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Using Species Diversity to Improve Pasture Performance
Anyou Liu and Clinton Revell, Department of Agriculture, Northam, W.A.

ABSTRACT
Why do species mixtures abound in native pasture communities? They are nature’s way of exploiting environmental variability through diversity. Increasing the species diversity of annual pasture legumes can increase pasture stability, production and the quality of feed for grazing animals. However, focused management is the key to achieving these desirable outcomes in agricultural systems.

INTRODUCTION
Most pastures are a mixture of various components (legumes, grasses and herbs). Some components are desirable, others are weeds. Traditionally, wheatbelt pastures have been established as a legume monoculture of either a subclover or medic variety. Sometimes a mix of varieties within a species is sown, but sowing a mix of different species has not yet been widely adopted. Although key management inputs such as insect control, fertiliser, liming, herbicide manipulation and strategic grazing can help to maintain legume dominance in pastures based on a single legume species, pasture quality invariably declines over time due to factors beyond the control of farm managers (eg false breaks). We have evaluated the concept of growing mixtures of annual legumes to combat environmental variability at a long-term rotation site at Jennacubbine in the Western Australian wheatbelt (Liu and Revell, 2001, Liu and Revell, 2003). In this article we (a) highlight the potential benefits of sowing a mix of desirable pasture species, (b) emphasise the need to set clear goals to guide both species selection and management inputs, and (c) discuss the impact of fertilisation, herbicide manipulation, grazing and fodder conservation on pasture composition over time. Practical examples illustrating these principles will be presented at the conference and are based on lessons learned from the Jennacubbine and supplementary sites between 1995 and 2003.

REVIEW
Environmental variability within a paddock or across paddocks is widespread. The key sources of this variability are edaphic (e.g. differences in soil depth and soil fertility), biological (e.g. differences in the presence of disease, insect pests and weeds), and climatic (e.g. rainfall, temperature). The recent development of species such as serradella, biserrula, arrowleaf clover, gland clover, and sulla has greatly enhanced the genetic resources available to cope with this variability. These species vary in characters such as perenniality, growth habit, canopy structure, hardseededness and rooting depth.

There are a number of potential advantages from growing a mix of pasture species;

- Mixtures have the potential to improve the productivity and stability of pastures in variable environments.
- Mixtures have the potential to explore environmental resources more efficiently as different species can complement each other in canopy structure, rooting system, seed dormancy attributes and resistance to pests and diseases.
- Mixtures can also provide a more balanced diet for grazing animals, lift green feed supply at the break of season and extend pasture growth at the end of season.

However, the performance of mixtures will very much depend on the type and number of species sown, the individual characteristics of each species, and management input. Where a mix is sown, focused management is required to match the individual requirements of component species especially in terms of herbicide and grazing tolerance. A few principles are outlined below.

Establishing a mixture
It is essential to have a clear goal in mind before sowing and establishing a pasture mixture as this will influence species choice. For example, is the pasture base primarily intended for the benefit of the following crops (in a pasture and crop rotation) or for grazing animals? While a legume dominant pasture with a high level of hardseededness is desirable in a pasture crop rotation system, a balanced mixture of legumes and grasses might be more suitable for a livestock production system especially for permanent pastures. A mixture of perennial and annual species has the potential to extend the growing season and
utilise out of season rainfall. If the intention is to cut pastures for hay or silage, the inclusion of legume species with an upright growth habit (such as serradella or crimson clover) plus a grass or cereal to minimise lodging will boost production.

A mixture of 2 to 3 desirable components is a good starting point. One or two species should be selected to take the leading role and the rest to perform supplementary functions, such as filling gaps created by disturbance or a change in soil type. Attention to detail such as inoculation, sowing depth and weed and insect control is critical.

Managing a mixture

Population density and composition. In a self-regenerating pasture, density and composition after break of the season is directly related to the size and composition of the seed bank. A low legume content can be amended through reducing competition from weeds, or sowing a legume component into the existing pasture.

Fertilisation. Different species vary in their adaptation to soils and requirement for nutrients. In addition fertilisation, liming and previous cropping history can all change the soil environment and cause a shift in the composition of a pasture. For instance, the accumulation of soil N after a long phase of a legume-based pasture will usually favour weedy species and displace legumes.

Herbicide manipulation. Herbicides remain the most effective way to quickly suppress or remove the undesirable species and lift legume production. However, there are wide variations in the tolerance of pasture legumes to broadleaf herbicides (Revell, 2003). Combining species with similar herbicide tolerance will simplify management.

Selective grazing by animals. Grazing has a profound effect on pasture composition. Selective grazing can result in a decline of the more palatable species. Heavy grazing can reduce the ecological advantages of species with an upright growth habit. For these species, grazing pressure may need to be reduced at flowering to ensure adequate seed production and self-regeneration in the following year. On the other hand, reasonable grazing pressure will promote the dominance of species with a prostrate growth habit, especially subterranean clover.

Cutting for hay or silage. Under certain circumstances, the pastures might be left ungrazed in order to cut for hay or silage. Erect species like crimson clover will be advantageous. While mowing is a good way of controlling herbicide resistant weeds, it can also cut seed production of aerial seeded species. However, in a paddock with a good seed bank of hardseeded legume species, such as biserrula and yellow serradella, this might be a way of promoting legume dominance in subsequent years.

CONCLUSION

Most pastures consist of a dynamic mixture of species. However, focused management is needed to lift or maintain the density of desirable species on the one hand and suppress or remove undesirable species on the other. While management needs to be flexible to reflect changing seasonal conditions and objectives, the principles of maintaining a productive pasture base remain the same.

ACKNOWLEDGMENTS

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Paper reviewed by: David Ferris

SELECTED REFERENCES


New Annual Pasture Legumes for Sheep Graziers
Phil Nichols, Angelo Loi, Brad Nutt and Darryl McClements
Department of Agriculture Western Australia, South Perth

ABSTRACT
Nine new pasture legume cultivars have recently been released by the National Annual Pasture Legume Improvement Program (NAPLIP). This includes four subterranean clovers: Izmir, suited to areas with ≤375 mm annual rainfall, Urana to 400-525 mm and Coolamon to areas with 500-700 mm, while Napier is a waterlogging tolerant variety for areas with ≥750 mm annual rainfall. Erica and Margurita are hardseeded French serradellas, which can persist through cropping rotations in 350-500 mm rainfall areas. Mauro is a later flowering, softer-seeded biserrula suited to 450-700mm rainfall areas. Scimitar and Cavalier are softer-seeded burr medics suited to areas with ≥325mm and ≥425mm rainfall areas, respectively. Plant Breeders Rights have been sought for all cultivars.

INTRODUCTION
The National Pasture Legume Improvement Program (NAPLIP) is a national program aimed at developing pasture legume cultivars for the farming systems of southern Australia. Elite breeding lines, developed through breeding and selection programs in Western Australia and South Australia, then undergo field evaluation in target environments across southern Australia.

NAPLIP has recently released nine new pasture legume cultivars. These include Urana, Coolamon, Napier and Izmir subterranean clovers, Margurita and Erica French serradellas, Scimitar and Cavalier burr medics and Mauro biserrula. Plant Breeders Rights have been sought for all cultivars. This paper discusses their characteristics and potential use.

RESULTS
Urana, Coolamon, Napier and Izmir subterranean clovers (Trifolium subterraneum)

Urana is suited to areas with annual rainfall of 400-525 mm and where the growing season extends to mid-October. It has a flowering time later than Dalkeith but earlier than York and Seaton Park and should be well suited to mixtures with these cultivars. Urana has very vigorous growth and its high hardseededness should also enable it to persist better in cropping rotations than current cultivars. Limited testing suggests that Urana is susceptible to Race 1 of clover scorch, but may have some resistance to the Race 2. Good seed quantities will be available in 2005.

Coolamon is a replacement for Junee, suited to areas with 500-700 mm annual rainfall and where the growing season extends into November. It is suited to both mixed farming and permanent pastures. Coolamon has resistance to both Race 1 and Race 2 of clover scorch, giving it a distinct advantage over Junee, which is susceptible to the newer race. It is susceptible to powdery mildew, but less so than Junee, and is not likely to cause production losses in grazed situations. Across all sites Coolamon had 11% better regeneration density and produced 10% more herbage in winter, 14% more herbage in spring and 4% more seed than Junee. Limited seed will be available in 2005.

Napier belongs to the waterlogging-tolerant subspecies yanninicum of subterranean clover, recognised by its cream to amber coloured seeds. It is a replacement for Larisa and Meteora, suited to areas with annual rainfall ≥750 mm and where the growing season extends to late November. Napier produces more herbage in winter and spring than Larisa and Meteora, has much greater seed production and is resistant to Race 1 and Race 2 of clover scorch. Its main use will be on soils prone to waterlogging or with good water-holding capacity. Its late maturity and erect habit also makes it well suited to forage conservation (hay and silage). Limited seed will be available in 2005.

Izmir is a more hardseed replacement for Nungarin with greater persistence in cropping rotations. It is suited to areas receiving ≤375 mm annual rainfall. Over all trial measurements, Izmir produced 10% more winter herbage and 7% more spring herbage than Nungarin. This advantage was greater following seasons where trial sites were either cropped or sprayed out to prevent seed set. Limited seed should be available in 2006.
**Margurita and Erica hardseeded French serradellas (Ornithopus sativus)**

French serradella is a highly productive forage legume for sandy soils. It is very acid tolerant and can exploit deep soils to remain green longer than most other annual pasture legumes. Cadiz, the first cultivar developed, has been highly successful. However, it does not persist in the long term or in crop rotations, due to its almost complete lack of hardseeds.

Erica and Margurita are new hardseeded types of French serradella developed from Cadiz suited to 350-500 mm rainfall areas. Margurita is very similar in growth habit and appearance to Cadiz and is well suited to forage production. Erica is more prostrate with finer leaves and stems and is considered more grazing tolerant. Their hardseed attributes ensure good germination at the break of season, while also enabling persistence through crop rotations. Seed of both Erica and Margurita is easily harvested using a conventional grain harvester (as with Cadiz), but needs to be extracted from pods and scarified for high germination. Seed of both cultivars will be plentiful in 2005.

**Mauro Biserrula (Biserrula pelicinus)**

Biserrula is well adapted to a wide range of soil types and pH levels, but does not tolerate waterlogging. It is a very productive species with a deep root system, enabling it to provide a longer period of green feed for grazing animals. Biserrula is extremely hard seeded, making it ideal for ley farming systems. Furthermore, its seed does not soften until mid-late autumn, allowing it to escape false breaks. Sheep tend to preferentially avoid grazing biserrula in spring, with consequent benefits for herbicide-free weed management. A few instances of photosensitisation have been reported for sheep grazing biserrula-dominant pastures and the Department of Agriculture is investigating their possible connection. More details are provided in the paper by Clinton Revell.

Mauro is two weeks later flowering than the existing cultivar, Casbah. It is suited to mixed farming and permanent pastures in 450-700 mm rainfall areas. It is less hardseeded than Casbah, resulting in higher second year regeneration densities. Good seed quantities will be available in 2005.

**Scimitar and Cavalier burr medics (Medicago polymorpha)**

Burr medics are adapted to mildly acid loam and clay soils. They are generally hardseeded, making them well suited to ley farming systems. They are also tolerant of moderate salinity, particularly in the absence of prolonged waterlogging, and have application on barley grass flats or as understorey plants with saltbush. Santiago, Circle Valley and Serena have previously been released as cultivars. However, their high hardseededness results in poor second year regeneration in phase farming or permanent pasture systems.

Scimitar and Cavalier are more productive and softer-seeded than the original cultivars. Scimitar is an alternative to Santiago, suited to ≥325 mm annual rainfall areas, while Cavalier is a replacement for Circle Valley, suited to ≥425 mm annual rainfall areas. Both have low levels of blue-green aphid resistance, but are susceptible to cowpea aphids. Seed of both cultivars should be available in 2005.

**CONCLUSION**

These new pasture legumes have been selected with attributes leading to increased productivity and persistence and increase the options available to sheep graziers. By increasing legume dominance of the pasture, feeding value of the pasture is increased, with consequent benefits for animal production. Crops in rotation also benefit through increased nitrogen fixation. Mixtures of cultivars and species can be used to provide a buffer against different seasonal effects and soil types within the paddock.

**KEY WORDS**

Subterranean clover, serradella, medics, biserrula, pasture legumes, cultivars

**ACKNOWLEDGMENTS**

The Grains Research and Development Corporation and Australian Wool Innovation Ltd have provided funding for the development of these cultivars.

**Paper reviewed by:** Clinton Revell
Pastures from Space – Can Satellite Estimates of Pasture Growth Rate be used to Increase Farm Profit?
Lucy Anderton, A Stephen Gherardi and Chris Oldham B
A Regional Economist, Department of Agriculture Western Australia, Albany, 6330.
B Senior Research Officers, Department of Agriculture Western Australia, South Perth 6051.

ABSTRACT

A remotely sensed pasture management technology, Pasture Growth Rate (PGR) has been developed by a research consortium of the Department of Agriculture Western Australia (DAWA), Commonwealth Scientific and Research Organisation (CSIRO), and Department of Land Information (DLI).

A pilot study was funded by Australian Wool Innovation in 2003 to deliver the PGR information to a number of producers; four cooperative groups in the Great Southern and two groups in Dandaragan. Six producers from these groups were studied during the pasture growing season to determine how they used the technology and assess improvement in profitability, if any of their farming business.

Key Findings

• In all cases the use of PGR improved the profitability of the sheep enterprise. The increase in gross margin ranged from $23 to $334/per winter grazed hectare (WGHA).
• The increased margin resulted from better utilisation of pasture, more effective feed budgeting and the introduction of new management techniques into the farming system.
• The information on PGR provided timely information that was not discernible from observation of either the animals or pasture in the paddock until two to three weeks later.
• The information on PGR improved confidence in decision making and helped reduce stress levels.

AIMS

The objective of the project in 2003 was to assess the value of the technology to the project co-operators through:

• qualitative surveys
• economic analysis

This paper reports on the results of the economic analysis undertaken with six of the producers in the project.

METHOD

The producers studied were interviewed at the beginning of the season (2003) and given criteria on which to record information for the analysis. They received the PGR information weekly giving them real time PGR and a 7-day forecast for each paddock. They were asked to record information about decisions that would impact on financial outcomes and how they used the technology.

Enterprise gross margin analysis was used in all case studies. Financial outcomes of the new management incorporating PGR information (the “with” situation) were compared with financial outcomes from previous management when PGR was not available (the “without” situation). All prices and values used were current. Case study 6 also includes a return on investment analysis due to it being based on a small area of the co-operator’s farm and for only a six-month production period.
RESULTS

Table 1 shows a summary of the economic analysis 'with' and 'without' PGR information for the 6 co-operators in the project.

Table 1: Gross margin results of case studies; 'with' the PGR information and 'without'

<table>
<thead>
<tr>
<th>Case Study</th>
<th>Management Methods using the PGR information</th>
<th>Gross Margin /WGHA ‘With’</th>
<th>Gross Margin /WGHA ‘Without’</th>
<th>Difference in Gross Margin /WGHA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Increased stocking rates from 9 DSE/WGHA to 11 DSE/WGHA in the last two years. Deferred grazing by lot feeding wethers at the break of the season.</td>
<td>$223</td>
<td>$200</td>
<td>$23</td>
</tr>
<tr>
<td>2</td>
<td>Increased stocking rates from 12 DSE/WGHA to 16 DSE/WGHA: rotational grazing and agistment</td>
<td>$386</td>
<td>$314</td>
<td>$72</td>
</tr>
<tr>
<td>3</td>
<td>Increased stocking rates from 11 to 14 DSE/WGHA: A mixture of rotational grazing and set stocking, silage production, Time rite applications and agistment</td>
<td>$433</td>
<td>$343</td>
<td>$90</td>
</tr>
<tr>
<td>4</td>
<td>Increase in traditional stocking rate (set stocking) from 10 to 10.4 DSE/WGA</td>
<td>$371</td>
<td>$322</td>
<td>$49</td>
</tr>
<tr>
<td>5</td>
<td>Application of fertiliser on an underperforming paddock</td>
<td>$371</td>
<td>$344</td>
<td>$27</td>
</tr>
<tr>
<td>6</td>
<td>Strip grazing versus Set stocking using PGR to make informed decisions on stock grazing. Return on Investment</td>
<td>$686</td>
<td>$354</td>
<td>$332</td>
</tr>
</tbody>
</table>

CONCLUSION

The case studies demonstrate PGR assists with making informed decisions about stocking rates, stock movement, agistment, fertiliser applications and conservation of feed (silage). It provides a catalyst to producers for change management, resulting in better utilisation of pastures and consequently increased profitability.

It is possible to feed budget through measurement and visual appraisal of food on offer (FOO) and by monitoring animal condition. However, the PGR information is unique in providing information three weeks earlier than it would be through visual means and it gives predictions for the coming week. This information provides the means for producers to manage their livestock and feed supplies in a pre-emptive manner rather than as a reaction to visual appraisal.

An additional benefit of the new technology reported by all case study producers is the increased confidence in decision making - with a subsequent reduction in stress levels.

KEY WORDS

Pastures from Space, pasture growth rates, gross margin

ACKNOWLEDGMENTS

The investment of Australian Wool Innovation and the Pastures from Space consortium (CSIRO and Departments of Agriculture and Land Information). The producers who were willing to be scrutinised and provided the information for the case studies.

Paper reviewed by: Alan Herbert
Summer-active Perennial Grasses for Profitable Sheep Production
Paul Sanford and John Gladman, Department of Agriculture, Albany W.A.

ABSTRACT

The most promising tropical grasses in this study based on yield and metabolisable energy were setaria followed by finger grass, signal grass, premier digit grass and guinea grass.

Introduction

Deep-rooted summer-active tropical grasses have the potential to reduce the incidence of secondary salinisation while increasing profit from livestock via higher stocking rates and a reduced dependence on conserved feed. The aim of this study was to evaluate a range of commercially available tropical grasses to identify grasses that could potentially improve both production and sustainability of livestock production.

METHOD

The study was conducted near Wellstead WA between 2001 and 2003. The soil type was duplex sandy gravel. Annual rainfall for the experimental period 2001, 2002 and 2003 was 515, 454 and 816 mm respectively. Summer rainfall (Dec, Jan, Feb) in 2000/01, 2001/02, 2002/03, 2003/04 was 23, 91, 175 and 110 mm respectively. The complete list of grasses evaluated is given in Table 1. The trial was sown in October 2001. Each plot comprised 36 plants. Superphosphate was applied in 2002 and 2003. Urea was applied in 2003. Plants were cut frequently to determine yield. Harvested material was washed, dried at 60°C and weighed. Samples were assessed for dry matter digestibility (DMD) and converted to metabolisable energy (ME). The GrazFeed program was used to calculate the potential liveweight change of merino cross bred lambs on a pasture consisting of 1000 kg dry matter/ha green and 1000 kg dry matter/ha dry. ME values used are presented in Table 1, crude protein values used averaged 11% and ranged from 7 to 15%.

RESULTS

Overall, the highest yielding grasses based on rank were setaria, rhodes grass, finger grass, signal grass, guinea grass and premier digit grass (Table 1). All these grasses yielded well in summer and autumn though rhodes grass, finger grass and signal grass were consistently good (Table 1). Purple pigeon grass and buffel grass yielded very poorly. Amongst the best yielding grasses setaria and finger grass recorded the highest metabolisable energy values (Table 1).

While none of these grasses could grow lambs at a similar rate to lucerne (213 g/head/day) setaria and finger grass would have potentially grown 25 kg lambs at 138 and 136 g/head/day respectively in February 2002 (Figure 1). Overall these two grasses were the best for growing livestock. Rhodes grass had the lowest ME.

CONCLUSION

While these results are preliminary, when yield and ME are taken into consideration the most promising species were setaria followed by finger grass, signal grass, premier digit grass and guinea grass. On the basis of summer and autumn growth these grasses could be expected to provide a reduction in groundwater recharge and subsequent salinity. Based on GrazFeed simulations, they may also provide sufficient ME out-of-season to grow lambs. Rhodes grass performed well in terms of yield but based on ME it would only grow livestock at low rates. Makarikari grass also is worth further consideration as it was high in ME in 2002 and yielded well in 2003. Purple pigeon grass and buffel grass appear to be unsuited to the study environment.
Table 1 Yield ranking (g/plot and g/plant), percentage of yield produced in summer and autumn and metabolisable energy (MJ/kg) for 2002 and 2003.

<table>
<thead>
<tr>
<th>Common name</th>
<th>Cultivar/Type</th>
<th>Yield 2002 rank g/plot</th>
<th>Yield 2002 rank g/plant</th>
<th>% Yield summer-autumn</th>
<th>Yield 2003 rank g/plot</th>
<th>Yield 2003 rank g/plant</th>
<th>% Yield summer-autumn</th>
<th>ME (MJ/kg) Feb 2002</th>
<th>ME (MJ/kg) May 2002</th>
<th>ME (MJ/kg) Jan 2003</th>
<th>ME (MJ/kg) May 2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setaria</td>
<td>Solander</td>
<td>1</td>
<td>5</td>
<td>72</td>
<td>4</td>
<td>6</td>
<td>39</td>
<td>11.3</td>
<td>10.3</td>
<td>10.0</td>
<td>8.7</td>
</tr>
<tr>
<td>Rhodes grass</td>
<td>Katambora</td>
<td>2</td>
<td>7</td>
<td>81</td>
<td>9</td>
<td>10</td>
<td>55</td>
<td>9.8</td>
<td>9.2</td>
<td>8.1</td>
<td>8.1</td>
</tr>
<tr>
<td>Finger grass</td>
<td>Strickland</td>
<td>3</td>
<td>8</td>
<td>74</td>
<td>5</td>
<td>7</td>
<td>65</td>
<td>11.2</td>
<td>10.3</td>
<td>8.7</td>
<td>9.3</td>
</tr>
<tr>
<td>Rhodes grass</td>
<td>Pioneer</td>
<td>4</td>
<td>6</td>
<td>61</td>
<td>7</td>
<td>9</td>
<td>60</td>
<td>9.6</td>
<td>8.9</td>
<td>8.0</td>
<td>8.9</td>
</tr>
<tr>
<td>Signal grass</td>
<td>Basilisk</td>
<td>5</td>
<td>4</td>
<td>55</td>
<td>6</td>
<td>5</td>
<td>73</td>
<td>10.1</td>
<td>8.7</td>
<td>8.9</td>
<td>9.0</td>
</tr>
<tr>
<td>Guinea grass</td>
<td>Gatton</td>
<td>6</td>
<td>1</td>
<td>30</td>
<td>10</td>
<td>2</td>
<td>-</td>
<td>10.7</td>
<td>9.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Setaria</td>
<td>Splenda</td>
<td>7</td>
<td>2</td>
<td>40</td>
<td>1</td>
<td>3</td>
<td>42</td>
<td>10.7</td>
<td>10.0</td>
<td>10.0</td>
<td>9.5</td>
</tr>
<tr>
<td>Digit grass</td>
<td>Premier</td>
<td>8</td>
<td>3</td>
<td>44</td>
<td>2</td>
<td>1</td>
<td>38</td>
<td>10.1</td>
<td>9.2</td>
<td>9.5</td>
<td>9.3</td>
</tr>
<tr>
<td>Makarikari grass*</td>
<td>Bambatsi</td>
<td>9</td>
<td>9</td>
<td>50</td>
<td>3</td>
<td>4</td>
<td>34</td>
<td>10.3</td>
<td>8.7</td>
<td>9.0</td>
<td>9.0</td>
</tr>
<tr>
<td>Digit grass</td>
<td>Jarra</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>8</td>
<td>8</td>
<td>86</td>
<td>-</td>
<td>10.4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Purple pigeon Grass</td>
<td>Inverell</td>
<td>11</td>
<td>11</td>
<td>0</td>
<td>=11</td>
<td>=11</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Buffel grass</td>
<td>Gayndah</td>
<td>12</td>
<td>12</td>
<td>0</td>
<td>=11</td>
<td>=11</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Also known as Bambatsi panic

Figure 1. Potential liveweight change of 25 kg merino cross-bred lambs calculated using GrazFeed.

KEY WORDS

Tropical perennial grasses, yield, metabolisable energy, liveweight gain.

ACKNOWLEDGMENTS

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Paper reviewed by:  Roy Butler and Tim Wiley
Pastures From Space – Validation Of Predictions Of Pasture Growth Rates


CSIRO, Livestock Industries, PMB 5, Wembley, WA, 6913. Department of Agriculture Western Australia, Bentley, WA, 6983. Department of Land Information Western Australia, Floreat, WA, 6214.

ABSTRACT

Near real-time assessment of feed resources is a key element in sound decision making for livestock producers. Remotely sensed pasture growth rate (PGR) is the product of integrating satellite imagery with climate information, which could not be easily calculated or observed by producers. Remotely sensed predictions of PGR were validated against field observed PGR on a selected set of paddocks and accounted for over 83% of the observed variability in three farms. In two additional farms where poor validation relationships were found, climate and environmental anomalies were identified and protocols modified to account for these anomalies in future. The level of accuracy achieved in the quantitative estimation of PGR by this technology provides a high level of confidence for decision-making and is highly valued by producers.

INTRODUCTION

Efficient use of feed resources is a major driver of profitability in the livestock industries of Australia. In order to improve the sustainability of Australian agriculture, new technologies are needed to monitor and assist the management decisions associated with the use of grazing systems. However the ability of producers to realise this benefit is being restricted by the lack of information on which to base production decisions from one season or year to the next. Very few farmers could provide the time and resources to assess PGR on all farm paddocks necessary for adequate budgeting of feed resources.

The Pastures from Space project aims to deliver near real time information at the whole farm and within paddock level that underpin tactical and strategic decision making for Australian agricultural businesses. Two products form the basis of the project. PGR (kg DM/ha.day) is derived using a deterministic model and feed on offer (FOO) (kg DM/ha) is estimated using an empirical model to provide quantitative estimates of green biomass and its rate of growth (Edirisinghe et.al. 2000) in a GIS environment. The dynamics of PGR responses in the winter dominant rainfall region of southern Australia reflects a characteristic growth pattern showing a substantial increase in growth in late spring. This relationship between normalised difference vegetation index (NDVI) and fAPAR (fraction of absorbed photosynthetic active radiation) provides the fundamental basis for estimating PGR remotely. The relationship is further improved by including local climatic information provided by the Bureau of Meteorology in Melbourne. This paper reports the validation of the model using observed vs. predicted PGR and comparing satellite imagery from two satellite sensor sources.

METHOD

Five farms distributed over the south west of WA were used to collect field PGR values at regular time intervals by setting 30-50 exclosure cages across a number of farm paddocks. The cages were GPS located on each of the farms. Paddock averages were compared to satellite predicted values.

To estimate PGR current weekly spatial climatic surfaces were integrated with satellite information (Edirisinghe et al. 2000). Prediction required timely and frequent access to these data sets; DLI provided NOAA AVHRR satellite time series data with a pixel size of 1100m². From early 2002 the TERRA MODIS sensor delivered information to the PGR model with a pixel size of 250m², in the form of bimonthly composited normalised difference vegetation index (NDVI = (red channel – NIR channel) / (red channel + NIR channel)). Both these sensors provided a NDVI that is used as an estimate of fAPAR in the PGR model. The higher resolution MODIS image provided an improved NDVI with ground registration (±50m) allowing larger clumps of remnant vegetation to be removed.
RESULTS

The accuracy of prediction for Farms 1, 3 and 4 was markedly higher than for Farms 2 or 5 (Table 1) regardless of the source sensor, with over 82% of the variability in observed PGR accounted for from the MODIS sensor. Farm 2 contained a large number of parkland type scattered trees while prolonged low soil temperatures due to frosts affected observed PGR in Farm 5. Field PGR was between 1-10 kg/ha.day on Farm 5 compared to 20-30 kg/ha.day on adjacent non-frost affected farms for a comparable period.

Table 1. R² for predicted and paddock PGR, combined paddocks on farms, southwest WA 2003 season.

<table>
<thead>
<tr>
<th>Farm</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODIS</td>
<td>0.83</td>
<td>0.46</td>
<td>0.90</td>
<td>0.84</td>
<td>0.50</td>
<td>Paddock PGR = 1.1x -2.9    R²=0.74</td>
</tr>
<tr>
<td>AVHRR</td>
<td>0.66</td>
<td>0.10</td>
<td>0.74</td>
<td>0.80</td>
<td>0.40</td>
<td>Paddock PGR = 1.1x + 2.9    R²=0.54</td>
</tr>
</tbody>
</table>

In Farm 2 although native forest and remnant vegetation had been masked, parkland cleared trees remained and inevitably would reduce the accuracy of PGR prediction. There is an option to use other sources of higher resolution imagery to report only those selected pixels containing a higher proportion of pasture. Identification of frost-affected areas will be improved in 2004 by deploying automatic weather stations throughout the region. The introduction of data from the MODIS sensor increased the accuracy of the prediction substantially, even in farms where anomalies substantially degrade the prediction. An additional 20% of the observed variability overall was accounted for by the introduction of the higher resolution data. When a pilot study was conducted to assess the potential value of these technologies to Australian woolgrowers, of the 43 PGR pilot study participants 77% (33) adopted the PGR technologies during the pilot study (Sneddon et. al. 2004). Real time PGR was utilised to improve gross margins by up to $332 per winter grazed hectare (Anderton et. al. 2004).

CONCLUSION

This validation has shown that PGR can be accurately estimated at regional, catchment, farm and paddock scale at weekly intervals using satellite imagery. Since the inception of MODIS in 2002 the accuracy of PGR prediction has increased. With better accuracy, producers have a higher level of confidence to apply this technology and are reaping financial rewards in doing so because of informed decision making and more efficient use of their feed resources.

KEY WORDS
PGR, FOO, Pastures from Space, remote sensing, pastures, biomass, climate, pasture growth rates, management, NDVI, satellites

ACKNOWLEDGMENTS
We gratefully acknowledge the contribution of the collaborating producers through feedback and evaluation of the data and access to their properties for data collection.

Paper reviewed by: G. Mata, A. Edirisinghe and S. Gherardi

REFERENCES
Production and Management of Biserrula Pasture - Managing the Risk of Photosensitivity

Dr Clinton Revell and Roy Butler, Department of Agriculture Western Australia

ABSTRACT

Casbah biserrula (Biserrula pelecinus L.) is estimated to have been sown on 60,000 ha of farmland since its release in 1997. This annual pasture legume has been highly productive on loamy sand to clay loam soils which are neutral to mildly acidic, especially in the northern wheatbelt. It is very hardseeded and is being used successfully in intensive pasture/crop rotations.

An interesting feature of Casbah is the apparent change in animal preference during the growing season. Over a short period of time, sheep begin to avoid biserrula and preferentially graze the non-legume components of the pasture, rapidly leading to legume dominance. This is highly beneficial for the management of herbicide resistant weeds, but in certain circumstances this change also appears to be associated with the occurrence of photosensitisation (sunburn-like signs) in some animals.

The main types of photosensitivity are (i) primary, when animals ingest particular plant compounds that are photodynamic and (ii) hepatogenous (or secondary), where toxins in plants, fungi or algae cause liver damage, which in turn results in the accumulation of the photodynamic compound, phylloerythrin in the blood. Phylloerythrin is a fluorescent porphyrin product resulting from the bacterial metabolism of chlorophyll in the rumen. It is normally metabolised by a healthy liver and excreted.

Several isolated incidents of photosensitisation in wheatbelt sheep flocks were investigated in 2003. Blood tests from affected animals suggested that liver damage was unlikely to be the cause of the photosensitisation. A grazing study at Katanning in 2003 demonstrated the dramatic change in pasture composition when biserrula was grazed and animal performance on biserrula assessed as liveweight change was unaffected. No photosensitivity occurred in this grazing study.

Until more is known farmers should adopt a cautious approach to the management of sheep grazing Casbah biserrula, particularly when this plant makes up a high proportion of the pasture. Rotational grazing should reduce the risk of photosensitisation. In particular, lambs and bare shorn animals should not be grazed on biserrula for periods greater than two weeks. Provision of an alternative feed source such as hay may be beneficial.

Sheep should be observed regularly for the early signs of photosensitisation, which include swelling of the ears, eyelids and muzzle, and sheep seeking out shade. Suspect animals should be removed from the pasture as soon as any of these signs are seen. It is unclear whether the new biserrula cultivar, Maurox, predisposes sheep to photosensitivity.

AIMS

Recent work has shown differences in the relative palatability of Casbah biserrula pasture at various times of the growing season. This characteristic could be exploited in a pasture phase to directly increase the grazing pressure on weeds and reduce weed seed-set for the benefit of subsequent crops. The main aim of this research is to quantify the changes in composition of grazed biserrula pasture compared with other annual pasture legumes. In addition, research will investigate the possible link between Casbah biserrula and photosensitisation in grazing sheep.

METHOD

Grazing Experiment

A grazing experiment was established on a loamy sand soil (pH CaCl₂ 5.1 at the surface, P - 51 ppm, K - 63 ppm, organic carbon 1.36%) at the Great Southern Agricultural Research Institute, Katanning in 2003. Pasture treatments included 20 kg/ha each of Casbah biserrula, Erica French serradella, Dalkeith subterranean clover and an equal mixture of these three cultivars. Pastures were sown on 22 May 2003 into a background population of annual ryegrass that was supplemented with a further 4 kg/ha of Missile annual ryegrass. Plot size was 0.5 ha and there were three replications. Adult merino wethers (average 71
kg/hd) were grazed from 2 September to 2 November 2003 at 10 DSE/ha (5 sheep/plot). Sheep were allocated to the plots to achieve a consistency of liveweight, and liveweight and condition score were assessed monthly. Blood samples were taken at the commencement and completion of grazing to assess changes in liver function. Pasture production, growth rates and composition was measured at monthly intervals by direct cuts taken from exclusion cages. Plant material was collected regularly for analysis of nutritive value and anti-nutritional factors.

**On-farm investigation of photosensitivity**

Three farmer reports of photosensitivity in sheep grazing Casbah pastures in 2003 were investigated. This involved a combination of veterinary inspection, information on grazing history, collection of blood samples for analysis of selected liver enzymes (GLDH and GGT) and bilirubin (total and direct), assessment of liveweight change and pasture analysis.

**RESULTS**

There were substantial shifts in pasture composition between treatments established in the grazing trial. The proportion of weeds (predominantly grass) declined dramatically in biserrula plots after 4-5 weeks grazing and was maintained at a very low level (46% down to 23%). This is consistent with some previous observations where sheep appeared to develop some aversion to biserrula after extended periods of grazing (Dean Thomas pers. comm.). No decline in the proportion of weeds was evident when biserrula was sown in a mixture with other legumes (54% up to 61%). The proportion of weeds declined initially in French serradella plots but then increased later in the season (63% down to 36% then up to 50%). Initial feed on offer ranged from 1.6 t/ha (Casbah) to 2.1 t/ha (Dalkeith) at the commencement of grazing and slowly increased over the period of grazing, with feed on offer at the end of grazing ranging from 2.3 t/ha (Dalkeith) to 3.4 t/ha (Casbah).

Animal performance over the 8 week grazing period (as assessed by liveweight change and condition score) was similar for all pasture treatments. There was no evidence of photosensitisation in the sheep grazing biserrula in this experiment and blood tests for liver function showed no change over time and no significant differences between pasture treatments.

In the on-farm investigations the incidents of photosensitisation tended to occur in late winter when the pasture was growing rapidly and biserrula had become the dominant feed available. Signs of photosensitisation on the face and upper tail were apparent in young animals as early as ten days after beginning to graze, but recovery was normally rapid once animals were removed from the pasture. Animals invariably continued to gain weight but sometimes at rates less than expected, based on the nutritional value of the pasture. Blood tests performed before and after grazing indicated that liver damage was unlikely to be the cause of photosensitisation. Research is now investigating whether there are primary photosensitising compounds in biserrula which directly sensitise the skin to sunlight. Analysis has recently commenced using GC-MS (gas chromatography-mass spectrometry). There is no indication of the involvement of hypericin or hypericin-like compounds.

**CONCLUSION**

The information to date suggests that the combination of Casbah biserrula pasture with grazing will be a useful tool for the management of herbicide resistant ryegrass and reduce the use of herbicides in cropping systems. The greatest changes in composition are likely when Casbah is the dominant component of the pasture. To date, the incidents of photosensitivity in sheep grazing biserrula appear isolated and unpredictable, but until more is known, farmers are urged to adopt a cautious approach to grazing where young or high value animals are concerned (as described in the Abstract).

**KEY WORDS**

pasture legume, biserrula, ryegrass, grazing, photosensitivity, photosensitisation

**ACKNOWLEDGMENTS**

We acknowledge the technical support of Deon Pickett in the conduct of the grazing trial and the support of Brad Nutt and Dr Angelo Loi for the on-farm investigations.

**Paper reviewed by:** Dr Jeremy Allen
ABSTRACT

Weaner and hogget wethers were grazed on either a saltbush-based pasture or in a stubble/dry pasture paddock for 14 weeks on one of two farms. The sheep were also supplemented with up to 200 g/d of barley grain. At the end of the experiment all sheep were slaughtered and both carcass characteristics and eating quality of the meat assessed. There were no differences in eating quality associated with consumption of saltbush but the carcasses from saltbush fed sheep were leaner at the same carcass weight.

AIMS

Forage halophytes such as saltbush (Atriplex spp.) are being widely used to revegetate saline land and provide a medium quality fodder source for sheep. However, little research has been done to determine the effects of grazing saline pastures on the carcass and eating quality of sheep meat. There is widespread anecdotal evidence to suggest that saltbush improves eating quality, furthermore previous work by Hopkins et al. 1999 has shown increased aroma strength of meat from animals fed a saltbush-lucerne (Medicago sativa) or saltbush-grain diet versus lucerne alone. In addition, saltbush contains high concentrations of sodium chloride and high salt diets have been shown to reduce the overall fat content of the carcass. The aim of this study is to determine if grazing saltbush-based pastures would influence meat eating quality and carcass characteristics.

METHODS

Two studies were conducted, one on a property 20km from Goomalling and the second 25km from Wickepin in Western Australia. On the Goomalling property fifty (2 x 25) 6 month old Merino lambs (average starting liveweight 38kg) were used while fifty (2 x 25) 18 month old Merino hoggets (average starting liveweight 45kg) were used at Wickepin. On both properties the sheep were grazed on either a saltbush-based saline pasture or a barley stubble/pasture plot. Both groups were supplemented with approximately 200g/d.hd of barley grain adjusted weekly depending on the liveweight gain of the animals. Following 14 weeks grazing, the sheep were commercially slaughtered.

Carcass quality

Immediately following slaughter all carcasses were weighed and GR depth determined. Ultimate pH and colour of the Longissimus dorsi (LD) were measured 24 hours post slaughter. To determine the carcass composition, half of each carcass was scanned by an X-Ray Bone Densitometer to yield estimates of the relative fat, lean and bone content of the animal.

Eating quality

A single loin (from 12th rib to chump) was collected from each animal and cut into six (6 cm x 2.5 cm) samples from the 12th rib end with muscle fibres running longitudinally. Each sample was cooked on a silex flat top grill set at 200°C for 2 minutes and 15 seconds and served within 2 minutes to individual taste panellists. Samples were allocated to panellists and runs in a latin square design. The panellists were randomly allocated one meat sample per run, completed 6 runs per session and were not informed of the origin of the specific sample evaluated. The panellist's assessed odour, flavour, tenderness, juiciness, residual fat and overall acceptance on a continuous 10 cm scale. Separate panels were run for both properties.
RESULTS

Comparisons were made between treatments within farm only for both carcass and eating quality. Saltbush grazed animals from Goomalling had a significantly lower fat content and sheep from both properties displayed a lower GR depth compared to the stubble grazed animals (Table 1). Grazing saltbush had no significant effect on any of the eating quality attributes (Table 2), carcass weight, colour or ultimate pH for either property.

Table 1. Carcass quality attributes (mean ± standard error of the mean).

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Goomalling</th>
<th>Wickepin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Saltbush</td>
<td>Stubble</td>
</tr>
<tr>
<td>PRESLAUGHTER LIVEWEIGHT (KG)</td>
<td>34.6 ± 0.8</td>
<td>35.7 ± 0.7</td>
</tr>
<tr>
<td>Hot carcass weight (kg)</td>
<td>14.5 ± 0.3</td>
<td>14.8 ± 0.4</td>
</tr>
<tr>
<td>Fat content (% fat on carcass)</td>
<td>12.4 ± 0.4a</td>
<td>14.3 ± 0.3b</td>
</tr>
<tr>
<td>Lean content (% lean on carcass)</td>
<td>84.4 ± 0.4a</td>
<td>82.3 ± 0.3b</td>
</tr>
<tr>
<td>GR fat depth (mm)</td>
<td>1.4 ± 0.2a</td>
<td>2.1 ± 0.1b</td>
</tr>
<tr>
<td>Colour L</td>
<td>34.3 ± 0.4</td>
<td>34.9 ± 0.4</td>
</tr>
<tr>
<td>Ultimate pH</td>
<td>5.6 ± 0.02</td>
<td>5.6 ± 0.04</td>
</tr>
</tbody>
</table>

na- Not available at time of printing
* Within rows and farms- numbers with a different superscript are significantly different (P < 0.05)

Table 2. Eating quality attributes on a score out of ten (mean ± standard error of the mean).

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Goonamlling</th>
<th>Wickepin</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Saltbush</td>
<td>Stubble</td>
<td>Saltbush</td>
</tr>
<tr>
<td>ODOUR STRENGTH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liking of odour</td>
<td>5.4 ± 0.6</td>
<td>6.1 ± 0.6</td>
<td>6.0 ± 0.9</td>
</tr>
<tr>
<td>Flavour strength</td>
<td>4.2 ± 0.7</td>
<td>5.6 ± 0.7</td>
<td>5.6 ± 0.9</td>
</tr>
<tr>
<td>Liking of flavour</td>
<td>5.9 ± 0.6</td>
<td>5.7 ± 0.6</td>
<td>6.7 ± 0.9</td>
</tr>
<tr>
<td>Tenderness</td>
<td>5.4 ± 0.8</td>
<td>5.4 ± 0.8</td>
<td>6.7 ± 0.9</td>
</tr>
<tr>
<td>Juiciness</td>
<td>5.8 ± 0.8</td>
<td>5.4 ± 0.8</td>
<td>6.5 ± 0.9</td>
</tr>
<tr>
<td>Overall acceptance</td>
<td>4.0 ± 0.7</td>
<td>3.9 ± 0.7</td>
<td>2.8 ± 0.9</td>
</tr>
<tr>
<td>RESIDUAL MOUTH FEEL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall acceptance</td>
<td>5.5 ± 0.7</td>
<td>5.9 ± 0.7</td>
<td>6.5 ± 0.8</td>
</tr>
</tbody>
</table>

* Within rows and farms- numbers with a different superscript are significantly different (P < 0.05)

CONCLUSION

There was no detectable improvement or decline in eating quality resulting from feeding saltbush. Sheep that had grazed saltbush for 14 weeks had significantly less fat in the carcass.

KEYWORDS

Saltbush, carcass quality, eating quality, sheepmeat, fatness

ACKNOWLEDGEMENTS

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PAPER REVIEWED BY- NORM ADAMS AND EMMA BERMINGHAM FROM CSIRO LIVESTOCK INDUSTRIES

REFERENCES

Lifetime Wool – Carryover Effects on Subsequent Reproduction of the Ewe Flock
Chris Oldham A Andrew Thompson B
A Department of Agriculture Western Australia, South Perth WA 6151, B Primary Industries Research Victoria (PIRVic), Dept of Primary Industries, Hamilton, Vic 3300

ABSTRACT

The ‘Lifetime Wool’ project imposed a range of nutritional treatments on ewes during pregnancy and lactation that resulted in ‘carryover’ effects on their liveweight and condition score at their next joining. The liveweight at artificial insemination in February/March 2001 of groups of single bearing ewes at sites in WA and VIC was 46 kg. After weaning in November at both sites, all ewes were grazed together at the standard commercial stocking rate, on pasture or a combination of stubble and pasture, until joining the following February/March 2002. Initially, the pattern was for the heavier flocks to lose liveweight/condition score while the lighter flocks gained liveweight/condition score until mid January. Thereafter, all flocks tended to lose liveweight/condition score at a similar rate resulting in a range of mean liveweight for treatment groups at their next joining (41 to 51 kg in WA and 44 to 48 kg in VIC). Overall, the mean liveweight was similar 46.3 v 46.7 kg, as was the fertility 86% v 89% and prolificacy 111% v 112% in WA and VIC respectively. However, the fecundity of the single bearing ewes decreased at about 3 fetuses/100 ewes joined in WA and 5 fetuses/100 ewes joined in VIC for each kg decrease in fleece free liveweight at joining in 2002. The relationship at both sites was higher than previous published estimates of around 2 lambs born/100 ewes joined. More of the variance in fecundity was explained by the mean condition score than by fleece free liveweight. The reduction in fecundity had a large effect on the outcome from whole-farm modeling of the economic consequences of the various feeding systems.

AIMS

The importance of the liveweight (LW) at joining to the reproductive performance of flocks of adult Merino ewes is well recognised; fecundity (lambs scanned in utero per ewe joined) is the combination of fertility (ewes pregnant/ewe joined) and the prolificacy or twinning rate of ewes pregnant. Fecundity has been shown to increase by at least 2 lambs per kg increase in the average liveweight of the flock at joining (Kelly and Croker 1990). The ‘Lifetime Wool’ project (Thompson and Oldham 2004) imposed a range of nutritional treatments on ewes during pregnancy and lactation that resulted in carryover effects (Ferguson et al. 2004) on their LW and condition score (CS; Russel et al. 1969) at their next joining. At day 90, following the introduction of rams in 2002, the ewes were scanned for litter size using real-time ultrasound to test the hypothesis that lower LW/CS at their next joining due to the ‘Lifetime Wool’ treatment group would reduce their fecundity.

METHOD

At two sites (VIC and WA) ewes with a mean LW of 46 kg and mean CS of 2.5 at artificial insemination were differentially fed to achieve a CS of either 2.0 or 3.0 by Day 90 of pregnancy. At Day 90, sheep within each CS flock were allocated to plots maintained at five different levels of feed on offer (FOO; Hyder et al. 2004) until lambs were weaned (design = 2 CS x 5 FOO = 10 plots). There were 2 or 3 replicates of 20 or 30 pregnant ewes in WA and VIC respectively. After weaning at both sites, all ewes were grazed together, on pasture or a combination of stubble and pasture, until joining the following February/March 2002. At day 90, following the introduction of rams in 2002, the ewes were scanned for litter size using real-time ultrasound.

RESULTS

The experiments were successful in generating a large range of LW/CS profiles for the ewes during pregnancy and lactation at both sites (Ferguson et al. 2004). However, common grazing after weaning resulted in the mean liveweight of treatment groups ranging from 41 to 51 kg in WA and 44 to 48 kg in VIC at their next joining in 2002. Overall, the liveweight was similar (46.3 v 46.7 kg), as was the fertility (86% v 89%) and prolificacy (111% v 112%) in WA and VIC respectively. However, the fecundity the single bearing ewes at each site varied with their LW/CS at joining in 2002. The decrease in fecundity, for each kg decrease in fleece free liveweight at joining in 2002, was greater in VIC than WA (2.6 v 4.6; P < .001) and higher than Kelly and Croker 1990 reported in their extensive review (2 lambs/100 ewes joined).
More of the variance in fecundity was explained by the mean condition score of the flocks than by their fleece free liveweight (figure 1b).

**Figure 1.** The influence of a) mean fleece free liveweight and b) condition score, on the fecundity (fetuses scanned at day 90 of pregnancy) of the ewes in the plot scale experiments conducted by Lifetime Wool in 2001 (WA ◆ & VIC □) at their next joining in 2002.

**CONCLUSION**

The relationship between the mean LW/CS of flocks of Merino ewes at joining and their fecundity may be greater than was previously thought. In the plot scale experiments conducted by Lifetime Wool during 2001, effects on the LW/CS of different grazing pressures, while reduced by common grazing over summer were still significant at their next joining. The resulting reduction in fecundity had a large effect on the outcome from whole-farm modeling of the economic consequences of the various feeding systems (Young et al. 2004).

**KEY WORDS**

Ewes, Fecundity, Liveweight, Condition score and Carryover effects

**ACKNOWLEDGMENTS**

The Lifetime Wool project was initiated as a cooperative project between the Department of Primary Industries, Victoria and the Department of Agriculture of Western Australia. Since, 2001 it has become a National project funded by Australian Wool Innovation Limited with on-farm experimental sites in all the main wool producing states.

**Paper reviewed by:** Andrew Peterson and Mike Hyder

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Ewe Productivity Trials - a Linked Analysis

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^ Department of Agriculture Western Australia, Narrogin District Office
b Department of Agriculture Western Australia, Katanning District Office
c School of Animal Biology, Faculty of Natural and Agricultural Sciences, University of Western Australia.

ABSTRACT

Wether trials have enabled producers to benchmark the genetic merit of their flock for wool traits. They have provided valuable information to producers, enabling them to make informed decisions and hence obtain greater genetic improvement and greater profitability. Ewe productivity trials measure the genetic merit of reproductive performance as well as wool traits. They provide additional information about ewe fecundity and lamb performance. These trials can be linked through common link teams. By using a link team it is possible to calculate the environmental variation between trials and hence compare flocks across the state. Early results have revealed significant genetic variation for both reproductive performance and wool traits. Models using these results suggest that reproductive performance has a greater influence on total income than wool. Reproductive performance will become increasingly important to the profitability of a sheep enterprise as sheep prices improve.

AIMS

Wether trials have demonstrated a huge variation in productivity related to wool traits (1). However the production of surplus lambs is evolving as a key profit driver for traditional wool producers (2). Despite this, little is known about the genetic merit of reproductive traits in these flocks (2). The Western Australian Department of Agriculture has set out to resolve this situation by establishing an ongoing program to benchmark the genetic merit for both wool and lamb production through a series of linked ewe productivity trials. Linkage between trials is enabled by each trial including one or more teams that participated in another trial (3).

METHOD

Teams of 25 –50 ewes are entered in each trial. These are delivered to a host farm as soon as possible after weaning to minimise pre-trial environmental effects. They have an even up shearing soon after arrival. The ewes in the trial have three more shearings and two lambing opportunities. Teams are benchmarked for their wool traits using Wether Trial software. In this regard there is little difference to wether trials other than the length of the trial. Ewe trials also collect data on the number of lambs weaned by ewes in each team, the weight of lambs weaned from each team and the value of wool produced by the lambs from each team. All results are reported as value in dollars so that different aspects of production can be readily compared.

Linked analysis

To make valid comparisons between different trials environmental variation between trials needs to be estimated. Having a team that is common to each trial enables this to occur. The results for different trials are adjusted mathematically so that each trial site is considered on an equal environmental basis. This allows for direct comparison of all teams in each trial.

RESULTS

Different teams have significant genetic variation for all aspects of production. The variation for wool traits has previously been demonstrated in wether trials and is confirmed by these results (Figure 1). The variation in income derived from lamb production for each team is even greater than the variation for income from wool. (Figure 1). The variation between wool production and lamb production is demonstrated when the income from the wool produced by the ewe is plotted against the income produced by the lambs (Figure 2). The teams that produce the greatest income, teams 8 and 6, show a great deal of variance for these two traits (Figure 2). The variance between these two points represents potential genetic gain.
CONCLUSION

The trial results demonstrate that a flock does not have to perform well in both wool and lamb production to do relatively well in total production. The results show that team 8 that had the lowest income from wool production yet performed best in lamb production and in total production (Figure 1). In contrast, the second best team (team 6) performed best for wool production and second best in lamb production (Figure 1). This tends to suggest that in the model used lamb production has a greater influence on total production than wool production. Figure 2 emphasises the variation in genetic merit between these two teams for the two traits. These trials have shown that the genetic merit for wool or lamb production has demonstrated that there is potential for significant gains in genetic merit and thus productivity. The exciting challenge for the sheep industries is to exploit the variance in order to realise that potential.

Future Trials

The recent Ovine Johnes Disease (OJD) incident has highlighted the importance of farm biosecurity. Sheep productivity trials have an important role if the sheep industry is to continue to make genetic progress. If the industry chooses to live with OJD then that is what it must do. That may mean an increased level of biosecurity for host farms or utilising reproductive technologies to work around the problem of biosecurity. Industry must not use biosecurity as an excuse to retract from development.

KEY WORDS

Genetic merit, Reproductive traits, Wool, Lambs.

ACKNOWLEDGMENTS

Ben Hewson from Broomehill and Bruce Taylor from Darkan for hosting the two trial conducted. Ian Robertson from Kojonup for providing the link teams.

Paper reviewed by: Dr James Skerritt.

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Grain Finishing Systems For Prime Lambs
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Department of Agriculture, Merredin, Department of Agriculture, Esperance

ABSTRACT
When determining the most cost effective feeding system for finishing prime lambs it is important to consider lamb growth rate, feed conversion ratio, feed cost, feeds offered, target market specifications and time taken to finish lambs. This experiment considers the growth rate and feed use of Merino and crossbred lambs in three commonly used grain finishing systems.

AIMS
To compare the growth rate, feed conversion ratio and carcase characteristics of Merino and first-cross lambs from three different feeding systems.
To undertake economic analysis of the three feeding systems to determine their profitability.

METHOD
195 Merino and 195 Poll Dorset x Merino first-cross wether lambs were held in a small scale feedlot at Esperance Downs Research Station from February to May 2004. The experiment involved 2 lamb genotypes x 3 feeding systems with 3 replicates of each treatment, resulting in a total of 18 group pens containing 20 lambs per pen. An additional 30 lambs were included during the introductory feeding period.

The lambs were sourced for feedlot entry at 40.5 kg liveweight and condition score 1.2 (Merino) or 40.3 kg liveweight and condition score 1.7 (crossbred). Lambs were initially split into three feeding groups (n=65) within each genotype:
- Pelleted finishing diet;
- Loose mixed ration containing milled hay;
- Ad libitum access to grain mix and baled hay

The diets consisted of oat hay, lupins, barley, oats, salt, lime sand and minerals designed to provide 11 MJ ME/kg DM and 15% crude protein. The pelleted diet and loose mixed ration were identical in composition. The grain/hay diet was designed to provide the same level of nutrients when consumed in the ration of 70% grain and 30% hay. All ingredients were sourced from the Esperance region. The loose diets were prepared on site and the pelleted diet was manufactured at Glen Forrest Stockfeeds.

The lambs were slowly introduced to one of three feeding systems over 2 weeks. At the conclusion of the introductory period, five lambs identified as shy feeders were excluded from each group. Shy feeders were identified using a combination of liveweight change and paint marker bars to identify individuals that did not approach the feeders. The remaining lambs in each group were further divided into three replicates (n=20) and confined in group pens 10 m x 20 m for the main feedlot period.

Liveweight and condition score were assessed weekly. After 10 weeks, lambs predicted to fall within the target specifications of 22+ kg carcase and fat score 2-3 were slaughtered at Shark Lake Meatworks, Esperance.

RESULTS
Merino lambs offered the pelleted diet were heavier than those on the other two feeding systems from week 5 to the final weighing (Figure 1a). The crossbred lambs fed the pelleted diet also had a higher liveweight than those receiving the other two diets from week 5 but this difference disappeared by week 7 (Figure 1b). The pelleted diet resulted in a faster growth rate than the loose mixed ration for both genotypes for the duration of the feeding period (Table 1). The grain/hay feeding system resulted in a growth rate intermediate between the pelleted diet and the loose mixed ration.
Figure 1. Liveweight of a) Merino and b) crossbred lambs fed grain based diets either ▲ pelleted, ♦ loose mixed ration or □ ad libitum grain/hay (values are means ± sem).

Table 1. Linear growth rate of all lambs from week 0 to initial slaughter (week 10) and carcase characteristics of lambs slaughtered in initial kill.

<table>
<thead>
<tr>
<th></th>
<th>Pelleted diet</th>
<th>Merino Loose mixed ration</th>
<th>Ad lib grain/hay</th>
<th>Pelleted diet</th>
<th>Crossbred Loose mixed ration</th>
<th>Ad lib grain/hay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth rate (g/day)</td>
<td>136 ± 5.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>112 ± 4.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>121 ± 5.1&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>180 ± 6.1&lt;sup&gt;c&lt;/sup&gt;</td>
<td>164 ± 6.0&lt;sup&gt;d&lt;/sup&gt;</td>
<td>169 ± 6.9&lt;sup&gt;cd&lt;/sup&gt;</td>
</tr>
<tr>
<td>Number slaughtered</td>
<td>11</td>
<td>4</td>
<td>4</td>
<td>37</td>
<td>28</td>
<td>34</td>
</tr>
<tr>
<td>Carcase Wt (kg)</td>
<td>24.7</td>
<td>24.7</td>
<td>25.2</td>
<td>24.9</td>
<td>24.8</td>
<td>26.4</td>
</tr>
<tr>
<td>Dressing %</td>
<td>43.0</td>
<td>42.8</td>
<td>45.0</td>
<td>45.0</td>
<td>44.5</td>
<td>46.6</td>
</tr>
<tr>
<td>GR depth (mm)</td>
<td>13.2</td>
<td>11.5</td>
<td>16.2</td>
<td>14.9</td>
<td>13.3</td>
<td>15.9</td>
</tr>
</tbody>
</table>

Within a row, values with different superscripts are significantly different (p<0.05). Growth rate values are means ±sem.

The feeds offered, cost of each diet and number of lambs finished must also be considered when determining the most appropriate feeding system. Preliminary estimates indicate that lambs on the pelleted diets were offered around 50% more feed than those on the loose mixed ration and 25% more than those offered the grain/hay diet. The lambs offered the grain/hay diet were fed around 20% more feed than those on the loose mixed ration. Lamb behaviour and feeder design contributed to the high level of wastage observed.

The data from the initial kill indicates that lambs fed the pelleted and loose mixed diets had similar carcase characteristics, but there may be some differences in carcases produced from the ad libitum grain/hay diet (Table 1). More crossbred lambs than Merino lambs had reached the target slaughter weight by the date of the first kill. All data will be statistically analysed following the slaughter of the remaining lambs and complete results will be presented at the Agribusiness Sheep Updates.

CONCLUSION

The preliminary results indicate that the pelleted diet promoted the highest growth rate resulting in 20% more lambs reaching target weight by the first slaughter date, however, more feed was used to achieve this outcome.

KEY WORDS

Grain, lamb, meat, confined feeding

ACKNOWLEDGEMENTS

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Paper Reviewed by: Rob Davidson, Faculty of Natural and Agricultural Science, UWA.
The Effects of Nutrition and Genotype on the Growth and Development, Muscle Biochemistry and Consumer Response to Lamb Meat

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ABSTRACT

A lamb growth experiment was conducted with the objective of understanding the genetic and nutritional influences on growth and development, and on the biochemical and sensory attributes of muscle and meat. Growth and carcass traits showed significant positive effects when lambs were raised on a high plane of nutrition. The expression of greater genetic potential for growth was facilitated by nutrition with the genetic effect being reduced by 60% in the low nutrition group. By contrast, the expression of genetic potential for eye muscle development was not reduced by nutrition. Slower rates of growth as a result of low nutrition reduced fat deposition beyond that attributable to weight indicating slow growth per se will reduce carcass fatness. The amount of fat in the carcass of the lambs in the high nutrition treatment was reduced in the lambs from highly muscled sires strongly indicating that selection for eye muscle depth biologically programs the partition of nutrients toward muscle. Muscle biochemistry was strongly influenced to become more anaerobic and less aerobic in the animals sired by the muscle selected lines suggesting that selection at this axis strongly impacts on the biological makeup of muscle. There is a suggestion that selection for muscling reduces the consumer appreciation of grilled lambs steaks but this needs further analysis and testing especially given the very large financial incentives to both producers, processors and retailers of highly muscled prime lambs.

AIMS

A lamb growth experiment was conducted with the objective of establishing the effect of plane of nutrition on the expression of genetic potential for growth and muscling in second cross prime lambs. In addition the study was used to understand both genetic and nutritional influences on biochemical and sensory attributes of muscle and meat.

METHODS

This study, run in Armidale NSW, provided growth and development data for 387 lambs generated by sires with genetic capacity for high muscling (M), high growth (G) or industry standard performance (C) based on the Lambplan system of estimated breeding values (EBV) for post weaning weight (PWWT) and post weaning eye muscle depth (PEMD). The sires were chosen to minimise differences in the estimated breeding value for fat depth. The range of EBV's for PWWT and PEMD was 1.4-13.8 kg and –1.8-3.4 mm respectively. Lambs were reared on either ‘low’ or ‘high’ all of life nutrient availability, with nutrition being regulated from 10 d of age by pasture availability and supplementation. The resulting average growth rate to slaughter was approximately 130 and 190g/d for the low and high nutrition groups respectively. At 8 months of age the lambs were slaughtered with a resulting hot carcass weight of 16.3 and 26.6kg (sem=0.81) and GR tissue depth of 6.6 and 21.3 mm (sem=0.70) for the low and high nutrition groups respectively. At slaughter 140 female lamb carcasses from across all treatment groups received electrical stimulation after which the loins were collected for consumer evaluation at 5 days of aging as part of Meat and Livestock Australia’s sheepmeat eating quality program. An additional 56 lambs collected across all treatment groups were used for generation of carcass bone out data and also for the collection of samples to evaluate muscle biochemistry.

RESULTS

Growth: All measured growth and carcass traits showed significant positive effects of high nutrition. Siretype affected pre- and post-weaning liveweight gain and preslaughter live weight (LW) of lambs such that the LW and live weight gain of G lambs was greater than that of C or M lambs. However expression of greater genetic potential for growth was strongly facilitated by nutrition, with 1 unit of PWWT EBV delivering 275 g and 683 g of extra final weight under low and high nutrition respectively.
Fat Development and Distribution: The results for fat development were influenced by the method of fat determination. Based on ‘GR’ tissue depth, the G lambs had a reduced fat depth than for C or M lambs when adjusted for differences in liveweight. Under low nutrition, the GR tissue depth of the low nutrition lambs was less both as measured (by 9.4 mm) and when expressed at the same carcass weight, indicating nutrition had modified fat deposition beyond that attributable to weight. Carcass fat, determined via commercial bone out, when considered at a constant carcass weight, was similar in lambs from all siretypes under low nutrition. However under a high nutrition the G and C lambs had more dissectable fat than M lambs. The reduced propensity for M lambs to deposit carcass fat on a high plane of nutrition had not been anticipated and was not indicated by the carcass GR of these lambs, suggesting regional distribution of fat within the carcass differs between genotypes. The effect for reduced fatness on the higher plane of nutrition in the M lambs was evident in the saddle and loin area, and also tended to occur in the forequarter.

Loin Muscle Development: The expression of the PEMD EBV was consistent across nutrition levels, with 1 mm of PEMD EBV delivering 0.61 mm of extra eye muscle across both nutrition levels. The effect of the EBV for PEMD on eye muscle depth was much stronger than on carcass protein, indicating that selection for PEMD is not selecting on total protein mass.

Eating Quality: Nutritional treatment had no impact on the eating quality score of the grilled lamb loins. However there was a significant effect for the EBV for PEMD to decrease the consumer score. For each mm of PEMD EBV the consumer score was significantly decreased by 1.8 and 1.3 (sem = 0.6) points for tenderness and overall liking respectively. This equates to a decline of 6-7 overall liking points for grilled lamb steaks over the range of PEMD EBV’s studied (lowest to highest PEMD). The true significance of this result is still uncertain given that there was a high standard error and that one of the M sires was homozygous for the Carwell gene which has been previously been shown to produce tough loin meat.

Muscle biochemistry: As the EVB for PEMD increased the muscle biochemistry of the progeny became less aerobic and more anaerobic. Similarly to eye muscle depth the increased expression of anaerobic activity in response to the EBV for PEMD was not influenced by nutrition. There was a strong correlation between anaerobic enzyme expression and muscle yield.

CONCLUSION

This work has highlighted the importance of adequate nutrition especially to fully capture the genetic benefits of selection for growth. Moreover the work suggests that selection for growth has little impact on muscle structure, biochemistry or eating quality and that this selection index results in animals with an increased body size. By contrast, selection for muscling has powerful metabolic effects on the muscle and fat metabolism within the prime lamb progeny. Animals selected for muscle development partition energy toward muscle regardless of nutritional regime. The resultant reduced fatness in prime lambs is of great importance to the prime lamb industry since this results in economic advantages to producers (better feed conversion), processors (better lean meat yield), retailers (better lean meat yield and product presentation). However newer technologies of carcass assessment, such as Viascan, will be necessary to segregate the highly muscled animals as current Industry measures could not differentiate the carcasses. The powerful effects of selection for muscling on muscle biochemistry are also likely to translate into positive Industry outcomes such as better meat colour, improved colour shelf life, better response to electrical stimulation. The tentative outcome that selection for muscling reducing the eating quality of lamb meat warrants further investigation.

KEY WORDS

Estimate breeding value, muscling, growth, nutrition, biochemistry, eating quality

ACKNOWLEDGMENTS

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‘Lifetime Wool’ - Effects of Nutrition During Pregnancy and Lactation on Mortality of Progeny to Hogget Shearing
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Mark Ferguson and Darren Gordon, Primary Industries Research Victoria (PIRVic), Dept of Primary Industries, Hamilton, Vic 3300

ABSTRACT

The ‘Lifetime Wool’ project imposed a range of nutritional treatments on single-bearing ewes during pregnancy and lactation that were successful in generating a range of liveweights/condition scores at lambing and during lactation at experimental sites in VIC and WA in 2001 and 2002. The birth weight was not influenced by maternal nutrition to day 90 of pregnancy. Average feed-on-offer (FOO) between day 90 of pregnancy and lambing explained 40% (P < 0.001) of the variation in birth weight in both years at the VIC site, and 57% of the variation at the WA site in 2001. However, there were no consistent effects of either condition score at day 90 or FOO during late pregnancy and lactation on the mortality of single lambs to 48 hr after birth, with the exception of the 800 kg DM/ha FOO treatment at the VIC site (31 v 14%; P < 0.002). High mortality from weaning to hogget shearing was associated with 100 mm of rainfall over 3 days within one month of weaning (WA 2001) and a summer water problem (VIC 2002) but in neither case was it related to the nutritional treatments. At these same sites and years there was a significant effect of the lowest FOO treatment on the mortality between marking and weaning in WA (25% ± 5 v 5% ± 3 for the other treatments; P < 0.002) and between 48 hr after birth and marking in VIC (10% ± 3 v 2% ± 3 for the other treatments; P < 0.001). The progeny deaths relating to FOO treatment after weaning had a major impact on the profitability of the different ewe feeding strategies.

AIMS

Lamb mortality is largely a function of birth weight and cold stress around the day of birth (Holst et al. 1986; Obst and Day 1968). Restricting the level of nutrition to the pregnant ewe can reduce lamb birth weight and increase mortality of newly born lambs depending on the timing and severity of the restriction and subsequent nutrition (Holst et al. 1986). However, most of the literature on lamb mortality only follows survival to marking. The full impact of lamb mortality is not realised in whole-farm profit until the progeny are either sold or shorn for the first time (Young et al. 2004). The ‘Lifetime Wool’ project (Thompson and Oldham 2004) imposed a range of nutritional treatments on ewes during pregnancy and lactation. These treatments were successful in generating a large range of liveweight (LW)/condition score (CS; Russel et al. 1969) profiles at experimental sites at Coleraine in Victoria (VIC) and Kendenup in Western Australia (WA) (Ferguson et al. 2004). This paper reports on the influence of the nutrition treatments on winter/spring lambing ewes on the mortality of single born progeny from birth to their first adult shearing at around 18 months of age.

METHOD

At two sites (VIC and WA) ewes with a mean LW of 46 kg and mean CS of 2.5 at artificial insemination in February/March of 2001 and 2002 were differentially fed to achieve a CS of either 2.0 or 3.0 by Day 90 of pregnancy. At Day 90, sheep within each CS flock were allocated to plots maintained at five different levels of feed-on-offer (FOO; Hyder et al. 2004) until lambs were weaned in November each year (design = 2 CS x 5 FOO levels = 10 plots). There were 2 or 3 replicates of 20 or 30 pregnant ewes in WA and VIC respectively. Lambs were born in late July (WA) and late August (VIC) and were weighed and tagged at birth. After weaning at both sites, all progeny were grazed together.

RESULTS

The average birth weight of single born lambs at both sites and both years were between 4.5 and 5.5 kg, and mortality in the first 48 hr varied from < 5 to 30%. The birth weight was not influenced by maternal nutrition to day 90 of pregnancy in VIC in either year and in WA in 2002. FOO between day 90 of pregnancy and lambing explained 40% (P < 0.001) of the variation in birth weight in both years at the VIC site, and 57% of the variation at the WA site in 2001. However, There were no consistent effects of either CS at day 90 or FOO on the mortality of single lambs to 48 hr, with the exception of the 800 FOO treatment at the VIC site (31 v 14%; P < 0.002). High mortality from weaning to hogget shearing was
associated with 100 mm of rainfall over 3 days within one month of weaning (WA 2001) and a summer water problem (VIC 2002) but in neither case was it related to the nutritional treatments (figure 1). In these same sites and years there was a significant effect of the lowest FOO treatment on the mortality between marking and weaning in WA in 2001 (25% ± 5 v 5% ± 5 for the other treatments; P < 0.002) and between 48 hr and marking in VIC in 2002 (10% ± 3 v 2% ± 3 for the other treatments; P < 0.001).

CONCLUSION

It is clear that with a winter/spring lambing when ewes had > 800 kg DM/ha of FOO in front of them from day 90 of pregnancy that birth weight and survival of single born lambs was remarkably resilient. However, changes in other important progeny traits such as wool production and quality (Paganoni et al. These proceedings) may be induced at levels of maternal nutrition that do not necessarily influence birth weight and survival. The progeny deaths relating to FOO after weaning had a major impact on the profitability of the different ewe feeding strategies reported by Young et al. (2004).

KEY WORDS

Lifetime Wool, Ewe nutrition, birth weight and lamb mortality.

ACKNOWLEDGMENTS

The Lifetime Wool project was initiated as a cooperative project between the Department of Primary Industries, Victoria and the Department of Agriculture of Western Australia. Since, 2001 it has become a National project funded by Australian Wool Innovation Limited with on-farm experimental sites in all the main wool producing states.

Paper reviewed by: Keith Croker, Ian Watson

REFERENCES

ABSTRACT

Comparing the profitability of a range of farm management systems using computer modelling ensures that optimal systems are identified for implementation on farms. The Great Southern version of MIDAS was used to analyse the 2001 progeny results from ‘Lifetime Wool’, a project aimed at developing principles for managing ewes to optimise their productivity. The analysis showed differences in farm profit of up to $50 000 per year from varying nutritional treatments. Optimal target liveweights will be determined when further trial results are available.

AIMS

The ‘Lifetime Wool’ project aims to determine the optimal allocation of feed resources and then develop profitable ewe management guidelines for woolgrowers across Australia. A previous analysis based on the results of Kelly (1) showed the effect of varying ewe nutrition on progeny wool production could increase whole farm profit by as much as $5 per ewe per year (2). This paper demonstrates how data from ‘Lifetime Wool’ will be used to calculate the profitability of different target liveweight patterns for reproducing ewes on farms in Australia.

METHOD

The whole-farm computer model MIDAS represents a ‘typical’ farm in the Great Southern of WA (3). It comprises a mixed cropping and merino sheep farm. Mathematical equations are used to represent sheep live weight patterns, wool and meat production, pasture growth and other biological components of a farm. Farm costs and commodity prices are included in the model. The results presented are for a farm with 3000 ewes.

For this paper MIDAS was used to compare the profitability of 5 nutritional treatments during lactation imposed on 2 groups of ewes. One group of ewes lost condition and the other maintained condition during pregnancy (4). A feed budget for the whole flock was then calculated based on the liveweight patterns of the ewes in the trial. The feed budget calculated the optimum stocking rate and level of grain feeding that would maximise profit if ewes followed that liveweight pattern. The value of production from both the ewes and their progeny was calculated and compared to the costs associated with achieving the live weight responses. The results are presented as response curves of profit to nutrition.

RESULTS

For the 2001 experimental results farm profitability is very responsive to nutrition during lactation. Farm profit increased by between $40 000 and $50 000 per farm per year with increasing feed availability up to 1500 kg/ha DM in both treatment groups (figure 1).

![Figure 1: Difference in farm profit with varying nutrition of ewes during pregnancy and lactation](image-url)
The response curves are based directly on the experimental results and include some unexplained biological variation. The big difference between the 1500 and 2000 points is caused by this variation, but with only 1 year of data it is not possible to conclude which point is correct.

Changes in farm profitability are determined by differences in the value of production from the flock and differences in the costs of providing the required feed. The difference in the value of production is the sum of progeny fleece value, ewe fleece value, progeny survival and conception in the following year. The value of production increased with increasing nutrition up to 1500 kg/ha (figure 2a).

The difference in the cost of providing the required feed is determined by the stocking rate and the amount of supplement required to achieve the target liveweights. Higher stocking rate and lower supplementary feed contributed approximately $10 000 towards the profitability of the farms on which the ewes lost weight during pregnancy compared to maintaining weight during pregnancy (figure 2b).

CONCLUSION

This analysis demonstrates the importance of quantifying target liveweights for ewes. Results from the first year of the trial had a range in profit of $50 000 per farm per year for different nutritional treatments for the ewes. This is a large difference in profit and indicates the magnitude of difference that farmers may be able to achieve if optimum liveweight targets can be calculated.

To identify optimum targets will require analysis of more of the experimental results from subsequent years of the trial. This will occur as the data becomes available. To date only 1 year of data has been analysed, however, by the completion of the trial there will be 3 years of small plot trial results.

KEY WORDS

MIDAS, economics, profitability, liveweight, ewe nutrition

ACKNOWLEDGMENTS

The Lifetime Wool project was initiated as a cooperative project between the Department of Primary Industries, Victoria and the Department of Agriculture of Western Australia. Since, 2001 it has become a National project funded by Australian Wool Innovation Limited with on-farm experimental sites in all the main wool producing states.

Paper reviewed by:  Lucy Anderton (WA Dept of Agriculture)

REFERENCES

Lifetime Wool - Effects of Nutrition During Pregnancy and Lactation on the Growth and Wool Production of their Progeny at Hogget Shearing

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ABSTRACT

The 'Lifetime Wool' project imposed a range of nutritional treatments on ewes during pregnancy and lactation that mimicked typical variations in nutrient supply experienced between years and regions. A similar experimental design was used at sites in WA and VIC in 2001 and 2002. At both sites ewes were at mean condition score ~ 2.5 at artificial insemination in February/March and then randomly allocated to two flocks and differentially fed to achieve a condition score of ~ 2.0 or ~ 3.0 by Day 90 - 100 of pregnancy. Within each condition score flock at Day 90, they were then allocated to pastures maintained at five different levels of feed on offer until lambs were weaned (design = 2 CS x 5 FOO = 10 plots x 2 or 3 replicates of 20-30 pregnant ewes). After weaning in November at both sites, all progeny were grazed together at the standard commercial stocking rate. The CFW and mean FD were measured at hogget shearing.

The treatments resulted in changes to clean fleece weight and fibre diameter of their progeny that appear to be dose responsive to maternal nutrition. In general clean fleece weight increased and the mean fibre diameter decreased as the level of feed-on-offer during late pregnancy and lactation increased. However, the linear response for clean fleece weight was only significant in WA (0.09 kg of clean fleece/500 kg of feed-on-offer; p = 0.003) and the linear decrease in fibre diameter was only significant in the combined progeny from both years in VIC (-0.09 µm/500 kg feed-on-offer; p < 0.001). These responses at the extreme treatments are greater than previously reported in the literature and had a significant impact on the outcome from whole-farm modeling of the economic consequences of the various feeding systems.

AIMS

Gross changes in nutrient supply during critical stages of embryonic, fetal and early post-natal development can cause modifications in growth and development that, in turn, program adult performance. For instance, it has been documented that restricting nutrition of ewes during pregnancy can result in permanent changes to the clean fleece weight (CFW) and mean fibre diameter (FD) of progeny (Kelly et al. 1996). However, there is no published information on how these commercially important characteristics vary in progeny under more typical variations of nutrient supply to their mothers. This experiment tested the hypothesis that wool characteristics of the progeny would respond in a dose responsive way to changes in the nutrition of their mothers.

METHOD

Over 2 years (2001 and 2002) at two sites; Hamilton, Victoria (VIC) and Kendenup, Western Australia (WA), ewes were in mean condition score 2.5 (CS; Russell et al. 1969) at artificial insemination and then differentially fed to achieve a CS of ~ 2.0 or 3.0 by Day ~ 90 of pregnancy. Within each CS flock at Day 90, they were then allocated to pastures maintained at five different levels of feed on offer (FOO; Hyder et al. 2004) until lambs were weaned (design = 2 CS x 5 FOO = 10 plots x 2 (WA) or 3 (VIC) replicates of 20-30 pregnant ewes). The progeny were weaned off the plots at pasture senescence and run together under commercial grazing conditions. In VIC in both years the progeny were shorn as lambs and then as hoggets at 17 months with 12 months wool. In WA the progeny were first shorn at 9 months and then again at 21 months with 11 months wool. At the first adult shearing the greasy fleeces of all progeny were weighed and standard midside samples were measured for yield and mean fibre diameter. The CFW and mean FD was measured at hogget shearing (17 to 21 months). Linear mixed models were fitted to the CFW and FD data with random effects of rep and plot and fixed effects of FOO, CS, year, rear type, birthweight, age, sex and ram source and significant two-way interactions.
RESULTS

The experiments were successful in generating a large range of CS profiles for the ewes during pregnancy and lactation at both sites (Ferguson et al. 2004). The WA progeny were ~13 kg heavier than the VIC progeny at their hogget shearing and consequently cut more wool that was broader (Figure 1). At shearing there were still significant differences in liveweight of progeny between extreme treatments due to maternal nutrition (VIC : 1.5 ± 0.4 kg; p = 0.006 and WA : 3.2 ± 1.4 kg; p = 0.01). The VIC progeny from CS 3 mothers cut significantly more wool (+ 0.08 kg ± 0.031; p = 0.02) that was finer (- 0.17 ± 0.07 µm; p = 0.018), than progeny from the CS 2 mothers, however there was no difference between CS treatment groups in the WA progeny (Figure 1). Nutrition during late pregnancy (FOO) had a significant positive linear effect on CFW at the WA site (0.09 kg/500 kg FOO; p = 0.003), but had no significant effect at the VIC site (p = 0.32). Alternatively, FOO had a negative effect on FD (- 0.09 µm/500 kg FOO; p < 0.001) at the VIC site, and although a similar pattern was evident in WA it was not significant (p = 0.32).

Figure 1. The predicted treatment means ± SE for clean fleece weight (CFW; kg) and fibre diameter (FD; µm) of the progeny in VIC (2001&2002 combined in CS 2 (▲) or CS3 (●)) at Day ~ 90) and WA (2001 CS 2 & 3 combined; ■), plotted against mean actual FOO (kg DM/ha) during late pregnancy and lactation.

CONCLUSION

Restricting the nutrition of ewes during pregnancy and lactation has resulted in significant changes to the wool production of the progeny, supporting the previous findings of Kelly et al. (1996) and strongly suggest that they are dose responsive. These responses at the extreme treatments are greater than previously reported in the literature and had a significant impact on the outcome from whole-farm modeling of the economic consequences of the various feeding systems (Young et al. 2004).

KEY WORDS

Ewe nutrition, condition score, progeny wool production, fibre diameter, clean fleece weight.

ACKNOWLEDGMENTS

The Lifetime Wool project was initiated as a cooperative project between the Department of Primary Industries, Victoria and the Department of Agriculture of Western Australia. Since, 2001 it has become a National project funded by Australian Wool Innovation Limited with on-farm experimental sites in all the main wool producing states.

Paper reviewed by: Johan Greeff

REFERENCES

RFID Technology – Esperance Experiences
Sandra Brown, Department of Agriculture Western Australia, Esperance

ABSTRACT

The ASHEEP group at Esperance is trialling radio frequency identification (RFID) on three properties. Through the Sheep CRC 10,000 sheep were tagged with electronic ear tags in 2003/04 in Esperance. This paper will describe how the technology is being used on one property in Esperance, provide feedback on lessons learnt so far, and suggest future uses for the technology in sheep production.

INTRODUCTION

RFID technology is now available; however there are gaps in the knowledge and understanding of this technology. Esperance farmer and ASHEEP member Ash Reichstein is currently assessing the RFID technology on farm. Based on our Esperance experiences, ease of use, likely uses and the potential future of the technology are discussed in this paper.

REVIEW

Baroona Farm is a sheep and cropping property with 33% of the net area under winter grazed pasture with the balance cropped. The sheep flock comprises both a self replacing Merino component and a Prime Lamb breeding component. The objective for the wool flock is to reduce fibre diameter (currently 22micron), while maintaining fleece weight. Ash also wants to select for better frame and to improve meat value characteristics while increasing number of lambs weaned to 100%.

Racewell Sheep Handler

The Racewell Sheep Handler can automatically weigh and draft on a number of different characteristics. The Racewell reads the RFID tags by way of an “Allflex Panel Reader” embedded in the wall of the handler. As sheep enter the handler their RFID tag is read by the panel reader and the weight is captured by the Tru -Test XR 3000 weighing indicator. The Tru -Test indicator assimilates the animal’s data, and will then draft the animal based on one or more criteria.

Monitoring Lambs using RFID

Ash successfully monitored lamb weights throughout 2003/04. For example Ash tagged the weaner lambs in the race, weighed in the handler and vaccinated and crutched (if needed). The weaners were drafted into 3 weight categories; 0-25 kg, 25-40 kg and 40+ kg. With one person pushing up, one person tagging and one person drenching and vaccinating, they did 481 lambs in 3.5 hours. In comparison the ‘old’ way would have taken them all day, with the animals double handled. Now Ash has refined the system he can weigh, record and draft 3 ways; 400 lambs in 1 hour using three dogs. Once the sheep start running smoothly, the electronic data captured means that Ash does not need to be standing at the handler, manually drafting and restricting the smooth flowing of the sheep.

Tracking Fleeces at Shearing

During shearing in October Ash trialled the Allflex wand reader which was attached to a barcode printer. As the sheep was shorn, the operator captured the electronic id and printed off two barcode labels from the handheld printer. One label was kept with the fleece for the whole time, the other went with the sample. The first barcode scanner was attached to the Ruddweigh fleece table and laptop, so as the fleece was weighed the barcode label was scanned, and the weight was recorded against that ID. Finally the wool sample was analysed using a laserscan, with the second barcode scanner capturing the ID, and recording the results. When this system was working it went well. Ash needed three extra staff to track the fleeces, however this is normal for manual fleece testing too.

Pregnancy testing

During February Ash and local stock scanner John Thurn were pregnancy scanning the ewes using real-time ultrasound technology. While John has his own sheep handler and laptop, it was not set up to read RFID tags. Initially Ash and John set up the ASHEEP Racewell Handler and ran the ewes through that. The idea was that the electronic ID would be captured; John would then scan the ewe and determine
whether it was a dry, single or multiple, and then record that on the Tru-Test screen. The ewes would then be drafted automatically according to their pregnancy status. This didn’t work so John and Ash replaced the Racewell handler with John’s handler.

Problems with the Technology

Ash has found that the technology can be very frustrating when it isn’t working, and very rewarding when it does work. Looking back now, Ash identified that most problems were due to operator error, simply not understanding the technology. At shearing the cable on the barcode printer was too long and kept getting tangled. It was accidentally pulled out, which meant that they went back to the manual system of writing the tag number on the label and fleece weight too. A significant increase in tag reading and data error rate was noted as the result of using a manual system. Also at shearing 2 one reader and two barcode scanners were trialled, this meant that the data needed to be matched up at a later date. This posed a problem if Ash wanted to cull animals after shearing but before going back to the paddock.

During November Ash weighed the ewes, and they ran through the machine really well. It wasn’t until he uploaded the data file onto the computer that night that he realised none of the weights had been recorded. Although the EID and weight had displayed on the Tru-Test monitor in the yards, they hadn’t been captured. Ash has also found that even though the panel reader can potentially read tags through mud, dust, bone and so on, he now puts the RFID tag into the right ear and not the left, so that the tag is alongside the panel reader.

CONCLUSION

The first six months using the technology have been spent dealing with issues as they arise. Often it was due to the operator not knowing the limits or extent of the software. If this technology is to be adopted by the commercial sheep producer, the producer needs to attend a workshop or course, exploring how the software and hardware match up.

Currently Ash is using the RFID technology for recording individual animal fibre diameter, yield and fleece weight measurements, reproductive ability as well as recording body weights to make sure the animals meet specifications. To improve profitability these activities needs to be more focussed, so that individual animals can be identified as key meat or key wool performers using a suitable combination of the data collected.

Ash and many potential RFID users will collect many measurements – but what will they do with the measurements? A Sheep Handler and RFID technology will save the producer time and labour costs for data collection, but the capacity for the producer to use these measurements has not kept pace with their ability to cheaply and efficiently collect information.

Currently ASHEEP own the Racewell Sheep Handler, and it is based at the Reichsteins farm. With a round trip of up to 150km, it is not economically viable for the other focus farms to share the machines use. Ash has certainly recognised the value of the Handler and will be looking at purchasing his own in the future. For other sheep producers in Esperance – is there a need for a contractor? This way the contractor is the “expert”, owning and travelling with the equipment. These and many other issues will be explored further during 2004 on Baroona Farm.

KEY WORDS
RFID, Electronic Identification, Sheep CRC, Esperance, ASHEEP

ACKNOWLEDGEMENTS
Ash and Megan Reichstein, Ian McFarland and the Sheep CRC for supporting this project.
Paper reviewed by: James Skerritt, Ian McFarland, DAWA Narrogin

REFERENCES
The Role of Radio Frequency Identification (RFID) Technology in Prime Lamb Production - a Case Study

Ian McFarland, * John Archer **
* Department of Agriculture, ** Producer

ABSTRACT

Current prime lamb production systems use bodyweight and condition score as the key characteristics for determining the performance and suitability of a lamb for a market. The opportunity exists to use growth rate as well as bodyweight and condition score as the key performance indicators. Radio frequency identification (RFID) technology allows for the easy identification and monitoring of these indicators on individual prime lambs. A trial on the property of John and Rosemary Archer at Narrogin using RFID technology has shown that the performance of lambs in a feedlot is extremely variable impacting on the potential profits from this enterprise. Using the technology to make real time decisions is the challenge.

AIMS

To use individual animal identification technology to improve a prime lamb production system

To validate the use of RFID technology in a prime lamb production system

METHOD

Background

John and Rosemary Archer run 'Caranoo', a 1,950 hectare mixed farming enterprise ten kilometres east of Narrogin. Approximately 60% of the property is cropped to mainly wheat and barley. The sheep flock consists of 3000 Merino ewes lambing in June/July. 1500 are mated to Poll Dorset and South Suffolk rams. The prime lambs are turned off through the Q-lamb alliance from mid-October. All lambs are finished in a feedlot, targeting an 18 to 22 kilogram carcase weight. To achieve this lambs are moved from the paddock into a backgrounding feedlot when they reach 33 to 40 kilogram body weight. They are supplemented ad-lib with oats, mineral mix and oaten hay. They are moved to the finishing feedlot and fed Q-lamb pellets when they reach 40 kilogram plus bodyweight. They are sent for slaughter at 44 kilogram plus bodyweight.

Trial design

430 of the lighter weight lambs from the draft were tagged with RFID tags in October 2003. The lambs were weighed on a monthly basis whilst in the paddock and fortnightly whilst in the background feedlot. Whilst in the finishing feedlot lambs were weighed weekly. The lambs were followed through to slaughter with carcase weight and fat depth being recorded. A Racewell Super Sheep Handler was used to weigh the lambs initially. Latter weights were recorded using an Allflex stick reader connected to a Ruddweigh 600 indicator, scales and crate.

RESULTS

Individual animal identification has enabled the current system to be benchmarked. Until now performance has been measured on a mob basis. Time on the feedlot for individual lambs, growth rate and breed differences have not been known.

Turnoff time from tagging to slaughter varied from 55 days to 146 days.

Lamb performance in the finishing feedlot also varied tremendously, the average growth rate was 274 grams per day with a standard deviation of 121 grams. Time in the finishing feedlot varied from 10 to 100 days (see Graph 1). There were breed differences with Suffolks growing 29 grams per day faster (on average) than the Dorsets.

Average carcase weight at slaughter was 19.05 kilograms (with a standard deviation of 1.06) (see Graph 2).
Bodyweight into the feedlot had a significant impact on the length of time in the feedlot. The mean growth rate of the lambs in the feedlot more than 60 days was 222 grams per head per day (compared to the average of 274). However, entry weight into the feedlot for these lambs was 31 kilograms compared to the average of 37 kilograms.

Whilst the current system is efficient in achieving the target carcase weight, the trial has identified a number of issues that may be impacting on the profits. With a feed cost of about 25 cents per head per day, lambs on the feedlot more than 50 days are costing the enterprise significantly. Using RFID technology these animals can be identified. Analysis of the data is continuing to find out how early the poorer performing lambs can be identified.

**Using RFID technology**

There were minimal problems with the use of electronic ear tags. Tag losses were minimal and the occurrence of ‘dud’ tags was less than one percent. Up to 450 lambs per hour could be run through the Racewell handler, capturing the ear tag number, weight and drafting three ways (on weight). Recording information using a stick reader attached to the Ruddweigh indicator and manually drafting was marginally slower but required extra labour.

**CONCLUSION**

Cararoo’s current system is achieving the target carcase weight quite efficiently, however this trial has identified a number of areas that may improve the system and thus profits from the enterprise.

RFID technology, although relatively costly at this point of time, provides an easy way of identifying and monitoring individual animals. Monitoring will assist in identifying inefficiencies in the system. Further trial work is required to identify the growth rate indicators that can be used and develop a real time system that can be used in the yards to make decisions.

**KEY WORDS**

RFID technology, prime lamb, case study

**ACKNOWLEDGMENTS**

Thanks to Sandy Turton and Martin Atwell for assisting John in the collection of the data. Thanks to Matthew Kelly, CSIRO for the preliminary analysis of the data.

**Paper reviewed by:** Pat Page
ABSTRACT

Sheep producers in Western Australia are keen to increase the number of lambs weaned from Merino ewes. To do this, more twins need to be successfully reared to weaning. An impediment to producing twins is that, compared to singles, more of them die around birth. To solve this problem, twin-bearing ewes need to be managed more precisely. Producers can use naturally synchronised matings by ‘teasing’ Merino ewes and new developments in scanning technology to predict the time of lambing. Twin-bearing ewes can be separated from single-bearing and empty ewes. Single-bearing ewes given a suitable environment should lamb adequately. Attention can then be focused on the twin-bearing ewes that lose their lambs often because they do not produce enough colostrum at birth. These, and only these ewes, can be targeted for feeding at a high level just before lambing to lift their production of colostrum. This strategy should be economical because extra resources are applied only to twin-bearing ewes that are both the most vulnerable and the most responsive to the colostrum feeding strategy plus they have double the number of lambs of single-bearing ewes.

INTRODUCTION

The key to improving the number of lambs weaned from Merino flocks in WA is to increase the number of twin lambs that are weaned [1]. Unfortunately, many producers do not believe this can be achieved because they know far more twins die than singles. Consequently techniques to raise weaning rates [2] have not been adopted. To solve this problem, we are developing an integrated strategy to increase the survival of twin lambs. The first part of this strategy is precise management of the reproductive cycle. This can be achieved in two ways. The first is to synchronise matings so that we know, within narrow limits, when the ewes are going to lamb. This can be done without drugs by ‘teasing’ ewes to invoke the ‘ram effect’. The second way to achieve control is through skillful ultra-sound scanning of pregnant ewes – skilled operators can both identify twin fetuses and determine their age to within a week. The second part of the strategy is to feed twin-bearing ewes with an appropriate supplement in the last week of pregnancy to make sure they produce enough colostrum to give their lambs a good chance of surviving.

REVIEW

A major cause of the high mortality amongst twins is insufficient colostrum at birth. A study with single-bearing ewes at UWA showed that feeding a high level of lupins just before lambing increased colostrum production [3]. Recently we found corn to be much more effective than lupins for this purpose [4]. In searching for a cereal grain suitable to use in WA, barley was found to be equally effective as corn in twin-bearing ewes [5]. In all of our studies where twin- and single-bearing ewes were compared, a key result was that the response with twin-bearing ewes was always higher and more spectacular than with single-bearing ewes. The large lift in nutrition just before lambing improved the hormonal and physiological factors that control the formation of colostrum and led to the production of a greater quantity of less viscous colostrum at lambing. In addition, the high level of feeding for a short period at the end of pregnancy, when the ewe’s appetite is depressed, helps to avert pregnancy toxaemia yet does not substantially increase the birth weight of twin lambs so there is no increase in the likelihood of dystocia.

The key to implementing these findings economically on farms is to be able to identify those ewes pregnant with twins and to know when they will lamb. Without this information there are two risks: first, feed will be wasted on single-bearing ewes that benefit less than twin-bearing ewes, thus increasing feed costs; and, second, feeding single-bearing ewes for too long could increase the size of their lambs and thus contribute to dystocia. A strategy to use this knowledge must encompass both a means of identifying the pregnancy status of individuals or groups of Merino ewes and implementing an appropriate feeding regime. With stud or high-value Merino ewes, artificial insemination is often used and the time of lambing for individual ewes can be easily predicted. However, these ewes are only a small proportion of the WA Merino flock. A much larger proportion are the commercial Merino ewes mated between October and late January and most of these ewes could respond to ‘teasing’ and be synchronised naturally [6]. A further advantage of ‘teasing’ is that it ensures the ewes begin to conceive immediately after the introduction of entire males so joining can be restricted to 30 days. The result is a compact lambing and, in conjunction with scanning, the twin-bearing ewes can be separated into two lambing groups based on their estimated...
time of lambing. By contrast, Merino ewes mated after late January will have commenced their breeding season and will be in oestrus spontaneously with little possibility for natural synchronisation. However, even these ewes can be separated into lambing groups to implement the colostrum feeding strategy. Modern scanning equipment in the hands of skilled operators allow the accurate identification of single- and multiple-fetuses and at the same time their ages can be estimated accurately and used to predict lambing dates.

Armed with this information, producers can set-up lambing groups and take advantage of the colostrum feeding strategy for twin lambs to enhance their survival. The first step is to eliminate dry ewes from the lambing program. Second, single-bearing ewes, in normal seasons, should rear a lamb without further nutritional assistance and, if good quality pastures are available, they should not need to be supplemented. Finally, the ewes that have been identified with twins can be separated into groups about 10 days apart based on their mean estimated lambing dates. The total extra cost for this strategy compared with conventional lambing is the cost of management and feeding the twin-bearing ewes in each group for 10 to 20 days. Usually, ewes bearing multiples do not constitute the highest proportion of the flock and so these costs are not high. An additional advantage is that lambs from twin-bearing ewes are the most in danger of suboptimal nutrition but twin-bearing ewes respond even more readily to nutritional stimulation than single-bearing ewes (Table 1).

Table 1: Colostrum (g) available to single or twin lambs at birth from control ewes and from ewes supplemented with whole barley (600 g per ewe daily) when fed lucerne hay in the last week of pregnancy (Adapted from 5). Values are mean ± sem (12 control & 11 supplemented single-bearing ewes; 8 in both for twin-bearing ewes).

<table>
<thead>
<tr>
<th>Nutritional regime</th>
<th>Birth Type</th>
<th>Single</th>
<th>Twin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Single</td>
<td>190 ± 44</td>
<td>292 ± 116</td>
</tr>
<tr>
<td>Supplemented with barley</td>
<td>Twin</td>
<td>360 ± 81</td>
<td>684 ± 95</td>
</tr>
</tbody>
</table>

CONCLUSION

A low cost package that combines the control of reproductive events and focused feeding with barley just before lambing should enhance the survival of twin lambs and increase the total number of lambs weaned from Merino flocks in Western Australia.

KEY WORDS

Merino ewes, twins, colostrum, barley

Paper reviewed by: Dr Ian Williams, The University of Western Australia.

REFERENCES

Precision Sheep Need Precision Wool Harvesters
Jonathan England, Castle Carrock Merinos, Kingston SE, South Australia

ABSTRACT

Being a woolgrower in the new millennium requires far more attention to detail than in the past. We must be more precise. Growers are using technology to a far greater degree than at any time in history to achieve these new levels of precision.

Biological wool harvesting using the Bioclip process is just one tool we are using to improve our business. There are many advantages of Bioclip over conventional shearing in terms of wool, sheep and labour.

INTRODUCTION

What is Castle Carrock Merinos? Castle Carrock Merinos is in the business of growing fine wool. It is run by my wife Danielle and I, near Kingston in the South East of South Australia. The self-replacing flock consists of 4,500 spring lambing ewes, 2,000 wethers and followers.

We recognise the need for precision in our woolgrowing business. Tools employed in our business include faecal egg testing and worm resistance testing, dry matter on offer assessments and pasture quality analysis, fleece testing and weighing, electronic identification of animals, autumn shearing and biological wool harvesting.

REVIEW

Castle Carrock Merinos and the limitations of conventional shearing

At Castle Carrock Merinos we are, like many in the industry, concerned about the limitations of conventional shearing, and believe that these issues will only become more restrictive in the future. These are:

- It is clear that the Australian wool industry faces a shortage of shearers and skilled shed staff. There are too few young people entering the shearing industry, and many existing workers are becoming too old to continue shearing very far into the future.
- It is a fact that shearing is hard work, and that despite back aids, wide gear and sealed bearings in handpieces, most shearers are still dragging heavy sheep across the board for an 8 hour day, bending over to shear sheep in a vast range of climatic conditions, and holding a dangerous handpiece that has unguarded, rapidly moving blades.
- Lambing in spring is critical to us in terms of placing our peak feed demand at the time of the year when we have peak food on offer. Shearing in autumn allows us to cut the wool fibre near the area of lowest tensile strength, hence maintaining good strength in the middle of the staple. The problem is we then shear our lambs with only six months of wool, to allow us to line up with adult shearing, without sacrificing staple length on our hogget wool. However by doing this we achieve shorter lambs wool and hence lower prices.
- A good shearer when shearing sheep, in particular lambs, with a conventional handpiece will invariably cut skin, at worst, shearers can damage teats, pizzles and hamstrings. These injuries can affect the sheep, ranging from reduced growth rates during the healing process to permanent disability or death. Lambs will suffer from these injuries to a greater extent than adults.

Castle Carrock Merinos and the Bioclip process.

Given these limitations with conventional shearing, and the positive animal welfare benefits of biological wool harvesting, the Bioclip process has become a part of our strategy for a number of reasons:

- Bioclip is relatively easy to use. That is it is easy to learn, and can be performed by both young and old operators. Unlike conventional shearing, relatively unskilled labour can be used, and within minutes achieve good throughput.
- The handling equipment delivers the sheep to the operators at waist height, and there is no bending or dragging. The netting and harvesting are both performed in purpose built cradles.
that plug into the handling system. The Bioclip system is currently targeting young sheep up to 55kg due to net design constraints, however a system for large animals is currently under development.

- Bioclip allows us to remove the wool from our lambs at seven months of age instead of shearing them at six months. Bioclip breaks the wool, so all wool above the base of the follicle will be available for harvest as opposed to shorn wool which can be of varying lengths depending on the shearer and the number of second cuts or locks made. We are achieving an extra months wool growth, plus because there are no locks we are gaining a further 10-15 mm staple length. The hogget fleeces from the Bioclip lambs are the same length compared to that of the shorn lambs, even though the Bioclip lambs had only 9 months to its hogget shearing compared to 10 months for those shorn lambs. This is due to less stress in the Bioclip process than in shearing, and there are no injuries or wounds that require energy for the healing process that must be diverted away from growing wool and meat.

- Bioclip has no means of mechanically injuring a sheep. All teats, pizzles and skin are intact. Our young sale sheep are presented better for sale.

Bioclip has other additional advantages

- Stained wool from the crutch and around the pizzle falls off in the paddock reducing the need for a pre-shearing crutch.
- Medullated fibres from the shanks fall off in the paddock, reducing medullated fibre contamination in the clip.
- Grass seeds can fall out of skin after harvest, reducing skin and carcase damage due to seed penetration and potentially reducing vegetable matter levels in the wool.
- Clean lambs wool is easily skirted away from secondary wool (seedy, dusty or coloured), rather than the lottery that is usually associated with picking lambs wool. The result is superior clip preparation.
- Longer, more even length staples with lower CVs of length resulting in increased hauteur.
- Did I mention no skin pieces and no locks?

Castle Carrock Merinos can achieve even more precision.

Bioclip allows us to break the wool of all of our lambs within hours of each other, right at the base of the follicle. Consequently when we measure staple length and fleece weight at hogget shearing, the results are not affected by the amount of wool left on that sheep by the shearer at lamb shearing. What we see is the full nine months wool growth, enabling us to better compare the production of individuals. And increased production per head leads to increased profits per hectare.

CONCLUSION

Bioclip suits us because…

For the labourer it is easier and safer than shearing with no dragging or bending. There is less stress on the sheep and no damage due to shearing cuts. The wool is longer with no locks or skin pieces and gives superior clip presentation.

Bioclip is precision wool harvesting.
EBVs and Indexes – Genetic Tools for your Toolbox
Sandra Brown, Department of Agriculture Western Australia, Esperance

ABSTRACT
More than one hundred sheep breeders in Western Australia participate in the LAMBPLAN or Merino Genetic Service (MGS) genetic information system. These breeders submit raw measurements and other records to LAMBPLAN, where it is analysed and results are sent back in the form of Estimated Breeding Values (EBVs) and selection indexes. EBVs allow breeders and commercial sheep producers to compare rams across flocks and across breeds. Improved industry understanding of EBVs and selection indexes will mean ram buying and selection decisions are based on sound genetic principles and not just on visual assessment.

INTRODUCTION
LAMBPLAN and Merino Genetic Services (MGS) are national performance recording systems that supply genetic information to the Australian sheep industry. Currently LAMBPLAN and MGS have more than 530 Australian sheep breeders; 125 are based in Western Australia. These breeders record many fertility, wool, disease and carcase measurements (2). In doing so they provide a lot of objective genetic information in the form of EBVs and selection indexes at their ram sale. For the commercial producer this can be overwhelming and may alienate individuals from using EBVs. This could result in the producer resorting to raw measurements and/or visual assessment, rather than a combination of EBVs, selection indexes and visual assessment with a consequently reduced rate of genetic gain. It is therefore important that ram breeders and commercial sheep producers understand these tools to take full advantage of the benefits. This paper explains what EBVs are and how to use them effectively.

REVIEW
Data Collection
An effective animal evaluation system relies on collecting relevant and accurate data. Sheep breeders collect raw measurements such as wool weights, body weights and scanning of fat cover and eye muscle depth on live animals. Information can be collected at birth, weaning, early post weaning, post weaning, yearling, hogget and adult ages (1). Additional information on birth type, rearing type, management group and pedigree data is also sent to LAMBPLAN or MGS for data analysis.

Estimated Breeding Value
An EBV is an estimate of the sum effect of all the genes an animal will pass onto its progeny (2). An EBV is adjusted for how heritable the trait is, information from other relatives, relationships between traits, management and other factors such as birth type, age of the dam, sex of the animal and so on (1). EBVs don’t always reflect what is seen in the paddock. Put simply

Phenotype (what it looks like) = Genotype (its genes) + Environment (how managed)

EBVs are always expressed in the same unit as the raw measurement e.g. an EBV for fat is expressed in millimetres. Looking at the EBVs for fat in Table 1, Sire 1 and 3 will produce progeny that are leaner than average (both have negative EBVs). However Sire 1 will also produce progeny that have a smaller eye muscle depth. Sire 2 and 3 will produce progeny that are more muscled, indicated by a positive EBV for eye muscle depth. Sire 3 has the highest EBV for post weaning weight, meaning he has the greatest potential for producing progeny that will grow faster.

EBVs determine the genetic potential for traits that are difficult to see, such as worm resistance, or a trait that can only be measured on one sex; such as milk production or reproduction rate, this is where EBVs will benefit breeders.

A producer can compare the EBVs of animals within the flock, and across the breed, provided the environmental or management component has been adjusted for by using a genetic linkage. Genetic linkage occurs when two or more studs share common genes. Genetic linkage is also required for breeders to compare across management groups and years within a stud.
Selection Index

The overall aim for any ram breeder is to produce superior sires. But how do you do that and which traits do you select to improve? Usually a combination of traits is desirable. This means that instead of the breeder looking at a number of EBVs, the desirable EBVs are weighted (weighting reflects the economic importance of each trait) and combined into a selection index. Once an index value has been assigned to each animal, the animals can then be ranked. Animals with higher indexes will produce lambs that are more suited to the market addressed by the index. Many sheep breeds have a customised index that reflects their priorities.

In the Australian Sheep Industry terminal sires are selected with an emphasis on fast growth and high carcase merit; maternal breeds are selected with an emphasis on fertility, mothering ability and lambs with high growth; and merinos are selected for wool, growth, reproduction and carcase value (1).

Table 1: Example of a ram sale catalogue with a mix of carcase, wool and disease traits

<table>
<thead>
<tr>
<th>Sire ID</th>
<th>Post Weaning Weight (kg)</th>
<th>Post Weaning Fat Depth (mm)</th>
<th>Post Weaning Eye Muscle Depth (mm)</th>
<th>Hogget Fibre Diameter (micron)</th>
<th>Faecal Egg Count (eggs per gram)</th>
<th>Carcase Plus</th>
<th>8% Micron Premium Plus FEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>030001</td>
<td>0.9</td>
<td>-0.6</td>
<td>-0.5</td>
<td>-2.3</td>
<td>-0.4</td>
<td>110.6</td>
<td>154.0</td>
</tr>
<tr>
<td>030002</td>
<td>3.7</td>
<td>0.1</td>
<td>0.4</td>
<td>0.3</td>
<td>0.7</td>
<td>125.3</td>
<td>124.1</td>
</tr>
<tr>
<td>030003</td>
<td>5.4</td>
<td>-0.3</td>
<td>0.1</td>
<td>-1.3</td>
<td>-0.1</td>
<td>137.3</td>
<td>135.5</td>
</tr>
</tbody>
</table>

From Table 1, Sire 1 has the lowest Carcase Plus index of the three sires which is only 10.6 points above the average of this flock (Selection Index average is 100). The Carcase Plus index places 60% emphasis on post weaning weight, 20% on fat and 20% on eye muscle depth. That is why Sire 3 has a higher index than the other two sires. In this example Sire 3 is most suitable to sire lambs for the 20-24kg, fat score 2-3 within 6 months for the domestic market. However when focussing on wool and disease resistance Sire 1 is more suited with an index rating of 154. Progeny from Sire 1 will have a lower worm burden and reduced fibre diameter while maintaining fleece weight.

CONCLUSION

When selecting superior animals, tables of EBVs and selection indexes can be very confusing. It is the individual’s responsibility to familiarise themselves with these genetic tools before selecting animals. Consultants, State Department of Agriculture Officers and LAMBPLAN and Merino Genetic Service staff have an important role in extending this information to ram breeders and their clients – the commercial sheep producer.

KEY WORDS

LAMBPLAN, Merino Genetic Services, EBV, Selection Index

ACKNOWLEDGMENTS

Paper reviewed by: Johan Greeff, DAWA Katanning and Lock Butler, DAWA Narrogin

REFERENCES

ABSTRACT

With the increasing use of feed budgeting and objective assessment of pastures by farmers, there is a need for an easy-to-use feed budget tool. The Green Feed Budget Paddock Calculator is a computer-based tool that allows the user to feed budget on a paddock basis throughout the green period. It uses feed intake data generated from GrazFeed® where the inputs have been modified to best describe clover-dominant annual pastures in WA. The calculator offers a choice of six scenarios, including calculations for strip grazing, deferment, and stocking rate. It is a stand-alone program, which allows it to be run on any IBM PC. It is low cost, easy to understand and quick to operate, and it complements pasture growth rate (PGR) and feed on offer (FOO) data now available over the Internet.

INTRODUCTION

Feed budgeting is an essential tool for farmers wishing to improve the efficient management of green feed. Knowledge of the principles of feed budgeting will enable farmers to achieve animal production targets by better matching pasture supply with the demand of the grazing animal. Pasture utilisation will improve from the low 30-40% which commonly occurs under conservative stocking regimes, and profitability will likely increase as stocking rates approach district potentials.

We set out to provide an easy-to-use program for farmers wanting to feed budget. This calculator is designed to provide the basics to enable farmers to commence feed budgeting, and will lead to increased confidence and skills needed to run whole farm budgets.

REVIEW

The calculator contains six scenarios outlined in the main menu (Fig 1). The scenarios are divided into two phases - Establishment (usually autumn and winter) and Vegetative (usually late winter spring) - to take account of the differences in pasture morphology (e.g. height, % dry matter).

Once the scenario has been chosen it is a matter of working through the input boxes. Inputs are based on a paddock scale and represent the standard inputs for feed budgeting.
Points to Note

There are a number of important points underlying the feed budget calculations.

- The FOO inputs used for this calculator are derived from calibrations cut to ground level using a scalpel, leaving no residual FOO behind. FOO data is a crucial driver of the outputs of the calculator and needs to be as accurate as possible.
- The feed intake versus FOO relationship curves for the different classes of stock were generated from GrazFeed® using modified FOO and height data that better represents WA’s legume-dominant, annual-based pastures.
- The energy requirements for maintenance of sheep used in this calculator are generated from GrazFeed.
- PGR inputs are now available from the internet rather than using estimates from a measured property within the region or ‘guesstimating’ rates from knowledge of past years.

CONCLUSION

Farmers needing a cheap and easy-to-use calculator for feed budgeting in the green phase may find the ‘Green Feed Paddock Budget Calculator a good starting point. The full version of the calculator is available from the Department of Agriculture for $15. An abridged version is available on the Departments website at www.agric.wa.gov.au (search on feed budget).

KEY WORDS

Feed budgeting, decision tool, green feed, supplementary feeding

ACKNOWLEDGMENTS

Mike Hyder for the background to the calculations and the revised feed intake equations

David Weaver for his software assistance in developing the calculator

Paper reviewed by: Mike Hyder
Minimising the Impact of Drought - Evaluating Flock Recovery Options using the ImPack Model
Karina P. Wood, A Ashley K. White, B B. Lloyd Davies, C Paul M. Carberry, D
A NSW Department of Primary Industries (NSW DPI), Cowra
B NSW DPI, Cowra, C NSW DPI, Tocal,
D NSW DPI, Tamworth

ABSTRACT
Drought forces most producers to carry out some form of destocking strategy on their properties. Having insufficient stock numbers to utilise the pasture resource following drought limits income earning potential. StockPlan’s ImPack model is a unique decision support tool that allows producers and their advisers to comprehensively analyse restocking options by entering their own flock information and prices.

AIM
To evaluate restocking options for four drought strategies by comparing the impact of those options on gross margin returns over a ten year post-drought timeframe.

METHOD
The ImPack model is used to evaluate restocking options for four possible drought strategies using the example enterprise in Table 1. The specific drought strategies and flock recovery options are identified in Table 2 (in the results section).

Table 1: Self-Replacing Merino Ewe Enterprise (Spring Lambing) and Ten Year Post-Drought Assumptions, Great Southern Zone, Western Australia

| Enterprise breeding factors and assumptions for ten years following drought (1) |
|---------------------------------|---------------------------------|
| Base flock size: 1,000 ewes | Wether price: $48.00 |
| Weaning percentage: 80% | Surplus maidens price: $43.00 |
| Weaning percentage in first year after drought: 70% | Cull and CFA ewe price: $40.00 |
| Cast for age (CFA) ewes: 6 years old | Dry ewe price: $45.00 |
| Net wool return per ewe: $39.00 | Drought sale price for ewes sold: $40.00 |
| Variable costs per ewe: $30.00 | Discount rate¹: 12% |

¹ Use a discount rate in order to allow for coverage of interest and some risk.

RESULTS
Running the three restocking options through ImPack for each drought strategy produces the results in Table 2 for the enterprise example described in Table 1. The baseline strategy of feeding instead of selling (Strategy 1) has the least impact on discounted gross margin over ten years following drought. Reducing flock size by 15% results in a similar impact on gross margin to that of the baseline strategy. As the level of destocking increases the impact on gross margin compared with the baseline strategy becomes more significant – as much as 14% difference for the Strategy 4/Option C combination.

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² StockPlan® comprises three computer decision support tools (Drought Pack, FSA Pack, and ImPack) that enable cattle and sheep producers to explore management options in the early stages of drought and during drought. These tools assist producers to make management decisions that minimise the environmental and financial impacts of drought.

³ Assumes full drought feeding ration of 3.5 kg/dry sheep equivalent (DSE)/week for Summer/Autumn feeding of twenty weeks (January through to May). Feed is valued at $300/Tonne in the drought year. ³ For example, in the ten years following drought Strategy 4/Option C results in a discounted gross margin that is 14% less than the discounted gross margin for Strategy 1.
Table 2: Impact of restocking options on cost of drought

<table>
<thead>
<tr>
<th>Drought strategy</th>
<th>Flock restocking options in year after drought (each option is topped up to 1,000 breeding ewes when buying in replacements)</th>
<th>Percentage difference in gross margin over 10 years following drought compared with the gross margin for Strategy 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategy 1 (baseline): Feed instead of sell</td>
<td>N/A</td>
<td>0%</td>
</tr>
<tr>
<td>Strategy 2: Reduce flock size by 15%</td>
<td>Opt. A: Buying replacement ewes now at $80 each.</td>
<td>-2%</td>
</tr>
<tr>
<td></td>
<td>Opt. B: Not buying now, but buying replacement ewes in 12 months time at $60 each.</td>
<td>-2%</td>
</tr>
<tr>
<td></td>
<td>Opt. C: Breeding back by retaining 97% of maiden ewes until breeding ewe numbers return to 1,000.</td>
<td>-1%</td>
</tr>
<tr>
<td>Strategy 3: Reduce flock size by 35%</td>
<td>Opt. A: Buying replacement ewes now at $80 each.</td>
<td>-4%</td>
</tr>
<tr>
<td></td>
<td>Opt. B: Not buying now, but buying replacement ewes in 12 months time at $60 each.</td>
<td>-3%</td>
</tr>
<tr>
<td></td>
<td>Opt. C: Breeding back by retaining 97% of maiden ewes until breeding ewe numbers return to 1,000.</td>
<td>-4%</td>
</tr>
<tr>
<td>Strategy 4: Reduce flock size by 60%</td>
<td>Opt. A: Buying replacement ewes now at $80 each.</td>
<td>-9%</td>
</tr>
<tr>
<td></td>
<td>Opt. B: Not buying now, but buying replacement ewes in 12 months time at $60 each.</td>
<td>-8%</td>
</tr>
<tr>
<td></td>
<td>Opt. C: Breeding back by retaining 97% of maiden ewes until breeding ewe numbers return to 1,000.</td>
<td>-14%</td>
</tr>
</tbody>
</table>

Changes in commodity prices affect the results in Table 2. For instance, an increase in feed price will cause the destocking options to have a more favourable impact on gross margin. Conversely, increases in the prices received for wool and sheep sales will cause the gap between feeding and destocking results to widen. The value of the ImPack model is its capability to test a whole range of such variables in order to minimise the impact of drought. Producers have the power to choose their flock restocking options. For example, in Strategy 4 producers can influence their gross margin result by as much as 5% depending on their chosen restocking option.

CONCLUSION

Having insufficient stock numbers to utilise the pasture resource following drought will limit income earning potential. Besides restocking, it is crucial to examine alternative land use options such as cropping, a trading operation, and fodder conservation. In addition, there are a range of changes in management that may contribute toward recovering full stocking capacity – only three options are tested in this example. StockPlan’s Impack model has the potential to save producers large amounts of money by evaluating drought strategies and restocking options. In this example, the result was as much as 14% difference in discounted gross margin over ten years following drought.

KEY WORDS

Drought strategy, flock structure, restocking options, evaluate

ACKNOWLEDGEMENTS

Phil Graham, NSW DPI, Yass; and Emma Kopke, Department of Agriculture, Western Australia.

Paper reviewed by: David Hopkins

REFERENCES

Lifetime Wool - Modifying GrazFeed® for WA
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C Biometrics, Department of Agriculture Western Australia, Albany, W.A. 6330

ABSTRACT

GrazFeed® is a nutritional management program designed to help graziers make the best use of their pastures by providing predictions of feed intake and energy and protein requirements for different classes of grazing animals. However, inconsistencies between GrazFeed® predictions and animal liveweight responses measured in the Lifetime Wool Project are possibly linked to two key GrazFeed® inputs: (a) feed on offer (FOO, kg DM/ha) and (b) pasture height (PH, mm).

Research from the Lifetime Wool project has led to modifications of these two key inputs in GrazFeed® which take into account the clover-dominant nature of annual pastures in WA. In addition, faecal samples are being analysed using the alkane technique to estimate feed intake from ewes and wethers grazing annual pastures ranging in FOO, composition and height. These data will redefine the relationship between FOO and intake for pastures common to WA. When completed, these modifications will make GrazFeed® a valuable feed budgeting tool for use by WA graziers.

AIMS

In GrazFeed®, feed on offer (FOO, kg DM/ha) is estimated from calibrations harvested using a shearing handpiece. This method leaves behind a residual amount of pasture which may be significant when compared to the scalpel harvesting method employed in WA. The magnitude of this residual may also vary depending on the stage of maturity of pasture and clover % in the pasture. The functions in GrazFeed® which describe the relationships between FOO and PH were generated for grass-dominant pastures with a significant perennial component. However, most pastures in south-western Australia contain a significant proportion of subterranean clover, which is likely to increase as grazing systems intensify to improve pasture utilisation and increase profitability. Because of the prostrate nature of clover, especially under grazing, the relationship between FOO and PH will likely differ from that for grasses. In addition, the more erect nature of pastures early in the establishment stage of maturity [6-8 weeks after the break], compared with the later vegetative/reproductive stage [winter/spring], may also have an effect on these relationships.

Given the sensitivity of feed intake to FOO and PH in GrazFeed®, we investigated for clover-dominant annual pastures in WA the relationships between (a) FOO harvested using a scalpel compared to that harvested using a shearing handpiece, and (b) FOO, clover composition and PH.

METHOD

**FOO Residual**

On 3 occasions in 2002 (1 July – establishment; 19 August and 1 October - vegetative) and 2 occasions in 2003 (3 June and 30 June - establishment), pasture in calibration quadrats was harvested first with a shearing handpiece (FOOshears) to simulate the GrazFeed® method, followed by a scalpel (FOOscalpel) to remove the remaining residual. Both fractions were sorted, washed, dried and weighed, and then summed to give the total dry matter weight. PH was measured in each calibration quadrat using a ruler, and composition (clover, grass and broadleaf) estimated.

**Pasture height**

FOO in 1-2ha plots was maintained at target amounts ranging from 300 to 2500 kg DM/ha during winter and spring. Estimates of FOO and composition (% clover, % grass, % broadleaf) were made in quadrats at 30-45 positions along transects in each of 20 plots on the same 3 occasions stated above. The mean PH of the pasture sward was measured in each quadrat using a ruler.
Regression analysis showed significant effects of growth phase, PH and clover composition on the relationships between FOOshears and FOOScalpel for WA pastures. Equations converting WA FOO estimates to GrazFeed® FOO inputs, in the establishment or vegetative stages of maturity, are shown below:

GrazFeed FOO **Establishment** = - 205.5 + 0.8486 x WA FOO + 3.33 x PH - 92.4 x clover%/100

GrazFeed FOO **Vegetative** = - 462.4 + 0.8486 x WA FOO + 5.34 x PH - 341.4 * clover%/100

Regression analysis showed a curvilinear relationship between PH and FOO that varied significantly \((p<0.001)\) with clover composition and pasture maturity (Fig.1). Even with zero clover, lower heights are predicted for vegetative pasture up to about 3 t DM/ha than from the linear relationship that is used in GrazFeed® (viz. 30 mm per t DM/ha). Equations describing these relationships between FOO, PH and clover for establishment and vegetative stages are shown below.

![Graph showing relationship between FOO and PH](image)

When used in GrazFeed®, these modified inputs significantly improve the match between predicted liveweight change (LWC) and actual measured LWC (Table 1).

**Table 1. Effect of modifications to FOO and height inputs on GrazFeed predictions.** Inputs: 48kg lactating ewe, condition 2 at lambing, single lamb 20d old, pastures 75% digestibility and 50% clover.

<table>
<thead>
<tr>
<th>FOO input (kg DM/ha)</th>
<th>Modified FOO (kg DM/ha)</th>
<th>GrazFeed height (mm)</th>
<th>Modified height (mm)</th>
<th>GrazFeed LWC (g/h/d)</th>
<th>Modified LWC (g/h/d)</th>
<th>Measured LWC (g/h/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>996</td>
<td>262</td>
<td>30</td>
<td>11</td>
<td>+ 7</td>
<td>-158</td>
<td>-141</td>
</tr>
</tbody>
</table>

**CONCLUSION**

Modifications to FOO and PH inputs, and ultimately feed intake for sheep grazing clover-dominant annual based pastures, will make GrazFeed® a valuable feed budgeting tool for use by WA graziers.

**KEY WORDS**

Feed on offer, pasture height, GrazFeed®, liveweight change

**ACKNOWLEDGMENTS**

The Lifetime Wool project is funded by Australian Wool Innovation Limited.

**Paper reviewed by:** Mandy Curnow
Profile Calculator – A Way to Manage Fibre Diameter Throughout the Year to Maximise Returns

Andrew Peterson, Research Officer, Department of Agriculture WA

ABSTRACT

This paper introduces the Profile Calculator – a computer program used to estimate the economic value of wool based on the shape of a fibre diameter profile.

INTRODUCTION

In Western Australia, 40 wool producers have monitored the monthly change in fibre diameter in at least 1 of their flocks (House et al. 2002; Oldham et al. 2002). The technique used is called ‘measure as you grow’ and involves measuring the fibre diameter of 2 mm snippets taken from the base of a staple every month or longer interval. Producers have nominated a target FD, staple length (SL), staple strength (SS) and liveweight that they want their flock to achieve 12 months in advance. By monitoring monthly changes in FD, a fibre diameter profile is progressively generated. The shape of the profile, and consequently the properties of the wool, are manipulated using various forms of grazing management. For example, many of these growers have increased stocking rates in late winter to counter the rapid increase in fibre diameter that normally occurs with abundant green feed. The result is finer and generally stronger wool at the expense of lower fleece weight, less staple length and lower liveweight.

In response to demand for a tool that integrates the effects of fibre diameter profile changes on other wool properties, the Western Australian Department of Agriculture has developed a software package called the ‘Profile Calculator’. The software estimates the mean fibre diameter, clean fleece weight, hauteur and price of a fleece using information from a complete fibre diameter profile. The Profile Calculator is primarily used to predict changes in wool quality as a result of modifying the shape of the fibre diameter profile.

REVIEW

The Profile Calculator is a simple computer program that runs on any Microsoft Windows PC. The program accepts user input and stores this data within the program. Data input includes the fibre diameter profile (length and diameter), wool prices x micron, and the expected difference in diameter between the sample site and the fleece.

The program calculates the resultant mean fibre diameter, clean fleece weight, hauteur and fleece value for a given diameter profile. As a result the user can modify the shape of the diameter profile and view the effects on the wool properties of the fleece. Wool price is determined from one of three user defined micron price curves with a premium/discount calculation based on hauteur. This calculation is based on actual premiums and discounts for wool sold at auction in Australia in the last 10 years at any given micron and hauteur (resolution of 0.1 \( \mu m \) and 1 mm respectively).

Clean fleece weight is calculated from a simple linear relationship between mean fibre diameter and fleece weight developed from experimental data relating the fibre diameter of young Merino sheep with increases in their stocking rate (Peterson et al. 2000).

It is envisaged that the user will modify the fibre diameter profile at various points along the staple in an attempt to meet certain wool specifications for sale. The first part of the profile may consist of actual measurements (using the measure as you grow technique) whilst the remainder may be added and modified according to expected wool growth prior to shearing. Whilst the calculated clean fleece weight could vary greatly between different genotypes, the estimated figure can still be used as a guide since flattening the diameter profile through restricted feeding will give similar decreases in wool cut. The relative effect on overall fleece value is a more important guide than the weight of wool cut per head. A sample screen for the ‘Profile Calculator’ is shown in figure 1.
Figure 1. Main screen of the Profile Calculator showing the user data, diameter profile and estimated wool properties and value of the fleece.

CONCLUSION

Profile Calculator offers a simple approach to predicting the effect of different fibre diameter profile shapes on the economic value of wool. It is envisaged that the program will be used by farmers as a guide to meeting wool specifications well before shearing and wool selling.

KEY WORDS

Fibre diameter profile, calculator, software, hauteur

ACKNOWLEDGMENTS

Paper reviewed by: Chris Oldham, Senior Research Officer, Department of Agriculture WA

REFERENCES

Pasture Watch - a Farmer Friendly Tool for Downloading and Analysing Pastures from Space Data
Roger Wiese, Stephen Gherardi, Gonzalo Mata and Chris Oldham

ABSTRACT
This paper describes Pasture Watch, a farmer friendly tool developed by Fairport Technologies, that simplifies the downloading and analysis of the Pastures from Space data reporting pasture growth rate (PGR) within individual paddocks.

INTRODUCTION
About 50 producers from Moora to Franklin have been collaborating with the Pastures from Space project for the past three years (Gherardi et al. 2003). The producers have been receiving weekly estimates of PGR and monthly estimates for feed on offer (FOO) for individual paddocks on their farm via a website (http://spatial.agric.wa.gov.au). Producers have provided feedback on the technology to the Pastures from Space consortium. During 2003, Fairport Technologies developed Pasture Watch to simplify the downloading and analysing of PGR data. Farmers were able to use Pasture Watch to download the PGR calculations weekly with a single mouse click. The data could then be automatically graphed to show changes in PGR and total dry matter production on a paddock-by-paddock basis. The accuracy of the PGR predictions are reported by Donald et al. (2004).

REVIEW
The delivery of the Pastures from Space data is undergoing a trial commercialisation in association with Fairport Technologies in 2004. Pasture Watch has been further enhanced and now has three modules that assist farmers in their decision-making.

Pasture growth rate and total dry matter production
The first module enables PGR of individual paddocks to be viewed and compared with other paddocks along with the farm average (Figure 1). Data for selected paddocks from previous years may also be viewed (Figure 1). Cumulative PGR (total production), percentage utilisation (if FOO is available), FOO watch points (optimum FOO at break of season before grazing, growing season FOO low watch point, growing season high watch point and optimum residual FOO at end of the season) can also be set and viewed for individual paddocks.

In order to have data delivered for their farm, producers need to have their paddocks digitised to create the paddock boundaries used by the Pastures from Space consortium to calculate PGR. This can be carried out by the producer or a Pasture Watch consultant using an aerial photograph or a satellite image provided.
After the paddock boundaries have been registered into the Pastures from Space system, the farmer is ready to start receiving data by simply clicking the download button on the main screen of Pasture Watch each week. All the complicated analyses are performed in the background and the graphs are updated automatically.

**Pasture budgeting**

The second Pasture Watch module is a pasture budgeting system that doubles as a paddock-by-paddock grazing planner. The planning process involves setting up default background information regarding the paddock rate of pasture growth (or decline) for each month of a 12-month period and the daily intake of a livestock unit (DSE) on a monthly basis. These default values can be altered to suit a farmer's local conditions.

Using module two requires the farmer to enter for each month of a 12-month budget period, the number and DSE ratings for each stock class (e.g. dry ewes, pregnant ewes, wethers, weaners etc.). The stock classes are then allocated to paddocks and graphs are produced showing pasture demand and expected supply for individual paddocks on their farm (Figure 2). Supplementary feeding or nitrogen applications or a mix of both can be used to rectify pasture deficits. This is available, as an interactive system that calculates the rate per head for each supplement, or the unit of N required per hectare. Pasture surpluses are carried over into subsequent months.

As the year unfolds, the Pastures from Space PGR data can be shown on the budget graph to provide an actual vs. budget comparison.

**Grazing management**

The third Pasture Watch module is a user-friendly Green Feed Budget Paddock Calculator. The tool enables a farmer to make grazing management decisions at a paddock level by better matching the energy requirements of a particular class of stock with what is available and what is needed from a paddock. Decisions can then be made which can help to better match energy needs and energy available. The Green Feed Budget Paddock Calculator is covered in more detail in the paper of Curnow (2004).

**CONCLUSION**

For the first time Pasture Watch coupled with weekly online delivery of PGR allows producers to quantitatively budget feed production and requirements for the whole year. The budgeted pasture production can then be compared against actual PGR as the season progresses and demands modified to match changes in supply away from the expected. This provides the producer with the opportunity to make timely informed decisions, which would lead to increases in pasture utilisation and productivity while reducing risk.

**KEY WORDS**

Pasture Watch, pasture growth rate, Pastures from Space, feed on offer

**ACKNOWLEDGMENTS**

We gratefully acknowledge the contribution of the collaborating producers through feedback and evaluation of Pasture Watch.

**Paper reviewed by:** Emma Kopke, Research Officer, Department of Agriculture WA

**REFERENCES**

An Analysis of a Cropping System Containing Sheep in a Low Rainfall Livestock System.
Evan Burt\textsuperscript{1}, Amanda Miller\textsuperscript{2}, Anne Bennett\textsuperscript{3}, Department of Agriculture, Merredin\textsuperscript{1}, Lake Grace\textsuperscript{2} and South Perth\textsuperscript{3}

**ABSTRACT**

The Low Rainfall Livestock Systems (LRLS) of the Lake Grace and Merredin districts are dynamic; currently we are witnessing a return of sheep to this system. The current farming system has the capacity to sustain more sheep, but it is believed adjustments to the farming system can further increase this capacity. It is expected the adjusted system will also be more profitable than the current system. The analysis for comparing the two systems requires that the causes and effects of sheep upon cropping and pasture rotations are understood and captured in the economics.

**AIMS**

To investigate if incorporating an increased legume component into the cropping system and improving sheep management will increase farm profit.

**METHOD**

The STEP Model (Simulated Transitional Economic Planner), is a decision tool that can be used to simulate the financial viability of different farming systems over time. It also has the ability to assess whether the farm business can afford to make the transition to the new system. Sensitivity of the systems to price and production levels can also be analysed (Peek, 2003). Within the model the same cost and price assumptions were used for both the current and future farming system calculated over a 10-year period. The base assumptions are listed in Table 1.

**Table 1. Base assumptions for the current farming system in the low rainfall eastern Wheatbelt**

<table>
<thead>
<tr>
<th>Arable Area</th>
<th>3000 ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereal</td>
<td>1638 ha</td>
</tr>
<tr>
<td>Legume</td>
<td>162 ha</td>
</tr>
<tr>
<td>Pasture</td>
<td>1020 ha</td>
</tr>
<tr>
<td>Saltland Pasture</td>
<td>180 ha</td>
</tr>
<tr>
<td>Merino Sheep</td>
<td>1852 head</td>
</tr>
<tr>
<td>Merino Lambing Percentage</td>
<td>72%</td>
</tr>
<tr>
<td>Cross-bred Sheep</td>
<td>423 head</td>
</tr>
<tr>
<td>Cross-bred Lambing Percentage</td>
<td>80%</td>
</tr>
</tbody>
</table>

Model the improved farming system that is based upon best practice management that includes an increased legume component in the cropping system (increase from 9 to 15 % of the cropped area) and improved livestock management resulting in improved ewe productivity and lamb survival up to 100% lambing for Merinos and 120% lambing for crossbred sheep in 10 years.

Compare and contrast the two systems based upon simulated results.

**RESULTS**

The results are based upon a 10-year time frame. Gross margin and business enterprise costs were used to calculate the overall net position of the farm enterprise. The analysis shows the two systems are at least as profitable as each other.

<table>
<thead>
<tr>
<th>Financial Information Summary</th>
<th>Improved Farming System</th>
<th>Current Farming System</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Yr. cumulative position (after interest &amp; tax)</td>
<td>$2,798,931</td>
<td>$2,797,365</td>
</tr>
</tbody>
</table>

In increasing the number of legume crops such as field peas and lupins, the improved farming system has a larger proportion of lower gross margin producing crops and relies upon the sheep production system generating a larger revenue stream to remain as profitable. This diversification reduces single commodity
price risks within the cropping system as well as between the cropping and animal production system. This income stream generated via sheep consists of:

- Trading sheep;
- Feeding pregnant and lactating ewes at an optimal level (Moir, 2002); and
- Improving lambing / marking percentages through improved management.

To improve sheep revenue, paddock size was decreased to improve stock management. This allowed for greater lambing survival through improved sheep management; the potential for a more diversified cropping and pasture mix; and an increased potential for crop and pasture disease control.

Six per cent of the farm is salt land. The improved system increased the productivity of this area by planting saltland pastures at a cost of $40,000 spent over the first three years of the system change. Long term benefits of this action not included in the analysis include management of the saline area; and reduced potential of land degradation through salinisation and rising water tables.

Sheep trading is included as an activity in the improved farming system and it is not a part of the current farming system. Sheep trading allows for better utilising of crop and pasture feeds by timing the purchase and selling decisions based upon available feed.

Although the improved farming system when assessed using the STEP model has a long-term performance similar to the current system, the improved farming system potentially reduces the risk exposure of the farm. Possible risk factors include:

- Herbicide resistance;
- Reliance on one enterprise to return the bulk of farm income;
- Crop and pasture disease control; and Land degradation.

Overall farm financial risks are reduced due to having a greater range of crop and animal income producing streams that can act as a buffer if a commodity price is adversely affected.

**CONCLUSION**

The results demonstrate that a shift to a more sustainable farming system does not require a large investment of capital to remain as profitable. The improved system with an increased emphasis on sheep management reduces overall risk pressures from a financial and agronomic perspective. The enterprise becomes more sustainable through managing salt land pasture areas and diversifying risks throughout the business enterprise. The change in land use to a more environmentally aware system, although not included in this analysis, would mean the long-term financial viability of the future system would exceed that of the current system through better management of constraining issues.

**KEY WORDS**

Sheep, sheep management, STEP, Simulated Economic Transitional Planner, Farming System

**ACKNOWLEDGMENTS**

In recognition of the systems thinking contribution to this paper by: Graham Mussell (Cropping systems); Sally Phelan (Saltland Pasture Systems); Danielle Power (Livestock Systems); and Michael Lloyd (Saltland Pasture Establishment).

**Paper reviewed by:** Tanya Kilminster

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Peek, C. 2003. How profitable are your pasture systems - Take the STEP to find out. Department of Agriculture Western Australia
Lucerne-based Pasture for the Central Wheatbelt – is it Good Economics?
Felicity Flugge\textsuperscript{A}, Amir Abadi\textsuperscript{A,B} and Perry Dolling\textsuperscript{A,B}
\textsuperscript{A} CRC for Plant-based Management of Dryland Salinity; \textsuperscript{B}Dept. of Agriculture, WA

\textbf{ABSTRACT}
This analysis evaluated the economics of lucerne-based pasture for a central wheatbelt farm in WA. Using a whole-farm model, the analysis found that including lucerne-based pasture increased farm profit by 3\%. However, including lucerne-based pasture and allowing the option of running merino prime lambs and cross-bred lambs increased farm profit by 23\%. Management changes, such as a change of rotations and a change in livestock structure, were necessary to realise the gains in profit.

\textbf{AIMS}
To determine if lucerne is profitable for a central wheatbelt farm. To determine what factors affect profitability of lucerne and what farm management changes occur if lucerne is adopted.

\textbf{METHOD}
The analysis used the central wheatbelt version of MIDAS (Model of an Integrated Dryland Agricultural System). MIDAS is a whole-farm model, which jointly emphasises the biology and economics of the farming system. The model determines a mix of enterprises which maximise profit, subject to managerial and resource constraints. For a full description of MIDAS see Kingwell and Pannell (1987). The central wheatbelt MIDAS model (CW-MIDAS) is based on a typical farm in the central wheatbelt region of Western Australia. CW-MIDAS assumes a farm size of 1800 ha, made up of 8 land management units (LMU).

The lucerne biomass data was estimated by the Agricultural Production Systems Simulator (APSIM, Robertson \textit{et al}, 2002) based on historical weather data (1957-2002) from Cunderdin. The lucerne biomass includes an annual pasture component during winter and spring, thereby making it a lucerne-based pasture (for ease of reporting, lucerne-based pasture is referred to as lucerne). The data was estimated for a soil representing good sandplain (LMU 3). The study involved simulating a repeating rotation of four years of lucerne (sown in the first year and removed in the 5\textsuperscript{th} year) followed by two years of wheat. To simulate a 6 week rotational grazing pattern in APSIM, the lucerne was cut (to simulate a grazing event) on 26 November in the initial year and then every 6.5 weeks after the first cut. The lucerne stem density was 150 stems/m\textsuperscript{2} throughout the study. The average lucerne biomass production for each 6.5 week period was then used in CW-MIDAS. The biomass of other LMUs was estimated relative the base LMU. Poor sandplain (LMU 1) was 50\% of the biomass of good sandplain, average sandplain (LMU 2) 65\%, shallow duplex (LMU 4), heavy valley floors (LMU 5) and sandy surfaced valleys (LMU 6) 75\% and medium heavy (LMU 7) and deep duplex soil (LMU 8) 100\%. Establishment costs of lucerne were assumed to be $120/ha (including fertiliser, chemicals, cash machinery costs, machinery depreciation and seed costs). Maintenance costs of lucerne pasture in subsequent years were assumed to be $20, which is similar to the cost of continuous annual pasture.

The option of selling prime and crossbred lambs was included in the analysis. Prime lambs and crossbred lambs were assumed to sell for a premium of $12/head and $17/head over unfinished lambs. Time of lambing was assumed to be May and prime and crossbred lambs were sold in December. For ease of reporting results, prime and crossbred lambs are referred to jointly as prime lambs. Note that the farm is still predominantly running a wool producing flock, as only a portion of lambs can be sold as prime or crossbred lambs.

\textbf{RESULTS}

\begin{table}[h]
\centering
\begin{tabular}{|l|l|l|l|}
\hline
                  & Without lucerne or prime lambs & With lucerne only & With prime lambs only & With lucerne and prime lambs \\
\hline \% profit change from base & - & 3\% & 12\% & 23\% \\
\% of farm in crop & 60\% & 59\% & 55\% & 54\% \\
\% of farm in annual pasture & 40\% & 35\% & 45\% & 34\% \\
\% of farm in lucerne & - & 6\% & - & 12\% \\
\hline
\end{tabular}
\end{table}
When lucerne rotations were made available to the model, lucerne was selected as part of the optimal plan at 6% of total farm area (Table 1). This has a small impact on whole-farm profit, increasing it by 3%. The main economic benefit from lucerne, in this case, was that it decreased supplementary feed requirements by 5kg/DSE. Including the option of prime lambs (without lucerne) had a larger impact on profit, increasing it by 12% (Table 1).

Adopting both lucerne and prime lambs together had a multiplying effect with a larger gain in profit ($26,300 per year, or 23%) than adding the two options together (Table 1). Selling prime lambs increased the optimal area of lucerne from 115 ha to 215 ha. Profit increased because the additional feed provided by the lucerne meant that more more ewes were carried and more prime lambs were finished per hectare of pasture. Prime lambs are finished during the months of September, October and November. Including lucerne allowed some deferment of the annual pasture from September until November. The lucerne also provided feed of higher quality during October and November.

With the introduction of both lucerne and prime lambs, the proportion of farm in crop decreased by 6% (Table 1). The percentage of farm selected as lucerne was 12%, meaning there was replacement of annual pasture with lucerne. However, this was not a direct replacement of annual pasture with lucerne (Table 2). Lucerne rotations were selected on LMUs 7 and 8 and replaced a three year crop rotation of wheat and field peas/lupin. Consequently, the annual pasture which is selected on part of LMU 2 was replaced by a three year crop rotation of wheat and lupins. Therefore, the optimal way of including lucerne in the farm plan involves a shift, not only on the LMU’s where lucerne is to be grown but on another of the LMUs as well.

<table>
<thead>
<tr>
<th>Land Management Unit</th>
<th>Without lucerne</th>
<th>With lucerne</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average sandplain (LMU 2)</td>
<td>PPPP</td>
<td>WWL</td>
</tr>
<tr>
<td>Sandy surfaced valleys (LMU 7)</td>
<td>WWF</td>
<td>3UCC/WWF</td>
</tr>
<tr>
<td>Deep duplex (LMU 8)</td>
<td>WWL</td>
<td>3UCC/WWL</td>
</tr>
</tbody>
</table>

PPPP = continuous annual pasture; WWL = wheat, wheat, lupin; WWF = wheat, wheat, field pea; 3UCC = lucerne, lucerne, lucerne, cereal, cereal

The importance of the rotational changes to the profitability of lucerne was tested by constraining the model in one of two ways. Firstly, lucerne was made available to the model only on LMU’s that were previously in annual pasture. Secondly, the model was constrained so that lucerne was only available on the optimal LMUs, i.e. LMU 7 and 8, but no other rotations could be changed. The change in profit for each of these scenarios, relative to the scenario with prime lambs included only, was -6% and -1%, compared with a potential 11% when the optimal set of rotation changes occurs. These results indicate that both growing lucerne on the optimum LMUs and changing the rotations of other LMUs are both important factors in maximising profit from lucerne.

CONCLUSION

This analysis has shown that lucerne-based pasture can be a profitable option for central wheatbelt farming systems. However, some whole-farm management changes underlie the profitability of lucerne. In particular, this analysis has identified two whole-farm adjustments, a change in livestock management to include prime lambs, and a change in rotations, which will influence the profitability of lucerne. Future research and extension of lucerne will need to include consideration of whole-farm management practices.

KEY WORDS

Whole-farm modelling, profit, whole-farm management, prime lambs

Paper reviewed by: Emma Kopke

REFERENCES

Kingwell, R.S., and Pannell, D.J., eds. 1987. MIDAS, a bioeconomic model of a dryland farm system, Pudoc, Wageningen.

Sheep and Biserrula can Control Annual Ryegrass
Dean Thomas, John Milton, Mike Ewing and David Lindsay, The University of WA
Clinton Revell, WA Department of Agriculture

ABSTRACT

The dual aims of higher productivity from pastures and better control of crop weeds may be achieved by manipulating the grazing behaviour of livestock and the genotype of the legume. Among pasture legumes, Casbah biserrula is a good candidate to manipulate the grazing behaviour of sheep. Sheep targeted annual ryegrass selectively in pastures sown with biserrula compared with those sown with other species. We reasoned that sheep grazing a biserrula and ryegrass pasture target ryegrass because they develop an aversion to biserrula. To test this we grazed sheep on pastures with only biserrula, 50% biserrula and no biserrula. Sheep that grazed a pasture with a high proportion of biserrula developed an aversion to this forage while sheep that grazed a pasture with a lower proportion of biserrula did not. Providing that there is enough biserrula in the pasture mix, this species in conjunction with grazing, can effectively control crop weeds such as annual ryegrass.

AIMS

Favourable changes in the composition of pastures can be achieved by manipulating the grazing behaviour of livestock. This may be achieved either by using the inherent differences in the preference of livestock among pasture species or by managing their learned preferential behaviour. This paper reports a strategy to improve control of crop weeds in pastures by exploiting the selective grazing behaviour of sheep. In this strategy, a useful pasture legume is one that is less preferred by sheep than other pasture components, particularly plants such as annual ryegrass that can be a weed in a subsequent crop. Sheep grazing this mixed pasture would be expected to avoid grazing the legume and eat the ryegrass, thus reducing the number of ryegrass seeds produced. The extra nitrogen and organic matter produced by the legume should also benefit the subsequent crop.

Biserrula has been identified as a useful legume for this strategy since sheep are known to graze annual ryegrass selectively in a pasture sown with biserrula (1). However the reasons for this grazing behaviour are largely unknown as biserrula is not inherently unpalatable. Rather, in short-term preference tests, sheep unfamiliar with biserrula were found to have a moderate acceptance of biserrula relative to other legumes (2)(3). Postingestive feedback is known to have a strong influence on diet selection by sheep (4). In view of this we hypothesised that sheep may develop an aversion to biserrula when they graze a pasture in which it is a major constituent and so make it more effective in weed control strategies.

METHOD

Five groups of 10 Merino hoggets grazed for four weeks on pastures sown with i) 100% Casbah biserrula, ii) 100% crimson clover, iii) 100% annual ryegrass, iv) 50% biserrula and 50% annual ryegrass or v) 50% crimson clover and 50% annual ryegrass. Each group then grazed randomized monoculture rows of biserrula, crimson clover and annual ryegrass and their preference was calculated from the decrease in the biomass of pasture samples that were taken from paired sites before and after grazing using the Chesson-Manly selection index (5). A new group of hoggets was used in the experiment at the vegetative, reproductive and senesced phases of pasture growth.

RESULTS

Sheep that grazed the pasture sown only to biserrula subsequently avoided biserrula, while those that grazed pastures sown to 50% or no biserrula showed no apparent aversion to biserrula when offered a choice among the monoculture rows (Table 1). This avoidance behaviour was seen at both the vegetative and reproductive phases of plant growth, but not with senesced pasture.
Table 1. The relative preference ($\alpha$) of five groups of Merino hoggets for crimson clover, biserrula and ryegrass after each group had grazed a different pasture at three phases of growth

<table>
<thead>
<tr>
<th>Phase of Growth</th>
<th>Pasture previously grazed</th>
<th>Crimson clover</th>
<th>Annual ryegrass</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Biserrula</td>
<td>0.02$^{a} \pm 0.02$</td>
<td>0.67$^{bc} \pm 0.04$</td>
</tr>
<tr>
<td></td>
<td>Biserrula/ryegrass</td>
<td>0.32$^{cd} \pm 0.07$</td>
<td>0.46$^{a} \pm 0.06$</td>
</tr>
<tr>
<td></td>
<td>Crimson clover</td>
<td>0.41$^{b} \pm 0.06$</td>
<td>0.49$^{ab} \pm 0.08$</td>
</tr>
<tr>
<td></td>
<td>Crimson clover/ryegrass</td>
<td>0.19$^{bc} \pm 0.05$</td>
<td>0.52$^{ab} \pm 0.07$</td>
</tr>
<tr>
<td></td>
<td>Ryegrass</td>
<td>0.10$^{ab} \pm 0.05$</td>
<td>0.81$^{a} \pm 0.07$</td>
</tr>
<tr>
<td>P-value</td>
<td>&lt;0.001</td>
<td>0.004</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Errors are standard errors of the mean (n=6). Values within columns for each phase of growth with different superscripts are different (P<0.05). For neutral preference $\alpha = 0.33$.

CONCLUSION

Sheep that grazed a pasture with a high proportion of Casbah biserrula developed an aversion to this forage. This aversive behaviour does not appear to be a result of the sheep becoming familiar with biserrula nor some inherent unpalatability of this forage. The aversive behaviour of sheep may explain why biserrula is proving to be effective to control crop weeds with biserrula dominant pastures, in a pasture phase. However, sheep grazing a pasture with a low proportion of biserrula are less likely to develop an aversion and may continue to eat the biserrula.

KEY WORDS

Sheep, biserrula, crop weeds, aversive behaviour

ACKNOWLEDGMENTS

We are grateful for the technical assistance provided for this study by Steve Gray, Manager, Allandale Farm, Wundowie.

Paper reviewed by: Dr Ian Williams

REFERENCES


Pasture Utilisation, Fleece Weight and Weaning Rate are Integral to the Profitability of Dohnes and SAMMs.

Emma Kopke, Western Australian Department of Agriculture
John Young, Farming Systems Analysis Service

ABSTRACT

Very favourable market conditions for lamb and mutton over recent years and continuing uncertainty over the demand for wool, has led some broadacre producers to switch from the Merino to other sheep breeds better suited to meat production. This analysis examines the importance and sensitivity of characteristics of the Dohne Merino and the South African Mutton Merino on profit, using the whole-farm model MIDAS. Results indicate that weaning rate, fleece weight and pasture utilisation are keys to the profitability of Dohnes and SAMMs. Further research to determine the performance of these breeds in Western Australian farming systems will assist producers to make more confident and informed decisions about these breeds.

AIM

To examine the importance and sensitivity of characteristics of the Dohne and the SAMM on whole farm profitability. Weaning rate, fleece weight, fibre diameter and pasture utilisation are analysed.

METHOD

The South Coast farming system model (SC-MIDAS) was used in this analysis. MIDAS is a whole-farm, profit-maximizing model that calculates optimal farm management practices, given a set of production relationships provided by the user. Optimal combinations of enterprises are found through using detailed biological, technical and financial information to compare the relative profitability of various enterprise combinations. For a full description of MIDAS see Kingwell and Pannell (1). The SC-MIDAS model is based on a typical mixed crop and livestock farming system in the region north of Albany to east of Esperance (medium rainfall: 400-500 mm) with an assumed farm size of 2500 ha.

Australian Merino (Merino), Dohne Merino (Dohne) and South African Mutton Merino (SAMM) flocks were examined. The flocks were self replacing and allowed up to 33% of Merino wether and surplus ewe lambs and 90% of Dohne and SAMM wether and surplus ewe lambs to be sold as prime lambs. The most profitable pure Merino flock structure was used for comparison in this analysis (2).

To date very little research on the performance of Dohnes and SAMMs in Australian farming systems has been carried out. For this reason, assumptions on the performance of these breeds were estimated from South African research (Table 3).

Table 3: Standard characteristics of the Merino, Dohne and SAMM

<table>
<thead>
<tr>
<th></th>
<th>Merino</th>
<th>Dohne</th>
<th>SAMM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of lambing</td>
<td>August</td>
<td>August</td>
<td>August</td>
</tr>
<tr>
<td>Time of lamb sale</td>
<td>January</td>
<td>January</td>
<td>January</td>
</tr>
<tr>
<td>Age at first mating (years)</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Lambs weaned per ewe joined (%)</td>
<td>81</td>
<td>91</td>
<td>111  (+30%)</td>
</tr>
<tr>
<td>Average weaning weight (kg)</td>
<td>25</td>
<td>29</td>
<td>31   (+24%)</td>
</tr>
<tr>
<td>Ewe mature weight (kg)</td>
<td>67</td>
<td>71</td>
<td>76   (+13%)</td>
</tr>
<tr>
<td>Stocking rate (DSE/ winter grazed ha)</td>
<td>8.3</td>
<td>7.3  (-11%)</td>
<td>6.8  (-22%)</td>
</tr>
<tr>
<td>Clean fleece weight (kg cln wt)</td>
<td>2.44</td>
<td>1.70 (-30%)</td>
<td>1.22 (-50%)</td>
</tr>
<tr>
<td>Fibre diameter (µm)</td>
<td>20</td>
<td>20</td>
<td>21.5 (+7.5%)</td>
</tr>
</tbody>
</table>

Due to uncertainty surrounding the performance of Dohnes and SAMMs in Australian farming systems, a sensitivity analysis was carried out to identify characteristics most likely to affect profitability. Characteristics analysed were clean fleece weight (CFW), fibre diameter and weaning rate (lambs weaned per ewe joined). The break-even changes in each characteristic to make Dohnes and SAMMs as profitable as Merinos were identified also.
Two levels of feed utilisation were examined for Dohnes and SAMMs. Firstly, feed utilisation of Dohnes and SAMMs was assumed to be the same as Merinos. With this assumption the model was forced to run Dohnes and SAMMs at a lower stocking rate than Merinos (Table 1). Secondly, feed utilisation rates of Dohnes and SAMMs were increased to allow the same stocking rate to be run for each genotype. This was achieved by altering the relative feed intake of each breed in the model.

RESULTS AND DISCUSSION

Dohnes and SAMMs are approximately 7% less profitable than Merinos, given the assumed characteristics in Table 3. Feed intake, weaning rate and CFW influence the profitability of Dohnes and SAMMs. However the impact of fibre diameter on profit is negligible.

Figure 1(a) illustrates the impact of CFW on whole-farm profit of Dohnes and SAMMs. Dohnes require a CFW of 1.84 kg (8% greater than the assumed 1.7 kg) to be as profitable as Merinos, when Dohne weaning rate is 91%. Similarly, SAMMs require a CFW of 1.40 kg (15% greater the assumed 1.22 kg) to be as profitable as Merinos, when the SAMM weaning rate is 111%. Dohne profitability is more sensitive to CFW because Dohnes produce more, higher value wool (finer fibre diameter) than SAMMs.

Weaning rate is defined as the number of lambs weaned per ewe mated. Figure 1(b) illustrates the impact of weaning rate on the profitability of Dohnes and SAMMs. Dohnes require a weaning rate of 99% (9% greater than the assumed 91%) to be as profitable as Merinos, when Dohne CFW is 1.70 kg. Similarly, SAMMs require a weaning rate of 119% (7% greater than the assumed 111%) to be as profitable as Merinos, when the SAMM CFW is 1.22 kg. SAMM profit is more sensitive to weaning rate because SAMMs produce larger lambs than Dohnes.

Unfortunately, there have been no experiments conducted to indicate whether the required weaning rate or fleece weight increases occur in practice.

Fibre diameter has very little impact on the profitability of Dohnes and SAMMs, largely due to the current lack of fibre diameter price premiums.

It has been assumed in the results presented so far that the pasture utilisation of each breed is the same. This causes the stocking rate of Dohnes (7.3 DSE/ha) and SAMMs (6.8 DSE/ha) to be lower than Merinos (8.3 DSE/ha). This is because Dohnes and SAMMs are both larger animals and therefore have a higher maintenance requirement than Merinos (9). But when the pasture utilisation rates of Dohnes and SAMMs were increased to allow the same stocking rate to be run for each genotype, profit increased markedly (19% and 31%) (Table 2).

<table>
<thead>
<tr>
<th>Feed Intake Scenario</th>
<th>Dohne</th>
<th>SAMM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same pasture utilisation, different stocking rate (standard)</td>
<td>$145,500</td>
<td>$144,700</td>
</tr>
<tr>
<td>Different pasture utilisation, same stocking rate</td>
<td>$173,000</td>
<td>$190,000</td>
</tr>
</tbody>
</table>

It is difficult to determine which scenario best reflects what happens on-farm, and there is no research to support either. Even if Dohne or SAMM producers may have maintained their stocking rate after switching genotype, it is difficult to determine whether this is due to genotype differences or because pastures were
previously under-utilised. It is important to verify if differences in relative and potential feed intakes of Merinos, Dohnes and SAMMs exist, given the large potential difference in profit between the scenarios.

Ideas for further consideration

- This analysis has highlighted the characteristics that Dohnes and SAMMs require to be as profitable as Merinos. In reality, because of the effort, cost and additional risk associated with changing genotype, profit increases need to be much more than just break-even.

- The Merino flock used for comparison in this analysis isn’t the most profitable flock for the South Coast (2). When weighing up breeds, farmers need to consider alternative ways of improving the profitability of their Merino flock, such as changing breeding objectives or altering their flock structure to include more profitable enterprises such as first cross prime lambs.

- If standard assumptions in this analysis are correct and Dohnes and SAMMs are less profitable than Merinos, then breeding programs designed to improve meat characteristics of the Merino may not necessarily improve profit. To balance price risk by increasing income from both meat wool production may be less profitable than specialising in either (10).

- Higher stocking rates are an alternative way of maximising pasture utilisation.

CONCLUSION

Pasture utilisation, weaning rate and fleece weight are key determinants of the profitability of Dohnes and SAMMs. Fibre diameter had very little impact on the profitability of these breeds. Further research on the performance of Dohnes and SAMMs in Western Australian farming systems is necessary if producers are to make more confident and informed decisions on the profitability of these breeds.

KEY WORDS

Whole-farm modelling, South Coast, alternate sheep breeds.

ACKNOWLEDGMENTS

Paper reviewed by: Ross Kingwell

REFERENCES


Environmental Impact of Sheep Confinement Feeding Systems
E A Dowling and E K Crossley, Department of Agriculture Western Australia

ABSTRACT

When it comes to confined feeding, are sheep ‘mini-cows’? Legally sheep confinement feeding systems should be set up and managed according to cattle guidelines and most recommendations for the design and management of sheep confinement feeding systems are based primarily on the cattle feedlot guidelines. However, there are significant differences between feedlotting cattle and sheep confinement feeding that suggest the environmental impacts of the two systems may not be similar. Differences between the two systems include the composition and consistency of manure, particularly in relation to pollution potential and the way manure should be handled. The “Sustainable Sheep Confinement Feeding Systems” project is exploring the environmental impact of sheep confinement feeding systems by measuring nutrient run off, groundwater contamination, greenhouse emissions, dust potential, noise, odour and flies at a number of sites in dryland WA. These results will be used by industry to develop a code of practice for confinement feeding of sheep.

INTRODUCTION

Confinement feeding systems are defined as “an enclosed area where all feed and water are brought to the animal. This includes any grain finishing systems from purpose built systems through to small paddocks with self feeders” (1). In dryland Australia, confinement feeding systems have been primarily used to achieve a consistent quality of lambs to meet market specifications (2) and to maintain the base flock in times of drought without further depleting soil and pasture resources (3). However the potential of sheep confinement feeding systems to cause land degradation, pollution and other related effects at the farm and catchment level has not been quantified. Neither has there been any research into how site and environmental factors such as slope, soil type, hydrology, rainfall, and distance to waterways affect potential degradation. Currently sheep confinement feeding systems for less than 10,000 animals are subject to the same EPA restrictions as cattle feedlots. It is the responsibility of the operator to neither pollute nor cause any form of environmental harm without “appropriate approvals” (4). Many state departments of agriculture have developed guidelines for sheep confinement feeding systems but these are based on data from other intensive industries, primarily cattle feedlotting and general land conservation. In effect sheep are viewed as ‘mini cows’ by legislators and agricultural advisers despite some fundamental differences between intensive cattle and sheep production. This paper concentrates on the differences in sheep and cattle manure as documented in literature.

REVIEW

Pollution potential of cattle and sheep manure

Manure is loaded with nutrients such as nitrogen, potassium and phosphate, as well as salts and can be highly pollutive. The pollution strength of the organic matter in manure is often expressed as the biochemical oxygen demand (BOD5), which is the amount of oxygen required to stabilise decomposable organic material under aerobic conditions. Another useful measure is the BOD:COD ratio (biochemical oxygen demand: chemical oxygen demand) which measures the degradability of organic carbon (5). The higher the BOD:COD ratio, the faster the sample will degrade and cause nuisance conditions. Once the available oxygen has been used up, manure decomposes anaerobically, resulting in emission of greenhouse gases and noxious odours such as hydrogen sulphide, ammonia and methane.

Manure quantities and composition are influenced by many factors including age, breed, rations and weight (7). Currently there is little documentation on the composition of sheep manure under dryland Australian conditions. However, the differences between feedlot cattle and sheep manure characteristics are documented in the following table (5).

<table>
<thead>
<tr>
<th>Manure characteristics</th>
<th>Beef Cattle</th>
<th>Sheep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet excreta waste (as % total liveweight) per day</td>
<td>4.6</td>
<td>3.6</td>
</tr>
<tr>
<td></td>
<td>Total solids excreted (as % total wet excreta waste) per day</td>
<td>% Total Nitrogen in manure</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------------------------------------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Total solids excreted</td>
<td>17.2</td>
<td>7.8</td>
</tr>
<tr>
<td>(as % total wet excreta</td>
<td>29.7</td>
<td>4.0</td>
</tr>
<tr>
<td>waste) per day</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

On a kilo for kilo basis, sheep produce two thirds as much manure; it is drier; has half the concentration of nitrogen and almost twice as much potassium (6). Sheep manure has a much lower biochemical demand for oxygen. Whilst these figures suggest that sheep manure is less polluting than cattle manure, there is a wide range of documented values which illustrates the need for a range of ‘norms’ for sheep manure in Australian conditions.

**Manure management**

Manure management is a major environmental issue for intensive livestock production. “For every kilogram of animal product consumed by humans, over 20 kg of wastes are generated in animal feedlots” (5). Sheep manure is difficult to dilute or mix with water, as solids tend to float. Consequently, with the exception of manure from early-weaned lambs on a liquid diet, sheep manure is best handled in solid form (6). The comparative dryness of sheep manure is a potential benefit. With good manure management, moisture levels could be kept below 33% where there is no oviposition from any flies or any fly development (5).

**CONCLUSION**

If confinement feeding systems are to be an ongoing part of wool and sheepmeat production, they need to meet and exceed consumer demands for product integrity which includes environmental sustainability and animal welfare. The industry therefore needs to know what the normal ranges of nutrient composition and pollution potential of manure from sheep confinement feeding systems are under dryland Australian conditions and to develop a code of practice to minimise their environmental impact. An industry code of practice will assist producers in site selection, design and management of sheep confinement feeding systems and guarantee wool and sheepmeat will meet existing and future international and domestic consumer requirements for environmentally sustainable production.

**KEY WORDS**

Environment, manure, confinement, feeding

**ACKNOWLEDGEMENTS**

Paper reviewed by: Lock Buttler

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Smart Grazing Management for Production and Environmental Outcomes

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ABSTRACT

Producers and scientists often disagree about whether rotational grazing can improve production and profitability. Grazing trials in small paddocks have failed to capture the spatial aspects of rotational grazing, and research that only controls timing of grazing consistently shows limited benefits, if any. Producers practicing rotational grazing manage animal distribution as well as rest from grazing, and are usually happy with the result. Some form of innovative grazing management may be the only way to manage livestock with environmental and financial sustainability, especially in the pastoral zone.

INTRODUCTION

Smart producers with livestock on pastures should be asking themselves a few key questions: Is the consumable forage resource a finite amount based on my plants, soil and climate, or can I manage livestock to enhance forage available for grazing? Is my carrying capacity based simply on pasture productivity, or can I improve my sustainable stock numbers through better grazing management? Can I improve or at least maintain the nutritional quality of forage through grazing management? Can smart grazing management allow me to reduce risk and be better prepared for poor seasons? The answer to all these questions is Yes! Smart grazing management is all about achieving the highest level of livestock production on an ecologically sustainable basis at a lower cost:benefit ratio.

The high-risk scenario

Livestock set-stocked on paddocks year-round, or for the length of the grazing season in the wheatbelt, is a high-risk grazing strategy. Sheep and cattle are creatures of choice and habit. They will eat plants that taste better, and they will look for preferred food in familiar places. Over time, repetitive grazing weakens preferred plants, and they eventually die out. Over time, the pads that radiate from water points and camps turn into erosion channels. Over time, the familiar foraging areas become overgrazed patches with poor-quality plants, less ground cover, poor infiltration, and soil loss. Low stocking rates, and regular adjustment of stocking rate to match seasonal conditions, can counteract this scenario to a degree, and some soil and vegetation types are naturally less susceptible to grazing. In general, however, set-stocked continuous grazing is a recipe for declining productivity and land degradation. The risk of unsustainability is high. This was recognised in the pastoral zone 50 years ago (Nunn and Suijendorp 1954).

Management to break grazing habits

The challenge for a smart manager is how to break livestock grazing habits, and achieve a low-risk yet high-yielding production system. The manager may not alter selection of preferred forage plants, but he wouldn’t want to. Palatable plants tend to be more nutritious, and livestock can select the most nutritious parts of the plants. If the same plant is grazed repeatedly, the material taken in successive bites is progressively less nutritious. On the other hand, grazing can stimulate regrowth consisting of new shoots that are palatable and nutritious, but produced at high metabolic cost to the plant. Grazing regrowth can reduce the plant’s ability to compete with neighbours. Livestock need to be taken away from plants that are being selected into oblivion, and those plants given a chance to recover.

The most powerful grazing management tool is to move stock into fresh paddocks, breaking the habits of travelling along familiar pads and grazing familiar patches. A relatively short stay in each paddock will lessen the impact of a new set of spatial habits, and reduce repetitive grazing on preferred plants. In the pastoral zone paddocks are grazed for 3-8 weeks, or for longer during lambing, and a rotation cycle through every paddock may take a year or more to complete, providing about a year of rest.

This management strategy is rotational grazing, but it goes by different forms and labels depending on who the advocate is. Rotational grazing has a mixed reputation, mainly because most research doesn’t support the higher livestock performance that graziers claim to get from it. However, grazing research has focussed on the timing of grazing, and has failed to study how rotational grazing alters animal distribution at the property scale. Taking spatial aspects of grazing into account, together with provision of rest,
suggests that control over animal distribution and density may be more important to livestock production and environmental outcomes than the timing of the rotation (Norton 1998).

**SMART GRAZING MANAGEMENT**

*Management to increase available forage and carrying capacity*

Left to themselves in paddocks large enough to provide feed for a year, livestock develop spatial patterns of grazing that exploit only a fraction of the total area. The bigger the paddock, the greater the area untouched or lightly grazed. Merely by subdividing a large paddock, and moving stock into parts of the landscape previously neglected, a manager can override habitual behaviour and increase de facto the amount of forage available. Pastoralists have observed that even without paddock subdivision, a large mob grazing for a short time will achieve more even utilisation of the whole paddock, than a small herd grazing for a long time. In each case, more area supplying feed means higher carrying capacity.

*Management for animal nutrition*

Set-stocked continuous grazing will eventually eliminate the most palatable plants in habitual foraging sites, and encourage species that have mechanisms to avoid or tolerate grazing. Providing rest from grazing allows preferred plants to recover their competitive strength. This recovery is particularly important for root growth into deeper soil layers. Drought survival is a function of root access to soil water reserves. Management to maintain palatable nutritious plants is fundamental, and it can be done through paddock rotation (Earl and Jones 1996). When time in a paddock is limited, livestock select from the most nutritious fraction of preferred plants, reducing intake of coarse, less-digestible material. Short grazing periods have been linked to higher animal production (Norton 2003).

*Improved planning and risk reduction*

Rested paddocks are stores of future feed, readily assessed. Gauging available forage for the season ahead is easier in a rotation, and adjustments of stock numbers can be made with confidence. Waiting for animal condition to signal the need to de-stock is a high-risk strategy. Operating costs of labour and vehicles are reduced when the need to check water is confined to the paddocks where the sheep are. This issue is acute in the pastoral zone, where 8 man-days per week during summer may be devoted to checking water if every paddock is stocked. Freed from whole-station infrastructure service, pastoralists have more discretionary time. Delivery of nutritional supplements and other husbandry practices is easier to a few paddocks at a time. A paddock rotation that delivers sheep to the shearing shed at shearing time is more efficient than mustering every paddock.

**CONCLUSION**

Pro-active grazing management using paddock rotation to control animal impacts on preferred plants is also a tool for improving land-use efficiency and providing the best plane of animal nutrition. Other benefits include easier matching of forage demand to anticipated supply, and lower operating costs, which collectively reduce risk when compared with set-stocked continuous grazing.

**KEY WORDS**

Grazing management, rotational grazing, risk reduction

**Paper reviewed by:** Dr Leigh Hunt, CSIRO Sustainable Ecosystems, Winnelle, NT

**REFERENCES**

Common Causes of Plant Poisoning in the Eastern Wheatbelt of Western Australia.
Roy Butler, Dryland Research Institute, Department of Agriculture, Merredin

ABSTRACT
In the eastern wheatbelt, most cases of plant poisoning are caused by a relatively small group of plant species. Excluding annual ryegrass and narrow leafed lupin stubble, the plants commonly associated with sheep poisoning in the eastern wheatbelt are slender ice plant, caltrop, a few members of the Gastrolobium genus and marshmallow.

INTRODUCTION
Outbreaks of plant poisoning in sheep often seem to be unpredictable and therefore un-preventable. In fact in the eastern wheatbelt, relatively few plant species cause most of the cases of poisoning. With some knowledge of the common toxic plants and the circumstances under which poisoning occurs, farmers could prevent most of the sheep losses and suffering due to plant poisoning.

REVIEW
Slender ice plant (Mesembryanthemum nodiflorum) (1)

In WA there are four species of plant that are commonly called ice plants: three Mesembryanthemum species (M. nodiflorum, M. crystallinum and M. aitonis) and Cleretum papulosum subspecies papulosum. All four are succulent, introduced annuals and all contain the potential poison, oxalate. Soluble oxalate levels up to 35.78% dry wt. for M. nodiflorum and 28.20% dw for C. papulosum have been measured. Plant levels of soluble oxalate above 2% dw are considered to be potentially toxic. The ice plant responsible for most cases of ice plant poisoning is M. nodiflorum, (slender ice plant).

Slender ice plant poisoning usually occurs in summer, when sheep eat the dead, dry plant. Its high sodium content – 3.48% in one sample collected in March - may be the attractant. Typically, sheep are found dead or recumbent within three days of entering a fresh paddock, usually a cereal stubble. Sheep die quietly, without struggling. Affected live animals are weak, and may have a watery nasal discharge. Pregnant ewes, young sheep, hungry sheep and sheep that have not previously had access to other oxalate containing plants are more susceptible to oxalate poisoning, but any sheep may be affected. The primary cause of death is acute hypocalcaemia, often complicated by renal, pulmonary and gastrointestinal damage from calcium oxalate crystals.

Early treatment with intravenous or subcutaneous calcium borogluconate can save animals.

Caltrop (Tribulus terrestris) (2,4)

Caltrop is a summer growing annual herb. It is uncertain whether the caltrop in WA was introduced or is native. In other States caltrop may cause nitrate poisoning and staggers, but in WA the only syndrome seen is due to liver damage from steroidal saponins, possibly in conjunction with some other agent.

Caltrop poisoning occurs when sheep eat rapidly growing or just wilting plants. The most prominent sign is photosensitisation, or sunburn, of any skin not protected by wool, commonly the face and ears. Severe jaundice is usually evident at autopsy. Complete recovery of affected sheep may be prolonged (1 – 2 months) and there is no specific treatment.

The Gastrolobium genus (3)

There are over 30 poisonous species included in this genus. They are native shrubs, pea-flowered and pod-bearing. Concentration of the toxin, mono-fluoroacetic acid, is generally highest when plants are growing rapidly (as after summer storms), flowering or podding. High available soil fluorine levels and low soil pH also increase plant toxicity by enhancing fluorine uptake.

Signs of poisoning appear 0.5 to 2.5 hours after consumption of the plant. Signs vary from dejection and separation from the flock, to excitement, muscular spasms and convulsions. Heart rate is rapid and
irregular, and breathing is laboured. Moving affected sheep may increase the death rate. Treatment is rarely attempted or successful. Dead sheep often have bloody froth at the nostrils and mouth and decompose rapidly.

In the eastern wheatbelt most of the stock losses due to Poison bushes seem to be caused by Box, Wodgil and Narrow−Leaf Poison. There is a need for a simple, mainly pictorial guide to the identification and distribution of the Gastrolobium species in south-west WA.

**Marshmallow or small flowered mallow (Malva parviflora) (4,5)**

Marshmallow is an herb introduced from Europe. It is commonly found in neglected gardens, chicken runs, stockyards, disused feedlots and, increasingly, in pastures.

Marshmallow plants may contain toxic levels of nitrate, but marshmallow poisoning, or staggers, is mostly due to another, unidentified toxin. Usually, the condition is seen in late winter−spring after sheep have spent less than 24 hours in yards full of marshmallow, but it may also occur after some weeks of grazing pastures in which marshmallow is a prominent component.

Sheep do not show signs of poisoning until they are driven. In a mob of ewes and lambs, only the lambs may be affected. Affected sheep are reluctant to walk, and take progressively shorter steps, moving stiffly with back arched. They usually stop, lie down within 20 metres and recover unless forced to move, when they will lie down again after a shorter distance. The signs shown are due to pain and weakness in damaged muscles, and the nervous system is unaffected. Deaths are rare.

There is no treatment for marshmallow poisoning. Hungry stock should not be put into yards or paddocks infested with the weed, unless given alternative feed, such as hay.

**CONCLUSION**

Plant poisoning is one of the common causes of illness and death of sheep in the eastern wheatbelt. By learning to recognise the small number of plants responsible for most cases of poisoning and understanding the circumstances under which poisoning occurs, most farmers could shift the emphasis, in relation to plant poisoning, from diagnosis and treatment after the event, to prevention.

**KEY WORDS**

Sheep, Poisonous Plants

**Paper reviewed by:** Dr Jeremy Allen

**REFERENCES**

Selecting Sheep for Resistance to Worms and Production Trait Responses
John Karlsson¹, Johan Greeff¹ & Geoff Pollott², ¹Department of Agriculture, Katanning WA & ²Imperial College London UK

ABSTRACT

The Rylington Merino (RM) flock has been selected for worm resistance based on low faecal worm egg count (FEC) since 1988. The annual genetic gain of over 2% was obtained with a practical selection methodology suitable for the industry.

The economically important production traits are measured in the RM flock. No adverse genetic or phenotypic correlations have been found between FEC and the production traits.

Benchmarking the RM flock against industry flocks with FEC information on a National Genetic database indicates that the RM flock has a high level of worm resistance without any reduction in production trait performance.

AIMS

To determine if selection of sheep for resistance to worms resulted in any correlated responses in production traits

To link previous within line analysis of the Rylington Merino selected and control lines with industry flock data through current genetic links.

METHOD

Data supplied from Merino flocks with faecal worm egg (FEC) and production data and linkages to the Rylington Merino (RM) flock was analysed to determine genetic trends and correlated responses.

RESULT

The genetic response (Fig1) to selecting for low FEC in the Rylington Merino selection line represents an annual improvement of over 2%. Over the first four years selection was based on the individuals own performance from the average of monthly FEC between weaning and hogget age. Then with pedigree information and the use of ‘Best Linear Unbiased Prediction’ (BLUP) analysis methodology the individual FEC counts were reduced to two per animal at weaning and hogget age. However, it is critical that these measurements are taken when there is a discriminating worm challenge resulting in an average flock FEC of app. 500 eggs per gram of faeces.

The genetic trend of clean fleece weight (CFW) within the RM flock (Tab 1) shows that selection for low FEC has not resulted in any unfavourable response in CFW and no real difference between the two lines. The RM flock is slightly above industry average for CFW in this data set.

For fibre diameter (FD) there is no difference between the two RM lines (Tab1). However, they are both above this data set of industry values. This industry sub set is probably finer than the wider industry value for this trait. Phenotypically the average micron for the hogget shearing typically ranges from 18 to 19 microns in the RM flock.

Hogget body weight (HBW) EBV’s are similar for the two lines and both are above this industry sub set.
Figure 1 Estimated Breeding Values for Hogget FEC in 2001 born RM Hoggets

<table>
<thead>
<tr>
<th>Line</th>
<th>CFW (kg)</th>
<th>FD (µ)</th>
<th>HBW (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.208</td>
<td>2.62</td>
<td>4.35</td>
</tr>
<tr>
<td>Selected</td>
<td>0.290</td>
<td>2.33</td>
<td>4.14</td>
</tr>
</tbody>
</table>

**CONCLUSION**

Selection for low FEC has not resulted in any unfavourable responses in the key production traits. The only consideration for individual breeders will be how much emphasis they should place on FEC in their selection index compared to other economically important traits.

**KEY WORDS**

Selection, Worm Resistance, Production

**ACKNOWLEDGMENTS**

The Rylington Merino selection line has been funded by; Wool Grower Funding, Rylington Merino membership and Department of Agriculture Western Australia. Liked data from industry.

Paper reviewed by: Dr Dieter Palmer
Production and Water Use of Lucerne and French Serradella in Four Soil Types
Diana Fedorenko\textsuperscript{1,4}, Darryl McClements\textsuperscript{2,4} and Robert Beard\textsuperscript{3,4}, Department of Agriculture, \textsuperscript{1}Northam and \textsuperscript{2}South Perth; \textsuperscript{3}Farmer, Meckering; \textsuperscript{4}CRC for Plant-based Management of Dryland Salinity.

ABSTRACT
Lucerne can be established successfully on a wide range of soil types in agricultural land at risk of salinisation, providing best agronomic practices are implemented. On typical serradella country, lucerne established and persisted in years with below average annual rainfall. However, during the 3-year pasture phase, lucerne produced less dry matter and used more water than French serradella.

AIMS
Lucerne or alfalfa (\textit{Medicago sativa} L.) has the potential to use water throughout the year in recharge areas to help prevent waterlogging and salinisation of agricultural land (Latta and Dawson 2001). In Western Australia, inadequate agronomic management and unsuitable soil conditions have resulted in poor establishment, production and persistence of lucerne. In order to better understand the scope for lucerne adaptation, this experiment was set up to evaluate the production and water use of lucerne and French serradella (\textit{Ornithopus sativus} L.) under different soil types and in the same environment.

METHOD
On 7 June 2001 lucerne cv. Sceptre was sown at 6 kg seed/ha and French serradella cv. Cadiz at 12 kg pod/ha. Plots were located on four different soils: gravel, yellow sand, white sand and duplex. These soils all had a topsoil (0-10 cm) pH of more than 4.8, according to recommended agronomic practice (Latta \textit{et al.} 2003), but were more acidic at depth. Electric conductivity was lower than 4 mS/m, meaning that they were not saline. The size of each plot was five times the width of the farmer's seeder (61 m) x 50 m. Plant density and dry matter were sampled using six - 0.25 m\textsuperscript{2} quadrats/plot. Stored soil water was determined to a depth of 3 m using a neutron moisture meter. Data were collected during three years. Student t-tests were performed to compare plot means.

RESULTS
Annual rainfall was 284, 216 and 420 mm in 2001, 2002 and 2003, respectively.

Dry matter production
French serradella produced more dry matter than lucerne during the pasture phase (Figure 1). In general, production of both species was lower than expected in the first two seasons due to drought. In the third season, rainfall was above average and dry matter production between species was similar in all soils except the gravel.

![Dry matter production of lucerne and French serradella from July to June in 2001-02 ( ), 2002-03 ( ), 2003-04 ( ) in Meckering, WA.](http://example.com/dry-matter-graph.png)
Water use

Lucerne used more water than French serradella during the pasture phase on the four soil types (Figure 2). French serradella dried the soil profile more rapidly than lucerne only in the first year of the pasture phase while lucerne was establishing. The deficit of water in the soil created by serradella in the first spring was maintained throughout the following summer and autumn because of the lack of rainfall. Once rainfall occurred in the second summer, the soil profile under serradella was filled and remained wetter than under lucerne during autumn and winter. In the third spring, serradella dried the soil profile as much as lucerne on the gravelly soil and the sands. However, on the duplex soil, the profile was drier under lucerne.

CONCLUSION

Current recommendations suggest that lucerne can be grown on soils with pH higher than 4.8 on the top 30 cm, that are well drained, not waterlogged for extensive periods, not saline and have low weed burdens (Latta et al. 2003). Our results show that lucerne can be grown at pH lower than 4.8 and still be productive and dry the soil profile. However, prior to sowing, subsoil layers with pH below 4.8 should be tested for free aluminium, as levels above 2 mg/kg prevent root growth in most crops.

Producer Robert Beard said: “I am pleased to see how well lucerne has done on acid sands, which were considered typical serradella country, despite being established in two very difficult seasons. In September 2003 I have produced lucerne hay and we would have been able to do the same in December if we had managed to fit this activity in during harvest. As this was not possible, we harvested lucerne seed in the summer”.

KEY WORDS
Lucerne, French serradella, production, water use

ACKNOWLEDGMENTS
Thanks to Dr David Tennant for methodology to measure water use, Ross Thompson for neutron moisture meter readings, and Clayton and Chantelle Butterly for collection of production data.

Paper reviewed by: Eliza Dowling

REFERENCES
Latta, R. and Dawson, S. 2001. Department of Agriculture Western Australia. Farmnote No. 84.
Worm Burdens in Sheep at Slaughter
Brown Besier, Una Ryan, Caroline Bath

Department of Agriculture WA
Murdoch University

Abstract

In a survey of internal parasites in sheep at slaughter, high worm egg counts were found in a large proportion of lamb lines, suggesting significant production loss. Counts were lower in adult sheep, but were also significant in many lines. The protozoal parasites Giardia and Cryptosporidium were also commonly detected. Scouring was observed in some lines, and although not clearly related to parasitic infections, worm infections remain the most likely cause. It appears that many producers are not aware of the potential loss due to parasites in sheep intended for slaughter, and further investigation is required into the extent of losses and methods of prevention.

Aims

1. To investigate the prevalence of helminth and protozoan parasites in prime lambs and adult sheep delivered to abattoirs, and the association of these parasites with scouring.

2. To relate parasite burdens to sheep management and epidemiological factors.

Method

Faecal samples for parasite analysis were taken from selected lines of sheep in lairage at the Fletcher International abattoir in Narrikup, Western Australia, from September - November 2002 and January 2003. Lines were classified as either “scouring” or “non-scouring”. From all lines, faecal samples were taken from 10 individual non-scouring animals, and in scouring lines, from an additional 10 scouring sheep. On each day a maximum of 6 lines were sampled, with priority given to scouring lines when present. Worm egg counts and larval identification were conducted at the Albany Animal Health Laboratory, and sub-samples sent to the parasitology laboratory at Murdoch University for protozoal detection and identification, including the use of molecular methods.

A questionnaire was mailed to the owners of all lines sampled, regarding factors such as sheep age, nutritional regimen, lamb weaning status, paddock changes and drenching history.

Results

Worm burdens

A total of 113 lamb and 244 adult (mutton) lines were sampled. Average worm egg counts were higher than expected, especially in lambs, in which a large proportion of lines exceeded the high figure of 1000 eggs per gram (epg). Counts were also high in some adult sheep lines, although the mean count indicated only moderate burdens.

Table 1. Faecal worm egg counts (eggs per gram) in sheep sampled in lairage

<table>
<thead>
<tr>
<th></th>
<th>Lambs</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean worm egg count: all worms (excluding Nematodirus)</td>
<td>1525</td>
<td>486</td>
</tr>
<tr>
<td>Mean worm egg count: Scour worms**</td>
<td>1150</td>
<td>364</td>
</tr>
<tr>
<td>% lines &gt; 1000 eggs per gram</td>
<td>42.5%</td>
<td>13.1%</td>
</tr>
<tr>
<td>% lines &gt; 2000 eggs per gram</td>
<td>22.1%</td>
<td>6.1%</td>
</tr>
<tr>
<td>% Lines scouring</td>
<td>9.5%</td>
<td>9.3%</td>
</tr>
</tbody>
</table>

** Worm genera excluding Haemonchus contortus and Nematodirus spp.
**Relationship with scouring**

There was no statistically-significant difference in worm egg counts between scouring and non-scouring sheep or lines. However, mean counts were markedly higher in scouring lambs, possibly reflecting the small number of lines (11 of 113 total) available for analysis.

*Table 2. Faecal worm egg counts in relation to scouring (“scour worms” only)*

<table>
<thead>
<tr>
<th></th>
<th>Lambs</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Within lines (eggs per gram)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scouring sheep</td>
<td>1767</td>
<td>412</td>
</tr>
<tr>
<td>Non-scouring sheep</td>
<td>1097</td>
<td>365</td>
</tr>
<tr>
<td><strong>Between lines (eggs per gram)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scouring lines</td>
<td>1185</td>
<td>391</td>
</tr>
<tr>
<td>Non-scouring lines</td>
<td>958</td>
<td>356</td>
</tr>
</tbody>
</table>

**Protozoa**

*Cryptosporidium* was identified in 26.25%, and *Giardia* in 45.5%, of sheep, based on highly-sensitive PCR techniques. Lambs were nearly 4 times more likely to be positive than adult sheep for both parasites. However, scouring was far more common in adult sheep positive for both *Cryptosporidium* and *Giardia* (prevalence 10 and 3 times higher, respectively). A number of *Cryptosporidium* genotypes and 3 *Giardia* genotypes were identified, some with possible zoonotic potential. One *Cryptosporidium* isolate (*C. andersoni*) had not been previously recorded in sheep, or in Australia.

**Relationship with management factors**

There were significantly higher worm egg counts in unweaned compared to weaned lambs; lambs off pasture rather than from feedlots; and in undrenched lambs compared to those drenched up to 2 months prior to consignment. No significant differences in worm egg count were related to whether or not lambs remained in the lambing paddock, ewes were drenched up to 2 months before consignment, or pre-lambing drenching of ewes. No factors were significantly associated with the presence or absence of scouring between lines.

**CONCLUSION**

Even allowing for some increase in worm egg counts due to pre-slaughter faecal concentration during transport, the counts suggest that production loss is almost certain in many lamb lines. Although scouring was not statistically related to worm egg counts, the counts were higher in scouring lines, and worms remain the most likely cause. High counts were also relatively common in adult sheep. The scouring observed in some adult sheep may be a reflection of the recently-recognised syndrome of hypersensitivity to worm larvae in immune sheep.

Treatment should be relatively simple, as lamb lines drenched up to 2 months before slaughter had significantly lower counts. Regimens based on pasture management and drenching where necessary should effectively minimise the effects of worms on production.

Further investigations are needed to confirm the prevalence of worm burdens on a wider scale, to quantify the significance of findings, and to develop control measures.

The high prevalence of the protozoan parasites *Cryptosporidium* and *Giardia* had not been previously recorded in slaughter sheep, and their potential clinical significance warrants investigation.

**Key words**

Sheep, worms, nematodes, *Giardia, Cryptosporidium*, abattoir, scouring

**Paper reviewed by:** Rob Woodgate