MEAT & LIVESTOCK AUSTRALIA

finalreport

Project code: HRZ.200

Prepared by: Angela Avery

CRC Future Farming Industries (DPI Victoria)

Date published: November 2008

ISBN: 9781741914115

PUBLISHED BY

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

EverGraze – More Meat from Perennials

Profitable Animal Production from Perennials III

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

FUTURE FARM
INDUSTRIES CRC

Abstract

ABARE in its December 2007 commodity report predicted a 9% reduction in meat production by 2030, and a 13-19% decrease by 2050. Research, development and extension must provide farmers with options for growth in the face of climatic variability and change as well as protect on-farm and catchment natural assets.

EverGraze is a national research and delivery partnership between the CRC Future Farming Industries (CRC FFI), Meat and Livestock Australia (MLA) and Australian Wool Innovation (AWI). Demonstration sites were also supported by Catchment Management Organisations (CMO's). EverGraze aimed to deliver profitable livestock systems and catchment health from improved (and native[1]) perennial pasture systems in the high rainfall zone (>550 mm) of temperate Australia. The project combined farming systems research, bio-economic modelling, demonstration and extension to achieve this outcome. EverGraze will continue to 2011, this final report reports on the work undertaken from April 2005 to May 2008.

Despite being conducted in a period of unprecedented widespread and continued drought EverGraze has shown the value of perennial pasture species within farming systems at a scale that is of relevance to producers. The Hamilton Proof (research) Site, for example, has provided new benchmarks for meat production of close to 500 kg lamb live weight/ha or 40 kg carcass weight/ha/100mm rainfall and steer backgrounding systems exceeding 800kg live weight/ha with an average 195kg liveweight/ha/100mm annual rainfall without supplementation. EverGraze has placed perennials within farming systems based on land class to not only to increase year-round pasture supply and improved natural resource management but to further increase productivity through innovative livestock management (split joining), increased ovulation rates and lamb survival.

[1] *Note that EverGraze expanded to include Natives in 2006-07*

Executive Summary

EverGraze is a research, development and extension project that aimed to increase profit by 50% and significantly improve natural resource outcomes in the high rainfall (above 550mm) grazing zone of south eastern Australia. Increases in productivity were reflected through increased weaning percentage, changes in seasonal pasture supply and improved pasture utilisation. Since the instigation of EverGraze there has been considerable shift in the need to reduce recharge due to dry seasons.

EverGraze had its strongest presence in regions adjoining the six Proof Sites (Albany, Hamilton, Albury/Wodonga, Wagga, Orange and Tamworth). Our learning's over the two years with the implementation of Supporting Site and extension has highlighted that different approaches are required in different states due to the range of extension services, particularly the interaction between research and extension delivers and consultants. This has been particularly the case in WA.

The primary elements of the EverGraze farming system were perennial pastures (both improved and native), high genetic merit sheep, and matching pastures with soil type and land class. EverGraze measured productivity and environmental aspects of the system and depended on modelling for the development of the farming systems. The project research focus was at the farming system scale integrated with component research and farm to catchment scale modelling (Proof Sites). Adoption focused on demonstration through Supporting Sites and engagement with end-users (agency extension staff, NRM extension staff, Landmark agronomists, private consultants, livestock producers engaged in EverGraze and early adopter livestock producers).The project's practice change focused around regional networks, demonstrations (Support Sites) and extension plans connected into a national practice change program supported by a national awareness program.

EverGraze has demonstrated that perennial pastures established on the appropriate land class and used within a farming system context with high performing livestock have the potential to deliver significant gain for both the farm business and the environment. Due to the dry seasons within which EverGraze has operated we have been able to test the resilience and flexibility of summer-active perennial pastures. Split joining of ewes has been identified as a potential approach to optimise perennial pastures under variable seasonal conditions. The persistence of lucerne and chicory across all Proof Sites has been outstanding as has the persistence of kikuyu at the Albany and Hamilton Proof Sites. The variable persistence of tall fescue (from high performing to total failure) has highlighted the need to match land class within the region for this species. EverGraze has shown that perennials can be used in not only for livestock growth but for strategic roles within the farming system including the increases of ovulation in ewes (10-20% increase) and increased protection of lambs from cold winds. Due to dry seasons we were not able to measure recharge but the summer-active perennial pastures are drying the soil out to at least 3m.

EverGraze has increased the awareness of meat producers of the importance of perennials, sown to the appropriate land class and utilised by high performing livestock. This is evidenced by 4150 contacts being made with producers directly by the Proof Site teams, 400 people receiving the EverGraze Update, 62 media articles, 62 people directly involved in EverGraze Governance, and producer groups involved in the 55 Supporting Sites. We believe we have achieved the estimated t14, 400 producers need to be aware of EverGraze to achieve the EverGraze adoption target.

A new proposal for EverGraze is being finalised with the CRC Future Farming Industries and MLA to continue the EverGraze project. This will continue and value-add the to Improved Proof Sites (Years 1 and 2) providing new data and knowledge to enhance future use of models to predict systems outcomes; to understand the potential of the “best plant, best animal, best place” concept, and to support farming system adoption. The AWI funded 3 "native pasture" based sites and the fifty existing Supporting Sites (MLA - AWI Supporting Sites project) and regional extension from the FFI CRC will be further optimised. Looking towards the future, the EverGraze Proof Sites provide a unique network of farming systems from which we can better understand the impact of climate change.

Contents

1 Background

1.1 The role of livestock in the management of dryland salinity

Most of the dryland farming systems in southern Australia are based on the use of annual crops and pastures or degraded perennial pastures. The environmental sustainability of annual plant systems was questioned as long ago as 1924 when Wood (1924) suggested that replacement of native, perennial vegetation with annual plants was allowing penetration of fresh water into the deep aquifers and causing a rise in saline water tables. Salinity now threatens vast areas of southern Australia and extends up the Murray Darling Basin into Queensland. It has been hypothesized that overcoming dryland salinity will require "landscape change on a scale equivalent to the original advance of European agriculture across Australia" (Cocks 2003).

In the non-saline recharge areas of the landscape, poor use of water allows leakage past the root zone and raises the water table. The use of perennial species that use more water than annuals, is one of the options available in the management of water on-farm and within catchments in the high rainfall zone (550 mm/year) (Ridley and Pannell 2006). The challenge is to achieve adoption of perennial farming systems on sufficient scale to influence water management and salinity without imposing a major economic and social burden on the wider community (Stoneham *et al.* 2003). New perennial based animal grazing systems that achieve significant reductions in recharge over annual systems and increase profitability above current cropping and animal enterprises are needed.

1.2 The high rainfall zone (HRZ)

EverGraze operates in the high rainfall zone (> 550mm/yr) of southern Australia, where approximately 33,000 livestock producers (Allan et al. 2003), carry 33 per cent of Australia's sheep and a significant number of cattle. Pastures cover almost 20m ha, with native and naturalised pastures making up approximately 50% of the area and improved pastures making up the other half. Both improved and 'native' pastures contain complex mixtures of annual and perennial legumes, annual and perennial grasses and all manner of annual and perennial forbs and weeds. Over 70% of graziers report that weeds are a major issue on their farm.

During the early 1990s both naturalised and improved pastures in the EverGraze target region declined in productivity. The reasons cited include reduced fertiliser, poor grazing practices, weed invasion, increasing acidity, rising water tables and poor drought management. The Sustainable Grazing Systems Program targeted improved grazing management in this zone with dramatic increases reported in the number of producers rotationally grazing (21 to 46%), and reductions in those reporting pasture decline (57 to 15% - 60% of producers reported their pastures had improved over the 3 years to May 2001), or those reporting they had no grazing plan (40% to 26%) (Kemp and Dowling 2000).

1.3 A changing context for EverGraze

During the duration of this project April 2005 to June 2008 the national focus on salinity and the need to reduced recharge was overshadowed by drought and declining groundwater levels as evidenced by bore monitoring data. Further to this was the widespread recognition of the need to address climate change and multiple natural resource outcomes. The end result was a declining national emphasis on salinity and recharge.

During this time the Australian Wool Innovation joined the EverGraze project and expanded the projects focus to include native pastures. Native pastures cover a vast area of the high rainfall zone; they make a major contribution to the grazing industries and to biodiversity; they sometimes lack sufficient quality for high producing animals; and they are often threatened by weed invasion and poor grazing practices. Therefore, an obvious way to add value to EverGraze was to expand the focus to include native pastures and combinations, as well as increasing the opportunities for livestock producers to be involved.

Finally, the CRC Plant Based Solutions to Dryland Salinity (CRC Salinity) went through the re-bid process with a re-directed focus on farming systems to deliver profit and NRM change to successfully become the CRC for Future Farming Industries. It is under this CRC that EverGraze will continue for at least the next three years. From this it can be concluded that the initial EverGraze project developed by MLA and the CRC Salinity has been able to adapt to a rapidly changing operating environment and capture opportunities to significantly value-add to the project.

1.4 Target market for EverGraze

EverGraze aims for 3600 livestock producers in the HRZ of Victoria, NSW and WA to have adopted new grazing technologies based on principles and practises developed in EverGraze by June 2010.

The target group of producers are those who want more profitable grazing and livestock systems while improving the NRM outcomes on their farms (Figure 1). Livestock production systems comprise many different components, pastures, grazing management, animal genetics, animal health, marketing etc. Producers may adopt technologies in one area but be less interested in new information in a different part of their production system. It is likely that EverGraze technologies will appeal to producers with an interest in pastures, grazing management, livestock production systems and the balance between NRM and livestock production.

Figure 1. Final and next users for the EverGraze project.

Final Users:
High Rainfall Zone Livestock Producers interested in changing and improving their grazing systems;

Next Users:
People in the HRZ who provide information to Final Users;

• Proof Site teams	= 55
• State agency extension staff	= 20
• NRM extension staff/advisors in priority catchments	= 50
• Landmark pasture agronomists in HRZ	= 50
• Private consultants with grazing/pasture focus (est)	= 30
• Livestock producers involved in EverGraze Supporting Sites and Regional Groups	= 650
• Livestock producers who adopt new information directly from interaction with projects	= 300

Within EverGraze, the EverGraze Regional Groups (ERG's) have a high proportion of members from the Innovator category and Supporting Sites have many people from the Early Adopter group. The target audiences for EverGraze are the Innovators, Early Adopter and Early Majority groups. To get to these people, the EverGraze Extension and Adoption (E&A) plans works closely with the individuals and groups (Next Users) who provide information to these producers. By June 2009, the aim is for 50% of these advisors to be providing information sourced from EverGraze to their clients.

1.5 EverGraze the project

EverGraze is a project with ambitious goals. Where advances in farm productivity and environmental enhancement usually proceed in small steps, EverGraze is aiming for increases of up to 50% in profitability of sheep and cattle enterprises while simultaneously improving the NRM outcomes of improved water management, perenniality, biodiversity and soil health.

To achieve these targets, EverGraze looked at the whole farm system (the pastures, the animals and the management) and how they relate to the catchment – and brought the knowledge and experience of top farmers together with leading researchers in soil science, agronomy, hydrology, animal production, ecology, farming systems and farm economics. EverGraze focused in the following catchments of the high rainfall zone; South Coast and South West (WA); Glenelg-Hopkins and Corangamite (Vic); Murrumbidgee (NSW); Murray (NSW) and North East (Vic); Central West and Lachlan (NSW); and Border Rivers/Gwydir and Namoi (NSW)

The project has completed three phases with Phases I and II focusing on design and consultation and Phase III (this final report) on implementation of component and systems research as well as demonstration and communication. The construct of Phase III has been highly dependent on the previous Phases.

In **Phase I** of EverGraze (formally Profitable Animal Production from Perennials) established a national research team, designed an innovative and targeted approach to address the project aims, undertook consultation with stakeholders in catchments affected by salinity, and selected catchments in which to undertake this research. The assessment of suitable catchments in which to work involved several steps:

- Assessment of the area of land in high rainfall catchments with hydrologically responsive (ie: local) groundwater flow systems and high salt output:input ratios.
- Consultation with catchment management bodies in high rainfall zones of WA, Victoria (Glenelg-Hopkins, Corangamite Catchment Management Authorities) and NSW (Murrumbidgee, Murray Catchment Management Boards) to assess their interest in developing a collaborative research partnership through synergies between their objectives and those of this project. There was strong interest and willingness from all catchment groups visited to engage in a partnership with this project.
- Consideration of the capacity of CRC Salinity staff to service a research site.
- Assessment of the capacity of producers to embrace change and the enthusiasm of groups to undertake collaborative research.

In **Phase II** meat production systems that have the potential to achieve profitability and recharge targets were identified by designing farm scenarios for different perennial-based pasture systems (currently used; new but available- best practice stretch; hypothetical -pasture/tree to best achieve the goal) for each catchment (further detail is provided in sub-section 1.6). The design process involved consultation with key stakeholders in the catchment to determine the scenarios. The scenarios were used as inputs into two linked modelling processes:

- MIDAS; a farming system model that allows component testing to achieve the optimal systems in terms of profit.
- A paddock scale hydrological model that explores interactions between climate, soil and land use to determine the deep drainage and runoff from different farming systems.

The models were linked through input data (ie pasture growth curves) and collectively provided new farming systems that have the potential to achieve profit and recharge targets. The stakeholder groups in each catchment assisted by reviewing these farming systems for 'realism' and 'feasibility'. Changes were suggested and addressed in re-modelling processes. From this, key research priorities and innovative farming systems were identified for Phase III. These were further reviewed in a workshop of leading researchers, follow-up meetings and reviews with livestock scientists, researchers in the pilot catchments, MLA and catchment management and industry groups as well as individual farmers.

Initially **Phase III (a)** consisted of 3 large, systems-based research sites that had the challenging targets of a 50% increase in profit, and a 50% reduction in groundwater recharge, compared to current best practice. The sites are located near Albany, Hamilton and Wagga Wagga and all are targeting high performance systems with 150% weaning and lamb growth rates of 200g/d. In the south-west of WA, annual pasture systems use insufficient water to prevent the spread of dryland salinity, as well as exacerbating other soil degradation processes such as acidification, water repellency, and wind erosion.

In June 2006 **Phase III (b)** was commenced with the addition of three native research sites at Albury/ Wodonga, Orange and Tamworth. These sites under funded through a separate AWI contract but must be considered as part of the EverGraze project. Table 1 provides a brief overview of each of the six Proof Sites.

Phase IV of EverGraze is currently being finalised with the CRC FFI and MLA; this phase completes and value-adds to work from Phase III that was not able to be finalised due to the extended drought conditions and further develops, integrates and extends EverGraze farming systems.

This report should be considered as an "interim" final report as work is continuing with EverGraze. The report focuses on the activities and outcomes of Phase III (a) of EverGraze.

Table 1. Summary of the EverGraze Proof Sites

Albany (WA)	• Reducing recharge through the use of summer active sub tropical grasses (kikuyu, setaria) and temperate perennials (lucerne, tall fescue, chicory) • Productivity of dual purpose wool:meat merinos • Productivity of a wide range of summer and winter active pasture species
Hamilton (Vic)	• Reducing recharge and improving soil health through the use of summer active perennials (tall fescue, perennial ryegrass, lucerne, chicory and kikuyu) • Testing the use of "maternity wards" with tall wheat grass hedges to reduce mortality of twin lambs • Profitability of twin lamb systems compared to single lambing merinos
Wagga Wagga (NSW)	• Recharge control of summer active pastures (lucerne, chicory) and woody perennials • Using shrubs to provide shelter during lambing • Using summer active perennials to increase ovulation rates
Albury/Wodonga (NSW/Vic)	• Effects of grazing management and fertiliser inputs on pasture and animal productivity and NRM outcomes (ground cover, perenniality, recharge) of native pastures • Grazing management to increase native perennial grasses
Orange (NSW)	• Assessing the effect of Low, Medium and High intensity grazing of native pasture systems on animal production and NRM outcomes specifically, perenniality, biodiversity, ground water recharge and soil health.
Tamworth (NSW)	• Determining the most appropriate proportions of native and sown pastures for different land classes • Researching the value of lucerne mixtures to enhance productivity and NRM outcomes • Assessing the relationship between production and biodiversity and developing monitoring tools for farmers

1.6 Pre-experimental modelling

EverGraze provided an innovative approach to the development of profitable new farming systems to facilitate land use change in the high rainfall zone. In the initial phases of the project integrated bio-economic and hydrological modelling (Sanford and Young 2005). This analysis provides the basis for the experimental work undertaken in EverGraze.

Information was gathered from innovative farmers and researchers in two study catchments (Albany Eastern Hinterland, WA and Glenelg Hopkins, Vic). In particular, the potential for including more or different perennial species was explored. For the catchments a hypothetical (typical) farm was designed at the biophysical level. This included climate, soil types (texture and depth to B horizon) and farm size (Table 1). MIDAS (Morrison *et al.* 1986) and the Catchment Assessment Tool (CAT) (Beverly *et al*. 2005) were then used to analyse aspects of the farms to ascertain which farming systems are most likely to increase profit and reduce recharge. The models were linked via an exchange of pasture curves and paddock management protocols, the new options generated influenced both the amount and location of perennials on the farm (Table 2).

Table 2. Description and area of the hypothetical farm in the study catchments.

Study Catchment	Land management unit	Area (ha)	2 Farming Systems		
			Current	Improved	Future
Albany Eastern Hinterland	Deep sands	760	Annuals	[1]Ann, [2]Luc^{A}, Kik	Ann, Luc^{A}, [3]Kik, [4]Fes
	Waterlogging prone duplex	260	Annuals	Ann, Kik	Ann, Kik, Fes
	Medium depth and plain duplex	980	Annuals	Ann, Luc[1]	Ann, Luc[1], Fes
Glenelg Hopkins	Ridges	200	[5]PRG/annuals	[6]High PRG	[7]Luc^{B}
	Mid slopes	600	PRG/annuals	High PRG	High PRG
	Flats	200	PRG/annuals	High PRG	Fes

[1]Ann = annual pasture: sub-clover based annual pasture with volunteer grasses and herbs.
[2]Luc^{A} = lucerne: a mono-culture of lucerne grown in rotation with crops.
[3]Kik = kikuyu: a mixture of kikuyu and sub-clover.
[4]Fes = tall fescue: a mixture of summer active temperate perennial grass and sub-clover.
[5]PRG/annuals = perennial ryegrass: a mixture of sown perennial ryegrass and sub-clover but with ~ 50% annual grasses.
[6]High PRG = perennial ryegrass; a mixture of highly productive perennial ryegrass and sub clover with high fertiliser, <20 % annual grasses.
[7]Luc^{B} = lucerne: a mono-culture of lucerne

Optimum strategies for farms in the two study catchments are provided in Table 2 and 3. In the Albany Eastern Hinterlands the optimum management for the ‘current’ specialist wool producer with only annual pastures carried 8.1 DSE/ha and used 18.5 kg of supplement per DSE to a flock with 43% ewes and 34% wethers. Including the options of kikuyu and lucerne (‘improved’ system Table 3) substantially increased profit, with the optimum system predicted to be 45% kikuyu, no lucerne and 25% of the farm as annual pastures with a farm stocking rate of 10.7 DSE /winter grazed (WG) ha. Including the option of growing tall fescue in the ‘future’ farming system reduced the area of both annual pasture and kikuyu. The greater profitability of the tall fescue was driven by its high growth rates during winter and spring with only a small reduction in quality during summer/autumn. The total area of perennials selected in the ‘future’ farming system increased from 47% to 67%. Leakage below the root zone decreased by at least 45% (21mm) when any of the perennial systems replaced the ‘current’ pasture system. Implementation of the ‘future’ system provided a further small decrease in recharge. The meat Merino enterprise was more profitable than the specialist wool flock for each of the farm systems however the difference was greatest for the higher production ‘future’ system. This indicates that high quality perennials are most profitably utilised for meat production rather than wool.

Table 3. Production and management parameters for the improved pasture and livestock systems in the Albany Eastern Hinterland.

	Farm system			
	Merino flock[1]			Meat Merino[2]
	Current	Improved	Future	Future
Profit ($/ha.yr)	10	40	43	82
Stocking rate (DSE/WG ha)	8.1	10.7	10.1	12.0
Supplementary feed (kg/DSE)	18.5	8.3	6.9	8.4
Flock structure (% ewes)	43	45	72	87
Weaning (%)	87	92	92	92
Crop (% of farm)	30	30	30	30
Annual pasture (% of farm)	70	25	19	3
Kikuyu (% or farm)	0	45	16	21
Lucerne (% of farm)	0	0	0	0
Fescue (% of farm)	0	0	35	46
Pasture growth (t/ha)	6.6	7.0	7.2	7.5
Pasture utilisation (%)	35	46	47	50
Wool income ($/ha)	148	193	163	189
Sheep sales ($/ha)	42	60	95	189
Leakage below the root zone (mm/yr)	67	46	42	45

[1] Stocking rate (DSE/WG ha) assumes ewes are 1.5 DSE/hd and dry sheep 1 DSE/hd.
[2] Surplus ewes not needed to maintain the flock are mated to a terminal sire.

In the Glenelg Hopkins catchment, the optimum management identified by modelling for the ‘current’ system (Table 4) with moderately productive perennial ryegrass/annual clover and grass pastures carried 12.9 DSE/ha and used 30 kg of supplement per DSE to a flock with 52% ewes and 24% wethers. This system generated a net profit of $100/ha. Upgrading the pasture to highly productive perennial ryegrass increased profit by $163/ha. This was achieved by increasing stocking rate to 24 DSE/ha and increasing supplementary feeding to 39 kg/DSE. The ‘triple’ pasture system (tall fescue on the flats, perennial ryegrass the mid slopes and lucerne on the ridge) was not as profitable as the ‘improved’ (highly productive perennial ryegrass) but still generated $226/ha or $126/ha more that the ‘current’ pasture. The stocking rate was 22.3 DSE/ha and the level of supplementary feeding unchanged at 39 kg/DSE. Switching to the ‘meat Merino’ production system with a focus on meat production and with surplus ewes mated to a terminal sire increased profit by $72/ha, $146/ha and $171/ha in the ‘current’ ryegrass, the ‘improved’ ryegrass and the ‘triple’ systems respectively. The results for this comparison are shown in Table 3 and indicate that to get the most out of the triple pasture system, the animal system needs to be responsive to improved pasture quality and summer/autumn production. This is most likely to occur in a meat/wool system with high fertility ewes. Leakage was highest under the ‘current’ pasture system at 130 mm/yr. The ‘high’ production perennial ryegrass reduced leakage by 9 mm to 121 mm/yr. The ‘triple’ pasture system with 20% of the farm under lucerne and 20% under tall fescue reduced leakage by 32 mm compared to the ‘current’ system.

Table 4. Production and management parameters for the improved pasture and livestock systems in the Glenelg Hopkins catchment.

	Farm system			
	Merino flock[1]		Meat Merino[2]	
	Current	Improved High PRG	Future Triple[3]	Future Triple[3]
Profit ($/ha.yr)	100	263	226	397
Stocking rate (DSE/WG ha)	12.9	21.6	20.1	22.7
Supplementary feeding (kg/DSE)	30	39	39	52
Flock structure (% ewes)	52	52	52	85
Weaning (%)	71	71	71	122
Perennial ryegrass (% of farm)	100	100	60	60
Lucerne (% of farm)	0	0	20	20
Fescue (% of farm)	0	0	20	20
Pasture growth (t/ha)	9.0	12.4	11.8	13.1
Pasture utilisation (%)	52	61	59	59
Wool income ($/ha)	451	757	705	529
Sheep sales ($/ha)	69	118	108	458
Leakage below the root zone (mm/yr)	130	121	98	98

[1] Stocking rate (DSE/WG ha) assumes ewes are 1.5 DSE/hd and dry sheep 1 DSE/hd.
[2] Surplus ewes not needed to maintain the flock are mated to a terminal sire.
[3] Triple = tall fescue on flat, perennial ryegrass on the mid slopes and lucerne on the ridges

In summary, modelling has indicated that in high rainfall landscapes there are several livestock-based farming systems with the potential to deliver significant profit and hydrological improvements. In both study catchments meat production systems provide the greatest opportunity to improve profitability from summer-active perennial pastures. Profits were significantly influenced by weaning rates and lamb growth indicating that research and management to increase multiple ovulations, lamb survival (using nutrition and shelter) and the provision of adequate nutrition to allow lamb growth of 200 g/day from birth to weaning are priorities. Also in these catchments predicted groundwater recharge was reduced by 9-32 mm/yr by the increased use of perennial pastures.

2 Project Objectives

2.1 EverGraze Objectives

By 30 May 2008, to have designed, researched and validated new livestock production systems in high rainfall recharge zones that achieve the dual outcome of:

- A reduction in recharge by 50% (or an appropriate amount for the region) over current farming systems and;
- An increase in profitability by 50% above current best practice animal enterprises.

2.2 EverGraze expanded outcomes

The objectives of EverGraze were changed midway through this contract with the expansion of the project to include partnering with AWI and the inclusion of native perennials. The NRM objective was broaden to move the focus from recharge and to include perennial grass diversity, ground cover and biodiversity.

When the initial objectives of EverGraze are combined with additional AWI/CRC FFI objectives the outcomes for the expanded EverGraze project become:

1. Proof (at whole farm scale) that livestock production systems in the high rainfall zone, based on native pastures, sown pastures or combinations, can be 50% more profitable, while at the same time delivering significant improvements in regionally important NRM indicators;
2. The adoption/uptake by livestock producer of EverGraze recommended practices on a wide scale across the high rainfall zone (Target of 3,600 properties adopting by 2010);
3. Positive, active partnerships between Agencies, CMA's and the R&D Corporations, that can combine the research and information products from industry R&D, with the ability of CMA's to provided financial incentives to underpin practice change.

3 Methodology

3.1 Overview

The components that underpin EverGraze and contributed to its success across the high rainfall zone include (Figure 2 provides a diagrammatic representation of the EverGraze project):

- Component 1 - Proof Sites. The improvements at Proof sites have been achieved through the implementation of technologies that combine increased pasture production, and/or better utilisation, and/or improved management, and/or more productive animals, matched to land class to achieve the profit and NRM goals. There are six Proof Sites three improved and three native (Table 1). In addition to the farming system research each Proof Site we have conducted component research to further increase productivity and/ or NRM outcomes. This component research included increasing winter feed from summer active perennial pastures, ecology of tall fescue, hedge and shrub rows to improve lamb survival, the use of break-of-slope shrubs to manage recharge and the use of perennials to increase ovulation rates. Two desk top studies relating to improved livestock production (Early joining and Accelerated Lambing have also been undertaken.
- Component 2 - Supporting Sites. Supporting Sites are local trials or demonstrations where producer groups have implemented a sub-set of the technologies being applied at the Proof sites – ie. farmers showing other farmers what can be achieved and demonstrating the scale profitability and NRM outcomes that are possible within commercial farming operations. These Supporting Sites form part of a coordinated network aimed at achieving change by target audience. Supporting Sites are generally aligned in CMA regions adjoining the Proof Sites.
- Component 3 - Extension. Extension is based on regionally specific extension and delivery plans that link to the national extension plan that has the target of adoption of EverGraze principles and practices on 3,600 farms. These Plans align with the CRC FFI Adoption and Commercialisation Plan and therefore the CRC FFI business plan. EverGraze has been extremely successful in attracting additional resources in the last 12 months which has allowed for the development and implementation of a nationally coordinated extension program.
- Component 4 - Building Partnerships. EverGraze is been able to build on partnerships between R&D Corporations, Government Agencies and CMAs for active collaboration in co-planning, co-investment and in sharing information and delivery networks. MLA and the CRC FFI have been very supportive in this area of the project.
- Component 5 - Project Coordination Activities. These activities have been required to provide governance, coordination, communication and monitoring and evaluation.

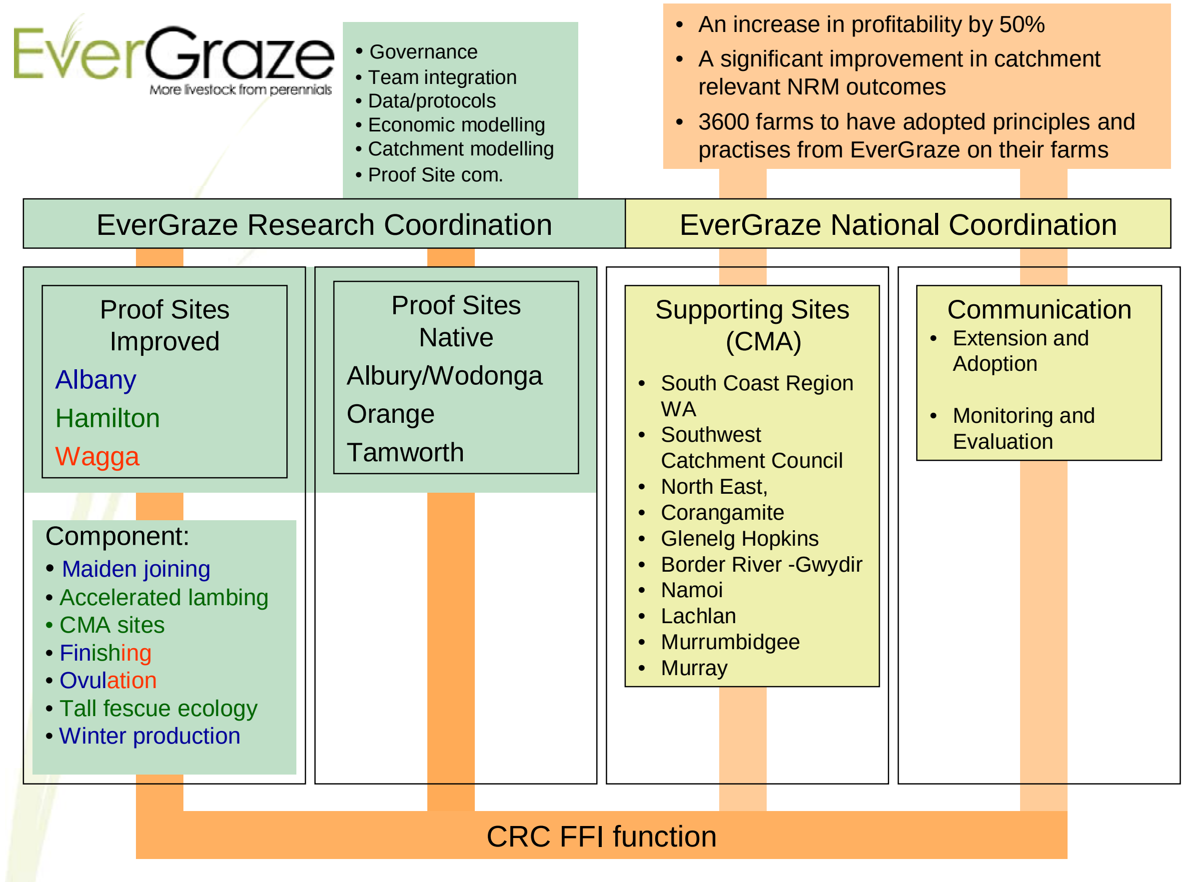


Figure 2. Diagrammatic representation of the EverGraze project

3.2 National methodology

3.2.1 Governance

EverGraze was governed through a National Advisory Committee (NAC) with producer and investor stakeholder representatives. This group had established terms of reference and met at least twice per year to advice on project decisions at a strategic and National level. The NAC provided strong advocacy for EverGraze over the last three years. Regional EverGraze Groups (ERG) were established around each of the Proof Sites and had producer, CMO and Landmark representatives. The ERG's provided regional strategic input into the Proof Sites and their role expanded to include the selection of Supporting Sites and advice on regional extension plans. Collectively the NAC and the ERG's form the basis for the next-users in the EverGraze adoption plans.

3.2.2 Coordination and management

EverGraze had a Research Leader (ERL) and a National Coordinator (NEC) who worked together across the high rainfall zone, five agencies, and throughout the multidisciplinary research to adoption continuum to deliver the project. Regular teleconferences and annual whole-of-team meetings were important to keep the project on-track. At the start of EverGraze a measurement protocol was developed to ensure consistent data collection across the Proof Sites and to ensure that the data would support the development of new parameters for modelling and enable farm and catchment modelling and validation. The SGS database was modified to collect EverGraze data and Proof Site team training was conducted. Other cross-site activities included technical officer exchanges, finishing, modelling and extension workshops.

EverGraze reported every six months to CRC FFI and MLA. These reports were based on an annual operation plan that was developed and endorsed by the NAC.

3.2.3 Communication and adoption

A national approach was taken to the promotion of the project and the communication of the findings. A distinctive EverGraze brand has been developed and is well recognised. This is used in conjunction with standard presentation templates etc. Good adherence to style has been achieved with the project and partnering organisations.

Delivery of communication, adoption and commercialisation was through the Extension and Adoption Plans (National and Regional) and the Communication Plan. EverGraze awareness (communication) was delivered through the communication plan. The EverGraze Research Leader (ERL), National EverGraze Coordinator (NEC) and the CRC employed communication officer were responsible for the development and implementation of the plan. Each year an annual operation was developed and approved by the NAC. All research and extension project members contributed to the delivery of the annual communication operational plan. The communication plan is based on achieving profit simultaneously with NRM outcomes. It is estimated that 14,400 producers need to be aware of EverGraze to achieve the adoption target of adoption on 3,600 farms by 2010. In summary the work included representing EverGraze in a range of forums, development of brochures and fact sheets, quality assurance, scientific publications, contribution to the EverGraze Updates well as and maintaining contact database.

The adoption (extension) plan was delivered through regional and national EverGraze Adoption plans. The NEC was responsible for the development and implementation of the regional and national plans. As with the communication plan annual operational national and regional adoption plans were approved by the NAC. All research and extension project members contributed to the delivery of the annual operational adoption plans. It is estimated that 7,200 producers need to participate in EverGraze events to achieve the adoption target of change on 3,600 farms by 2010.

3.2.4 Monitoring and evaluation

Monitoring and evaluation is completed in alignment with the Monitoring and Evaluation plans developed and delivered through the National EverGraze Coordinator. Specific activities included:

- Reporting templates to collect information about publications, activities and outputs,
- Achievement of milestones against targets,
- Collection of information about attendees at events (User group, contact details, involvement in EverGraze activities),
- Feedback sheets to determine immediate reactions of attendees at EverGraze events,
- Collation of information pertaining to professional development and KASA change in the project team (National Advisory Committee, EverGraze Regional Groups, Proof Site Teams,
- Surveys of livestock producers and Next Users,
- Modelling the impacts of EverGraze on profits and NRM outcomes,
- Collation of information pertaining to stakeholder opinion of EverGraze,
- Evidence from Next Users on how EverGraze results have been incorporated into their extension material.

3.2.5 Farm economic and catchment modelling

The EverGraze project used bio-economic modelling (CAT/MIDAS/Grassgro(SGS)) to further understand the systems and to support management decisions at each of the sites. Strong relationships have been established with the Whole Farm Systems Analysis project through site leader interaction and modeller interaction.

Economic modelling: Economic modelling accounts for spatial interactions on farm, mainly in relation to the supply and demand for feed. The marginal value of feed varies greatly throughout the year, and pasture species and the rotation of livestock between paddocks can influence pattern of supply. Therefore the profitability of changing the management of a livestock enterprise must be considered on a whole-farm basis. MIDAS is a modelling approach that determines the impact of changes to the system, such as the introduction of new technology, on farm profit. The farm strategy that maximises whole farm profit can be determined, given the change in the farming system. While MIDAS has strengths in evaluation of strategic management options it also has limitations, particularly in assessing the profitability of tactical management options that farmers may pursue in response to specific seasonal conditions. MIDAS models the interactions between enterprises both within and between seasons (average) at the whole farm level. The pasture and livestock sub-matrices describe 10-12 periods (depending on the version) of different growth rates/availability and quality from a range feed of sources for up to 8 land management units. MIDAS provides a comprehensive output, optimising flock structure, stocking rate and pasture/crop sequence for each Land Management Unit. Information is also provided on the best mix of feed sources for each period and growth rates for different LMUs.

Farming systems modelling: One-dimensional models (PERFECT and GrassGro) were used to develop pasture curves for the different biophysical environments under consideration. We have continued to improve parameter sets and further validate available models. The model developed has the capacity to estimate deep drainage under crops as well as pasture systems. It provides estimates of the water balance (interception, transpiration, evaporation, deep drainage, runoff and soil water), production (total green, total tops) and feed management (supplementary feed requirement) for various grazing enterprises (including fixed and tactical rotation strategies) and environmental conditions.

Catchment scale hydrological modelling: The catchment-modelling framework brings together one-dimensional farming systems models (as discussed above) and tree based models (eg 3PG) with various landscape components. These models are connected in a spatial framework where the size of the landscape unit can be varied, depending upon the fineness of scale of data layers, such as soils, topography and existing vegetation. Furthermore land units are connected to streams and also there is connectivity between the one-dimensional farming systems and tree models and the groundwater system. As such, the input data and functionality were consistent between these different modelling activities. The catchment model estimates the likely impacts of landscape and land management change on catchment water yield, sediment loss, saltload and area of salinisation – subject to availability of available data layers. It is the 50% reduction in recharge at the catchment scale that will be the ultimate test of whether particular animal production system are to be of benefit in reducing recharge.

Model linkage: Linkage between MIDAS and the farm-scale hydrological model is via cross exchange of pasture curves along with paddock management overlays. The linkages between the 3 models are shown in Figure 3.

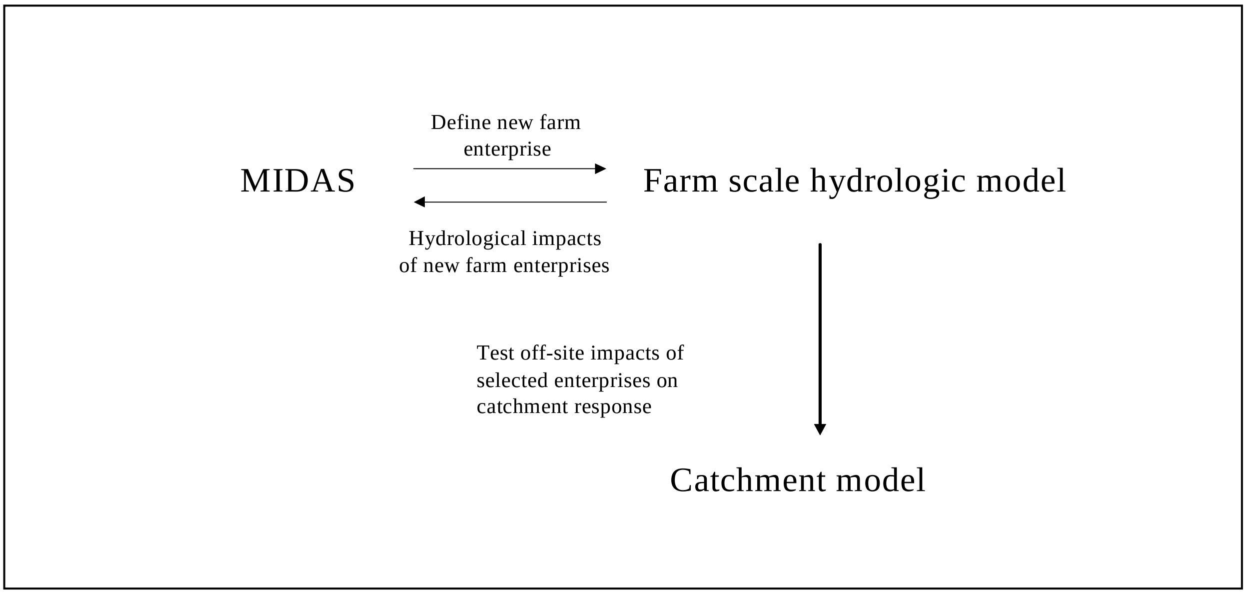


Figure 3. Linkage between modelling activity

Drought throughout the Phase III of EverGraze has limited the ability of EverGraze to undertaken the complete modelling methodology due to little or no recharge being generated from any of the Proof Sites and due to two years of extreme seasonal conditions not providing data from which to validate the models. Modelling activities, both at the farm (bio-physical and economic) and catchment, have been carried forward into Phase IV of EverGraze.

3.2.6 High performance pastures and livestock production

EverGraze focussed on the “right plant, right place, right purpose” principle and this was consistently applied across the Sites. An important aspect of the methodology was the ability of the Proof sites in the different regions to use summer-active deep-rooted perennial pastures to reduce recharge and maintain perennial ground cover. As expected farming systems with increased summer-active perennials quickly become limited by winter pasture growth and stocking rates. Through modelling tall fescue was identified as a species that grew in summer as well as providing winter feed. All Proof Sites therefore had a significant part of the farming system sown to tall fescue. Lucerne and chicory were other summer-active perennials that were consistently used across all sites to achieve the profit and NRM targets.

Consistency in livestock production across the Proof Sites was also important to achieve the profit targets of the project. Base on the modelling conducted in Phase II the high performance lamb production system needed to achieved at least 150% weaning and lamb growth rates of 200g/d. To achieve this, a tender was let through MLA to supply high performance ewes to the EverGraze project. This resulted in the Southern Proof Sites using Centre Plus and the Albany Proof Site using Merinotech. Ram with similar EBVs for growth and muscling were used across all Proof Sites. The Hamilton Proof Site included Tolan ewes to provide further genetic comparison.

3.3 Proof site methodology

3.3.1 Albany

Objectives:

- Establish the Perennial Based Lamb Production System on a farm in the AEH
- Through a combination of monitoring and modelling provide evidence that the Perennial Based Lamb Production System is 50% more profitable and reduces groundwater recharge by 50%. Note: for comparison the water-use of an annual pasture will be determined on a adjoining pasture
- Support farmer adoption of Perennial Based Lamb Production System both in the AEH and the south coast
- Use the data collected to model the impact that the Perennial Based Lamb Production System would have on the hydrology of the AEH catchment if adopted widely
- Extend the research findings to farmers, development officers and researchers state-wide and nationally

Proof Site description/ methodology:

The Albany Proof Site team undertook the following activities; 60 ha Proof Site that investigated high performance lamb production system; component research on increasing winter production and ovulation and a desktop/ modelling study on early joining. In addition to this they managed the site ERG and supported communication and extension activities.

Comprehensive EverGraze pre-experimental modelling suggested that a Merino prime lamb production system based on summer-active perennials and high-performance meat genetics could substantially increase profit while reducing groundwater recharge. The Albany systems experiment was a demonstration of the model output with some modification. In 2005 a 60 ha site was chosen in the target catchment of Albany Eastern Hinterland.

The site was characterised including the use of historical air photos obtained, paddock history incomplete, EM38 survey, soil mapping and soil pit descriptions physical analysis and chemical analysis and pasture species allocated to the most appropriate land class. Pasture establishment was completed by November 2005. The lucerne had to be sown again in early October due to slow and patchy germination. All pastures established well including tall fescue, chicory and the lucerne. The Albany EverGraze farming system was sown to tall fescue (16 ha, 8 paddocks), lucerne (8 ha, 4 paddocks), kikuyu (18 ha, 2 paddocks), setaria/panic (3 ha, 1 paddock) and chicory (15 ha, 4 paddocks) in spring. In February 2006 Merinotech ewes were delivered to the site and joined to Poll Dorset rams in March. Measurements commenced in early 2006 and comprise of frequent assessment of pasture, livestock and water based on the EverGraze Protocol. Annual pasture was also assessed for comparison.

Initial stocking rate aim for the Albany site was 12 dse/ha. Ewes were be mated to terminal sires over a three to five week period in February for a July lambing. Lambs were sold out of the system at either 40 kg liveweight or 7 months of age whichever occurs first. Lucerne and tall fescue were rotationally grazed under a four-paddock rotation but drought conditions disrupted planned grazing plans and ewes were feedlot for extended periods in spring, summer and autumn. Livestock was managed under best management practice. In February 2008 the area of the demonstration was reduced to 30ha and 9 plots primarily as a consequence of the loss of tall fescue. The new configuration preserves the original design with respect to pasture types.

Component Research:

Winter Production: Pre-experimental MIDAS modelling identified the need to increase winter pasture production of all pastures by around 27% to meet the 50:50 profit and recharge target. Improved winter production is required as a higher proportion of the ‘future’ farm is under summer-active perennials leading to winter pasture availability constraining livestock production. Unfortunately solutions need to be low cost, so for example tactical N application to grassy pasture is not an option as the cost is similar to the additional profit. A range of options were tested to meet this goal. Perennial grasses were established in Spring 2005 and a range of annual grasses were oversown in autumn. Lucerne/oats and kikuyu/subclover/ryegrass are just two examples of the 43 treatments in the trial. The trial is situated in a 600 mm rainfall environment, plots are 13 m wide and 20 m long, the 6 ha trial is crash grazed for 1 or 2 days by sheep and pasture regrowth measured for between 4 to 6 weeks before the next grazing. The perennial species were established in spring 2005 and the annual species in July 2006.

Ovulation: The aim of this study was to investigate the effects of grazing green kikuyu pastures on Merino ovulation rates in February/March compared to dry subterranean based pasture with and without lupins. The objective was to produce more prime lambs through increased ovulation rate using high water-use perennial pastures. Unfortunately it was not possible to run this experiment in 2007 as the kikuyu plot had no green feed available due to the drought and 2 separate defoliations by locusts. Alternative sites were investigated however all farmers contacted had insufficient feed and could not provide a suitable area without compromising the nutrition of their own stock. Approval has been given to repeat this study in 2008 within the original WA budget.

Desktop study – joining at 7 months of age: A genuine research issue is how to manage high growth rates in ewe lambs so they can be mated at 7 months, and then quantify the impact on embryo survival. There is data (UK and now in NZ) that suggest fast-growing young sheep partition energy to themselves for growth rather than to the pregnant uterus, and hence embryo survival and lamb development can be compromised. A literature review was carried out to determine the physiological constraints to joining ewe lambs at seven months of age; this focused on the interactions between liveweight, condition score and sexual maturity. It also considered factors such as the ewe's prior experience with rams. Modelling was undertaken to explore the feasibility of this tactic in the HRZ of WA, Vic and NSW from an economics, production and systems perspective.

3.3.2 Hamilton

Objectives:

To develop and demonstrate pasture based livestock production systems that reduce recharge by 50% and increase profitability by 50% compared to current systems.

Proof Site description/ methodology:

The Hamilton Proof Site team undertook the following activities; 70 ha Proof Site that investigated high performance lamb production system (including CentrePlus: Tolan comparison); desktop/ modelling study on accelerated lambing; PhD on tall fescue ecology. In addition they managed the site ERG and supported communication and extension activities.

The Hamilton EverGraze systems experiment was established from spring 2004 when summer active perennials (kikuyu, tall fescue, Lucerne, chicory) were sown through autumn 2005 temperate perennials (perennial ryegrass, Italian ryegrass, over sown sub clover) were drilled. The Proof Site was based on basalt soil. The 70 ha site was established by separating the area into different land classes, crest (well drained), slopes (moderate drainage) and flats (poor drainage) and subdividing the land within each land class into 1 ha plots. One plot (total 3 ha) of each land type made up a "system" area. The site was stocked with experimental ewes in February 2006 and steer treatments started in April 2006. The area used for the experiment is split into well-drained crests, slopes and poorly drained clay flats. The experiment consists of three pasture treatments, and all pastures have been sown with a mix of white and sub clover.

- Perennial ryegrass; Fitzroy, Avalon, Banquet sown on separate areas of crest, slope and flats respectively.
- Triple pasture system; Lucerne, Avalon plus N fertiliser, Tall Fescue on separate areas of crest, slope and flats respectively.
- Novel pasture system; Chicory, Italian ryegrass, Kikuyu on separate areas of crest, slope and flats respectively.

To study the interactions between pasture type and animal requirements, merino ewes carrying either 100% or 200% lambs were allocated to the pasture treatments in mid June each year, following mating in April. Pasture targets at different times of the year were set, with twin lambing ewes managed to a higher condition score and with higher pasture availability pre lambing than single bearing ewes. Hence the pastures were grazed by three animal systems.

- Single lambing ewes; ewes scanned to be carrying one lamb allocated to the plots in June and remain on these pastures for the next 12 months.
- Twin lambing ewes; ewes scanned to be carrying twins allocated to plots and remain for the following 12 months.

These two treatments allow consideration of potential new animal production systems (high fertility flocks) with the current farming practice. For example, is moving to a flock where most ewes have twins good for profits and the environment compared to current practice?

- Steers are grazed on the Ryegrass and Triple pasture systems from March to January. This treatment is designed to allow a comparison of the impact of cattle vs. sheep grazing on the different pasture types.

Table 5. shows the current treatment design and matrix applied across the experimental site at Hamilton.

Table 5. Treatment matrix for the experimental site at DPI Hamilton in 2007.

No	Pasture treatment / System	Animal Type	Proposed Weaning %	Soil type and pasture species		
				Gravel (Crest)	Loam (Slope)	Clay (Valley)
1	Perennial Ryegrass	Single Ewes	90	PRG Fitzroy	PRG Avalon	PRG Banquet
2	Perennial Ryegrass	Twin Ewes	>150	PRG Fitzroy	PRG Avalon	PRG Banquet
3	Triple	Single Ewes	90	Lucerne SARDI 7	PRG + N Avalon	Tall fescue Quantum MP
4	Triple	Twin Ewes	>150	Lucerne SARDI 7	PRG + N Avalon	Tall fescue Quantum MP
5	Perennial Ryegrass	Steers	NA	PRG Fitzroy	PRG Avalon	PRG Banquet
6	Triple	Steers	NA	Lucerne SARDI 7	PRG + N Avalon	Tall fescue Quantum MP
7	Novel	Single Ewes	90	Chicory Puna II	Italian RG Feast II	Kikuyu Whittet

It is possible to feed and manage merino ewes to achieve high ovulation and conception rates. However, around 50% of merino twin lambs born in western Victoria die from exposure within 48 hours of birth. Also, the hydrological modelling has shown that it is difficult to meet the recharge targets even with TPS, mainly due to low water use on the mid-slopes sown to ryegrass. Use of a shrub or some other 1-2m hedge plant to reduce wind speed and hence lamb survival and also increase water use.

Pastures were initially stocked with Merino ewes of high genetic merit at stocking rates 12-15 ewes/ha, depending on how well pastures established. The carrying capacity of the different pasture systems is an outcome of the experiment. Each month, feed on offer (FOO) is determined and the number of stock in a paddock is adjusted if necessary to ensure that the average FOO on all systems is similar and aligned with achieving condition score targets set based on the Lifetime Wool project. Ewes were mated to terminal sires over a three to five week period in April for a late September lambing. Ewes were scanned during pregnancy to separate twin-bearers from single-bearers, and early lambers from late lambers. Twin-bearers were transferred into treatments 2 and 4. When summer pasture was insufficient for growth, lambs were finished in a feedlot and sold at either 40 kg liveweight or 7 months of age whichever occurs first.

All pastures were rotational grazed. A four-paddock rotation was implemented initially within any pasture type; however the number of cells in the rotation may increase if this system failed to provide adequate periods of rest. Each group of animals grazed across the different land classes to optimise productivity and water use.

Component Research:

Ecology and persistence of summer active tall fescue pastures: Tall fescue has potential to reduce recharge in the wetter parts of the landscape in western Victoria. However, farmers are reluctant to use tall fescue as there is limited information on the grazing management required to ensure persistence and performance, especially of the new summer active cultivars. Basic research was required to understand how fescue grows and survives and the management practices that will enhance its persistence and contribution to the grazed pasture. There is ability to alter the time and frequency of grazing tall fescue to improve persistence of the species. A PhD student (Maggie Raeside) was engaged to work on this module of the project at Hamilton. The research involved monitoring the persistence, contribution to the pasture, number of tillers and tiller survival, rooting depth and water use of the tall fescue within the Research Site. In addition, small plots were established within the Research Site to implement additional grazing treatments, including complete seasonal rests.

Demonstration Site - Demonstrating the value of summer active perennials for production and sustainability: Farmers in western Victoria have traditionally relied on temperate perennial species such as phalaris and ryegrass and there is some resistance to the use of alternative perennials due to lack of experience, limited management packages and past persistence problems. However, over recent years, many farmers have started to use tall fescue and several have good stand of lucerne that has persisted for over ten years. This module identified six farmers across the region that had existing stands of summer active perennials and monitor the effect of these pastures on farm productivity and water use. On each farm, simple measures of soils, pastures and animals were made. These demonstration farms were the precursors to the Supporting Sites and were used to extend the messages about the use of perennials and obtain feedback on problems or knowledge gaps for incorporation into the experimental program.

Accelerated Lambing Systems – Desk Top Study: This study investigated increased lambing frequency as an opportunity to simultaneously increase the profitability and sustainability of sheep meat production in southern Australia. Increasing the lambing frequency or accelerated lambing is not a new concept and the potential for some breeds to lamb more frequently than once annually had been documented as early as the 1930's. EverGraze undertook a desktop study to review the opportunity for accelerated lambing in pasture systems in the high rainfall zone.

3.3.3 Wagga

Objectives:

- Meat-merino systems will make more profitable use of a perennial pasture base than a wool only system.
- Delaying lambing from July to September allows better use and more profit from a perennial pasture base.
- A system incorporating 40% lucerne will be more profitable and use more water than the same system incorporating 20% lucerne.

Proof Site description/ methodology:

The Wagga Proof Site team undertook the following activities; Proof Site that investigated high performance lamb production system (including split joining); ovulation studies; lamb survival, and hydrology studies. In addition they managed the site ERG and supported communication and extension activities.

New animal production systems offer the potential for much higher productivity but have nutritional demands that are difficult to meet with the current annual pasture-base at profitable stocking rates. Systems that produce more lambs require a feedbase with a high plane of summer nutrition. Summer-active perennials such as lucerne combined with winter-active species are likely to be able to support these systems. Two management applications were identified as having potential to increase profits with systems based on summer-active perennial pastures. These were the “Split Joining” and “Later Lambing” management practices.

- “**Split Joining**” involves joining a portion of the flock to a terminal sire earlier in the year to enable first-cross lambs to be finished by the end of the year. The remainder of the flock is joined later in the year to Merinos so lambing coincides with peak pasture production.
- “**Later Lambing**” involves joining ewes later for a September lambing. This has the advantages that peak feed requirement of the ewes coincides with peak feed supply and that producers may be able to capture high sheep meat prices.

The “Later Lambing” system is based on the “Yearling Sheep” management practice described by McEachern (2004) that enables producers to capture high sheep meat prices within their existing resource base. Such a system reduces nutrient demand when pasture supply is limiting, potentially allowing higher stocking rates and requiring less supplementary feed. Such a system has the potential to make more profitable use of a perennial-pasture base than the current livestock system. The “Later Lambing” system provides a more realistic option for producers in the upper reaches of the catchment who do not have the potential to sow significant amounts of chicory or lucerne (due to slope and/or soil acidity), which would be required to run a “Split Joining” enterprise.

Each livestock treatment consisted of a lucerne, tall fescue and phalaris paddock. The three pasture types were sown on the most appropriate soil class. Each treatment had three replicates resulting in 12 farmlets. For ease of management, each farmlet was composed of three paddocks located close together, within this constraint the farmlets have been randomized within 3 blocks. Stocking rate was initially based on the current carrying capacity in the district and was subsequently increased within a policy of having a consistent mid-winter stocking rate on each treatment. Each farmlet was 5.1 ha in size.

“Split Joining” involved joining ewes to a terminal sire for 1 week in late February. Joining occurred while the ewes were grazing lucerne (placed on lucerne 10 days prior to joining) in an attempt to increase ovulation rates (link to Site 2). Ewes were pregnancy scanned in mid-late March, with those ewes not pregnant joined to a Merino sire for 3 weeks in April, again being joined on lucerne in an attempt to increase ovulation rate. Both groups of ewes were managed together from weaning of Merino lambs (mid December) until joining of non-pregnant ewes to the Merino sire in April. Terminal lambs were aimed to be weaned at 12 weeks of age (approx. 30kg liveweight) onto lucerne with the aim of finishing lambs to 45+ kg liveweight by the end of the year. If lambs were not finished by this time, and if seasonal conditions permit, they were to continue to graze lucerne during January. Merino lambs were weaned at 12 weeks of age and we aimed to graze lucerne pastures if seasonal conditions permit. All lambs were to be sold out of the system by the end of January. Drought conditions over the first two years prevented this system being fully implemented.

Later Lambing" involved joining ewes to both Merinos and terminal sires such that ewes lamb in September, which is much later than current common practice. The concept is based on Holmes and Sackett's yearling sheep system which aims to grow lambs to saleable weights and replacement ewes out to joining weights over two springs better; these better matches feed demand with herbage production to take advantage of the spring grown feed and optimise year-round stocking rate. The later lambing strategy with a summer-active perennial-pasture base, hence longer growing season, could potentially enable the finishing of lambs within the one growing season, which is what we will attempt to test with this treatment. Ewes were separated at joining into a terminal and Merino group. Both groups were to be placed on lucerne 1 week prior to joining to increase ovulation rate and were rotated through lucerne paddocks during a 4-week joining period. Ewes were then managed together until next joining. Lambs were be weaned at 12 weeks of age . Replacement ewe lambs were removed from the system at weaning to simulate the practice of a 20 % culling rate ewes in a mixed-age mob.

The "Traditional Practice" system was the control treatment for this experiment and is based on the common practice in the region. The treatment consisted of Merino ewes joined to Merino rams for spring lambing. Ewes were joined in early February for 4 weeks (to provide consistency with the joining time on the other treatments). Ewes were joined on lucerne in an attempt to stimulate ovulation rate. Lambs were weaned at 12 weeks of age.

Component Research:

Reproductive benefits of perennial pastures and shrubs (ovulation and lamb survival): The EverGraze production systems require a high percentage of lambs weaned to meet the objective of being 50 % more productive than traditional systems. There is potential to profitably increase weaning percentage and concurrently reduce recharge by including shrubs and summer-active perennial pastures in the farming system. This project addressed two key aspects in achieving high reproductive performance:

- Increasing ovulation using lucerne and chicory (referred to as flushing from this point on)
- Increasing lamb survival through the use of woody perennial shrubs and phalaris hedgerows

In this project, the same ewes were used for the two studies (ovulation and lamb survival) (Figure 4). While intensive measurements were taken at the focus times of ovulation and lambing, the ewes and lambs are managed throughout the year to meet target condition scores, and pastures are managed to herbage mass targets.

The aim of flushing experiment was to investigate the effects of short-term grazing of lucerne, chicory and phalaris pastures on ovulation rate in Merino ewes. The phalaris pasture treatment was grazed either with lupin grain supplementation or without supplementation, so that a comparison between novel pastures, existing pastures (phalaris) and current flushing practice (lupin supplementation) can be made. The research hypothesis was that short term flushing of ewes with high energy and protein perennial pastures such as chicory and lucerne from day 8 of the oestrous cycle will increase ovulation rates similar to providing lupin grain supplements on a phalaris pasture paddock, and will be more effective than grazing phalaris alone.

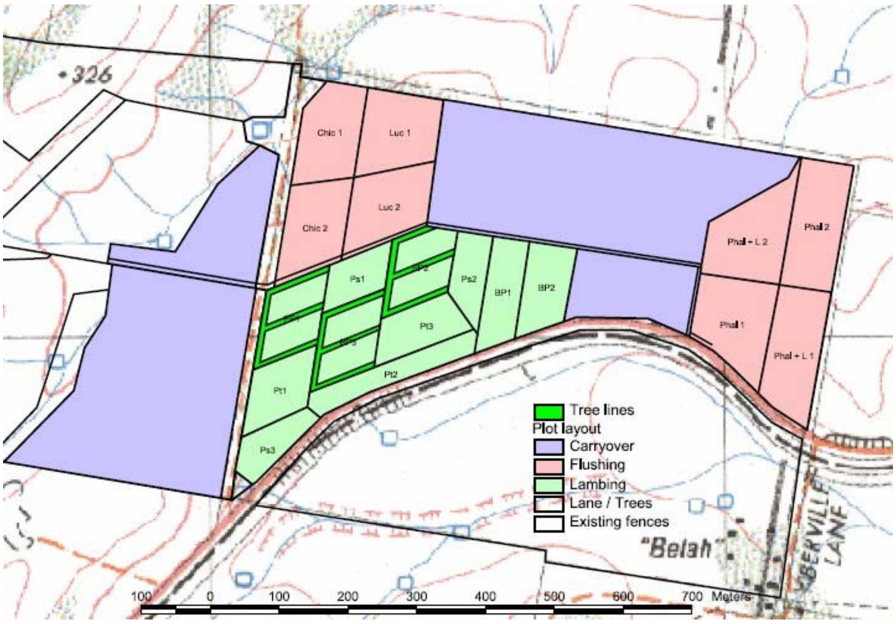


Figure 4. Research site at Coreinbob via Wagga Wagga (map by John Broster)

Hydrological modelling indicates that pasture plants alone will not meet recharge targets, whereas, widespread tree planting will not meet the economic targets. Strategic placement of woody perennials in the landscape may enable the achievement of both targets if they are planted in a way to create profit. The 'maternity ward' concept involves using perennial vegetation to provide protection from wind to improve the survival rate of twin lambs. Increased survival of twin lambs born into the microclimate created by the woody perennials, would most likely be due to reduced energy expenditure and reduced post-natal mortality in cold conditions. Thus, an aim of this experiment was to investigate the potential of woody perennials to create satisfactory microclimate conditions to improve survival of twin lambs. A 13.1 ha paddock which had a south easterly aspect was chosen for the lamb survival study (Figure 4 – green shading). The experiment consists of 4 protection treatments (Table 6) with hedgerows of phalaris or hedgerows of perennial shrubs. The mortality rate of twin lambs born into each of these protection treatments was compared to mortality rates in the ewes bearing single lambs. It is presently not known how vegetation and stocking density affects maternal behaviour at lambing. The intermediate areas between the hedgerows and shelterbelts consisted of phalaris and sub clover pasture. A control group of ewes lambed down on an annual-based pasture containing sub-clover, ryegrass and phalaris, with no hedgerows or shrub belts.

Table 6. Protection treatments and the number of ewes per treatment (3 replicates)

Treatment number	Shelter treatments	Ewes/treatment
1	Protected with twins (phalaris hedgerows)	96[¥]
2	Protected plus with twins (year1 phalaris hedgerows, year 2 and 3 shrub rows)	96[¥]
3	Protected with single lambs (positive control)	96
4	Traditional best practice with single lambs (control)	96

[¥]The proportion of twins is based on the estimation that of the 400 ewes joined, 12% will be dry ewes and a twinning rate of 55%. Single bearing ewes may be brought in to met the group size of 90 for single bearing ewe treatments.

<u>*Effect of targeted planting of shrubs on recharge and production:*</u> Hydrological modelling indicated that recharge under perennial pastures would be contributing to groundwater rise in the pastoral region to the east of Wagga Wagga. This region has a propensity for increasing watertables due to the large proportion of hilly topography with shallow soils. It is thought that both vertical recharge and subsurface lateral flow in these duplex soils are contributing factors to the increase in groundwater. A change in current farming practise is sought to further decrease recharge whilst maintaining profitable animal production. The use of woody perennials grown in alleys has been shown to be effective in decreasing water movement in cropping areas in Western Australia yet little is known of the ability of shrubs to achieve this outcome when grown in belts in combination with perennial pastures. Shrubs exhibit rapid early growth and relatively large leaf area expansion compared to young trees of similar age. Shrubs also exhibit relatively high transpiration responses to changing actual evaporation when compared to overstory canopy species (Hurtley *et al.* 2000). These properties create the potential for greater water use than trees in the initial stages of development thereby drying out the profile and decreasing the opportunity of recharge occurring. In a sheep grazing system the protection shrubs offer to grazing animals will be beneficial especially during lambing and harsh winters. Therefore the use of shrub belts within perennial pastures as a management option to decrease recharge in a pasture system was tested.

The experiment is to be conducted as either a randomised block or split plot design with 4 blocks located at similar positions on the slope. Four treatments are to be tested: lucerne without shrub belts; lucerne with shrub belts; phalaris/annual without shrub belts; phalaris/annual with shrub belts. The shrub species grown were *Acacia deanei, A. iteaphylla, A. decora, A. decurrens, A. cardiophylla, A. cultiformis, A. hakeoides* and *A. podalyriflora*. Some of these species are noted as edible species, which may provide additional incentives for landowners to introduce them into their farming system. In the treatments including shrubs, the shrubs were grown in belts running across the slope. Shrub belts were 10 m deep and 50 m apart down slope (Figure 6). Livestock were used on the site for maintaining suitable pasture biomass levels.

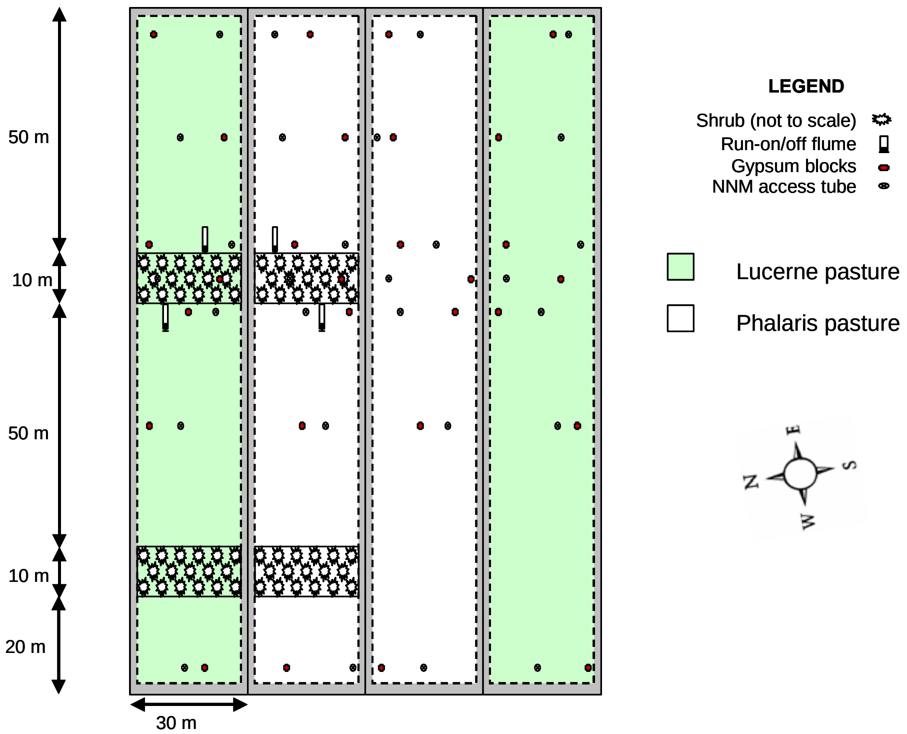


Figure 6. Representative layout of a single replicate within Site 3.

3.4 Supporting Site methodology

Supporting Sites were local trials or demonstrations where producer groups implemented a sub-set of the pasture and grazing management technologies being applied at the Proof sites, in order to demonstrate their impact on increasing productivity, profitability and better NRM outcomes within commercial farming operations. That is, farmers showing other farmers what can be achieved by farmers and demonstrating the scale of improvement that is possible.

The basic concept of a Supporting Site was to provide livestock producers with the opportunity of testing technologies for relevance to their locality, and to exchange information with the research teams involved in the Proof sites. Supporting sites continue to be a focal point for regular information delivery and education activities to build the knowledge, skills and confidence of producers.

Given the NRM focus of EverGraze it was felt that building partnerships with NRM groups (CMA's and their equivalents) to align EverGraze with the significant activities and incentives available to support better profit and NRM outcomes was a sensible approach. The initial plan was to have up to 10 Supporting Sites established in each EverGraze priority catchment. Supporting Sites however were not established in some regions due to lack of CMA involvement but Supporting Sites were expanded to other regions including Gippsland and South Australia.

While the producer group was responsible for setting up and managing the Supporting Site, funding was made available to assist with the start-up costs. The local CMA staff, ERG and scientists from the Proof Sites assisted with the selection of appropriate practises to be trialled at the Supporting Sites. Training and some assistance in monitoring of NRM and production outcomes was conducted.

Monitoring needed to be carefully designed due to time and skill shortages in some regions. The project developed EverGraze Quickchecks for monitoring around 5 key principles; measuring changes over time rather than averages for the paddocks; comparisons with Proof Sites; encouraging collaboration between producers and catchment staff; and consistent monitoring at all Supporting Sites.

4 Results and Discussion

4.1 National coordination

4.1.1 Governance

The governance structure around the EverGraze has been important in supporting strategic national and regional direction for the project, maintaining and reviewing progress, tailoring key messages within communication and adoption plans as well as being advocates for the project.

Fifty-six stakeholders (producers, consultants, Landmark and CMO representatives) have been directly engaged in project governance. Table 7 provides a meeting record for the ERC and NAC.

Table 7. The meeting frequency of the NAC and ERG's associated with EverGraze.

Date	Location	Attendance	Date	Location	Attendance
Albany			***Hamilton***		
22 August 2005	Wellstead	10	21 June 2005	DPI Hamilton	-
22 September 2005	Wellstead	8	12 October 2005	DPI Hamilton	-
22 November 2005	Wellstead	9	9 March 2005	DPI Hamilton	11
27 September 2006	Wellstead	5	17 July 2006	DPI Hamilton	10
23 May 2007	Wellstead	8	9 March 2007	DPI Hamilton	14
22 August 2007	Wellstead	6	10 August 2007	DPI Hamilton	19
13 May 2008	Wellstead	7	23 November 2007	DPI Hamilton	18
			14 March 2008	DPI Hamilton	20
Wagga Wagga			22 July 2008	DPI Hamilton	15
7 October 2005	CSU	7			
14 November 2005	CSU	6	***National Advisory Committee***		
1 February 2006	'Somerset', Ladysmith	7	11 October 2005	Holiday Inn Melbourne Airport	9
15 May 2006	CSU	-	13 & 14 December 2005	DPI Hamilton	8
22 August 2006	CSU	-	24 November 2006	Hilton Hotel Melbourne Airport	10
24 October 2006	CSU	7	22 & 23 May 2007	Pavilion Hotel, Wagga	12
14 March 2007	CSU	-	13 & 14 November 2007	DAFWA Albany	12
25 June 2007	CSU	-	7 & 8 May 2008	DPI Orange	14
24 August 2007	Shanty Hotel, Alfredtown	-e	28 & 29 October 2008	Sanctuary Inn, Tamworth	10
27 March 2008	CSU	11			
7 July 2008	Field Sites	-			

Project governance comes with a cost of sitting fees, administration, and time in communication, maintaining engagement and meeting organisation. The ERGs worked well however the Albany ERG was identified as being too localised and was not able to have the wider relevance and impact needed for the potential perennial zone in WA. This issue has been addressed in the new proposal. Governance meetings were evaluated, Table 8 provides some examples of the feedback provided by members.

Table 8. Governance (NAC) feedback

<u>What worked well</u>

- Good to hear presentations by the Improved Proof Site Leaders x 3.
- Breaking into producer and funding body groups for 'brainstorm'. Maybe do this every 2nd meeting, not necessarily every time.
- Good discussion opportunities to improve EverGraze.
- Stakeholder discussion – feedback.
- Good interaction with local ERG
- Half day field trip encouraged good discussion and relevant questions without being overly long and getting off track.
- Meeting papers good.
- Receiving papers prior – but still need them earlier! Only received on Friday.
- Good exchange of ideas between all participants

<u>What needs to be improved</u>

- Try and get meeting notes out a little earlier but realistic this very difficult.
- Needed more time to discuss the interactions at the end, once we've had a chance to give more thought.
- Visit to Supporting Site.
- Would like a NAC reflection session on the site visited, so that some constructive feedback could be offered to the Proof Site Leader.
- Would have liked to meet farm owner/manager on site if possible.
- Time to address/provide solutions to big governance questions

Involvement of producers in the EverGraze governance structure has also increased meat producer capability; for example Chris Mirams, the Chair of the NAC, has undertaken the Australian Rural Leadership Program and has been a runner up in NSW Producer of the year.

4.1.2 Coordination and management

The EverGraze project has undergone considerable growth in the last three years. EverGraze has grown in its impact across the high rainfall zone, in the issues addressed (expansion to natives and wider than just recharge NRM outcomes), its partners and its coverage of the RD&E continuum (strategic research (PhDs/ component research), applied research (Proof Sites), demonstration (Supporting Sites), awareness (communication program and officer), adoption (Extension Officers) and monitoring and evaluation (National EverGraze Coordinator)). The original EverGraze project was just three Proof Sites with a modest communication budget.

The growth in EverGraze has however been disruptive at some points and has demanded considerable more time in addressing coordination and sequencing issues as well as contractual and partnership issues. In hindsight we believe the contracts associated with the expansion of EverGraze should have all been put the same "central" agency ie CRC FFI. Despite this the outcome has definitely justified the effort in terms of increased coordination and stakeholder input.

This EverGraze project operated during a period of perhaps unprecedented times with the debate and understanding of climate change being opened and widespread combined with 3 years of drought in the high rainfall zone. EverGraze engaged with the Australia Green House Office and we hope is now well place in the recent DAFF climate change program. In the initial expansion of EverGraze the expectations were high in terms of CMO investment into the Supporting Sites. The project has found it very difficult to realise these expectations due to the changing national approach to NRM funding.

EverGraze has been made up of research and extension staff from a range of disciplines and agencies. The multi-disciplinary approach has provided an opportunity to address a range of production and NRM outcomes and there has been some good cross-discipline discussion. The whole team have met at a Proof Site at least once per year, the site leaders have also met around a range of issues throughout the project (finishing/ ovulation workshops through to extension message workshops) and we have had monthly teleconferences. There have also been several exchanges of technical officers between Proof Sites (Figure 7).

Figure 7. EverGraze Proof Site teams at the NAC chair's property

Despite the multi-disciplinary basis of EverGraze there has been a tendency for Sites to fall back to the area of science discipline expertise and this has been reflected in the underlining focus of the Proof Site. For example the Wagga Proof Site tends to have a livestock "flavour" and the Albany Proof Site has a pasture "flavour". The local ERGs have played an important role in modifying this however we have also seen some impact of the preferences of the ERG on the Proof Site. For example the Hamilton ERG are very production focussed, they showed some resistance to EverGraze expanding into native pastures, conversely the Albury/ Wodonga ERG were very NRM focussed and it took the NAC Chair to step in to ensure a more balanced approach to production and NRM.

Multi-disciplinary farming system RD&E is challenging and it has become clear that it is difficult to achieve a systems approach. EverGraze has provided a window to look into capability and we believe there is a need for greater emphasis on system science. Few RD&E professionals are trans-disciplinary and sufficiently understand the system; most agricultural researchers are trained in traditional scientific methodology. We would also conclude that is a shortage of livestock science as evidenced by several Proof Sites not being able to recruit livestock scientists.

Perhaps a future approach may be to have highly experienced farm manager employed alongside the Proof Site Leader to co-manage the Proof Site. There would need to be a constructive process that allows decision making and trade-offs between research and farm system management. The farm manager would be responsible for presenting financial and NRM performance to the “owners” (ERG) as well as play an important role in adoption, the Site Leader would be responsible for presenting the underpinning evidence in a scientific valid way.

The CRC FFI and the EverGraze project have brought together a range of science groups and agencies. Each agency and group within an agency have different cultures and drivers and completing demands, this adds further complexity to the delivery of a project like EverGraze. Understanding these drivers and demands upfront is important in the design and implementation of projects like EverGraze. We have also experience very different approaches and cultures in relation to the interaction between research and extension. This extends from how the disciples work together to more fundamental differences about what, when and confidence levels around the extension of research findings. Such differences make driving a National RD&E program challenging.

The EverGraze project utilised common tools to support integration and analysis. These included:

- The development and consistent use of the Proof Site measurement protocol and the sheep selection and inspection protocol. Specifying the experimental protocols upfront ensured that sites collected the same information, used the same methods and the same recording system to facilitate cross-site analyses and modelling. The protocol specified the minimum data sets that must be collected at all sites to enable modelling, importantly modellers were engaged at the start to ensure sufficient data was collected from the Proof Sites. Initial discussions between the modellers (both biophysical and economic) and the Proof Site teams were extremely important for collective understanding in term of understandings around particularity at technical officer level through to the projects ability to validate and extrapolate at the modeller level.
- The modification of the Sustainable Grazing System Data base and the training of all Proof Site teams in the functionality and use. All sites are inputting data into this common database. In addition to this the Hamilton Proof Site developed up a program to support paddock management due to the complexity of the site and this has been integrated with the modified SGS database. The SGS is a series of relational databases for an individual site the database provides an efficient data storage system with data being entered directly or through the importation of Excel spreadsheet. The SGS database provided an enhanced ability to understand linkages between different data sets and improved data access. Importantly data is provided in a form whereby related data sets can be gathered for modelling purposes.
- Bio-economic modelling (discussed under Section 5.1.5)
- Website/ members area where common documents etc were stored and accessible.

EverGraze provide milestone reports to stakeholders in May and November. The following process was used; the NAC meetings would be held just before the submission date of the milestone report this provided a mechanism for governance and reporting to be aligned. Milestone reports were largely based around an annual operational plan that included national and Proof Sites and communication, adoption and evaluation. There were developed on an annual basis and when approved where report against through a score card approach. A CD has been provided with this report to provide previous EverGraze milestone reports. The benefits of the annual operational plans were to adjust the project to external influences for example drought. Such an approach could be considered as a first step towards adaptive research management but maintaining the ability to deliver against fixed contracts. We would encourage further development and use of such approaches for RD&E.

4.1.3 Communication and adoption

EverGraze started in 2003 with plans finalised in 2004, treatments established in 2005 and animals on plots in 2006. As previously highlighted there have been significant changes in the operating environment over this 5 year period and perhaps have had the greatest impact on the relevance of EverGraze messages and adoption by Next Users (NU) and producers. Since 2005, southern Australia has endured the lowest 3 year rainfall on record as shown in Figure 8.

The negative effects of these extreme climatic conditions on EverGraze have been that;

- The combination of drier conditions, low stock numbers and low returns from livestock has seen a dramatic expansion in cropping, for example south of Hamilton and near Manjimup in WA.
- Significant supplementary feeding has reduced cash supply
- Loss of perennials pastures such as perennial ryegrass and phalaris
- Farmers are reluctant to engage in discussion about new or alternative production systems
- Many farms have greatly reduced stock numbers and water supply is the limiting factor on many farms. The way pastures are grazed is often now set by water availability rather than optimum pasture management.
- There is reduced interest by some next users in perennial pasture systems.

There are however some positive implications for EverGraze;

- Some farmers are beginning to see a need for different systems to deal with a new climate. However, they do not have the capital to make changes.
- Poor persistence of temperate perennials especially perennial ryegrass has lead producers to look for alternatives.

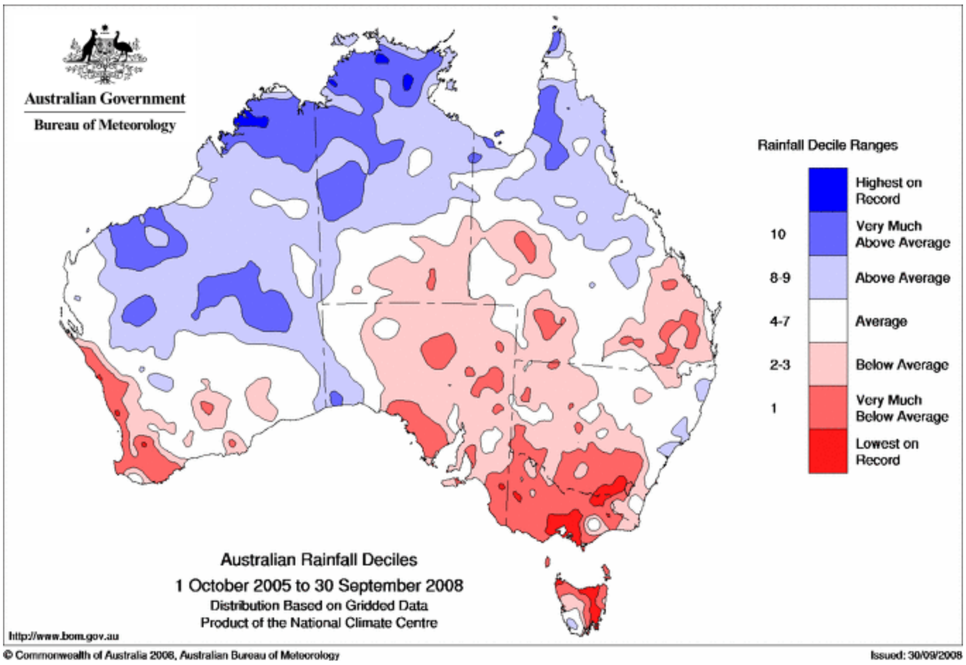


Figure 8. Australian rainfall deciles October 2005 to September 2008

More recently there have been significant changes in both local and global economic conditions and changes in relative returns between different enterprises. Input costs have increased dramatically, especially seed, fertiliser and chemicals. Also, high grain prices means that cropping is seen as being much more profitable than livestock in the high rainfall zone. Conversely tradition lower rainfall cropping regions a starting to consider low input livestock systems as increased input cost and risk are impacting on viability. The negative implications include;

- Grain prices are high leading many producers to opt to crop significant proportions of their farms. Reliable rainfall in southern Vic and southern WA suggests that cropping will continue to expand at least until there is a wet year.
- The current credit crisis means many farmers will have reduced equity and also difficulty in accessing funds for expansion or productivity improvements.

EverGraze has tried to context the massages to ensure compatibility with the current environmental and market conditions. EverGraze has successfully used a combination of branding, website, publications and activities to increase the awareness of the project through a communication plan. Importantly the underlying message of profit with sustainability and the right plant, right place right purpose massages has been maintained throughout these activities.

Communication plan: A significant communication and public relations program was required to assist the EverGraze achieve its objectives and maximise the benefits of the research and demonstration. Communication was also required to ensure all partners in the project – the CRC, MLA, AWI, agency partners and catchment management authorities and the many individuals were part of the communication network. Furthermore, the EverGraze project provided significant opportunity for increasing public awareness, improving the knowledge, understanding and reputation of the project partners.

The EverGraze embraced an approach that took stakeholders and key audiences through awareness, participation and adoption. This was because both MLA and the CRC realised that to address resource management issues widespread change of practice is required. Importantly, both partners recognise that profitable solutions are a key to driving change. EverGraze focused on achieving change through ensuring participation. Our guiding principles were:

- EverGraze pursues animal systems that incorporate best genetics, best feeding, best management and best landscape – very opportunity should be taken to communicate the dual outcomes of the project; single issue focused communication should be discouraged
- EverGraze embraces two-way communication and recognises that effective communication is as much about listening to our audiences as it is about developing and delivering messages to them. We will collect feedback and analyse for useful lessons, on-farm application and other opportunities
- Measurement and evaluation will be built into all EverGraze activities

A Communication plan was developed each year for EverGraze and was implemented by the whole project team under the coordination of the CRC funded Communication Officer (Jo Curkpatrick and more recently Gill Fry). EverGraze took the role of cross-promotion between programs within the CRC FFI, MLA/ AWI and the various agency and CMO partners. An example of this is that other agency products that are consistent with the EverGraze principles were distributed from Rutherglen along with other EverGraze products to field days and other events.

<u>Website:</u> Lcubed were subcontracted to develop a website with the following functionality; enable management of the database of EverGraze subscribers, publication of the EverGraze Update, access to EverGraze publications and tools, information and results from the Proof Sites and updates on Supporting Sites and a members area.

The EverGraze website was designed to be the platform for communication activities. It was updated on a frequent basis. All of the upcoming field days and events have been included on the website along with new fact sheets and newsletters. Website links were established from other organisations to enhance Google searches to the EverGraze website – links include; Making more from sheep, MLA in the 'useful links section, Dept Ag WA, Border Rivers CMA, Murray CMA, Glenelg Hopkins CMA, Central Highlands Agribusiness Forum, Southern Grampians Shire, Grasslands Society of Southern Australia

The website database now contains 2000 valid entries. Entries are about 50:50 producers and next users with high support from Victoria but less numbers from NSW and WA. Of 2000 entries, about 300 producers have only snail mail access. Despite this, the database has been used to provide useful lists for regional field days and other activities. The member's area now contains areas for EverGraze people to log details of all events. Using a web-based system should make it easier to manage details of attendance at events. The member's area also allows details of publication to be stored and allows sharing of information between people and sites. Uptake of this facility by Team members has been limited.

<u>Publications and field days:</u> The EverGraze project has achieved 62 media publications ranging from national, state and regional coverage; three refereed journal articles; 7 refereed conference journal articles; 16 conference proceedings; 60 extension publications (ie field day notes etc); 6 posters; 3 media releases; 9 radio interviews; 17 field days (with another 41 being planned for September through to December 2008) (Figure 9); and 75 site visits. This equates to six communication activities every month for the 3 years of the EverGraze project. EverGraze has targeted key industry publications including; ProGrazier Magazine, MLA Feedback, Beyond the Bale, CRC Future Farm magazine. Appendix 1 provides a catalogue of these activities.

Figure 9. Field day at Chiltern Proof Site

Newsletter: The EverGraze Update newsletter has been designed and distributed quarterly to those on the database. On average 400 copies needed to be printed and sent to those on the database without email addresses. With the September edition a letter was included encouraging these members to update their details if they had an email address, this lead to 45 people registering for email contact. Past versions (seven) of the EverGraze Update can be viewed on the website.

Site brochures: EverGraze has produced a number of brochures including; (i) national brochures (EverGraze, Supporting Sites and General Information and Contacts) (ii) regional brochures (Southwest WA brochure ,Southern Vic brochure, Southern Slopes NSW brochure, NE Victoria and Murray NSW, Northern NSW - Namoi & Border Rivers (Tamworth) brochure ,Central NSW - Lachlan and Central West (Orange) brochure) and general information brochure (Native Grasses). EverGraze has also produced fridge magnet and large sticker that aim to direct people to the website.

Fact sheets: EverGraze identified the need to develop fact sheets around the farming systems as well as the key inputs/ components of the system for example different summer-active pasture species. We also recognised the need for two types of information sheets; (i) the EverGraze Actions which provided simple steps to achieve a specific outcome, for example how to establish and manage phalaris (Figure 10); and (2) EverGraze Exchanges which tended to discuss an issue and provide potential solutions but their was less certainty around the management practice for example lamb survival. EverGraze Action sheets are shown on the website in both high and low format to enable either producers to print off for their use or team members to print for field days.

EverGraze Action - Growing and using Chicory on the East Coast
EverGraze Action - Growing and using Chicory in WA
EverGraze Action - Perennial grass hedges provide shelter at lambing
EverGraze Action - Growing and using Lucerne
EverGraze Action - Growing and using Kikuyu in WA
EverGraze Action - Productive, persistent Perennial Ryegrass
EverGraze Action - Growing and using summer active Tall Fescue
EverGraze Action - Growing kikuyu for summer feed and soil cover
EverGraze Action - Grazing Phalaris for production and persistence
EverGraze Exchange – Lamb survival

Figure 10. EverGraze Actions available on the Website

Branding and templates: EverGraze employed a graphic designer to identify a distinct style for EverGraze, this has captured the key partner's logos and has the consistent running line "EverGraze is a research and delivery partnership between the CRC FFI, MLA and AWI (Figure 11)**.** A series of templates have been developed to ensure a consistent EverGraze 'look' is used. These templates are; Flyer template, Poster template, Supporting Site handout, Field day agenda, and Media release template. These templates were loaded on to the member's area of the website for easy access and all EverGraze members have been informed of their availability. Branded hats and shirts have been provided to the EverGraze team and NAC.

EverGraze
More livestock from perennials

Figure 11. The logo and colour scheme for the EverGraze project

Summary of communication: EverGraze has undertaken significant communication activity in the last three years and has exceeded project targets as specified in the HRZ.200 contract which required the development of six guideline documents, 3 field days/year, 3 technical workshops/ conferences/year, 10 media articles/year and 1 brochure/year, 3 scientific papers and 3 presentations/year. However with the continuation of the Proof Sites for another two years there will be greater opportunity for media articles, fact sheets and scientific publications.

Extension and adoption plan: Adoption was delivered through regional and national EverGraze Adoption plans. The NEC was responsible for the development and implementation of the regional and national plans. All research and extension project members contributed to the delivery of the annual operational adoption plans. It should be recognised that the Plans needed to be aligned with the projects adoption targets, the strategic direction set by the NAC and the CRC FFI Adoption and Commercialisation and Business Plans. Specifically, the adoption plans aligned with the CRC FFI theme areas of: Action learning by regional Partners, Associates and users; Farming systems x zones x regional delivery; Training the public/ private adviser workforce; Commercialisation and Monitoring and evaluation. The aim is for at least 3,600 farms to have adopted principles and practises from EverGraze on their farms by June 2010. Key Performance Indicators for adoption have included; Project displays at 4 major grazing industry forums (NSW, Vic * 2, WA); National EverGraze activities; Major Field day/s at each Proof Site = 600 participants; 4 visits/presentations' by producer/Next User groups at each Proof Site = 480; 60 Supporting Site activities = 1200; Engagement as per regional extension plans; 10 E&A activities involving 100 Next Users; and E&A activities directly involving 800 producers.

Key adoption messages: The CRC FFI was a key driver in moving EverGraze through the process of developing the value proposition around key adoption messages; it would be fair to say that the project team has found this a challenging task due to only having two years of drought data and due to the conservative nature of most researchers. Key adoption messages are messages that are compelling, new, and likely to engage producers. They need to be supported by financial, system and NRM information. Extension and researchers met to review the results and design the key extension messages for EverGraze, these are provided in Table 9.

Table 9. Summary of key messages and value proposition from EverGraze Improved Proof Sites

Message	Summary	Next Users	Complex	Labour	Capital costs	Risks	Conflict Message	Trial-ability	Envio benefit	Where
Perennials for place in Landscape to increase profits	Definite National Immediate	Supportive	Higher, several sps to manage	No change	Higher	Same	Yes	Yes	Yes	W Vic N Vic Gipps SA WA S NSW
Lucerne has wide applicability	Definite National Immediate	Supportive	Higher first time users	No change	Higher	Different to grass pastures	No	Yes	Yes but erosion	W Vic N Vic Gipps SA WA?? Stn NSW
Summer active tall fescue	Definite Regional Immediate	Mixed, Agro's yes Consul no	Higher establish	No change	Higher	Higher failure to establish	Yes, some oppose	Yes	Yes	W Vic Gipps WA??
Chicory as an alt. to lucerne for summer	Definite National Immediate	Supportive	Higher first time users	No change	Higher	Different to grass pastures	No	Yes	Yes	W Vic N Vic Gipps SA WA S NSW
Kikuyu for tough situations	Definite National Immediate	Mixed; Consultant yes	Lower Easy to manage	No change	Higher	Poor management	Yes	Yes	Yes but Weed	Gipps SA WA
Perennial shelter systems improve lamb survival	Emerging National On hold	Mixed	Higher, need to scan ewes	Higher	Higher	Lower	Yes	Yes	Yes	W Vic N Vic Gipps SA WA?? S NSW
Green pasture pre-mating increases conception	Emerging National On hold	Mixed	Lower	No change	Lower	Lower	Yes	Yes	Yes	N Vic Gipps SA WA?? S NSW
Split joining reduces risk in variable climates	Emerging National On hold	Unknown	Higher, 2 lambing's	Higher	Lower	Lower	Yes	Yes	????	N Vic Gipps SA WA?? S NSW

4.1.4 Monitoring and evaluation

Monitoring and evaluation plan: The EverGraze Project team were responsible for supporting monitoring and evaluation plan through the collection of data and feedback. The plan was developed under the CRC evaluation plans to ensure alignment to key performance indicators (both project and CRC FFI). Deliver against the EverGraze monitoring and evaluation plan was reviewed at least annually by the NAC.

Surveys: An initial random survey of producer attitudes in the North East Victoria CMA area was undertaken by Kate Sergeant from DPI Victoria. This survey uses both in-depth qualitative interviews of 15 -20 producers and a wider phone/mail survey to develop clear picture of the current knowledge and practises and the way producers adopt new grazing and livestock systems. The results will determine the indicators of change in KASA and practice. It also determined the proportion of producers receptive to new grazing and pasture practises. A detailed survey was undertaken with EverGraze producers in NSW, Vic, SA and WA with 240 respondents. Data still to be fully analysed but some points are that producers keen on perennials to improve both profit and the environment, however their biggest concern is poor persistence; phalaris most commonly use temperate species; there is low knowledge and use of summer actives except for lucerne, summer active tall fescue and chicory not used; surprisingly Kikuyu more common in Gippsland than in WA; rotational grazing used is used extensively in Gippsland, Northern and Central NSW, Northern Vic, and is not widely used in WA and SW Victoria. There is strong interest by producers in systems to improve persistence of perennials (4.4 out of possible 5.0) and different perennials suited to different parts of the farm and summer active perennials (4.2)

Feedback information: Feedback received from over 30 EverGraze events has been summarized and is shown in Table 10. The feedback shows both regional differences and differences in attitudes of producers and NU to the EverGraze concepts as summarized below;

- Perennials improve financial returns and provide environmental benefits
    - Strong support for perennials across most regions
    - NU more enthusiastic than producers
    - Central, Northern NSW and NE Victoria strongest support for perennials
    - Southern NSW weakest support for perennials
- 2-3 perennials matched to soil and landscape improve financial returns and provide environmental benefits
    - Lower support than for perennials in general
    - NU more enthusiastic than producers
- Summer active perennials improve financial returns and provide environmental benefits
    - Lower support than for 2-3 perennials
    - Strongest support SW Victoria,
    - Weakest support Southern NSW
- 70% ground cover is essential to maintain soils and pastures
    - NU more enthusiastic than producers
    - Strong support Northern & Central NSW, NE Victoria,
    - Weakest support Southern NSW
- Rotational grazing would improve persistence and production of perennials
    - Northern NSW producers strongly support rotational grazing
    - SW Victorian producers ambivalent about benefits of rotational grazing

Table 10. Feedback from producers regarding their attitudes to perennials and NRM

"Perennials are important to increase profits and provide environmental benefits"

	Producers				Next Users			
	Str Ag	Agree	Neutral	Disagree	Str Ag	Agree	Neutral	Disagree
Overall average	64	32	3	1	74	24	1	0
Northern /Central NSW	79	21	0	0	88	11	2	0
Southern NSW	49	40	7	4	62	33	4	1
NE Victoria	66	33	1	0	83	17	0	0
SW Victoria	62	29	4	2	76	23	1	0

"2-3 perennials matched to soils and landscape will improve profits and provide environmental benefits"

	Producers				Next Users			
	Str Ag	Agree	Neutral	Disagree	Str Ag	Agree	Neutral	Disagree
Overall average	50	42	7	1	66	28	5	0
Northern / Central NSW	52	42	6	0	71	26	4	0
Southern NSW	53	39	5	3	51	43	4	2
NE Victoria	49	42	9	0	92	8	0	0
SW Victoria	54	40	5	2	69	19	12	0

"Summer active perennials will improve profits and provide environmental benefits"

	Producers				Next Users			
	Str Ag	Agree	Neutral	Disagree	Str Ag	Agree	Neutral	Disagree
Overall average	47	39	11	3	38	43	17	2
Northern / Central NSW	42	39	16	3	36	48	14	3
Southern NSW	49	33	10	7	15	48	34	3
NE Victoria	42	45	13	0	47	36	17	0
SW Victoria	62	29	4	4	57	28	14	1

"Maintaining at least 70% ground cover is essential to protect soils and maintain production on farms"

	Producers				Next Users			
	Str Agr	Agree	Neutral	Disagree	Str Ag	Agree	Neutral	Disagree
Overall average	71	25	3	1	78	17	3	2
Northern /Central NSW	80	18	2	0	88	12	0	0
Southern NSW	52	48	1	0	70	25	1	3
NE Victoria	81	16	1	0	100	0	0	0
SW Victoria	71	22	3	5	72	20	3	6

"Rotational grazing would improve persistence and production of perennials on my farm"

	Producers				Next Users			
	Str Agr	Agree	Neutral	Disagree	Str Ag	Agree	Neutral	Disagree
Overall average	61	30	7	1	58	30	9	3
Northern /Central NSW	74	22	4	0	63	27	10	0
Southern NSW	58	29	6	4	52	33	11	4
NE Victoria	64	35	2	0	64	19	17	0
SW Victoria	49	31	14	3	61	25	5	7

Participation at EverGraze Events: Participation at various EverGraze events is provided in Table 11. Collection of participation data has now been streamlined via the web to increase access for the large team and to reduce re-working of data. Over 1200 people mainly producers attended 40 extension & adoption activities in autumn 2008. Activities were held in Albury/Wodonga (15), Hamilton (5), Wagga (8), Orange (2), Albany (5), Tamworth (2) and SA (3). These activities consisted mainly of farm walks at Supporting Sites and field days where EverGraze results were presented.

Table 11. Participation in EverGraze events 2005-June 2008

		Contacts segmented into Key Audiences - Proof Site visits and external presentations by Proof Site staff (Awareness)						Total Contacts via Proof Site	Proof Site Visits only	Total attendance at specific E&A activities
Site	Year	Producers	NRM CMA staff	Private Agronomists Consultants	Agency staff	Land mark	Others			
Albany	2005	189	25	29	39	7	36	325	25	78
	2006	123	87	19	41	10	1	281	94	25
	Jun-Dec 07	197	28	63	122	17	84	511	143	0
	Jan - Jun 08	100		50	50			200	0	177
Alb/Wod	Jun-Dec 07	104	21	13	88	3	16	245	111	90
	Jan - Jun 08	33	8	2	37	1	2	83	80	417
Hamilton	2005	59	0	3	41	0	0	103	103	
	2006	226	0	57	71	1	44	399	389	
	Jun-Dec 07	386	2	135	75	13	82	693	388	176
	Jan - Jun 08	203	4	74	73	0	50	404	311	147
Wagga	2005									
	2006	44	0	24	34	0	0	102	82	
	Jun-Dec 07	80	20	50	123	5	120	398	187	12
	Jan - Jun 08	62	9	1	44	0	9	125	17	273
Tmworth	Jun-Dec 07	40	29	7	43	2	0	121	68	0
	Jan - Jun 08	12	4		4	2		22	0	50
Orange	Jun-Dec 07	13	3	0	9	2	23	50	24	
	Jan - Jun 08	32	5	1	33	1	19	91	91	62
S Aust	Jan - Jun 08									106
Totals		**1903**	245	528	927	64	486	**4153**	**2096**	1613

The Hamilton Proof Site continues to host many visits by producers and agency staff to the site, compared to all other regions. 150 people attended the Hamilton Proof Site field day in May 2008. Visits by groups to Proof Sites were Albury/Wodonga (4), Hamilton (9), Wagga (1), Orange (3), Albany (0) and Tamworth (0). The benefits of having a Proof Site on a research far has been exemplified by the Hamilton Proof Site it will be interesting to gain a greater understanding if this higher participation relates to increased adoption. If so it may challenge the paradigm that greater adoption rates occur when research is undertaken on farms.

To June 2008, over 5700 people have visited EverGraze Proof Sites, attended events where EverGraze information was presented or attended specific EverGraze extension activities. Of 4150 EverGraze contacts by Proof Site staff, there is a 50:50 split between contact at the actual experimental site and at external presentations. Of 4153 EverGraze contact, there is a 50:50 split between producers and other interest groups. There continues to be low participation by Landmark staff in EverGraze activities.

4.1.5 Farm economic and catchment modelling

Farm economic and catchment modelling has been effected by a lack of validation data due to the drought conditions experienced in the two years of EverGraze. The Hamilton Proof Site has been the only site to measure recharge. Economic modelling has been important to support decision making throughout the management of the Proof Sites in terms of supplementary feeding and finishing lambs. Obtaining timely analysis has been difficult due to the demands on limited external consultants and matching their time with Proof Site available time.

MIDAS has been further characterised for the high rainfall regions where EverGraze has a research interest. Preliminary analysis is provided under Section 5.2 Proof Site results and discussion. Recent experiences from life time wool and EverGraze itself is indicating that producers require further/ different economic analysis. To address this we organised a workshop with Melbourne University to identify and potentially implement additional economic analysis. This approach looks at more than an average annual years and the cost of capital and cash flow. It is hoped that linkage with the CRC FFI economics program will offset some of the cost to the EverGraze project.

At a whole-of-project level EverGraze has worked with the Whole Farm Systems Analysis Tool to align skills and run applications in the livestock area. We have also worked together in providing linkage to CAT and developing a pasture module with NZ that links to APSIM. This linkage will be important for future work in integrating enterprises. Additionally, a native pasture model has been developed and is now incorporated into CAT.

4.1.6 High performance pasture and livestock

The Section 5.2 provides significant detail on the results to data of the three Improved Proof Sites. EverGraze was based on the concept of high performance pastures matched to land class with high performance livestock delivering natural resource outcomes. This section of the final report summarises some of the cross-site trends that are starting to become apparent from the EverGraze project.

<u>Pasture persistence:</u> With all Proof Sites experiencing significant lower than average growing season rainfall EverGraze has provided a good opportunity to test the persistence of summer-active perennials. Lucerne and chicory have persisted consistently well across all three Proof Sites when sown in the appropriate place and managed to best practice. The persistence of tall fescue has been variable ranging from total failure to good persistence at the Hamilton Proof Site indicating that requirements for the use and management of tall fescue in farming systems will need to be more refined and dependent on regions and use (Table 12).

EverGraze is fortunate to have a PhD study on tall fescue in South West Victoria to provide further insight into the ecology of this species. While not completed this work has identified that heavy soils that retain summer moisture, summer rainfall are important for persistence and that the grazing system altered the morphology of the swards, with set stocked areas having a high tiller density and residual leaf area, whereas rotational grazed areas comprised a lower tiller density and were of an erect and tufty nature. While tall fescue persistence has been poor at the WA winter production site it has sown that Fraydo is proving to be more persistent than Quantum (cultivar that failed at the Proof Site) but the persistence is significantly less than kikuyu, setaria and tall wheat grass.

Table 12. Percentage basal cover decline of key summer active perennials

Pasture species	Albany	Hamilton	Wagga
Lucerne	79	43	+102
Chicory	0	37	-
Tall fescue	100	25	+42

<u>Chicory:</u> EverGraze has significantly increased our understanding of chicory and has exposed many producers to this species in a different context, especially in its ability to persist through drought. Chicory's high nutritive value and ability to grow lambs have proven to be valuable at all sites. Chicory continues to record high dry matter digestibility and crude protein values in summer. Its nutritive value was demonstrated in October 2008 recording average lamb growth rates of 248gm/hd/day over a 2 week period at the Albany Proof Site.

The Albany Proof Site is suggesting that a productive chicory stand requires a strong annual component but we are unclear whether it is possible to maintain annuals in the sward during drought. The Hamilton Proof Site has developed management strategies to increase chicory sward density and these have been included in the chicory EverGraze Action. The Wagga Proof Site has utilised chicory to increase the reproductive performance of the system and have shown that increases in mean ovulation rate in ewes grazing chicory, lucerne and lupin grain were all around 7-10% higher than ewes grazing phalaris and increases in the proportion of ewes with multiple ovulations for these treatments ranged from 20-33% higher than the phalaris treatment (differences not significant in preliminary analysis).

<u>Groundcover:</u> Despite the extreme drought of 2006 and the dry conditions of 2007, groundcover at most sites within each pasture type was maintained above 60%, and mostly above 70% (NRM benchmark), through the extensive use of drought-lots. At Hamilton both lucerne and chicory exceeded 20% bare ground at 10% of pasture assessments, whereas kikuyu and Italian ryegrass exceeded it at 3% of assessments. Avalon, Fitzroy and tall fescue never exceeded the 20% bare ground level. Kikuyu played an important role in the EverGraze farming system at the Albany and Hamilton sites enabling drought-lotting with minimal soil degradation. There tended to be more bare ground in the lucerne pastures in late autumn than in any other pasture or at any other time of the year across all sites. The ability to develop sowing combinations between lucerne and other perennial species will be important for both winter production and maintaining soil structure. The winter production site in WA has highlighted that sowing oats into perennial grass swards will increase winter feed however the oats have limited impact on autumn groundcover.

Water use efficiency: Summer active perennials have proven to be extremely efficient in converting rainfall into dry matter (Table 13). During dry seasons and the high cost of supplementary feeding this efficiency has benefits to the farming system. Soil moisture measurements have shown that lucerne and chicory have an ability to dry the soil to depth.

Table 13. Water use efficiency of summer active perennials (kgDM/ha/mm)

Species	Year	Albany	Hamilton[1]	Wagga
Lucerne	2006	13	18.3	
	2007	10	17.5	
Tall fescue	2006	16	23.1	
	2007	4	18.2	
Chicory	2006	4	15.7	
	2007	9	10.8	
Kikuyu	2006	18	18.8	
	2007	14	18.4	
Phalaris	2006	-	-	
	2007	-	-	
Perennial ryegrass	2006	-	18.3	
	2007	-	18.0	
Annual ryegrass	2006	14	22.4[2]	
	2007	3	16.2[2]	

[1] 2006 figures based on growth measurements that started in May 2006. Therefore 2006 represents May to December and 2007 January to December

[2] Figures for annually sown Italian Ryegrass

Primary pasture species: The underpinning pasture species for the Albany system was kikuyu (provided most dry matter/ grazing days), while underpinning species for the Wagga system was lucerne. The Hamilton Proof site compared three systems within the ryegrass systems Avalon on the slope provided the greatest dry matter accumulation, while the in the Triple System gained the greatest yield from tall fescue in the valley.

Livestock reproductive performance: Reproductive performance was generally lower than what was targeted through the pre-experimental modelling. There are several factors that may have attributed to this; age of the ewes, drought conditions however CS benchmarks were maintained throughout the drought, ram selected with too high EBV's for birth weight as a high proportion of lamb deaths were attributed to dystocia. It is also plausible that the stated average weaning % of the flock is based on relatively low stocking rates.

Table 14. Cross site reproductive performance (marking %)

Pasture species	**Albany**	**Hamilton**					**Wagga**			
		Triple		**PRG**		**Novel**				
		S	**T**	**S**	**T**	**S**	**SRM**	**SJ**	**HL**	**LL**
2006	119	78	132	81	140	82	123	117	109	103
2007	124	81	153	84	148	84	90	91	76	66
2008	123	93[1]	154[1]	112[1]	162[1]	106[1]	103	94	88	92

[1] Hamilton 2008 figures are interim values of live lambs per 100 ewes, where Merino ewes are on previous single systems (S) and Coopworth ewes are on previous twin systems (T). Figures include singles and multiples.

The average number of ovulations per ewe for was 1.28, 1.41, 1.39 and 1.36 for phalaris, lucerne, chicory and lupins respectively at the Wagga Proof Site while the average ovulation numbers at the Albany Proof Site were 1.51, 1.55 and 1.39 for annual pasture, annual pasture/

lupins and kikuyu respectively. The EverGraze ovulation workshop identified that the genetic potential for ovulation rate would be around 1.5 to 1.6/ ewe. It is encouraging to see the potential of the Merinotech flock in terms of their ovulation potential.

<u>Lamb performance:</u>

Table 15. Total lamb produced per 100 mm (kg/ha/100mm)(based on calendar year rainfall)

Pasture species	Albany	Hamilton					Wagga			
		Triple		PRG		Novel				
		S	T	S	T	S	SRM	SJ	HL	LL
2006	67	78	99	86	123	71	56	69	67	67
2007	60	64	90	59	97	71	32	41	31	29

Note: The project team cautions using lamb produced/100mm rainfall as it can be misleading. For example, at Wagga 2007 results are far worse than 2006, but in reality the overall production and economics were better. This is because only 252mm was recorded in 2006 while 500mm was recorded in 2007, so even though production was far better in 2007 it looks far worse on a kg/100mm rainfall basis. The problem is that 2007 rainfall was largely out of season, so the ability to 'capture' it in kg lamb was limited. Further work is to be undertaken to develop a more realistic metric that enables cross-site comparisons.

4.2 Proof sites

4.2.1 Albany Results and Discussion

Figure 11. 2006 - Map showing pastures sown in spring 2005.

Performance of the farming system: Due to the continuing drought conditions the profit goal of a 50% increase compared to an average rainfall year will not be reached. Economic analysis shows the Proof Site made a loss in both 2006 and 2007 (Table 19). The site did however did produce more lamb for every 100mm of rainfall than the MIDAS modelled systems. Unfortunately neither year was profitable due to the high cost of supplement and the inability to finish lambs due to lack of feed. Based on the number of lambs weaned the field system has the potential to produce between 42 and 70 kg lamb per 100mm in an average season. Analysis examining the effect of season on profit using MIDAS (Figure 12) supports the field results that perennials are not profitable in drought. Further investigation will provide insights into how the perennial system compares to one based on annuals and how losses in dry years may be minimised. Encouragingly MIDAS suggests the perennial system is highly profitable in average to wet seasons (Figure 3).

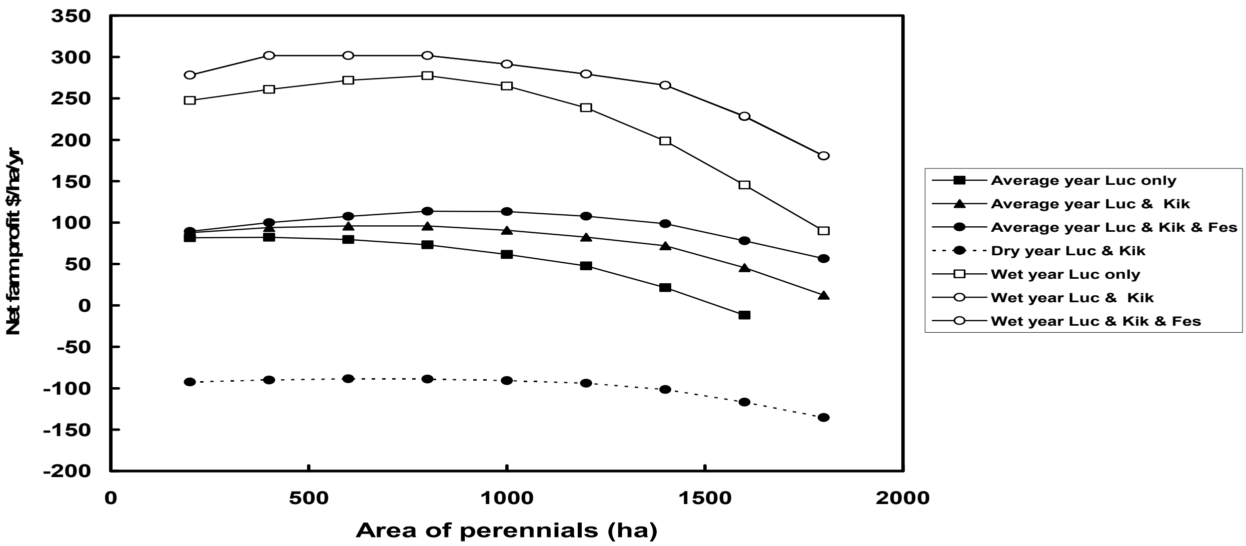


Figure 12. Preliminary MIDAS analysis examining the effect of season on profit. Wet year = 646mm, average year = 524mm and dry year = 378mm. Analysis uses a new pasture parameter set generated by GrassGro and validated with field results.

NRM performance: The NRM goal is to reduce groundwater recharge by 50% however soil moisture readings show that no groundwater recharge has occurred at the site since 2005. A wet end calibration for the soil moisture measurements will be taken in November 2008.

Pasture performance: Key outcomes to date include the excellent persistence of kikuyu, lucerne, chicory and setaria/panic pastures throughout the drought compared to tall fescue the majority of which died (Table 16). The lack of persistence of tall fescue is thought to have been as a consequence of moisture stress rather than defoliation as the plots where not grazed during summer/autumn. This is supported by tall fescues survival at higher rainfall sites e.g. winter pasture production and supporting sites at Woogenellup, Narrikup and Denbarker.

Pasture yields have been low in 2008 (Table 16) due to the lack of moisture. While kikuyu has consistently yielded well, this year lucerne has produced slightly more herbage. Kikuyu and lucerne have reliably produced dry matter efficiently throughout the drought converting every mm of rainfall to between 10 and 18 kgDM/ha (Table 16). Apart from 2007 annual pastures have produced reasonable amounts of dry matter. Chicory performed well in 2007 (Table 16) possibly as a consequence of sowing subclover into the sward leading to higher legume density (Figure 17). However its yield in 2008 has been similar to that in 2006 at 1200 kgDM/ha. Results suggest that a productive chicory stand requires a strong annual component whether it is possible to maintain annuals in the sward during drought remains to be seen. Given that prior to this investigation we would have not expected chicory to survive one year of drought its persistence has been outstanding, if through management yields can be improved this species has potential on the south coast of WA. The setaria/panic pasture was sown on the least productive soil type at the proof site and while its yield (Table 16) over the three years is indicative of this situation its unlikely that these two subtropical grasses have the yield potential of kikuyu in this environment. These two species however are extremely drought tolerant as indicated by the fivefold increase in basal cover from 2006 to 2008 (Table 16).

In every year kikuyu has provided more grazing days (Table 16) demonstrating its value during drought. While chicory was not the highest yielding pasture it provided more grazing days than lucerne and setaria/panic (Table 16). The grazing value of tall fescue was demonstrated in 2006 when it provided 86 grazing days (Table 16) mostly in autumn and winter. Since measurements commenced at the proof site FOO values have rarely been above 1400 kgDM/ha indicating efficient utilisation of pasture and low pasture growth rates. Rain in December 2007 and lower stocking rates resulted in higher FOO levels in early 2008 in comparison to 2007 (Figure 13). However a dry winter and spring and higher livestock demand (lactation) saw FOO levels return to 500 to 600 kgDM/ha for most pastures for the remainder of the year. Tall fescue was not grazed during early 2008 as it was resown in 2007 and was still in its establishment period (Figure 13).

Botanical composition of perennial pastures is presented in Figures 14, 15, 16, 17 and 18. Of note is the dominance of kikuyu and chicory throughout much of the drought clearly these species are very competitive for soil moisture to the extent they displace annuals. Historical research has demonstrated that kikuyu and subclover are very compatible when soil moisture is less limiting. Dry matter digestibility values and percent crude protein values across the different pasture types are presented in Figure19 and 20 respectively. Chicory continues to record high dry matter digestibility and crude protein values in summer. Its nutritive value was demonstrated in October 2008 recording average lamb growth rates of 248 gm/hd/day over a 2 week period. For nutritive value chicory is closely followed by lucerne which as expected has superior crude protein.

Table 16. Yield, basal cover and grazing days of different pasture types at the EverGraze demonstration at Wellstead in 2006, 2007 and 2008.

	Year	**Kikuyu**	**Tall Fescue**	**Lucerne**	**Chicory**	**Setaria panic**	**Annual pasture**
Yield (kgDM/ha)	**2006**	5307	4753	3902	1235	1096	4020
	2007	4551	1229	3261	3115	1657	1036
	2008[a]	2838	1781[b]	3262	1204	1866	2854
Water use efficiency (kgDM/ha/mm)	**2006**	18	16	13	4	4	14
	2007	14	4	10	9	5	3
	2008[a]	13	8	14	5	8	13
Basal Cover (%)	**2006**	83.6	3.7	1.4	2.7	1.0	-
	2007	85.4	0.0	0.3	2.6	4.0	-
	2008	97.0	4.2[b]	0.3	2.9	5.0	-
Grazing days	**2006**	97	86	34	28	10	-
	2007	94	0	21	43	9	-
	2008[a]	211	43[b]	16	56	26	-

[a] to date ~ end of September. [b] resown tall fescue.

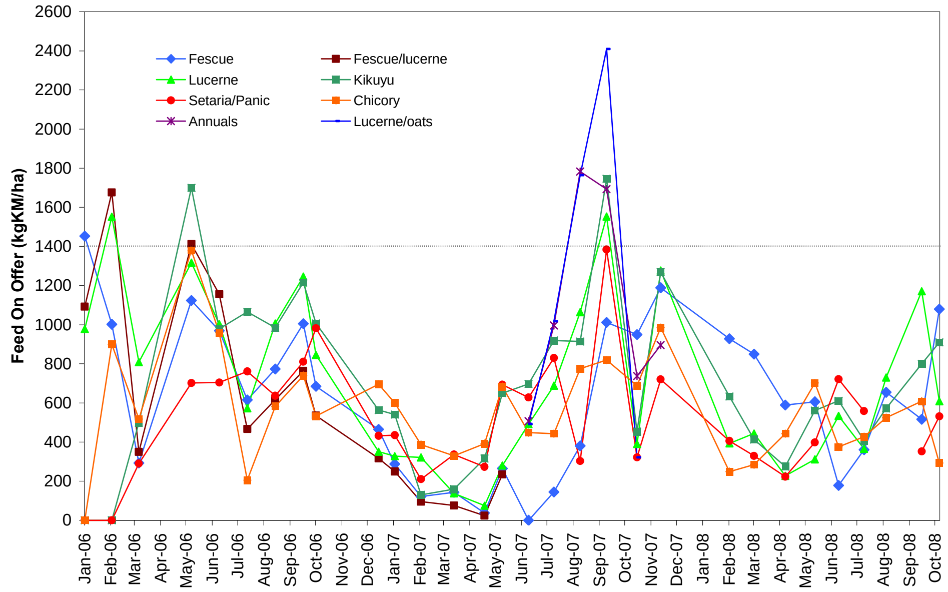


Figure 13. Average FOO values across the different pasture types.

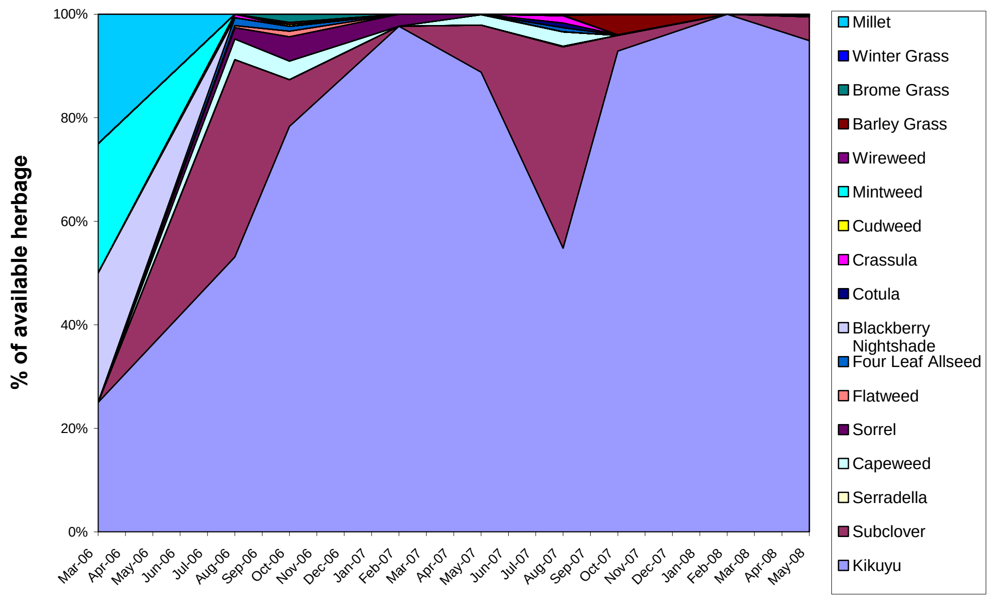


Figure 14. Typical botanical composition of kikuyu pasture at the Wellstead proof site from 2006 to 2008.

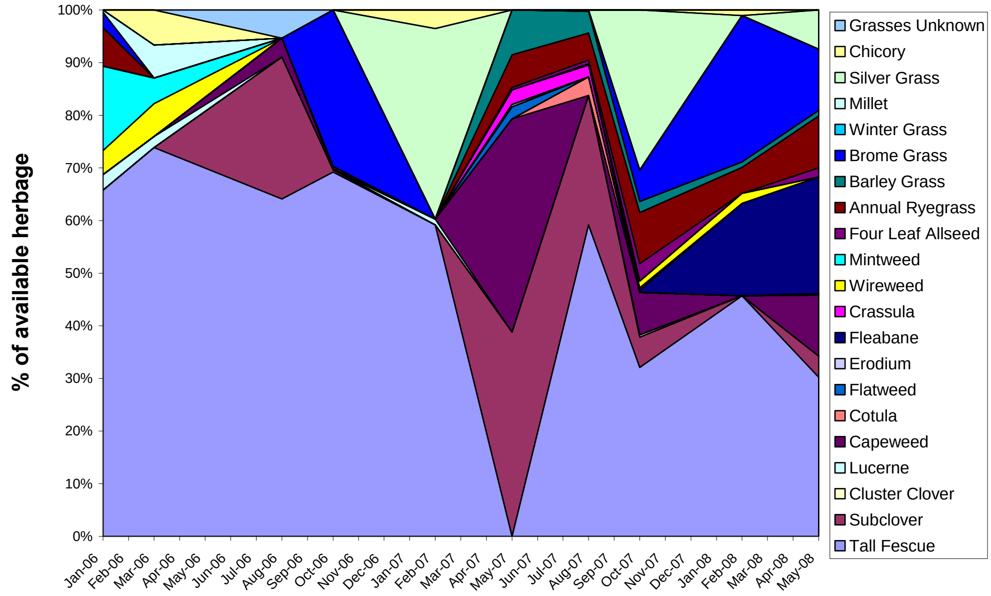


Figure 15. Typical botanical composition of tall fescue pasture at the Wellstead proof site from 2006 to 2008.

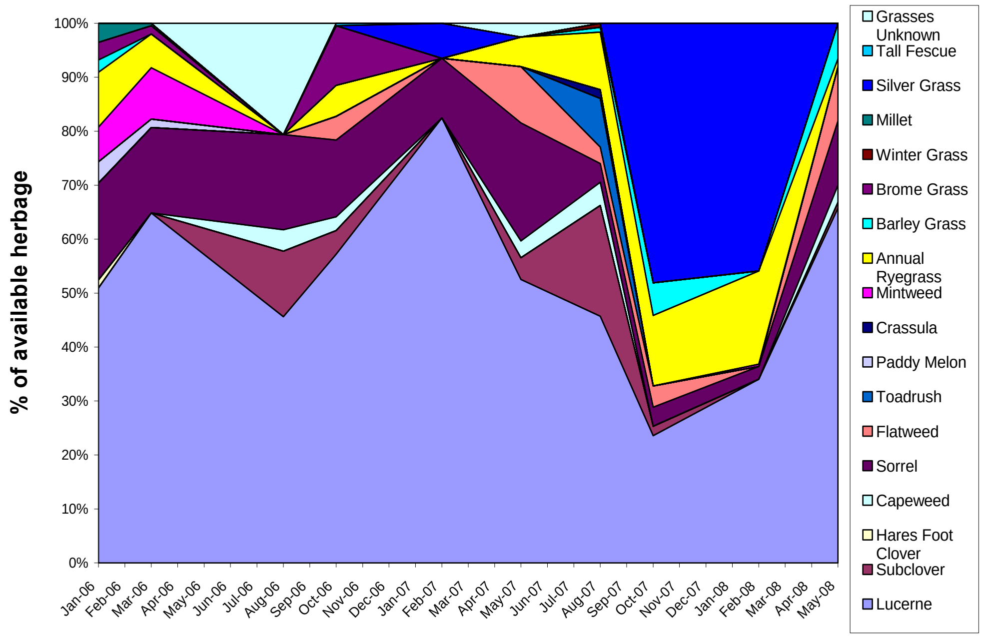


Figure 16. Typical botanical composition of lucerne pasture at the Wellstead proof site from 2006 to 2008.

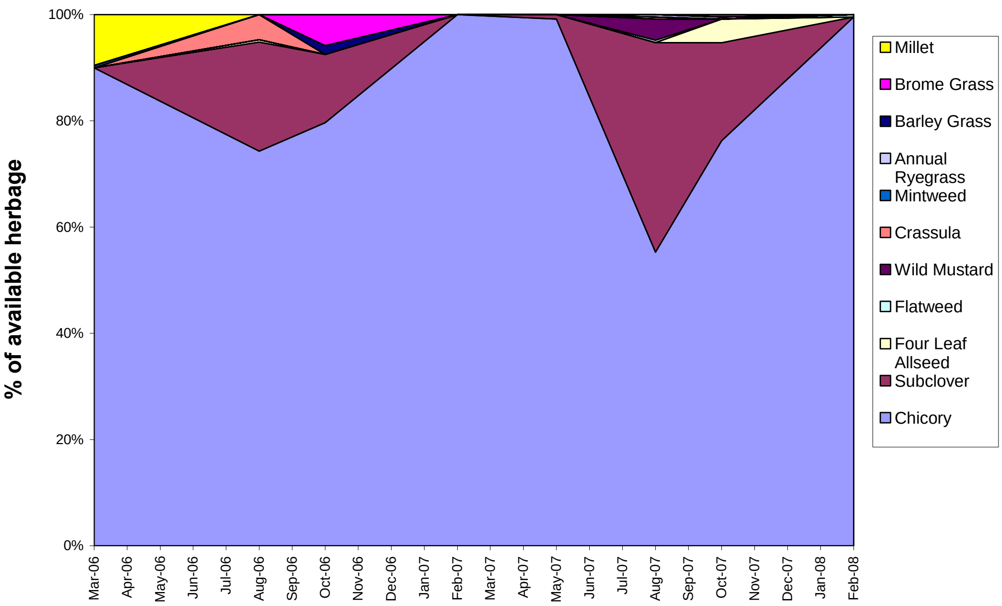


Figure 17. Typical botanical composition of chicory pasture at the Wellstead proof site from 2006 to 2008.

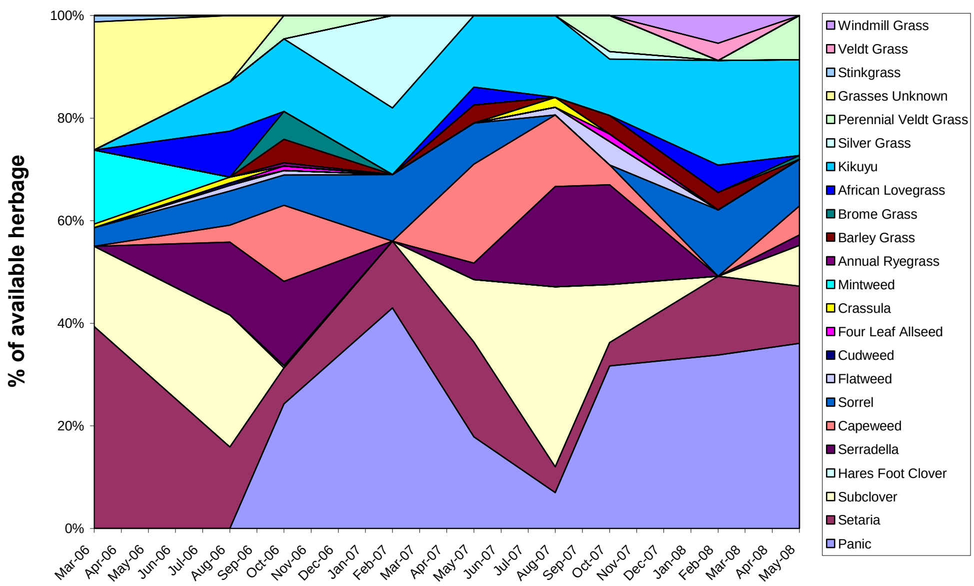


Figure 18. Typical botanical composition of setaria/panic pasture at the Wellstead proof site from 2006 to 2008.

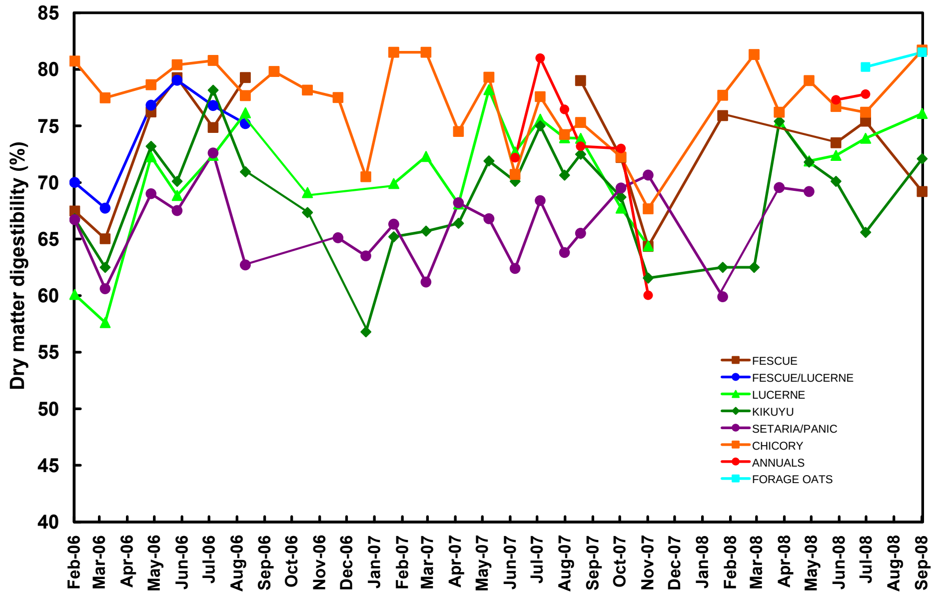


Figure 19. Percentage dry matter digestibility values of different pasture types at Wellstead proof site as determined by a whole of pasture sample.

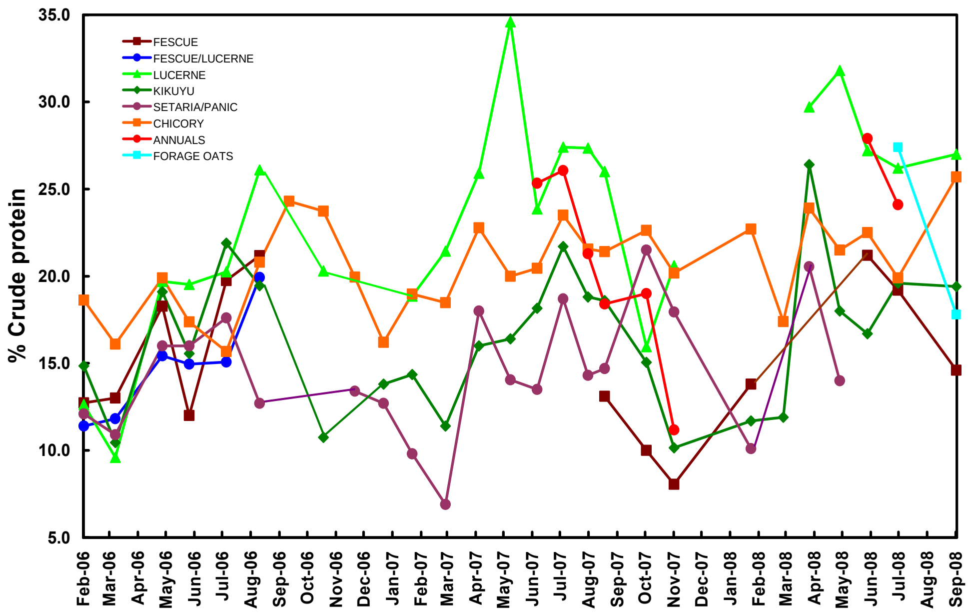


Figure 20. Percentage crude protein values of different pasture types at Wellstead proof site as determined by a whole of pasture sample.

Livestock Merino ewes were joined to Poll Dorset rams in February 2008. Lambs were weaned in late September at a weaning percentage of 123% and average weight of 22kg. Unfortunately the ewes were agisted to Mount Barker Research Station in early October due to a lack of feed at the proof site. The lambs are currently on pasture. The original project goal was to achieve 104% weaning in every year this has been exceeded with weaning percentages of between 119 and 124% (Table 17). The reason for lamb mortalities over the three years is presented in Table 18 most being lost as a consequence of mismothering and dystocia.

A greater loss of lambs to hypothermia was possibly avoided in 2008 as a result of the shelter provided by the setaria/panic stand.

Ewe liveweight and condition score is presented in Figure 21. Table 9 compares the performance of the proof site to the original MIDAS modelling that set the project targets. While drought reduced the benefits of perennials and substantially increased the amount of supplement fed the proof site produced more lamb for every 100mm of rainfall than the simulated annual and perennial pasture systems. Unfortunately neither year was profitable due to the high cost of supplement and the inability to finish lambs due to lack of feed. Based on the number of lambs weaned the field system has the potential to produce between 42 and 70 kg lamb per 100mm in an average season. However the key to how profitable the system could be is the amount of supplementary feed required.

Table 17. Reproductive performance at Wellstead proof site in 2006, 2007 and 2008.

	Scanning (%)	Weaning (%)
Goal	-	104
2006	164	119
2007	146	124
2008	156	123

Table 18. Reasons for lamb mortalities (numbers) at Wellstead proof site in 2006, 2007 and 2008.

Reason for death	**2006**	**2007**	**2008**
Mismothered	81 (61%)	9 (24%)	22 (53%)
Dystocia	23 (17%)	9 (24%)	4 (10%)
Stillborn	10 (8%)	2 (5%)	2 (5%)
Orphan/ewe died	2 (2%)	0 (0%)	4 (10%)
Hypothermia	0 (0%)	1 (3%)	6 (14%)
Predation	4 (3%)	4 (11%)	4 (11%)
Aborted	0 (0%)	2 (5%)	0 (0%)
Unknown	12 (9%)	10 (28%)	0 (0%)
Total	132	37	42

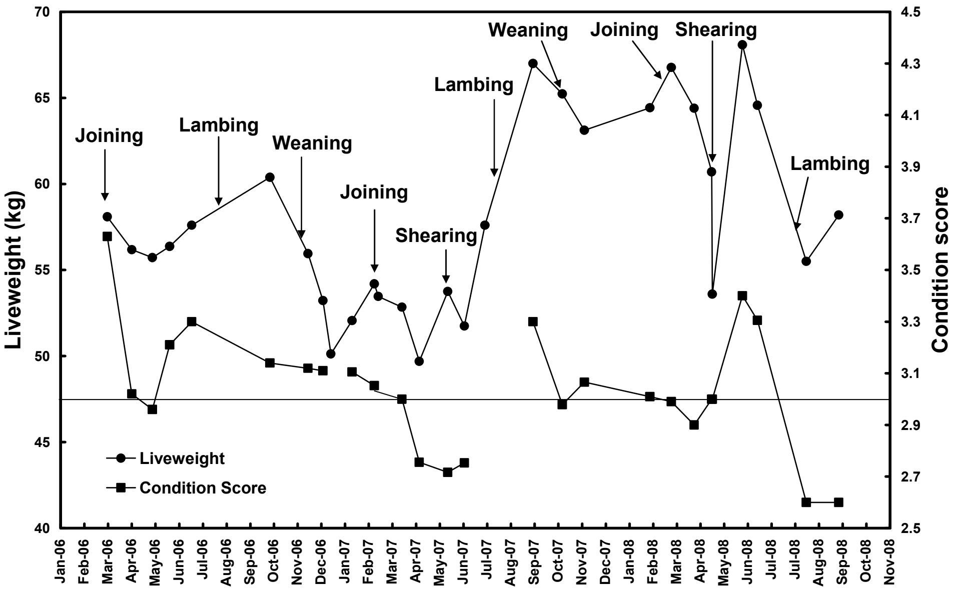


Figure 21. Liveweight (kg) and condition score of ewes at Wellstead proof site.

Table 19. Comparative performance of Wellstead proof site with MIDAS simulated annual and perennial pasture system.

	Rainfall (mm)	**Stocking rate (dse/ha)[a]**	**Supplementary feed (kg/ha)**	**No of lambs weaned per ha**	**Total lamb produced (kg/ha)**	**Total lamb produced per 100 mm (kg/ha/100mm)**	**Profit $/ha**
Simulated annual	500	8.5	279	4.6	161	32	32
Simulated perennial	500	12.0	95	7.3	260	52	82
Field site 2006	290	9.9	559	7.8	195	67	-259
Field site 2007	333	6.0	627	4.7	197	60	-180
Field site 2008[b]	227	6.1	227	5.0	-	-	-

[a] Based on one Merino ewe is equivalent to1.5 dse. [b] to date ~ end of September.

Component experiments Unfortunately the ovulation study was not conducted in 2008 as a consequence of the drought conditions. The ovulation work is now concluded. The results from 2006 are presented in Table 20 and Figure 22. Two factors significantly influenced ovulation rate in the 2006 experiment, higher liveweight and to a lesser degree condition score, independent of treatment increased ovulation rate. The relationship between liveweight, condition and ovulation is not surprising since the impact of ewe nutrition on ovulation is well understood. Kikuyu pasture resulted in a small decrease in ovulation rate however this was not significant (Table 20). Overall ovulation rates were high in this experiment possibly as a result of the availability of green feed across all treatments due to a substantial rainfall event (Figure 22). While it is not possible to speculate whether dry annual pasture alone would have resulted in lower ovulation rates compared to green kikuyu the EverGraze investigation at Wagga is suggesting a relationship between ovulation rate and the amount of available green feed irrespective of pasture type.

Changes in basal cover at the winter production site are presented in Figure 23. Interestingly only 3 perennials have a higher basal cover now than in 2006 that is kikuyu, setaria and tall wheat grass. These species are demonstrating excellent drought tolerance. Amongst the tall fescues the winter active cultivar Fraydo is proving to be more persistent than Quantum. This is not entirely unexpected given the loss of Quantum at the main site and the superior drought tolerance of the winter active types. Plantain and lucerne basal cover has declined to zero and chicory to 0.2%. While it is uncertain to what extent this decline has been caused by the drought the loss of plants to some extent has been caused by preferential grazing by native wildlife. The greatest increases in winter pasture yield have been achieved by sowing either oats or annual ryegrass into summer active perennial stands (Figure 24). Winter production data for 2008 is not presented as growth has been poor due to drought and kangaroos from the coastal reserve have grazed what little has grown. We are planning to measure winter growth of key treatments in 2009.

Table 20. Ovulation study 2006 Numbers of ewes in each ovulation rate category

Treatment	**Ovulation rate**				**Significantly different at P<0.05**
	1	**2**	**2**	**Mean**	
Annual pasture	34	36	0	1.51	a
Annual pasture + lupins	34	35	2	1.55	a
Kikuyu pasture	42	24	1	1.39	a

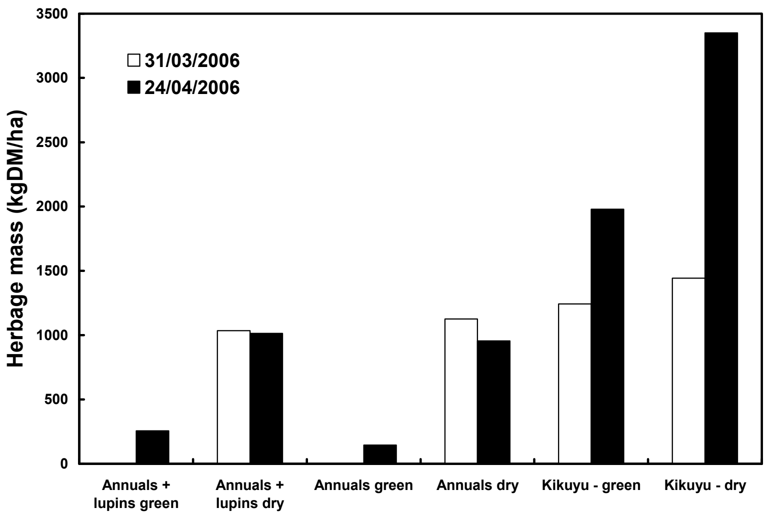


Figure 22. Green and dry herbage mass on the 31st March and 24th April 2006 at Wellstead ovulation study site.

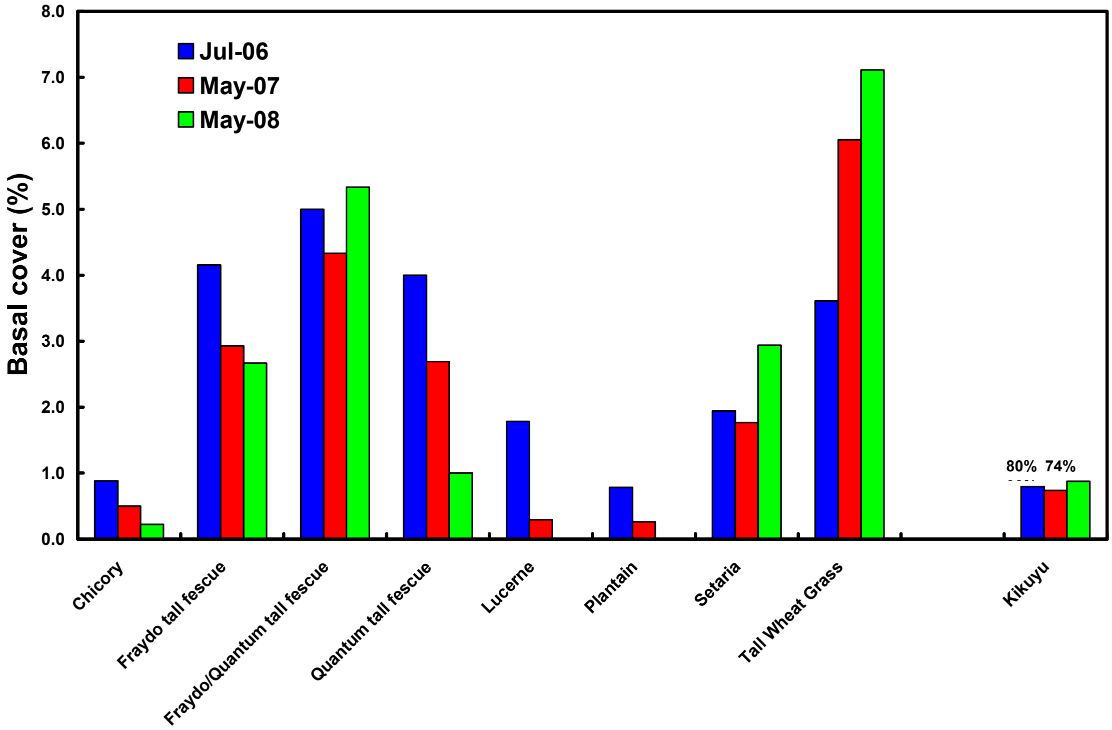


Figure 23. Basal cover (%) of tall fescue, lucerne, plantain, setaria, tall wheat grass and chicory plus percent cover of kikuyu at the Wellstead winter production site in July 2006, May 2007 and May 2008.

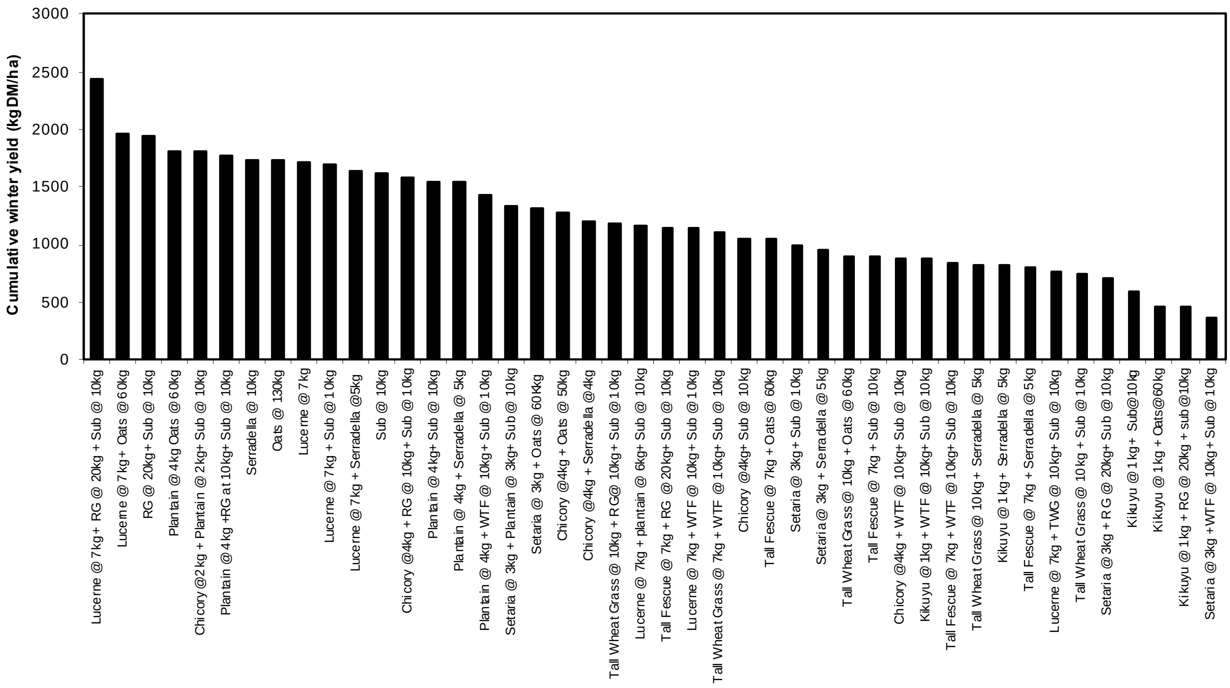


Figure 24. Winter growth rates of treatments in 2007 at winter pasture production trial Wellstead.

4.2.2 Hamilton Results and Discussion

Figure 25. The Hamilton Proof Site.

Performance of the farming system: Results under drought conditions in 2006 and those in 2007 indicate that the site is likely to demonstrate improvements in productivity that are close to 50% greater than performance indicators (DSE/ha, liveweight/ha, liveweight/ha/100mm rainfall) for the top 20% of lamb, beef and wool enterprises as benchmarked in the Farm Monitor Project. For some indicators the site is close to doubling industry average figures.

These results require further validation under full statistical analysis and economic analyses to determine how effectively the plot/experimental scale performance of the pasture and animal systems translate to whole farm profitability. The site is also showing increased water use and drier soil profiles under summer active species.

The site is starting to show significant changes in pasture composition and species persistence. New results on species persistence and productivity life of these pastures systems that will occur over the next two years of the project will be critical for determining the sustainability of increased productivity from the EverGraze systems. Furthermore, validating the long term nature of the results will lead to improved adoption and uptake of the project outcomes by industry. While a large number of producers have been very involved with the site and continue to visit, it is clear many are watching and waiting for long term persistency and production data coupled with economics to convince them.

The project has now completed two full production years and while the full statistical analysis on all data is yet to be completed the interim findings can be summarised as follows;

Summer actives pastures on appropriate soil types perform: The performance and the approach of matching pasture species to areas of the landscape where they are most likely to perform has allowed pastures to thrive at the Hamilton site. The growth and persistence of Tall Fescue on the valley floors and the 3-4 four year old stands of Chicory and Lucerne on the crests have been very successful.

Increased summer / autumn feed & quality: The pastures have been able to extend the shoulders of the growing season with improved pasture growth at the end of the growing season and early growth after the autumn break. The triple system has been particularly effective in capturing the benefits of Lucerne and Tall Fescue but also a highly productive perennial ryegrass pasture for winter growth.

Increased flexibility to manage variable seasons: The 2006 / 2007 growing season had a short spring and extended dry period punctuated by a high summer rainfall total. Under these conditions the Triple and Novel pasture systems were able save up to $20/head in containment feeding costs compared to the Perennial ryegrass system which was unable to respond to the summer rainfall. Thus summer activity of these pastures systems has allowed some flexibility to cope with variable rainfall and growing conditions with reduced supplementary feeding.

Good winter growth with modern cultivars: The site has shown that with modern cultivars of summer active pastures the trade off for winter growth has not been significant. In other words, summer activity does not have to come at the expense of winter production.

High overall pasture dry matter production: Pasture production has been very high across the trial supporting high stocking rates throughout spring and into summer and autumn.

There has been increased water use, particularly from lucerne and chicory: Lucerne and Chicory have continued to draw down soil moisture to facilitate growth at depths of 3m.

Modern perennial ryegrasses offer high winter/spring production but have not persisted as well after 2006: The cultivars Fitzroy and Avalon have suffered the most from the 2006 season with clear losses in plant frequency and count.

Summer-active tall fescue production and persistence is improved by: Sowing low lying heavy soils, Rotational grazing based on the 3-leaf stage, Applying 25 kg N/ha after break for rapid autumn/winter growth

Summer actives - green cover and plants for soil stability: Summer active pastures have maintained ground cover within pastures despite heavy grazing during hot and dry times of the year.

Pre- Experimental Modelling has shown the merino – meat terminal system is highly profitable but as pasture summer activity increases there is more benefit for meat enterprises. However, results from the current trial call into question some of the assumptions of the modelling and these differences may influence the outcome of post-experimental modelling.

Sheep systems geared for high twinning offer higher production per hectare but: Ewe condition score, Feed on Offer, feed quality, stocking rate and lamb growth needs to be managed to meet specifications of market segments. Single lambing systems still show substantial productivity and allow for higher turnoff weights.

Summer active pastures offer some advantages in stocking rate and growth late in the growing season for cattle backgrounding; Cattle systems have primarily differed in the stocking rate achieved but in both the Perennial Ryegrass and Triple pasture systems performance has been outstanding setting new benchmarks for beef production per hectare.

Overall the project is showing that improved pastures carefully managed can double productivity over the district averages. By matching the species to the landscape production is optimised and persistence improved. This should lead to a sustainable increase in productivity and financial profitability while also and improving efficiency of resource use.

NRM performance:

Soil moisture

Crests: Over the 2m of the soil profile, the annual pattern of soil wet-up and dry-down was similar for all 3 pasture species, but Fitzroy perennial ryegrass was consistently wetter than Lucerne or chicory (Figure 26). At a depth of 3m, Fitzroy had an increase in soil moisture in the winters of 2007 and 2008, as the winter water surplus wetted up this layer. Because Fitzroy does not have roots at this depth, this water is most likely to pass through this layer to eventually join the groundwater table. However, Lucerne and chicory did not experience the annual soil wetting cycle at this depth, and have instead continued to dry the soil out since the start of measurements in February 2006 (Figure 27).

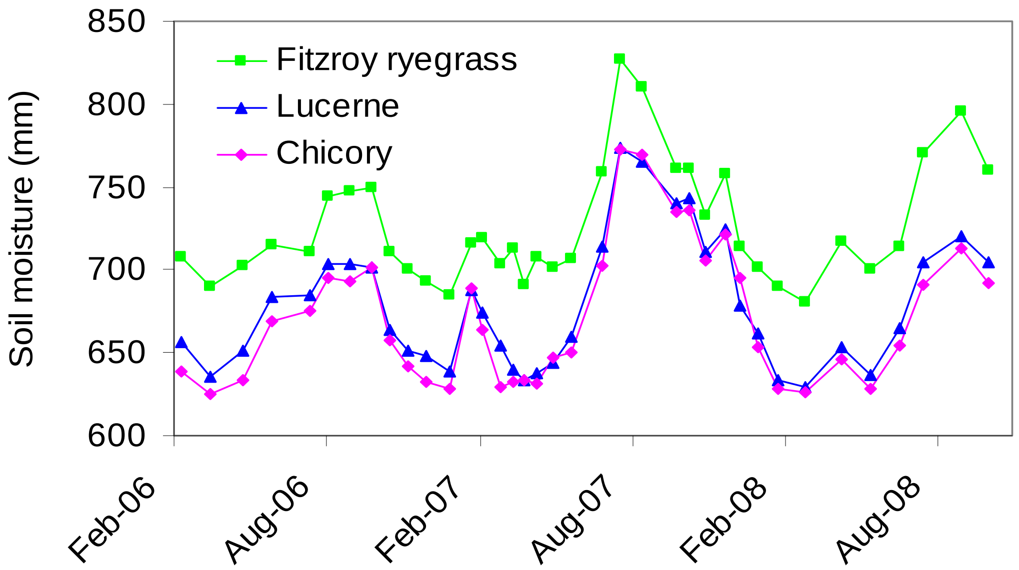


Figure 26. Soil moisture 0.1 to 2m on the crests

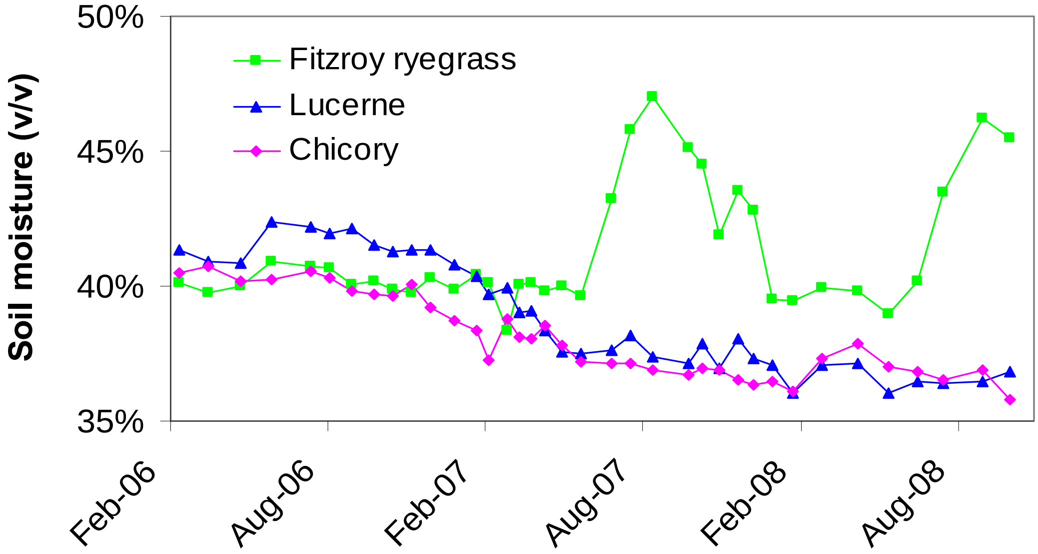


Figure 27. Soil moisture at 3m depth on crests

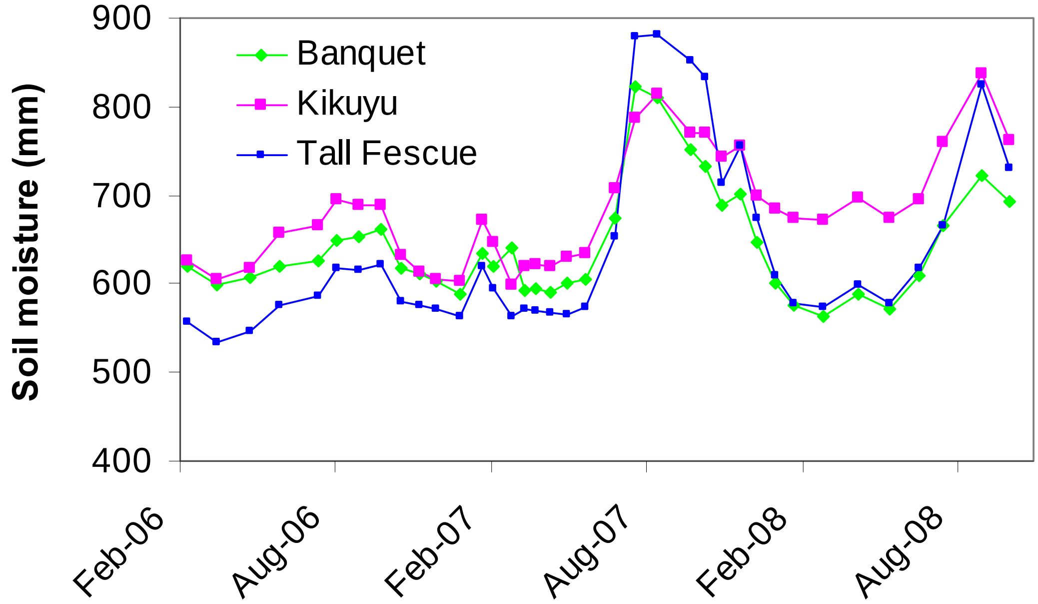


Figure 28. Soil moisture 0.1 to 2m on valleys

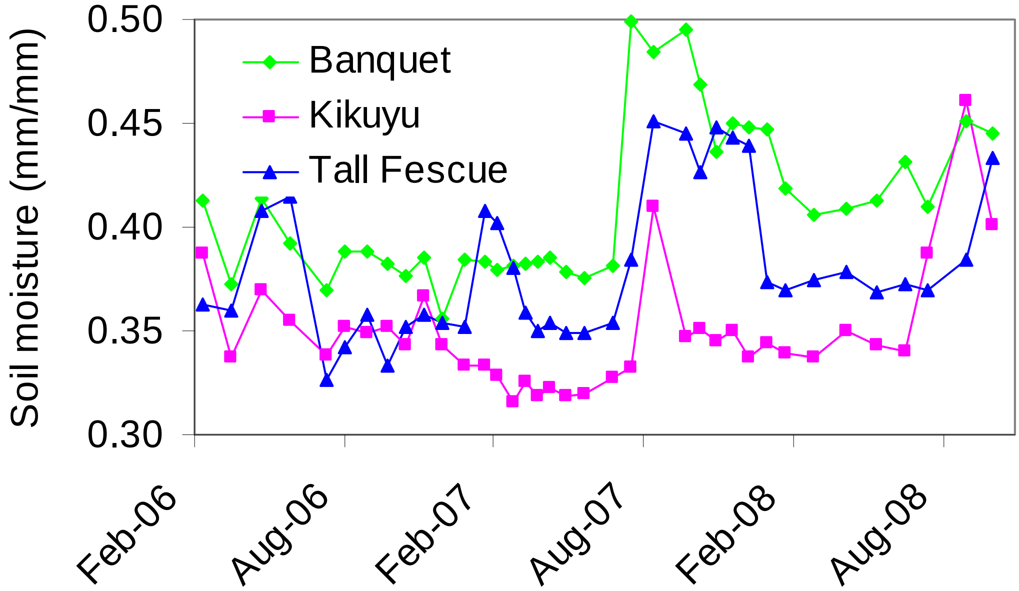


Figure 29. Soil moisture 3m on valleys

Valleys: In the summer of 2007/08, the wettest treatment was kikuyu, while tall fescue and Banquet both had similar soil moisture (Figure 28). This contrasts with the previous 2 summers, when kikuyu was more similar to the other species to a depth of 2m, and drier than other species at a depth of 3m (Figure 29). The high level of moisture on the kikuyu treatment was surprising, and was caused by a large carryover of annual clover and silver grass dry matter following good spring growth. This delayed the growth of kikuyu until mid to late January 2008. The presence of kikuyu does not therefore guarantee good summer water use if the dry residues of annual species are allowed to dominate during summer and the Kikuyu fails to establish in the sward. Winter cleaning was conducted on the kikuyu treatment in July 2008 to reduce its silver grass content.

Soil characteristics, calibration and water balance modelling: Soil pits were excavated in October 2007 and March 2008 to determine water-holding characteristics of the soil for modelling and develop a calibration relationship for the neutron probe. Comparison of soil moisture between the 2 sampling dates provides an estimate of the plant-available water-holding capacity (Table 21), which is not dependent on the calibration relationship used for the neutron probe. Between October 2007 and March 2008, the tall fescue pasture was able to extract from the top 1.6m of the soil profile, 160 mm on the crest, and 210 mm on the valley. This compares with a value of 217 mm in pre-experimental modelling for both parts of the landscape.

Table 21. Comparison of the lower limit (LL) of plant-extractable soil water, the drained upper limit (DUL) from soil pit determinations of the EverGraze site, and values used in pre-experimental modelling.

Depth mm	Crest		Valley		Model	
	Mar 08	Oct 07	Mar 08	Oct 07		
	LL	DUL	LL	DUL	LL	DUL
	mm water/mm soil					
0-100	0.08	0.45	0.07	0.43	0.16	0.36
100-200	0.15	0.30	0.12	0.40	0.13	0.30
200-400	0.21	0.35	0.17	0.35	0.13	0.30
400-600	0.33	0.46	0.35	0.46	0.21	0.29
600-800	0.40	0.47	0.39	0.47	0.24	0.37
800-1100	0.42	0.49	0.43	0.50	0.24	0.37
1100-1300	0.46	0.51	0.46	0.54	0.24	0.37
1300-1600	0.50	0.53	0.41	0.51	0.24	0.37

These revised soil parameters have been used in several modelling studies, including a study of the influence of climate change on pasture production led by Brendan Cullen, in GrassGro and Farmwise modelling as part of a Masters within the EverGraze project by Andrew Kennedy, and in the CAT1D implementation of the PERFECT model. Soil samples were also taken in October and March to calibrate continuously recording soil moisture sensors attached to the weather station. These sensors are located beneath Italian ryegrass and a tall wheatgrass hedge. Preliminary simulations have shown good agreement between observed soil moisture from these continuously-recording sensors, and simulations for Italian ryegrass (Figure 30). Soil beneath the tall wheatgrass hedge was consistently drier than the Italian ryegrass, because the tall grass of the hedge intercepts more rainfall, and its high green leaf area causes more rapid depletion of soil moisture.

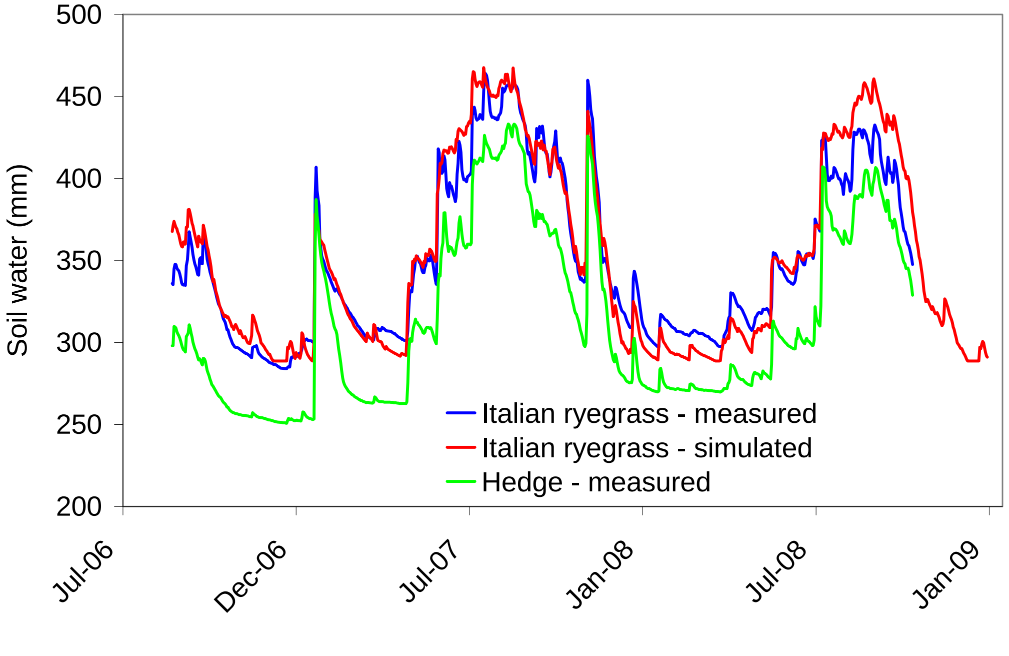


Figure 30. Soil moisture 0-1m recorded beneath Italian ryegrass and a tall wheatgrass hedge near the weather station, and simulated by the CAT-PERFECT model for Italian ryegrass (preliminary data).

The simulation model was supplied with weather data from 2006 to complete the year 2008 from 10 October onwards, as an indication of what could occur if spring weather remained dry. The simulation showed that by 22 October, soil moisture would be similar to that just prior to a 107 mm rainfall event in November 2007. By 12 November 2008 (the date of a planned Hamilton open day), soil moisture would be similar to that of 31 October 2006 – a year when growth finished much earlier than normal.

The CAT-PERFECT model has been used to provide a check on the neutron probe calibration. There was good agreement between modelled and NMM soil moisture for the crest (Figure 31), but for the valley, the NMM calibration appears to over-predict soil moisture at the wet end (Figure 32). The degree of soil wetting calculated from NMM data for July and August 2007 could not have been achieved with the rainfall that was measured. The calibration will be revised in early 2009.

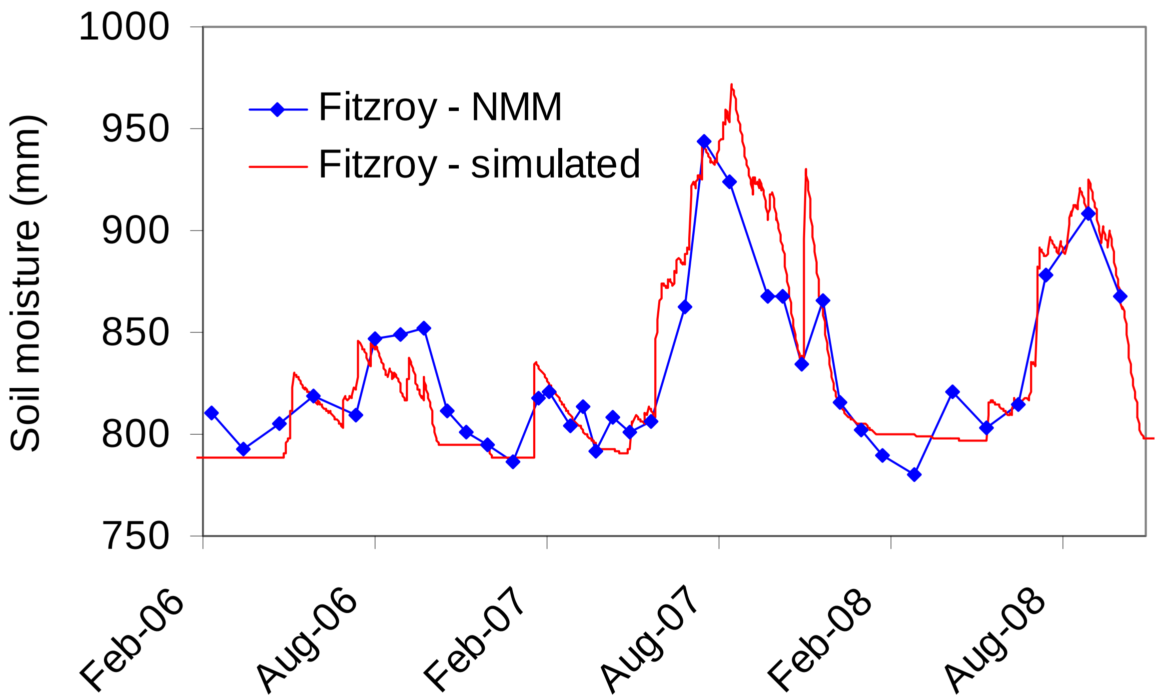


Figure 31. Soil moisture 0.1 to 2.25m from NMM measurements and a simulation for Fitzroy perennial ryegrass on the crest

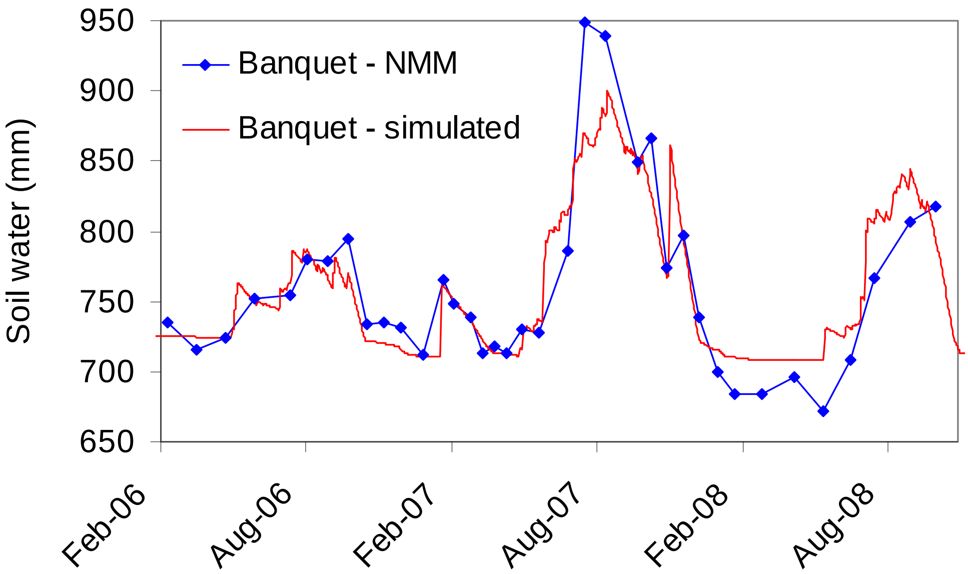


Figure 32. Soil moisture 0.1 to 2.25m from NMM measurements and a simulation for Banquet perennial ryegrass on the valley

Ground cover: Bare ground has been highest on the chicory and Lucerne pastures, but even here it rarely exceeded 20% except when these pastures were establishing in 2006 (Figure 33). When the proportion of bare ground exceeds 30%, the risk of erosion increases dramatically, because patches of bare ground tend to inter-connect.

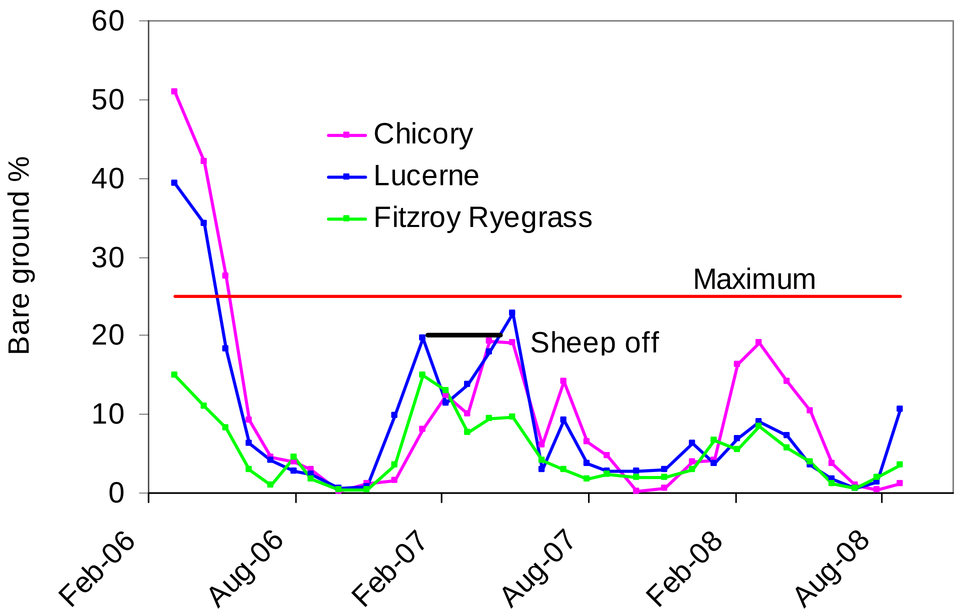


Figure 33. Proportion of bare ground for pasture types on hilltops. A desirable maximum level of 25% is shown by the red line, and the period when sheep were removed from the ryegrass treatment as a black line.

Both Lucerne and chicory exceeded 20% bare ground at 10% of pasture assessments, whereas kikuyu and Italian ryegrass exceeded it at 3% of assessments. Avalon, Fitzroy and tall fescue never exceeded the 20% bare ground level (Figure 34).

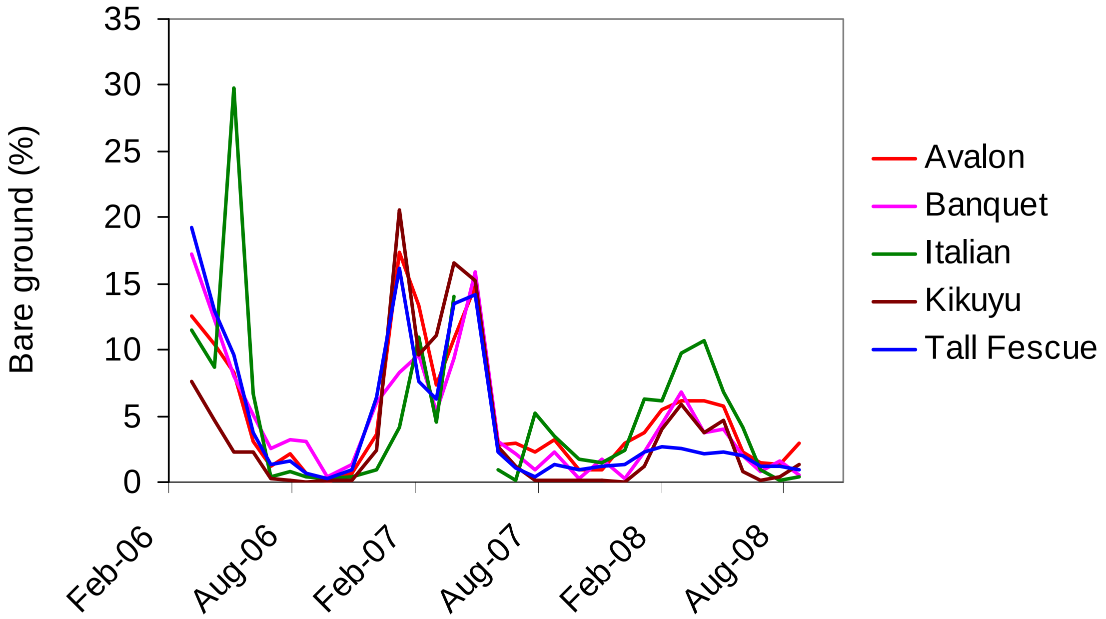


Figure 34. Proportion of bare ground for pasture types on slopes and valleys.

Runoff: Surface runoff is measured from about half the site, but cannot be assigned to treatments. No runoff was recorded in 2006 or 2008, but in 2007 a total runoff of 12 mm was recorded (Figure 35 and 36). Surface inspection during each runoff event showed that kikuyu (which had dried the soil out well in the summer of 2006) appeared to have as much surface water as other treatments on the valley, such as tall fescue. With high water-using perennials covering most of the landscape on the EverGraze site, runoff can be expected to occur more erratically than where annual pastures or crops dominate.

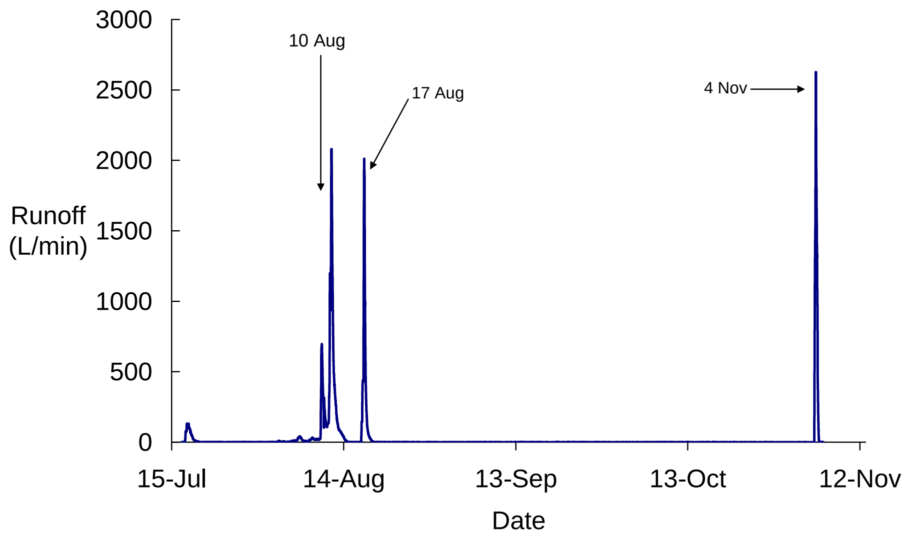


Figure 35. Runoff occurrences in 2007.

Figure 36. Surface runoff at the measurement flume 17 August 2007

Wind speed and lambing shelter: In May 2008, Italian ryegrass between the tall wheatgrass hedges was sprayed out and resown to Banquet II ryegrass. By lambing time in September 2008, there was only sufficient feed on the newly sown pasture in the hedgerow areas to support one third of ewes, and the other two thirds lambed in open paddocks on the slope and valley. No groups of ewes lambed on the more exposed crest areas. Wind speed was measured at a lamb height of 40 cm in some of the open paddocks and compared to that at a height of 2.3m at the weather station, which is located in one of the hedgerow areas. Wind speed was also measured at various distances from the hedges near the weather station. Since wind speed has little influence on lamb survival when winds are light, only data from 10-minute time increments when the wind speed at a 2.3m height exceeded the upper quartile (14.9 km/hr) were selected for further analysis. During September 2008, the majority of these winds were from the north-west, followed by the north, and then the west (Table 22). However, previous analyses have shown that winds with a westerly component (north-west, west and south-west) are the most dangerous for lambing, because it often coincides with rain and low temperatures.

Table 22. Direction of wind that exceeded the upper quartile wind speed

Wind direction	Occurrence (%)
NW	40.6
N	26.3
W	19.2
SW	9.2
S	4.4
SE	0.4
E	0.0
NE	0.0

When wind was from the west, wind speed in open paddock on the exposed crests ranged from 61-65% of the 2.3m wind speed, while on the slope and valleys it was 49-56%, and adjacent to hedges less than 1% (Table 23). Weather conditions during the September 2008 lambing were mild, and few lamb deaths were attributed to hypothermia. Artificial shelter such as that provided by hedges is more likely to show benefit for winter lambing than the spring lambing practiced here.

Table 23. Wind speed during the September 2008 lambing period at various parts of the experimental site for the 3 most predominant wind directions.

Measurement location	Wind direction		
	N	NW	W
	Wind speed (% relative to that at 2.3m height)		
Open paddocks			
North crest	61	58	61
North valley	56	57	52
West crest	51	60	65
West slope	45	51	56
South valley	8	33	49
Near hedge on north block			
20cm to east of hedge	32	4	0.5
1m east of hedge	45	18	6
2.15 m east of hedge	47	30	18
5m east of hedge (middle)	56	46	33
2m west of hedge	60	52	41
20cm west of hedge	39	46	38
20cm east of hedge	17	1	0.3

Pasture results:

Total Pasture Production and growth rates: Total pasture production from May 2007 to April 2008 was higher compared to the previous year between May 2006 to April 2007 (Figure 37 and 38). However, the components of the totals have differed with winter, spring and early summer growth being a larger proportional contributor to the total production. Figure 37 shows the total dry matter accumulation per hectare for each pasture system over the last two and half production years. This data shows that for the highly winter-spring active perennial ryegrass system production was 49% greater in 2007/08 than 2006/07. In contrast the production from the triple system and novel systems with higher summer activity were only 26% and 5% greater respectively in 2007/08 than 2006/07. Species trends in the responsiveness to the spring growth are also reflected in Figure 38 where the perennial ryegrass pastures recorded the largest increases (40% to 60%), while Chicory and Lucerne produced only marginally more in 2007/08. The Quantum Tall Fescue was 24% greater.

Total pasture production from May 2007 to April 2008 varied from 8.5 t DM/ha for the Chicory up to 15.7 and 16.1 t DM/ha for the Avalon perennial ryegrass and Quantum Tall Fescue (Figure 35). The ryegrass pastures all performed well producing between 13.3 to 16.1t DM/ha compared to 11.7t DM/ha for Lucerne. Interestingly, the Kikuyu/sub-clover pasture produced 12.3t DM/ha, slightly more than year earlier but the composition of growth was substantially different between the two years (Figure 41). In the first year data Kikuyu summer growth contributed a large portion of growth while in 2006 it was the spring growth that set up the total. This difference in growth subsequently had impacts on the level of kikuyu performance with dead biomass reducing kikuyu growth during the summer-autumn period (Figure 38 & 40).

Total pasture production from the 2008 autumn break until July 2008 is also presented in Figures 37 and 38. Production was low from all pastures due to cool winter temperatures and low levels of solar radiation. Production was slightly better from the Tall Fescue, Avalon Perennial Ryegrass, Lucerne and Chicory pastures than from the others. On a system basis the Triple System has been the most productive and the novel system the least.

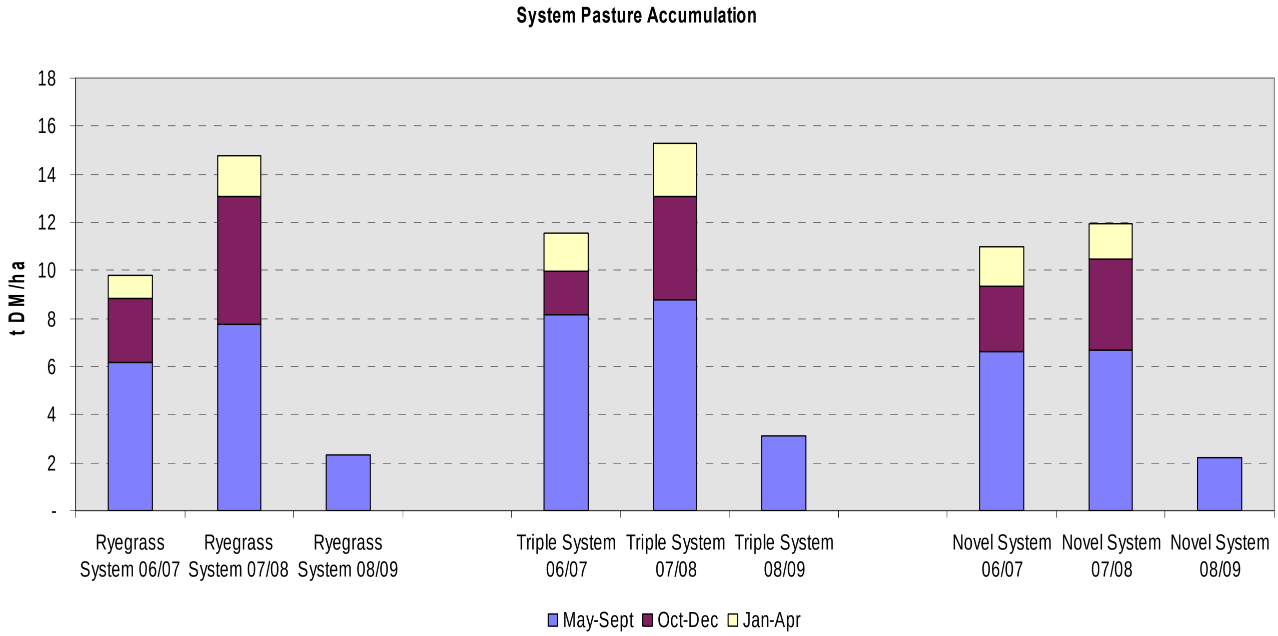


Figure 37. Pasture accumulation for each pasture system in total tonnes of dry matter per hectare from May 2006 to April 2007, May 2007 to April 2008 and May 2008 to July 2008.

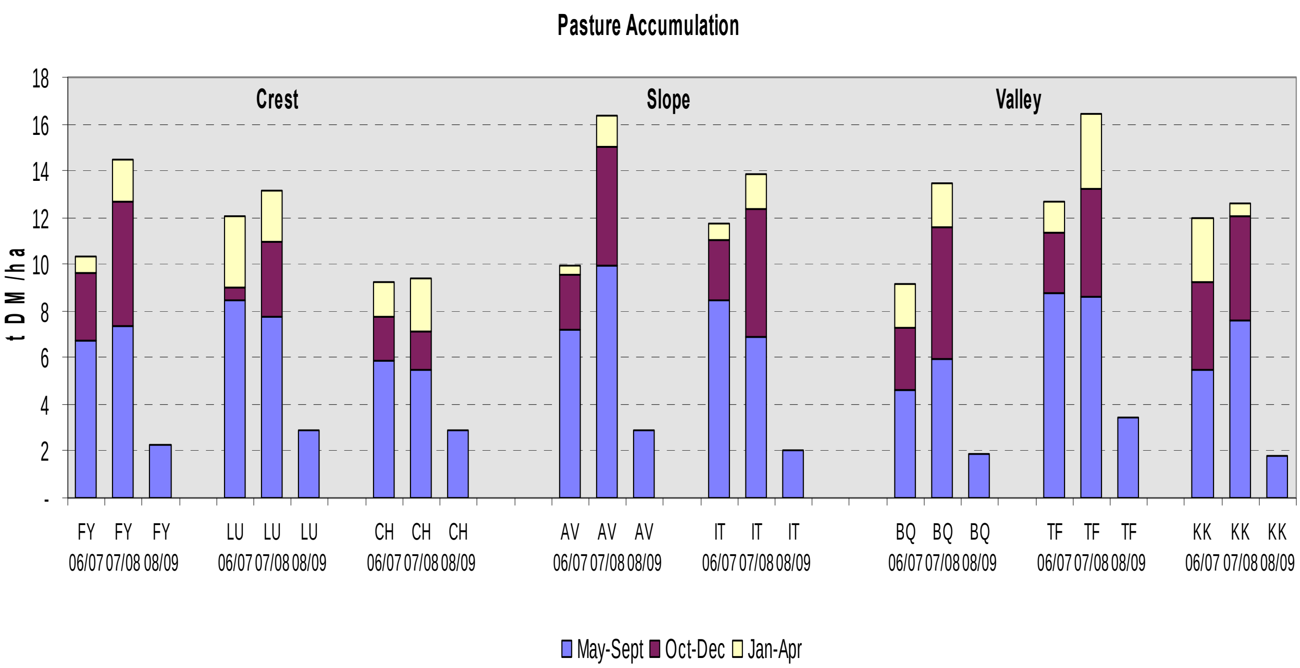


Figure 38. Pasture accumulation for pasture species in tonnes of dry matter per hectare from May 2006 to April 2007, May 2007 to April 2008 and May 2008 to July 2008.

The pasture growth rates for all systems and pastures are presented in Figures 39 and 40. General trends observed were;

- All pasture systems appeared to achieve similar peak spring growth.
- The Ryegrass and the Triple System appear to generally follow similar growth rates during the growing season (autumn break to pasture hay off).
- In 2007/08, summer and late autumn/early winter is where pastures and the systems start to differentiate. The Quantum tall fescue continued to grow at very high rates (>60kg DM/ha/day) during December and January comparing favourably with all other pastures ranging from 15 to 30kg DM/ha/day over the same period.
- The low growth rates for the Kikuyu/sub clover pasture in January to March 2008 are due to the hay off of annuals and sub-clover in these plots and the inhibition of the Kikuyu growth by high feed on offer dry matter levels from November (5000kg DM/ha) to February (3000kg DM/ha). Additionally, as reported earlier rainfall in summer – autumn 2008 was lower and the Kikuyu subsequently did grow (Figure 40).
- While the Novel system shows lower growth rates in winter, its spring growth is similar to the other systems. The lower winter growth arises due to the poorer growth of Chicory/sub-clover and Kikuyu/sub-clover in which the clover component does not have high growth rates until late winter-spring. Additionally, this system could also be improved with the replacement of the Italian ryegrass by an autumn-early winter performing perennial as the establishment phase of the Italian ryegrass reduces growth (Figure 40).
- Pasture growth rates for all treatments were below 30 kg/ha/day for most of winter 2008 and well below the growth rates measured in the winters of 2006 and 2007 (Figure 39 & 40). The Italian Ryegrass was re-sown in 2008 to Banquet II Ryegrass.

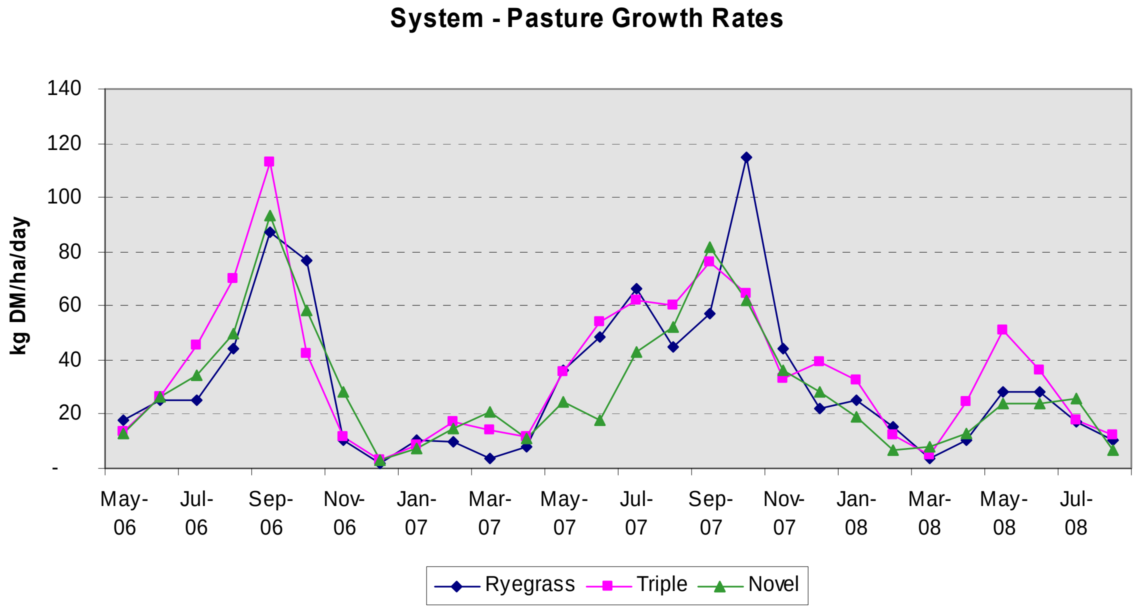


Figure 39. Pasture growth rates (kg DM/ha/day) from May 2006 to August 2008 for the three pasture systems.

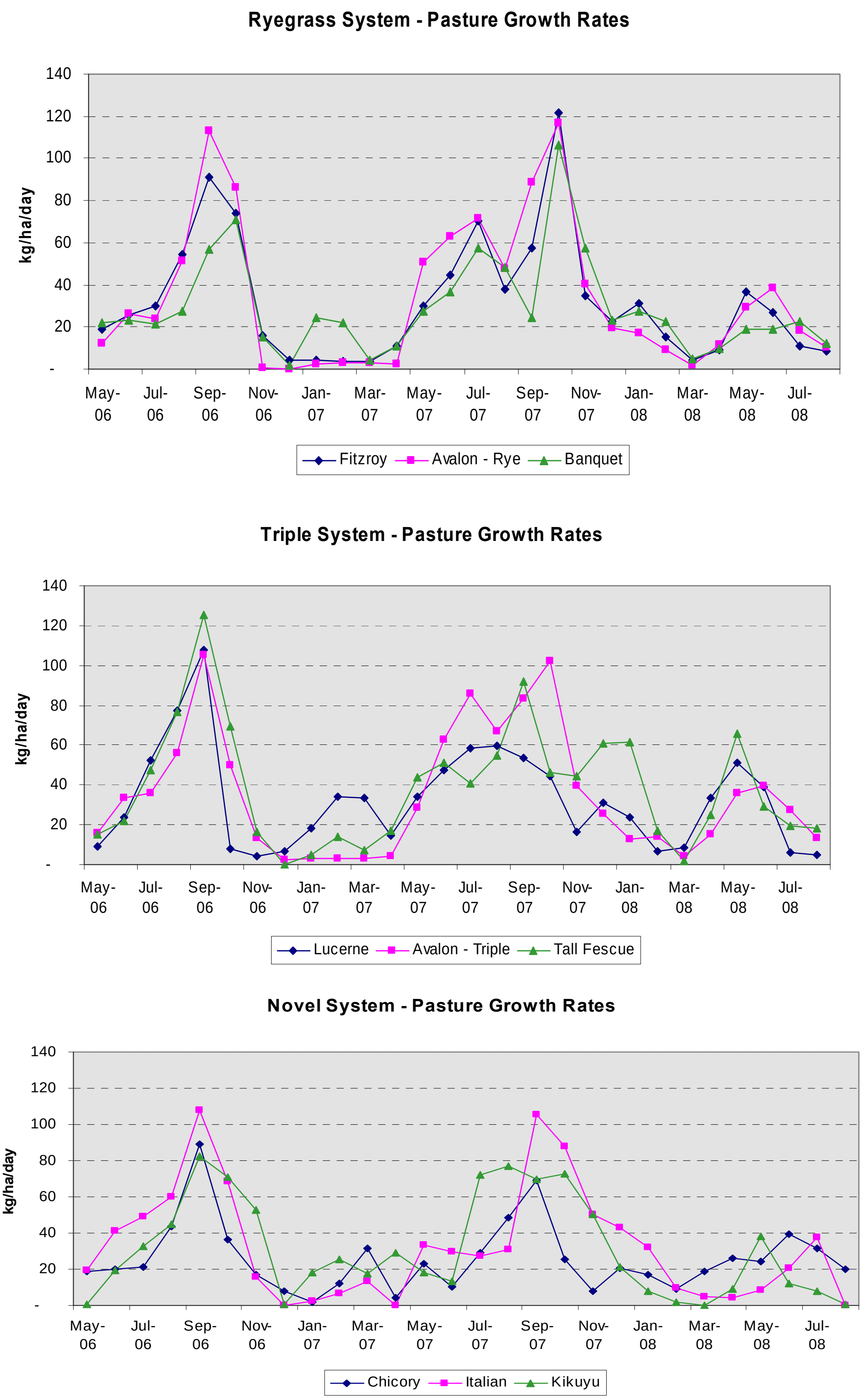


Figure 40. Pasture growth rates (kg DM/ha/day) from May 2006 to August 2008 for different pasture systems and their species.

Species Composition: Most pastures remain dominated by the sown perennial species, with the content of sown species in winter and spring of 2007 being comparable to the previous year (Figure 41). Fitzroy and Avalon perennial ryegrasses have declined in the content of sown species and the Italian ryegrass which had been resown. The newly sown Banquet II Perennial Ryegrass in the Novel System has been slow to establish (botanical composition data from early October has not yet been computed but the swards are now largely dominated by Perennial Ryegrass and Subterranean Clover).

Annual grass and broadleaf (mainly Erodium and Capeweed) weeds constituted up to 40% of the pasture mass in the Lucerne, Chicory and Italian Ryegrass pastures during the winter and spring of both 2006 and 2007. However composition for both Lucerne and Chicory were not dissimilar to the pattern followed by the Fitzroy and Avalon Ryegrasses.

Kikuyu made up only a small proportion of the pasture mass in winter and spring in both years but dominated the swards during the summer. However, Kikuyu did not regain the lost ground due to large mass of pasture produced at the end of 2007. The Kikuyu pastures in winter 2008 were dominated by Subterranean Clover and annual grass weeds. The annual grass has since been controlled with a winter cleaning (herbicide treatment) and grazing management. Time will tell how well the Kikuyu returns over the warmer months. There is visual evidence of a decline in Chicory plant numbers as we head into the warmer months and preliminary plant count data supports this observation. An assessment will be made later in the season whether or not to allow the Chicory stand to reseed.

As would be expected from the impact of the 2006 season annual weed species (both grass and broadleaf) have generally increased as a component of all pastures during 2007, colonising bare areas, where perennials or sown species were lost. Capeweed and to a lesser extent Erodium were problematic in most pastures in winter 2007 and 2008. A campaign of spraying and grazing has brought these weeds under good control by October 2008. Across most pastures the clover content has been lower in 2007 than in 2006 and again in 2008 (to date). Tall Fescue and Banquet have both increased as a component of their plots, while clover content has decreased. This may in part be function of the rotational grazing used on the trial. However, visual observations this spring are suggesting sufficient clover content in most pastures.

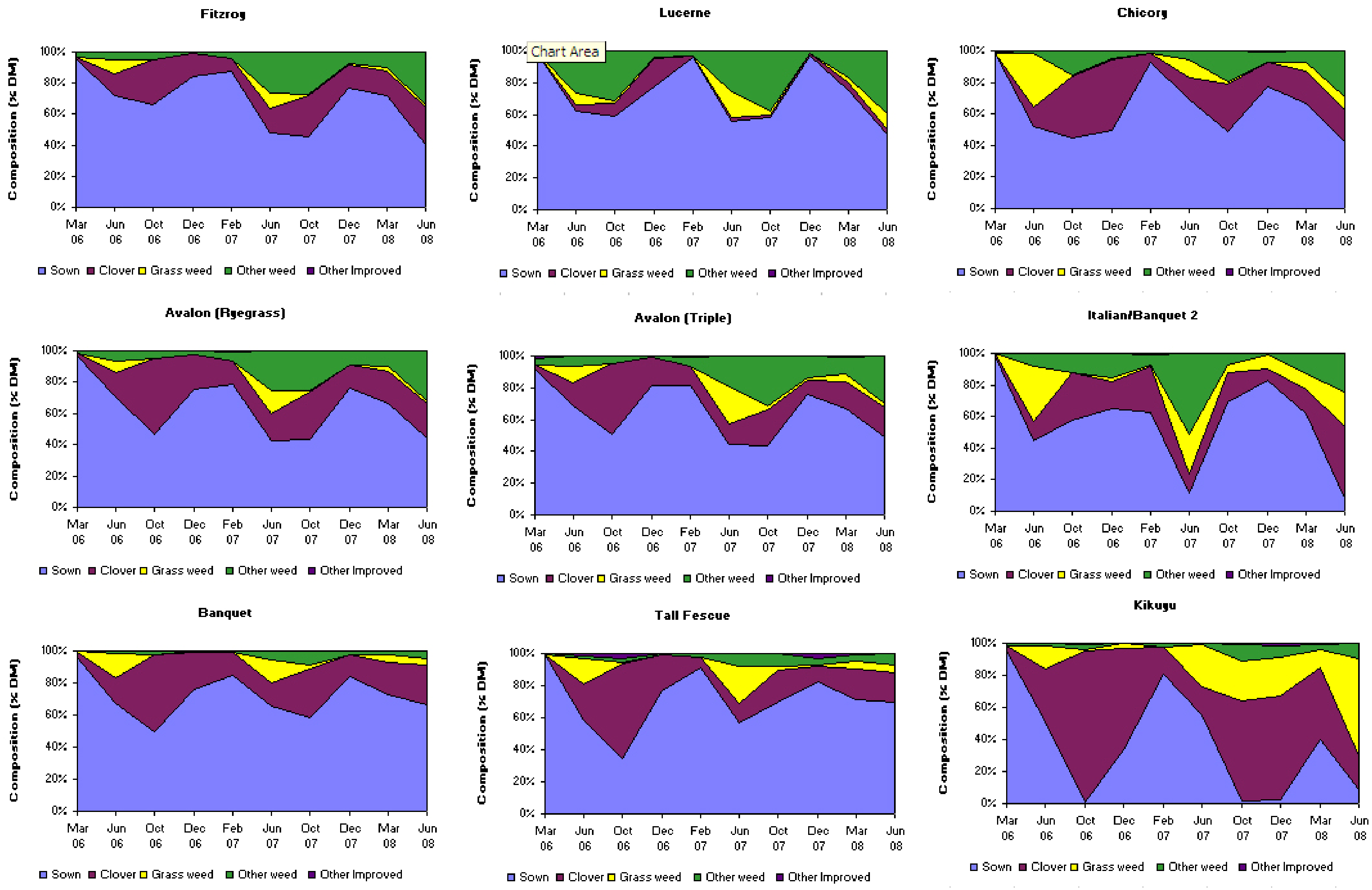


Figure 41. Botanical composition from March 2006 to June 2008.

Pasture persistence: The sown species have generally persisted well with the exception of the Fitzroy and Avalon perennial ryegrasses in which both the basal counts and plant frequencies declined markedly between 2006 and 2007 (Figures 42 and 43). The Italian ryegrass was resown in autumn 2007 due to poor persistence. The data presented is as reported for previous milestones as data for 2008 is yet to be fully updated and completed.

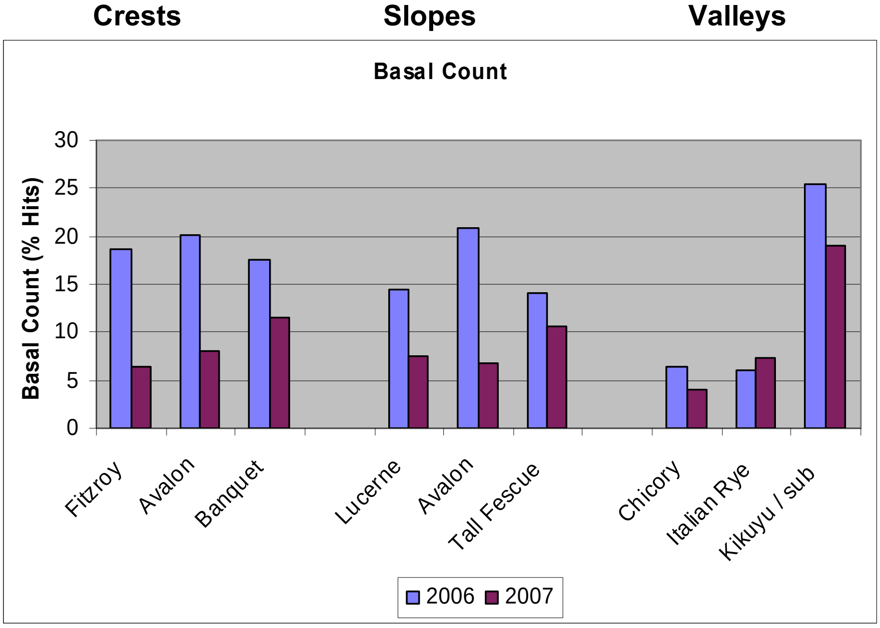


Figure 42. Basal counts in 2006 and 2007

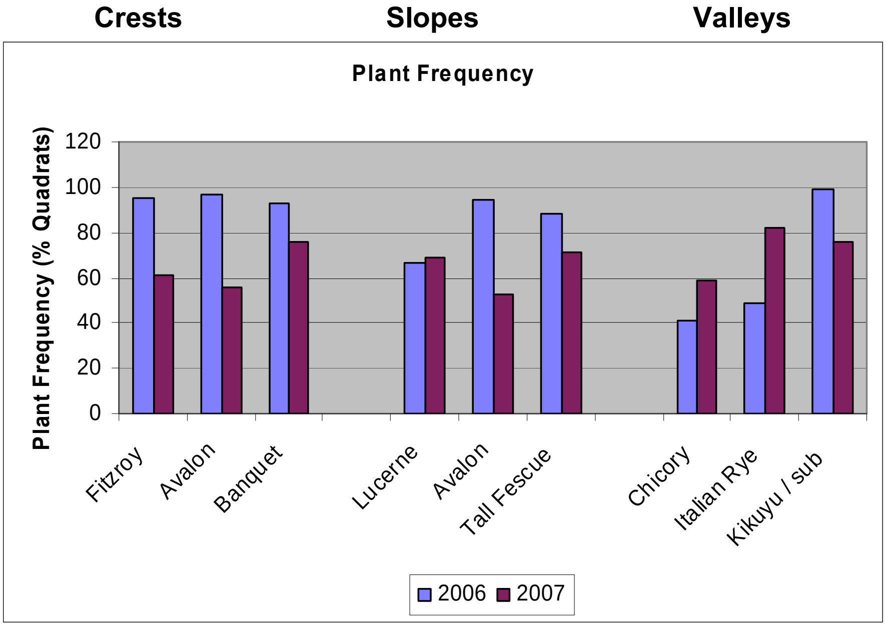


Figure 43. Plant frequency in 2006 and 2007.

Livestock: Livestock data for the 2006 year was reported at the May 2007 milestone report and further updates for 2007 data were included in the November 2007 Milestone Report and May 2008 Milestone Reports. For the purposes of this report data from these previous reports are presented and additional information across the two years of data has been summarised.

Stocking rate: In 2007/2008 the sheep systems increased stocking rate, reflecting the better seasonal conditions than those experienced in 2006/2007 (Figures 44 and 45). The mean stocking rates for twin lambing systems compared to the single lambing system is presented in Figure 46.

In Figures 47, 48, 49, 50 and 51 the breakdown of stocking rate for the pasture system treatments (e.g. Novel, Ryegrass and Triple systems) and the single and twin lambing treatments is provided. Within each figure the amount of stocking rate attributed to each pasture type within a system can be seen on a monthly basis (number of ewes multiplied by the proportion of days spent on pasture type). Most notable is the reduction in stocking rate for the Ryegrass systems in early 2007 after low annual rainfall during 2006 and the increase in stocking rate from July 2007 onwards. (This is also reflected in Figure 44 and 45 and in the liveweight and condition score presented later). Although the stocking rates are better in the Novel and Triple systems, it must be noted that the stocking rate for all three systems are at high levels and in the vicinity of approximately 30-40 DSE/ha.

Since May 2006 stocking rates have averaged approximately 14-15 ewes per hectare (Table 24.) Proportion of grazing time on each land class and relevant pasture type have been similar, with the exception of the flat areas on both the Novel and Ryegrass single treatments (the relevant pasture type can be ascertained by referring to the experimental design (e.g. Flat for the Novel system contains Kikuyu).

Table 24. Summary of stocking rate for system and single and twin lambing treatments from May 2006 to May 2008. Included is the average stocking rate for the period, the proportion of stocking rate spent on each land class, including time spent on the Tall Wheat Grass (TWG) hedges for the twin lambing treatments.

System	Pregnancy Status	Average (Ewes/ha)	Flat (%)	Slope (%)	Crest (%)	Tall Wheat Grass Hedgerows (%)
Novel	Single	14.8	41	28	31	
Ryegrass	Single	14.5	38	30	32	
Triple	Single	15.1	32	35	33	
Ryegrass	Twin	13.7	32	30	26	11
Triple	Twin	14.7	31	26	31	12

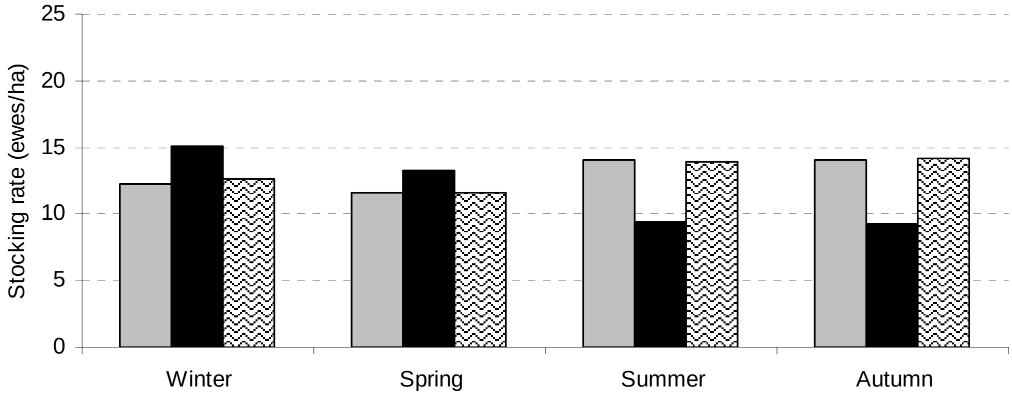


Figure 44. Stocking rate for single lambing systems for Novel (▫), Ryegrass (■) and Triple (▨) in 2006-07

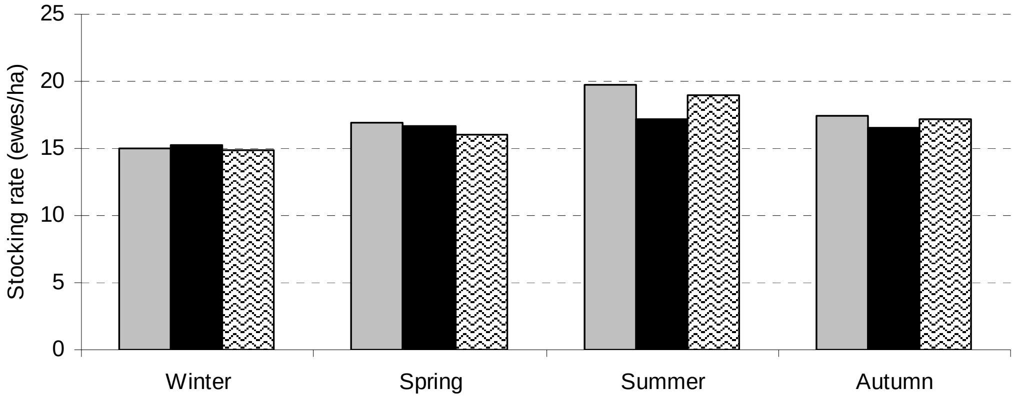


Figure 45. Stocking rate for single lambing systems for Novel (▫), Ryegrass (■) and Triple (▨) in 2007-08 (▫).

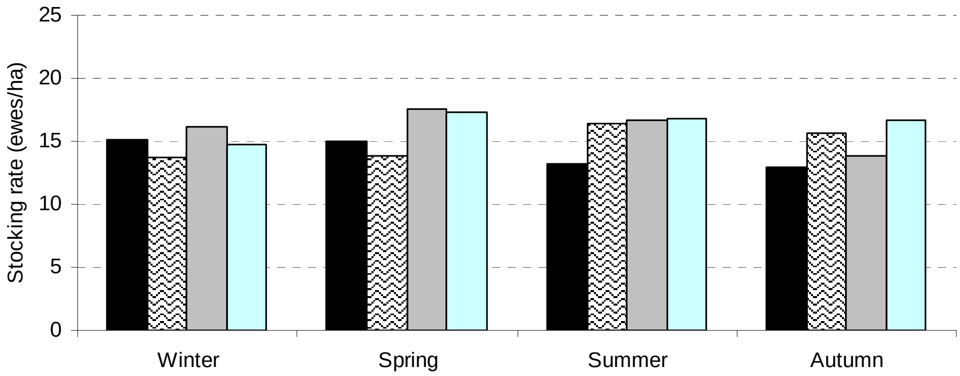


Figure 46. Mean stocking rate for Ryegrass (■) and Triple (▨) single lambing systems and Ryegrass (▫) and Triple (▫) twin lambing systems.

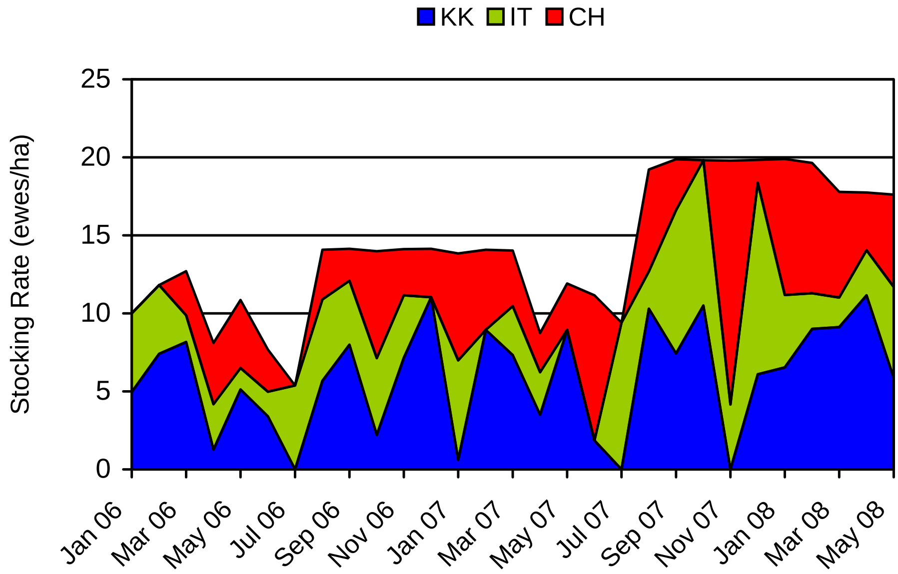


Figure 47. Stocking rate for the novel system and single lambing ewe treatment. Kikuyu (KK), Italian ryegrass (IT) and Chicory (CH) are the pasture types in the novel system. The contribution of the Kikuyu pasture over summer allows stocking rate to be maintained, however its contribution during winter months is a result of sub clover and annual grass production.

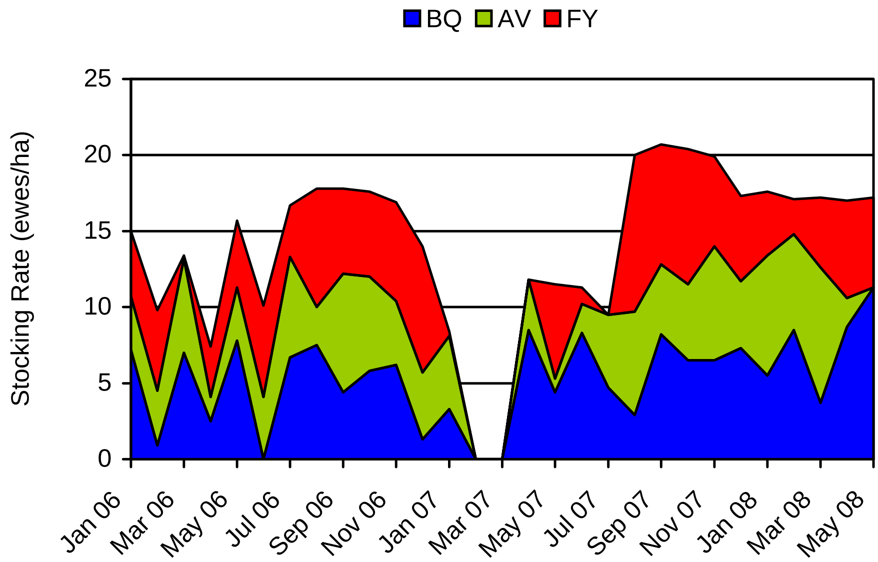


Figure 48. Stocking rate for the Ryegrass system and single lambing ewe treatment. Banquet ryegrass (BQ), Avalon ryegrass (AV) and Fitzroy ryegrass (FY) are the pasture types in the Ryegrass system. High stocking rates during late winter and spring are required to utilise pasture growth, however this struggles to be maintained during late spring and summer. Note the destocking of the system in early summer 2007.

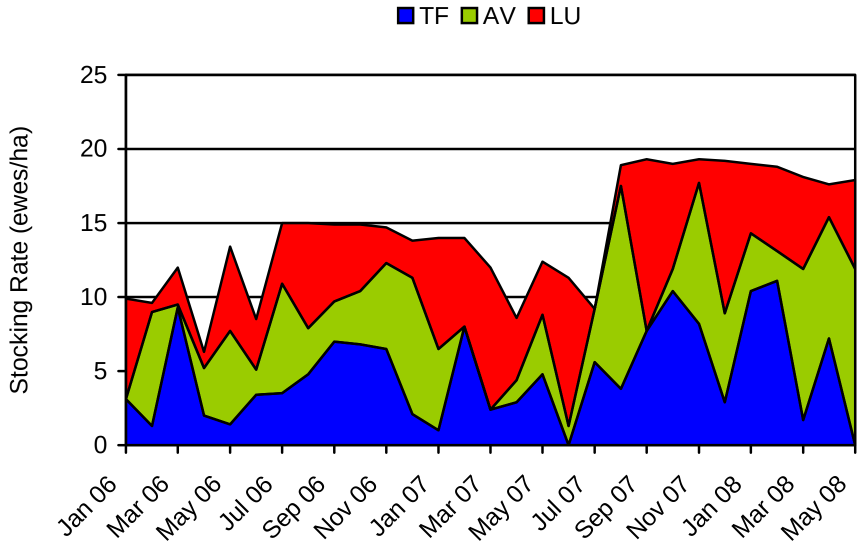


Figure 49. Stocking rate for the Triple system and single lambing ewe treatment. Tall Fescue (TF), Avalon ryegrass (AV) and Lucerne (LU) are the pasture types in the Triple system. The Triple system has been able to carry a similar stocking rate achieved by the novel system. Note the contribution of Lucerne and Tall Fescue to the stocking rate in winter 2006 and 2007.

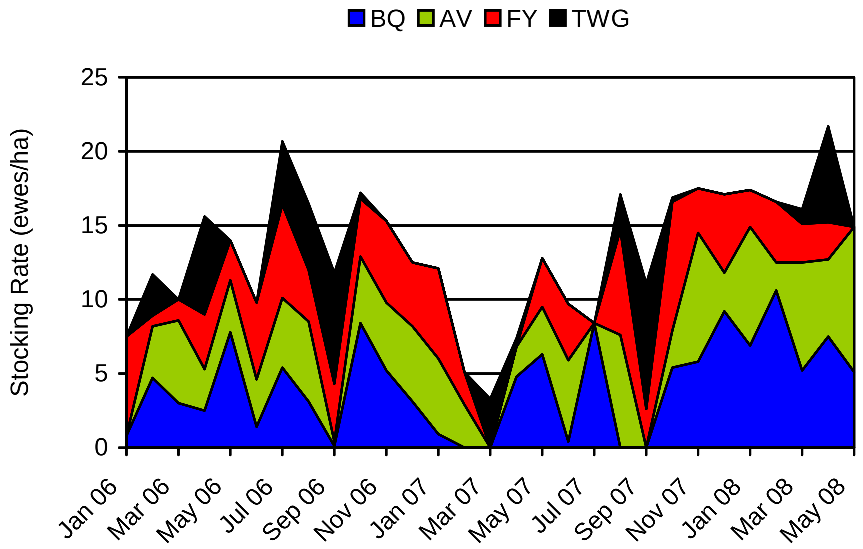


Figure 50. Stocking rate for the Ryegrass system and twin lambing ewe treatment. Banquet ryegrass (BQ), Avalon ryegrass (AV) and Fitzroy ryegrass (FY) are the pasture types in the Ryegrass system. The black bars represent when livestock entered the Tall Wheat Grass (TWG) hedges, with the periods corresponding to September/October representing lambing and other periods by additional livestock for hedge management. Note that ewes were removed from system during late January in 2007.

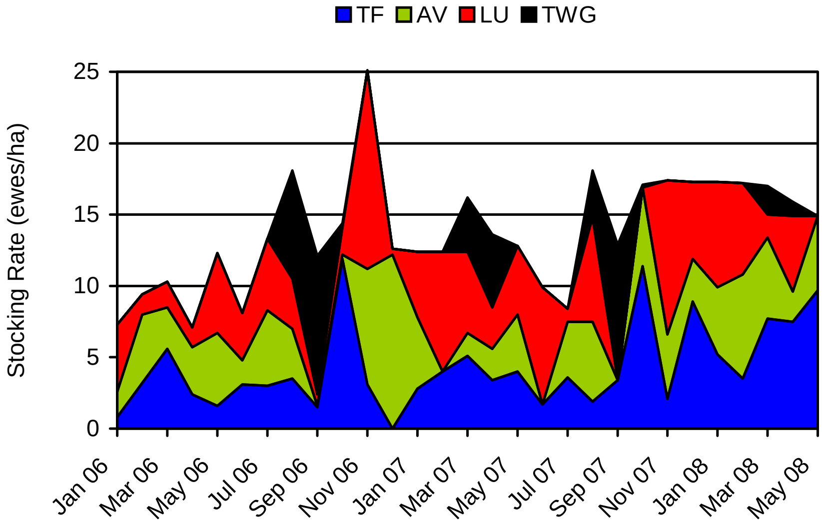


Figure 51. Stocking rate for the Triple system and twin lambing ewe treatment. Tall Fescue (TF), Avalon ryegrass (AV) and Lucerne (LU) are the pasture types in the Triple system. The black bars represent when livestock entered the Tall Wheat Grass (TWG) hedges, with the periods corresponding to September/October representing lambing and other periods by additional livestock for hedge management. The contribution of the Tall Fescue seems to replace the contribution of Avalon ryegrass when compared with the Triple single ewe treatment, this may be a result of the removal of ewes into hedges at a time when Tall Fescue reaches maximum growth, which subsequently requires longer duration of stocking to remove biomass.

Ewe live weight and condition score: The increase in stocking rates across all systems from July 2007 onwards has reduced ewe live weight and condition score (CS) in both the single and twin lambing treatments (Figures 52 and 53). In particular the increase in stocking rate negated the expected spring increase in ewe liveweight and CS, and has reduced ewe liveweight and CS in the single treatments more markedly. Both the seasonal variation in liveweight and CS was reduced and the differences that occurred in 2006 between pasture systems (Figure 52) have narrowed. Overall, there were few differences between pasture systems. However, small increases in liveweight and CS were established by the novel system during late spring through summer-autumn in both years. This occurred at similar or higher stocking rates to the other pasture systems and may be the result of higher feed quality during this time of year from the chicory and sub-clover dominant Kikuyu pastures. Certainly the availability of green feed during these times of the year by the Chicory and Kikuyu has also had a role in maintaining ewes CS and liveweight while the perennial ryegrass systems have lost weight.

Bloodlines: Bloodline differences in liveweight between Centreplus and Tolland ewes have been evident throughout the last two years (Figure 54 and 55). However, under the higher stocking rates particularly in single bearing ewes the genotype differences have narrowed. Differences in the order of 5-6kg have been more than halved under higher stocking rates in 2007/2008. Condition Score did not vary greatly between the two ewe bloodlines.

a)

b)

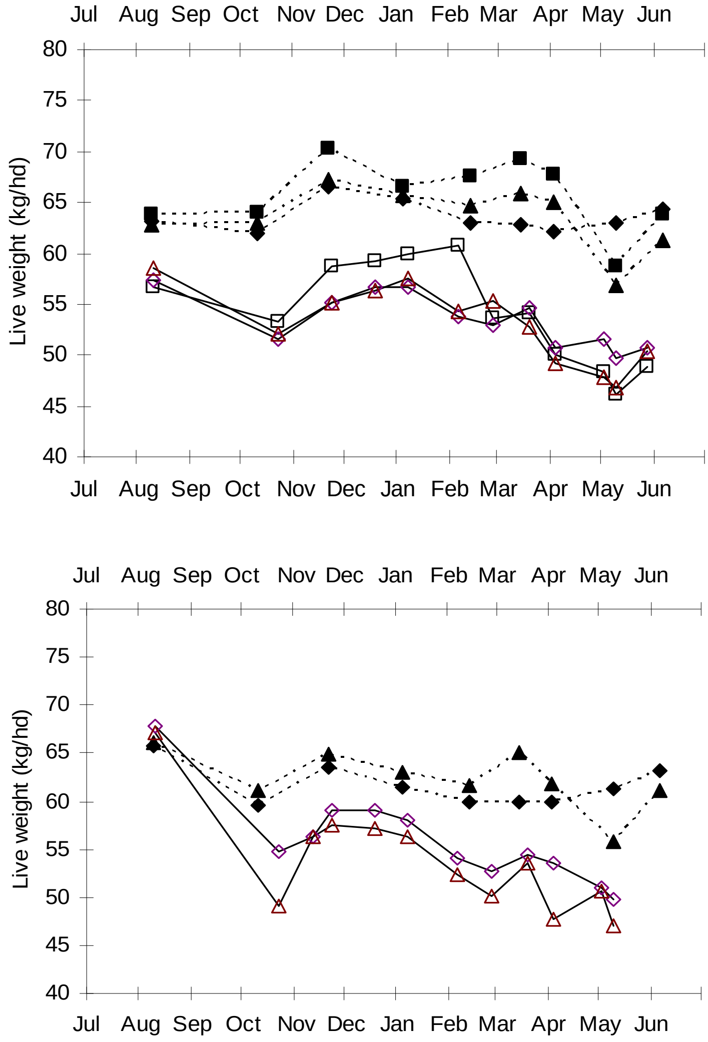


Figure 52. Ewe live weight comparison for the single lambing systems (a) for the Novel (- - -■- - -), Ryegrass (- - -◆- - -) and Triple (- - -▲- - -) pasture systems in 2006-07 and Novel (—□—), Ryegrass (—◇—) and Triple (—△—) pasture systems in 2007-08. Ewe live weight comparison for the twin lambing systems (b) for Ryegrass (- - -◆- - -) and Triple (- - -▲- - -) pasture systems in 2006-07 and for Ryegrass (—◇—) and Triple (—△—) pasture systems in 2007-08.

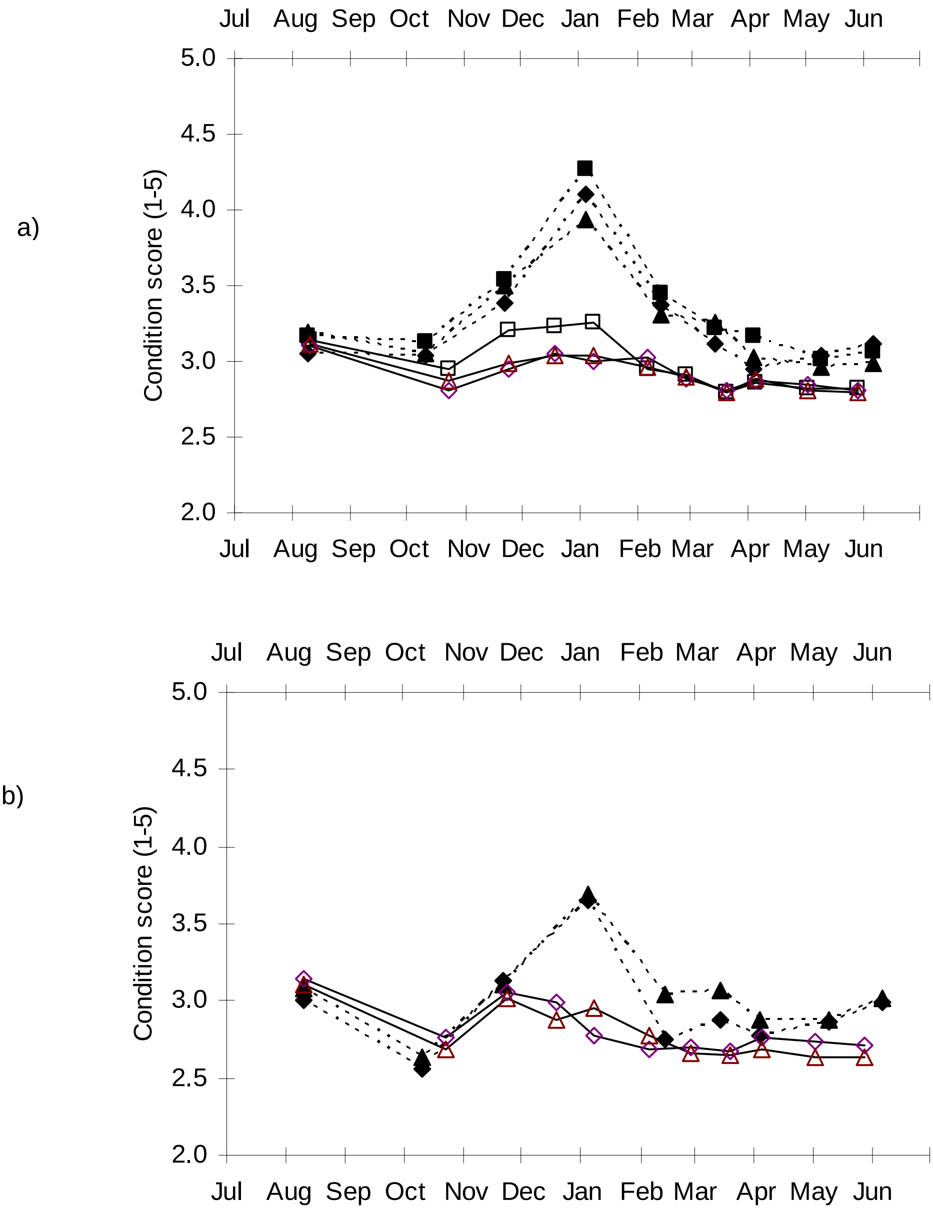


Figure 53. Ewe condition score comparison for the single lambing systems (a) for the Novel ( ), Ryegrass ( ) and Triple ( ) pasture systems in 2006-07 and Novel ( ), Ryegrass ( ) and Triple ( ) pasture systems in 2007-08. Ewe condition score comparison for the twin lambing systems (b) for Ryegrass ( ) and Triple ( ) pasture systems in 2006-07 and for Ryegrass ( ) and Triple ( ) pasture systems in 2007-08.

a)

b)

c)

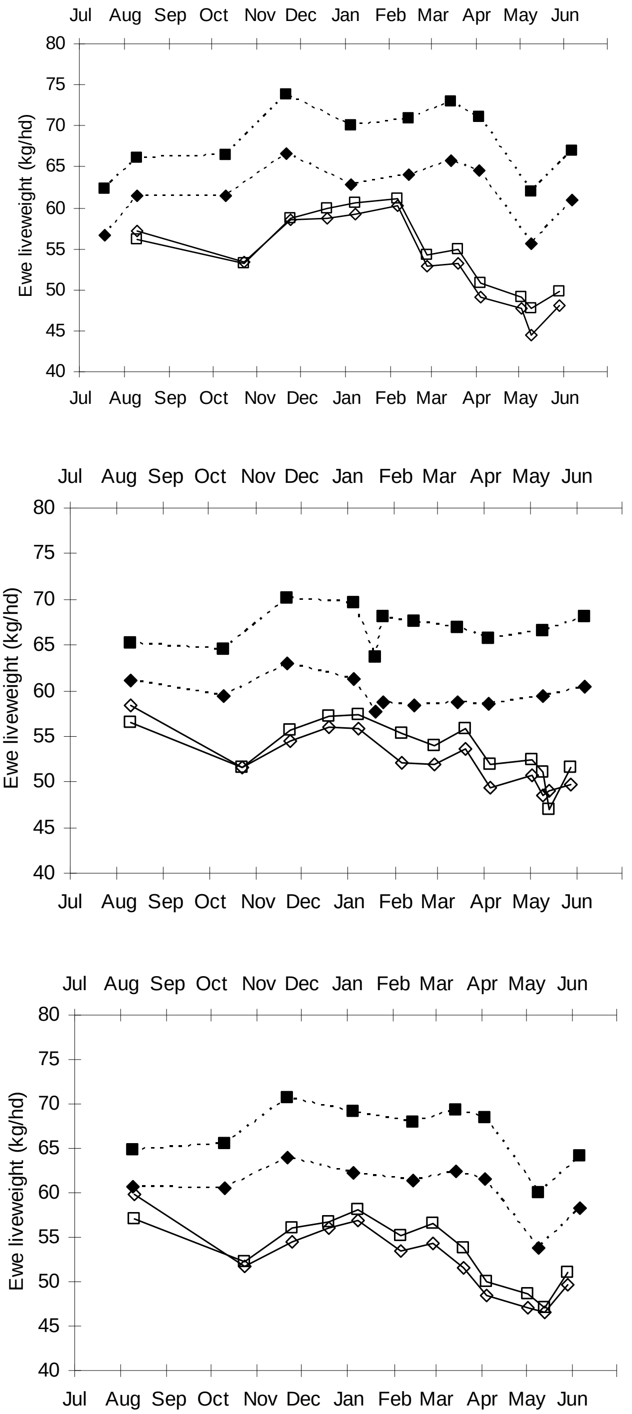
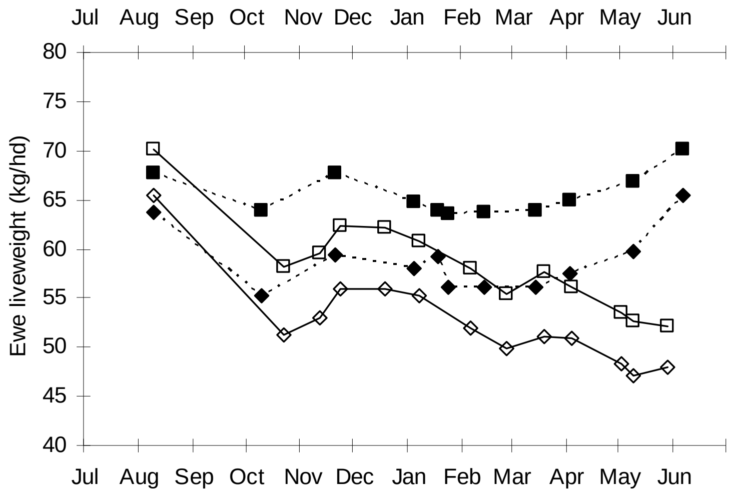


Figure 54. Ewe live weight for single lambing systems for the Novel (a), Ryegrass (b) and Triple (c) pasture systems for Centreplus ( ) and Tolland ( ) genotypes in 2006-07 and Centreplus ( ) and Tolland ( ) genotypes in 2007-08 experimental years.

a)



b)

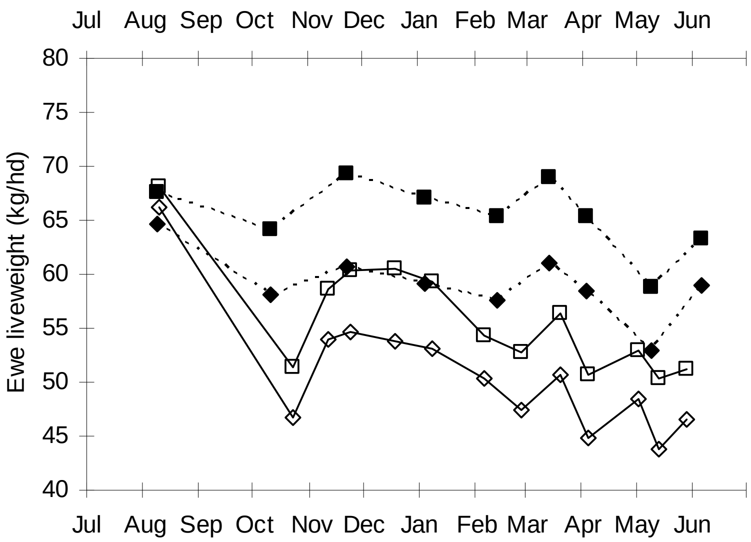
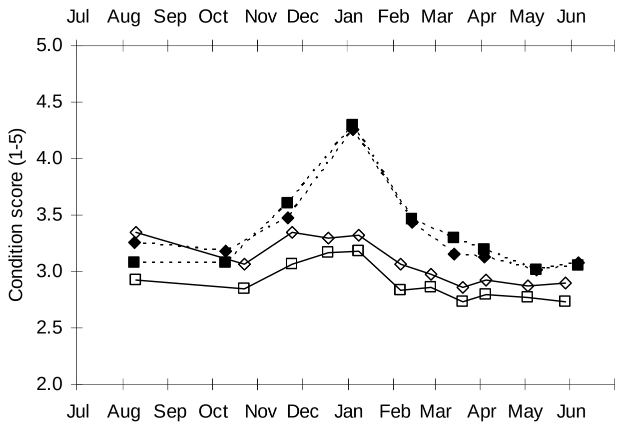


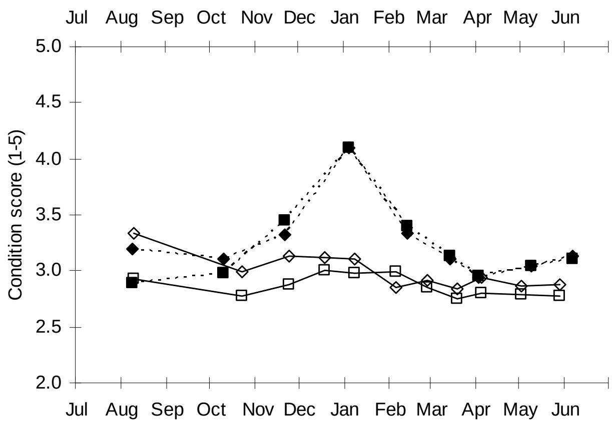
Figure 55. Ewe live weight for twin lambing systems for the Ryegrass (a) and Triple (b) pasture systems for Centreplus (···■···) and Tolland (···◆···) genotypes in 2006-07 and Centreplus (—□—) and Tolland (—◇—) genotypes in 2007-08 experimental years.



a)



b)



c)

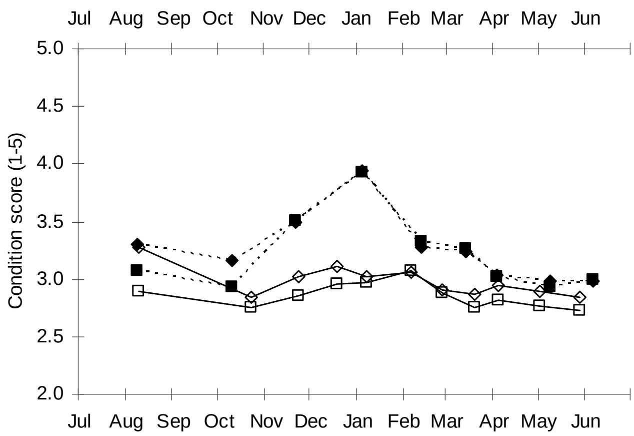
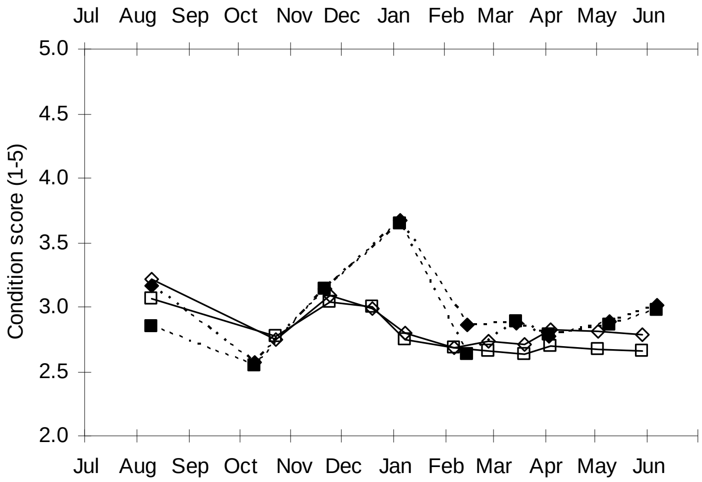


Figure 56. Ewe condition score for single lambing systems for the Novel (a), Ryegrass (b) and Triple (c) pasture systems for Centreplus (- - -■- - -) and Tolland (- - -◆- - -) genotypes in 2006-07 and Centreplus (—□—) and Tolland (—◇—) genotypes in 2007-08 experimental years.



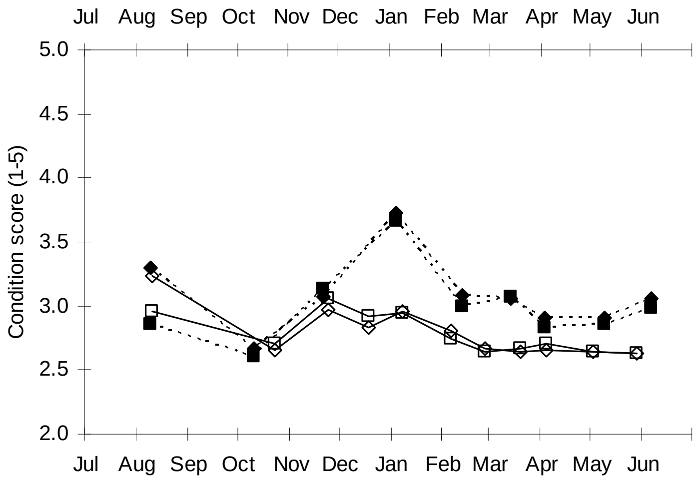


Figure 57. Ewe live weight for twin lambing systems for the Ryegrass (a) and Triple (b) pasture systems for Centreplus ( ) and Tolland ( ) genotypes in 2006-07 and Centreplus ( ) and Tolland ( ) genotypes in 2007-08 experimental years.

Wool Production 2006/07: The average wool cut for all sheep at the June 2007 shearing was 6.1kg greasy (4.4 kg clean) with a fibre diameter of 20.5 micron, coefficient of variation of diameter of 17.3%, yield of 74.4%, staple length of 113mm and staple strength of 33N/ktex. The raw data means for wool production in each pasture system by sheep system are presented in Table 7. As expected wool production from twin bearing ewes was lower for fleece weight, fibre diameter, staple length and staple strength than for single bearing ewes. There were also small differences between the pastures systems with the Novel/single system having higher fleece weight, fibre diameter, staple length and strength compared to the other systems. This difference was primarily due to the higher condition score and liveweight of ewes in this system during 2006/07. Wool production per hectare calculated using only core sheep in each system reached an average 52-53kg clean wool per hectare in the twin systems and 59-64kg clean wool per hectare in the single systems. While twin bearing ewes are able to produce more lamb per hectare this is also offset by a reduction in wool production (per head and per ha) and staple strength. The reduction in staple strength of 5 to 8N/ktex is sufficient to influence wool price and together with per ha production reduce wool income per ha by approximately $94/ha.

Analysis of wool production from 2007/2008 is still awaiting completion of wool tests. Preliminary data indicates a substantial reduction in fleece weight, wool production and fibre diameter. This is as expected given the reductions in ewe live weight profile during pregnancy and lactation in 2007, as they are substantial determinants of ewe wool production (www.lifetimewool.com.au). The average greasy fleece weight of ewes was 4.4kg with preliminary greasy wool production estimate of 52kg/ha averaged across single and twin systems.

Table 25. Raw data means for greasy fleece weight (GFW), clean fleece weight (CFW), yield (YLD), fibre diameter (FD), staple length (SL) and staple strength (SS), clean wool production per hectare and their impact on clean price and income per hectare from the different pasture and sheep systems at the June 2007.

Pasture System	Pregnancy Status	GFW (kg)	CFW (kg)	YLD (%)	FD (μm)	SL (mm)	SS (N/Ktex)	Clean Wool Per Ha (Kg/Ha)	*Clean Price (cents/kg)	*Wool Income Per Hectare
Novel	Single	6.6	4.9	75.4	21.0	115.8	38.1	64	986	$631
Ryegrass		6.2	4.5	74.3	20.5	114.5	32.7	61	1000	$610
Triple		6.2	4.5	74.7	20.4	114.0	37.0	59	1015	$599
Ryegrass	Twin	5.6	4.0	73.1	20.2	109.5	27.8	52	989	$514
Triple		5.7	4.2	74.4	20.4	110.2	29.2	53	987	$523

*clean price predicted using www.woolcheque.com.au using the southern prices over the last 12 months. Wool income per hectare is a predicted gross estimate that is not adjusted for skirtings and oddments or selling costs.

The Hamilton site also runs two Merino bloodlines as part of the Merino by terminal sire lamb production system. These animals run together across all treatments and it is possible to compare their performance. Table 26 shows the raw data means for each of the bloodlines. The data shows that the Tolland sheep cut more wool that was higher yielding and longer in staple length but the CentrePlus sheep were finer in diameter.

Of interest in this comparison is that on a per head basis, at prices over 2007/08, fleece weight outweighs the price difference due to lower fibre diameter. However having a larger impact on predicted production per hectare is the average 6kg lower liveweight of the Tolland bloodline that when stocking rates are adjusted for equivalent levels of liveweight per hectare, the Tolland bloodline produces approximately $73/ha more gross wool income. While this is only rough example of differences in estimated income these differences illustrate the importance of the interaction between sheep performance, stocking rate and the standard reference weight of sheep.

The differences in other wool parameters between the bloodlines were not significant. Initial data from the 2007/2008 year indicates that while fleece weights were reduced (average 4.4kg) the difference (0.3kg) between the ewe bloodlines has been maintained. Data analysis will be completed once wool testing results have been received.

Table 26. Raw data means for greasy fleece weight (GFW), clean fleece weight (CFW), yield (YLD), fibre diameter (FD), coefficient of variation of fibre diameter (CVD), staple length (SL) and staple strength (SS), clean wool production per hectare and their impact on clean price and income per hectare from the CentrePlus and Tolland Merino ewes at the June 2007.

Bloodline	GFW (kg)	CFW (kg)	YLD (%)	FD (µm)	CVD (%)	SL (mm)	SS (N/Ktex)	*Clean Price (cents/kg)	*Income per head	*Wool Income Per Hectare
CentrePlus	5.9	4.2	73.1	19.9	17.3	111.4	32.3	1041	$43.72	$586
Tolland	6.2	4.6	75.8	21.1	17.4	114.4	33.7	974	$44.80	$659

*clean price predicted using www.woolcheque.com.au using the southern prices over the last 12 months. Wool income per hectare is a predicted gross estimate that is not adjusted for skirtings and oddments or selling costs and assumes a stocking rate that adjusts to an equivalent level given that the Tolland ewes were 6kg lighter in liveweight on average than CentrePlus ewes.

Lamb production: Lambs were born in September of each year. All systems had reasonable levels of lamb losses at lambing, with lamb mortality at approximately 15-20% over both years for single born lambs and approximately 23-34% for twin lambs (Table 27). The improvement in lamb marking rates in 2007, in particular for the Triple twin system, improved the amount of lamb produced per hectare.

Table 27. Lamb Marking rates for 2006 and 2007.

System	Single Twin	Scanning (%)	Marking 2006 (%)	Marking 2007 (%)
Novel	S	100	82	84
Ryegrass	S	100	81	84
Triple	S	100	78	81
Ryegrass	T	200	140	148
Triple	T	200	132	153

On a per hectare basis lamb live weight is highest in the twin treatments due to almost a doubling in the number of lambs per hectare, although individual lamb live weight is lower than the single treatment (Table 27). The performance of the Triple system in the twin treatment was lower than all other systems (Figure 58) and is most likely the result of the requirement to graze excessive pasture mass that had rapidly declined in quality. This is further emphasised in the lamb growth rate in Table 4, where lambs grew at 20 grams less per day than the ryegrass twin system. In comparison to 2006, the 2007 per hectare increases in lamb production improved from increased lamb number per hectare, while lamb weight was not very different given the quite different seasonal conditions between the two years (Table 28). On average the single systems increased lamb live weight per hectare by 130 kilograms and the twin systems increased lamb live weight per hectare by 200 kilograms in 2007. Using per hectare measurement of lamb production in this circumstance can be misleading. The twin systems have produced record amounts of lamb weight per hectare, but they would not have met the required specifications for feeder lamb production, requiring significantly more input during the backgrounding stage before feedlot entry.

Table 28. Lamb production summary from September born lambs for 2006 and 2007.

Year	System	Single Twin	Lambs No. (head/ha)	Lamb weight (kg)	Total weight (kg/ha)
2007	Novel	S	15.2	37.4	568
2007	Ryegrass	S	14.1	33.3	470
2007	Triple	S	15.0	34.0	509
2007	Ryegrass	T	28.1	27.5	774
2007	Triple	T	26.7	26.8	717
2006	Novel	S	10.6	33.0	351
2006	Ryegrass	S	13.6	31.0	422
2006	Triple	S	12.0	32.0	385
2006	Ryegrass	T	24.2	25.0	604
2006	Triple	T	18.8	26.0	490

Further highlighting the difference between single and twin lamb performance, is the small difference observed between systems (with the exception of the Triple Twin system) and the ewe genotype on an individual lamb basis (Table 29). However, lambs that were born and reared as a twin grew at 40-50 grams per day slower than single born and reared lambs (Table 29). Lambs that were born as a twin, but reared as a single had growth rates 10-20 grams per day higher than twin reared lambs. The absence of large differences in growth rate between genotypes is surprising given the 6 kilogram difference in mature weight of the two genotypes.

Table 29. Lamb growth rate (grams/day) for System, Single and Twin lambing treatment and Genotype from birth to weaning (exit from systems).

System	Single Twin	Centreplus	Tolland
Novel	S	188	198
Ryegrass	S	197	204
Triple	S	192	200
Ryegrass	T	168	165
Triple	T	140	140

Table 30. Lamb growth rate (grams/day) for Single and Twin status, ewe Genotype (C = Centreplus, T = Tolland) and rear type (single or twin) from birth to weaning (exit from systems).

Single Twin	Genotype	Rear type single	Rear type twin
S	C	192	
S	T	200	
T	C	170	149
T	T	161	148

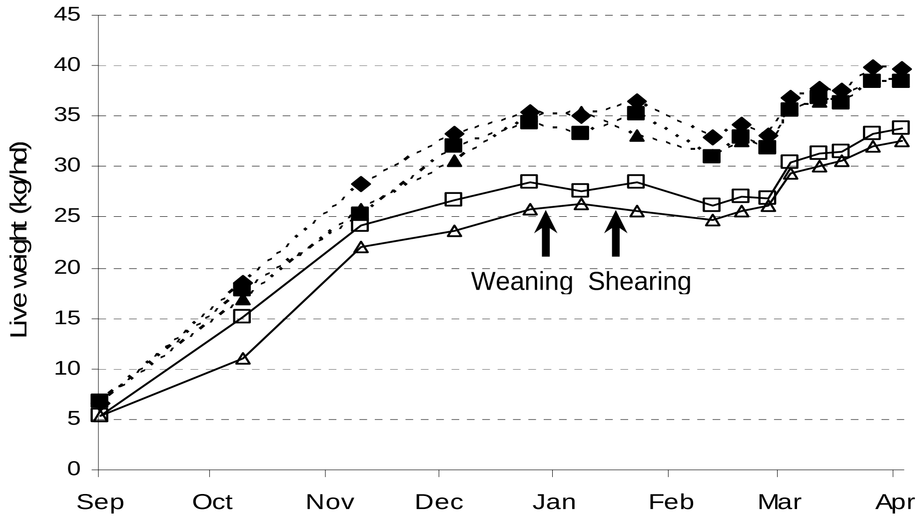


Figure 58. Lamb weight in 2007/2008 for single lambing treatment in the Novel ( ), Ryegrass ( ) and Triple ( ) pasture systems and lamb weight for twin lambing treatment for Ryegrass ( ) and Triple ( ) pasture systems. Time of lamb weaning, shearing and start of backgrounding phase is indicated by the arrows.

Lamb Backgrounding and Finishing: For the 2007/2008 drop of lambs a backgrounding operation on a pelleted diet was undertaken from weaning (early February) to early April before these animals were delivered to three different feedlot finishers for final finishing prior to slaughter (Figure 58). The data shows that post-weaning nutrition was able to close the differences between pasture systems but small advantages in liveweight were maintained. In contrast twin born lambs were on average unable reach single lamb weights during the backgrounding phase and the differences established during lactation and prior to weaning were unable to be changed during the backgrounding phase. The data collected from the finishing studies on the EverGraze lambs has been the subject of another DPI project on feedlot performance. The EverGraze 2007 lambs were randomly allocated to each of the 3 feedlot operations taking into account the EverGraze design structure. The average lamb liveweight data is presented in Table 31 and Figure 59 showing significant differences in the performance of each feedlot operation. The data from this project is currently being analysed and a report is being prepared.

Table 31. Lamb live weights at various weigh dates prior to slaughter across three different feedlot operations.

Farm	Wt 21/4/08	Wt 22/4/08*	Wt 6/5/08	Wt 20/5/08	Wt 3/6/08
A	39.7	35.9	42.6	46.3	49.8
B	39.8	35.6	40.1	41.4	43.9
C	39.6	35.3	41.3	43.7	47.3
**Empty weight after transport. (All other weights were off feed <3 hours).*					

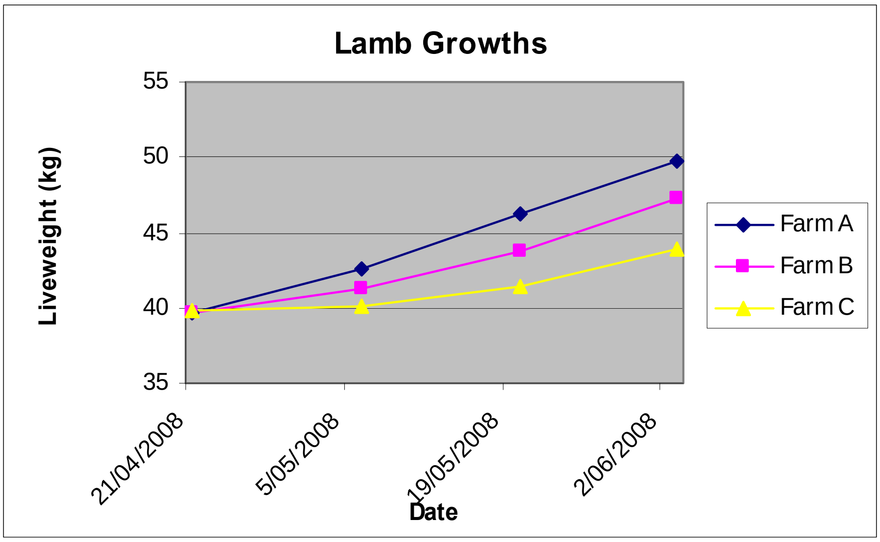


Figure 59: Lamb live weight growth

Cattle production: Spring-born weaner steers were grown out to feedlot entry weights on perennial pastures from March to January without supplementation. In 2006 and 2007 approximately 70-80 Angus steers were weaned and transferred onto the EverGraze Hamilton site during March of each year. Steers were weighed and randomly allocated to pasture treatments to ensure all groups had a similar average starting weight. The pasture treatments were replicated three times and consisted of a Perennial Ryegrass System (Ryegrass) and Triple Pasture System (Triple). Both the 'Ryegrass' and 'Triple' systems consisted of three paddocks and represented three distinct land classes that included lower flat areas prone to water logging, mid-slope areas and gravely free draining crest areas.

Each paddock contained different species or cultivars of perennial species suitable for the relevant land class and system. The 'Ryegrass' system consisted of three cultivars; Fitzroy, Avalon and Banquet perennial ryegrasses, and the 'Triple system' consisted of Quantum Tall Fescue, Avalon Perennial Ryegrass and SARDI 7 Lucerne. All treatments were sown with sub-clover. The steers were removed from treatments in January of each year and transported to a Northern cattle finisher when the majority reached feedlot entry weights of greater than 400 kg live weight.

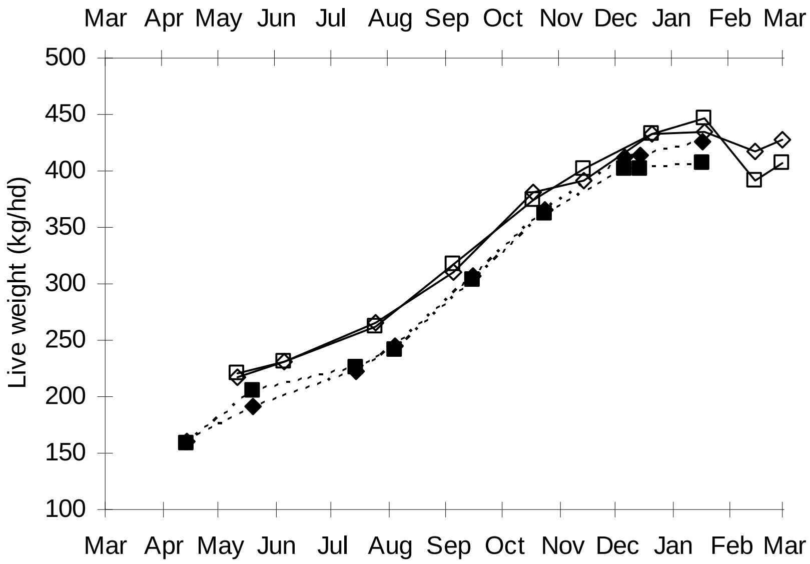


Figure 60. Steer live weight for the Ryegrass ( ) and Triple ( ) pasture systems in 2006-07 and Ryegrass ( ) and Triple ( ) pasture systems in 2007-08.

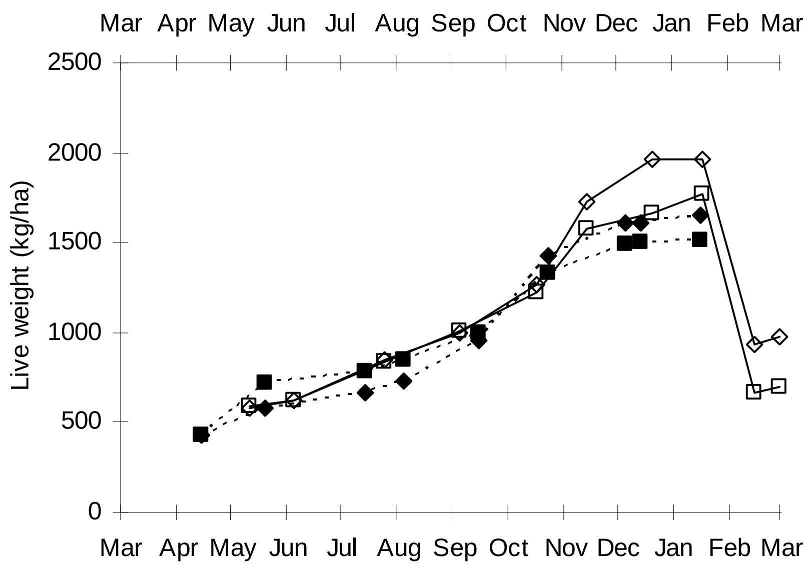


Figure 61. Steer total live weight per hectare for the Ryegrass (···■···) and Triple (···◆···) pasture systems in 2006-07 and Ryegrass (—□—) and Triple (—◇—) pasture systems in 2007-08.

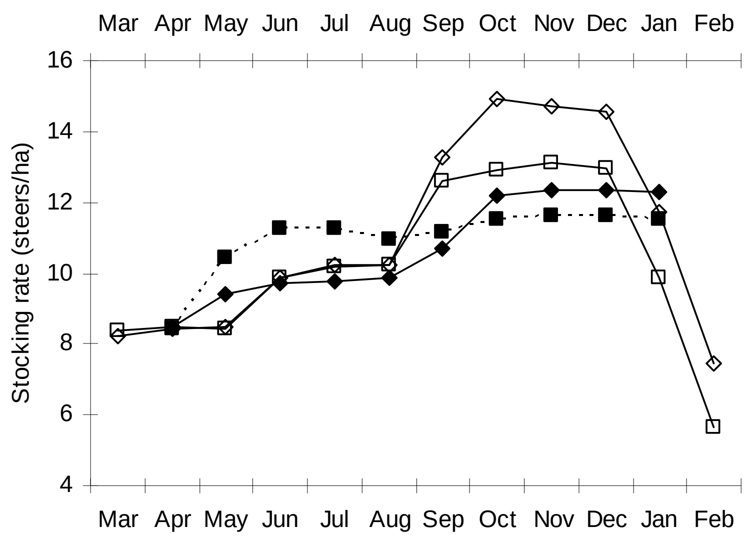


Figure 62. Steer stocking rate for Ryegrass (···■···) and Triple (···◆···) pasture systems in 2006-07 and Ryegrass (—□—) and Triple (—◇—) pasture systems in 2007-08.

Overall there was little difference between treatments in growth rates for steers in both 2006 and 2007 (Figure 60). In both years the growth paths were very similar. In 2007 steers had a higher starting live weight, but were placed on systems 25 days later than in 2006, and only a small difference in liveweight at similar time points persisted until turnoff in early January.

A feedlot entry weight of between 400 – 450 kg was achieved for 90% and 95% of all steers in 2006 and 2007 respectively. Liveweight differences between systems were small with separation occurring at the end of spring in 2006, whereas larger differences occurred between years due to a heavier starting weight in 2007 (Figure 60, 61 and 62, Table 32).

Table 32. Cattle production summary for 2006 and 2007.

Year	System	Start weight (kg)	Finish weight (kg)	Growth rate (kg/day)	Days on system	Average Stocking rate (steers/ha)	Total weight gain (kg/ha)
2006	Ryegrass	159	407	0.896	277	3.5	837
2006	Triple	161	426	0.957	277	3.5	907
2007	Ryegrass	221	446	0.893	252	3.6	816
2007	Triple	218	435	0.861	252	3.9	873

The data in Table 32 shows that in both years the steers achieved strong growth rates at high stocking rates. Steers in 2007 produced slightly less total kg/ha beef gain but this was due to a heavier starting weight and less time on system. The ‘Triple’ system in both years produced 57-70 kg/ha more beef than the ‘Ryegrass’ system. This difference in liveweight has been large driven by stocking rate differences that occurred during spring both years (Figures 61 and 62). It should be noted that the summer feed supply of the triple system is currently not effectively used in the steer backgrounding system. The steers are removed at a target live weight (400-450kg) for feedlot entry and therefore not making the full use of the summer activity these pasture species post-December. Collectively, this performance sets a new beef steer production benchmark of 872 and 844 kg/ha and 178 and 131 kg/ha/100mm rainfall in 2006 and 2007 respectively using perennial pasture systems without supplements.

New Sheep Treatments (June 2008): Four hundred and eight Coopworth/composite ewes were purchased from two flocks averaging CS 3.2 (65kg liveweight) and CS2.7 (56kg liveweight) respectively. These animals were mated in April 2008 and allocated post-shearing and scanning in June 2008 to the revised sheep system design shown in Table 33. Many of the ewes are essentially ex-stud ewes and most of the ewes have breeding figures and sire information that has been provided by the suppliers.

For 2008/2009, the ewes were allocated to pastures systems such that the lower reproductive rate of the Merino Prime Lamb system was allocated to the existing single bearing ewe systems, while the Specialist Prime Lamb system was allocated to those previously stocked by twin bearing ewes. It is anticipated this design will approximately maintain the difference in reproductive rate between the two current single and twin systems.

Preliminary Pregnancy Scanning Data: For the Coopworth ewes at scanning there were 5% drys, 29% singles, 57% twins and 9% triplets with 2 sets of quads. Overall the ewes scanned at an average of 172% and were CS 2.8 and weighed 54.4 kg at mating. In comparison the Merino ewes scanned at approximately 112% with around 15% dry, 60% singles and 25% twins with a small number of triplets and quads. As the ewe groups were individually sire mated a couple of poor ram mating performances increased the number of dry ewes particularly in the Merinos. In June 2008, following scanning and shearing, the Coopworth ewes were allocated to each of the pastures systems in the trial at a scanning percentage of 179% (excluding dry ewes). Merino ewes were allocated at a scanning percentage of 129% (excluding dry ewes).

Table 33. New Sheep System Design (including replicates and numbers of individuals) for 2008/2009.

No	Pasture treatment / System	Animal Type	Replicates	Core Stocking Rate (ewes/ha)	Total Core Sheep	Peak Stocking Rate (ewes/ha)	Total Sheep
1	**Perennial ryegrass**	Merino Prime Lamb	3	16	144	21	189
2	**Perennial ryegrass**	Specialist Prime Lamb	3	16	144	21	189
3	**Triple**	Merino Prime Lamb	3	16	144	21	189
4	**Triple**	Specialist Prime Lamb	3	16	144	21	189
7	**Novel**	Merino Prime Lamb	3	16	144	21	189

Notes;
- It is proposed to lift the core stocking rate in 2008 to 16 ewes/ha.
- Each replicate comprises 3 paddocks of 1ha that represent the pasture treatment, so that there is total of 3 ha per pasture treatment replicate.
- Core sheep only are used for analysis of performance e.g. wool, liveweight and condition score, as these stay on the treatments.
- In the Merino Prime Lamb System, CentrePlus and Tolland will be applied across age groups in order to achieve approx equal representation of each bloodline in each replicate.
- Thus at a core stocking rate the aim will be to have approximately 72 sheep per treatment (or 24 per replicate) representing each bloodline.
- In the Specialist Prime Lamb System Coopworth/Composite ewes will be applied at a core stocking rate. Sheep are randomly allocated taking into account liveweight, scanning and type or bloodline.

Component Experiments

Measuring on farm production and water use of perennial pastures: Two component studies of the project that were funded by the Corangamite Catchment Management Authority (CCMA) and the Glenelg Hopkins Catchment Management Authority (GHCMA) have been reported in full at earlier milestones in May and November 2007 (refer to attached CD).

Ecology and management of summer-active tall fescue in Western Victoria: In Western Victoria, the hot and dry period that occurs prior to the autumn break often causes poor pasture persistence, resulting in pasture degradation, the cost of which is incurred by livestock producers as lost livestock production or increased supplementary feeding. Summer-active tall fescue may survive and remain productive during this time because the species is heat tolerant, is able to access and utilise soil moisture via a deep root system and responds quickly to summer rainfall events. Therefore, in 2006 a PhD project commenced as a component study in the EverGraze project at the Hamilton proof site to develop management guidelines for summer-active tall fescue (*Lolium arundinaceum* syn. *Festuca arundinacea*).

This PhD project commenced in autumn session 2006 and is due for completion in spring session 2009 in compliance with the 3.5 year time frame proposed for the project. The project comprises 4 components, which are as follows:

1. The current use and management of summer-active tall fescue in the Western District of Victoria: a survey.
2. The response of summer-active tall fescue to leaf stage based grazing systems.
3. The response of summer-active tall fescue to N fertiliser.
4. The response of summer-active tall fescue to establishment procedures.

Progress on all components of the research is progressing according to schedule.

Publications

Raeside M, Friend M, Lawson A (2008a) Effect of grazing system on the yield and quality of summer-active tall fescue in the Western District of Victoria. In 'Salinity, Water and Society - Global Issues, Local Action: Proceedings of the 2nd International Salinity Forum'. Adelaide, South Australia. (CD-ROM).

Raeside M, Friend M, Lawson A (2008b) Grazing summer-active tall fescue in south-eastern Australia. In 'Multifunctional Grasslands in a Changing World: Proceedings of the XXI International Grassland Congress and VIII International Rangeland Congress'. Huhhot, China. (Ed. Organising Committee of IGC/IRC Congress) p. 103. (Guangdong People's Publishing House).

Raeside M, Friend M, Lawson A (2008c) Response of summer-active tall fescue to nitrogen in late-autumn and winter. In 'Survive, Adapt, Prosper: Proceedings of the 49th Grassland Society of Southern Australia Conference'. Bairnsdale, Victoria. (Ed. Jeff Hirth Editorial and Agronomic Services) pp. 138 - 141. (Grassland Society of Southern Australia).

Raeside M, Friend M, McKenzie F, Lawson A (2007a) EverGraze 8. Effect of grazing interval on tiller density of summer-active tall fescue. In 'From the Ground Up: Proceedings of the 48th Grassland Society of Southern Australia Conference'. Murray Bridge, South Australia. (Ed. Jeff Hirth Editorial and Agronomic Services) p. 107. (Grassland Society of Southern Australia).

Raeside M, Friend M, McKenzie F, Lawson A (2007b) EverGraze 9. Effect of grazing interval on tiller appearance and death rate of summer-active tall fescue. In 'From the Ground Up: Proceedings of the 48th Grassland Society of Southern Australia Conference'. Murray Bridge, South Australia. (Ed. Jeff Hirth Editorial and Agronomic Services) p. 108. (Grassland Society of Southern Australia).

The current use and management of summer-active tall fescue in the Western District of Victoria: a survey: A literature review revealed a lack of information on summer-active tall fescue in the Western District of Victoria. Therefore, a survey was conducted. The survey consisted of 2 stages. The first stage was a series of telephone interviews with graziers and sheep and cattle stud breeders sampled from the yellow pages. This stage aimed to quantify the current use of the species and identify barriers to adoption. The second stage was a detailed mail survey of summer-active tall fescue users and aimed to determine how the species responded to different management strategies.

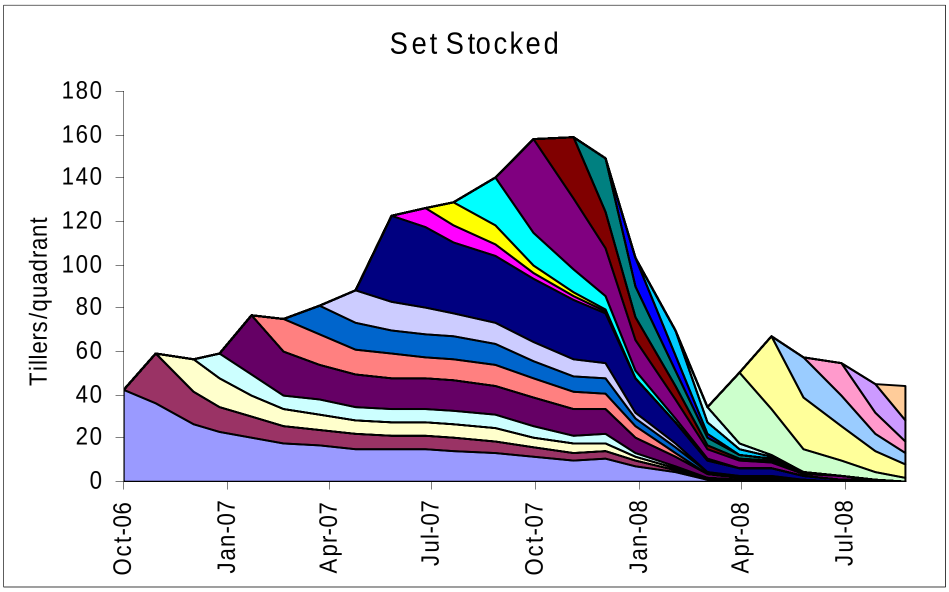
- Current use of summer-active tall fescue
    - Use of the species was uncommon. Only 11 of 77 graziers and sheep and cattle stud breeders interviewed currently use summer-active tall fescue.

    - Generally less than 5 % of a property was sown to summer-active tall fescue. Respondents were reluctant to invest large areas of their properties in summer-active tall fescue due to a lack of knowledge about the species.
    - The most commonly used cultivars were Advance and Quantum. Soft leaved cultivars were used most commonly for dairy production, while tough leaved cultivars were used most commonly for wool production.
    - Many respondents specifically used summer-active tall fescue as a hay crop or on saline areas.
- Constraints to adoption
    - Association of Demeter with low quality herbage in spring.
    - Lack of knowledge of new cultivars.
    - Slow establishment.
- Factors affecting sward persistence and production
    - Sowing on clay soils and soils prone to waterlogging improved persistence and productivity.
    - Long grazing intervals, particularly over winter when growth was slowed by low temperatures and ground was susceptible to trampling, improved sward persistence.
    - Sward persistence was also improved by ensuring residual grazing heights of at least 4 cm, especially in spring.

The response of summer-active tall fescue to leaf stage based grazing systems: This work aims to develop a leaf stage based indicator of when summer-active tall fescue should be grazed to maximise pasture persistence and production. Four treatments, replicated 3 times, were imposed on Quantum summer-active tall fescue The treatments were; set stocked, or rotational grazing systems based on grazing at the 2-, 3- or 4-leaf stage, where all treatments were grazed to a residual height of 1000 kg DM/ha by merino or Coopworth ewes/lambs. The sward was established in spring 2004 on a low lying heavy soil and has been oversown with subterranean and white clovers.

Tiller population dynamics: Set stocking generally produced a more changeable sward than any of the rotational grazing treatments (Figure 63). Tiller appearance rates under set stocking increased rapidly in response to favourable growing conditions, but decreased rapidly if growing conditions became unfavourable. In contrast, rotational grazing produced a more stable sward, with changes in tiller numbers becoming less variable as grazing frequency decreased. The periods of maximum tiller appearance were during spring and following the autumn rains in mid- and late autumn. Rapid tiller appearance also occurred following 123 mm of rain in January 2007, however, with little follow-up rain over February and March, subsequent tiller death rates were also rapid. Tiller death rates declined most dramatically during summer and early autumn of 2008 in response to dry conditions. The tillers most susceptible to death during this time were those initiated following the 120 mm of rain in November 2007. Generally, newly initiated tillers were most prone to death in the month immediately following initiation, with the magnitude of this response being greatest for tillers initiated during stressful conditions.

Pasture consumption: Basing grazing rotations on the 3-leaf stage resulted in the greatest pasture consumption (Figure 64). Total pasture consumption under each treatment over the duration of the project was 17.6, 16.0, 21.6 and 17.9 t DM/ha under set stocking or rotational grazing at the 2-, 3- or 4-leaf stage, respectively. Greatest pasture consumption occurred over October and November 2007.



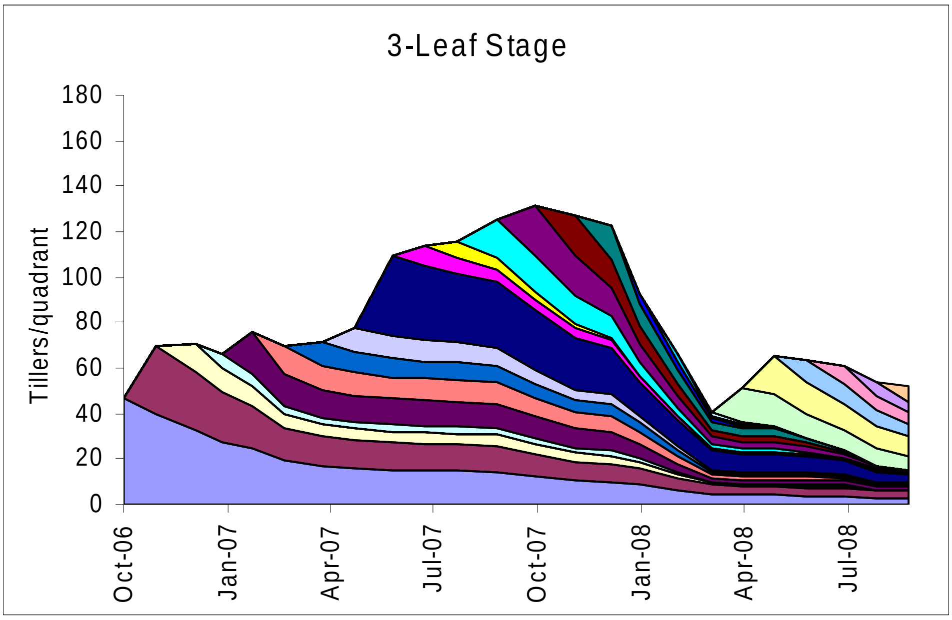


Figure 63. Changes in tiller population and tiller age profiles for summer-active tall fescue under set stocking or rotational grazing at the 3-leaf stage. Shaded sections indicate trends in the population of tillers present at the start of the experiment and those appearing at successive monthly intervals

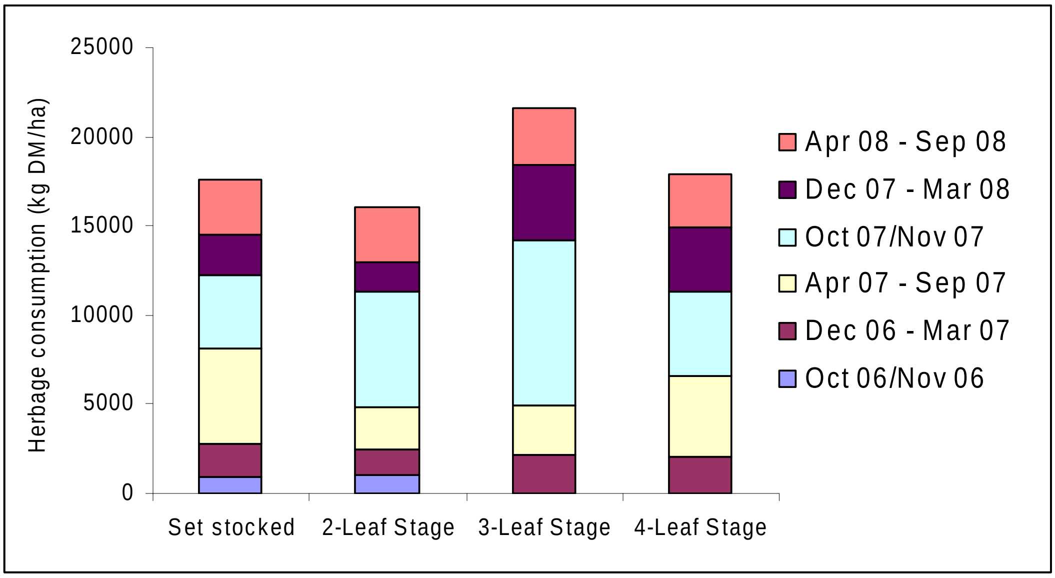
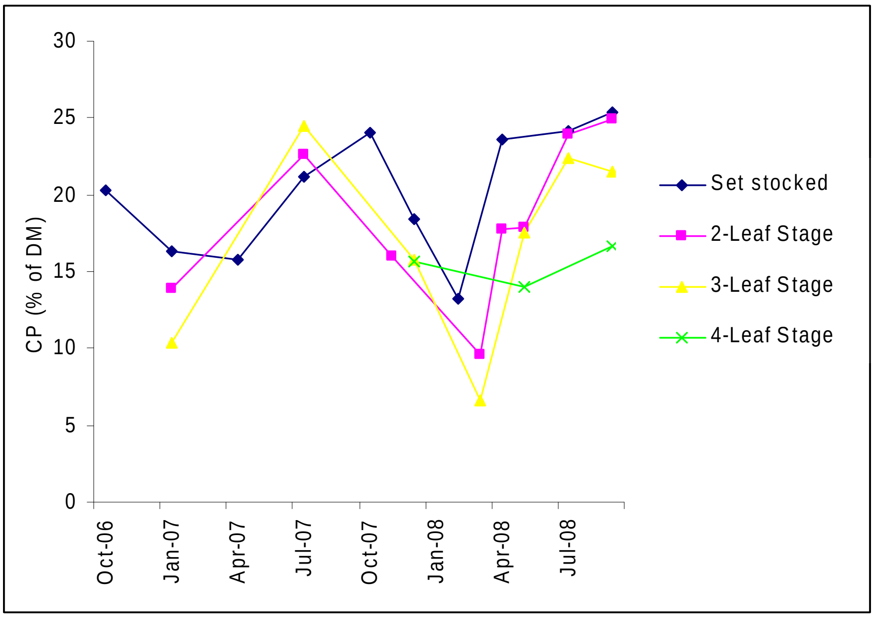


Figure 64. Herbage consumption under set stocking or rotational grazing at the 2-, 3- or 4-leaf stage

<u>Pre-grazing whole sward quality:</u> Whole sward quality was determined by the maturity of herbage and the botanical composition of the sward (Figures 65 and 66). In January 2007, all treatments contained in excess of 95 % summer-active tall fescue. Therefore, the decline in CP with each successive leaf stage was the result of increasing herbage maturity. However, in August 2007, set stocked plots and plots grazed at the 2-leaf stage became invaded with annual grass with the subsequent displacement of tall fescue and clover, which was detrimental to the CP content of these plots, resulting in the 3-leaf treatment being of higher whole sward CP during this time. In autumn, winter and spring 2008 pasture quality declined with the initiation of each successive leaf due to the deposition of mature structural materials as the plant matured, and also the displacement of summer-active tall fescue by annual grasses under set stocking and grazing at the 2-leaf stage. This effect was especially apparent in spring 2008 where grazing at the 4-leaf stage lowered sward quality to the extent that sheep showed a preference against eating stem material, indicating low palatability.



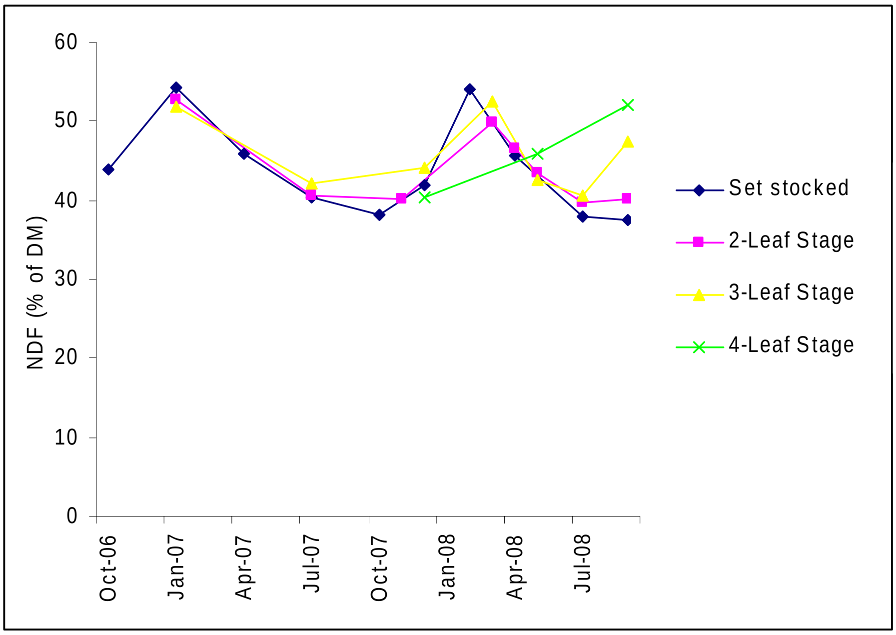


Figure 65. Whole sward pre-grazing CP and NDF under set stocking or rotational grazing at the 2-, 3- or 4-leaf stage

Botanical composition: At the commencement of the project in September 2006, all plots contained in excess of 80 % summer-active tall fescue. In August 2008 tall fescue comprised 45, 57, 71 and 84 % of DM under set stocking or grazing at the 2-, 3- or 4-leaf stage, respectively. The set stocked plots and plots grazed at the 2-leaf stage were most susceptible to invasion by annual grasses over winter and spring, especially in 2008. All plots contained between 20 – 25 % subclover in October

2007. However, subclover production in autumn 2008 was greatest under set stocking, comprising 25 % of DM under set stocking, relative to 11, 3 and 3 % of DM under rotational grazing at the 2-, 3- and 4-leaf stage, respectively. This is likely due to the relatively dry early autumn conditions in 2008 and the low amount of herbage build up under set stocking favouring clover production.

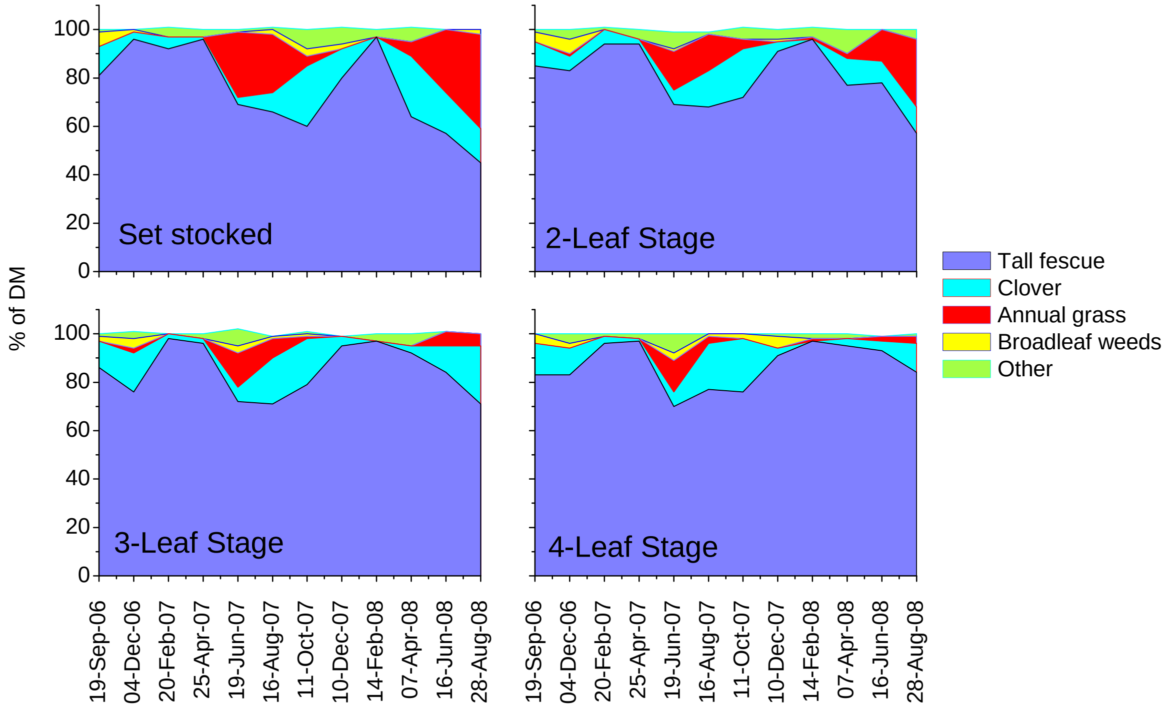


Figure 66. Botanical composition under set stocking or rotational grazing at the 2-, 3- or 4-leaf stage

The response of summer-active tall fescue to N fertiliser: This work aimed to test the response of summer-active tall fescue to strategic application of N fertiliser. Five treatments were imposed in a randomised block design with 3 replications in September 2006 on a Quantum tall fescue pasture. The treatments were strategic applications of 0, 25, 50, 100 or 200 kg N/ha applied on 14 September 2006, 27 April 2007, 23 August 2007, 7 April 2008 and 12 September 2008.

Pasture consumption: The strategic application of 25 or 50 kg N/ha resulted in the greatest total pasture consumption (Figure 67). Applying greater than 50 kg N/ha did not increase pasture consumption relative to the control. The application of 25 or 50 kg N/ha generally also resulted in the highest pasture growth rates following N application (Figure 68). This effect was closely correlated with moisture availability.

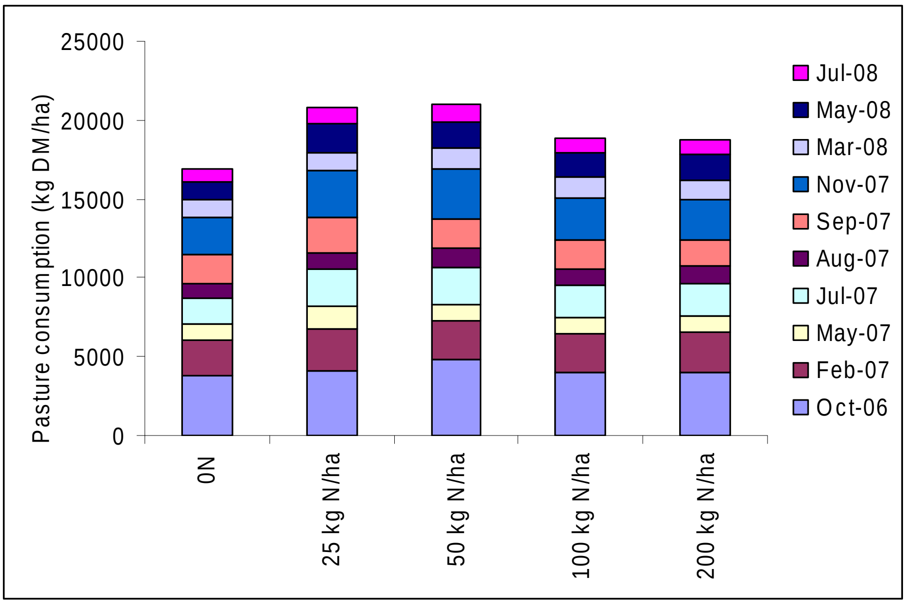


Figure 67. Pasture consumption in response to different N rates

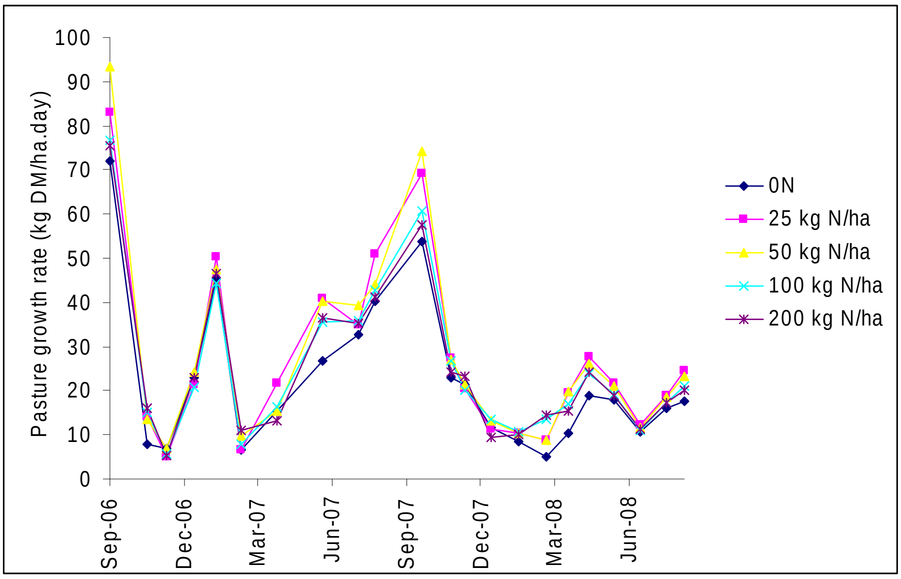


Figure 68. Pasture growth rate in response to different N rates

Pre-grazing whole sward quality: Relative to the control, the application of 100 or 200 kg N/ha increased the CP and ME and reduced the NDF content of the sward (Table 34). The effect of N on pasture quality was confounded by the effect on botanical composition. The quality of the control plots in May 2008 was improved by a high content of subclover relative to the other plots. In contrast the pasture quality of N treated plots in May and October 2008 was reduced by the detrimental effect of applied N on clover production and the invasion of these plots by nitrophilous weeds, such as capeweed and erodium.

Table 34. Pre-grazing whole sward quality in response to different N rates.

	16-Oct-06	19-May-08	10-Sep-08
CP			
0N	16.4	24.5	26.5
25 kg N/ha	15.2	25.1	27.8
100 kg N/ha	17.5		27.4
NDF			
0N	42.7	41.8	37.9
25 kg N/ha	44.4	43.8	35.6
100 kg N/ha	40.6		34.5
ME			
0N	12.3	12.3	12.5
25 kg N/ha	11.9	12.7	12.8
100 kg N/ha	12.6		13.4

Botanical composition: At the commencement of the research in September 2006, all plots contained between 72 and 80 % summer-active tall fescue. In September 2008 summer-active tall fescue contributed 79, 80, 80, 68 and 67 % of DM under 0, 25, 50, 100 and 200 kg N/ha, respectively. All plots were invaded by broadleaf weeds in winter 2007. In winter 2008 all N treatments were again invaded by nitrophilous broadleaf weeds, with this effect becoming more apparent as the rate of N increased. Nitrogen application also reduced the clover component of the swards, with clover contribution to DM in the 100 and 200 kg N/ha treatment being negligible in 2008.

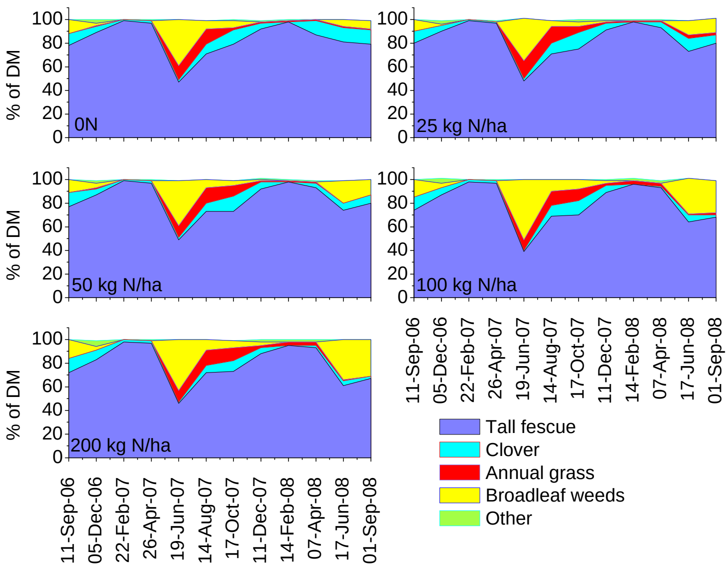


Figure 69. Botanical composition in response to different N rates

The response of summer-active tall fescue to establishment procedures: It was revealed from the survey that the slow establishment of summer-active tall fescue is a major constraint to the adoption of the species. Therefore, a field experiment will be conducted to determine the effect of sowing rate and sowing depth on the establishment and early growth of summer-active tall fescue. Two factors, each with 4 levels, were imposed in a randomised block design with 8 replications. The factors were sowing rates of 8, 16, 24 or 32 kg/ha and sowing depth of 0, 15, 30 or 45 mm. Site preparation for this experiment commenced in winter 2007 to prevent weed competition. The experiment was sown in mid-October 2008 with data collection occurring until May 2009.

To date, this research has collected two years of data relating to the effect of grazing systems and nitrogen fertiliser rates on the ecology of summer-active tall fescue and has compiled an extensive user survey of the current use and management of summer-active tall fescue in the Western District of Victoria.

This research has clearly demonstrated the importance of complementing pasture species with landscape feature, with the persistence and productivity of summer-active tall fescue being maximised by sowing on heavy soils that are prone to waterlogging over winter and spring. It is necessary to provide summer-active tall fescue with a source of moisture to survive and continue growth over summer, which is the time of the year when other pasture species often fail to survive. Moisture is obtained from the soil profile via a deep root system and from summer rainfall events, to which the species responds rapidly.

Grazing throughout the year at the 3-leaf stage maximised sward productivity and persistence, in terms of tall fescue contribution to DM, and produced a stable tiller population. However, in spring shorter grazing intervals are required to avoid rapid quality declines and associated low palatability that occurs when the species produces reproductive stems and prolific growth increases the fibre content and lowers the carbohydrate content of the herbage.

Grazing system altered the morphology of the swards, with set stocked areas having a high tiller density and residual leaf area, whereas rotational grazed areas comprised a lower tiller density and were of an erect and tufty nature. These results demonstrate the survival mechanisms of summer-active tall fescue to cope with different grazing stresses.

Further yield increases from summer-active tall fescue can be generated with the application of N fertilisers. The species was very efficient in converting low rates of N into DM in late autumn and winter 2007, generating 45 kg DM/kg N when 25 kg N/ha was applied following the autumn rains. There were few benefits from applying greater than 25 kg N/ha to summer-active tall fescue, due in part to changes in botanical composition. The application of high rates of N generally favoured the invasion of nitrophilous weeds and was detrimental to clover production. The species was also very responsive to N in spring, however, given the prolific growth of the species in spring, further yield increases during this time may not be required to fill feed gaps.

4.2.3 Wagga Results and Discussion

Figure 70. Site 2 sowing the shrub and phalaris rows (E's on the bottom left of the picture)

Performance of the farming system: Lucerne has persisted exceptionally well under rotational grazing at the systems site, and has provided the most feed/ha during the dry seasons encountered. Direct seeding of clover into these pastures may be required in 2009. Measured phalaris and fescue plant density has declined, although basal frequency has increased or remained constant. The perennial grass pastures are still functional but will probably require direct seeding of annual grasses and perhaps clover in 2009.

The Split Joining system appears to be best able to cope with climate variability to maximise gross margin under dry conditions. It is likely to produce similar gross margins to higher stocking rate, greater risk later lambing systems in better years. Summer active perennials have reliably produced increases in the ovulation rate of synchronised ewes. Type of pasture appears less important than the amount of green feed available.

Provision of shelter is yet to show marked improvements in lamb survival, largely due to mild conditions at lambing and dry conditions limiting hedge/shrub growth. The most recent data however suggest that provision of shelter may improve the survival of singles, and may increase the survival of twins to a level similar to that seen in unprotected singles. This appears largely due to a reduction in mortality due to SME. This is likely due to reductions in windspeed, but may also be related to enhancement of the ewe-lamb bond. The hydrology site is now instrumented with TDR equipment and tipping buckets. This will enable the water balance to be closed. Soil moisture data indicate that a phalaris pasture combined with shrubs can dry the soil to a similar extent as a lucerne pasture, but not as well as a lucerne pasture with shrubs.

NRM results:

Groundcover: During the extreme drought of 2006, groundcover in all treatments within each pasture type was maintained above 60%, and mostly above 70% (Figure 71), through the extensive use of droughtlots. There were no real treatment differences, although as a generalisation the lower stocking rate treatments (SRM and SJ) maintained higher levels of groundcover.

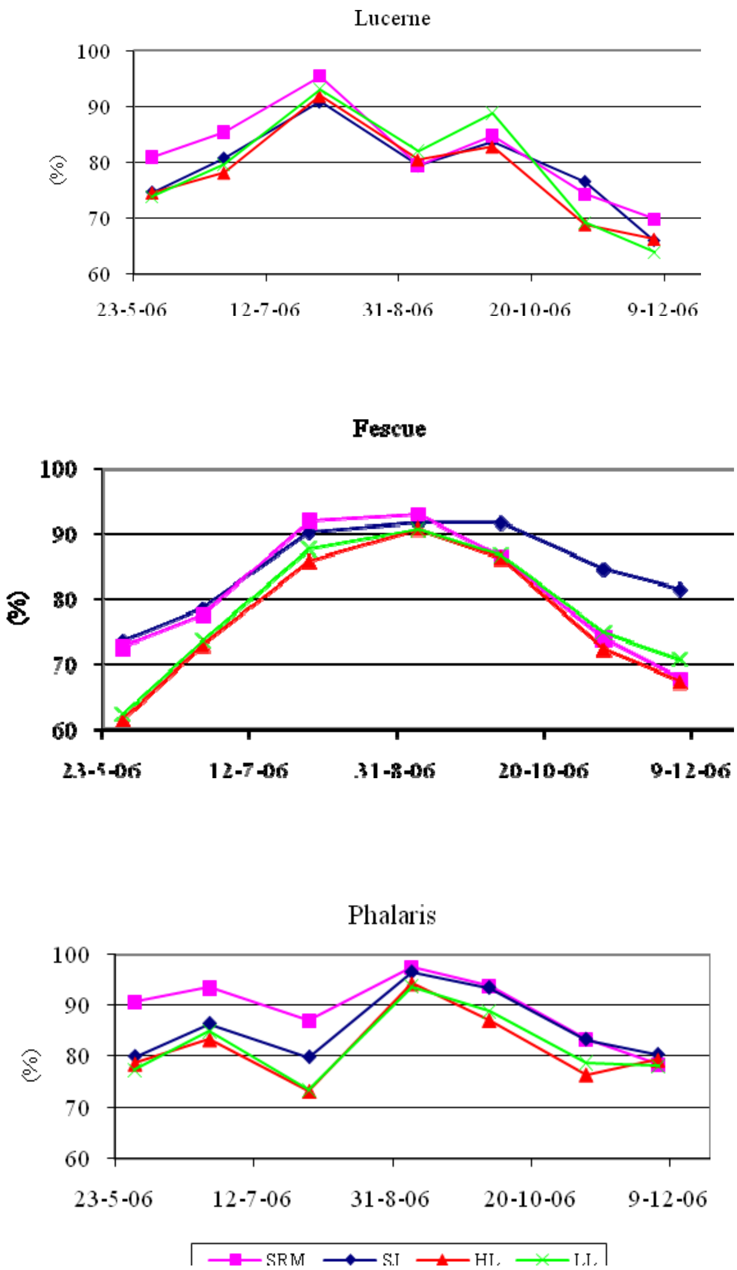


Figure 71. Groundcover for each treatment in each pasture type during 2006.

Apart from opportunistic grazing of lucerne over joining in 2007, stock remained in droughtlots until the break of season in April/May 2007. As a result, groundcover in phalaris and fescue generally exceeded 60% throughout 2007 (Figure 72). Groundcover in lucerne remained lower in all treatments during autumn 2007 due to sheep grazing plots during joining, but rebounded after the break of season. There were no substantial treatment effects on groundcover.

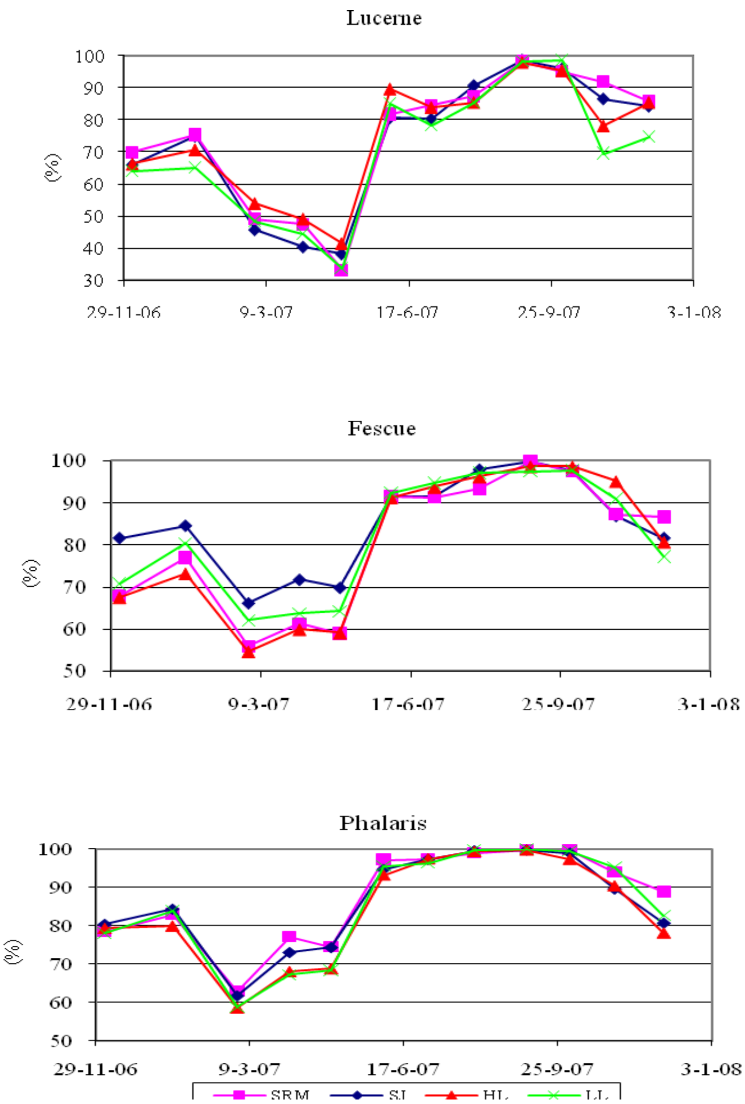


Figure 72. Groundcover for each treatment in each pasture type during 2007.
Groundcover during 2008 to date has exceeded 60% (and mostly above 70%) in grass pastures, and 50% in lucerne. Treatment effects have been small, although in phalaris and lucerne pastures the Later Lambing treatment (LL) has often had a lower groundcover than all other treatments (Figure 73).

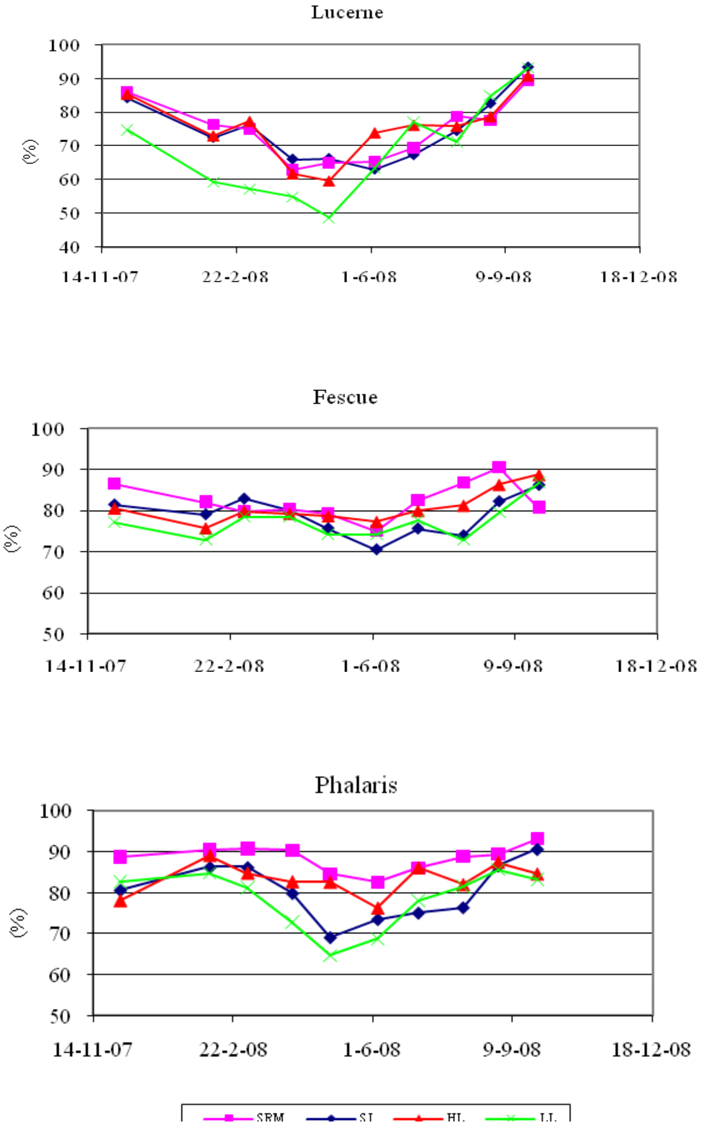
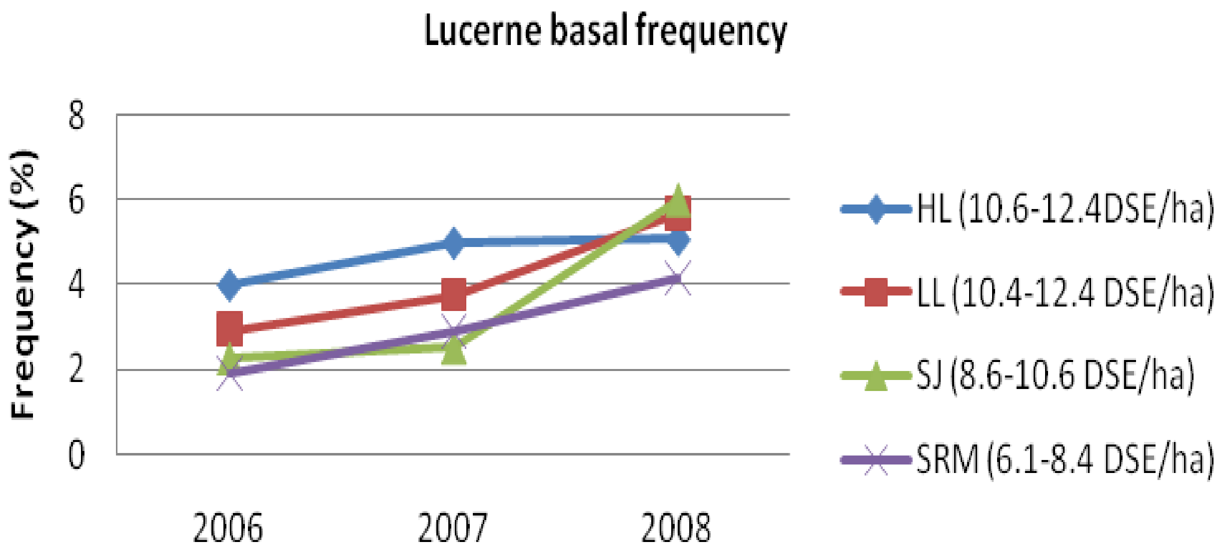


Figure 73. Groundcover for each treatment in each pasture type during 2007.

Plant density and basal frequency: Lucerne density has not changed while basal frequency has increased. There has been no real effect of treatment on either of these traits (Figure 74).



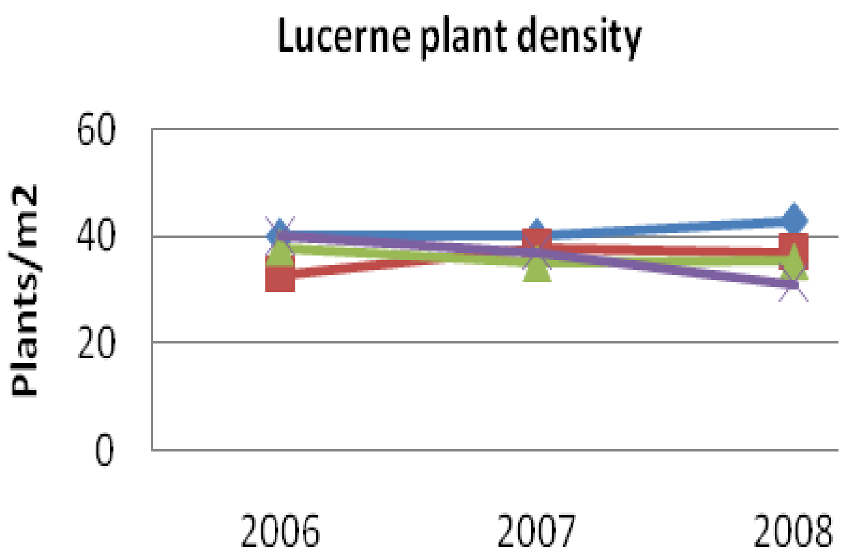


Figure 74. Lucerne basal frequency and plant density

Tall fescue plant density has declined over the experiment, with no effect of treatment (Figure 75). This has been compensated by a slight increase in basal frequency.

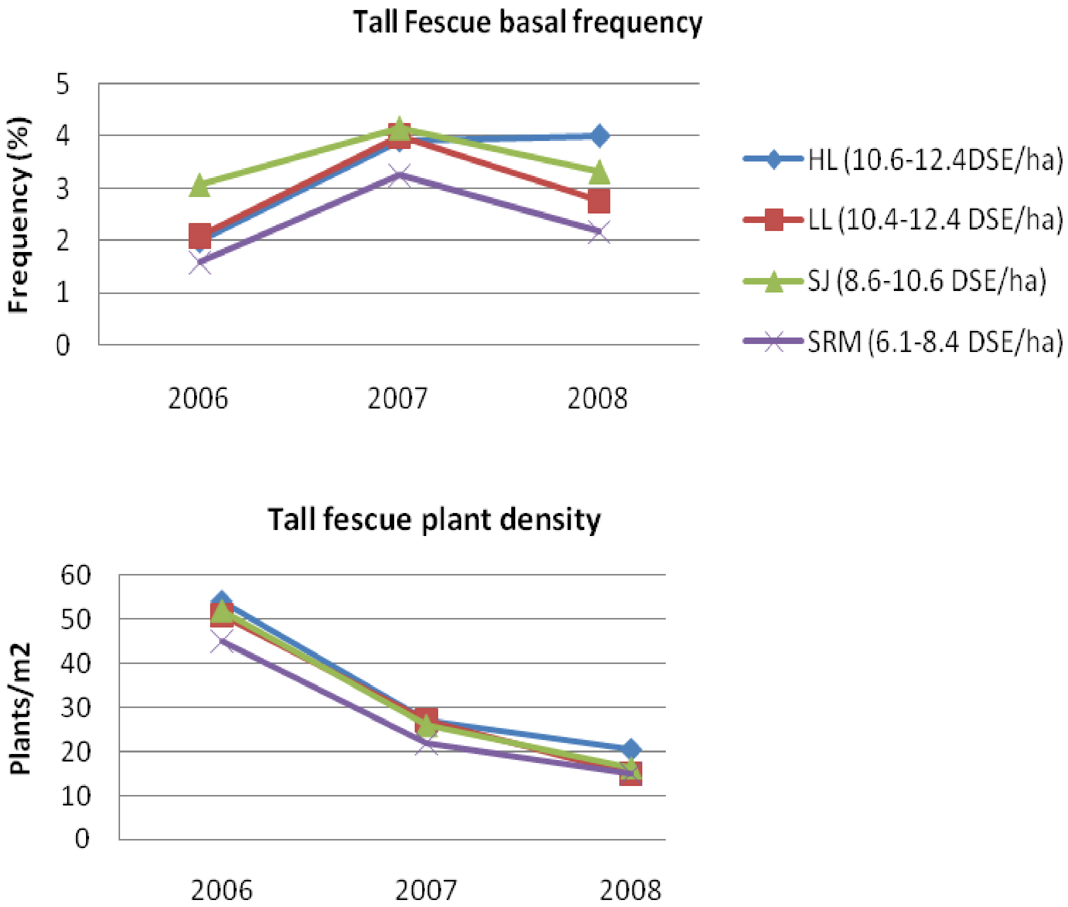


Figure 75. Tall fescue basal frequency and plant density.

Phalaris density has declined in all treatments and to a greater extent in the LL treatment (Figure 76). Plant density figures should always be interpreted with caution given the difficulty in identifying individual plants from the 'clump'. It is clear, however, that phalaris and fescue plants have died over the past few years. In phalaris, as in fescue, this has largely been compensated for by n changes in basal frequency – the surviving plants are increasing in size. The potential treatment effect for phalaris should also be interpreted with caution – in the LL treatment (and also SJ treatment) one phalaris paddock is substantially worse than the others in this treatment. This will need to be dealt with in a full statistical analyses. The decline in basal frequency in phalaris in the HL treatment is peculiar and of some concern.

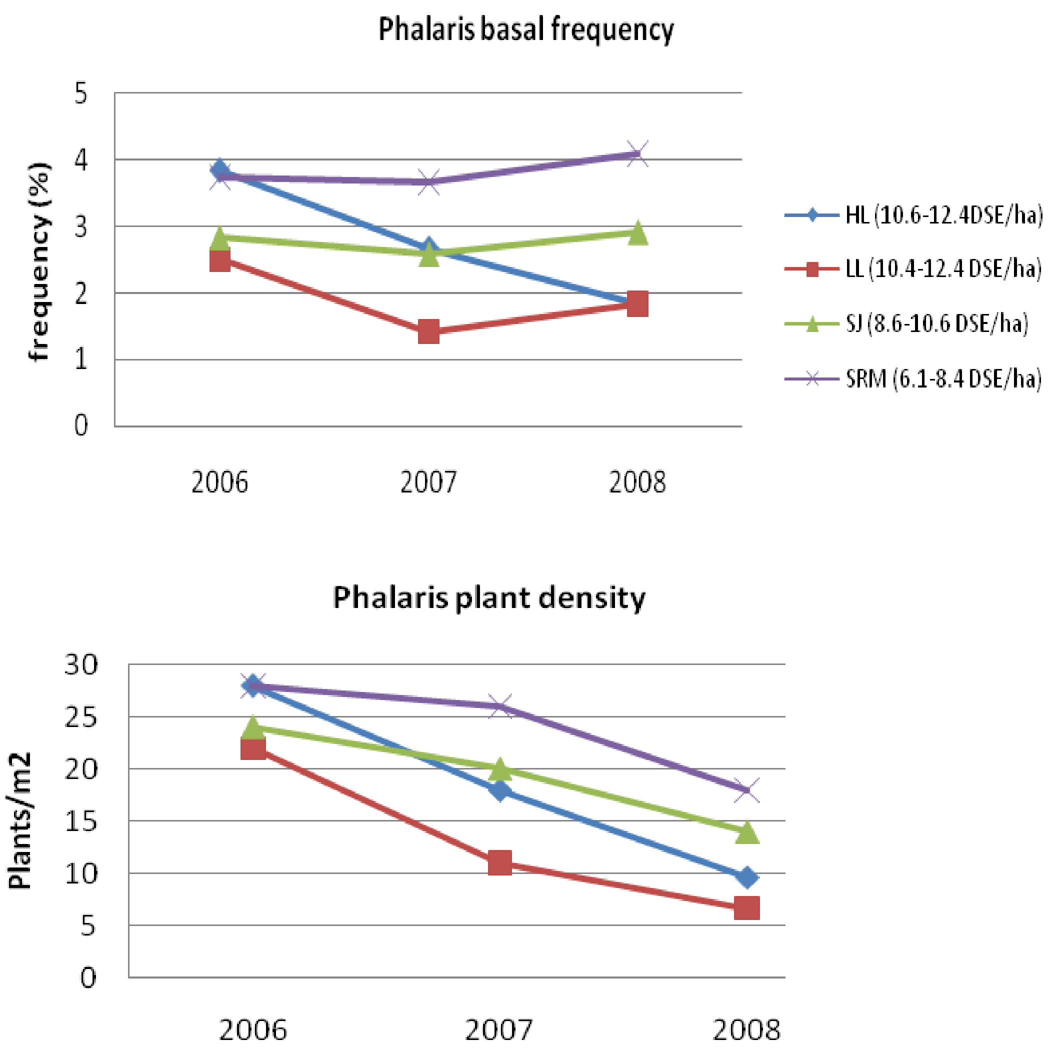
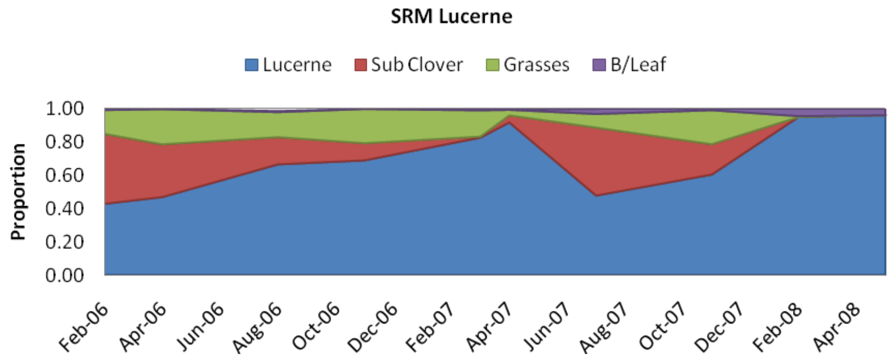
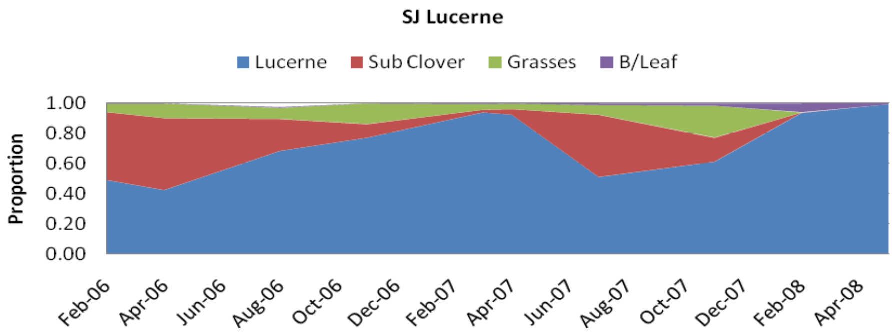
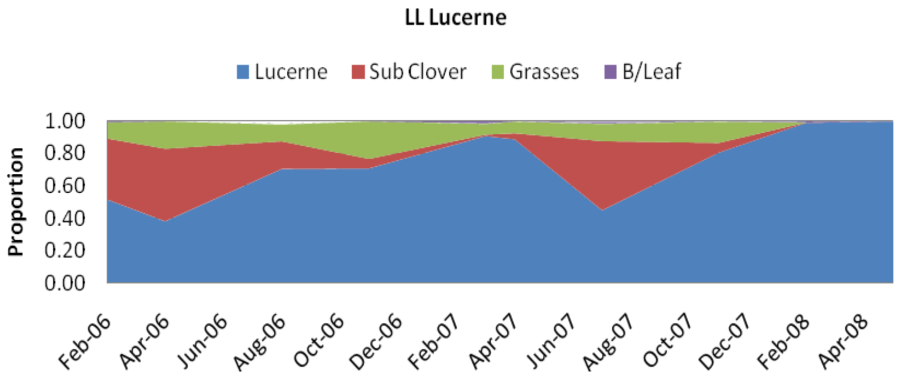


Figure 76. Phalaris basal frequency and plant density.

Botanical composition: Figure 77 demonstrates very little difference in compositional changes in lucerne over time between treatments, and the gradual decline in grass content. This is despite no herbicide spraying of lucerne, demonstrating that lucerne has effectively competed for limited soil water and prevented other species predominating. The next measurement is expected to show some increase in grass and broadleaf content, due to recent growth of barley grass in particular in some reps. Nevertheless, the graphs demonstrate how relatively ‘clean’ the lucerne pastures are, and how important lucerne has been in providing biomass. Of concern is a limited germination of sub-clover this year in lucerne after 2 years of failed seed-set. This may require direct seeding or broadcasting of sub-clover next year, depending on seed-set this year.


SRM Lucerne
Lucerne
Sub Clover
Grasses
B/Leaf
Proportion
1.00
0.80
0.60
0.40
0.20
0.00
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Oct-07
Dec-07
Feb-08
Apr-08


SJ Lucerne
Lucerne
Sub Clover
Grasses
B/Leaf
Proportion
1.00
0.80
0.60
0.40
0.20
0.00
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Oct-07
Dec-07
Feb-08
Apr-08


LL Lucerne
Lucerne
Sub Clover
Grasses
B/Leaf
Proportion
1.00
0.80
0.60
0.40
0.20
0.00
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Oct-07
Dec-07
Feb-08
Apr-08

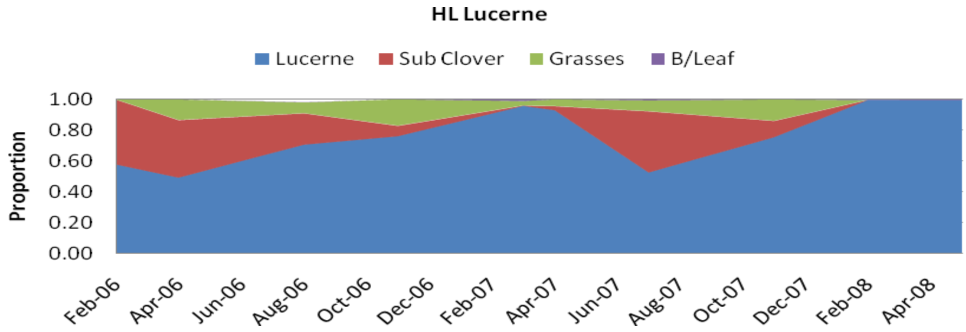
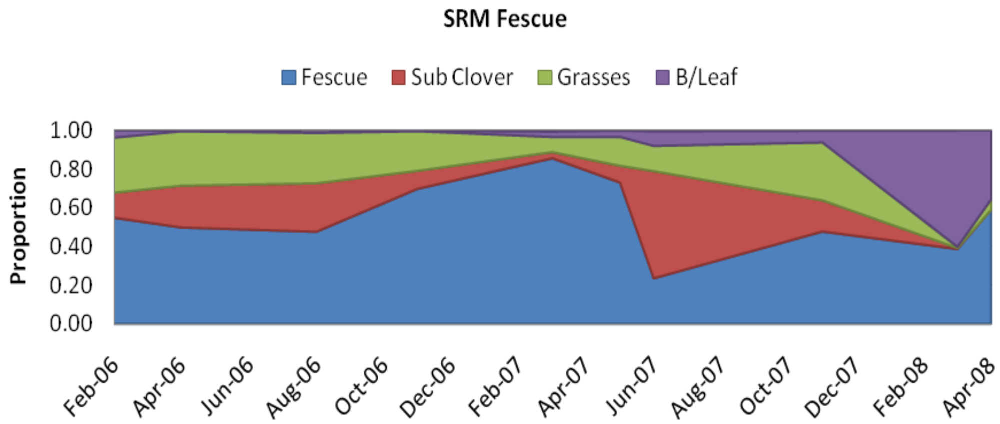


Figure 77. Composition of lucerne pastures in each treatment

Figure 78 shows little effect of treatment on the composition of tall fescue pastures. Tall fescue has remained the dominant species in each treatment until recently when summer rainfall resulted in the germination of considerable quantities of the broadleaf weed goosefoot. As this is relatively palatable, and contributes to groundcover, a decision was made not to spray this weed out. All fescue pastures were sprayed after the break of season with Tigrex to control the winter broadleaf weeds of capeweed and saffron thistle. The next botanal estimate is expected to show the predominance of fescue in the mix. There may be some treatment effect with some reps showing greater quantities of annual ryegrass and wild oats. Similar to lucerne, of concern is the limited sub-clover germination this year. This may require attention next year if seed set is not good.



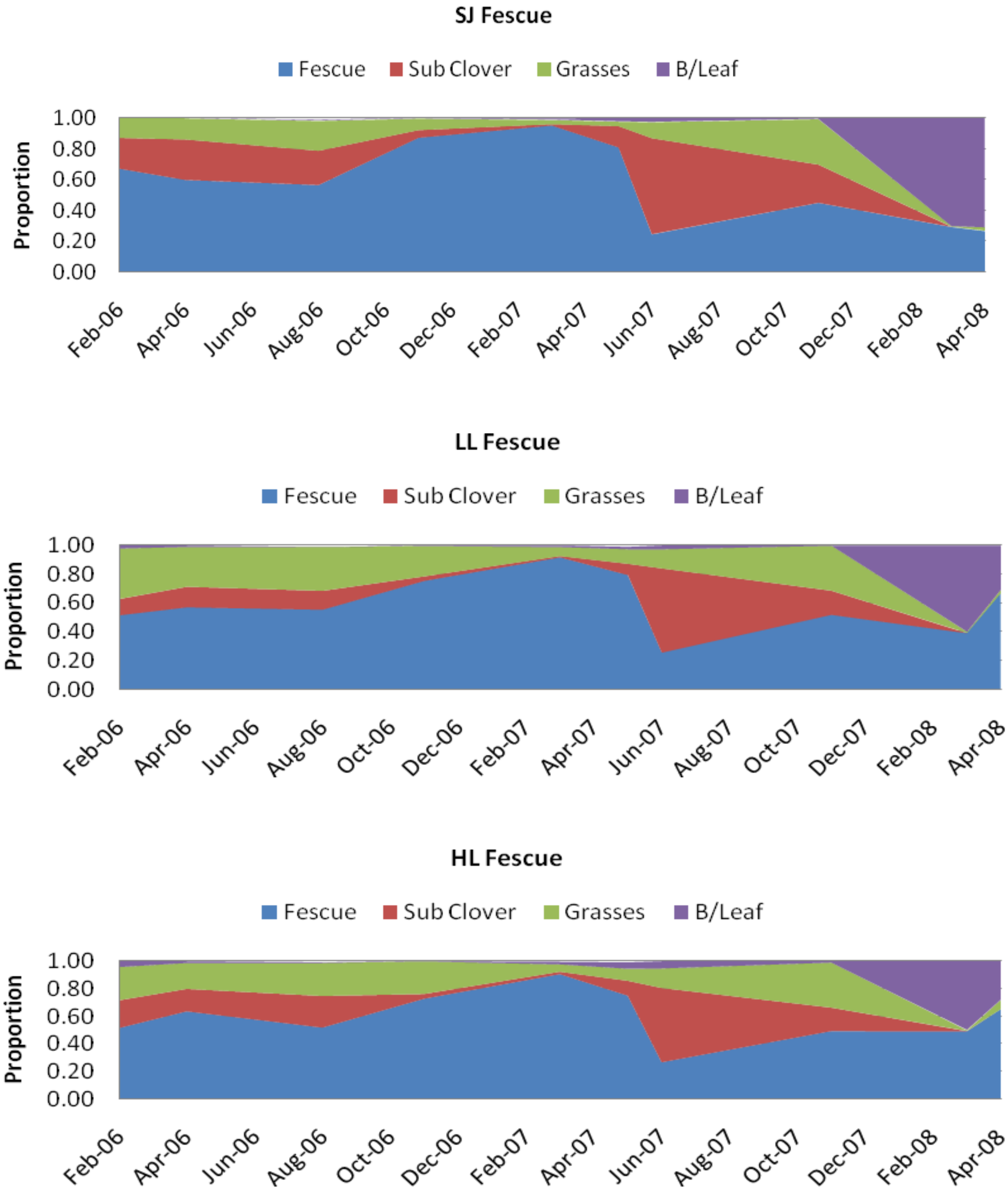
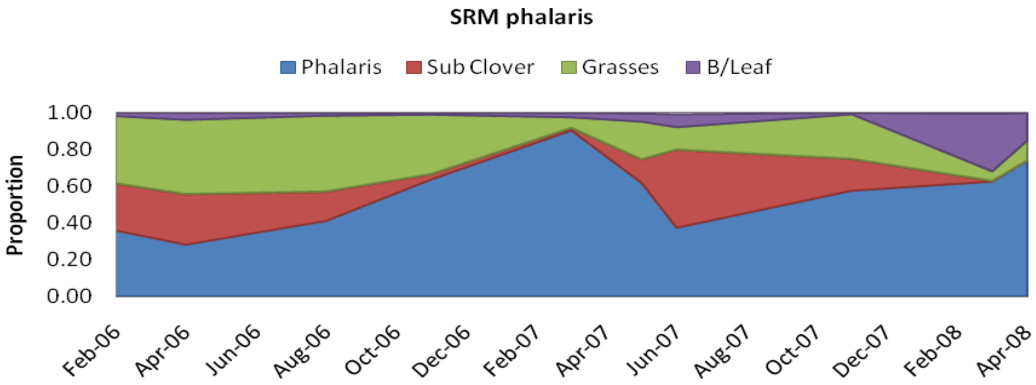
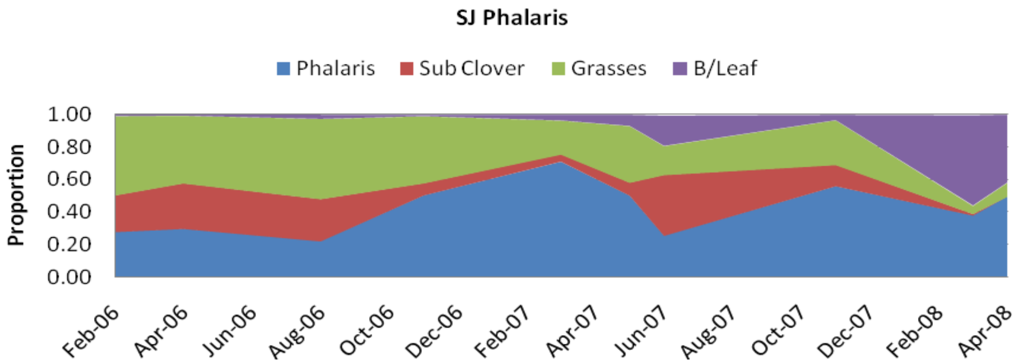


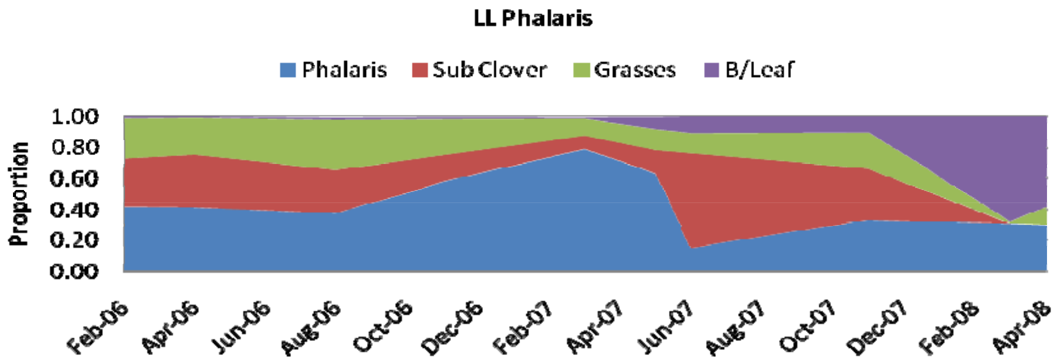
Figure 78. Composition of tall fescue pastures in each treatment

Figure 79 shows a similar compositional change over time in phalaris pastures to fescue pastures. Treatment effects are inconsistent, but it appears the lowest stocking rate treatment (SRM) has maintained the greatest phalaris composition. Phalaris has still remained the dominant species in all treatments. Similar to tall fescue pastures, broadleaf invasion of goosefoot over the 07/08 summer provided valuable summer feed and groundcover. All phalaris pastures were sprayed in winter 08 to control winter broadleaf weeds (predominately saffron thistle), and as a result they are now very 'clean'. The next botanal assessment is expected to demonstrate an increase in sub-clover content (much more so than in lucerne or fescue pastures) and the lack of annual grasses.

As a result, we will consider direct drilling annual ryegrass next year into phalaris pastures to provide more winter feed, and may also drill subclover depending on seed set.







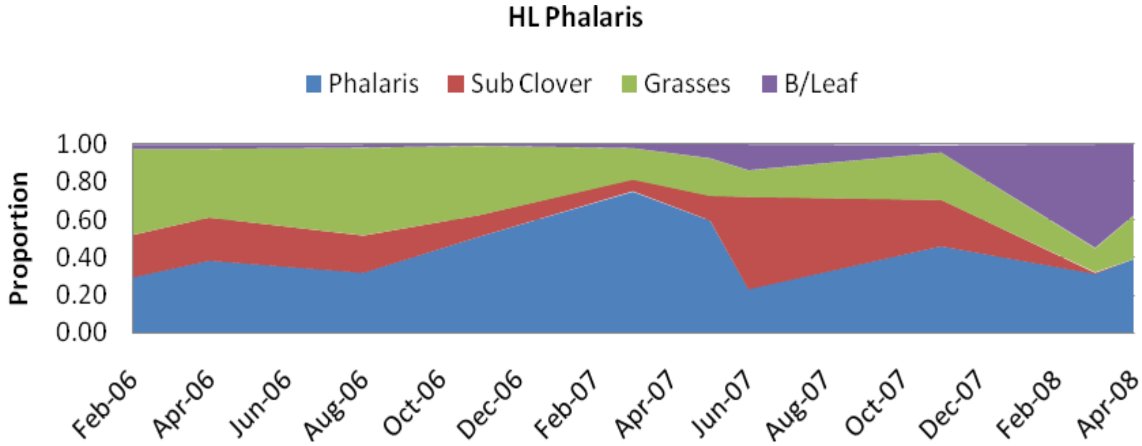


Figure 79. Composition of phalaris pastures in each treatment

DSE grazing days: Figure 80 shows the DSE grazing days/ha for each pasture type within treatment. Within a treatment, the amount of grazing provided by each pasture type was similar in 2006, although lucerne was noticeably more important in the LL treatment. The extreme drought conditions of 2006 limited all pasture growth, and as a result animals spent much time of plots. During 2007, lucerne clearly provided the most grazing/ha in all treatments.

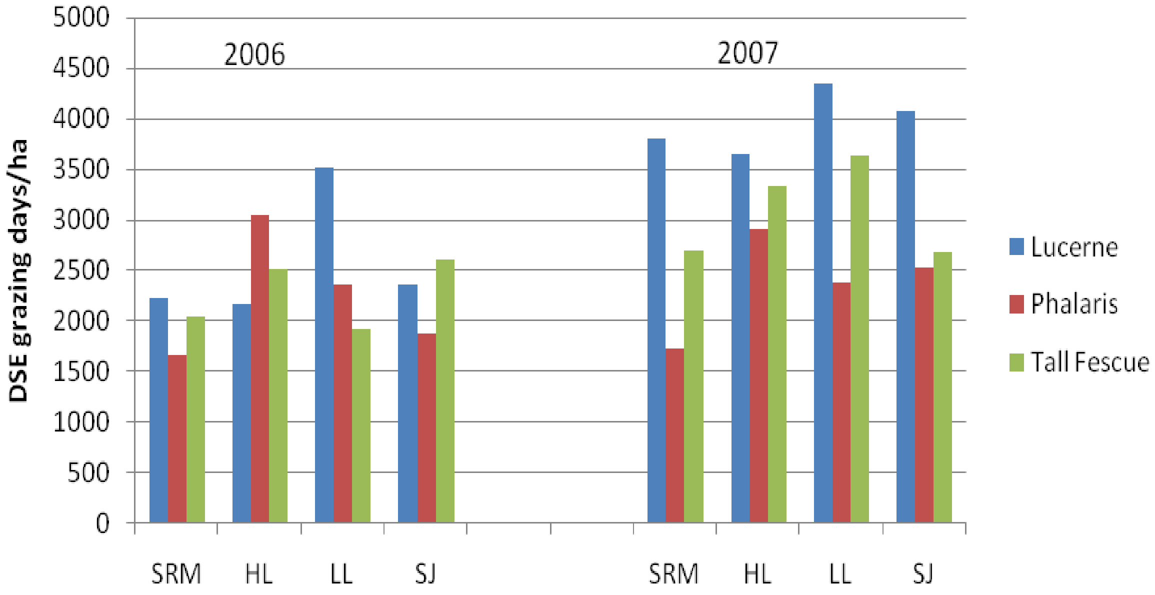


Figure 80. DSE grazing days/ha for each pasture type within each treatment.

Soil moisture: Neutron moisture meter readings over the past summer for lucerne (Figure 81) shows a tendency for the lower stocking rate treatments (SRM and SJ) to dry the soil to a greater extent at depth. It should be noted these are raw, uncalibrated readings at this stage, so this tendency should be interpreted with caution until calibrated (although all four readings are on the same soil type). Any effect of stocking rate is likely due to the lower grazing pressure on the SRM and SJ treatments, which has allowed them to maintain a greater leaf area to rapidly respond to summer rainfall. All readings were taken as soon as possible after significant rainfall events.

Neutron moisture meter readings over the past summer for fescue (Figure 82) shows no obvious treatment effect, although the SRM treatment may be drying the soil to a slightly greater extent at depth due to its lower stocking rate. While a comparison between lucerne and fescue is invalid because of differing soil types, the pattern of the lucerne and fescue graphs clearly demonstrate the greater ability of lucerne to dry the soil at depth.

Neutron meter access tubes have only recently been installed at site 1 – the shallower soil type combined with dry conditions had prevented installation to date. Attempts were made, but after several equipment breakages a decision was made to delay installation until winter/spring 2008.

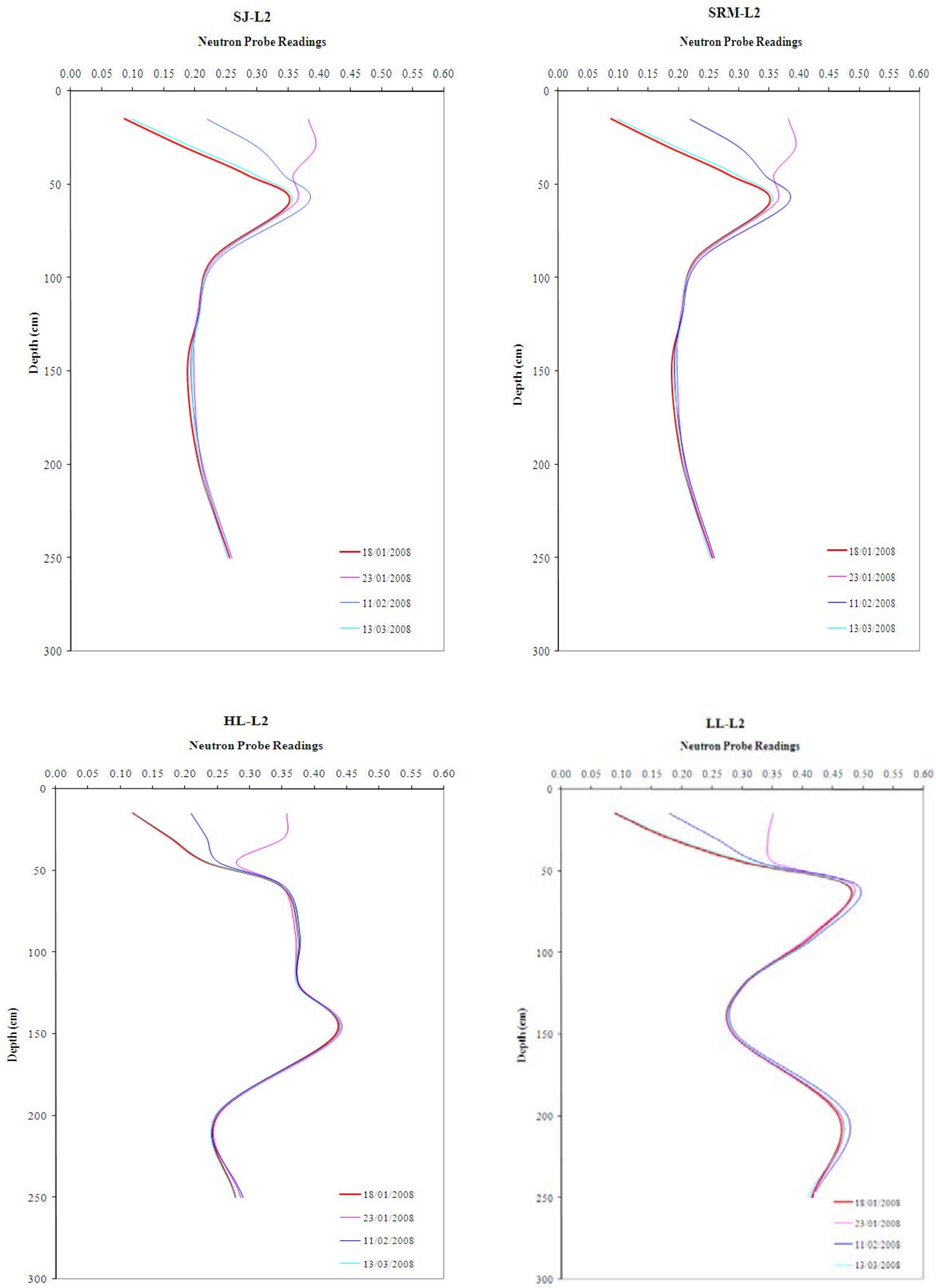


Figure 81. Neutron moisture meter counts (Jan-Mar 08) for lucerne replicate 2 of each treatment.

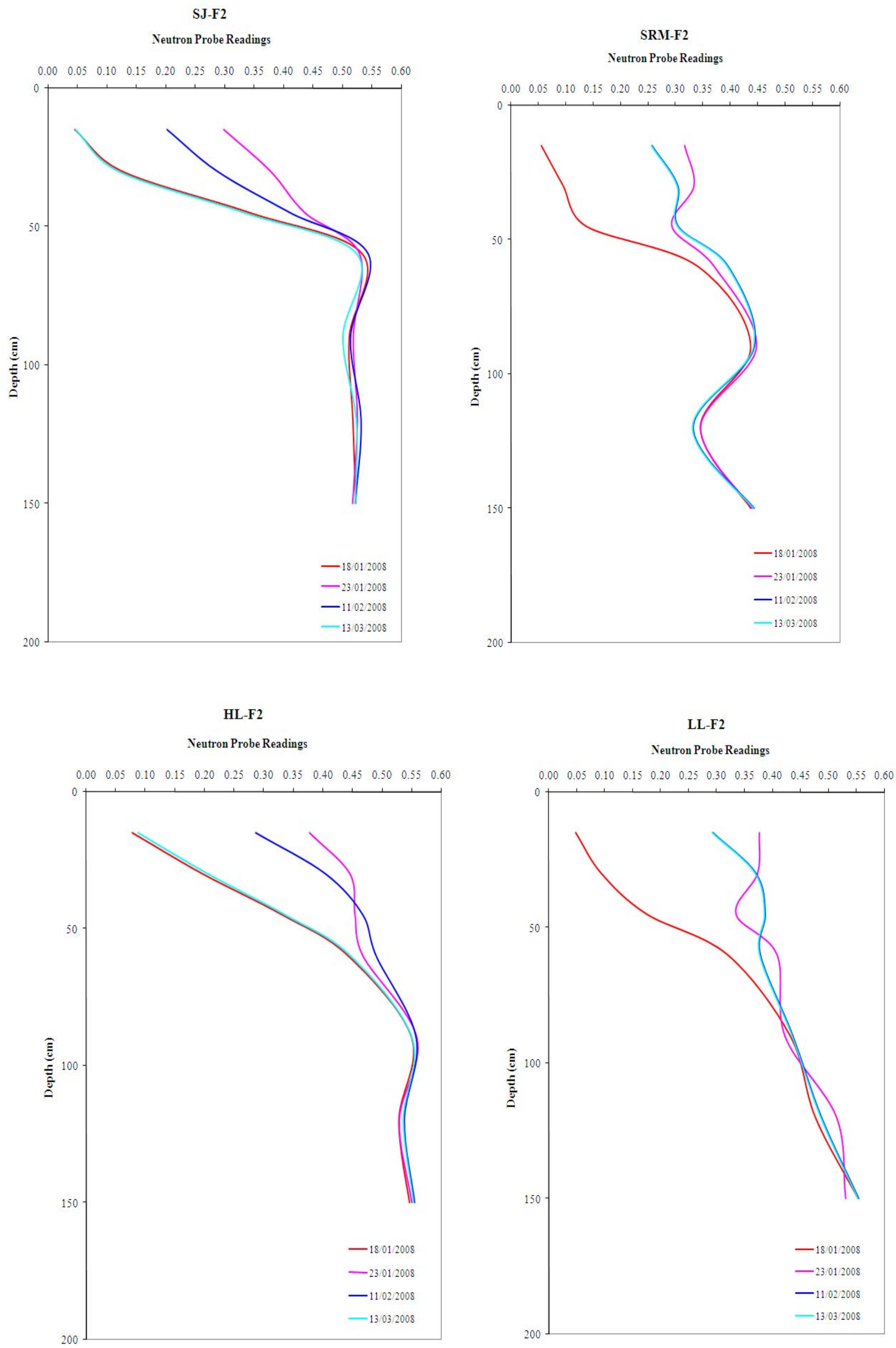


Figure 82. Neutron moisture meter counts (Jan-Mar 08) for fescue replicate 2 of each treatment.

Soil test data: All 36 plots were sampled in early 2008for comprehensive soil testing. Results were variable between treatments, pasture type and replicates of treatment within pasture type. pH of lucerne paddocks did not vary between treatments, averaging 5.7 (minimum of 5.2), nor did it vary between treatments in fescue paddocks (mean 5.9, minimum 5.3) or phalaris paddocks (mean 6.3, minimum 5.8). Colwell P was highly variable, ranging from 38 – 64ppm for all lucerne paddocks (means SJ 42, LL 39, HL 49 and SRM 45ppm), 37-74ppm for fescue paddocks (means SJ 46, LL 40, HL 46 and SRM 54ppm) and 37- 68ppm for phalaris paddocks (means SJ 56, LL 48, HL 41 and SRM 43ppm). Given all plots were above the critical value of 35ppm for these soil types, 16kg/ha P will be applied to all plots based on the maximum estimated annual stocking rate of 16DSE/ha (for LL and HL treatments weaning 120% lambs). This equates to 180kg/ha single superphosphate. In calculating gross margins in future, the amount of P required to replace P removed from each of the systems will be used to calculate P costs.

General comments and conclusions on pastures: As a result of extended drought conditions, the measured density of sown grass species has declined. However, agronomic advice to date is that these pastures are still functional, although we need to consider in our analyses whether one of the reps is removed due to notably lower phalaris populations in the LL and SJ phalaris paddocks of this replicate. Nonetheless, it is clear that has we not had perennial pastures, the level of groundcover and feed provided would be very poor, given that annual pastures currently comprise very little of total botanical composition at present. Therefore, an issue to consider, in consultation with the ERG, is whether annual species are drilled into phalaris and fescue pastures next year, in order to provide more feed, given the disappearance of annuals from the pastures over the duration of the experiment. Sub-clover may need to be drilled in next year, depending on seed set this year.

Lucerne has once again shown its resilience during dry conditions when rotationally grazed. It has provided by far the greatest amount of feed/ha (it should also be noted that its advantage would be even greater if the quality of feed provided was taken into consideration), has maintained plant density and increased basal area, and has dried the soil to depth, indicating its ability to make use of sporadic rainfall. The only concern in lucerne paddocks is the relatively low amount of sub clover, which may require attention next year.

Livestock

Ewe liveweight and condition score: Liveweight of sheep in the SRM treatment has generally remained higher than sheep in other treatments (Figure 83). The extreme drought, in combination with extensive supplementary feeding between October 2006 and April 2007, resulted in the development of a distinct ‘tail’ of shy feeders. As a result, sheep were some 10kg lighter in autumn 2007 than they were at the start of the experiment. This undoubtedly contributed to the lower reproductive performance in 2007. The current liveweight of animals is greater than at the commencement of the experiment, and this is despite older ewes being culled and replaced with maiden (lighter) replacement ewes born in the project in 2006.

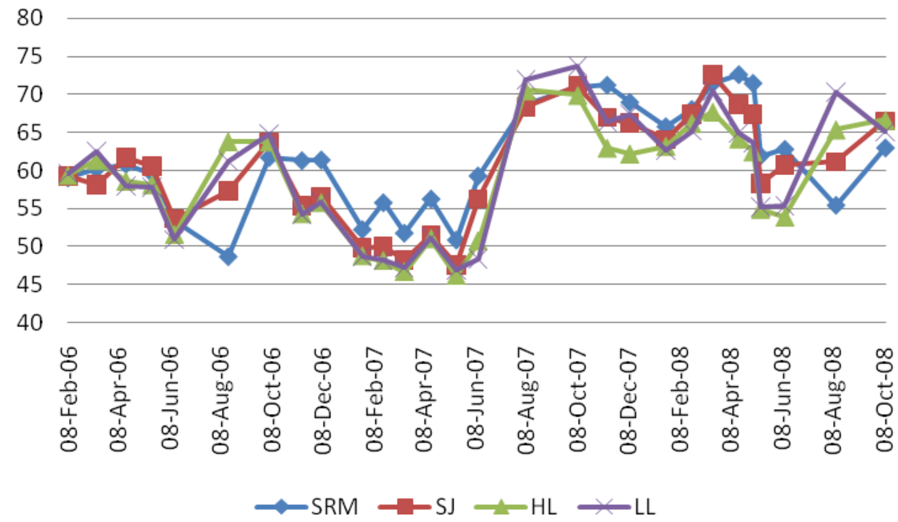


Figure 83. Liveweight of sheep in each treatment

Condition score data (Figure 84) reflect liveweight data. At joining in 2006 and 2008, all groups exceeded a mean condition score of 3, while in 2007 all groups except SRM were slightly below CS 2. Sheep have generally lambed at close to condition score 3, and certainly above 2.8 in all cases.

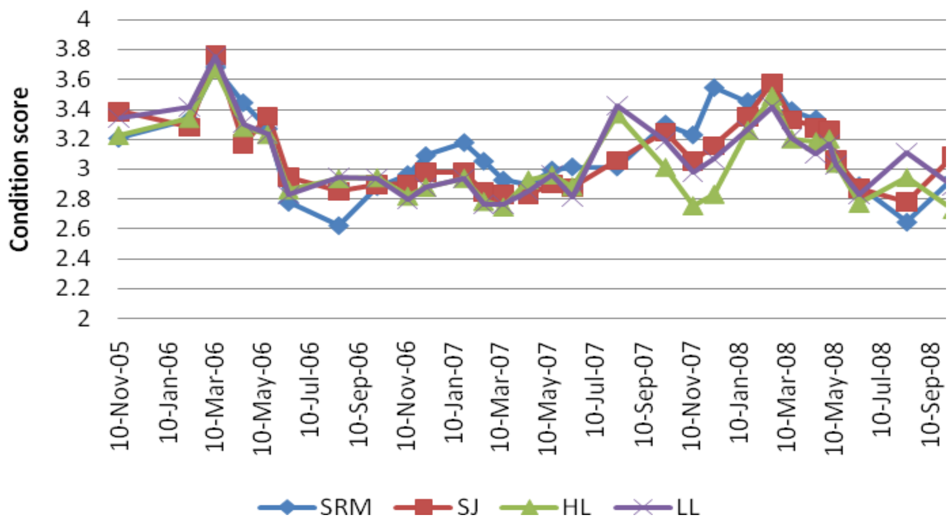


Figure 84. Mean condition score of sheep in treatment groups.

Lamb liveweights: In 2006 all lambs were sold at weaning. Reasonable early winter rainfall resulted in acceptable weaning weights for early born lambs (all SRM and SJ crossbred), but poor weights for September born lambs (Figure 85 and 86).

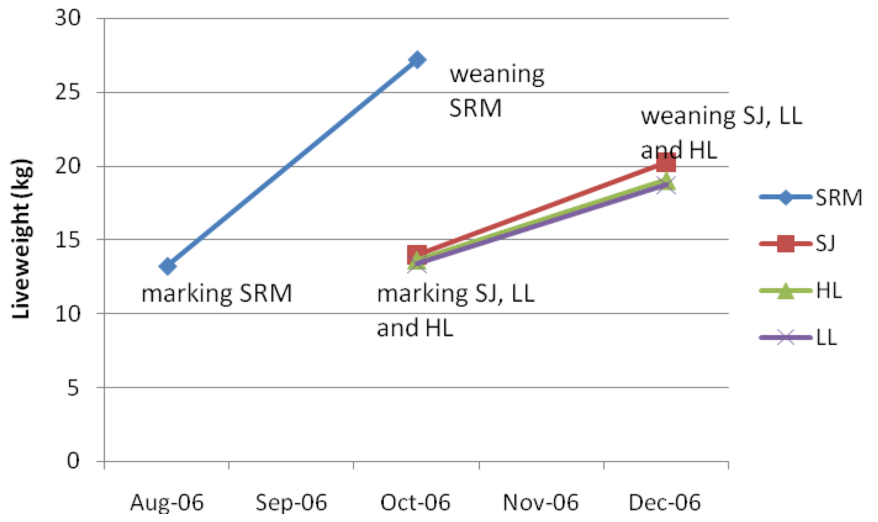


Figure 85. Marking and weaning weights in 2006 for merino lambs

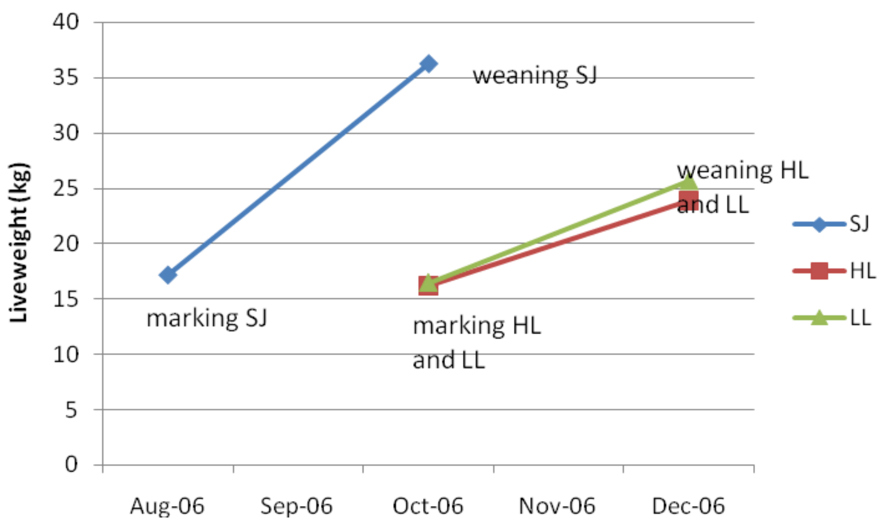


Figure 86. Marking and weaning weights in 2006 for crossbred lambs

In 2007 marking weights of merino lambs were similar in all treatments, but weaning weights were much greater for merino lambs in the SRM treatment (Figure 86), due to lower stocking rates and the earlier birth date (hence not being affected by the failed 2007 spring). From October, the growth rate of all lambs was similar. SJ merino lambs were retained for a month after weaning to opportunistically use lucerne grown as a result of above average November and December rainfall.

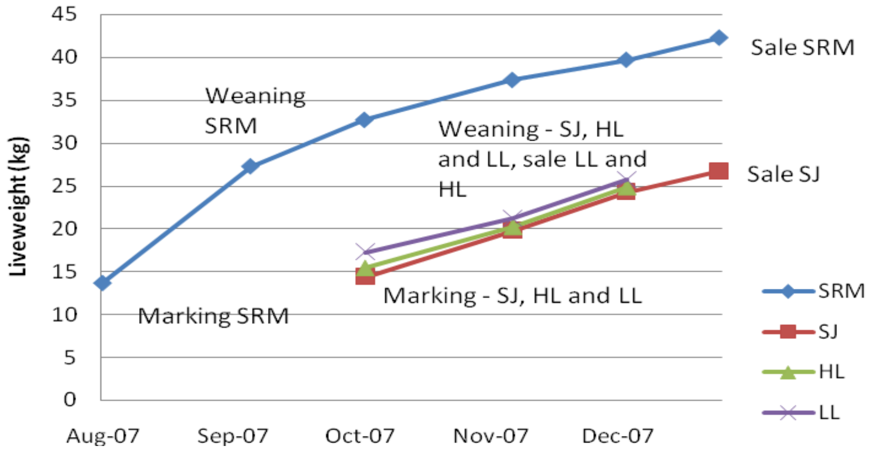


Figure 87. Merino lamb weights for the treatments in 2007.

Marking weights of crossbred lambs were similar for treatments, but weaning weights were greatest for lambs in the SJ treatment, due to the lower stocking rate and earlier lambing time (Figure 87), thus being less affected by the failed spring.

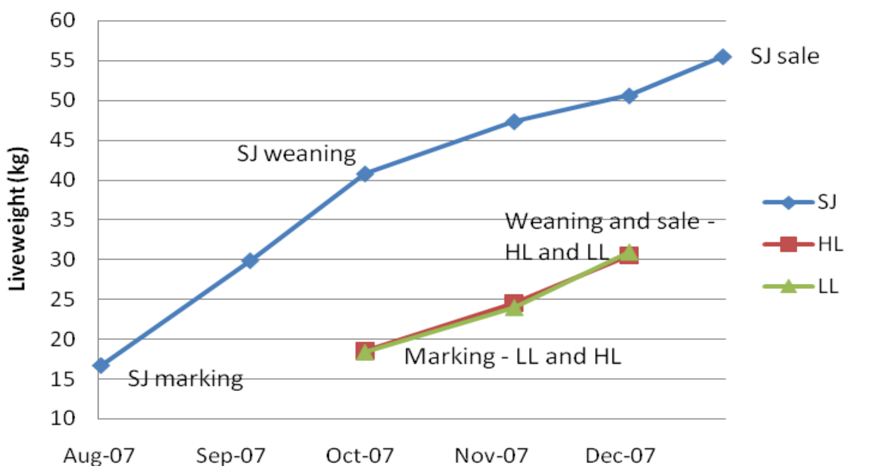


Figure 88. Crossbred lamb weaning weights in 2007.

In 2008, merino lambs were marked at approximately 12.2kg (range 12.0kg for LL to 12.4kg for HL), while SRM lambs were weaned recently at 27.3kg. SRM lambs are currently grazing lucerne to finish. Crossbred lambs were marked at 14.1, 15.0 and 16.3kg for the LL, HL and SJ treatments respectively. SJ lambs were weaned recently at 34.7kg, and are currently being finished on lucerne.

Eye muscle depth for each treatment: As expected, eye-muscle depth at weaning was greater for crossbred lambs (comparing lambs with the same birth dates) and was also greater for July than September born lambs (Table 35).

Table 35. Eye-muscle depth (mm) at weaning for merino and crossbred lambs

Treatment	**Merino**	**Crossbred**
	2006	
SRM	19.9	n/a
SJ	14.9	24.4
HL	14.4	18.8
LL	14.2	18.5
	2007	
SRM	22.9	n/a
SJ	17.1	28.9
HL	15.9	21.5
LL	17.6	21.4
	2008	
SRM	20.2	n/a
SJ	tba	25.8
HL	tba	tba
LL	tba	tba

Ewe wool data: Table 36 presents wool data representing wool grown predominately in 2006 and 2007 (shorn in May 2007 and May 2008). A few points are noteworthy: It is unusual given the stocking rate differences that larger differences are not apparent in fleece weights. This is likely due to the efficacy of the supplementary feeding program. Yields were particularly poor in 2006, largely due to the extreme drought. Staple strength data generally follows stocking rate – higher stocking rates were associated with lower SS. The approximate gross margins presented later are based on a single wool price and do not account for any treatment differences in wool value due to SS etc.

Table 36. Wool data for each treatment

Treatment	GFW (kg)	MFD (µm)	Yield (%)	CVFD (%)	SS (N/ktex)
			2006		
SRM	4.61	19.5	59.3	17.9	43.1
SJ	4.64	19.0	57.1	18.3	34.4
HL	4.46	18.8	57.6	17.9	35.6
LL	4.59	18.4	58.7	17.8	31.0
			2007		
SRM	5.07	21.3	67.5	17.0	42.6
SJ	4.87	21.7	65.3	16.9	41.8
HL	4.73	20.5	66.0	17.5	35.9
LL	5.41	21.2	64.6	17.2	35.4

Reproductive data: Reproductive performance of the flock has, in general, been disappointing. Given the ewes were sold on the basis of weaning in excess of 120% lambs, and that we have ensured they are in at least condition score 3 at joining and lambing, it is disappointing only the lowest stocking rate treatment (SRM) achieved this weaning % in one year. Given the data below (Table 37) show that treatments with higher stocking rates had lower weaning %, we can conclude the stated average weaning % of the flock is based on relatively low stocking rates. Undoubtedly, the dry conditions have contributed to the less than anticipated reproductive performance (especially in 2007), but this should have been offset by the large amounts of supplementary feed fed. Age of the ewes may have also played a part – the ewes were 4 and 5 years old in 2005 when purchased. This may have also contributed to the poor performance in 2007. We have sought to address this by replacing older ewes with maiden ewes born on site. These ewes are included in 2008 data, and ewes born on site in 2007 (as well as new ewes purchased as part of the new contract) will be included in 2009. We expect this will improve reproductive performance, providing seasonal conditions are adequate.

Table 37. Reproductive data for each treatment

Treatment	Lambing %	Marking %	Weaning %
	2006		
SRM	166.7	123.3	120.0
SJ	140.7	117.3	111.1
HL	139.2	109.2	102.5
LL	140.0	102.5	97.5
	2007		
SRM	126.0	89.9	88.4
SJ	111.0	90.8	89.7
HL	93.0	75.8	73.3
LL	82.0	65.8	65.8
	2008		
SRM	151.0	103.4	101.1
SJ	141.0	93.7	tba
HL	116.0	88.2	tba
LL	112.0	92.2	tba

The poor reproductive performance can be attributed to: Poor joining results for all groups in 2007, as a result of extended dry conditions and a 'tail' of shy feeders developing (although these were identified and fed separately), and barely adequate results for the higher stocking rate treatments in 2008. Poor lamb survival, particularly in 2006 (all treatments) and 2008 (lower stocking rate treatments). The majority of deaths (data not shown) have been attributed to SME, although dystocia has been too high. We have recently purchased new Lampro rams (higher EBV's than the Elsted sires currently used, except for birthweight – all are less than +0.2), which will be used in 2009 in an attempt to reduce dystocia. Interestingly, dystocia has also been high in the SRM treatment.

Overall production data and economics: Table 38 clearly shows over the past 2 dry years the higher supplementary feed costs associated with the higher stocking rate (HL and LL) systems. In 2006, despite these systems producing the most wool and meat/ha, they lost money (Table 39) due to high supplementary feed costs. In 2007, poor joining results, in combination with higher supplementary feed costs and a failed spring (limiting lamb weaning weights), resulted in these treatments producing less meat/ha than the split joining system. This indicates that higher stocking rate, later lambing systems entail more risk. However, the potential production from these systems is indicated in the 2008 provisional data – they have marked much more lamb/ha. However, this is unlikely to translate to more lamb sold/ha, as poor spring rainfall again will limit the ability to wean lambs at high weights, and supplementary feed costs are likely to be greater in these systems again this year. Nevertheless, the data show the potential production from these systems, indicating that providing we can maximise joining results, lamb survival and growth rates from spring pastures, while minimising supplementary feed costs, potential exists to achieve high gross margins. Potential gross margin of these systems at 13 DSE/ha MWSR, and 120% weaning, is $491/ha (Table 39).

Table 38 Production data for each treatment in each year. Note that in 2006 and 2007 the mid-winter stocking rate was 10DSE/ha, while in 2008 it will be 13DSE/ha.

		Self-replacing Merino	**Later lambing**	**High Lucerne**	**Split joining**
Joining time		**Feb**	**April**	**April**	**Feb & Apr**
Merino/terminal joining		100/0	50/50	50/50	50/50
2006	Annual stocking rate	6.1	10.4	10.6	8.6
	No. breeding ewes/ha	3.8	7.7	7.7	5.2
	Lamb weaned/ha	4.6	7.5	7.9	5.8
	Merino lamb sale/weaning weight (kg)	31	19	19	21
	Crossbred lamb weaning weight (kg)	n/a	26	24	36
	Total lamb produced (kg/ha) (all sold at weaning in 2006)	143	174	173	169
	kg wool/ha	17.3	36.2	35.5	24.3
	Supplementary feed costs ($/ha)	121	342	318	210
2007	Annual stocking rate*	8.4	12.4	12.4	10.6
	No. breeding ewes/ha	4.4	7.7	7.7	5.6
	Lamb weaned/ha	3.8	5.1	5.7	4.8
	Merino lamb sale weight (kg)	42	26	25	27
	XB sale weight (kg)	n/a	31	31	56
	Kg lamb sold/ha	163	145	160	208
	kg wool/ha	19.5	40.3	39.6	27.3
	Supplement cost/ha	83	157	142	102
2008	Annual stocking rate	10.7	16.0	16.0	12.7
	No breeding ewes/ha	5.6	9.8	9.8	7.1
	Lamb marked/ha	5.6	9.0	9.3	6.7
	Kg lamb marked/ha	70.0	118.8	118.3	96.3

[1]Supplementary feed costed at $200/T hay and $300/T grain, wool 19µm clean price of 898c/kg, lamb sales 320 c/kg CW crossbreds and 240 c/kg CW merinos.
*Stocking rate increased by 25% in August 2007 by addition of hoggets

Table 39. Approximate gross margins for 2006 and 2007, and potential gross margin

	DSE/ha July	Rainfall (mm)	Self-replacing Merino	Later Lambing	High Lucerne	Split-Joined
Potential at 120% weaning	13	620	297	491	491	440
2006	10	252	14	-129	-116	6
2007*	10	500 (70mm Aug-Oct)	103	76	95	188
2 year average			59	-27	-11	97
*Stocking rate increased by 25% in August 2007 by addition of hoggets						

While the potential gross margin of the lower stocking rate systems is lower, results to date suggest these systems may be more appropriate in unpredictable seasons. The split joining system appears to offer the most promise for several reasons:

1. Its potential gross margin is only 10% less than the higher stocking rate systems;
2. The estimated gross margins in 2006 and 2007 have been substantially higher. In fact, when gross margins are calculated more thoroughly, it is likely the difference will be greater as this system has produced more marketable lamb than the high stocking rate systems, and potentially higher value wool due to better SS;
3. It is more likely, given the negative relationship between SR and weaning %, that the target weaning % of 120% will be achieved in this system than in the higher stocking rate systems, thus getting the actual GM of this system closer to potential than the higher stocking rate systems;
4. It is highly flexible. In 2006, the very poor season meant early born xb lambs could be sold at good store weights from this system at weaning (rather than attempt to finish), thus achieving relatively good production/ha at lower supplementary feed costs. In contrast, the higher stocking rate systems, with new lambs at foot, required extensive supplementary feeding just to get lambs to survival weaning weights. In 2007, xb lambs from this system were able to be finished opportunistically to export weights as a result of late spring/early summer rain. The higher stocking rate systems, while they produced better lambs than in 2006, were not able to retain lambs without supplementary feeding.

It should be noted that flexibility in the spilt joining system was made possible by the availability of perennials, in particular lucerne. Had summer active feed not been available, this system would have not been able to capture higher production from summer rainfall. While differences between the two higher stocking rate systems (LL and HL) have to date been small, it is likely that if climate uncertainty continues that the system including more lucerne may be superior, given that the overall pasture base of this system has been less affected by the drought than the system with less lucerne. The effect of varying proportions of lucerne in other systems (particularly the split joining system) should be modelled.

General comments on livestock production and economics: The potential production from the systems has been obviously limited by reduced pasture growth as a result of dry conditions. It also appears the Centreplus ewes have not performed to expectations, for reasons discussed earlier. This is likely to limit the ability to achieve the potential gross margins in better years.

Nevertheless, the relative differences in the performance of the systems is invaluable in thinking about how we best use a perennial pasture, and what systems may be best suited to uncertainties in climate. Clearly, if reduced spring rainfall eventuates (as forecast), then higher stocking rate, later lambing systems may not be the most appropriate system. While the lower stocking rate, earlier lambing system is clearly least sensitive to this climate variability, from the limited data available, a split joining system may be an appropriate strategy to limit risk while maximising long-term gross-margins from a perennial pasture base.

Component experiments

Ovulation rate study: Experiment 1 compares four flushing strategies (2 replications): Phalaris pasture (negative control); Phalaris pasture plus 500 g/ewe.day lupin grain (positive control); Chicory and; Lucerne. 400 'CentrePlus' ewes were oestrus synchronised and grazed the pastures for 9 days either until oestrus in 2006 or until 2 days prior to oestrus in 2007 and 2008. Stocking rate on plots was 23 ewes/ha. Ovulation rate was measured in March 2006 (via laparoscopy) and in January 2007 and 2008 (via trans-rectal ultrasound). The levels of significance (where included) in the following data are the result of preliminary analysis. Formal analysis of 2008 data and data from all 3 years of the experiment is currently taking place.

In 2008, pre-flushing live pasture biomass was greater than in previous years (Figure 89). Live biomass post-flushing was variable between replicates especially within the chicory and lucerne treatments where live feed remaining was nearly double the amount in one replicate compared to the other (1159 vs. 498 kg DM/ha and 649 vs. 374 kg DM/ha respectively). There were significant quantities of dead pasture in all pasture types with chicory and lucerne having >800 kg DM/ha post-flushing.

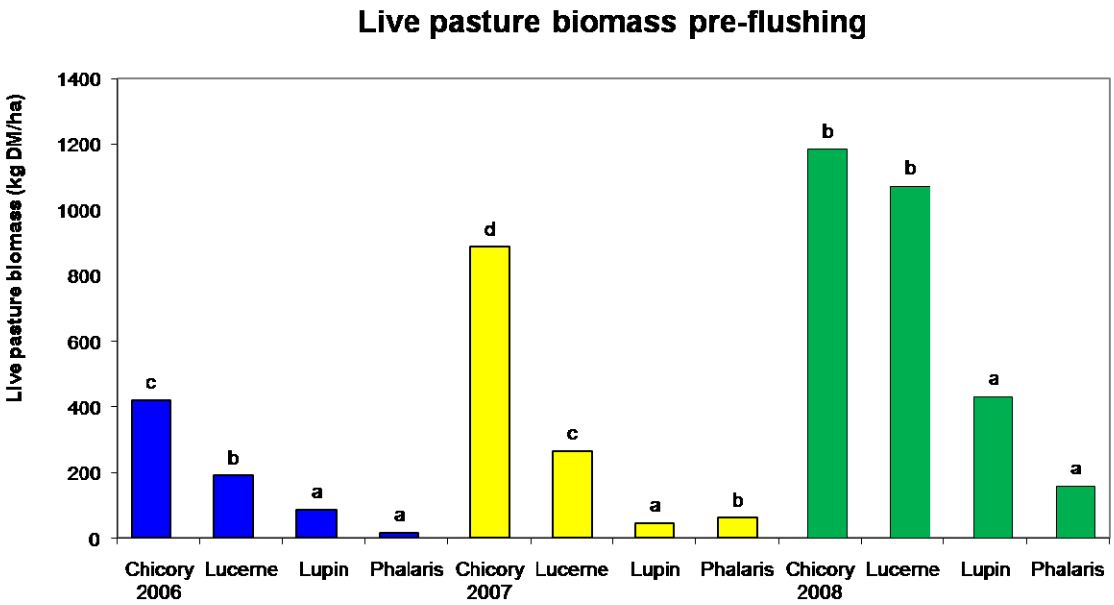


Figure 89. Live pasture mass pre- flushing treatment at site 2. Letters represent differences at P<0.05 level within years.

Before the trial ewes weighed an average of 60 kg and were in a stable average condition score of 3.0. Mean ovulation rate between years of the study is presented in Figure 90. In 2008, increases in mean ovulation rate in ewes grazing chicory, lucerne and lupin grain were all around 7-10% higher than ewes grazing phalaris and increases in the proportion of ewes with multiple ovulations for these treatments ranged from 20-33% higher than the phalaris treatment (differences not significant in preliminary analysis). The response to lucerne compared to phalaris has been consistent across the 3 years of the trial (around 10% increases in mean ovulation rate), but in 2008 this treatment resulted in a higher number of ewes with triplets. Increases in ovulatory response in the chicory and lupins compared to phalaris in 2008 were much lower than increases observed in 2007 (mean ovulation rates in 2007 up 22% and 17% respectively and the proportion of ewes with multiples up 185% and 135% respectively). This could be explained by higher ovulation rates in phalaris ewes this than in 2007. This may be in response to higher amounts of green pasture in the phalaris plots this year. Moreover, variation in live biomass between replicates reflected differences in ovulatory response between replicates. Preliminary regression analysis indicates that live pasture biomass pre- and post-flushing across all the pasture treatments in 2007 and 2008 explained up to 60% of the variation in ovulatory response (P<0.05). The effect of condition score on ovulatory response to short term flushing is still to be analysed.

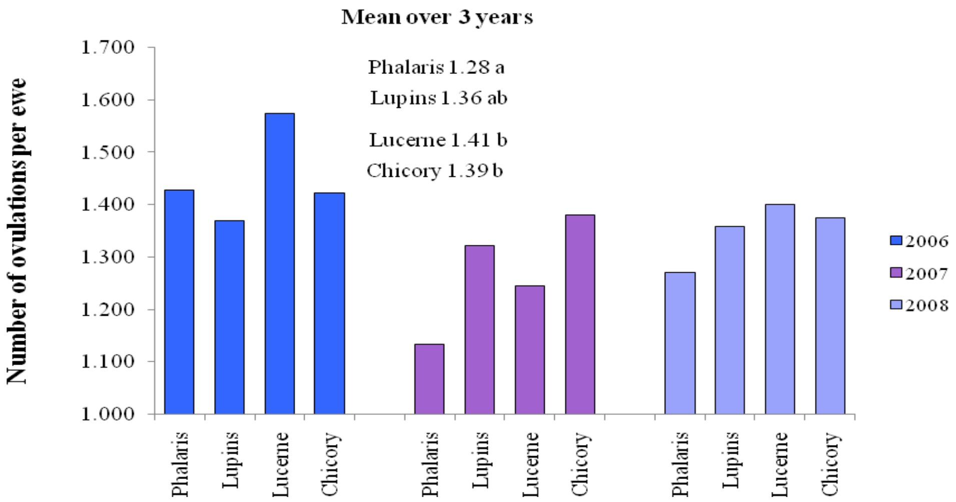


Figure 90. Mean ovulation rate at site 2. Letters represent differences at P<0.05 level.

When live pasture mass (pre and post grazing) was regressed against ovulation rate (excluding the lupins treatment and 2006 data – due to slight differences in management that year), over half the variation in ovulation rate could be explained by green feed available (Figure 91).

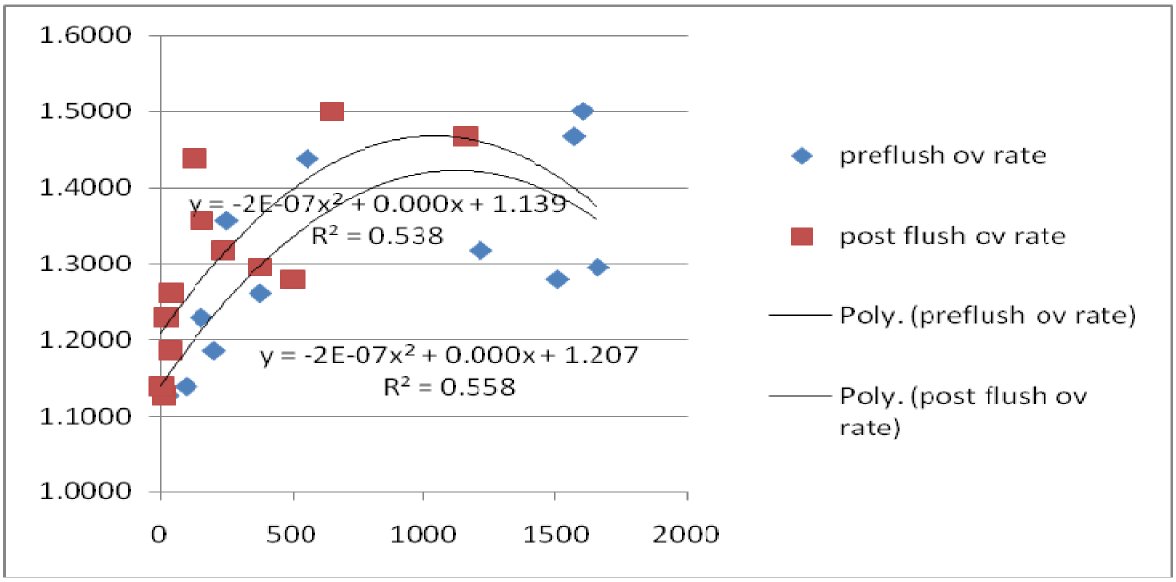


Figure 91. Ovulation rate vs green feed (kg/ha) pre and post grazing.

In summary the short-term grazing of summer active perennials increased ovulatory response by up to 22% and live pasture biomass appears important in determining the ovulation rate of synchronised ewes.

Lamb Survival study: Ewes lambed over a 4 week period in winter under 4 management regimes (replicated 3 times): Singles with no protection; Singles with phalaris hedgerows; Twins with phalaris hedgerows and; Twins with shrubs.

Ewes from the ovulation rate experiment were oestrous synchronised and treated with PMSG and joined to harnessed rams over a 4 week period. In 2006 and 2007, phalaris hedgerows were used, while in 2008 hessian hedgerows were used due to degeneration of phalaris hedgerows after 2 consecutive springs of no seed-set.

Table 40 shows the higher mortality of twins compared to singles in 2006. This can be attributed to a mild winter combined with shrubs being immature. In 2007, singles and twins lambing in hedgerows had similar mortality, largely because of the elevated mortality of singles in hedgerows – it was unclear why this was the case. 2008 data are beginning to show the potential of shelter – mortality of twins was below 30% in both forms of shelter and similar to the mortality of singles without shelter. Provision of shelter may have also offered a benefit to single lamb survival in 2008, although data are still to be statistically analysed. As expected, the level of SME is generally higher in twins. Weather conditions during the lambing of 2008 were worse (although by no means extreme) than in 2006 and 2007, and it can be seen the SME loss in single lambs was much higher than in previous years. Encouragingly, the level of SME loss in singles provided with shelter was less than half that of those with no shelter, and the level of SME in twins provided with shelter (in the form of shrubs) was similar to that of twins with no shelter. Preliminary analyses of ewe-lamb GPS and proximity collar data (as a part of John Broster's PhD) suggests the shrub rows may have enhanced ewe-lamb bonding.

Table 40. Mortality and level of SME in the lamb survival experiment.

Year		**Singles -No shelter**	**Singles - hedges**	**Twins - hedges**	**Twins shrubs -**
2006	Mortality %	21	20	37	34
	SME % / lambs born	8 .5	10.2	17.0	18.7
2007	Mortality %	20	31	28	37
	SME % / lambs born	5.1	8.6	11.0	17.3
2008	Mortality	30	23	30	27
	SME % / lambs born	13.6	6.2	18.5	13.3

Windspeed data (not shown) is starting to show the effect of shelter on reducing windspeed.

Additionally, as goitre was observed at both sites 1 and 2 last year, a small iodine supplementation trial was conducted this year. This trial involved drenching half of the ewes (n=138) in the lamb survival trial with potassium iodide to l. Additionally, in twin-bearing ewes not used for the lamb survival experiment (n=68), half were dosed with potassium iodide, and lambed down together. Preliminary data indicate a 10% higher lamb survival from ewes drenched with iodine in the additional trial.

As iodine drenching has no negative impact on ewes and their lambs, all ewes in the systems trial (site 1) were drenched with potassium iodide as a precautionary measure.

Hillslope hydrology – the interaction between pastures and shrubs:

Shrubs to manage water and shelter stock
Wagga Wagga

Background and Treatments
Alleys/belts of woody perennials have been effective in reducing water movement and saline outbreaks in cropping areas of Western Australia. The impact of lucerne and belts of woody vegetation on hillslope hydrology is being tested with four treatments (Figure 1):
- lucerne
- lucerne with shrub belts
- phalaris
- phalaris with shrub belts

Shrub Belts
Belts of native, drought and frost tolerant acacias were planted in July 2005. Shrub belts have three rows; the middle row are tall *Acacia deanei* and the outer rows are short, dense *A. iteaphylla* and *A. decora*.

Pasture and Shrub Growth
Initial pasture establishment failed because of weed pressure; pastures were successfully re-sown in mid 2006. The phalaris population has declined and annuals now dominate.

Shrub survival was greater in the upper shrub belt where the soil is much shallower (Table 1). Spatial species specific patterns in survival are also evident: more *A. decora* survived in the lower belt and more *A. iteaphylla* and *A. deanei* survived in the upper belt. 44% of the *A. deanei* in the lower belt died. These findings demonstrate the effect of different growth habits of certain species in varying soils. This knowledge can be used to maximise survival of future plantings by matching shrub species with soil depth.

A. decurrens used to replace dead A. deanei were found to be more competitive with adjacent pasture

Shelter
By January 2008 – 32 months after planting 75% of the paddock was sheltered from damaging wind (Figure 2).

Hydrology
The upper shrub belts dried the soil of both pasture types (Figure 3a). The lower shrub belts only dried the soil of the phalaris/annual pasture (Figure 3b)

Key Findings
- Shrubs survive and grow
- Reasonable shelter within 3 years
- Apparent hydrological benefit in phalaris/annual pasture
- Little competition with pasture
- These benefits come at the cost of 3 or 4 ewes per ha less carrying capacity

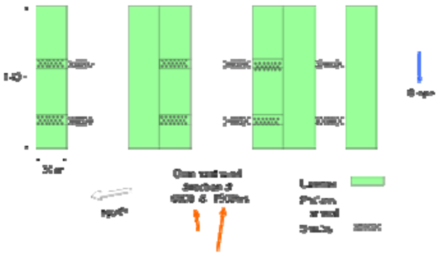


Figure 1: Trial Design

Table 1: Survival (%) of shrubs Jul 2005 – Aug2007

		Belt	
	Both	Upper	Lower
All Species	95	97	93
A. Decora	89	87	91
A.Iteopylla	97	96	77
A.Deanei	74	92	56

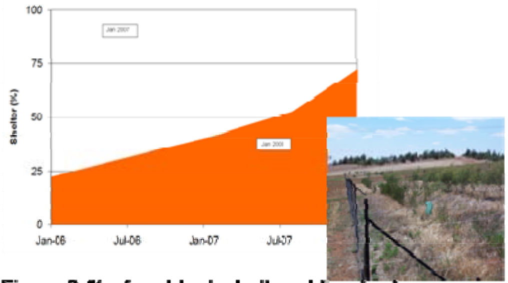


Figure 2: % of paddock sheltered by shrubs

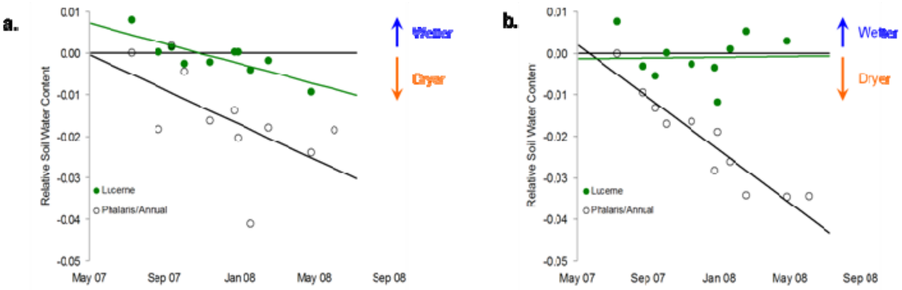


Figure 3: The drying effect (Pasture – Shrub) of placing in shrub belts pastures.

EverGraze
More livestock from perennials

4.3 Supporting sites

4.3.1 Summary

Fifty-five Supporting Sites have been established, with 43 in EverGraze priority regions and 12 in other high rainfall areas of southern Australia. For further detail on the individual Supporting Sites please refer to the EverGraze website. Limited time and funding available impacts on the measurements that have been taken. Many regions have cut back to the “bare bones” approach just undertaking the minimum set out in the Support Site contracts but some groups have taken additional activities and assessments. Access to experienced pasture agronomy, pasture utilisation/economic assessment expertise makes management and use of the site has proven difficult in some regions.

4.3.2 Western Australia

There are eleven Supporting sites in WA which are comparing annual pastures with sown perennials. Perennials include kikuyu, tall fescue, chicory, lucerne and tall wheat grass. There is strong interest and support from both NRM groups with significantly higher funding and time input than other regions. There is also high levels of interest in economic outcomes despite being driven through NRM groups. There is excellent expertise in agronomy and pasture management available to Supporting Sites however the links between Support Site and Proof Sites could have been greater.

4.3.3 South Australia

There are four Supporting Sites in SA that are comparing annual pastures with sown perennials. Two of these sites are addressing kikuyu in coastal environments. Time and funding of SARDI staff limits measurements and exposure of sites. However good technical expertise is available.

4.3.4 Victoria

In Victoria an initial demonstration trial was conducted with the Corangamite and Glenelg Hopkins CMA. The final report is provided in on the CD provided with this final report. Unfortunately due to funding constraints EverGraze was not able to grow these demonstration sites. The expansion of EverGraze introduced the Supporting Sites which ended up being an excellent substitute.

CMA’s have limited involvement in funding and management of Supporting Sites, with most managed by DPI/DSE staff or private consultants/agronomists. The pasture agronomy and utilisation expertise available to site is variable in Victoria and can limit the value of some sites. Within the Glenelg Hopkins/Corangamite CMA *there* 3 Supporting Sites comparing sown summer active perennials with degraded pastures, two sites looking at improved grazing management of native pastures, and five sites are being established to evaluate sown summer active perennials. An additional funding from “Caring for Our country” has provided a significant boost to the sites.

There are eight Supporting Sites in Northeast Victoria, four are evaluating sown perennials and four are comparing grazing management of native sites. In Gippsland there are four Supporting Sites covering hedges of saltbush, management of native pastures, summer active perennials and grazing management of sown perennials. The Wimmera has two Supporting Sites one comparing grazing management of native perennials and one with sown perennials. Finally the Goulburn/Broken has two Supporting Sites comparing grazing management of native and sown perennials.

4.3.5 Tasmania

A Supporting Site has recently been sown near Oatlands to hedges of Doricium with new cocksfoot in the inter-hedge area. Sowing was delayed for 12 months due to adverse seasonal conditions.

4.3.6 New South Wales

In NSW the Supporting Sites have been arranged by the four CMA's involved. These groups provided the funds and labour to do setup the sites and undertake measurements according to the measurement protocol. DPI NSW staff have been involved in some extension activities. Supporting Sites have been established as part of on-ground grant to producers to improve environmental outcomes and sites are much larger than those in other states 100-200 ha. The large and variable sites make monitoring of response a major challenge. CMA's had a very strong focus on NRM and need continual reinforcement on the need to obtain production data. This model best represent the aspiration approach outlined in the business case to expand EverGraze, while successful to a certain extent in NSW it has not worked well in some of the other states.

Murrumbidgee has six Supporting Sites, three are involved in an on-farm evaluation of summer active perennials to increase ovulation rates and three are comparing persistence and production of sown perennials. Large reductions in funding to the CMA has made it difficult for staff to effectively manage SS and get value to local producers. *The* Lachlan CMA has a very strong interest in intensive rotational grazing systems and has established three Supporting Sites to compare different grazing systems. Large and variable native pasture paddocks make monitoring very difficult. Adequate funding and time available, however sites will only appeal to certain group of producers.

Namoi has a very strong interest in intensive rotational grazing systems and has established three Supporting Sites comparing different grazing systems. Border Rivers / Gwydir have established two sites with one comparing animal species (sheep, cattle, goats) to manage pasture composition and one addressing different grazing and management to control love grass in native pastures. Ongoing discussion with Murray CMA has lead to the Holbrook Landcare group to take over establishment and management of Supporting Sites in the region and two potential sites have been identified.

5 Success in Achieving Objectives

5.1 Success in Achieving Objectives

5.1.1 Success Achieving Objectives

The EverGraze project has been affected by dry seasonal conditions and drought. The Albany Proof Site for example this year had only received 227 mm by the end of September, 174 mm less than the long term average. These conditions have made it difficult to demonstrate a 50% increase in profit and a reduction in recharge by 50% (recharge was only measured at the Hamilton Proof Site). Despite the dry conditions there are some important indicators of the value of the EverGraze farming system (ie perennial pasture sown to land class and managed to best practice with high performance livestock) especially as move into future with more variable seasons.

<u>Profitability</u>

Albany Proof Site: Overall the EverGraze farming system has indicated potential of the livestock system to perform better than the MIDAS simulated results for both perennial and annual pastures in term of number of lambs weaned. However the perennial pastures were not able to perform with annual rainfall of 290 mm, 333 mm and 227 mm (end of September) for 2006, 2007, 2008 respectively compared to annual average of 500 mm. The Albany Proof Site has been affected the most my drought.

The EverGraze farming system made a significant loss in both 2006 and 2007. The system did however did produce more lamb for every 100 mm of rainfall than the MIDAS modelled systems. Unfortunately neither year was profitable due to the high cost of supplement and the inability to finish lambs due to lack of feed. Based on the number of lambs weaned the field system has the potential to produce between 42 and 70 kg lamb per 100mm in an average season. Analysis examining the effect of season on profit using MIDAS supports the field results that perennials are not profitable in drought. Encouragingly further MIDAS analysis suggests the perennial system is highly profitable in average to wet seasons. Further work is required how losses in dry years may be minimised, this work will be even more important when future predictions of climatic variability are considered

Hamilton Proof Site: Overall the EverGraze farming system has shown a doubling in productivity over the district averages. By matching the species to the landscape production is optimised and persistence improved. This should lead to a sustainable increase in productivity and financial profitability while also and improving efficiency of resource use.

In both 2006/2007 and 2007/2008 the Hamilton Proof Site established new benchmarks for productivity growing between 8.5t DM/ha and 16.1t DM/ha. This included achieving winter growth rates exceeding 50kg DM/ha/day which is significant when the EverGraze farming system was designed to have a greater emphasis on summer activity. Wool production from the EverGraze farming system was 50-60kg clean wool per ha, while lamb production from single bearing ewes exceeded 500kg liveweight/ha and twin systems over 700kg/liveweight per hectare. Stocking rates during spring to early summer ranged between 17 and 20 ewes/hectare. Steer backgrounding has resulted in liveweight gain of greater than 800kg liveweight/ha. The 2006 / 2007 growing season the Triple and Novel pasture systems were able save up to $20/head in containment feeding costs compared to the perennial ryegrass system which was unable to respond to the summer rainfall. Thus summer activity of the EverGraze farming system has allowed some flexibility to cope with variable rainfall and growing conditions with reduced supplementary feeding.

Wagga Proof Site: The potential production from the EverGraze farming systems has been obviously limited by reduced pasture growth as a result of dry conditions. The relative differences in the performance of the farming systems provides valuable understanding about how to best use a perennial pasture, and what systems may be best suited to uncertainties in climate. Clearly, if reduced spring rainfall eventuates (as forecast), then higher stocking rate, later lambing systems may not be the most appropriate system. While the lower stocking rate, earlier lambing system is clearly least sensitive to this climate variability, from the limited data available, a split joining system may be an appropriate strategy to limit risk while maximising long-term gross-margins from a perennial pasture base.

Over the past two dry years the higher supplementary feed costs associated with the higher stocking rate (HL and LL) has reduced the profitability of these systems. In 2006, despite these systems producing the most wool and meat/ha, they lost money due to high supplementary feed costs. In 2007, poor joining results, in combination with higher supplementary feed costs and a failed spring (limiting lamb weaning weights), resulted in these treatments producing less meat/ha than the split joining system. This indicates that higher stocking rates, later lambing systems entail more risk. However, the potential production from these systems is indicated in the 2008 provisional data as they have marked much more lamb/ha. However, this is unlikely to translate to more lamb sold/ha, as poor spring rainfall again will limit the ability to wean lambs at high weights, and supplementary feed costs are likely to be greater in these systems again this year. This however highlights the potential production from these systems, indicating that providing we can maximise joining results, lamb survival and growth rates from spring pastures, while minimising supplementary feed costs, potential exists to achieve high gross margins. Potential gross margin of these systems at 13 DSE/ha MWSR, and 120% weaning, is predicted to be approximately $490/ha.

While the potential gross margin of the lower stocking rate systems is lower, results to date suggest these systems may be more appropriate in unpredictable seasons. The split joining system however offers a potential gross margin of only 10% less than the higher stocking rate systems. In dry years gross margins have been substantially higher in 2006 and 2007. It is more likely, given the negative relationship between SR and weaning %, that the target weaning % of 120% will be achieved in this split-joining system than in the higher stocking rate systems, thus getting the actual gross margin of this system closer to potential than the higher stocking rate systems. The split-joining system is also highly flexible with this flexibility being enabled due to perennial pastures. In 2006, the very poor season meant early born crossbreed lambs could be sold at good store weights from this system at weaning (rather than attempt to finish), thus achieving relatively good production/ha at lower supplementary feed costs. In contrast, the higher stocking rate systems, with new lambs at foot, required extensive supplementary feeding just to get lambs to survival weaning weights. In 2007, crossbreed lambs from this system were able to be finished opportunistically to export weights as a result of late spring/early summer rain. The higher stocking rate systems, while they produced better lambs than in 2006, were not able to retain lambs without supplementary feeding.

Further refinement of the EverGraze farming system: While the Proof Sites addressed EverGraze farming systems the project also aimed to further explore the potential of components within the systems.

Sheep genetics and wool production: EverGraze has highlighted the importance of the interaction between sheep performance, stocking rate and the standard reference weight of sheep. Results indicate that the Centreplus ewes have not performed to expectations and this is likely to limit the ability to achieve the potential gross margins in better years. At the Hamilton Proof Site Tolland sheep cut more wool that was higher yielding and longer in staple length but the CentrePlus sheep were finer in diameter. Of interest in this comparison is that on a per head basis, at prices over 2007/08, fleece weight outweighs the price difference due to lower fibre diameter. However having a larger impact on predicted production per hectare is the average 6kg lower liveweight of the Tolland bloodline that when stocking rates are adjusted for equivalent levels of liveweight per hectare, the Tolland bloodline produces approximately $73/ha more gross wool income.

Reproductive performance: By utilising summer active perennials with the EverGraze farming system there is the potential to increase ovulatory response by up to 22%. By creating live pasture opportunities through summer active perennials growing on the appropriate land class there appears important in determining the ovulation rate of synchronised ewes. Average ovulations per Centreplus ewe at Wagga was 1.36 compared to 1.48 for the Merinotech at Albany. Reproductive performance was generally lower than what was targeted through the pre-experimental modelling at the Hamilton and Wagga Proof Sites. There are several factors that may have attributed to this; age of the ewes, drought conditions however CS benchmarks were maintained throughout the drought, ram selected with too high EBV's for birth weight as a high proportion of lambs deaths were attributed to dystocia. It is also plausible that the stated average weaning % of the flock is based on relatively low stocking rates. There appears to be a higher proportion of lambs dying from dystocia compared to starvation mismothering at the Hamilton and Wagga Proof Sites. Average marking percentage over the three years were 122%, 113% and 96% for the Albany, Hamilton and Wagga Proof Sites respectively. At all site mismothering and dystocia were the main factors that reduced weaning percentages.

<u>Recharge</u>

Given the lack of rainfall over the three years of EverGraze it has not been possible to measure leakage of water below the root zone and hence we have not been able to demonstrate a 50% reduction in recharge. Under current seasonal conditions our target audiences are less concerned about recharge and are significantly more interest in surface runoff.

The EverGraze farming systems have been able to demonstrate the ability of perennials place on the appropriate land class to develop deep roots and dry the soil profile to depth. Lucerne and chicory have been shown across most Proof Sites to draw down moisture from 3m and this was achieved two years after establishment. At the Hamilton Proof Site kikuyu in the valley floor initially dried the soil profile to a greater depth than tall fescue, however the following year tall fescue was more effective at drying out the soil profile to depth. It is felt that the late summer-activity due to the milder summer conditions in SW Victoria may limit the potential of kikuyu to use water to depth in early summer. Both shrubs and pastures dried the soil significantly, but, shrubs dried the soil much more. Soil water content increased following rainfall but this response is dampened and less prolonged beneath shrubs where stronger drying recommenced sooner than beneath the pastures. Too date limited completion has been observed between the annual and perennial pastures however it is estimated that stocking rate would be reduced by three to four ewes/ha. Thirty-two months after planting the 75% of the paddock was sheltered from the damaging wind. Using shrubs within the EverGraze farming

Additional NRM benefits: The EverGraze farming systems have been able to demonstrate the appropriate perennials for different land classes and regions within the high rainfall zone that persist and maintain ground cover. The persistence of tall fescue has been sown to be high dependent on soil type and grazing management. Persisting well on heavier soils that are able to maintain soil moisture in summer and failing on lighter poor moisture retaining soils. The persistence of lucerne and chicory has been a highlight however while ground cover has been maintained above the critical benchmark the amount of bear ground is of some concern from both a production and NRM view point. The use of kikuyu as a drought lot due to its ability to stabilise the soil surface has been shown to be highly valuable due at both the Albany and the Hamilton Proof Sites.

5.1.2 Success in Achieving Outputs

Table 41 provides a summary of progress against contracted milestones. The majority of the delay in outputs is due to the dry seasons and the inability to model the EverGraze farming systems due to livestock being drought-lotted for significant parts of the production cycle, no recharge being measured at several of the Proof Sites, longer establishment times due to drought (ie growth rate of shrubs) and the failure of some pastures to persist. The project has been highly success in other "non-contracted" areas and these are discussed further in Section 6.1.3.

Table 41. Progress against contracted milestones.

Contracted output	% complete	Comment
Developed, demonstrated and produced guidelines for the implementation of livestock systems (on the south coast of WA, in south west Victoria and southern NSW) that increase profit and reduce recharge (final report and fact sheet).	80%	Measurements have been taken, guidelines not developed. Recommend another year to better understand the systems.
Economic analysis (through MIDAS) of livestock systems on the south coast of WA, in south west Victoria and southern NSW) that increase profit and reduce recharge (final report and fact sheet*).	60%	Analyses have been undertaken throughout the project but final analysis should include next year's results.
Guidelines for the implementation of the high performance lamb system in different environments in the high rainfall zone (on the south coast of WA, in south west Victoria and southern NSW) (final report and fact sheets*). Guidelines on using pasture (summer-active) to increase ovulation (fact sheet*).100% Will be able to further add to this over the next 12mths.	80%	Measurements have been taken, guidelines not developed. Recommend another year to better understand the systems.

Table 41. Progress against contracted milestones *(continued).*

Contracted output	% complete	Comment
Guidelines on the management of summer active pasture species for persistence to increase animal production and water use.	70%	Measurements have been taken, guidelines not developed. Recommend another year to better understand the systems
Guidelines for improving lamb survival on the south coast of WA, in south west Victoria and southern NSW.	100%	Will be able to further add to this over the next 12mths.
Guidelines on using woody perennials as maternity wards for lamb survival (fact sheet*).	100%	Will be able to further add to this over the next 12mths
Two desktop studies (literature reviews) (3 lambs in 2 years and maiden joining at seven months) (short reports).	100%	
Contribution to the understanding of GxE interactions through linkage with MLA programs in the selection of ewes and the livestock performance measurement (communication and discussion in final report).	20%	Will be able to make some comment in the final report but full analysis should be undertaken with next years results.
Guidelines on the suitability and appropriate placement at farm and catchment scales of summer-active perennial pastures (final report and fact sheet*).	70%	Measurements have been taken, guidelines not developed. Recommend another year to better understand the systems.
Preliminary guidelines on the suitability and appropriate placement at farm and catchment scales of woody perennials (final report and fact sheet*) (experimental data + modelling outcome).	50%	Work has been undertaken in years with minimum rainfall. It is difficult to make an assessment of the placement of woody perennials. Will comment in the final report but data from next year will add value.
Research (4 sites) /satellite (3 sites) /demonstration (at least 3 sites) sites and technical reference (3 groups) /management committee (1 committee) across the High Rainfall Zone addressing profit and recharge trade-offs. This will include active engagement of CMAs (sites and groups).	100%	
At least 2 partnership projects with CMA.	100%	

Contracted output	% complete	Comment
At least 3 field days, 3 technical workshops, and 10 media articles per year along with at least 1 CRC project brochure per year.	100%	
At least 6 visits by or presentations to farmer groups each year	100%	
At least 3 scientific publications (3 for whole of project) ready for submission to appropriate Journals and at least 3 scientific seminar presentations per year.	80%	Science publications have occurred but final publications need to account for the complete set of results.
With the support of MLA and the CRC (and possibly CMAs) integration of new knowledge and guidelines into extension programs such as EDGE-network, More Beef from Pasture and Program 1 activities.	30%	New extension officers will bring additional resources to support this. EverTrain will also be involved. Again difficult to integrate without non-drought effected results.
Water balance (runoff, deep drainage, recharge) impacts of different levels of implementation of future farming systems in three catchments presented spatially at the catchment scale (final report and maps).	70%	Measurements have been taken, guidelines not developed. Recommend another year to better understand the systems.
Improved ability to predict the impact of on-farm management to catchment outcomes using hydrological and MIDAS models. These tools will support catchment management strategies and future design of livestock research and systems	30%	More sensible to undertake full catchment runs with final datasets.
Data in a described format that can be used by future research programs and other scientists (metadata and data)	90%	Database has been developed and is being used. Sensible to wait until the end of project to finalise data.
Validated parameter sets on summer-active perennials to support feedbase decision support tools and models such as GrassGro (parameter sets in final report).	70%	As above
Recommendations to perennial pasture breeding programs on desired traits to minimise trade-offs between profit and recharge (recommendations in final report and through CRC).	80%	CRC FFI plant breeding work has been placed within the EverGraze farming system. Greater linkage is expected in the next 12 months.
Lessons learnt from farm systems research approach (discussion in final report). This would include lessons from the biometric expert panel established to advise this project.	100%	Lots of lessons learned! These will be documented in the final report.

5.1.3 Success of Project

Sections 6.1.1 and 6.1.2 document the success of the project to date against the objectives and contracted outputs however the EverGraze project as a whole has achieved further success that is not adequately capture in objective and output discussion.

In September EverGraze was significantly expanded to include new work (native Proof Sites, wider NRM objectives and Supporting Sites) through involvement with AWI. This resulted in an additional $2.6 million dollars of funding. In addition to this we have been able to capture the attention of a number of CMA and other groups to fund and establish Supporting Sites. This has resulted in many people across the high rainfall zone being directly involved in EverGraze. There are currently 55 EverGraze Supporting Sites in the high rainfall zone and these have been developed despite significant funding changes and pressures being experienced by al CMAs.

In 2007 with the commencement of the CRC FFI a new foundation project was developed to continue EverGraze until at least 2011. This not only resulted in an additional $600K of funding from the CRC but the commitment of 3.6 extension staff to EverGraze by DPI Victoria and NSW to the EverGraze project. In addition the CRC FFI has committed funding to employ a communication officer to work on the project 2-3 days per week.

EverGraze is an extremely strong image and the branding is now widely recognised in the high rainfall zone. We have recently protected the name/brand through Trademark. The Website is well used by participants and next and end-users. The website maintains our contact list from which we distribute 400 EverGraze Updates each quarter. The Governance structure has been established and is working well, with extremely positive feedback being received from a recent evaluation of the National Advisory Committee Meeting in October 2008. There are currently 56 next users directly involved in the Governance of the EverGraze not only to they meet their governance terms of reference but they form a valuable step in the adoption strategy for EverGraze farming system principles and practices.

The number of EverGraze events has been significantly increased in the last two years in the introduction of EverGraze month. This year there have been 41 EverGraze events during September to November. One hundred and sixty publications have been generated from the EverGraze project. The monitoring and evaluation of the EverGraze project has also been significant with a major survey being conducted by Kate Sargeant (DPI Victoria). The EverGraze producer survey served two purposes:1) To assess the current knowledge, attitudes, skills and practices of producers in relation to technologies promoted by EverGraze, and 2) To assist with the development of an extension strategy for the project. A total of 270 surveys were collected and a 120 page report produced. Further to this all EverGraze events and visits nationally are consistently monitored and recorded directly into the team room on the website. This data is rapidly building and now has sufficient numbers to start to reveal trends in attitudes and practices.

There has been development of modelling capability and capacity through the EverGraze project with linkage to the Whole Farm System Analysis project. This has resulted in EverGraze staff training in model use but also the development of linkages between the SGS model, NZ models, cropping models and CAT.

The EverGraze project has also undertaking positioning within the new climate change agenda including meeting with the Australian Greenhouse Office, discussions with senior Ministers and a key platform for Kevin Goss's presentation at the Rural press Club. EverGraze is currently part of a number of proposals that are currently under the consideration of DAFF.

6 Impact on Meat and Livestock Industry

6.1 Impact on Meat and Livestock Industry – now & in five years time

6.1.1 Impact on Meat and Livestock Industry

EverGraze has operated in the high rainfall zone (> 550mm/yr) of southern Australia, where approximately 33,000 livestock producers, carry 33% of Australia's sheep and a significant number of cattle (Figure 92). Pastures cover almost 20m ha, with native and naturalised pastures making up ~ 50% of the area and improved pastures making up the other half. There are approximately 23,000 livestock producers in this zone with 9,000 farms with >1000 DSE.

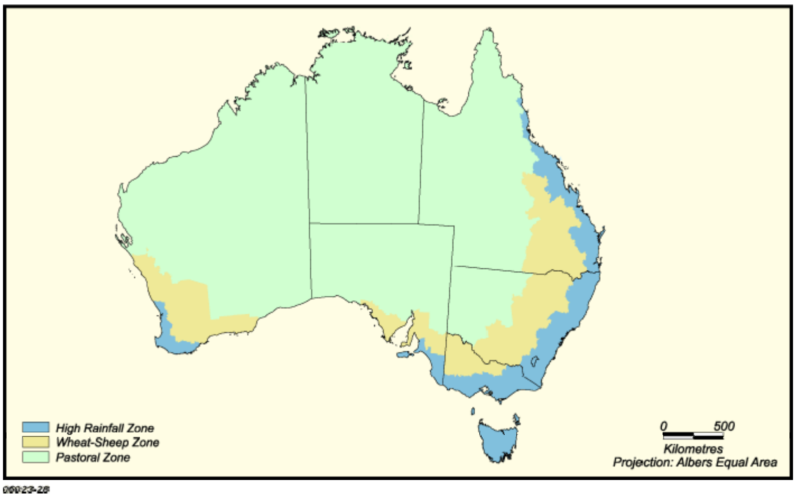


Figure 92. The agricultural zones of Australia, with the High Rainfall Zone shown in blue

To date EverGraze has focused on adjoining CMA regions to the six Proof Sites (Figure 93). The Supporting Site network has already moved beyond these CMA regions.

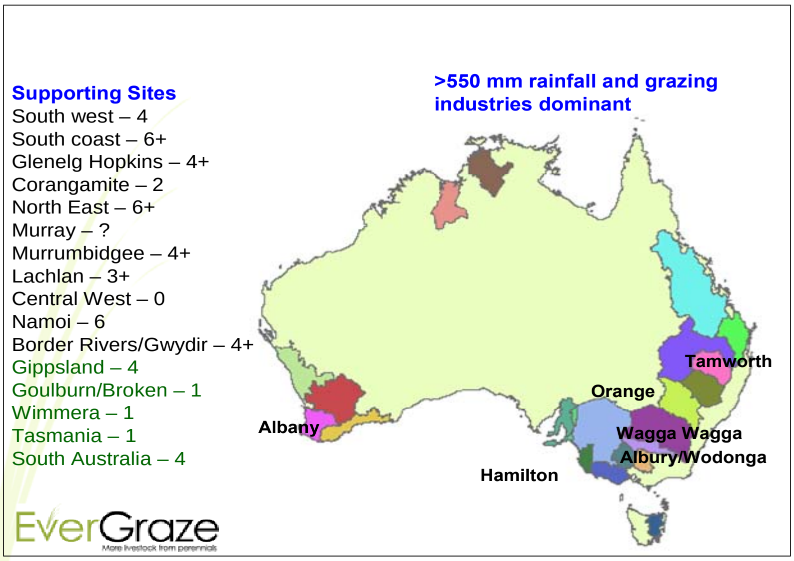


Figure 93. EverGraze spatial coverage

The EverGraze project has been implemented across a range of scales. While the focus on the project is at the farming system scale EverGraze works from the very detailed PhD work (Tall Fescue ecology), to component work (lamb survival and hedge rows, through to farm and catchment scale bio-economic modelling. The project is addressing farm and catchment scale impacts.

EverGraze has increased the awareness of meat producers of the importance of perennials, sown to the appropriate land class and utilised by high performing livestock. This is evidenced by 4150 contacts being made with producers directly by the Proof Site teams, 400 people receiving the EverGraze Update, 62 media articles, 62 people directly involved in EverGraze Governance, and producer groups involved in the 55 Supporting Sites. We estimate that 14,400 producers need to be aware of EverGraze to achieve the adoption target. We believe we have achieved this if you consider the above numbers and distribution of industry journals where EverGraze has been a regular feature including Feedback, Prograzier and beyond the Bale.

Achieving practice change and adoption has been more difficult to achieve, monitor and attribute. As stated in Section 5.1.3 of this final report the severe climatic conditions, the increases in input costs and the more recent down turn in the national and global economy has made achieving practice change difficult. A paper was presented the NAC at the October meeting to discuss this impact and to re-consider our approach to key extension messages and delivery programs. Section 5.1.4 provides information on the monitoring and evaluation activities and the potential for future adoption.

There are however some positives for EverGraze. Some farmers now see the need for different systems to deal with a new climate. However, they do not have the funds to make changes now. The poor persistence of temperate perennials especially ryegrass has lead producers to look for alternatives. However, it is interesting to see that in southern Victoria, the immediate reaction is a doubling in use of perennial ryegrass in autumn 2008 as producer's over-sowed drought affected degraded pastures (Table 42 -data provided by Landmark Hamilton). This is an immediate reaction to get some perennials back into the pastures but there is also strong interest in alternative perennials such as chicory and lucerne recorded in feedback sheets (see feedback summary)

Table 42. Proportion of different perennials sold through Landmark Hamilton – based on kg total seed sold

	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08
Clover	43	42	48	50	43	28
Phalaris	8	10	6	7	7	7
Lucerne	7	10	2	2	7	3
Ryegrass	34	29	34	35	31	**57**
Fescue	6	7	8	4	8	4
Chicory	1	1	1	1	4	1

6.1.2 Meat and Livestock Industry in five years

The EverGraze project will continue for at least another three years and will undertake the activities described in Table 43. This continuation of EverGraze we expect the following impacts:

- To increase in profitability by 50% above current best practice through a farming systems approach that matches plant and land capability and further improves livestock performance through increased stocking rates, weaning percentages and pasture utilisation.
- To achieve a significant improvement in on and off farm NRM outcomes simultaneously with productivity improvements in the high rainfall grazing zone.
- To support on farm, catchment and industry decision making through the development of information and tools pertaining to tactical management points, integration of native (low input) and improved (high input) systems and assessment current and future impact of livestock in the high rainfall zone.
- To target improved management on over 300,000 ha in the HRZ and have principles and practices from EverGraze on 3,600 farms by June 2011.

Table 43. Major components to be undertaken in the next phase of EverGraze

1. <u>Continued and value-add to the Hamilton and Wagga improved Proof Sites (Years 1 and 2).</u> There is the need to evaluate perennials under a range of conditions (not just the dry extreme of the past two years) to fully understand their perenniality and potential. Value-adding includes additional NRM measurement (perennial diversity, groundcover, soil) and understanding at each site, new livestock treatments at Hamilton (Year 1) (specialist prime lamb system), and PhD projects (lamb survival, ovulation, economics). In partnership with Program 6 we will also use economic modelling using case studies based on farms.
2. <u>New research and adoption approach for WA.</u> Budget reduction and review have identified that a fresh approach to EverGraze application is required in WA. Preliminary meetings have been held with key stakeholders and the EverGraze National Advisory Committee (NAC) will further address in late October. The approach that is favoured at this stage is to build onto Supporting Sites with Component Research and greater measurement of Supporting Sites in the areas of livestock and economics.
3. <u>Impact of livestock systems (Year 2).</u> EverGraze using an integrated approach will provide a spatial analysis of the impact of livestock systems on key natural resources in the high rainfall zone with an emphasis on water and soil. The approach will work from the Proof and where possible the Supporting Sites, use modelling (Whole Farm System Analysis Tool (SGS/ GrassGro) and CAT) and combined with the expert knowledge of adoption (spatial and temporal) to provide an expert assessment of impact. This could include future impact if the DAFF proposal is successful.

4. Proof Site Integration (Year 3). Improved and Native pasture farming systems will be integrated to develop guiding principles on the spatial arrangement at the sub-catchment level in 3-4 eastern start regions associated with the Hamilton, Albury/Wodonga and Orange (possibly Tamworth) proof sites. These will consider a gradient of rainfall, soil type management intensity, in association with most appropriate livestock production systems, to ensure increased profit, sustainability, resilience (suitability) of those regional systems. Bio-economic modelling will also be used to extend the coverage of EverGraze farming systems into other catchment areas. We believe this stage of the project will enable EverGraze to provide some insight on reducing input costs in the grazing systems in the high rainfall zone. Note that in Year 3 that AWI investment will also be requested as the current AWI contracts end in Year 3 of this project and their investment will be required to achieve improved and native pasture system integration.
5. Pilot EverFarm (Year 3). EverFarm will be a process that will allow the determination and delivery of the most appropriate grazing systems incorporating perennials, livestock systems and the landscape assets of their farm to optimise profit and catchment health and deliver tailor-made new farming systems design for their business. Using the results from EverGraze we will conduct focus studies using bio-economic modelling with leading farmers to integrate perennial pastures, livestock and the landscape assets of their farm to optimise profit and catchment health and deliver tailor-made new farming systems design for their business. The EverFarm concept will be developed and piloted in up to 3 regions. If successful EverFarm will be rolled out across the high rainfall zone during 2011-2014. This approach will work with the Farm Business/NRM simulation game being developed by Program 6 in the CRC FFI.
6. Tactical management regimes (Year 3). Using Proof Site data (Improved and Native) as well as new information from integration activities we will commence the development case-study annual management plans for different farm to market value chains that account for profit, risk and natural resource objectives. We expect this will link closely to Program 6 which is taking a case study approach to farming systems. Finalisation of these plans will depend on work conducted in 2011-2013 on EverFarm and benchmarking.
7. Design new farming systems.(Year 3). Using data and knowledge gain in EverGraze we will go back and re-construct/re-design new farming systems that have even greater potential to address both profit and NRM outcomes in a resource challenged future. This will provide a platform for new farming system research, development and implementation and the transition into the final stage of EverGraze (2011-2013).
8. Targeted EverGraze extension and adoption: EverGraze will continue to produce an extensive target range of tools and products to achieve practice change on 3,600 farms aligned to the principles of a farming system approach to achieve production increases through stocking rate, weaning percentage and pasture utilisation simultaneously with NRM improvement. Specifically the products will include 50 Supporting Sites and associated networks, EverGraze website, at least fifteen EverGraze Actions, Exchanges and four Updates per year, instigation and continuation of EverGraze month as well as additional field days and farm walks. Measure of success will include delivery of products and the contribution of the products to achieving the adoption targets (as measured by the monitoring and evaluation process). EverGraze will develop/ pilot two new training products an EverGraze training package/pathway through EverTrain and EverFarm.
9. Using the biodiversity assessment tool: Biometric, biodiversity value will be assessed and correlated with regional assessment of the plant conservation value of each site. EverGraze will develop and deliver management and decision packages that promote farming systems that integrate production and biodiversity outcomes

7 Conclusions and Recommendations

7.1 Conclusions and Recommendations

7.1.1 Conclusions and Recommendations

7.1.1.1 The farming system

- That perennial pastures established on the appropriate land class and used within a farming system context with high performing livestock has the potential to deliver significant gain for both the farm business and the environment.

- That there appears to be greater divergence between summer-active perennial system and annual system performance under dry conditions. In some environments such as at the Albany Proof Site a perennial system would appear to be more vulnerable whereas at the Hamilton Proof Site the superiority of summer-active perennials over the tradition system (perennial ryegrass) comes to the fore. Interestingly, the Proof Site at Wagga would appear to site between the two and its vulnerability to dry conditions seems to vary between the livestock system that has been implemented to utilise the summer feed with the split joining system providing greater flexibility.

- Even in the dry years summer rainfall has occurred and each of the EverGraze farming system due to the summer-active pasture on the best land class have been able to utilise the growth generated. They have used green feed in various ways including growing out lambs, increasing condition scores of ewes prior to joining and for pasture flushing to increase the potential for multiple births. One of the important points of difference has been the reduced levels of supplementary feeding required by the different systems.

- All Proof Sites have identified the need to increase winter production from the farming system and would like to explore opportunities to oversow species into lucerne and chicory to address the winter feed as well as ground cover issues. The other critical feed gap identified in the farming systems was very late autumn. At the Hamilton Proof Site kikuyu was found it fill this gap to a limited extent.

- By having a range of pasture species across different environments has enabled greater ability to maintain ground cover over dry seasons. With the extreme being at the Albany and Hamilton Proof Sites where kikuyu pasture could confidently be used for drought- lotting without the risk of soil erosion and damage.

- While we have not been able to measure deep drainage (surrogate for potential recharge) for the majority of the experiment all summer active perennials are drying the soil profile to at least a depth of three meters and hence indicates the potential for the EverGraze farming systems to reduce recharge. In the future we will need to consider both surface runoff as well as recharge.

7.1.1.2 The components

- EverGraze has shown that lucerne reduces risk and adds flexibility in high rainfall areas. Lucerne has been the most persistent perennial under tough climatic conditions, better than phalaris at Wagga and perennial ryegrass at Hamilton. It responds to out of season rainfall and means significantly less supplementary feeding required. Lucerne provided high quality forage in summer and autumn for weaners, prime lambs, ewes prior to mating. The winter production of lucerne in dry years has been shown to equal perennial ryegrass and phalaris.

- Chicory has been shown to be an alternative summer active. It is suitable for areas where lucerne cannot be used, due to wet soils or soil acidity. Chicory has been less productive then lucerne but has proven to be very persistent in tough conditions. Chicory and lucerne provide equal benefits in ovulation rates and water use to date has been equal to lucerne. EverGraze has shown that chicory stands can be thickened by letting chicory set seed.

- Kikuyu has proven to be a valuable species in tough conditions. Kikuyu suits low water holding capacity soils in coastal areas where other temperate species will not persist. It is a robust species to use in stock containment areas. Kikuyu very persistent and productive, best of all perennials at the Albany Proof Site. It can cope with set stocking and hard grazing even in very dry years and provided full ground cover and prevents wind erosion.

- Tall fescue has been shown to be more particular in soil type and seasonal conditions. The species ranged from being high persistent and productive at the Hamilton Proof Site to being a complete failure at the Albany Proof Site. Tall fescue was included in the EverGraze farming systems for both winter production and summer activity. Where tall fescue is not suitable the EverGraze farming system will require a pasture or pasture mix that can exhibit the growth potential of summer-active tall fescue. Summer active tall fescue in suitable climates on appropriate soils increases pasture production and ground cover, provide green forage in summer and reduces animal health risks. At the Hamilton Proof Site tall fescue provide higher pasture production and excellent persistence on heavy clay soils. Tall fescue benefits from grazing at the 3 leaf stage compared with set stocking and low rates of N fertiliser (25 kg N/ha) very effective to increase winter growth.

- Perennial shelter systems improve twin lamb survival. Using hedgerows with shrubs or tall perennial grass will significantly improve survival of twin lambs compared to lambing in open conditions as well as increase the perenniality of the farming system as well as potentially improve biodiversity. Shrubs or perennial grass hedges have been shown to dramatically reduce wind speed. Shrubs can provide good shelter within 3 years.

- EverGraze has shown that synchronised ewes grazing green pasture pre-mating will have increased ovulation rates. Ovulation rates 10-20% higher in ewes grazing chicory or lucerne prior to joining in summer/autumn have been demonstrated and this is equivalent to supplementing ewes with lupins on dry pasture. Relatively low amounts of green feed will provide this benefit, 300-500 kg/ha. Current analysis is showing that the species is not critical; any green forage will provide a benefit (but not kikuyu).

- Split joining is emerging as a profitable and flexible system. Joining merino ewes to terminal sires for June lambing with merinos ewes mated to merino sires for September lambing is likely to be more profitable than autumn lambing and more flexible than spring lambing in regions with unreliable spring production.

7.1.1.3 The project

- Multi-disciplinary farming systems projects are complex and challenging. They are however required to address multiple outcomes and design farming systems for the future. Each Proof Site has a particular "flavour" and this is normally based on the science discipline base of the Proof Site Leader. Understanding farming systems and taking a systems approach is difficult for many scientists who have often been through more of a reductionism type of education systems. Systems science/thinking is required in research and extension teams.
- Livestock science capability is deficient in the high rainfall zone. Both the Albany and the Chiltern Proof Sites have struggled to recruit expertise.
- The project governance and reporting structure was effective in providing strategic input at the regional and national levels. The reporting structure through annual operational plans has provided opportunity for flexibility in delivering the EverGraze project.
- The expansion of EverGraze has added significant value to the project. Differences in phasing between contracts have caused some issues that required attention and time. The inclusion of extension staff with challenging targets before the Proof Sites had completed two years and the opportunity to analysis the results has created some tension. In the next year we will need to work at greater integration between the research and the extension teams.
- The years that the EverGraze project has operated under have been extremely different to the seasonal conditions under which the SGS project operated for example. The comparison between the results/ trends between the SGS project and the EverGraze project may provide some further understanding of perennial pasture systems in the high rainfall zone. Figure 94 provides the Tamworth long term intake from pastures under a stocking rate of 3 wethers/ha. The red indicates the years the SGS project was conducted.

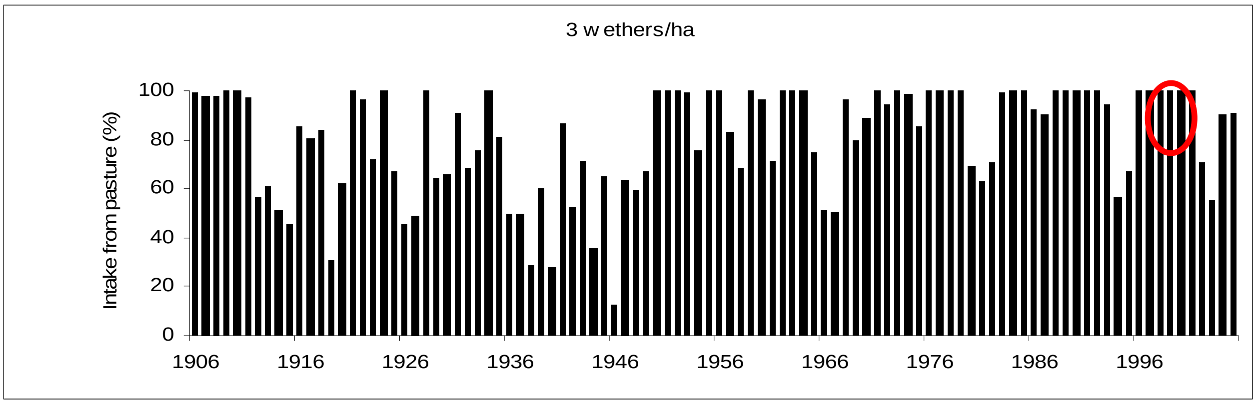


Figure 94. The long tem intake of pastures in the Tamworth region and the four years when the SGS project was conducted as indicated by the red circle.

8 Bibliography

Allan CJ, Mason WK, Reeve IJ and Hooper S (2003). *Australian Journal of Experimental Agriculture* Vol **43**, p 103143:1031.

Beverly, C., Bari, M., Christy, B., Hocking, M. and Smettem, K. (2005). Salinity impacts from land use change: comparison between a rapid assessment approach and a detailed modelling framework. *Australian Journal of Experimental Agricultural* In Press.

Cocks PS (2003) Land-use change is the key to protecting biodiversity in salinising landscapes. *Australian Journal of Botany* **51**, 627-635.

Kemp D R and Dowling P M (2000). *Australian Journal of Experimental Agriculture* Vol **40**, p 125

Morrison DA, Kingwell RS, Pannell DJ, Ewing MA (1986) A mathematical programming model of a crop-livestock farm system. *Agricultural Systems* **20**, 243-268.

Ridley AM, Pannell DJ (2006) The role of plants and plant-based research and development in managing dryland salinity in Australia. *Australian Journal of Experimental Agricultural* **45**, 1341-1355.

Sanford P, Young J (2005) Are new farming systems based on perennial pastures in south west Australia more profitable? In 'XX International Grasslands Conference'. Dublin, Ireland. (Eds FP O'Mara, RJ Wilkins, L ' t Mannetje, DK Lovett, PAM Rogers and TM Boland) p. 847. (Wageningen Academic Publishers; Wageningen)

Wood WE (1924) Increase of salt in soil and streams following the destruction of native vegetation. *Journal of the Royal Society of Western Australia* **10**, 35-47.

9 Appendices

9.1 Appendix 1- Communication activities

Media Articles

Profit bid in salinity plan **(August 2005).** In The Weekly Times.

High-rainfall project to push profits **(August 2005).** In Stock and Land.

Project aims to cut salinity, boost profit **(August 2005).** In The Courier Farmers Weekly.

Good News for farmers and environment **(September 2005).** In Western District Farmer

New research into summer-active pastures **(October 2005).** In The Standard.

EverGraze testing new perennial systems for the high rainfall zone **(Autumn 2006).** In MLA – Prograzier.

EverGraze – More livestock from perennials: Testing new perennial systems for the high rainfall zone **(May 2006).** In Western District Farmer.

Pasture key to lamb trials **(August 2006).** In The Weekly Times

Demonstrating production and water use of summer active perennial pastures **(August 2006).** In Western District Farmer

A perennial benefit is making sense **(August 2006).** In Farmers' Weekly

DPI unlocks key to drought **(October 2006).** In Hamilton Spectator

EverGraze Expanding **(November 2006).** In Hamilton Spectator

New pasture lines shine in tough season **(December 2006).** In Hamilton Spectator

The benefits of perennials **(February 2007).** In Farmers Weekly

EverGraze - On farm monitoring project **(March 2007).** In Balmoral Bulletin

Livestock and land management unite **(April 2007).** In Southern Weekly

Demonstrating production and water use of summer active perennial pastures **(April 2007).** In Western District Farmer

Demonstrating production and water use of summer active perennial pastures **(April 2007).** In Cavendish Community Chronicle.

Hedgerow hope for lambs **(May 2007).** In The Weekly Times

Climate Change Forum **(May 2007)** - reference to M. McCaskill's presentation. In Hamilton Spectator

Kikuyu proves its worth in study **(May 2007).** In Stock and Land

Kikuyu spreads the options **(May 2007).** In The Weekly Times

Strong interest in EverGraze **(May 2007).** In Hamilton Spectator

More Livestock from perennials **(May 2007).** In Stock & Land – Grasslands Conference preview

Wagga trial grazes on **(May 2007).** In The Land

EverGraze remedy for SA summer green pick **(June 2007).** In Stock Journal South Australia

Survival of sown species through a tough year **(July 2007).** In Hamilton Spectator - SheepVention supplement

Hedges for Lambing Shelter **(September 2007).** In Western District Farmer

Proof of pasture is in ovulation rates **(October 2007).** In The Border Mail – Country Mail

Reap rewards of late lambing **(October 2007).** In The Border Mail – Country Mail

EverGraze supporting sites in southwest Victoria **(October 2007).** In Western District Farmer

EverGraze pastures offer potential to modify animal production systems **(November 2007).** In Wester District Farmer

Managing summer-active tall fescue in Western Victoria **(November 2007).** In Wester District Farmer

Perennial pastures lift production **(November 2007).** In Farming Ahead

David's a grass-roots guy **(December 2007)**. In 'The Weekly Times

Summer-green pastures **(January 2008)**. In Western District Farmer

Perennials offer productivity boost **(March 2008)**. In Stock & Land

Farming Systems for a Changing Climate **(May 2008)**. In Western District Farmer

Trials and tribulations of a twin win **(May 2008)**. In The Weekly Times

Reducing the need for Feed **(May 2008)**. In Stock & Land

Seeds of Change **(May 2008)**. In The Border Mail

Fescue mission is one tall order **(May 2008)**. In The Weekly Times

Using nitrogen fertiliser to boost autumn production from summer-active Tall Fescue **(June 2008)**. In Western District Farmer

Fescue mission is one tall order **(May 2008).** In The Weekly Times.

Using nitrogen fertiliser to boost autumn production from summer-active Tall Fescue **(June 2008).** In Western District Farmer.

Pasture Options **(May 2008).** In On The Land

Southwest EverGraze supporting sites underway **(July 2008).** In Western District Farmer.

Good pasture – good lambs **(July 2008).** In Western district Farmer

Heritage seeds' sardi seven lucerne **(July 2008).** In Western District Farmer

Wagga trials watch sheltered mums **(July 2008).** In The Land.

Smart Grazing gets more lambs **(July 2008).** In The Land.

Rainfall too changes Outlook at Albury **(July 2008).** In The Land.

Innovation grows on these finalists' farms **(July 2008).** In The Land

Out-of-season rain gain **(July 2008).** In The Land.

Wool Production per hectare still a profit driver ***(July 2008).** In the Spectator.

Southwest EverGraze Supporting Sites **(July 2008).** In Western District Farmer.

Heritage seeds' sardi seven lucerne **(July 2008).** In The Spectator.

The prices are right with paddock pairing **(September 2008).** In The Weekly Times.

What drives wool income? **(September 2008).** In Western District Farmer.

Perennials reduce runoff **(October 2008).** In Western District Farmer

Perennial pastures lift production **(2008)**. In MLA Prograzier

Improving grazing viability **(2008)**. In The Land

Refereed Journal Articles

Masters DG, Edwards N, Sillence M, Revell D, Friend M, Sanford P, Saul G, Young J, Beverly CR, Avery AL **(2006).** The role of livestock in the management of dryland salinity. Australian Journal of Experimental Agriculture 46 (6-7), 733-741

Friend M, Robertson S, Masters D, Avery A **(2007)** EverGraze – a project to achieve profit and environmental outcomes in the Australian grazing industries. *Journal of Animal and Feed Sciences*, **16** (supp 2), 70-75.

Robertson SM, Friend MA, and King BJ **(2008)** Mild congenital goitre increases lamb mortality in southern NSW. *Australian Journal of Experimental Agriculture* **48** (7), 995–998.

Conference - Refereed

Ridley A and Avery A **(2005).** Australian farming systems, sustainability and salinity. At the International Salinity Forum - Managing Saline Soils and Water: Science, Technology, and Social Issues. Riverside, California, USA April 2005.

Masters D, Revell D, Edwards N and Avery A **(June 2007).** Vision for perennials in Australia's grazing landscape. Invited paper in *Proceedings of the Grassland Society of Southern Australia 48th Annual Conference*, Murray Bridge, South Australia.

Raeside M, Friend M, Lawson A **(2008).** Effect of grazing system on the yield and quality of summer-active tall fescue in the Western District of Victoria. In 'Salinity, Water and Society - Global Issues, Local Action: Proceedings of the 2nd International Salinity Forum'. Adelaide, South Australia.

Steve Clark, Belinda O'Brien and Alister Lawson **(August 2008).** Winter production from summer-active perennials. Proceedings of the GSSA Annual Conference 2008. Poster / Paper .

Margaret Raeside, Michael Friend and Alister Lawson **(August 2008).** Managing Summer Active Tall Fescue. Proceedings of the GSSA Annual Conference 2008. Poster / Paper .

Andrew Kennedy, Ralph Behrendt, Fiona Cameron, Matt Kelly, Andrew Phelan **(2008).** High lamb live weight per hectare – but do they meet specifications? Proceedings of the GSSA Annual Conference 2008. Poster / Paper.

Margaret Raeside **(June 2008).** Effect of post-grazing recovery time on summer-active tall fescue in south-eastern Australia. International IGC-IRC 2008 Congress Beijing.

Conference Proceedings – Non-refereed

Masters DG, Edwards N, Sillence M, Revell D, Friend M, Sanford P, Saul G, Young J, Beverly CR, Avery AL **(December 2005).** The role of livestock in the management of salinity. Australian Society of Animal Production Conference.

Ryan J. **(August 2006).** EverGraze – More Livestock from Perennials. Poster/paper - At 2007 Agribusiness Livestock Updates, Esperance WA

Sanford P, Young J and Ryan J. **(September 2006).** EverGraze – development of profitable and sustainable livestock systems for the high rainfall zone of Western Australia. Poster/ paper 13th Agronomy Conference in Perth 2006.

Sanford P **(February 2007)** EverGraze – livestock and perennial pasture performance in a drought year. At 2007 Agribusiness crop Updates : Farming Systems Updates. Presented at the Burswood Entertainment Complex, Perth Western Australia, 14-15 February 2007.

Friend M, Robertson S, Masters D, Avery A **(March 2007)** EverGraze: project to achieve profit and environmental outcomes in the Australian grazing industries. International Symposium on the Nutrition of Herbivores (in Beijing 2008).

Angela Avery, David Masters, Geoffrey Saul **(April 2007)**. EverGraze 1 - More livestock from perennials – Overview. In *Proceedings of the Grassland Society of Southern Australia 48th Annual Conference*, Murray Bridge, South Australia

Alister Lawson, Steve Clark, Frank McKenzie, Jayne Holmes, Belinda O'Brien **(April 2007).** EverGraze 2 - Pasture responses in a dry year. In *Proceedings of the Grassland Society of Southern Australia 48th Annual Conference*, Murray Bridge, South Australia

Susan Robertson, Belinda King, Michael Friend, Paul Sanford **(April 2007).** EverGraze 3 - Using perennials to boost ovulation rates in Merino ewes. In *Proceedings of the Grassland Society of Southern Australia 48th Annual Conference*, Murray Bridge, South Australia

Malcolm McCaskill, Steve Clark **(April 2007).** EverGraze 4 - Wind rows for 'bad' lambing weather. In *Proceedings of the Grassland Society of Southern Australia 48th Annual Conference*, Murray Bridge, South Australia

Malcolm McCaskill **(April 2007)**. EverGraze 5 - Tall wheatgrass hedges cut wind speeds. In *Proceedings of the Grassland Society of Southern Australia 48th Annual Conference*, Murray Bridge, South Australia

Fiona Cameron, Matt Kelly, Andrew Kennedy, Ralph Behrendt **(April 2007).** EverGraze 6 - Finishing steers on pasture in a short growing season. In *Proceedings of the Grassland Society of Southern Australia 48th Annual Conference*, Murray Bridge, South Australia

Malcolm McCaskill **(April 2007).** EverGraze 7 - Water use by lucerne and chicory. In *Proceedings of the Grassland Society of Southern Australia 48th Annual Conference*, Murray Bridge, South Australia

Margaret Raeside, Michael Friend, Frank McKenzie, Alister Lawson **(April2007)**. EverGraze 8 - Effect of grazing interval on tiller density of summer-active tall fescue. In *Proceedings of the Grassland Society of Southern Australia 48th Annual Conference*, Murray Bridge, South Australia

Margaret Raeside, Michael Friend, Frank McKenzie, Alister Lawson **(April 2007).** EverGraze 9 - Effect of grazing interval on tiller appearance and death rates of summer-active tall fescue. In *Proceedings of the Grassland Society of Southern Australia 48th Annual Conference*, Murray Bridge, South Australia

Susan Robertson and Michael Friend **(April 2007).** EverGraze: returns from perennial grazing systems in extreme drought. Grasslands Society of NSW Conference 2007 (Queanbeyan).

Sanford P **(July 2008).** EverGraze - Comparative performance of perennial pastures during drought. At 2008 Agribusiness Livestock Updates. Perth WA.

Extension Publications (Newsletters etc.)

Testing the future – using profit as a driver for land use change **(November 2004)** by Paul Sanford. In Evergreen farming newsletter.

Fortune favours the bold **(March 2005).** In CRC - Focus on Salt.

EverGraze – more meat from perennial$ **(April 2005).** In MLA – Feedback.

EverGraze and ORL 1.4 Our Biodiversity bringing scientists out of retirement to assist research on lamb survival **(June 2005).** In DPI Landscape Systems Platform Newsletter

Demonstrating production and environmental benefits of high-water-use perennial pastures on farms **(June 2005).** In CRC - Salinity Update Victoria and Tasmania.

EverGraze - More Livestock from Perennials **(Spring/Summer 2005).** In DPI Victoria – Primary Voice.

EverGraze - More Livestock from Perennial$ **(September 2005).** In CRC - Focus on Salt.

New Brochure: EverGraze - More livestock from Perennial$ **(September 2005**). In CRC - Salinity Update Victoria and Tasmania.

EverGraze – More livestock from Perennials **(October 2005).** By Geoff Saul, In GSSA Newsletter.

EverGraze - More Livestock from Perennial$ (November 2005). In Grasslands Society Newsletter.

EverGraze - More Livestock from Perennial$ **(November 2005).** In DPI Victoria Primary Voice Newsletter.

Designing maternity paddocks for improved performance **(December 2005).** In CRC e-news

EverGraze the first challenging year **(December 2005)** by Paul Sanford. In Evergreen newsletter

EverGraze site in Victoria on track **(March 2006).** In CRC- focus on salt.

EverGraze trials in WA **(March 2006).** In CRC - Salinity Update WA.

EverGraze – More livestock from Perennials **(April 2006).** In Riverine Plains Annual Review.

EverGraze update **(June 2006).** In CRC for PBMDS Newsletter.

Finding Future grazing systems for profit and production **(Spring 2006).** In MLA Prograzier

Demonstrating production and water use of summer active perennial pastures **(September 2006).** In Balmoral Community newsletter

Demonstrating production and water use of summer active perennial pastures **(September 2006).** In Woady Yallock Newsletter

Demonstrating production and water use of summer active perennial pastures **(October 2006).** In Cavendish Community Chronicle

Perennials for improved fertility **(December 2006).** In Landmark – Field Force

EverGraze expands the search for better pastures **(December 2006).** In CRC Focus on Salt

Reproduction and perennial pastures – getting the formula right **(Summer 2006/07).** In MLA Prograzier

Perennial pastures make best use of bonus summer rainfall **(February 2007).** In DPI - Plant Production Sciences Newsletter No. 23.

EverGraze – producing prime lamb on perennial pastures in a drought year **(March 2007**). In Agribusiness Livestock Updates

EverGraze a winner in big dry **(March 2007).** In CRC Focus on Salt

Demonstrating production and water use of summer active perennial pasture **(March 2007).** In Woady Yallock Newsletter, Number 32.

EverGraze perennials shine in tough season **(April 2007).** In MLA Publication – On-Farm.

EverGraze - more livestock from Perennials **(May 2007).** In GSSA Newsletter

Promoting productive, summer-active perennial pastures in south west Victoria **(May 2007)** by McKenzie, Ward, Bush and Holmes. In GSSA Newsletter

EverGraze Update **(May 2007).** EverGraze Newsletter

Hedges for lambing shelter **(May 2007).** In MLA - Prograzier

Changing the southern summer complexion **(June/July 2007).** In MLA- Feedback

Chicory delivers in dry times for EverGraze **(Winter 2007).** In MLA - Prograzier

Wagga weaning rates better than expected **(Winter 2007).** In MLA - Prograzier

EverGraze – Tough times **(June 2007)**. In CRC for PBMDS Newsletter

Planning spring sowing? Consider perennial pastures **(July 2007).** In DPI – Primary Voice Newsletter for Glenelg Hopkins and Wimmera areas

Project Report – Tall Fescue Work Award (Maggie Raeside) **(August 2007).** In DPI –Plant production science staff newsletter

EverGraze Update **(August 2007).** EverGraze Newsletter

Producers guide the way for increased profits and improved NRM **(Spring 2007).** In MLA Prograzier

EverGraze Update: Wagga grazing systems site **(September 2007).** In GSSA Newsletter

Managing summer-active tall fescue in western Victoria **(September 2007)** by Maggie Raeside. In GSSA Newsletter

EverGraze Update **(October 2007).** EverGraze Newsletter

Rolling out the research **(October 2007).** In CRC Focus on perennials

Summer –active perennials lift ovulation rates **(October 2007).** In CRC Focus on perennials

Production boost from perennials **(April –May 2008).** In AWI - Beyond the Bale Issue 33.

Profitable pastures lead to profitable towns **(April –May 2008).** In AWI - Beyond the Bale Issue 33.

EverGraze **(June 2008).** In Evergreen farming newsletter.

Perennial pastures lift production **(Autumn 2008).** In MLA Prograzier

Perennial pastures increase feed options and have environmental benefits **(April 2008).** In LandLife - Glenelg Hopkins Regional Newsletter

EverGraze Update **(June 2008).** EverGraze Newsletter

EverGraze **(July 2008).** In CRC e-news.

Using nitrogen fertiliser to boost autumn production from summer-active Tall Fescue **(July 2008).** In GSSA Newsletter.

EverGraze **(August 2008).** In CRC e-news.

EverGraze field days a great success **(August 2008).** In DPI News (Victoria).

EverGraze **(September 2008).** In CRC e-news.

Split joining put into practice **(Spring 2008).** In MLA Prograzier.

Shining the light on new growth **(September 2008).** In Focus on Perennials.

Winter production from summer-active perennials **(September 2008).** In Vickery Bros - Spring Newsletter.

Posters

Lodge G, Boschma S, Brennan M **(2008).** EverGraze research in northern New South Wales. In '23rd Annual Conference - Pastures at the Cutting Edge, NSW Grassland Society Conference'. Tamworth NSW.

Sanford P, Ryan J, Jakobsson P, Dobbe E, McCready E **(2008).** EverGraze – Prime lamb production on perennial based grasslands in southwest Australia. At 'International IGC-IRC 2008 Congress, Beijing

Saul G, Avery A **(2008)** EverGraze – More Livestock from Perennials. At 'International IGC-IRC 2008 Congress, Beijing

Sanford P, **(November 2006).** EverGraze. At the Albany Agricultural Show.

Saul G, Avery A, Friend M, Sanford P and Masters D **(2005).** EverGraze - More Livestock from Perennial$. New farming systems that reduce recharge and increase profit. At CSIRO Livestock Industries' Horizons in Livestock Sciences conference 'Redesigning Animal Agriculture'. Gold Coast, Queensland 2005.

Avery A, Saul G, Friend M, Sanford P, Beverly C and Young J **(2005).** EverGraze: More Meat from Perennial$ – the national project. In *Proceedings of the Grassland Society of Southern Australia 46th Annual Conference*, Ballarat, Victoria, 101.

Media Releases

EverGraze aims to increase profits and decrease salinity **(April 2006).** DPI Victoria – Media Release from the Minister for Agriculture.

EverGraze expands to include native pastures **(October 2006).** News Release

Improve your productivity with the right pasture **(August 2008).** DPI Victoria.

Other media

ABC regional radio – Albany **(August 2005).** Interview with Albany site leader Paul Sanford

ABC regional radio – Goulburn Murray **(August 2005).** '*Project looks at using plants to tackle salinity problem'* Interview with EverGraze Research Leader Angela Avery

ABC regional radio – Albany **(March 2007).** Interview with Albany site leader Paul Sanford

ABC regional radio - Wagga **(April 2007).** Interview with Wagga site leader Michael Friend.

ABC Country Hour – radio 3HA **(May 2007).** Field day advertisement run twice a day for a week prior to the 18th May.

ABC Country Hour **(July 2008).** SheepVention special with reference to EverGraze with Danae Reed.

Other

Research Fellowship **(May 2007).** Awarded to Margaret Raeside by the A. W. Howard Memorial Trust.

Field Days

WA Proof Site **(August 2006).** Field day for visiting South Australian farmers. 30 participants.

Wagga Proof Site **(August 2006).** Open field day

WA Proof Site **(September 2006).** WA systems site - 10 participants.

Hamilton Proof Site **(September 2006).** CCMA area in conjunction with SGSL – 75 participants.

Hamilton Proof Site **(October 2006).** GHCMA area.

Bolac Plains **(October 2006).** GHCMA area (Hamilton Proof Site Team).

Wagga Proof Site **(April 2007).** Open field day

Hamilton Proof Site **(May 2007).** 20 participants.

Wagga Proof Site **(August 2007).** Technical day

Hamilton Proof Site **(September 2007).** Spring Sowing Field Day.

Wagga Proof Site **(October 2007).**

Wagga Proof Site **(October 2007).** Technical Field Day.

Wagga Proof Site **(October 2007).** Open field day

Hamilton Proof Site **(May 2008).**

Wagga Proof Site **(September 2008).** External field day - South West Slopes Stud Merino Annual Show Day: Young, NSW.

Wagga Proof Site **(October 2008).** Open Field day.

WA Proof Site **(October 2008).** Open field day

Site Visits, workshops, presentations etc.

Oral Presentation **(July 2005).** "Are new farming systems based on perennial pastures in south west Australia more profitable?" at Sheep Updates by Paul Sanford.

Oral Presentation **(August 2005).** Paul Sanford at the Evergreen Field Day, Mt Barker provided background on the EverGraze project.

Presentation **(October 2005).** Paul Sanford at the WA Natural Resource Management Conference, Denmark.

Oral Presentation **(October 2005).** Paul Sanford at The Albany Eastern Hinterland Annual General Meeting.

Field Day Presentation **(October 2005).** Paul Sanford at the Mt Barker Research Station Field Day

Oral Presentation (**October 2005).** By Paul Sanford at the Walpole / Tingledale Catchment Group meeting.

Invitation **(October 2005).** To The Albany Eastern Hinterland Management Committee AGM and EverGraze launch.

Presentation **(November 2005).** To BeefCheque Farmers by Raquel Waller (Wagga Proof Site team).

Wagga site visit **(November 2005).** CRC - PBMDS NSW Node Meeting.

Presentation **(November 2005).** Murrumbidgee Catchment Management Authority by Michael Friend (Wagga Proof Site team).

Presentation **(November 2005).** AWI & GRDC by Geoff Saul.

External Presentation **(January 2006).** CRC Forestry W/S Canberra (Wagga Proof Site team).

Livestock systems based entirely on perennials **(June 2006).** Oral Presentation/Albany Hour, a seminar series, by Paul Sanford.

Wagga site visit **(July 2006).** NSW Grassland Society

Wagga site visit **(June 2006).** Australian Society of Soil Science

Wagga site visit **(June 2006).** Scientists, consultants and farmers – 12 participants.

Wagga site visit **(July 2006).** NSW Grasslands Society delegates - approximately 50 participants.

Wagga site visit **(July 2006).** The Riverina Branch of the Australian Society of Soil Science Inc.

Hamilton site visit **(July 2006).** Hamilton College Yr 10 & 11 Agricultural Students - 22 participants

External Presentation **(July 2006)**. CRC Node meeting (Wagga Proof Site team)

Hamilton site visit **(July 2006).** Field walk for Landmark staff. 7 participants.

SheepVention **(August 2006).** EverGraze Project display - 200 people viewed the display and spoke to project staff over the two-day period. Hamilton Proof Site team

Hamilton site visit **(August 2006).** DPI Soil & Water Statewide Leaders - 9 participants.

Hamilton site visit **(August 2006).** Farmers and Seed Merchants site visit **-** 12 participants.

Chicory Workshop **(September 2006).** DPI staff and farmers interested in growing and using chicory in south-west Victoria inspected chicory pastures near Lismore and Cavendish in south-west Victoria -10-15 industry agronomists. Hamilton Proof Site team.

Hamilton site visit **(October 2006).** Southern Australian Beef Research Industry Council - 16 participants.

Hamilton site visit **(November 2006).** CAS CMA relationship managers - 10 participants

Hamilton site visit **(November 2006).** EverGraze Regional Advisory Group - 9 participants.

Hamilton site visit **(November 2006**). Prograze group site visit - 12 participants.

Hamilton site visit **(November 2006**). MLA & DPI Managers **-** 6 participants.

Hamilton site visit **(November 2006).** Visiting Scientist, Mark Brunson – University of Utah USA.

Workshop **(December 2006).** In conjunction with Landmark Agronomist from throughout Victoria. Hamilton Proof Site team.

Hamilton Site visit **(January 2007).** Andrew Spiers - Mike Stevens & Associates (Host Malcolm McCaskill).

Hamilton Site visit **(February 2007).** Ewan Price - Ram supplier.

Hamilton site visit and presentation **(March 2007).** Stephens Pasture Seeds drought recovery forum Hamilton. 25 participants - Day 1. (Host Andrew Kennedy).

More livestock from perennial' **(March 2007).** Oral presentation at the Options 2020 workshop at Borden, WA by Paul Sanford – 60 participants.

Hamilton site visit and presentation **(March 2007).** Stephens Pasture Seeds drought recovery forum Hamilton. 59 participants - Day 2. (Host Andrew Kennedy).

Hamilton site visit **(March 2007).** EverGraze Regional Group.

Hamilton site visit **(March 2007).** Management solutions (MLA, producers, consultants) 20 participants - Day 1 (Host Ralph Behrendt and Andrew Kennedy).

Hamilton site visit **(March 2007).** Management solutions (MLA, producers, consultants) 6 participants - Day 2 (Host Andrew Kennedy).

Hamilton site visit **(March 2007).** Stephen Pasture seeds perennial pastures workshop. 34 participants. (Host Steve Clark).

WA Pasture walk **(March 2007).** Mount Barker Research Station on EverGraze research findings. 30 participants. Presented by Paul Sanford.

Hamilton Site visit **(May 2007).** School Students (yrs 10,11 & 12) as part of the Wool Industry Overview Program **-** 20 participants. (Host Fiona Cameron)

Hamilton Site visit **(April 2007).** Farmers and general community from a local church. 15 participants. (Host Malcolm McCaskill).

Hamilton site visit **(April 2007).** Pasture plants for a changed climate, presented by Malcolm McCaskill as part of a climate change presentation by RMIT. 85 participants.

Wagga site visit **(July 2007).** ERG visited the proof site.

Conference **(July 2007).** NSW Grasslands Society Annual Conference; Tamworth (Wagga Proof Site team).

External Presentation **(August 2007).** Grain and Graze day (Wagga Proof Site team)

External Presentation **(August 2007).** CSU students (Wagga Proof Site team)

Wagga site visit **(September 2007).** CMA and DPI staff (Wagga Proof Site team).

Conference **(September 2007).** International symposium on herbivore nutrition Wagga).

Wagga site visit **(September 2007).** In GSSA Albury – Wodonga (Wagga Proof Site team)

Wagga site visit **(September 2007).** Managing Seasonal Extremes. GSSA Bus Tour.

Wagga site visit **(November 2007).** Bookham Ag Bureau (Wagga Proof Site team).

Wagga site visit **(February 2008).** Chinese delegation - IGC org committee and David Kemp

External Presentation (**February 2008).** Graham Centre seminar series (Wagga Proof Site team)

External Presentation **(March 2008).** South West Merino Breeders Association AGM, Young NSW (Wagga Proof Site team).

External Presentation **(March 2008).** Bookham Ag Bureau monthly meeting (Wagga Proof Site team).

External Presentation **(April 2008).** Pasture recovery day Bookham (Wagga Proof Site team).

External Presentation **(April 2008).** Deniliquin drought recovery workshop (Wagga Proof Site team).

External Presentation **(April 2008).** Pasture recovery day Ellerslie, Adelong (Wagga Proof Site team).

External Presentation **(April 2008).** Cowra drought recovery workshop (Wagga Proof Site team).

External Presentation **(April 2008).** Forbes drought recovery workshop (Wagga Proof Site team).

External presentation **(June 2008).** Pasture recovery day Coolac (Wagga Proof Site team)

Workshop **(July 2008).** Farming in a Changing World Workshop, Harrow Victoria. (Hamilton Proof Site Team).

Hamilton site visit **(July 2008).** Site tour and overview for Coopworth Society members.

Hamilton site visit **(July 2008).** ERG visited the Proof Site

External Presentation **(July 2008).** Elders breakfast workshop. Hamilton site Proof Team.

Hamilton site visit and presentation **(July 2008).** BPP - Byaduk group.

Support Site Farm Walk **(August 2008).** Landholders in the Bookham District visited a SS (Wagga Proof Site team).

External Presentation **(June2008).** ASAP Southern NSW 'Pushing Grazing systems' workshop – Cowra (Wagga Proof Site team).

GSSA Conference - Bairnsdale, Trade Display **(August 2008).** (Hamilton Proof Site Team).

External Presentation **(August 2008).** Systems, ovulation rate and lamb survival results presented to undergrad students (Wagga Proof Site team).

Support Site Farm Walk **(September 2008).** Landholders in the Binalong District visited a Supporting Site (boost Ovulation rate in Ewes) (Wagga Proof Site team).

EverGraze stand at the Mount Barker Research Station field day (**October 2008).** WA Proof Site Team.

EverGraze Products

EverGraze Actions - Growing Chicory in southern Australia

EverGraze Actions - Perennial grass hedges provide shelter at lambing

EverGraze Actions - Native pastures for sustainable agriculture

EverGraze Actions - EverGraze Actions - Chicory is a champion in WA

EverGraze Actions - Growing and using summer active tall fescue

EverGraze Actions - Kikuyu is king on the south coast of WA

Brochure - North East (Victoria) and Murray (New South Wales) catchments

Brochure - Northern New South Wales – Namoi and Border Rivers – Gwydir catchments

Brochure - Central Slopes of New South Wales – Lachlan and Central west catchments

Brochure - Southwest WA

Brochure - Southern Victoria

Brochure - Southern Slopes NSW

Brochure - EverGraze - national

Brochure - Supporting Site

Brochure - Native pastures for sustainable agriculture

EverGraze Information Sheet and Magnet