final report

Project code: B.RMT.0002

Prepared by: Dr Dale Miller

Tasmanian Institute of Agricultural Research

Date published: May 2009

PUBLISHED BY

Meat & Livestock Australia Limited
Locked Bag 991
NORTH SYDNEY NSW 2059

Red Meat Targets Joint MLA/TIAR Senior Research Position in Meat Production Systems

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

Abstract

The Red Meat Targets Program (RMT) is a 5 year joint venture between MLA, the Department of Primary Industries & Water, Tasmania, and the University of Tasmania to deliver RD&E services to the Tasmanian red meat industry. This project was undertaken to provide leadership, co-ordination and reporting within the research sub-program of the RMT. This project has led to immediate and long-term benefits for red meat industries in Tasmania, including: expansion of livestock research capacity; linkages between local, national, and international research initiatives; post- and under-graduate student training; discovery of novel factors behind neonate lamb survival; development of irrigated winter cereal grazing systems; and investigations of simulation programs, benchmarking, and GIS as decision support tools for industry. The beneficiaries of this project are beef and sheep producers, processors, and the scientific community, both in Tasmania and nationally.

Executive Summary

The Tasmanian red meat industry is a major contributor to the state economy, with a farm gate value of $211 million (2006/07), and represents 22% of the state's total agricultural production. Tasmania holds about 1.9% of Australia's beef cattle herd and 3.2% of the sheep flock, and its climate is well suited to pasture-based animal production. The industry continues to face global, national and local factors that influence its sustainability. These include accelerating international competition for markets. The competitive advantage of Australian agriculture depends on improvements in output per land area and labour unit, or through increasing product values. Nationally, in addition to public scrutiny of animal welfare and environmental use, declining terms of trade has a major impact on the profitability of the red meat industry, highlighting the need for ongoing productivity improvements to achieve sustainability. Within Tasmania, the industry is challenged by competition with alternative land uses, the availability of livestock, and an ageing farmer population.

To support Tasmanian red meat producers as they met these challenges, Meat and Livestock Australia, the Department of Primary Industries & Water, Tasmania, and the University of Tasmania initiated a 5-year joint venture called the Red Meat Targets Program (RMT). This collaborative program delivers RD&E services to the Tasmanian red meat industry, to address priority issues and opportunities as determined by local industry stakeholders. The Red Meat Targets Senior Research Position in Meat Production Systems Project was undertaken to provide leadership, activity co-ordination, and reporting within the research sub-program of the RMT. It included the appointment of a Research Leader to meet a shortfall in red meat research expertise. The Research Leader was to achieve the objectives of; providing leadership in red meat production systems research to RMT; to maintain a current knowledge of the relevant R&D issues, technologies, and methodologies; and to maintain an effective network of contacts. Further they were to develop and implement a portfolio of research projects; represent, promote and defend the work of the sub-program team to various audiences; and to supervise post-graduate students.

Associate Professor John Roche was appointed in 2006 as TIAR Principal Scientist in Ruminant Nutrition and Farm Systems, covering the dairy (0.8 FTE) and red meat (0.2 FTE) industries. Due to the responsibilities of the joint appointment, Dr Dale Miller was also employed to work with Dr Roche to undertake RMT research activities. Following Dr Roche's resignation in October 2007, Dr Miller assumed the Research Leader responsibilities until project completion. Drs Roche and Miller commenced duty by reviewing the stake holder identified priorities and developing a 5-year program of research studies. An infrastructure development plan was implemented to update and equip laboratory facilities for ruminant nutrition studies, and equipment purchased for field grazing studies. The Research Leader provided scientific expertise to the RMT program and more widely in the partner organisations, and developed capability within technical staff and students to implement red meat research experiments. They have also promoted an integrated RD&E approach within RMT.

Based on an informed knowledge of red meat production systems research, the Research Leader implemented a portfolio of national and international collaborative projects addressing industry identified priorities. With a view towards developing sustainable grazing management practices to allow increases in pasture utilisation, international collaborative reviews were published on neurological and physiological regulation of feed intake in ruminant animals, both in dairy cows and expanded to include beef cattle and sheep.

To maximise the number of available animals to drive desired increases in pasture utilisation and to increase red meat production per hectare, the Research Leader initiated and implemented projects investigating the metabolic and endocrine maturity in the new-born lamb and its relationship to

neonatal survival, and edible shelter systems involving lambing on irrigated winter cereal crops, as well as contributing sections to a national review on the genetics and epigenetics of lamb survival.

Grazing management of prime lambs on irrigated winter wheat was also investigated in a MLA funded project looking at rotational and set-stocked systems and post-grazing forage residuals on meat and grain production outcomes, and the Research Leader contributed to another UTAS project investigating optimal stocking rates on these dual-purpose crops. This research area contributes to overcoming the winter feed gap experienced in parts of southern Australia, and improving continuity of supply of finished animals, as well as the integration of red meat production into whole farm systems.

Financial benchmarking has the potential to significantly increase enterprise financial performance, and overall industry profitability and resilience. The Sub-program implemented a DPIW funded project aimed at obtaining current financial benchmarking information of the red meat industry. Despite slow farmer uptake, the data collected provided indications of large variability in cost of production, operating profit margin, and returns on assets within the beef industry. This information was used in research priority identification for targeted activity within the proposed Phase II of RMT. To add value to the collected financial benchmarking information, and to build on a project that tested computer simulation programs at both farm and regional levels in Tasmania, MLA funded a Masters project investigating a novel technique of linking spatial environmental data to farm business performance using Geographical Information Systems. Close to completion, this project may allow improved computer modelling of scenarios or policy decisions at state-wide or national scales. Both the benchmarking and spatial analysis projects were aimed at increasing ability to monitor industry performance, and improve decision making to increase enterprise productivity.

Sub-program activities have been widely communicated in the print media, on radio, at field and discussion days, in presentations to meat industry representative bodies, through the scientific literature and conference presentations and invited seminars, and via collaborations with animal research groups at state, national, and international levels.

This MLA project has led to immediate benefits for the red meat industry in Tasmania and southern Australia through the provision of animal research expertise, and the development of practical management recommendations on integrating animals into whole farm systems and on farm business management. Longer term benefits will accrue through research capacity building and networking, and the application of scientific knowledge in the areas of feed intake control and lamb survival. Other beneficiaries include the supporting services and livestock processors in Tasmania.

It is recommended that partner organisations support a second phase of the Red Meat Targets program. Future research areas could include the development of productive, persistent and profitable pastures and suitable grazing management practices to sustain them, determining the potential animal production from newly developed adapted species of TIAR’s grass and legume development program, and continuing to seek profitable ways of integrating red meat production into whole farm systems.

Contents

1 Background

Beef and sheep meat production accounts for about 22% of Tasmania's gross value of agricultural commodities, and involves approximately 3000 farms. Tasmania holds about 1.9% of Australia's beef cattle herd and 3.2% of Australia's sheep flock, and its climate is well suited to pasture-based animal production, with a long pasture growing season. Average annual on-farm red meat production is in the order of 300 to 400kg/ha liveweight from beef- and lamb-finishing operations, although up to 2000kg of beef/ha has been achieved under experimental conditions.

The Tasmanian red meat industry continues to be faced with global, national and local factors that influence its sustainability. At a global level these include the liberalisation of world trade, and accelerating international competition for markets. The global competitive advantage of Australian agricultural produce depends on improvements in output per land area and labour unit, or through increasing product values. Nationally, in addition to public scrutiny of animal welfare and environmental use, declining terms of trade has a major impact on the red meat industry. For example, overall average annual productivity growth of Australian specialist prime lamb producers has been around 1.5% for the last 20 to 30 years, however over the same period lamb producer's terms of trade have eroded by an average of 2.1 % per annum (McEachern et al., 2005). This highlights the need for ongoing productivity improvements by producers to achieve sustainability.

Within Tasmania, competition with alternative land uses, availability of livestock and an ageing farmer population bring their challenges as well. The number of sheep in the state has declined dramatically since 1990, to levels not seen since the 1950s, primarily due to drought and low wool prices. This situation has a direct flow on effect for sheep meat production because the wool industry has traditionally provided the maternal genetics for prime lamb production. Further, the number of beef animals finished has remained relatively static during the last decade as well (http://www.dpiw.tas.gov.au; accessed 22/05/09). These data reflect an industry greatly susceptible to commodity price fluctuations and changes in enterprise representation on-farm. This obviously has significant consequences for the processing and post-farm-gate sectors within Tasmania.

A consultative process initiated by the Tasmanian Extensive Agriculture Research and Advisory Committee resulted in the development and publication in September 2003 of a red meat RD&E Business Plan for Tasmania, covering the period from 2003 to 2008. This process involved input from all sectors of the red meat industry, including beef and sheep producers, processors, retailers, service providers, and funding bodies. The developed Plan outlined the strategies for achieving the vision of creating a profitable and sustainable Tasmanian red meat industry.

The Red Meat Targets Program (RMT) was born out of this process. RMT was a 5-year joint venture agreement between MLA, the Department of Primary Industries & Water, Tasmania (DPIW), and the University of Tasmania (UTAS, through its collaborative venture with DPIW, the Tasmanian Institute of Agricultural Research, TIAR), to deliver RD&E services to the Tasmanian red meat industry. A Program Advisory Committee (PAC) provided strategic oversight and review of program operational activities, which were co-ordinated and managed by a Program Management Committee (PMC).

In the analysis it was highlighted that there was a shortfall in red meat research expertise within Tasmania. Identified industry issues requiring further research attention included sustainably increasing pasture utilisation, filling annual feed supply gaps to achieve continuity of supply and increase production of red meat per hectare, and integrating red meat production with alternate enterprises including dairying and cropping. The Red Meat Targets Senior Research Position in

Meat Production Systems Project was established to overcome the skills shortfall, and address these industry issues, and centred on the employment and resourcing of a senior scientist with experience in grazing and pasture management to lead the Research Sub-program of RMT. The project commenced on 11 March 2005.

2 Project Objectives

The Research Organisation, through the Research Leader, was to achieve the following objectives:

- Provide leadership in red meat production systems research to the Red Meat Targets program
- Maintain a thorough and current knowledge of red meat production systems R&D
- Maintain a current understanding of the issues, technologies, methodologies, and an effective network of contacts through which to achieve the former
- Develop and implement a portfolio of projects in agreement with the RMT industry advisory and program management committees
- Present, promote and defend the work of the research sub-program team to various audiences
- Represent the research sub-program at the program level to facilitate uptake of research output and identify researchable issues
- Supervise post-graduate students.

3 Methodology

UTAS was the agency responsible for undertaking research and administering the Research Sub-program within the RMT, and committed the appropriate resources to appoint a research leader at Academic Level B (Research Fellow). MLA contributions were available to provide additional funding for appointments at Academic levels C or D, given an appropriately qualified appointee, and for appropriate resourcing of the position. MLA funding totalled $250K over 5 years.

The appointee was to commence the sub-program by undertaking the following activities to address the priorities identified by stakeholders in the Business Plan:

1. Identify barriers to increasing the utilisation of existing pastures in red meat producing regions of Tasmania, and develop management options to address these
2. Desktop model initially, and then test new concepts for filling feed supply gaps, and subsequently increasing red meat production per hectare and continuity of supply, through:
   - Irrigation, particularly in the cropping zone
   - Determining management requirements and potential animal production from new species from the TIAR legume and grass development program
   - Management of conserved and purchased feed, including alternate feed systems such as small on-farm feedlots and strategic grain supplements.
3. Determine the biological and economic feasibility of alternative red meat production systems that meet increased production targets within whole farm operations, particularly those where dairy and cropping are significant business units

4. Determine environmental impact and best management practices for alternative production systems, particularly in collaboration with other R&D providers
5. Liaise with red meat production related CRCs and other national research programs to ensure application of their output to the Tasmanian industry.

Following their appointment, the Research Leader was to seek industry, university, and government research grants to address these specific industry issues, and to develop suitable laboratory infrastructure and other facilities to support these investigations.

4 Results and Discussion

4.1 Program Administration and Facilities

4.1.1 Program Administration

The Research Sub-program Leader position was initially advertised on 7 May 2005, and members of the university (New England, Melbourne, Adelaide, Sydney) and government (South Australia, Victoria, New South Wales, Western Australia, CSIRO and the Beef and Sheep CRCs) animal science communities were notified about the position. Details were also disseminated to research institutions in New Zealand. This round of advertising was unsuccessful in finding a suitable candidate and so Expressions of Interest were sought on 29 October 2005. This resulted in the appointment of Associate Professor John Roche as the Principal Scientist in Ruminant Nutrition and Farm Systems within TIAR, covering the dairy industry (0.8 FTE) and RMT (0.2 FTE). A Research Fellow in Meat Production systems, Dr Dale Miller, was also appointed on a full time basis to work with Dr Roche to undertake project activities. Assoc. Prof. Roche and Dr Miller commenced duties in June 2006 (Table 1).

The RMT PMC provided a forum for discussion of proposed project ideas by the relevant stakeholder representatives, including Dr David Falepau of MLA, and the Development and Extension Sub-program Leaders. Two significant events in the administration of the project occurred in mid-2007. The first was the resignation of Dr Falepau at the end of May 2007, and the second was the resignation on 16 July 2007 of Dr Roche from TIAR. Dr Roche finalised his duties on 12 October and, with MLA approval, the Subprogram leadership responsibility was taken up by Dr Miller on 15 October 2007, who managed the project until its completion.

In light of the resignation of Dr Roche, additional technical support was required for the implementation of the suite of project activities. Ms Anna Robertson was appointed as the Sub-program Technical Officer on a 0.5 FTE basis from 12 June 2007, and this was subsequently increased to a full time basis from 1 January 2008 until her resignation on 11 August 2008. Ms Robertson was subsequently replaced by Ms Jane Sykes (0.6 FTE) on 17 November 2008, who was increased to a full-time basis on 16 February 2009 through to the conclusion of the project.

Table 1 – Staff Resourcing of the Project (Full Time Equivalents)

Position	**2005/06**	**2006/07**	**2007/08**	**2008/09**	**Total**
Academic					
Level D	-	0.2	0.05	-	0.25
Level B	-	-	0.75	1.0	1.75
Level A	-	1.0	0.25	-	1.25
Technical	-	-	0.75	0.65	1.4

Total	-	1.2	1.8	1.65	4.65

With the replacement of Dr David Falepau in June 2007as the MLA representative on the PMC, the Research Sub-program moved from an emphasis on strategic research projects (outlined below), to a focus on research projects of more immediate application by industry.

Despite the delays in appointment of staff, disruptions caused by the various staff resignations and the changeover in MLA representation on the PMC, the Sub-program administrative structure has proven resilient, and capable of successfully achieving the project objectives, as outlined below.

4.1.2 Facilities

The facilities available to the Sub-program had suffered from a 15 year interval since the previous dedicated full time red meat researcher was employed, and this necessitated an infrastructure development plan be implemented to update and equip laboratory facilities for ruminant nutrition studies. This involved the purchase through a UTAS Equipment and Minor Works grant in mid 2007 of a refrigerated centrifuge (Eppendorf 5810R) for blood plasma hormonal analysis and general laboratory use, an *in vitro* rumen fermentation system (Ankom Daisy II), a fibre analyser (Ankom 220), and associated laboratory glassware and equipment. The preparation of 5 fistulated wethers was undertaken in 2008 to provide a source of rumen inoculum, and to provide the capacity for *in sacco* incubation studies. Metabolism crates for sheep were also ordered to enable metabolism and nutrient balance studies to be undertaken, including evaluation of the new TIAR pasture varieties.

Additionally, equipment for field studies was purchased to enable projects to be implemented on the farms of collaborating producers. These include a portable sheep scale, electronic identification equipment, a lap-top computer for automated data entry using Bluetooth technology, and an electronic pasture plate meter. Three weather stations have been purchased through MLA funded projects falling under the umbrella of the Sub-program, enabling accurate descriptions of field study conditions, particularly for lamb survival and behaviour studies.

In total, this has provided the basic laboratory and field facilities and equipment required for ruminant nutrition, microbial fermentation, dietary evaluation, animal behaviour, lamb survival and grazing studies. These have greatly added to the Sub-program's ability to undertake industry relevant applied science investigations, as well as attract local and interstate collaborators, funding and students. From this base, the next step towards increasing red meat research capabilities is to establish facilities for beef cattle specific nutritional research, such as fistulated animals, individual feeding pens, and metabolism crates.

4.2 Leadership, Knowledge and Networks

4.2.1 Research Leadership

The objectives of this project included:

1. To provide leadership in red meat production systems research to the Red Meat Targets program
2. To represent the research sub-program at the program level to facilitate uptake of research output and identify researchable issues.

Drs Roche and Miller commenced their duties by reviewing the identified priorities within the RMT Business Plan and developing a 5-year program of 2 farm systems experiments and a series of 6

component research studies. These were put forward at a PMC on the 13 October 2006. These consisted of a mix of immediately extendable, mid term and longer term strategic and applied research projects covering sheepmeat and beef production. A number of these project ideas were implemented and are covered in more detail in Section 4.3 below.

Dr Miller provided leadership to the Sub-program during the transition to more applied projects, involving identifying researchable issues and resourcing relevant projects to address them. He also worked towards a culture of stronger integration between the RMT RD&E Sub-program activities during 2007/08 to facilitate uptake of research output. This culminated in the funding of winter wheat grazing projects directly involving all 3 sub-programs, and a move from projects based on either RD or E activities to projects based on theme areas involving RD&E input as appropriate. Leadership in the identification of research priorities was also provided for the Strategic Plan of the second phase of RMT, which was put forward to MLA in April 2009. This included promoting an increased understanding of the mechanisms behind intake and selective grazing, and the drivers of neonate lamb survival, including developmental maturity at birth.

The Sub-program Leader was active in providing rigorous scientific evaluation and criticism of project proposals put forward by external agricultural consultancies and government departments to the PMC. An industry relevant internal review was also provided to the RMT PMC on fibre supplementation for livestock grazing lush temperate pastures, to guide the development of R&D Sub-program activities on the issue. Scientific papers of relevance to Tasmania were also circulated to the PMC and discussed.

Expertise in designing and developing animal studies and other experimentation including statistical analysis, was provided to TIAR employees and students, including the 8 x 5 Wool Profit Program (shrub evaluation, drought feeding) and within the Dairy Group (feed supplements, red vs. white wheat comparisons, NIRS). Comment on climate change impacts on animal industries was provided to the Centre Leader of the TIAR Vegetable RD&E Group, and further comment was provided to the Tasmanian representative on both a CSIRO Climate Adaptation project proposal, and the National Beef RD&E Framework. The Research Leader was also requested to be on the interview panel for a Scientific Officer position within DPIW, and was directly involved in the interviewing and employment of suitable technical support staff for the sub-program.

Sub-program research initiatives included implementing replicated grazing studies of irrigated winter cereals, in collaboration with Southern Farming Systems, driving the development of project submissions evaluating the animal performance potentially achievable from newly developed adapted pasture species, and their potential role in assisting producers to adapt to climate change.

In conclusion, the sub-program has been instrumental in identifying RMT research priorities for Tasmanian conditions, critically evaluating external project submissions, providing scientific expertise to other activities within TIAR and DPIW, and developing capacity in terms of staff capable of and facilities appropriate to red meat research. It continues to promote an integrated RD&E approach within the RMT.

4.2.2 Knowledge of red meat R&D and establishment of an effective network

An objective of the project was the maintenance by the Research Leader of a thorough and current knowledge of the issues, technologies, and methodologies of red meat production systems R&D, and an effective network of contacts through which to achieve this outcome.

Current R&D knowledge was maintained through the Research Leader(s) memberships in the Australian Society of Animal Production, Grasslands Society of Southern Australia, the American

Dairy Science Association and the American Society of Animal Science. This has been augmented with attendance at the ASAP conference (Brisbane, 2008), at the joint Annual meetings of the American Dairy Science Association, Canadian Society of Animal Science, and American Society of Animal Science (San Antonio, 2007 and Montreal, 2009), and the 3rd Dairy Science Symposium (University of Melbourne, 2007). Journal access comes with these memberships and notification of current Table of Contents of the Canadian Journal of Animal Science, Animal, Animal Production Science, Journal of Dairy Science, Crop and Pasture Science was also received, in addition to the use of scientific databases available through DPIW and UTAS, including CAB and Web of Knowledge. Thus good access to the national and international scientific literature was available and was utilised in developing and interpreting the results of the Sub-program's project portfolio.

Other networking opportunities were pursued with visits to research groups at:

- the University of South Australia
- the University of Adelaide
- the South Australian Research and Development Institute (SARDI)
- the University of Western Australia (UWA)
- Murdoch University
- the Department of Agriculture and Food, Western Australia (AgWA)
- Lincoln University, Canterbury, New Zealand
- DairyNZ, Hamilton, New Zealand
- TIAR Dairy Group
- the UTAS School of Agriculture
- the University of Melbourne.

A number of these visits resulted in collaborative reviews or research projects and these are outlined in Section 4.3.

The Sub-program has also contributed to activities within Program 1.2 - Reproductive Efficiency, of the Sheep Co-operative Research Centre. This included a review on the 'Genetics and epigenetics of lamb survival' which initially involved a meeting of researchers from SARDI, UWA, AgWA, CSIRO, Department of Primary Industries Victoria, Massey University, and Adelaide University. This provided a good opportunity to collaborate with a number of animal scientists focussing on sheep production systems research within southern Australia. Input was also provided for a Sheep CRC report on 'Learnings and observations from selected extension programs and products in the Sheep industry', aimed at improving future industry uptake and outcomes for work in this area.

Further RMT involvement in the national EverGraze project was explored in 2008 with the National Co-ordinator, looking at expanding the project within Tasmania beyond a single Supporting Site run by the 8 x 5 Project. Funding allocations had already been made to support the 6 existing Proof Sites in NSW, Victoria, and WA, however given the similarity in outcomes desired by both programs, expanded involvement will be sought in Phase II of RMT. Collaborations with the TIAR Dairy Group at Burnie have been explored to some extent but have yet to catalyse into funded collaborations. The visit to Lincoln University resulted in the RMT PMC discussing an opportunity to promote a PhD project on beef herd performance recording based on Beef Improvement Ontario's database system. Given the existence of similar herd improvement schemes funded by MLA within Australia, and following producer feedback, the decision was made not to promote the concept in Tasmania.

The Research Sub-program also presented the project activities to a scientific forum in February 2009, co-ordinated by NRM North in Tasmania, looking at improving the knowledge of agricultural and NRM related research projects and groups within the state.

In summary, a suitable body of red meat production systems R&D knowledge was available and effectively bought to bear on the Sub-program and RMT activities. Greater challenges were experienced by the Research Leader in developing strong networks, due in part to the competing time demands of project portfolio implementation and travel for meetings, as well as trying to integrate into previously planned and established national programs. Despite this, past contacts were positive and likely to result in a greater number of collaborative activities in the future.

4.3 Implemented Project Portfolio

Introduction
Dr Roche and Dr Miller initially put forward a 5-year program of systems experiments and a series of component research studies on 13 October 2006. These consisted of a mix of immediately extendable, mid term, and longer term research projects covering sheepmeat and beef production.

The systems research proposals covered:

1. Optimising whole farm productivity (sustainable pasture utilisation) for beef finishing, including a desktop modelling component
2. Evaluating alternative forages in bridging summer and winter feed gaps under dry land, partial or full irrigation.

The component research proposals covered:

3. Investigating the effect of rumen modifiers on the growth rate and carcase composition of strategically grain supplemented prime lamb and beef
4. Investigating the response of breeding units and growing animals to available supplementary feeds (energy, protein, fibre, minerals) under different conditions (breed, pasture allowance, quality, current growth rate)
5. Investigating the effect of peri-partum nutrition on lamb survival and weaning rate
6. *in vitro* analysis (rumen batch culture) of different types of forage and different forage qualities (e.g. NDF, ADF, digestibility) to allow us to model animal performance and inform management decisions based on routine forage quality measures
7. the role of the hormone ghrelin in feed intake control
8. epigenetics and foetal programming studies.

In response to requests by MLA in mid 2007 the Sub-program activities were realigned towards a greater focus on pasture and forage-based feeding systems. A planned, animal ethics approved $50K study on grain feeding and ionophore supplementation of grazing lambs to be funded by MLA was therefore discontinued. A review on filling the winter feed gap was also proposed to include sections on; the significance of the problem; current strategies to overcome the annual feed deficit including pasture species breeding and selection, the use of supplementation, alternative forages including winter cereals, grazing and livestock breeding management; systems management, social and economic considerations. This issue was progressed through examination of the grazing of winter cereals which is covered in Section 4.3.5 below.

Of a series of initially proposed literature reviews aimed at identifying knowledge gaps and developing suitable research projects, two were implemented. The first investigated neurological and physiological regulation of feed intake, with a focus on ruminant animals, initially within dairy cows and then expanded to include beef cattle and sheep (See Appendix). This was to support an understanding of the drivers of pasture intake with a view towards developing sustainable grazing management practices enabling the increases in pasture utilisation required for ongoing profitability of red meat enterprises. These international collaborative reviews were published:

- Roche, J.R., Blache, D., Miller, D.R., Sheahan, A.J., Miller, D.W., 2007. Neuroendocrine controllers of intake in dairy cows, *Proceedings of the 3rd Dairy Science Symposium*, 18-20 September, The University of Melbourne, Victoria, Australia, 3:93-110
- Roche, J.R., Blache, D., Kay, J.K., Miller, D.R., Sheahan, A.J. and Miller, D.W. 2008. Neuroendocrine and physiological regulation of intake with particular reference to domesticated ruminant animals. *Nutrition Research Reviews*, 21:207-234.

The second proposed review was aimed at examining epigenetics and foetal programming as it relates to ruminant production, and in particular offspring survival, and growth. A visit to South Australia and the research group at SARDI saw this interest in epigenetics being aligned with the issue of lamb survival and progressed as an activity under the Reproductive Efficiency Program of the Sheep CRC. This activity was led by Drs Forbes Brien, and Stefan Hiendleder (University of Adelaide). Researchers from SARDI, UWA, AgWA, CSIRO, Department of Primary Industries Victoria, Massey University, and Adelaide University met at Glenelg on 17 & 18 September 2007 to discuss the issue and draw up a structure for the review. The review was entitled 'The Genetics and epigenetics of lamb survival' and was aimed at identifying researchable questions within the CRC. The sub-program contributed a section entitled 'Components and determinants of lamb survival'. As at June 2009 this review has yet to be finalised, although once completed it will form the basis for further collaborative R & D projects in selective breeding for lamb survival within the Sheep CRC.

4.3.1 Improving neonate lamb survival

Introduction

According to ABS figures, sheep numbers within Tasmania have declined from a peak in 1990 of over 5.2M to an estimated flock size of 2.1M in 2008, approximating numbers last seen in the 1950s. Perinatal mortality is a major contributing factor to reproductive wastage in sheep (Hight and Jury, 1970; Sykes et al., 1976), with average losses of 20 to 30% of lambs born, and 30 to 40% of twins in Australian Merino flocks (Walker et al., 2003). Lambing in Tasmania coincides with cold seasonal conditions providing a high chill exposure in the period immediately after birth. Apart from being a serious animal welfare issue, these neonatal losses represent a loss of productivity in terms of feed costs of maintaining breeding ewes that do not carry lambs through to weaning, and a reduced supply of replacement animals. This project investigates metabolic and endocrine maturity in the neonate lamb, and the relationships between litter size, birth weight, and ewe nutritional status on behavior at birth and survival over the first 72 hours of life. Given current low sheep numbers, this research area is aimed at maximising the number of available animals to drive increased pasture utilisation and maximise red meat production per hectare.

Methods

Funding for this work ($60K) was provided through the Joint Senior Research Position Project to promote collaboration and to raise the profile of RMT both nationally and internationally. A study was run in 2007 investigating the effects of maternal low dose dexamethasone treatment on metabolic maturity at birth and neonate lamb survival and growth in 150 Merino ewes at Cressy R&D Station. Lambing commenced on 22 July and ran to 11 August 2007, with a 6-person team collecting lamb behaviour, physiological, and survival data, plus blood samples on a 24-hour a day basis. Of the 219 lambs born, 88 died during the lambing period, 130 were marked on 3rd September and 129 weaned and blood sampled on 8th October. The ewes were monitored during the July-August 2008 lambing period for any adverse carry-over effects from treatments, of which none were observed. Ewe and lamb temperament measures were also collected during the trial using commercially available weighing equipment.

As the 2007 trial highlighted the well recognised influence of adverse weather conditions on neonate lamb survival, a funding application was submitted to and accepted by MLA in mid-2009 for $47K to investigate the effect of providing edible shelter in the form of winter cereal crops on lamb survival outcomes. This project will contribute to the development of lambing systems offering improved neonatal twin lamb survival that can be effectively integrated into irrigated cropping operations. The development of an effective edible shelter system offers animal welfare improvements, strategic spelling of pastures for production and natural resource management benefits, and an increase in the continuity and/or volume of lamb meat supply or breeder replacements. Objectives are to:

1. quantify the benefits for twin lamb survival on either dryland or irrigated winter cereals in comparison to pasture-based lambing systems
2. identify potential animal welfare or management issues associated with edible shelter systems
3. quantify the economic outcome of these alternative lambing systems.

This will be achieved by running winter-lambing trials on 2 commercial properties and Cressy R&D Station in the Northern Midlands of Tasmania. Associated field-days and media releases will extend the results to the farming community.

Additionally a funding proposal was submitted to the Sheep CRC for $100,000 for a Commonwealth PhD project to further investigate the role of the various hormones associated with energy homeostasis in mediating the processes of development within the growing foetus. The experiments were designed to increase understanding of the mechanisms behind foetal development, their relationship to post-parturient ewe/lamb behaviour, neonate adaptation and survival during the 72 hours post-lambing, to aid in the selection of genetic markers for lamb survival and performance-related traits. As at the end of this project, this proposal has not yet been funded.

Results

This project revealed for the first time a relationship between ewe pre-lambing, and neonate pre-suckling plasma ghrelin concentrations and lamb survival to 72 hours after birth. Other results included:

- Dexamethasone treatment had no effect on lamb survival to 72 hours after birth, although treatment at the 3mg dose reduced lamb heart girth, and dexamethasone reduced birth weight and pre-suckling rectal temperatures in twin lambs
- Dexamethasone treatment at Day 141 of gestation increased ghrelin concentrations in singleton and male lambs
- Treatment did not affect the concentration of measured blood metabolites or hormones at weaning, or liveweight recorded 73 d after weaning
- Improved lamb viability at 72 hours after birth was related to lower chill indices at birth, singleton litter status, greater pre-suckling rectal temperature, increasing ewe pre-lambing plasma ghrelin concentration, female sex, heavier birth weight, and tended to be associated with lower lamb pre-suckling plasma glucose concentrations
- Birth weight was less in lambs born to ewes with high pre-lambing plasma glucose and leptin concentrations
- Greater pre-suckling plasma ghrelin and leptin concentrations were measured for shorter gestation lengths
- After accounting for DEX effects, pre-suckling plasma leptin levels were negatively associated with rate of weight gain to and weight at weaning.

Tasmanian lamb autopsy data from the 2007 trial on lamb survival was also contributed to an internal CRC review on the subject by Assoc. Prof. Geoff Hinch of the University of New England.

Conclusions

The role of ghrelin in ovine fetal development and lamb survival warrants further investigation. This study has also shown that commercial livestock scales are capable of providing a practical temperament score related to sheep liveweight and maternal behaviour at lambing. Shelter systems that provide shelter across the lambing paddock to decrease the chill experienced at birth may improve the survival of neonate lambs and will be investigated for 3 ewe breeds in the Midlands of Tasmania in 2009.

Outcomes (See Appendix for more details on these publications)
The results from this work point to a new avenue to improve lamb survival outcomes within the Australian sheep industry. This project has offered the RMT Research Sub-program an opportunity to become more widely connected in the research community addressing sheep production within Australia and internationally. This has included involvement in the Sheep CRC activities, including an international review on sheep reproduction. The sub-program's profile has been raised through dissemination of results in both scientific and industry forums, as detailed below.

Miller, D.R., Jackson, R.B., Blache, D. and Roche, J.R., 'Metabolic maturity at birth and neonate lamb survival and growth. I. The effects of maternal low dose dexamethasone treatment as two time points in late gestation', *Proceedings of the Joint Annual Meeting ADSA, CSAS, ASAS 2009*, 12-16 July 2009, Montreal, Quebec, Canada (In Press, and submitted as a full research paper to the Journal of Animal Science)

Miller, D.R., Blache, D., Jackson, R.B., Downie, E., and Roche, J.R., 'Metabolic maturity at birth and neonate lamb survival and growth. II. Association among maternal factors, litter type, lamb birth weight, plasma metabolic and endocrine factors, lamb survival and behavior', *Proceedings of the Joint Annual Meeting ADSA, CSAS, ASAS 2009*, 12-16 July 2009, Montreal, Quebec, Canada (In Press, and submitted as a full research paper to the Journal of Animal Science)

Miller, D.R., Jackson, R.B., Blache, D., and Roche, J.R., 'Metabolic maturity at birth and neonate lamb survival and growth. III. Association among pre-suckling plasma metabolic and endocrine factors and lamb growth to weaning', *Proceedings of the Joint Annual Meeting ADSA, CSAS, ASAS 2009*, 12-16 July 2009, Montreal, Quebec, Canada (In Press)

Horton, B., Pirlot, K., and Miller, D.R. 2009. Measurement of sheep temperament based on recording movement within a commercial weighing crate. International Journal of Sheep and Wool Science. (Submitted for publication)

Honours thesis – E. Downie. School of Agriculture, University of Tasmania. 2007.

'Light shines as scientists watch flocks', Tasmanian Country, November 23, 2007, P17. (Newspaper article)

Invited seminar 'Red Meat Targets Program and the Lamb Survival Project' presented at the Lincoln University, Canterbury, New Zealand on October 2008.

4.3.2 Benchmarking Tasmania's Sheep and Beef Industries

Introduction

Farm business benchmarking provides measures by which producers can monitor enterprise performance and identify factors limiting their productivity and profitability. In 2007 it was estimated that less than 100 Tasmanian sheep and beef producers benchmarked their farm businesses. They did so using the services of private consultants and so the data produced was neither consolidated nor made publicly available, and so could not be used to assess overall animal industry performance.

In mid 2007 the Tasmanian government through DPIW provided $120K over a 3-year period to the Sub-program to promote benchmarking as a business management tool to red meat producers, to better understand the state-wide range in business performance, and to bring performance data for the livestock industry into the public domain to allow the industry as a whole to respond to the findings. This initiative was aimed at increasing the red meat industry's ability to monitor performance and support decision making aimed at improving enterprise productivity. This project contributed to RMT project goals by providing robust, basic information about the performance of the Tasmanian red meat industries, and highlighted some limitations to long term economic viability of these businesses. This information will be used so that RD&E efforts can be more effectively targeted in Phase II of RMT.

Methods
Red Sky Agricultural Pty Ltd were sub-contracted to generate the financial performance measures from standard business compliance accounts, provided by participating producers through their accountants. The aim was to obtain a representative sample of the commercial beef, sheep-meat and wool producing enterprises in Tasmania to enable industry level overviews. The definition of a suitable enterprise was one involving the production from at least 50 head of cattle and/or 500 sheep. Data collection was of the 2005/06, 2006/07, and 2007/08 datasets. Financial data collection was for at least 200 enterprises in the first year of the project, building up to 300 participants in each of the second and third years of the project. An annual industry report was to be generated with each producer participant receiving an individual report including a comparison against the industry benchmarks. Regional workshops were to be run annually to present the industry benchmarks. DPIW were to work in partnership with local agribusiness consultants to encourage ongoing individual benchmarking analysis.

Results
The project obtained UTAS Human Research Ethics approvals and was officially launched by the Minister for Primary Industries on 12 July 2007, to run until June 2010.

Red Sky Agricultural had significant difficulty in obtaining the co-operation of accountancy practices servicing the red meat industry. Of the 16 practices contacted with significant numbers of producer accounts, only 3 signed onto the project by the end of October 2007, and these 3 were very slow to contact their clients and only weakly promoted the project. The lack of accountant interest appeared to revolve around competition for limited staff resources with their core tax-compliance role.

To respond to this development the decision was made to approach farmers directly using DPIW and TIAR channels and contacts. To the end of the second year of this project these have included:

- Newspaper articles (x 8)
- Radio interviews, bulletins and promotion (x 5)
- Mailouts to beef and sheep producers (x 4)
- Articles in DPIW and industry magazines or newsletters (x 7)
- Internet promotional web-pages (2 sites)
- Promotion at red meat producer meetings (x 13)
- Recruitment drives at agricultural field-days and shows (x 4)

- Presentations to industry representative bodies (x 2)
- Presentations at Tasmanian Accountants Congresses (x 2)
- Numerous direct producer contacts.

Promotional materials also included 2 producer testimonies on the benefits of benchmarking.

The current position of the project at mid-May 2009 was that 34 farms had submitted financial information, with a total of 59 complete datasets collected (5 farms x 3 years of data, 19 farms x 2 years and 6 farms x 1 year of data). Red Sky was regularly communicating with another 35 potential participants. A series of three regional discussion days were held at Rocky Cape (19 attendees), Campbell Town (19 attendees) and Scottsdale (12 attendees) in March 2009 to present the financial benchmarking industry overviews to both participants and other interested producers. These results are presented in Table 2. It should be noted that the sample size is small, so caution should be exercised in the interpretation of these figures.

Average beef enterprise profitability in 2007 represented a breakeven position after accounting for debt servicing. The top quartile beef farms were being operated on more valuable land, and were characterised by producing almost twice the amount of beef per hectare than the average, accomplished through a 43% increase in stocking rate. The top beef farms had a similar cost base to the average farms, so the lower cost of production was mostly through having higher levels of output. These initial results highlight the importance of maximising production per hectare. Due to the high variability of costs in pastoral livestock businesses, good management was characterised by keeping a tight control on costs, while maximising production per hectare. Labour efficiency (management & staff costs per DSE, and DSE managed per FTE) is generally not strong in the businesses analysed to date, and it would appear that in a number of the businesses there may be unrealistic expectations of what level of employment their business can provide, or alternatively how important it is for some individuals to grow their business if they want a more secure future. Generally the level of equity was high in the businesses being analysed (~90%) and return on equity (ROE) was generally above 10% after including capital gains.

Table 2. Summary financial benchmarking performance figures (2006/07) for participating beef, crossbred sheep, and Merino sheep enterprises (as at 15 May 2009).

Indicator	***Beef Enterprises (n = 25)***		***Cross-bred Sheep (n = 7)***	***Merino Sheep (n = 6)***
	Average	**Top 25%**		
Total DSE	5,530	4,211	2,885	9,897
Effective Hectares	394	210	254	1,241
Stocking rate (DSE/ha)	14.0	20.0	11.3	8.0
Tot. LW produced/ha	274	510	106	44
Operating profit/ha	$53	$384	$109	-$69
Equity % (4 year av. values)	89.4	84.8	94.3%	92.4%
ROA (4 year av. values)	0.8%	3.8%	2.1%	-3.4%
ROE (4 year av. values)	-0.1%	3.2%	1.7%	-4.4%
ROE including capital gain	13.1%	12.1%	15.8%	7.9%
Operating profit margin	12.5%	42.8%	24.2%	-36.8%
Cost of Prod. per kg	$1.36 (LW)	$1.01	$2.31 (Cwt.)	$12.90 (Clean)

Average value per kg	$1.51	$1.65	$3.55	$9.43

These conclusions are in agreement with the core messages being promoted by the RMT program, namely that increasing pasture utilisation through greater stocking rates can increase meat production and hence profitability per hectare; that costs of production needs to be understood and controlled; and that producers need to become more efficient for long-term sustainable red meat production in the State.

The difficulties encountered in recruitment revolved around a general shortage of beef and sheep producer advocates who have successfully applied benchmarking in the past, drought in significant regions of the state, accountant inertia, and a widespread perception amongst farmers that they 'don't have enough time', indicating benchmarking is seen as a low priority activity.

Conclusions
Financial benchmarking in Tasmania has the potential to significantly increase farm business performance, and overall industry profitability and resilience, given the emerging indications of large variability in cost of production, operating profit margins, and returns on assets managed within the industry. A longer period than the 3 years initially envisioned will be required for the project to build sufficient numbers of participants to generate the 'word of mouth' advertising and momentum needed to get at least 10% of the red meat producers in the state involved. Tasmanian red meat industries need to develop a culture of continuous improvement if they are to offset declining terms of trade and find the productivity improvements required for economic sustainability. This project is taking active steps to see that culture develop.

Outcomes
Every commercial red meat producer in Tasmania has been made aware of the project and the potential benefits of financial benchmarking through mailouts and media releases, and a sufficient body of data on the financial status of the industry will be available by the end of the project to provide clear indications of RD&E requirements and priorities within the state.

4.3.3 Testing simulation programs at farm and regional levels in Tasmania

Introduction
It was identified through the RMT participatory planning process that a need existed to develop the capability to use computer models to predict pasture and animal productivity, in order to test new ideas and concepts with multiple year impacts in a rapid and economical fashion. This capacity would allow the targeting of research in the most profitable areas or in areas where our current knowledge and understanding was limiting. It was thought that the outputs of these modelling exercises would be primarily used to identify RD&E priorities in Tasmania.

The objectives for this project were:

1. Use the models GrassGro, Sustainable Grazing Systems (SGS) and Stockpol to model 2 to 3 scenarios for typical Tasmanian sheep/beef areas (lower midlands, North east coast, Cressy area)
2. Use technical and industry reference groups to develop the inputs and evaluate the outputs
3. With input from the model owners test the response of different animal genotypes
4. Extend the modelling to express the benefits and constraints of potential new meat production systems at both the farm and regional scale
5. Identify strengths and shortcomings of the methodology

6. Build Tasmania's farm systems modelling capacity and promote the value of modelling to a core group of industry representatives.

Methods

This project commenced on 15 January 2006, and was implemented by Dr Mick Statham and Mr Rohan Dingemanse, with the assistance of Dr Richard Rawnsley. A Technical Reference Group of DPIW and TIAR R&E specialists was established, as was an Industry Reference Group, composed of producers, processors and consultants. These groups identified the importance of investigating the use of irrigation and nitrogen fertiliser to increase pasture growth, particularly where a pasture rotation was to be included in a cropping rotation. A number of alternative production systems were modelled, and an attempt was made to estimate the costs and returns from some of the enterprises using Red Sky financial analyses.

Results

Each of the models used had limitations and a range of issues was encountered when trying to link the outputs from one model as inputs for another model, primarily due to differences in the original intended purpose of the models. In order to examine the effects of nitrogen and irrigation on animal growth and production, animal growth was predicted from GrassGro and plant production from SGS, and these data were used in Stockpol, and the farm production data from Stockpol was used in Red Sky. The major problems were:

- Difficulties in defining actual fertiliser application rates additional to nitrogen in SGS, and in comparing fertiliser practices in the two pasture models
- Differences in plant production predictions between the models, which translated into difficulties in predicting animal growth rates from pastures with varying nitrogen and irrigation additions
- Determining the area used for irrigation, and therefore the cost of irrigation when it was used to grow animals.

The State wide area of each of the soil types used in the simulations was calculated from land capability data to indicate the area potentially influenced by management changes, but in the case of irrigation it was not possible to put a financial value on any potential changes to production systems, as there was no method available at the time to determine what proportion of those soils could be irrigated. Further, given the constraints of the project it was not possible to develop any different animal genotypes which could be modelled as this was beyond the capabilities of the models and would have necessitated rewriting some of the component modules.

The predicted pasture production response at Scottsdale under varying urea and irrigation regimes is shown in Table 3, as an example of the information generated by the project.

Table 3. Pasture DM production responses at Scottsdale under varying urea and irrigation regimes

No added fertiliser					
ML irrigation/ha	0.0	1.7	2.7	3.4	3.7
Annual DM production (T/ha)	8.2	10.4	12.2	13.5	14.1
130 kg urea/ha					
ML irrigation/ha	0.0	1.8	2.7	3.4	3.7
Annual DM production (T/ha)	9.2	11.4	12.8	14.0	14.4
220 kg urea/ha					
ML irrigation/ha	0.0	1.9	2.7	3.4	3.7
Annual DM production (T/ha)	10.0	12.0	13.6	14.4	14.9

440 kg urea/ha					
ML irrigation/ha	0.0	1.9	2.7	3.4	3.7
Annual DM production (T/ha)	11.6	14.8	16.0	16.4	16.6

From this information animal production data was calculated in Stockpol and then translated into Red Sky for a standard 1000ha property size. In the example above at Scottsdale, selling 500kg beef animals from a property not using any urea or irrigation and at a stocking rate of 14.7 DSE/ha would produce 108.1 kg carcase beef/ha at an operating profit of $243/ha. Adding 435kg urea/ha and 2.4ML/ha on 470 ha enabled an increase in the stocking rate to 19.9 DSE/ha and a production of 143.2 kg carcase/ha, but operating profit was reduced to $113/ha. This indicates the economic importance of ensuring input costs are out-weighed by the additional carrying capacity and output to ensure positive cost: benefit.

Conclusions
The members of the Industry Reference Group indicated that their interest was in predicting the pasture which could be produced under irrigation and differential nitrogen addition, and the project was able to supply the information needed for them to determine the value of these alternative production options on their own specific circumstances.

Outcomes
This project attempted to develop an integrated modelling system for evaluating different red meat production scenarios for three regions of the state. Despite some difficulties in this integration process, involving the intrinsic characteristics and purposes of the models involved, industry relevant information was generated and capacity in computer modelling developed within RMT/TIAR.

Statham, M. and Dingemanse, R., 2006. Testing simulation programs at farm and regional level in Tasmania. Final Report – December 2006. Tasmanian Institute of Agricultural Research. Kings Meadows, Tasmania.

4.3.4 Relating farm financial outcomes to bio-physical attributes using GIS

Introduction
This project was aimed at adding value to the previously described Benchmarking Tasmania's Sheep and Beef Industries Project, by investigating the extent to which the variation in business performance amongst Tasmanian beef and/or sheep producers could be explained by variation in farm physical/biological attributes, such as soil type, land capability class, land aspect, pasture type, and animal management. While bio-physical attributes alone will never explain all of the variation in farm business performance, the extent to which they do may be sufficient to allow for useful computer modelling of future red meat industry scenarios at state-wide or national scales. Digitised spatial data was available for many of the physical and climate variables of interest, and this project represents the first attempt in Australia to link such spatial environmental data to farm business data.

Methods
A full time Masters student from the University of Tasmania was to undertake the process of relating the financial benchmarking data with bio-physical and spatial data available for those enterprises. They were to be supervised principally by Professor Tony Norton and Dr Miller. This involved completing a literature review on benchmarking (both financial and physical production) and gaining a working understanding of spatial modelling techniques, as well as suitable statistical analysis methods. Following collection of a suitable dataset on the Tasmanian beef industry, the developed database was to be aligned with the bio-physical measures and statistical analyses undertaken to identify those measures that explained the majority of the variability in enterprise profitability. This

process was to produce a list of relevant key bio-physical performance indicators underpinning the financial benchmark outputs and profitability of Tasmanian beef enterprises. An industry level 'map' of Tasmania's beef production enterprises as a 'single farm system' was also to be developed using geographical information systems (GIS). This was to enable identification of regions where allocation of resources to particular enterprise types could be more closely aligned.

The second part of the project was to contrast the collected benchmarks against the potential performance theoretically achievable using currently available technologies using computer modelling techniques. This process would inform producers about where current limitations in their production systems were hampering their efforts to become more profitable. The established correlations could also point to the need for further information on managerial goal setting processes, attitudes to risk, skills levels, and confidence in implementing change, or alternatively a need to validate the findings through producer interviews or case studies.

This 2-year project commenced in mid-2007 and was jointly funded by MLA ($56.5K) and the UTAS ($20K).

Results

A Masters student, Ms Sarah Gatenby was enrolled in June 2007 and equipped with a suitable computer to undertake the spatial mapping tasks required. She undertook a literature review to collate previously identified drivers of production and profitability and developed, with producer collaboration, the required additional data collection forms required. Sarah developed the statistical methodology required in collaboration with a TIAR statistician, Ross Corkrey, and also received training on the financial benchmarking procedures of Red Sky Agricultural. She received GIS training (ArcGIS) in July and December 2007, and attended UTAS and DPIW seminars/forums on GIS in the second half of 2008. Sarah was also trained in the modelling program GrassGro in July and August 2008, to equip her to compare potential productivity against the current industry performance levels.

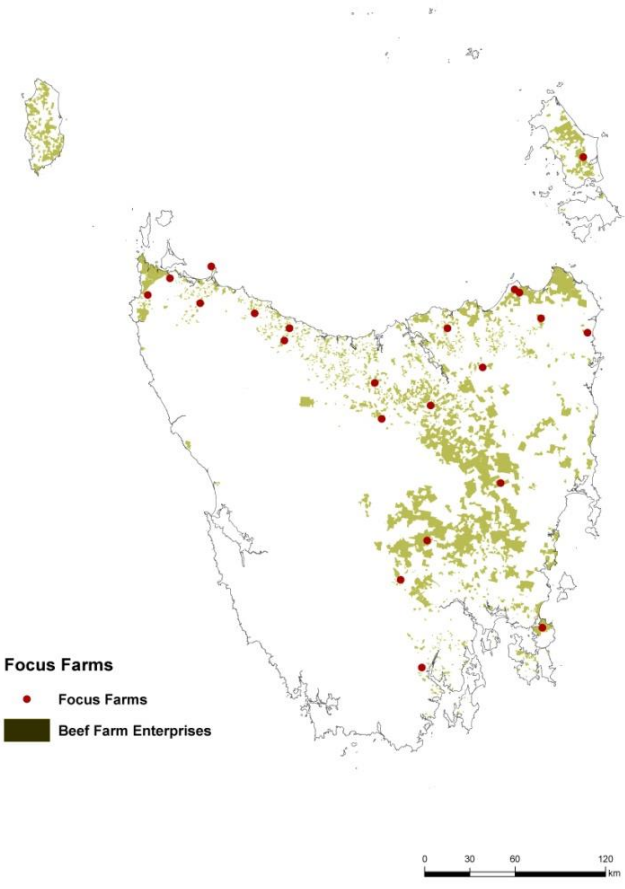

Figure 1. Distribution of the 22 Focus Farms within the wider beef industry in Tasmania (LIST- DPIW, 2009)

Due to the slow progress in recruiting red meat producers to the Benchmarking Tasmania's Sheep and Beef Industries Project, Sarah became an active advocate and recruiter for the project, preparing and delivering presentations at farmer group meetings, large field-days, industry representative bodies, and in one-on-one contacts. To publicise the project, Sarah presented a paper entitled 'Environmental factors affecting the profitability of Tasmanian beef production' at the Ecological Society of Australia Annual Conference in December 2008 at the University of Sydney.

As the collection of financial datasets fell short of the desired 100 enterprises by the end of the first year of the project, it was

decided to complete a 'proof of concept' using a smaller number of focus farms (Figure 1), combined with industry level bio-physical overviews using GIS techniques, and including 3 case studies to gain an understanding of how management attitudes might influence the use of bio-physical resources. A quantitative analysis of how representative these 22 focus farms are compared to the range of environments supporting beef farming across Tasmania is underway. A further 5 focus farms will provide financial benchmarking data, but not additional information on management practices. Sarah will complete the collection of the financial and additional data by the end of May 2009 and is close to completing the exploratory analysis of the whole Tasmanian beef industry, and the case study interviews.

GIS and spatial modelling techniques were used to create a 'farm' map of aggregated data of the landscapes supporting beef enterprises (n = 1793) in Tasmania. The information produced allows a picture of the beef industry to be compiled in terms of its geographical location, mean annual temperature, mean annual rainfall, slope, aspect, water balance, soil type, land use classification (Table 4). This process will be completed in June/July 2009.

Beef enterprises are geographically widespread in the established agricultural region of the State (Figure 1). In general, beef farms tend to occupy relatively warmer and drier sites than the State average. For example, the mean annual temperature for all Tasmanian farms is 10.9^{o}C, compared to the mean value for the State of 9.7^{o}C. This has implications for the potential pasture production expected within the industry. The temperature and rainfall experienced by beef farms on King and Flinders Islands have more narrow ranges compared to that experienced by beef farms on mainland Tasmania. Beef farms occur on a large range of slopes and aspects across the State, with the mean values for these biophysical attributes indicating that most beef farms exploit lower slopes. Despite this, the range and mean value for estimated annual water balance of beef farms did not vary from that estimated for the total State environment.

Table 4. Preliminary profile of landscapes supporting beef enterprises in Tasmania in comparison to the characteristics of the main island of Tasmania.

	Beef Enterprises			**Main Tasmanian landscape**		
	Mean	**Min.**	**Max.**	**Mean**	**Min.**	**Max.**
Mean Annual Temp. (^{o}C)	10.9	5.7	13.0	9.7	2.5	13.1
Mean Annual Rainfall (mm)	963	466	2382	1395	444	3400
Water Balance (relative scale)	79.5	54.0	100	88.1	52.0	100
Slope (^{o})	4.9	0.0	62.8	9.3	0.0	80.3

A relatively limited range of more productive soil types are a feature of the majority of beef farms. Beef farms were calculated to occur on 16 different soil types across the State, but interestingly around 40% of all beef farms are concentrated on just three soils: brown dermosol (15.1% of total area), brown chromosol (11.9%) and brown kurosol (9.5%). This has implications for locating beef trial sites to maximise applicability of results to industry.

The predominant land use class for beef farms in Tasmania is modified pastures (59% by area, 451,000ha), with irrigated cropping/pasture classes representing a total of 5.1% by area, 39,254ha (Table 5, and Figure 2). Improved pasture production through the use of irrigation, and its affect on farm performance, will be examined in more detail during the analysis of individual farm enterprises undertaken in the thesis.

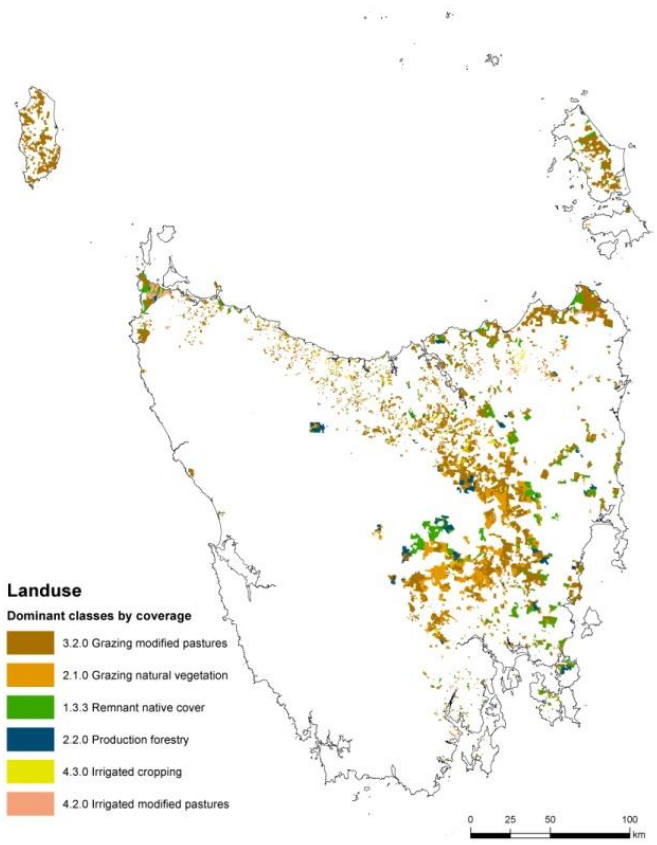

Figure 2. Land Use Classifications for beef enterprises in Tasmania

Analysis of environmental variation at a regional level (e.g. North West, North East) in Tasmania are possible using the spatial modelling approach outlined here and are currently under consideration as a basis to more closely examine the environmental profile of beef farms.

To the best of our knowledge, these GIS and spatial modelling techniques have not been used previously to quantitatively describe the environmental profile of an individual livestock industry as a basis to examine relationships between the inherent biophysical features of a farm and its financial performance.

Conclusions

While this project has been delayed by the slow recruitment of producers to the financial benchmarking project, the integration of GIS databases with data on financial performance and management offers a novel and potentially powerful decision support tool for addressing state and national industry level questions. These include more accurate estimation of the potential impacts of government policy decisions on agricultural industries, and the identification of areas requiring additional allocation of RD&E resources.

Table 5. Land use classes and land area aligned with beef production in Tasmania.

Land use classification	No of farms	Area (Ha)	% of area
Grazing modified pastures	735	451,165	58.7
Grazing natural vegetation	552	111,681	14.5
Remnant native cover	964	110,817	14.4
Production forestry	536	35,690	4.6
Irrigated cropping	732	25,372	3.3
Irrigated modified pastures	110	13,882	1.8

Outcomes

As data analysis is still underway, impacts on industry are yet to accrue. The main outcome to date has been the development of skills capacity in the area of application of GIS methodology to the red meat industries of Tasmania, and the training of the Masters student in research processes and communication.

Gatenby, S.J., Miller, D.R. and Norton, T.W. 2008. Environmental factors affecting the profitability of Tasmanian beef production, *Proceedings of the Ecological Society of Australia Annual Conference*, 1-5 December 2008, University of Sydney, Sydney, NSW. [Conference Extract]

4.3.5 Winter cereal crop grazing systems

Introduction

The use of dual-purpose wheat cultivars as a high quality forage for meat-producing lambs can contribute to overcoming the feed-gap that occurs during winter in temperate Australia, and which limits overall carrying capacity of farms in this region. The introduction of new dual-purpose cereal cultivars, bred for providing forage for livestock prior to subsequent harvest for grain, has renewed interest in this system. While the potentially conflicting aims of maximising animal production and grain yields have been achieved successfully for dryland cereals, past grain yield outcomes have been variable, ranging from a decrease due to grazing of almost 28% to an increase of 18%, and an average across 134 comparisons of a 4% reduction (Virgona et al., 2006). Beef research in Argentina has shown that leaf area index of winter wheat at anthesis is affected by grazing pressure and positively correlated with grain yield (Arzadun et al., 2003). Extensive areas of Tasmania have been developed for cropping under pivot irrigation, although little information exists on managing the grazing of these new cultivars under irrigation to maintain subsequent grain production.

While it is well understood that grazing must cease before stem elongation (Zadoks growth stage 30) to avoid removing the emerging grain head, this may be offset by providing irrigation to encourage tillering. While continuous grazing is more common under centre pivot irrigation systems to maximise animal performance, Australian producers are also using rotational grazing to better manage grazing pressure, reduce wastage and control feed intake. There was a lack of relevant information on the impacts of post-grazing residual and grazing system that would optimise animal live-weight production while maximising subsequent grain yields under irrigated conditions.

The aim of this project was to quantify lamb performance on irrigated dual purpose wheat and evaluate in agronomic, animal health, grain yield, and economic terms, set-stocked & rotational grazing systems and 2 end-grazing residuals for lamb performance.
This 2-year project was funded by MLA ($20K from the Joint Senior Research Position Project and $30K of additional funds) and contributed to the overcoming of winter feed supply gaps using irrigation, and the promotion of continuity of supply of Tasmanian red meat products. Mr Geoff Dean of TIAR, and RMT D&E Sub-program Leaders Peter Williams (deceased) and Peter Ball of DPIW were active collaborators in this project.

Methods

A preliminary trial of stocking rates suitable for dual-purpose winter wheat crops was run in 2007 by Southern Farming Systems with funding through the Grain and Graze program ($20K). The Research Leader had significant collaborative input into the planning phase of that work. It consisted of grazing 41 kg crossbred wether lambs on March-sown *Mackellar* wheat and set-stocked at five different rates (10, 20, 30, 40, 50 lambs/ha) to identify optimal stocking rates. The data that was produced by that preliminary trial was used in the planning of the experiment comparing post-grazing residuals and grazing management. This planning was also informed by an internal RMT review of the scientific literature undertaken by the Research Leader.

The trial was carried out in an irrigated *Mackellar* wheat paddock on Stewart McGee's property at Bishopsbourne in the northern Midlands of Tasmania. The crop was sown on 13 March 2008, with appropriate fertilisation, irrigation, herbicide and fungicide treatments applied. The treatments

comprised two grazing systems (set-stocked or a 4 paddock rotation) and two post-grazing residuals (400 and 800 kg DM /ha when the crop reached Growth Stage 30). Two set-stocked maximum utilisation (0 kg residual) plots were also included. The trial site was fenced into 14 x 0.2 ha plots (as 2 rows of 7 plots with a central laneway); with the 6 rotationally-grazed plots further divided using wire-netting fences. Mixed-sex, second cross, 10 month old, Dorset/Suffolk lambs of 37 kg and 2.5 condition score were used in the trial. The trial was stocked in late May 2008 when forage reached 1850 kg DM/ha and at a rate of 40 lambs/ha (providing 45 to 50 kg DM/lamb).

Lambs were weighed without a curfew at the same time weekly and BCS determined at the commencement and completion of grazing. Faecal samples were collected at initiation of grazing (pre-drenching) and then on a fortnightly basis, and ova counts completed for *Strongylus* and *Nematodirus sp*. Lambs were also supplemented with 1:1 magnesium oxide & coarse salt, provided *ad libitum* (about 20g/h/d, Dove et al., 2007) as a loose mix. As plots were grazed down to the desired forage residuals before Growth Stage 30 was achieved, all animals were removed from the trial site after weighing at the end of the fifth week of grazing, producing an initial grazing period of 35 days. To achieve the desired post-grazing residuals when the plants reached Growth Stage 30, plots were re-stocked 21 days later for a further 11 days. The additional forage production and utilisation, and animal production from this final grazing were recorded.

Crop measures included soil compaction, soil water profile, DM accumulation at harvest, grain yields/ha, protein contents, percentage screenings, and specific (test) weight.

Results

End-grazing residual DM amounts between rotational and set-stocked treatments were not different, being 410 ± 210, 520 ± 23 and 940 ± 29 kg DM/ha for the 0, 400 and 800 kg residual plots respectively. The 400 kg treatment end residual was less than the 800 kg treatment residual. Average growth stage at the end of grazing was 29.7 for the set-stocked plots and 30.3 for the rotationally grazed plots. The average daily forage growth rate during the grazing period was 38 kg DM/ha. Compared to the ungrazed areas, grazing tended to increase the soil's mechanical resistance to penetration at 15 and 30mm, and tended to be increased at 45 mm soil depth, however extensive pugging of plots was not observed.

Rotational grazing resulted in higher final NDF and ADF contents (44.9 and 26.2% of DM respectively) than set stocking (41.1 and 23.9% DM respectively) when grazed to the 400 kg residual. Crude protein concentrations at the end of the grazing period were lower for the rotationally grazed plots (21.7% of DM) than the set-stocked plots (26.9% of DM) when grazed to 400kg. *In vitro* DM digestibility at the end of grazing was lower for the rotationally grazed plots when grazed to a 400 kg residual (64.8%) compared to the 800 kg residual (68.3%) or the set stocked plots (71.2% and 69.5% for 400 and 800 kg residuals respectively). There was no difference in forage utilisation between set-stocked and rotationally grazed management types across both grazing periods.

The total number of lamb grazing days over the two periods did not vary between set-stocked and rotational management (Table 6). The average rate of LW gain each week declined through to Week 5, with the average for the set stocked 400 kg treatment being higher than the average LW gain for the 400 kg rotationally grazed treatment (224 vs. 168 g/d). LW change was linearly related to available forage, and lambs gained an average of 0.17 of a BCS over the period. Over the total grazing period, rotationally grazing for the desired 400kg DM/ha residual required a greater amount of growth-corrected forage DM per kg LW produced than set stocking for a 400kg residual or rotationally grazing for an 800 kg DM/ha residual. This included senescence and trampling losses.

Table 6. Lamb performance on grazed winter wheat.

	Set Stocked		Rotationally Grazed		SEM
Item	400	800	400	800	
Grazing Days /ha	1595	1463	1712	1595	104.4
LW gain, g/h/d	224[b]	207[ab]	168[a]	191[ab]	18.2
Kg LW produced	354	336	304	351	31.2
FCE Kg DM/ kg LW	8.2[a]	8.1[a]	10.3[b]	7.9[a]	0.69

Blood characteristics recorded after 28 days of grazing revealed that potassium concentrations were elevated above normal concentrations. The mineral analysis for the wheat forage indicated excessive potassium, marginal calcium and low sodium compared to dietary requirements for growing sheep. Internal parasites were effectively controlled by pre-grazing drenches, bloat was not observed, and a light incidence of footrot was effectively controlled by foot-bathing with a zinc sulphate solution. No lamb deaths occurred.

A minimum offer of 800 to 1000 kg DM/ha was required to maintain good lamb LW gain performance at the stocking rates used. It is recommended that magnesium & sodium supplements be provided and drenching applied pre-grazing. The associated field day was well attended (27 people), with both croppers and red meat producers present, and highlighted the level of interest in this topic. A survey of attendees confirmed that 80% thought that the information presented was of value to their businesses and all of these indicated that they would use it in their farming operations.

Grain yields and bulk densities were unaffected by grazing treatments (Table 7). Grain sizing showed that rotational grazing tended to produce more small seeds and fewer larger seeds than set-stocking; however grain weights were not different. Plant heights were also unaffected by grazing treatment.

Table 7. Grain yield characteristics following grazing on winter wheat.

	Set Stocked		Rotationally Grazed		SEM
Item	400	800	400	800	
Yield (T DM/ha)	5.04	4.27	4.58	4.86	0.372
Bulk density (kg/hL)	80.6	80.1	79.8	79.9	0.71
Crude protein (%)	10.8	11.7	11.2	12.0	0.43
100 grain wt (g DM)	3.89	3.75	3.86	3.79	0.082
Seeds < 2.2mm (%)	9.7	11.4	11.3	11.3	0.92
Seeds > 2.5mm (%)	66.6	65.2	63.9	61.7	2.28
Harvest height (cm)	83.3	85.0	81.3	82.1	2.96

Conclusions

Based on the lamb performance results to date there does not appear to be any advantage in implementing a rotational grazing system compared to set-stocking at the stocking rates used here. Rotational grazing to a low residual resulted in forage exhibiting higher fibre contents, and lower crude protein contents and DM digestibility than under the set stocking treatment. There may be advantages when residual levels are low of set-stocking, in terms of maintaining LW gain and forage use efficiency, given LW gain was maintained into week 4 of grazing under that system, when the rotationally grazed lambs had already started to lose weight, and given that LW produced per hectare was also higher at the end of the first grazing period. However, these differences did not persist after the final grazing to growth stage 30. There may be advantages of rotational grazing on larger paddocks to ensure patch-grazing does not occur, and to achieve even forage utilisation over the area. This would not be revealed under the small experimental plots used in the trial.

While grazing treatments did not cause any statistical change in grain yields or characteristics, set-stocking to a lower residual produced the highest yields, the heaviest bulk density and grain weights, and the lowest proportion of small seeds, although crude protein levels were also the lowest of all the treatments. In contrast, under a rotational system the higher end-grazing residual produced numerically greater yields, and higher protein contents than the lesser residual. Added to the decline in forage quality at the lower residual, and the lesser lamb liveweight produced, this suggests that an 800 to 1000 kg residual is most appropriate under rotational grazing. Under set-stocking, a lower residual did not compromise lamb production performance, presumably because the ability for dietary selection was maintained, and grain yields were preserved, albeit at a lower protein concentration.

Outcomes
This project has produced replicated data on animal and grain productivity under two grazing systems and intensities, of immediate application to red meat producers in the state. The results of this project have been presented at 3 x Southern Farming Systems days (125 total participants) and a RMT field-day (27 participants) in 2008, and a 4 page decision support document for farmers is in preparation for release at a concluding producer discussion day prior to project completion at the end of July 2009. A draft of a scientific paper has been prepared for presentation at the Australian Society of Animal Production conference in 2010.

As previously described under the lamb survival project, a trial will commence in July 2009 to investigate the effect of providing edible shelter in the form of winter cereal crops on lamb survival outcomes. This work will be funded by MLA ($47K) and will contribute to the development of lambing systems offering improved neonatal twin lamb survival that can be effectively integrated into irrigated cropping operations. Measurements will include nutritive quality, ewe weight and condition score changes during lambing, lamb survival and growth rates, and subsequent grain yields.

4.3.6 Limitations to animal production from Cocksfoot pastures

Introduction
Although the area of adaptation of *Dactylis glomerata* (cocksfoot) in Australia is about 20Mha, including about 7Mha present in the 400 to 600mm rainfall zone of mainland Australia (Harris et al., 2008), cocksfoot has generally been seen as a second class alternative to perennial ryegrass. Unfortunately, the persistence of ryegrass in lower rainfall environments is generally poor relative to cocksfoot, resulting in the loss of perennial ground cover and the dominance of annual species. Persistence of sown perennial species under grazing remains an important issue with botanical surveys of the Midlands and Derwent Valley regions of Tasmania indicating that sown grasses such as perennial ryegrass and cocksfoot frequently represent only about 5% of the sward cover (Friend et al., 1997).

Anecdotal evidence indications that cocksfoot pastures do not produce the levels of grazing animal performance that feed analyses would suggest is possible (Robin Thompson, pers. comm.). While the nutritive value of cocksfoot is slightly inferior to ryegrass at similar plant ages, cocksfoot-based pastures have traditionally been managed using principles applicable to ryegrass which do not reflect the different growth characteristics, and therefore largely drive the observed reduced herbage quality and animal performance. Additionally, over the past five years new cocksfoot cultivars have been developed by TIAR that have different seasonal growth patterns, different growth habits to traditional lines, are less competitive against companion species, are more frost tolerant and have better drought survival characteristics. Research on grazing of temperate species has largely focussed on perennial ryegrass and less information is available about cocksfoot management.

Given agriculture is facing unprecedented challenges including the need for increased resilience to rainfall variability and drought, plus the increasing cost and decreasing availability of fossil fuels and synthetic fertilisers, there is an urgent need to develop pastures and grazing systems that positively address these issues. Low-input, pasture-based livestock grazing systems are likely to become progressively more important for meeting the rising worldwide human demand for protein, particularly with the increasing cost of grain-based finishing systems due to biofuel production and increased fuel and fertilizer costs. Appropriate inclusion of legumes into perennial grass-based pastures offers a sustainable, low-input-cost option to maintain soil nitrogen levels and improve animal production.

Methods
From the need to develop resilient, low input perennial mixed grass legume pastures, particularly for the drier areas of Tasmania's grazing regions, an internal RMT review of the literature was undertaken by the Research Leader in early 2008. This sought scientific information around Cocksfoot pasture quality and grazing management, and to support progress of a wider project aimed at evaluating newly developed TIAR pasture cultivars in the context of these challenges to agriculture. Meetings were held with a pasture expert (Robin Thompson, DPIW) and pasture plant breeder (Eric Hall, TIAR) to initiate a collaborative project for developing perennial pastures for Tasmanian environments that are productive and resilient under grazing.

Results
The internal review revealed that management of the timing and severity of the grazing of cocksfoot swards is very important for maintaining feed quality and quantity. To maintain feeding quality, cocksfoot swards should not be allowed to become tall or rank during the growing season, and grazing interval needs to be flexible to account for seasonal variability in new root growth (Ridley and Simpson, 1994), aiming for defoliation intervals between the 4^{th} and 5^{th} leaf stages of regrowth (Rawnsley et al., 2002). Cocksfoot may be more actively selected, at least by sheep, during summer when it is actively growing, and so sustainable cocksfoot grazing systems also need to account for soil moisture conditions (Avery et al., 2000). N fertilisation can potentially be used to improve palatability and intake of cocksfoot in some seasons, and Mg availability to the animal (CSIRO, 2007) may be an issue for red meat production on pure swards. The challenge highlighted by the review was to determine under what environmental and management conditions the new generation of TIAR developed cocksfoot and other grass and legume cultivars will be sustained and productive under cattle and sheep grazing.

The RMT then involved Dr David Parsons, a UTAS researcher with experience in mixed-sward agronomy and small holder cropping and livestock system integration, and Dr Peter Lane, as Head of the School of Agriculture, UTAS. A proposal was developed and submitted to the federal government through the 'Australia's Farming Future' fund. This 3-year, $2.2M proposal was entitled 'Building resilience to climate change in Tasmania's low-rainfall grazing industries through improved perennial pastures and management practices'. It was aimed at evaluating a range of new grass and legume cultivars in both glasshouse and field situations for performance under current and expected changed climatic conditions.

The objectives of the project were:

1. To evaluate a range of new grass and legume cultivars under grazing conditions for increased resilience and productivity
2. To evaluate a range of new grass and legume cultivars in both glasshouse and field situations for performance under expected changed climatic conditions (water, temperature and CO_2).

3. To establish a modelling framework through calibration of the new cultivars in the 'EcoMod' pasture simulation model, in order to assess their potential in a wider range of climatic and soil conditions
4. To develop and deliver an extension program demonstrating the biological principles of pasture establishment and management using alternative species in the 400 –700 mm rainfall zone of Tasmania under a scenario of climate change, focusing on the production, environmental and economic opportunities of adopting improved perennial pastures.

Unfortunately the proposal for 'Australia's Farming Future' funding was unsuccessful, however funding is still being actively sought for this area of work.

Conclusions
The development of productive, persistent, mixed grass-legume pastures needs to be progressed further within Tasmania, as they are central to the future of profitable and sustainable red meat production in the State. This issue will be progressed further in the proposed RMT Phase II.

4.3.7 Future Project Priorities

RMT strategic planning meetings were held in August and December 2008, and in April 2009 to review the outcomes from Phase I. The Phase II RMT strategic planning process identified the following industry priorities that will build on research activities completed during Phase I:

1. Productive, persistent and profitable pastures and their grazing management
    - Evaluation of new pasture species agronomy and productivity
    - Understanding the mechanisms and manipulation of intake and selective grazing
    - Developing and promoting whole farm grazing systems
2. Increasing red meat production efficiency
    - Matching land capability to the most suitable red meat production systems and understanding the drivers of productivity and profitability
    - Effectively integrating livestock with alternative agricultural enterprises
    - Maximising reproductive rates to spread input costs over a greater output volume.

4.4 Student Supervision

The objectives of this project also included the supervision of post-graduate students. This objective promotes capacity building in Tasmanian agricultural science students towards undertaking red meat research, and while focussing on post-graduates, sub-program activities have also involved under-graduate students.

Dr Miller obtained a Certificate of Registration from UTAS as a supervisor/co-supervisor of graduate research candidates on 1 May 2007. He was a co-supervisor with Prof. Tony Norton of the Masters student, Ms Sarah Gatenby, who is relating farm financial outcomes to bio-physical attributes using GIS. Sarah is due to complete her candidature and submits her thesis in mid-2009. She has had extensive training in GIS, computer modelling, and statistical analysis. Due to low undergraduate student enrolments, which appears to be a national issue within agricultural and animal science courses, opportunities for supervision of post-graduates from UTAS have been limited. The Sub-program is currently in discussions around involvement in supervision of a potential PhD student within the Sheep CRC, on a project developing 'fit for purpose' sheep.

The Sub-program also had a successful Honours student completion, with Ms Emma Downie completing her project within the neonate lamb survival project. As part of developing linkages with

the UTAS School of Agricultural Science, the Sub-program leader reviewed an honours thesis in 2008 by Ms Ruth Walker on 'Sire genetics, protein and energy digestibility: Relationship with wool fibre diameter in canola and lupin-supplemented crossbred sheep'. He has also delivered guest lectures to the 2nd Year Students in 2008 and 2009 on the work of the Sub-program, and on ruminant physiology as it relates to protein nutrition.

The Sub-program leader has also supervised Year 11 work experience students with an interest in Agricultural Science in 2008 and 2009, and been involved as an invited judge for the state-wide Tasmanian Women in Agriculture High School Scientific Research Science Awards.

The Research Leader has employed two recent UTAS Agricultural Science graduands as Technical Officers, and two as casual employees on the 2007 lamb survival study. All of these graduates have had the opportunity to learn new skills associated with animal science research.

Conclusion
Given the shortage of animal science students in Tasmania, and in Australia more generally, these supervisory, training, and lecturing opportunities are vital for motivating the students involved to persue animal science as an interesting and rewarding career, and for increasing the skills of young scientists with an existing interest in this field to add to Tasmania's red meat research capacity.

5 Success in Achieving Objectives

5.1 Provide leadership in red meat production systems research to the RMT program

A Research Leader was appointed and the Sub-program developed capability and capacity in terms of suitable Technical and casual staff, and the appropriate facilities and equipment enabling research to be undertaken within the RMT Program in Tasmania. The Research Leader has been instrumental in identifying RMT research priorities, critically evaluating external project submissions, providing scientific expertise to other activities within TIAR and DPIW, and continues to promote an integrated RD&E approach within the RMT.

5.2 Maintain a thorough and current knowledge of red meat production systems R&D

The Research Leader has maintained a current knowledge of red meat production systems R&D sufficient to support the successful implementation of industry-relevant research projects.

5.3 Maintain a current understanding of the issues, technologies, methodologies, and an effective network of contacts through which to achieve the former

Through memberships in professional animal science societies both in Australia and internationally, regular access to journals, scientific and research centre databases, and personal contact with researchers active in the field, the Research Leader has maintained an understanding of new developments and technologies within the field. Networks have been established and developed with collaborations involving research groups in Western Australia, South Australia, New Zealand, New South Wales, and Tasmania (DPIW, UTAS, TIAR), resulting in scientific publications or collaborative research projects.

5.4 Develop and implement a portfolio of projects in agreement with the RMT industry advisory and program management committees

A portfolio of projects was developed and implemented. Project activities covered neonate lamb survival (developmental maturity, genetics and epigenetics, temperament, shelter), feed intake control mechanisms, winter cereal grazing systems (stocking rate, grazing method, and grazing intensity), financial benchmarking, bio-physical analysis using GIS, and productive, persistent, perennial pastures. Planned future activities include understanding the mechanisms and manipulation of intake and selective grazing.

5.5 Present, promote and defend the work of the research sub-program team to various audiences

Sub-program work has been presented, promoted and defended by the Research Leader to a variety of audiences including Red Meat Targets Program (Advisory and Management committees), industry representative bodies (TFGA, SABRAC), funding bodies (MLA, DPIW, TIAR, AFF), the scientific community in Australia and internationally (via conferences, invited seminars, forums, collaborations, meetings), red meat producers in Tasmania (via radio, newspapers, newsletters, magazines, internet, and direct contact), and to university and school students, and community groups.

5.6 Represent the research sub-program at the program level to facilitate uptake of research output and identify researchable issues

The Research Leader has regularly and effectively represented the Sub-program at RMT Program Management Committee meetings, has promoted integrated RD&E projects through to funding and implementation, and has identified researchable issues for Phase I of RMT and for the strategic planning process for the proposed Phase II, currently under consideration by MLA, DPIW and TIAR.

5.7 Supervise post-graduate students

The Sub-program has supervised a Masters student, an Honours student, under-graduate and high school students, and is in discussions about supervision of a PhD student within the Sheep CRC.

6 Impact on the Meat and Livestock Industry

Improving red meat production is a priority activity for Tasmanian agriculture because it has a gross value of $211 million (2006/07), accounts for 22% of the gross value of Tasmania's agricultural commodities, and involves about 3000 beef and 1800 sheep enterprises. In 2006, the Tasmanian red meat industry identified that it was lacking red meat research capacity in the state. This project has established the scientific skills, equipment and facilities needed to address that shortfall, and has started to raise the profile of Tasmania within the national livestock research community. This project has already commenced providing valuable information to industry, particularly on modelling pasture responses to irrigation and nitrogen fertiliser, developing cereal grazing systems, and measuring financial performance of the beef industry.

For example, the difference in gross value of meat produced from the best to the worst performing grazing system tested in the winter wheat grazing trial was $100/ha. This represents $2.50 per lamb

grazed at the same stocking rate; a significant potential profitability boost for irrigated grazing systems, mainly resulting from improved feed use efficiency. In the beef industry, the top quartile of farms analysed are producing almost double the amount of beef per hectare than the average enterprise, accomplished through a 43% increase in stocking rate. Their costs of production were only 75% of the average, mostly achieved through higher levels of output. Labour efficiency is also a potential weakness of Tasmanian beef production. This new data provides industry with immediate focal points for RD&E initiatives, and these are expected to strengthen as participation in the benchmarking project increases.

In 5 years time, this project will have promoted a culture of continuous improvement in the Tasmanian red meat industry through the benchmarking project, and through research trials demonstrating the potential productivity improvements achievable under Tasmanian red meat production conditions. The spatial analysis technique will have been tested, and possibly developed to the point of being a tool capable of being used for state and national level industry decision making, and policy development.

Significant future benefits are also indicated from the lamb survival work. Lambs born to ewes grouped in the top 25% of pre-lambing ghrelin concentrations had a survival rate to 72h after birth of 67.9%, compared to an average of 64.9%, and 58.5% for lambs born to ewes within the lowest 25%. If a system of genetic markers can be identified for the hormones mediating foetal development and adaptation to the lambing environment, such as ghrelin, it would enable selection for lamb survival. Given the results above, it could lift the weaning rate by 5% for ewes in Tasmania, representing an additional 50,000 lambs for every the 1M ewes lambing in the State.

This MLA funded project has led to other immediate benefits for industry including:

- Skills development and networking for an early-career animal research scientist
- Technical skills development for recent graduates in implementing red meat research trials
- Graduate & under-graduate student training in animal nutrition and reproduction techniques
- local and international networks established for information exchange and collaboration.

7 Conclusions and Recommendations

7.1 Conclusions

A Research Leader was appointed to establish the Research Sub-program within the Red Meat Targets program in Tasmania, and to deliver leadership, knowledge, facilities, and a portfolio of research projects in red meat production. This has been achieved successfully. Projects have focussed on delivering to industry; improvements in understanding of lamb survival and feed intake control in order to increase the supply of animals to improve pasture utilisation levels; desktop modelling of options to increase pasture production; information about improved integration of sheep grazing with irrigated cropping enterprises to fill the winter feed supply gap and increase weaner lamb growth rates; financial benchmarking and spatial modelling management tools to better understand the limitations to red meat productivity, profitability and sustainability. Challenges for the future include the development of productive, persistent and profitable pastures, suitable grazing management practices to support them, and determining the potential animal production from newly developed, locally-adapted species from the TIAR legume and grass development program.

7.2 Recommendations

7.2.1 Support for Red Meat Targets – Phase II

Given the significant investment in developing research capability and capacity during Phase I of RMT and the success of the Sub-program, it is recommended that a second 5-year Phase of RMT RD&E be supported by MLA, DPIW and TIAR.

7.2.2 Research into productive, persistent and profitable pastures

The global competitive advantage of Australian red meat production depends on the continuation and improvement of low-cost, and relatively high output per land area (and labour unit) production systems based on grazed pastures. Environmentally sustainable red meat production in Tasmania must address the prospect of increasing climate variability and changing government policies, and the effective management of drought events, such as has been recently experienced in the state. It is recommended that research efforts are directed at evaluation of the agronomy and productivity of adapted pasture species and increasing our understanding of the mechanisms and manipulation of intake and selective grazing in order to create grazing systems capable of maintaining highly productive mixed grass legume swards.

7.2.3 Integration of animal production into alternative enterprises

Red meat production systems are under-performing in terms of achieving productivity improvements capable of more than offsetting ongoing terms of trade declines. An outcome of this is the movement of resources into other alternative land uses, such as broadacre cropping or silviculture. It is recommended that research continue into both matching land capability to the most suitable red meat production systems, and developing whole farm grazing systems where livestock are effectively integrated with cropping and horticultural enterprises, particularly where irrigation is available.

8 Bibliography

Arzadun, M.J., Arroquy, J.I., Laborde, H.E., Brevedan, R.E., 2003. Grazing pressure on beef and grain production of dual-purpose wheat in Argentina. Agron. J., 95, 1157-1162.

Avery, A.L., Michalk, D.L., Thompson, R.P., Ball, P., Prance, T., Harris, C.A., FitzGerald, D.W., Ayres, J.F., Orchard, B.A., 2000. Effects of sheep grazing management on cocksfoot herbage mass and persistence in temperate environments. Aust. J. Exp. Agric., 40, 185-206.

CSIRO, 2007. Nutrient requirements of domesticated ruminants. M. Freer, H. Dove and J.V. Nolan. (Eds.). CSIRO Publishing, Collingwood, Victoria.

Dove, H., McMullen, G., Kelman,. W.M., 2007. Growth responses to magnesium or sodium supplements in lambs grazing dual-purpose wheats. J. Anim. Feed Sci. (Suppl. 2) 16:465-470.

Friend, D.A., Thompson, R. P., Ball, P. D., Corkerey, S. R., and Graham, B. R. F., 1997. The Pastures of the Midlands and Derwent Valley Tasmania - Relationships to Environment and Management Factors. Final report for Project DAT 44. International Wool Secretariat.

Harris, C.A., Clark., S.G., Reed, K.F.M., Nie., Z.N., Smith, K.F., 2008. Novel *Festuca arundinacea* Shreb. and *Dactylis glomerata* L. germplasm to improve adaptation for marginal environments. Aust. J. Exp. Agric., 48, 436-448.

Hight, G.K. and Jury, K.E., 1970. Hill country sheep production II. Lamb mortality and birth weights in Romney and Border Leicester x Romney flocks. NZ J. Agric. Res. 13:735–752.

McEachern, S., Sackett, D., Holmes, P., 2005. Keys to profitable lamb production – 2005 and beyond. Final report for Project SCSB.075. Meat and Livestock Australia, North Sydney.

Rawnsley, R. P., Donaghy, D. J., Fulkerson, W. J., Lane, P. A., 2002. Changes in the physiology and feed quality of cocksfoot (*Dactylis glomerata* L.) during regrowth. Grass & Forage Science, 57(3), 203-211.

Ridley, A.M. and Simpson, R.J., 1994. Seasonal development of roots under perennial and annual grass pastures. Aust. J. Agric. Res., 45, 1077-1087.

Sykes, A.R., Griffiths, R.G., Slee, J., 1976. Influence of breed, birth weight and weather on the body temperature of newborn lambs. Anim. Prod. 22:395–402.

Virgona, J. M., Gummer, F. A. J., Angus, J. F. 2006. Effects of grazing on wheat growth, yield, development, water use, and nitrogen use. Aust. J. Agric. Res., 57 (12), 1307-1319.

Walker, S.K., Kleemann, D.O., Bawden, C.S., 2003. Sheep reproduction in Australia. Current status and potential for improvement through flock management and gene discovery. Meat and Livestock Australia and the South Australian Research and Development Institute, Australia.

9 Appendices

9.1 Appendix 1 – Published scientific paper details

Neuroendocrine and physiological regulation of intake with particular reference to domesticated ruminant animals. John R. Roche[1,2*], Dominique Blache[3], Jane K. Kay[1], Dale R. Miller[2], Angela J. Sheahan[1] and David W. Miller[4]. Nutrition Research Reviews (2008), 21, 207–234

[1] DairyNZ Ltd, Hamilton, New Zealand
[2] University of Tasmania, Tasmania, Australia
[3] School of Animal Biology, University of Western Australia, Perth, Western Australia
[4] Murdoch University, Perth, Western Australia

The central nervous system undertakes the homeostatic role of sensing nutrient intake and body reserves, integrating the information, and regulating energy intake and/or energy expenditure. Few tasks regulated by the brain hold greater survival value, particularly important in farmed ruminant species, where the demands of pregnancy, lactation and/or growth are not easily met by often bulky plant-based and sometimes nutrient-sparse diets. Information regarding metabolic state can be transmitted to the appetite control centres of the brain by a diverse array of signals, such as stimulation of the vagus nerve, or metabolic 'feedback' factors derived from the pituitary gland, adipose tissue, stomach/abomasum, intestine, pancreas and/or muscle. These signals act directly on the neurons located in the arcuate nucleus of the medio-basal hypothalamus, a key integration, and hunger (orexigenic) and satiety (anorexigenic) control centre of the brain. Interest in human obesity and associated disorders has fuelled considerable research effort in this area, resulting in increased understanding of chronic and acute factors influencing feed intake. In recent years, research has demonstrated that these results have relevance to animal production, with genetic selection for production found to affect orexigenic hormones, feeding found to reduce the

concentration of acute controllers of orexigenic signals, and exogenous administration of orexigenic hormones (i.e. growth hormone or ghrelin) reportedly increasing DM intake in ruminant animals as well as single-stomached species. The current state of knowledge on factors influencing the hypothalamic orexigenic and anorexigenic control centres is reviewed, particularly as it relates to domesticated ruminant animals, and potential avenues for future research are identified.

Keywords: Neuroendocrine regulation: Intake: Hormones: Ruminants

Miller, D.R., Jackson, R.B., Blache, D., and Roche, J.R., 'Metabolic maturity at birth and neonate lamb survival and growth. I. The effects of maternal low dose dexamethasone treatment as two time points in late gestation', *Proceedings of the Joint Annual Meeting ADSA, CSAS, ASAS 2009*, 12-16 July 2009, Montreal, Quebec, Canada (In Press)

Also submitted for publication as research paper:

Metabolic maturity at birth and neonate lamb survival and growth: The effects of maternal low dose dexamethasone treatment[1]. 2009. D.R. Miller[*2], R.B. Jackson[§], D. Blache[#] and J.R. Roche* [3] Journal of Animal Science.

*** –** Tasmanian Institute of Agricultural Research, Mt Pleasant, TAS, 7250, Australia
[§] **–** Department of Primary Industries and Water, Mt Pleasant, TAS, 7250, Australia
[#] - School of Animal Biology, University of Western Australia, Crawley, WA, 6009, Australia

Perinatal mortality is a major contributing factor to reproductive wastage in grazing sheep industries. Enhanced metabolic and endocrine maturity at birth may improve the behavioral competency and thermoregulatory ability of neonates, potentially improving lamb survival over the first 72 h of life. Maternal glucocorticoid treatment in late gestation was investigated as a mechanism for manipulating metabolic and endocrine maturity in the ovine neonate. Multiparous, fine-wool Merino ewes (n = 150) were divided into 3 groups to lamb on pasture. Within each group, 5 single-lamb and 5 twin-lamb bearing ewes were randomly allocated to one of 5 treatments. Treatments included a saline control (1 ml), or dexamethasone (2 mg/ml as the sodium phosphate) injected intramuscularly at one of two dose rates (1.5 or 3.0 mg) at either Day 130 or Day 141 of gestation. Half of the control ewes were injected at Day 130 and the remainder at Day 141. Dexamethasone treatment had no effect on lamb survival to 72 h after birth, although there tended ($P = 0.09$) to be a lower proportion of lambs dying due to dystocia than for control lambs. Heart girth at birth in both singleton and twin lambs was reduced ($P < 0.01$) at the greater dose rate. Further, treatment also reduced birth weight (by about 5%) and pre-suckling rectal temperatures in twin lambs, but not in singleton lambs. These reductions were also dependent on the sex of the lamb. Dexamethasone treatment did not alter gestation length or lamb pre-suckling plasma glucose, NEFA, urea or leptin concentrations, but treatment at Day 141 increased ($P < 0.05$) ghrelin concentrations in singleton and male lambs. Behavioral interactions between ewes and neonatal lambs were generally unaffected, although treatment at Day 130 produced lambs that took longer to bleat than lambs of untreated ewes ($P < 0.05$). Treatment did not affect the concentration of measured blood metabolites or hormones at weaning. While there were interactions between litter size, lamb sex and the level and time of treatment on weaning weight, liveweight recorded 73 d after weaning was unaffected by treatment. Despite changes in birth weight, rectal temperature, lamb behavior and pre-suckling plasma ghrelin concentrations, survival in the first 72 h of life and lamb growth performance was unaffected by periparturient maternal glucocorticoid treatment.

Key words: behavior, dexamethasone, neonate, maturity, sheep, survival

Miller, D.R., Blache, D., Jackson, R.B., Downie, E., Roche, J.R., 'Metabolic maturity at birth and neonate lamb survival and growth. II. Association among maternal factors, litter type, lamb birth weight, plasma metabolic and endocrine factors, lamb survival and behavior', *Proceedings of the Joint Annual Meeting ADSA, CSAS, ASAS 2009*, 12-16 July 2009, Montreal, Quebec, Canada (In Press)

Also submitted for publication as research paper:

Metabolic maturity at birth and neonate lamb survival: Association among maternal factors, litter size, lamb birth weight, and plasma metabolic and endocrine factors on survival and behavior [1]
2009. D.R. Miller[*2], D. Blache[#], R.B. Jackson[§], E. Downie[*], and J.R. Roche[*3] Journal of Animal Science.

*** –** Tasmanian Institute of Agricultural Research, Mt Pleasant, Tasmania, 7250, Australia
[#] **–** School of Animal Biology, University of Western Australia, Perth, Australia
[§] **–** Department of Primary Industries and Water, Mt Pleasant, Tasmania, 7250, Australia
[3] **–** current address: Animal Science, DairyNZ, Hamilton, 3240, New Zealand

This paper reports an investigation into metabolic and endocrine maturity in the neonate lamb, and the relationships between litter size, birth weight, and ewe nutritional status on behavior at birth and survival over the first 72 h of life. Multiparous, fine-wool Merino ewes (n = 150: equal numbers of single-lamb and twin-lamb bearing status) were lambed on pasture, with dexamethasone treatments applied at d 130 or d 141 of gestation. Stepwise multiple regression analysis was used to investigate relationships between lamb survival, behavior, endocrinology, and physiology. Improved lamb viability at 72 h after birth was related to lower chill indices at birth, singleton litter status, greater pre-suckling rectal temperature, increasing ewe pre-lambing plasma ghrelin concentration, female sex, heavier birth weight, and lower lamb pre-suckling plasma glucose concentrations. Greater rectal temperatures were associated with heavier birth weight and gestation lengths shorter than 146 d, but no relationship with neonatal behavioral progression was evident. Pre-suckling glucose concentrations were greater in singletons and lambs born to ewes of high BCS at d 95 of gestation, and lambs of heavier birth weight, but were also associated with lower rectal temperatures. This might reflect a delay in glucose utilisation during the adjustment from a fetal metabolic rate to a level appropriate for cold external environments. Singleton lambs exhibited lower pre-suckling plasma NEFA concentrations, and were almost 8 times more likely to survive to 72 h than a twin-born lamb. Birth weight was less in lambs born to ewes with high plasma glucose and leptin concentrations prior to lambing, and was positively related to ewe BW at d 95 of gestation and to length of gestation. Greater pre-suckling plasma ghrelin and leptin concentrations were measured for shorter gestation lengths. Neonate pre-suckling ghrelin concentrations above 650 pg/ml tended (P = 0.077) to be associated with improved lamb survival to 72 h. This was consistent with a curvilinear decline in neonate survival rates to 72 h after birth as time latency to suckle increased. No relationships were observed between lamb plasma glucose concentrations and behavioral expression after lambing. Lambs exhibiting greater metabolic and endocrine maturity at birth had improved survival in a cold environment to 72 h after birth. The role of ghrelin in ovine fetal development warrants further investigation.

Key words: behaviour, ghrelin, neonate, maturity, sheep, survival

Miller, D.R., Jackson, R.B., Blache, D., Roche, J.R., 'Metabolic maturity at birth and neonate lamb survival and growth. III. Association among pre-suckling plasma metabolic and endocrine factors and lamb growth to weaning', *Proceedings of the Joint Annual Meeting ADSA, CSAS, ASAS 2009*, 12-16 July 2009, Montreal, Quebec, Canada (In Press)

This study investigated the metabolic and hormonal characteristics of Dorset cross lambs at birth and their relationship to subsequent growth to weaning. Multiparous, fine-wool Merino ewes (60 ± 6.5 kg BW, n = 150) of equal numbers of single and twin-lamb bearing status were untreated, or treated with 1.5 or 3 mg dexamethasone (DEX) at either Day 130 or 141 of gestation (n = 30 ewes per treatment) and lambed over 20 d on ryegrass dominant pastures. A 4 to 5 ml blood sample was collected from lambs prior to suckling (30 min after birth) and plasma analyzed for glucose, BHBA, urea, NEFA, insulin, ghrelin and leptin. Ewes and lambs grazed perennial ryegrass-based pastures and lamb BW, crown to rump length, and heart girth were measured 75 d after the commencement of lambing, which was 3 d before weaning (n= 130). Lambs grazed together for another 69 d on ryegrass pastures, and then for 4 d on a dual-purpose oat crop before final weighing and condition scoring. Data were analysed using stepwise multiple regression analysis where non-significant (P>0.05) independent variables were removed, with final models including DEX treatment, rate and timing of DEX treatment, and their interaction term. After accounting for DEX effects, pre-suckling plasma leptin levels were negatively associated with rate of weight gain to ($P < 0.05$) and BW at ($P < 0.05$) weaning, and BCS at final weighing ($P < 0.01$). Lambs with greater heart girth at birth were heavier and larger at weaning ($P < 0.01$). Presuckling plasma glucose, BHBA, urea, NEFA, insulin, or ghrelin levels were not ($P > 0.05$) associated with growth to weaning or BW at trial completion. In conclusion, these results indicate that birth size and pre-sucking leptin concentrations are associated with subsequent growth rate in lambs.

Key words: dexamethasone, neonate, growth, sheep

Horton, B.[1], Pirlot, K.,[1] and Miller, D.R.[2] 2009. Measurement of sheep temperament based on recording movement within a commercial weighing crate. International Journal of Sheep and Wool Science. (Submitted for publication)

[1] DPIW Tasmania,
[2]Tasmanian Institute of Agricultural Research

This study investigates the development of a practical system for temperament assessment in sheep on-farm using currently available weighing technology. Most commercial livestock scales are capable of recording multiple weights per second, which are normally used to obtain an average weight. The movement of a sheep within a weighing crate can be measured by this continuous liveweight recording system using the coefficient of variation (CV) of the weight measured over 5 to 20 seconds. Calmer sheep were defined as those exhibiting lower CV measurements. The repeatability of these measurements was 0.52 to 0.59 ($p<0.1\%$) in adult sheep, and was increased by greater experience of the weighing process. Movement scores at 6 to 7 months of age were highly repeatable and lamb scores at 7 months were correlated ($P<1\%$) with their dam's score. The calmest sheep exhibited higher liveweight, improved maternal behaviour, and increased lamb survival ($P<5\%$). Additionally, flight speed when the sheep leaves the crate can be measured using two or more detector beams across the race. This requires extra equipment, but does not require holding the sheep in the scale longer than the usual weighing time. This measure is repeatable ($P<0.1\%$) but was not closely related to the weight variation and so appears to measure a different aspect of behaviour. This study has shown that commercial livestock scales are capable of providing a practical temperament score related to sheep liveweight and maternal behaviour at lambing.