Selection for growth, muscling and fatness alters the maternal performance and intermediary metabolism of Merino ewes

This thesis is presented for the degree of Doctor of Philosophy of Murdoch University

Mark Bradley Ferguson

B. Ag. Sci. (Hons) (University of Melbourne)

November 2012
I declare that this thesis is my own account of my research and contains as its main content work which has not previously been submitted for a degree at any tertiary education institution.

..........................................................

Mark Bradley Ferguson
Abstract

There is growing interest in selectively breeding Merinos with higher growth and muscling and lower fatness. The effects of selection for these traits on ewe intermediary metabolism, body composition, reproduction and milk production and on lamb birthweight, survival and growth were studied in a series of experiments and analyses.

Ewes with higher genetic propensity for early growth had higher mature weight, reproductive rate, lamb birthweight, ewe milk production and lamb growth rate. Ewes with higher growth also had a higher circulating level of growth hormone during lactation.

Ewes with higher genetic propensity for muscling had a higher reproductive rate and produced lambs that were lighter at birth, but this did not result in lower lamb survival. Ewes with higher muscling maintained a higher condition score which may be at least partly attributed to a lower response to adrenaline at the level of the muscle in these higher muscled ewes. Similarly higher muscled ewes had lower growth hormone concentration in lactation which would result in lower mobilisation of tissues. In addition peripheral tissues were less responsive to insulin in high muscled ewes and blood glucose levels were also higher during the non-breeding state in high muscled ewes.

The genetic fatness of ewes was positively associated with lamb birthweight but only when nutrition was restricted suggesting that ewes with a higher genetic propensity for fatness can buffer lamb birthweight under periods of poor nutrition. Ewes with
higher genetic fatness had lower circulating growth hormone and a greater response to insulin providing potential mechanisms for the observed higher fatness. Furthermore, response to adrenaline at the level of liver was greater in ewes with higher fatness suggestive of a higher capacity for gluconeogenesis. The combined results of this work suggest that actively selecting Merino ewes to have higher growth, muscling and fatness is likely to have positive reproduction and therefore economic outcomes.
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Acknowledgements

This thesis is an accomplishment not just for me but for all of those who have helped and guided me along the way. As with the decade before, my enchanting wife Nisha has been there to guide me through the last six years of study and I am eternally grateful for her unwavering support and belief. During the journey I lost a great mentor in Dr Norm Adams and I am deeply saddened that Norm was not here to see the completion of this work but I will be forever grateful that I had the opportunity to have worked with, and learnt from him. He was a scholar of unquestionable integrity and brilliance and it was the greatest of pleasures to have studied under his guidance. I am fortunate that during the time this thesis was completed, three wonderful children graced our world. My beautiful daughter, Sitara Devi and gorgeous sons, Jai Nikhil and Kiran Shah together you have changed my world.

The work contained within this thesis was made possible by the generous support of many people. I was extremely fortunate to have the assistance, guidance and friendship from Mrs Jan Briegel and it is inconceivable to imagine the last six years without her. I would also particularly like to thank my supervisors Dr Graham Gardner and Dr Dave Pethick for their support, guidance, friendship and encouragement throughout. Never were there two men more dedicated to doing great science with practical outcomes for industry.

To Mum and Dad I thank you for creating possibilities and for a lifetime of love and support, to my brothers, I owe thanks to Brett for ending up at university in the first place and to Tim for an eternal passion to breed the perfect sheep. To Ian and Ganga thank you for your enduring support.
My industry collaborators were a very important part of this work and they not only made the sheep available for these studies but also provided considerable insight and knowledge that has helped shaped this thesis. They also provided many days of assistance and many opportunities to laugh. To Ian and Debbie Robertson, to Bill and Kay and Geoff and Emma Sandilands and to the board of Merinotech (WA) Limited, my sincerest thanks. Thanks also to Paul Daly for his many hours of help.

The opportunity to spend many evenings with Gus Rose was undoubtedly the highlight of my many trips south. To Kel Pearce, Johan Greeff, Geoff Cox, Steve Bell, and all of those who helped the DXA days pass, my thanks. I also thank Matt Wilmot, Hayley Norman, Valérie Kromm and Harriet Pugh for providing endless assistance and opportunities to laugh at various times throughout this process.

The animal house experiment described in the last four chapters of this thesis involved most of the research community in Perth, in addition to those already mentioned above. I would like to thank Kristy Glover, Margaret Blackberry, Beth Paganoni, Carolina Vinoles Gil, Peter McGilchrist, Sarah Bonny, Jim McMahon, Jen Clulow, Elizabeth Hulm, Paul Young, Shimin Liu, Mike Carthew, Phil Bullock, Rob Kelly, Mal Boyce, Paul Kenyon, Megan Chadwick, Di Mayberry, Andrew Toovey, Allan Rintoul, Dean Thomas, Roberta Bencini, Nic Wryde, Anthony Wryde and Ken Chong for making it possible. There were others too, too numerous to mention that made this possible.

Finally a thank you to my friend, mentor and boss Dr Andrew Thompson for his continued support. I am fortunate to have had the financial support provided by an Australian Post-graduate Award, the Sheep CRC, CSIRO Livestock Industries and Murdoch University.
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AUC10  Area under the concentration curve between 0 and 10 minutes relative to administering adrenaline
ASBV  Australian Sheep Breeding Value
CS    Condition Score
CW    Carcase Weight
DXA   Dual-energy X-ray absorptiometry
DXA fat Total fat tissue mass measured by dual-energy X-ray absorptiometry
DXA lean Total lean tissue mass measured by dual-energy X-ray absorptiometry
DXA bone Total bone mineral mass measured by dual-energy X-ray absorptiometry
EBV   Estimated Breeding Value
EMD   Eye Muscle Depth - The depth of the m. longissimus lumborum muscle at the C-site, defined as a point between the 12th and 13th ribs and 45mm from the dorsal midline
FAT   Subcutaneous fat depth at the C-site, defined as a point between the 12th and 13th ribs and 45mm from the dorsal midline
HWT   ASBV for weight at hogget age (15 months old)
GLUT1 Glucose transporter-1
GLUT4 Glucose transporter-4
HEMD  ASBV for eye muscle depth at hogget age (15 months old)
HFAT  ASBV for C-site fat depth at hogget age (15 months old)
HCFW  ASBV for clean fleece weight at hogget age (15 months old)
HFD   ASBV for mean fibre diameter at hogget age (15 months old)
HFDCV ASBV for the coefficient of variation of fibre diameter at hogget age (15 months old)
IGF-I Insulin-like growth factor -I
IIR   Insulin infusion rate
LW    Liveweight
NEFA  Non-esterified fatty acid
SSGIR Steady-state glucose infusion rate
Urea N Plasma urea nitrogen concentration
VFA   Volatile fatty acid