Poor ewe nutrition during pregnancy increases fatness of their progeny

Andrew Thompson, Department of Primary Industries, Victoria

ABSTRACT

Poor ewe nutrition during pregnancy can reduce lamb birth weight and survival and have permanent adverse impacts on their production. The 'Lifetime Wool' project has shown that progeny from ewes that lost a condition score during pregnancy produce up to 1 kg less wool during their entire lifetime and that their wool is 0.2 to 0.3 microns broader than those from ewes which maintained condition during pregnancy. Progeny from poorly fed ewes are also much fatter when they reach mature size, which may predispose them to various metabolic, cardiovascular and other diseases as occurs in humans. In this study, more than 80% of the variance in the proportion of fat (and lean) was explained by differences in mature size of the progeny and the liveweight profile of their dam during pregnancy.

AIMS

In the context of optimising whole farm stocking rate it is inevitable that the Merino ewe will be managed to achieve less than maximum rates of production for both herself and her progeny. Merino ewes typically lose significant weight at some stage during pregnancy or lactation. There has been a perception that nutrition during pregnancy has negligible effects on the offspring, largely due to the resilience of lamb birth weights to all but the most severe nutritional challenges, but this view is rapidly changing as evidence emerges that even subtle changes in nutrition during development *in utero* can have permanent impacts on the production potential and health of the progeny. Quantifying the impacts of foetal programming and its importance in the context of developing practical feeding systems for Merino ewes is the basis of the 'Lifetime Wool' project (Thompson and Oldham 2004). Low birth weight lambs are fatter up to 20 kg liveweight when compared with lambs with normal birth weights (Greenwood *et al.* 1998), but evidence is limited on whether this persists through to heavier weights. We hypothesised that such effects would be evident at mature size, given that small human babies tend to have significantly reduced muscle mass and higher overall body fat content in adult life (reviewed by McMillen *et al.* 2005).

METHOD

The experiment used progeny from the 'Lifetime Wool' project in Victoria (Thompson and Oldham 2004). Twenty four single born adult wethers were selected from ewes that experienced extreme differences in nutrition during pregnancy and lactation; the average condition score of the 'Low' and 'High' ewes was 2.7 *vs*. 2.6 at joining, 2.3 *vs*. 2.8 at Day 90 of pregnancy, 2.4 *vs*. 3.4 at lambing and 2.1 *vs*. 3.1 at weaning. Lambs from the 'Low' group were significantly lighter ($P<0.001$) at birth (4.6 *vs*. 5.9 kg) and at weaning (14.7 *vs*. 22.2 kg) than those from the 'High' group. All wethers were grazed together from weaning and differences in liveweight between groups persisted until 2 years of age.

At about 3.5 years of age, the wethers were allocated to individual pens in an animal house. They were initially offered a maintenance ration of oaten hay that was replaced over one week with step-wise increases in the amount of a roughage-based pellet (10.9 MJ/kg; 16.5% CP). The amount of pellets offered was increased gradually to *ad libitum* during the second week and then maintained at this level for 8 weeks. Feed intake was measured daily and liveweights weekly. Back fat and eye muscle depth was measured using ultrasound in weeks 1, 4 and 7, and whole body composition was measured at the end of the experiment using dual energy x-ray absorptiometry (DEXA).

RESULTS

- The 'Low' group grew slower than the 'High' group during the first 4 weeks of *ad libitum* feeding (172 *vs*. 238 g/d; $P <0.01$) and this trend continued over the 8-week period (131 *vs*. 173 g/day; $P = 0.06$).
- There were no significant differences in average daily feed intake between the 'Low' and 'High' groups (1.51 *vs.* 1.65 kg DM/day) or feed conversion efficiency (11.4 *vs*. 10.0 kg gain/kg intake). However, the 'High' group tended to eat more and be more efficient at converting feed into liveweight gain.

- There were massive differences in whole body lean and fat tissue mass measured by DEXA; on average, after correction for liveweight, the proportion of fat was greater (33.8 *vs.* 24.0%; P<0.001) and lean was less (63.1 *vs.* 72.0%; P<0.001) for the 'Low' than 'High' groups. These differences in whole body fat and lean were not reflected in difference in average depth of back fat (4.2 vs. 3.9 mm) and eye muscle (30.3 vs. 28.8 mm) after correction for liveweight.
- Body composition of adult wethers was most closely related to their liveweight. After correcting for differences in liveweight, lambs that were smaller and grew more slowly to weaning had less lean tissue and were fatter at mature size. More than 80% of the variance in the proportions of fat and lean was explained by differences in liveweight of progeny (PLW; kg), ewe liveweight at joining (ELW_0; kg) and changes in ewe liveweight between joining and day 90 of pregnancy (LWC_0-90; kg) and day 90 and lambing (LWC_90-L; kg).

Fat (%) = -5.0 + 1.12 PLW – 0.60 ELW_0 – 0.67 LWC_0-90 – 0.58 LWC_90-L ($r^2 = 0.83$; P<0.001)

Lean (%) = 102.2 – 1.00 PLW + 0.50 ELW_0 + 0.54 LWC_0-90 + 0.50 LWC_90-L ($r^2 = 0.84$; P<0.001)

CONCLUSION

These results indicate that nutrition *in utero* and pre-weaning has very significant effects on the physiology and body composition of mature Merino wethers. A 10 kg change in ewe liveweight during early/mid pregnancy or late pregnancy increased the proportion of fat by about 6% units, or in whole body terms from 24 to 30%. Increases in fatness were associated with decreases in lean of similar magnitude, as there were no effects of early lifetime nutrition on ash content. The effects on total body fat and lean were not evident from measurements of back fat and eye muscle depth measured by ultrasound, suggesting that the extra fat that resulted from nutritional stresses early in life was probably located in the abdominal region. This would be consistent with the human literature, and is significant because central obesity has been linked to increased incidence of metabolic, cardiovascular and other diseases. There is some evidence that animals that experienced poor nutrition during early life may have lower feed conversion efficiency, which is weakly linked to differences in body composition. More efficient steers have been shown to have less whole body fat and more whole body lean than less efficient steers, but differences in composition explained less than 5% of the variation in efficiency (Richardson and Herd 2004), indicating that other factors are clearly involved.

The importance of these nutritionally mediated effects on early-life programming of body composition and possibly feed conversion efficiency during adulthood in the context of developing practical ewe feeding systems and marketing systems requires further investigation. It is clear however that if we do not account for these and other impacts from manipulating ewe nutrition, both on the ewe and her progeny, then our ability to predict farm system level outcomes from changes in ewe management policies or environmental conditions will be limited.

KEY WORDS

Foetal programming, body composition, feed conversion efficiency, Lifetime Wool

ACKNOWLEDGMENTS

The authors wish to thank Australian Wool Innovation and the Department of Primary Industries, Victoria for funding this work.

Paper reviewed by: Ralph Behrendt and Geoff Saul, DPI Victoria.

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