



especially at the Katanning site. Liveweight data from 2009, 2010 and 2011 when ewes were two, three and four years old were used and repeated measurements on ewes meant that 5216 annual records were analysed. Of the 83 sires used, 27 Border Leicester and 43 Merino sires were common between the two sites. In this paper, we report predictions from sites at Katanning in WA and Kirby in NSW.

Ewes were weighed on average 5.8 times per year. Liveweights were corrected for a) wool weight, calculated from greasy fleece weights and assuming constant wool growth rates during the year; and b) conceptus weight (Freer *et al.* 1997). The liveweight profile for each ewe over 12 months following each weaning period was produced in Genstat using a random coefficient regression model including a cubic polynomial for time. The model used was:  $\text{Liveweight} = \mu + \text{day} + \text{ewe} + \text{ewe.day} + \text{spline}(\text{day}) + \text{ewe.spline}(\text{day})$ . Day was included as a fixed effect and all other terms were included as random effects. A covariance between the ewe intercept (ewe) and slope (ewe.day) was also included. Data was analysed in blocks (sire breed x site x year of birth x year).

The splined liveweight profile was used to derive the average liveweight, minimum, maximum and range in liveweight during each year. Liveweight loss (maximum to subsequent minimum) was analysed using SAS. Fixed effects in the base model were site (Kirby, Katanning), sire breed (BL, M), year (2009, 2010, 2011), age (2, 3, 4), birth type and rearing type of the ewe, and birth and rearing type of lambs raised by the ewe in the previous year and the current year. Year delineated the year in which each annual block of splined weight measurements commenced. Age described maturity and differentiated between parities. Ewe identification was included as a random term to account for repeated measures of ewes across years, and the sire random term allowed measures for each ewe to be utilised as replicates for sires. In a separate analysis ASBVs of the ewes sire for muscling (PEMD) and fat (PFAT) were included as covariates. Due to the significant correlations between these ASBVs (0.53 for BL sires and 0.71 for M sires) the breeding values were also tested individually to confirm their effects. First and second order interactions were tested and removed in a stepwise manner if non-significant ( $P > 0.05$ ).

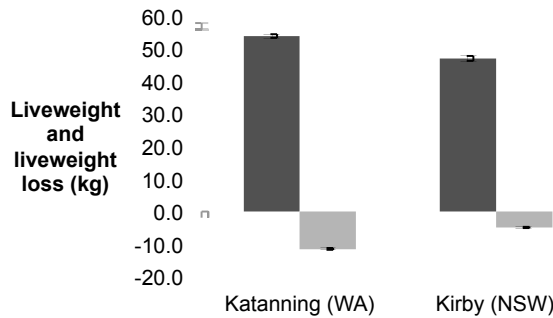
## RESULTS

Liveweight loss at Katanning occurred primarily between weaning and mid pregnancy. This period coincides with summer and early autumn, and limited availability of dry pasture and crop stubbles. At Kirby, liveweight loss occurred predominantly between joining and mid pregnancy which coincides with winter, and limited availability of green pasture.

The average liveweights of ewes from the different sites were 53.9kg  $\pm$ 0.6 at Katanning and 47.1kg  $\pm$ 0.6 at Kirby ( $P < 0.001$ ; Fig. 1). On average ewes from Border Leicester sires were heavier than ewes from Merino sires (54.1kg vs. 46.9kg,  $P < 0.001$ ). For both sire breeds, liveweight also increased with age, with three year olds ewes being heavier than two year old ewes (52.8kg and 47.3kg respectively,  $P < 0.001$ ). Average liveweight was also significantly affected by birth type and rearing type of the ewe (singles heavier than multiples); previous birth type and rearing type (non-productive ewes heavier than ewes that produced and reared multiples); current birth type and rearing type (ewes producing and rearing multiples heavier than non-productive ewes); and year (heavier in 2009 than in 2010).

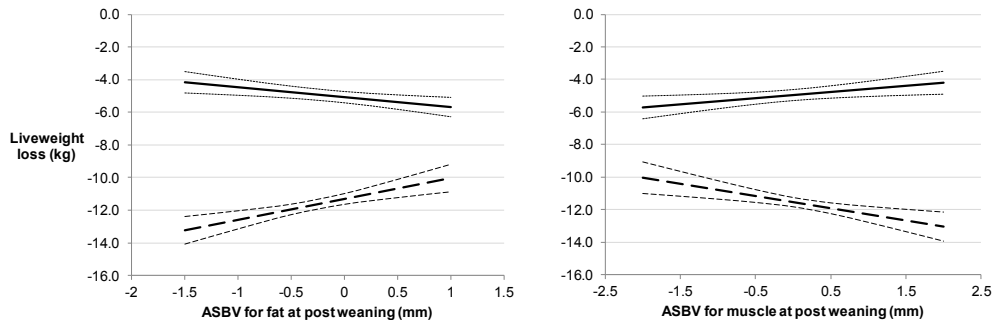
Liveweight loss was significantly different between the sites ( $P < 0.001$ , Fig. 1). Ewes at Katanning lost 11.5kg  $\pm$ 0.25 and ewes at Kirby lost 4.9kg  $\pm$ 0.33 between their maximum and minimum liveweights. Year had a significant effect with liveweight loss greater in 2009 than in 2010 at Kirby (10.7kg  $\pm$ 0.27 and 2.0kg  $\pm$ 0.37) and greater in 2010 than in 2009 at Katanning (8.1kg  $\pm$ 0.24 and 13.2kg  $\pm$ 0.26). Interactions between site, year and age of ewe ( $P < 0.001$ ) were as large as 9.5kg between two year old ewes in 2009 and 2010 at Kirby, and

as small as 1.4kg between two year old ewes in 2009 and three year old ewes in 2010 also at Kirby. The interaction between site by sire breed was also significant ( $P < 0.001$ ). Ewes at Kirby lost more weight if they had Merino sires than if they had Border Leicester sires (7.0kg *versus* 2.8kg), and ewes at Katanning lost more weight if they had Border Leicester sires than if they had Merino sires (12.3kg *versus* 10.7kg). Ewes that had previously raised a lamb lost less weight in the current year than those that were dry or were pregnant but did not raise a lamb to weaning. Ewes that were producing and rearing multiples in the current year lost more weight than those that were non-productive.



**Figure 1. Predicted average liveweight (dark grey) and liveweight loss (mid grey) in ewes grazed at Katanning (WA) and Kirby (NSW) over three years ( $\pm$ SE).**

On average, sire breeding values for fat had a significant impact on total liveweight loss ( $P < 0.05$ ), however there was a significant breeding value by site interaction ( $P < 0.01$ ). Ewes from sires with higher breeding values for fat lost less liveweight at Katanning (WA), with a reduction in liveweight loss of 3.2kg across the 2.5 mm range of sire PFAT values (Fig. 2). By contrast at Kirby (NSW) there was a negative relationship with an increase in liveweight loss of 1.5kg across the same range of sire PFAT values.



**Figure 2. Predicted relationship between liveweight loss and sire breeding values for fat and for muscle for ewe progeny grazed at Katanning, WA (solid line), Kirby, NSW (broken line) over three years ( $\pm$ SE).**

Sire breeding values for PEMD were also significant ( $P < 0.01$ ) and interacted significantly with site ( $P < 0.01$ ), with an increase in liveweight loss as sire PEMD increased at Katanning and a decrease in liveweight loss as sire PEMD increased at Kirby. Across the 4mm range of sire PEMD, liveweight loss increased by 3.0kg at Katanning but decreased by 1.5kg at Kirby.

There was no significant interaction between these sire breeding values and sire breed, so these liveweight loss responses to sire PFAT and PEMD at each site were equally evident for ewes from both Merino and Border Leicester sires.

## DISCUSSION

Sire breeding values for fat and muscle influenced liveweight loss in their ewe progeny and the response differed between sites and these results support our hypothesis. These differences in the liveweight response of the progeny could be due to a number of additional factors including dam genetics and environmental conditions. At Katanning, ewes from sires with higher breeding values for fat lost less liveweight during summer and autumn, which is prior to the break of season and germination of annual pastures. By contrast, ewes from sires with higher breeding values for fat lost more weight during winter at Kirby, where they grazed on limited amounts of green pasture due to cold temperatures and slow pasture growth. This interaction between sire fat and environment is consistent with Ferguson *et al.* (2010) who reported that ewes with higher ASBVs for fat had a higher reproductive performance in some years but not others. The sire ASBVs by site interaction in the current study could be explained by differences in the quality of the grazed pastures and or the size of the nutritional stress and weight loss. Adams *et al.* (2002) concluded that fat stores would be more important in Mediterranean climates where sheep lose weight on protein poor pastures in contrast to higher rainfall regions where the feed supply is more consistent throughout the year. While feed quantity and quality were not measured at either site, ewes at Kirby consistently lost less liveweight. Adams *et al.* (2002) also concluded that those animals with a greater proportion of lean had a greater drive to eat on green feed and so high muscling may be more important in regions where green feed is more consistently available.

The positive effects of sire fat on liveweight loss quantified at the Katanning site could have broader application across southern Australia, especially as the losses in liveweight during summer and autumn are typically greater for autumn/early winter lambing flocks which still dominate. Young *et al.* (2011) quantified the potential economic value of genetic differences in liveweight loss during summer and autumn and concluded that reduced weight loss could be worth up to \$2.30/kg per ewe. In the current study, a 1mm change in sire PFAT reduced liveweight loss by 1.3kg at the Katanning site which could equate to \$2.90 per ewe. Further work is needed to establish the genetic correlations between fat and other production and carcass traits before advocating what selection pressure should be placed on fat for different production systems and environments, but the results of the current study do suggest it could be more important than previously considered in environments where ewes lose significant weight during summer/autumn.

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## REFERENCES

- Adams N.R., Blache D. and Briegel J.R. (2002) *Aust J of Exp Ag* **42**: 399.  
Ferguson M.B., Young J.M., Kearney G.A., Gardner G.E., Robertson I.R.D. and Thompson A.N. (2010). *Anim Prod Sci* **50**: 1011.  
Freer M., Moore A.D. and Donnelly J.R. (1997) *Ag Sys* **54**: 77.  
Hopkins D.L., Stanley D.F., Martin L.C., Ponnampalam E.N., and Van De Ven R. (2007) *Aust J of Exp Ag* **47**: 1208.  
van der Werf J.H.J., Kinghorn B.P. and Banks R.G. (2010). *Anim Prod Sci* **50**: 998.  
Young J.M., Thompson A.N., Curnow M. and Oldham C.M. (2011). *Anim Prod Sci* **51**: 821.