--	--	**0.04 *(0.07)***	--	0.74 *(0.42)*	0.87 *(0.45)*
AFO2nwt	--	--	--	**0.09 *(0.05)***	0.01 *(0.20)*	0.05 *(0.21)*
YNLB	-0.02 *(0.03)*	0.02 *(0.03)*	0.06 *(0.02)*	-0.05 *(0.02)*	**0.20 *(0.05)***	0.92 *(0.15)*
YNLW	-0.02 *(0.03)*	0.01 *(0.03)*	0.04 *(0.02)*	-0.05 *(0.02)*	0.76 *(0.02)*	**0.17 *(0.05)***

*AFO (Age of first oestrus), AFOnwt (AFO without weight fitted as a covariate), AFO2(Synthetic AFO trait)

Heritability estimates of 0.20 ± 0.05 and 0.17 ± 0.05 for YNLB and YNLW are higher than what is commonly reported for number of lambs born and weaned from multi-parity analyses (Safari and Fogarty 2003). Bunter and Brown (2013) also reported higher heritability estimates for YNLB and YNLW, 0.13 ± 0.02 and 0.08 ± 0.01 respectively, though not as high as in this study.

Genetic and phenotypic correlations between YNLB and YNLW where high as was expected, 0.92 ± 0.15 and 0.76 ± 0.01. Phenotypic correlations between YNLB and YNLW and all AFO traits were low and generally not significantly different from zero. Genetic correlations between YNLB, YNLW and AFO traits were all positive with high standard error. Based on the assumption that animals that mature earlier are more likely to have a lamb, this is not what was anticipated as the direction of the correlation suggests that animals that mature later (marked at older ages by teaser) are more likely to rear a lamb. There are a number of possible explanations for this unexpected finding: firstly the low number of records, low number of progeny per sire and low trait heritabilities has resulted in a high standard error so we cannot be certain of this correlation. The length of teaser exposure in the collection of AFO data varied from the 4 month period from weaning to joining to a 5 week period immediately prior to joining. Due to incomplete recording of length of exposure to teasers this failure to follow the standardized procedures for collecting AFO could not be factored into the analysis.

Notter (1989) demonstrated that the continuous exposure of ewes to males delays the start of joining in comparison to ewes that are isolated from males prior to joining. NLB average for this data set was well below the 0.79 reported for yearling ewes by Bunter and Brown (2013). It is possible the use of teasers for an extended period delayed when some ewes were ready to join until after ram removal confounding measurement of YNLB and YNLW. This study seems to suggest that the use of teasers for extended periods is not a useful indicator for successful early reproductive performance and lead to lower lambing percentages.

CONCLUSIONS

Heritability estimates for YNLW and YNLB appear to be higher than estimates from multi-parity analysis. AFO heritability estimates were lower than reported elsewhere, possibly influenced by variation in length of teasing between sites. Genetic correlations were positive though associated with high standard error. This was unexpected as it seems to indicate that earlier maturing animals were less likely to have a lamb. Whilst the use of teasers for short periods prior to joining has been shown to successfully lift reproductive rate, the use of teasers for extended periods may in fact reduce lambing percentage. This coupled with the high standard errors found in this study seem to suggest that using teasers to measure AFO to improve early reproductive performance is not desirable. Thus, a need exists to find reliable measures for early reproductive traits including sexual maturity.

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