final report

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South West Prime Lamb Group (SWPLG) – Perennial pasture persistence

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Executive summary

South West Prime Lamb Group is a farmer group situated in the high rainfall zone of far South West Victoria. Members are primarily specialist prime lamb producers running high stocking rate production systems based on perennial ryegrass (PRG) and clover pastures.

Whilst members have focussed on genetics and meat production, it has been an ongoing frustration that they have not been able to get PRG to persist in their pastures and find that when they try new expensive varieties that are supposed to persist, they tend to disappear faster than the older high endophyte varieties such as Victorian PRG.

The objectives of this project were to:

- Survey local producers to identify their pasture establishment and intervention practices for pasture persistence.
- Undertake an economic analysis to define the payback period for different pasture establishment and persistence methods.
- Evaluate four methods of pasture renovation and establishment through on-farm trialling.

From the survey of producers, it became evident that only one third were getting pastures to persist for more than the six years, which the economic analysis showed to be the breakeven year. Most used full renovation as part of a summer crop rotation and hadn't used winter cleaning or spray topping as an intervention method to extend the life of their pastures.

The economic analysis of pasture sowing options found that the longer a pasture persists at its peak production the more profitable is the initial investment.

This project has shown that early intervention can improve the persistence of PRG in South West Victoria and that it is economic to do so. Interventions scenarios to extend the production peak had payback periods of two to four years and were much cheaper to implement than full pasture establishment scenarios. The most appropriate intervention would depend on the management of the farm, the extent and type of weed infestation and seasonal conditions.

All interventions for managing barley grass, silver grass and strategic spelling to improve PRG content had a positive annuity per ha at a base discount rate of 8% ranging from $35 to $137 depending on the intervention thus demonstrating that all interventions were worth implementing. In general, two consecutive years of chemical intervention was more effective than one.

This project received additional collaborative support from Agriculture Victoria, allowing the group to increase the scope of the research undertaken.

Table of contents

1 Background

1.1 South West Prime Lamb Group (SWPLG)

The SWPLG is a farmer group situated in the high rainfall zone of far South West Victoria. Members are primarily specialist prime lamb producers with pastures generally based on perennial ryegrass (PRG) and sub clover with some cocksfoot or phalaris based pastures in lower rainfall areas.

Their systems mostly depend on high stocking rates and prolific ewes to keep enterprises profitable. They farm a total of approximately 6000 ha. All properties run sheep (average 3,450 adult sheep) and half the group has cattle. Only one producer cropped (400 ha or 25% of his total area).

South West Prime Lamb Group has been running for 23 years and has maintained a membership of around 30 farm businesses throughout that period. Over the years the group has run many on farm trials including three Producer Initiated Research & Developments Sites and a Producer Demonstration Site as well as several small trials funded by the group and its producers. Trials have mainly focussed on effective prime lamb production, management and health, with this being the first feed base related project.

1.2 Issues faced by the group

The main motivation was to improve persistence of perennial ryegrass which is the main grass species in pastures in set stocked prime lamb production systems in far south west Victoria.

Producers acknowledge that there is a trade-off between persistence and production but don't have an understanding of the economics of continual grazing (with no re-sowing or interventions to extend the life of the pasture) versus chemical manipulation to improve pasture composition. If the pastures quickly repay their initial investment, would it be economic to re-sow more frequently or do they need to keep grazing a pasture for at least seven years to achieve payback, even if it has become unproductive?

Many members have trialled new cultivars of perennial ryegrass and have been disappointed with their persistence so are tending to return to old less productive varieties such as Victorian PRG as they appear to be the only ones that will persist. Annual rainfall decreases (650 mm) towards the northern (inland) parts of this region, and no perennial ryegrass persists at all so phalaris is used. There is concern that climate change will reduce the future persistence of all varieties due to increasingly long drier summers and autumns.

When ryegrass staggers outbreaks occur, varieties such as Victorian, which are high endophyte, can be a problem if it is the only variety sown, so some producers are trying to establish endophyte free varieties to create safe paddock havens.

Lack of persistence means they have to re-sow which is expensive, or use weed control to try to remove weeds to extend the life of the pasture. By far the biggest cost is taking a paddock out of production to allow the new pasture to establish.

Members of the group are aware that systems that are predominantly set stocking may keep pastures too short and deplete carbohydrate reserves so when possible they implement strategic use of rotational grazing to allow for better plant survival. However, they are not convinced that this offers the whole reason for lack of persistence.

1.3 Producer management practices

As previously described, members of the South West Prime Lamb Group are predominantly specialist prime lamb producers. Most producers lamb over winter or early spring and experience their highest pasture demands from July to October. Rainfall is predominantly in winter but it is not uncommon for at least a nine month growing season depending on the timing of the autumn break.

When paddocks become too infested with weeds, they tend to be re-sown to maintain high production. Some use interventions such as spray topping, or winter cleaning using simazine to remove silver grass and over sowing to try to improve pastures.

The group currently don't use strategic spelling for perennial ryegrass recruitment because of the long lock up periods involved which is difficult for some producers when their systems are reliant on utilising feed in the late spring period to finish lambs.

Group members are not familiar with using Shogun to remove barley grass. Some do use spray topping but treat for one year only and not consecutive years.

1.4 Motivation of the group

The group members value highly productive perennial pastures to support their prime lamb production systems. Whilst high stocking rates are manageable during the winter/spring growing season, pressure is put on pastures during the summer/autumn period where overgrazing can lead to weakening pasture species allowing opportunistic weeds such as barley grass and silver grass to establish. It can become a vicious circle as the high stocking rates are hard to maintain when pastures have to be destocked to re-sow due to lack of persistence and weed invasion. Some herbicide intervention treatments to reduce the weed burden also reduce pasture growth at critical times of the year and put pressure on the rest of the farm to carry extra stock.

Group members were keen to get an understanding of the drivers of persistence in their high rainfall environment and understand the economics of pasture persistence. To do so would enable them to make better decisions of when, what and how to sow and potential interventions that might fit their farm systems to increase persistence, especially of new ryegrass cultivars.

2 Projective objectives

This project forms part of MLA's Producer Research Site (PRS) program that is part of the southern Feedbase Investment Plan. In particular, this project supports the MLA-funded project *B.PBE.0038 – Pre-breeding in phalaris.*

The PRS project objectives were to:

- Survey local producers to identify their pasture establishment and intervention practices for pasture persistence.
- Undertake an economic analysis to define the payback period for different pasture establishment and persistence methods.
- Evaluate four methods of pasture renovation and establishment through on-farm trialling.

3 Methodology

3.1 Participant survey

The purpose of the survey was to get a better understanding of pasture persistence issues within the group and their pasture establishment and management practices. The information collected has helped ensure that the paddock trials are focussing on issues and opportunities where there can be gains made in pasture persistence.

The survey was completed using clicker technology at a workshop held in March 2015 with 14 participants in attendance. The survey questions are attached in **Appendix 1.**

There were 14 participants in attendance at the workshop. A copy of the program can be seen in **Appendix 2.** The objectives of the workshop were to:

- Use the questionnaire to ensure that the project is focussing on questions that the group wants answered
- Test assumptions used in the economic analysis and discuss the results
- Discuss modifications to the trials
- Choose sites for the trials

3.2 Economic analysis of pasture sowing options

The purpose of economic analysis of pasture establishment and intervention options was to:

1. Identify the economic costs and benefits of pasture interventions.

2. Help define profitable persistence and thus to enable better decisions of when, what and how to sow. For example, if producers can use cheaper methods of establishment (over-sowing versus full renovation with summer fodder crops) then they could potentially sow more often and then persistence wouldn't be such an issue as they would have a quicker pay back.

The initial economic analysis that was presented to the workshop was based on a composite sheep flock. The assumptions (see **Appendix 3**) were based on modelling a 500ha property where 10% of the area or 50ha was subjected to the following establishment/intervention techniques:

- Full renovation of poor paddocks
- Spray topping/ direct drilling
- Over sowing
- Spring sowing
- Seedling recruitment
- Weed control intervention – spray topping
- Weed control intervention - winter cleaning

A second economic analysis was conducted at the completion of the on-farm trials to check assumptions and include costs and benefits found in the on-farm trials and then evaluate the relative benefits of the various interventions trialled.

Lee Beattie of Beattie Consulting Services was contracted by the group to undertake the economic analysis. A discounted cash flow analysis was used to assess the annual flow of costs and benefits over the life of each pasture investment option.

3.3 On farm trialling

Site 1 Joseph - Barley grass control

Objectives of trial:

- To test if an older overgrazed PRG pasture was able to be regenerated with weed (barley grass) control
- Calculate the economics of one year control compared to two years of intervention versus no weed control.

The site was subdivided into two paddocks with permanent fencing in 2015.

Treatments included:

Paddock 1- one year of treatment

- Treatment 1: Control treatment. Managed according to Joseph's regular pasture management.
- Treatment 2: Winter cleaned 22/5/2015 with Shogun 200 mL/ha and 500 ml/ha Kwicken/100L of water.
- Treatment 3: Spraytopped with Gramoxone 400mL/ha in 27/10/2015 when grasses were coming into head and flowering. The aim is to reduce the production of viable seed and the seedling population in the following year.

Paddock 2 –two years of treatment (first year same as paddock 1)

- Treatment 1: Control treatment.
- Treatment 2: Winter cleaned 20/5/2016 with Shogun 200 mL/ha and 500 ml/ha Kwicken/100L of water.
- Treatment 3: Spraytopped with Gramoxone in spring 26/11/2016.

A strip of Avalon Standard Endophyte PRG 20 kg/ha was sown across all treatments just after the autumn break on 27/4/2016 in the second year.

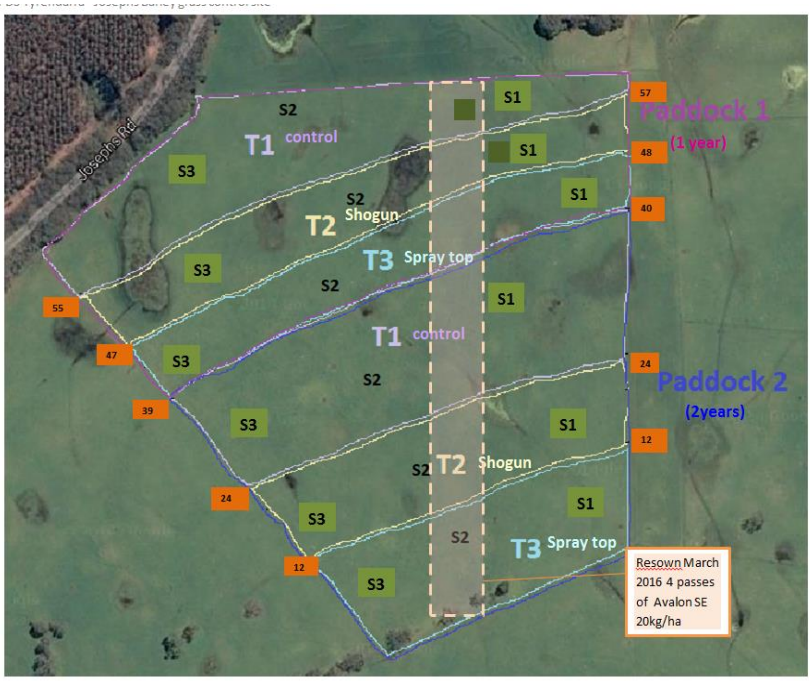


Figure 1. Treatment map at Joseph's site

Trial site management:

- At the commencement of the trial, soil tests were collected from the site at depths 0-10cm, 10-20cm & 20-30cm. The 0-10 cm samples were tested for basic soil fertility. The 10-20 cm and 20-30 cm tested soil pH & EC, soil texture, exchangeable cations and Aluminium ($CaCl_2$). (Results can be found in **Appendix 4**).
- Paddocks were set stocked from late May for lambing and not moved until after lamb marking (mid to late August).
- Measurements were taken at permanent sites using three quadrats marked with individually identified pegs in each treatment.
- Visual composition of each treatment was measured by assessing the percentage of ryegrass and barley grass using a quadrat grid (see Fig 2). Measurements were taken after the herbicide withhold period and in late spring in all six trial sites in each year. Shogun grazing withhold period was three days and spray topping (Gramoxone) withhold period was 24 hours.
- Photos were taken at all site visits at each monitoring point.
- Paddock diary for the site can be found in **Appendix 5**

Figure 2. This is the grid that was used for taking measurements. Measurements were taken in nine squares in opposite corners that can be seen in red

Site 2 Frawley - Perennial ryegrass strategic spelling and seedling recruitment

The trial investigates whether strategic spelling can be used to recruit perennial ryegrass seedlings to extend the life of perennial ryegrass pastures.

Treatments:
The strategic spelling treatment was loosely based on the management advice in the *EverGraze* publication 'Productive, persistent perennial ryegrass', which advocated allowing ryegrass to flower and set seed with strategic grazing according to season.
The strategic spelling treatment was compared to a control treatment. Each treatment had eight monitoring points. Seedlings that were recruited were counted in autumn following treatments using the same grid as pictured above (Figure 2).

Strategic spelling treatment: Livestock were removed from 30 October to 21 December 2015 (and 5 November 2016 to 3 January 2017) to allow flowering and seed maturation. Once seeds were mature on 22 December 2015 (and 4 January 2017), mesh was dragged across the treatment area to ensure seeds fall and cattle were put in to establish seed-soil contact before recommencement of sheep grazing. The pasture was grazed down to 1000 kg DM/Ha before the break. At the autumn break, grazing was deferred until seedlings reached the two-leaf stage to encourage seedling establishment (area was spelled from mid April to late May in 2016 and late February to late April in 2017)

Control treatment: The control area was managed according to the Frawley's usual pasture and grazing management program which involved grazing throughout the spring period and grazing over summer also down to 1000 kg DM/ha ready for the autumn break but with no autumn spell.

Paddock diary for the site can be found in **Appendix 6**

Monitoring included:

- Soil tests were taken as per the methodology at Joseph site (**Appendix 7**)
- Feed test samples were taken at lock up in the first spring and then again just prior to grazing.
- Seeds were counted in summer using the grid as pictured in Figure 2. To assess seeds in each square the count was given a rating of 1 (0-5 seeds), 2 (5-10 seeds) or 3 (>10 seeds) and then the average from each site was extrapolated out to number of seeds per square metre.
- Seedlings were counted at each monitoring point as actual ryegrass seedlings in the grid as per Figure 2
- The amount of PRG as a percentage of ground cover was measured using the grid in spring 2016

Site 3 Price – Silver grass control

Objectives tested:
The trial tested which of the following interventions was most effective for controlling silver grass to improve the productive life of the perennial ryegrass pasture. These included:

- Whether spraying for silver grass alone would allow PRG to regenerate
- Whether over sowing would allow PRG to out compete silver grass
- Whether Silver grass needs to be controlled prior to sowing
- Whether two years of spraying is required for effective silver grass control.

Data collection was used to refine the costs and benefits of silver grass control interventions for extending the productive life of perennial ryegrass pastures.

Treatments

Within the one paddock which had been sown to PRG in 1980 the following treatments were applied in strips:

Treatment 1: Control treatment. This was managed according to Price's regular pasture management.

Treatment 2: Oversown only: Dry-sown in April 2016 with Avalon SE at 20kg/ha

Treatment 3: Winter cleaned with Simazine 900 at 600 g/ha in July 2015 and oversown April 2016 with Avalon SE at 20kg/ha

Treatment 4: Winter cleaned Simazine 900 at 600 g/ha in July 2015

Treatment 5: Winter cleaned with Simazine 900 at 600 g/ha in July 2015

Each treatment was two boom spray widths equating to 37m wide by approximately 150 m in length.

Trial site management:

- Soil tests were taken as per the methodology at Joseph site (results can be found in **Appendix 8**)
- Stock management of the paddock included:
    - Paddock was set stocked for lambing from end of June
    - Lambing was completed and lambs marked by end of August
    - Paddock was stocked at around three ewes per acre for lambing

- Measurements:
    - Dry matter cuts were taken in the control and simazine treatments in spring 2015
    - Visual composition of each treatment was measured by assessing the percentage of ryegrass and silver grass using a grid at set monitoring points in each treatment (see Figure 2). These measurements were taken in autumn and spring 2015 and 2016 and autumn 2017
- Photos were taken at all site visits at each monitoring point.

Paddock diary for the site can be found in **Appendix 9**

3.4 Extension and Communication

Following the successful EOI application for the Feedbase Participatory R & D project members of SWPLG met on the 29th April 2014 to discuss the project topic and to seek agreement with researcher Professor Kevin Smith on participatory R&D activities, what research questions were to be investigated, and plan how the project might proceed.

In March 2015 there was a workshop to discuss the completed economic analysis and survey members on their management.

Annual review meetings with the management committee and researchers to discuss the project were held in November 2014, March 2016 and January 2017.

Field days visiting all sites were held in May 2016 and September 2017 with other visits to some sites held in September 2015 and August 2016 as part of other events.

Discussions on the project were held with SWPLG members at functions held in May and July 2015.

A newsletter article was produced for the SWPLG newsletter in February and December 2015 and the final results and summary of this report will be reported in early 2018.

Articles on the project have been in MLA feedback magazine Nov/Dec 2015 and May/June 2017

4 Results

4.1 Participant survey

The purpose of the survey was to get a better understanding of pasture persistence issues within the group, their pasture establishment and management practices.

The survey was completed using clicker technology at the workshop in March 2015 with 14 participants in attendance.

Summary of results

- 83% of participants believed a pasture should persist for more than seven years yet only 33% were successful in getting their pastures to persist for this period.
- All participants do some pasture renovation every year (in most cases 5-10% of their property).
- About 31% prefer full renovation, but then 16% indicated lack of confidence to direct drill or over sow
- Seasonal conditions tended to be the major determining factor as to what sowing method was used.
- When establishing a new pasture only 50% always sprayed weeds prior to direct drilling.
- 46% always establish a new pasture as part of a summer fodder crop rotation, very few participants winter clean or spray top prior to pasture establishment.
- 80% of participants were not confident about shutting up a pasture to allow reseeding and about 40% were not confident about strategic resting of pasture.
- Just over 20% felt confident about putting stock into a containment area
- A quarter of participants are not confident to use spray grazing techniques on their pastures and over three quarters were not confident about cultivar and endophyte options.
- No group members used spring sowing as a method of pasture establishment.

4.2 Economic analysis of pasture sowing options

The purpose of economic analysis of pasture establishment and intervention options was to help define profitable persistence and understand the economics of persistence to make better decisions of when, what and how to sow.

Assumptions are based on a 500ha property where 10% of total area or 50ha were subjected to one of six establishment/intervention techniques.

The main findings were:

- The longer a pasture persists at its peak production the more profitable is the initial investment.
- Increasing length of peak production is worth more than increasing pasture life – the earlier intervention occurs the more profitable the outcomes.
- Intervention scenarios to extend the production peak had pay back periods of two to four years and were much cheaper to implement than pasture establishment scenarios (see Table 1).

Table 1 Summary of debt calculations of six different pasture establishment /interventions presented to the workshop

Option No	Pasture Establishment/Intervention techniques	Peak debt	Peak debt occurrence	Breakeven year
Option 1	Full renovation of poor paddocks	$33,166	Year 2	Year 6
Option 2	Spray topping/direct drilling	$19,430	Year 2	Year 5
Option 3	Over sowing	$22,003	Year 2	Year 5
Option 4	Spring sowing	$33,074	Year 2	Year 6
Option 5	Seedling recruitment	$9,886	Year 2	Year 4
Option 6a	Weed control interventions Spray topping	$313	Year 1	Year 2
Option 6b	Weed control interventions Winter cleaning	$4,906	Year 2	Year 4

Results from economic analysis of interventions

It has been assumed that a 50 hectare paddock on the representative farm has been utilised for each of the pasture interventions evaluated. The key assumptions associated with each trial and the economic investment criteria results are described for each option below. (The full report with all assumptions can be found in **Appendix 10**)

A base discount rate of 8% has been used with a sensitivity of results to a 6% and 10% discount rate also provided. The discount rate represents the opportunity cost of the money invested in the pasture treatment. The opportunity cost of the money invested will depend on the source of the capital used. It has been assumed that the money is sourced from overdraft working capital so the investment will need to be earning at least the same rate of interest being paid on the borrowed amount, plus an additional margin for risk. Assuming a 6% interest rate on borrowed funds and allowing for a 2% risk margin accounts for the 8% base discount rate used.

Results are presented by their equivalent annuity. An equivalent annual annuity (EAA) approach evaluates the constant annual cash flow produced by a project over its lifetime. The optimum pasture cycle length occurs when the equivalent annuity for increasing the length of the pasture cycle by one more year begins to decline. The pasture investment with the highest annuity is

the investment that maximizes profit over cycles of pasture investments over the life of the business.

Site 1 Joseph - Control of Barley Grass

Assumptions

- Productivity of control pasture is expected to decline by 5% per year.
- Cost per ha is $21 for spring treatment (Gramoxone) and $22 for winter treatment (Shogun).
- The Shogun treatment slows pasture growth – expected loss of winter production of 12-15kg DM/Ha/day for 6 weeks @ 10 MJ ME/kg DM valued at 2c per MJ.
- For one year only treatments, it is expected that there would be two years of no treatment before treatment is required again (i.e. One treatment in every three years).
- For one year only treatments, expected productivity improvements have been assumed to decline by 20% in second year after treatment and by another 40% in third year before treatment again in fourth year.
- For two consecutive year treatments, it is expected that there would be four years of no treatment before treatment is required again (i.e. Two treatments in every six years).
- For two consecutive year treatments, it has been assumed that expected productivity improvements would be maintained for the two years following the second treatment, and would then decline by 20% in the third year after treatment and by another 40% in the fourth year.
- Assumed no pelt/carcase damage from Barley grass but eye damage valued at $1/hd/yr.

Productivity Benefits

Based on changes in barley grass % and PRG % for each trial the following benefits have been estimated:

Table 2: Productivity benefits for control of barley grass trial.

Treatment	**Productivity Benefits**
Gramoxone 1 year only	Increase in stocking rate of 1.1 DSE/Ha (0.5 ewes/Ha) and increase lamb turnoff weight of 2kg CW per head.
Shogun 1 year only	Increase in stocking rate of 2.2 DSE/Ha (1 ewe/Ha) and increase lamb turnoff weight of 2kg CW per head.
Gramoxone 2 years in a row	Increase in stocking rate of 3.3 DSE/Ha (1.5 ewes/Ha) and increase lamb turnoff weight of 2kg CW per head.
Shogun 2 years in a row	Increase in stocking rate of 4.4 DSE/Ha (2 ewes/Ha) and increase lamb turnoff weight of 2kg CW per head.

Results

Table 3: Investment criteria results for Joseph trial.

Investment	Peak Debt and year of occurrence	Breakeven year	Equivalent Annuity & Equivalent Annuity per Hectare		
			Lower discount rate scenario (6%)	Base discount rate (8%)	Higher discount rate scenario (10%)
Gramoxone 1 year only.	$1,056 in year 1	Year 2	$3,588	$3,543	$3,498
			$72/ha	$71/ha	$70/ha
Shogun 1 year only.	$9,927 in year 1	Year 3	$1,854	$1,748	$1,643
			$37/ha	$35/ha	$3/ha
Gramoxone 2 consecutive treatment years	$3,204 in year 1	Year 2	$7,027	$6,865	$6,704
			$141/ha	$137/ha	$134/ha
Shogun 2 consecutive treatment years	$11,848 in year 2	Year 4	$5,709	$5,445	$5,183
			$114/ha	$109/ha	$104/ha

Site 2 Frawley - Seedling recruitment of the ryegrass seedlings

Assumptions

- Base stocking rate of 12 DSE/Ha increases to 17 DSE/ha by year two (30% production loss if stocking rate not increased) at a cost of $70 per DSE.
- Very low cost mainly a loss in pasture quality - assumed 1.25 ME by 2.75 tonne of dry matter. ME valued at 2c per MJ, total cost of loss in pasture quality $68.75/Ha.
- $15 per hectare to drag the paddocks with mesh to drop the ryegrass seed.
- Stand off for 8 weeks post the break in the next year, agistment at 25c per DSE/week.
- Full production reached in year 2, decline in carrying capacity begins in year three.
- Intervention once every five years.
- No ongoing annual pasture maintenance costs post seedling recruitment above what was already being spent pre-recruitment.

Results

The peak debt for this option was calculated as $11,650 and was incurred in year one, and the break-even cumulative cash flow occurred in year four.

Table 4: Investment criteria results for seedling recruitment trial.

Investment	Peak Debt and year of occurrence	Breakeven year	Equivalent Annuity & Equivalent Annuity per Hectare		
			Lower discount rate scenario (6%)	Base discount rate (8%)	Higher discount rate scenario (10%)
Seedling recruitment	$11,650 in year 1	Year 4	$2,540	$2,314	$2,092
			$51/ha	$46/ha	$42/ha

Site 3 Price - Winter cleaning for silver grass

Assumptions:

- Control needs to happen two winters in a row.
- Cost per ha $20 per year chemical and contractor.
- Expected loss of winter production of 6kg DM/Ha/day for eight weeks @ 10 MJ ME/kg DM valued at 2 c per MJ ($67/Ha).
- Increase in productivity over two years.
- Treatment results in 25% increase in legume content which increases lamb production by 15kg LW per hectare with 20% less carryover lambs.
- Annual pasture decline of 10% for control (do nothing scenario).
- Intervention required every six years.
- Estimated that expected productivity improvements would be maintained for the two years following the second treatment, and would then decline by 20% in the third year after treatment and by another 40% in the fourth year.

Results

The peak debt for this trial was calculated as $3,543 and was incurred in year one, and the break-even cumulative cash flow occurred in year two.

Table 5: Investment criteria results for silver grass control.

Investment	Peak Debt and year of occurrence	Breakeven year	Equivalent Annuity & Equivalent Annuity per Hectare		
			Lower discount rate scenario (6%)	Base discount rate (8%)	Higher discount rate scenario (10%)
Silvergrass control	$3,543 in year 1	Year 2	$6,386	$6,240	$6,094
			$128/ha	$125/ha	$122/ha

4.3 Evaluation of methods by on farm trialling

Very dry spring conditions in 2014 meant that trial sites were not established until 2015.

In subsequent discussions following the workshop and questionnaire in March 2015 it was agreed not to continue with the spring sowing trial. It is unlikely that members would adopt this practice due to the following reasons:

- Most members do major pasture renovation as part of a summer crop rotation.
- Springs can also be unreliable and the plant root systems need to be established before the dry summer so it is considered high risk.
- Often paddocks are too wet in spring to be trafficable for sowing.
- Whilst grass species establish well in spring, clover hasn't time enough to set seed when sown in spring, so has to be sown in autumn.
- The initial economic analysis of various options presented at the workshop did not show financial advantage to spring sowing compared to a full renovation even though the new pasture would need to be spelled for approximately 6 weeks instead of 12 weeks.

Site 1 Joseph - Barley grass control

The two intervention methods for control of barley grass were to spray using in Shogun in winter on one third of each paddock, to spraytop one third of each paddock with Gramoxone in spring, and the remaining third was left as a control. The interventions were implemented in 2015 only for Paddock 1 and for both 2015 and 2016 for Paddock 2. The effects of the interventions on percentages of PRG and Barley grass can be seen in the graphs below.

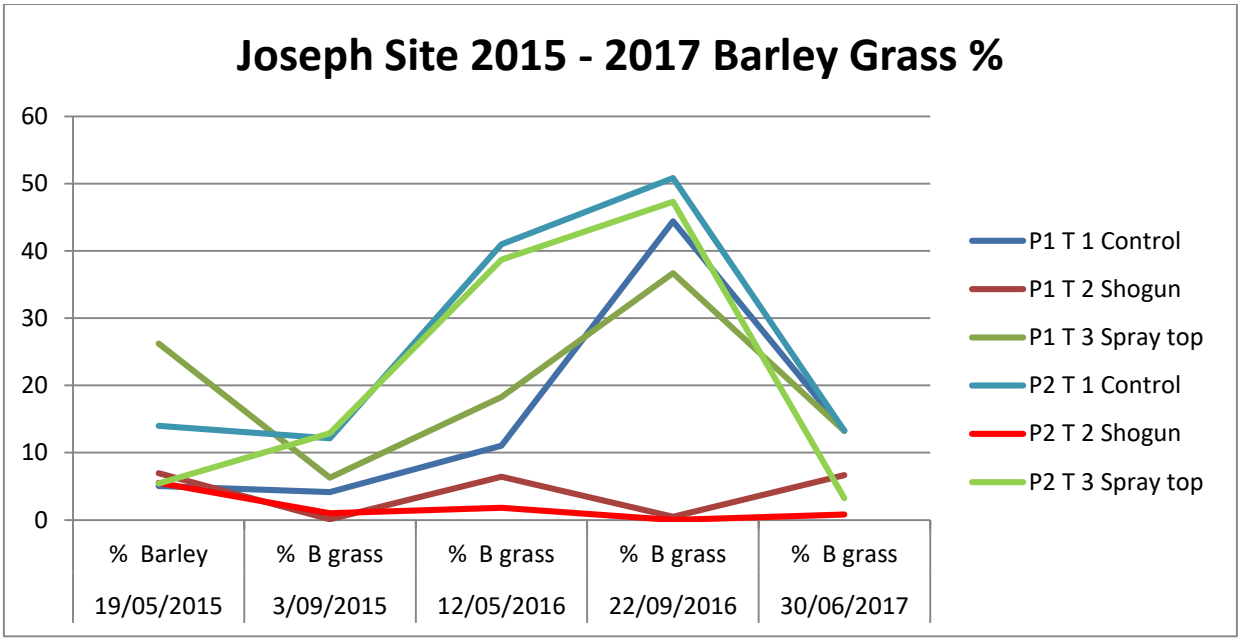


Figure 3: Percentage barley grass over time (P1= one year of treatment and P2 =two years of treatment)

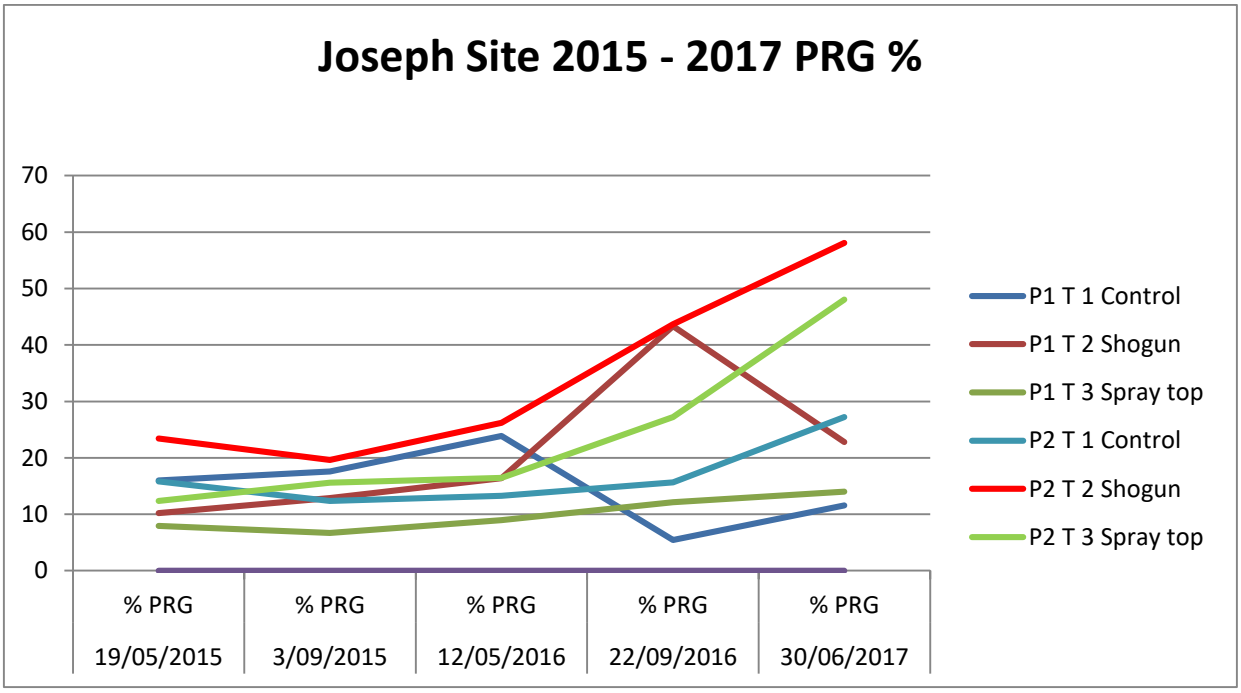


Figure 4: Percentage PRG over time for the three treatments (P1= one year of treatment and P2 =two years of treatment).

From the graphs above it can be clearly seen that two years of intervention greatly improved the amount of PRG in the pasture whether using Shogun or spray topping with Gramoxone.

Site 2 Frawley - Perennial ryegrass strategic spelling and seedling recruitment.

Total seed counts were taken from both the control and treatment sites in the summer following spring management. The results can be seen below in Figure 5.

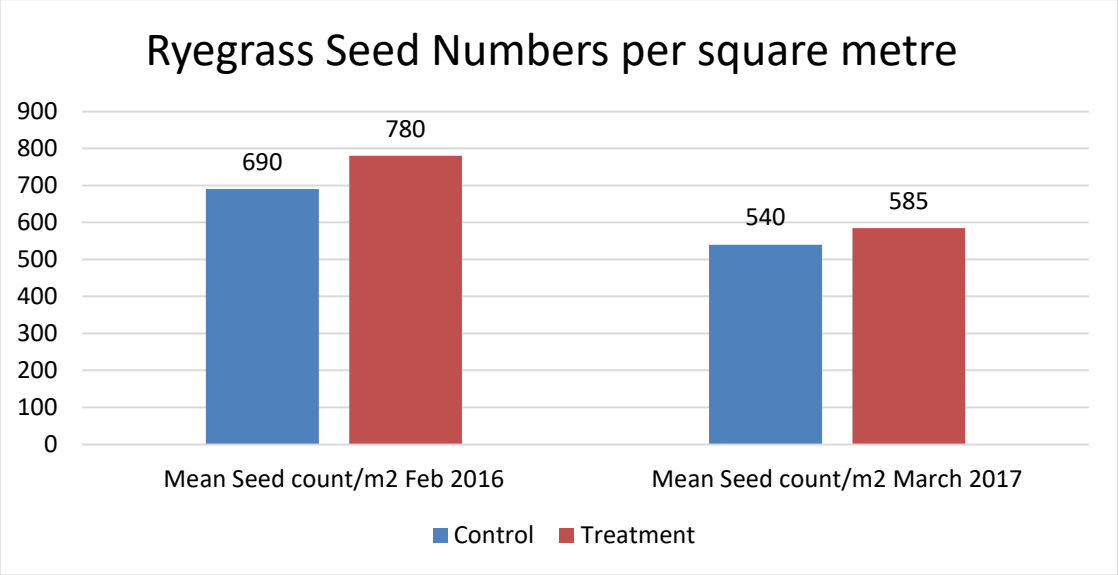


Figure 5: Mean seed counts from both the control and treatment site in 2016 and 2017.

It was interesting to note that whilst there was not much difference in seed count, there was a large difference between the seedling count between the control and treatment (see Figure 6 below)

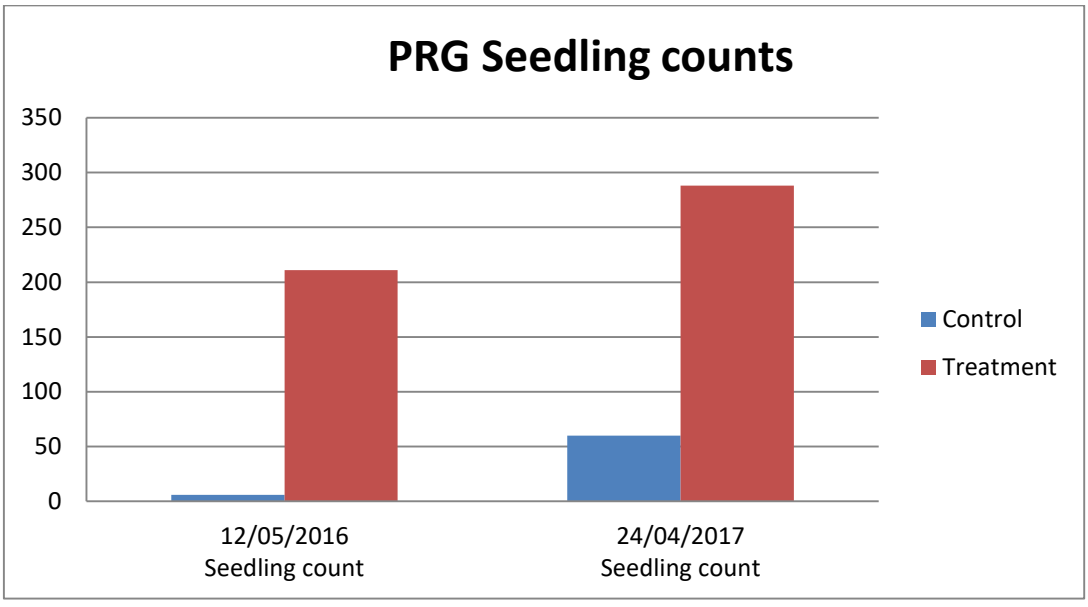


Figure 6: Average seedling counts from the control and treatment sites

The increase in PRG seedlings in turn improved the percentage of PRG in the pasture when measured in the following spring, as can be seen in Figure 7 below.

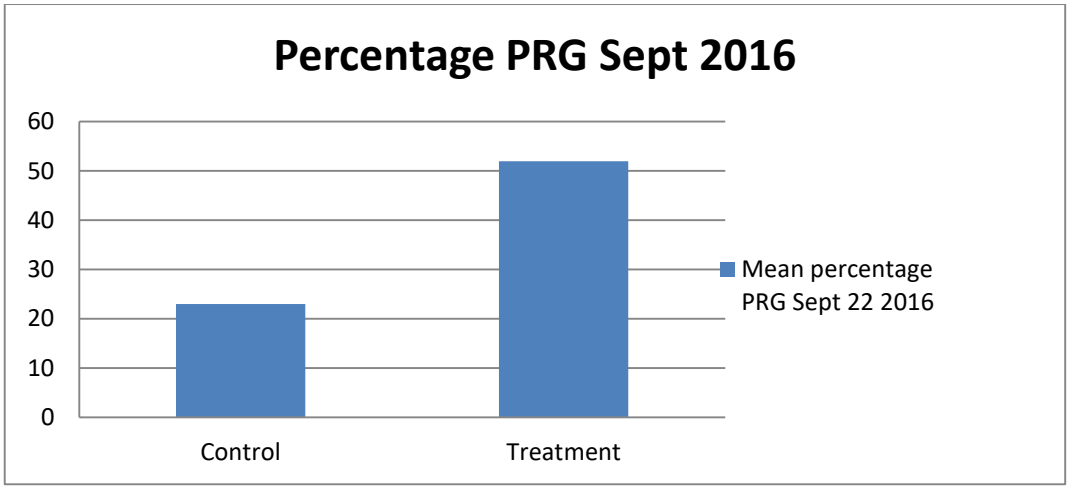


Figure 7: Mean percentage difference in perennial ryegrass in spring after the first year of treatment.

Site 3 Price – Silver grass control

There was not as much silver grass in the chosen site for silver grass control as there had initially been anticipated when the trial was established in autumn, however the treatments did lower the amount but from a low base. Over sowing without weed control proved to be of no value. The following table and graph show the results from this site.

Table 6: Percentage % of PRG and Silver grass measured in each treatment

		5/06/2015		3/09/2015		12/05/2016		22/09/2016		23/06/2017	
		% PRG	% Silver	% PRG	% Silver	% PRG	% Silver	% PRG	% Silver	% PRG	% Silver
Treatment 1	Control	48	3	27	1	39	0	58	0	49	0
Treatment 2	Oversown May 2016	48	4	27	3	45	0	71	0	50	2
Treatment 3	Simazine July 2015 & sown May 2016	30	14	60	0	39	0	28	0	52	4
Treatment 4	Simazine July 2015 only	31	15	50	1	24	0	51	0	53	1
Treatment 5	Simazine July 2015 & Gramoxone Spring 2016	34	6	58	2	25	1	34	2	29	5

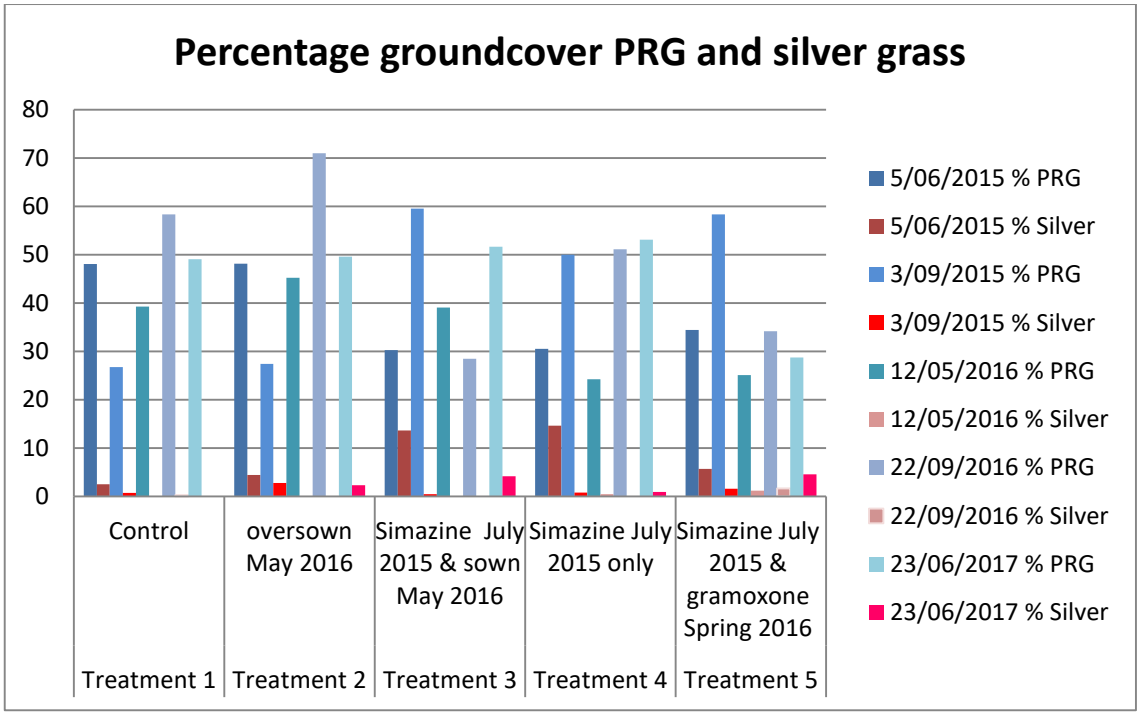


Figure 8: Changes in composition of PRG and silver grass across the treatments over time

4.4 Extension and communication

A summary of communication activities is shown in Table 10. During the project there were 16 extension activities involving 220 people which were primarily producers. (Note: this does not include the Feedback articles which MLA produced in November 2015 & May 2017 mentioned in Table 7 below)

Table 7. Extension activities and communications delivered

Date	Event/ Activity	No of participants
April 2014	Project planning initial meeting, Hamilton	13
	Factsheet snapshot.	Circulation 5000
November 2014	Project committee meeting	5
February 2015	SWPLG newsletter article on project	Circulation 42
March 2015	Project Workshop on economic results, survey, Hamilton	14
May 2015	Project update to SWPLG members at tour event to JBS Bordertown	15
July 2015	Project update to SWPLG members at marketing event	23
September 2015	BWBL meeting & inspection, Tyrendarra	16
November 2015	MLA Friday Feedback magazine Lifting the Lid on Rundown	Circulation 5000
December 2015	SWPLG newsletter article on project	Circulation 45
March 2016	Project committee meeting	9
June 2016	MLA PRS workshop, Attwood	65
June 2016	Paper. Project notes for national workshop.	Researchers workshop 60
August 2016	Networking event Tyrendarra	15
May 2016	Annual review & field day, Tyrendarra	22
January 2017	Extraction meeting, Warrnambool	6
June 2017	Pastures to push production In Friday Feedback	Circulation 5000
September 2017	Field day & final review, Tyrendarra	20
September 2017	BWBL group meeting – Economic model, Hamilton	15

All functions run by SWPLG are open to the general public and were also attended by non members.

Pre and post surveys were taken at the beginning of the project and at the end to track changes in knowledge, skills and confidence to adopt by Lisa Miller (Victorian PRS Group Co-ordinator). Results can be seen in Table 8.

Table 8. SWPLG producer survey responses in 2014 (pre project) and 2017 (post project)

Year	No of producers surveyed	Potential of the research	Knowledge	Skills and expertise	Confidence in adopting
2014	8	**3.7**	**3.3**	**2.9**	**3.3**
2017	8	**4.0**	**3.6**	**3.5**	**3.9**

5 Discussion

5.1 Survey and economic analysis (benefits/costs)

Lack of persistence means producers have to re-sow which is expensive and risky, or use herbicide intervention to try to remove invasive weeds to extend the life of the pasture. By far the biggest cost is taking a paddock out of production to allow the new pasture to establish. There are examples of paddocks that contain Victorian perennial ryegrass that have persisted over many years and despite lower production, producers often see this cultivar as a safer investment. Producers in the group believe the newer varieties of perennial ryegrass don't persist and so trade off production for persistence. They fear persistence will only get worse with weather patterns changing and experiencing longer drier summers and autumns.

Surveys of the producers indicated the group had a much higher sowing rate of new pastures (5-10%) compared to the southern Victoria average of approximately 1 to 2%. The lack of persistence of the group's pastures may be due to their high input grazing systems which could lead to the invasion of early germinating weeds of barley grass and silver grass.

The survey found that group members were not really using any intervention methods to prolong the productive life of their pastures (strategic spelling or herbicide interventions) despite these having lower costs and conveniences than full renovations. Even though spring sowing might lessen the time the pasture is out of production, the survey found that spring establishment of pastures isn't a technique used by the group with preference to sow a summer fodder crop instead to clean up weeds and provide summer feed. As a result the spring sowing intervention mentioned as an option in the projects initial objectives did not have support and was not continued.

The economic analysis highlights persistence of the pasture at its peak production as a key driver of pasture sowing profitability. Profitable persistence is to be aspired to. This is a new way of looking at the economics of pasture establishment and highlights the importance of intervention techniques that maintain the pasture in peak production. Producers may not intervene early enough in the life of a new pasture to remove weeds or promote regeneration. Established pastures tend be allowed to become "run down" with weeds both lowering their production value and their persistence.

The payback periods for different pasture sowing scenarios was about five years which is faster than the seven to ten years often quoted in studies. This is mainly due to the short time frame that the pasture is rested before grazing commences. Extension material quotes NSW work where phalaris pastures are rested in marginal rainfall areas for up to 10 to 12 months before grazing. In grazing only enterprises in South West Victoria this is unlikely to occur.

From the economic analysis across all interventions the break even cumulative cash flow occurred in years two to four. The intervention that gave the best return at the base discount rate of 8% was treating barley grass infested pastures with Gramoxone two years in a row. This returned an annuity per ha of $137 with the peak debt of $3,204 occuring in year 1 and the break even cumulative cash flow occurring in year 2. When the paddock only had one treatment of Gramoxone the breakeven cash flow also occurred in year 2 but the equivalent annuity per ha was only $71 at the same base discount rate.

The major difference between one and two years of intervention was when Shogun was used in barley grass control. The peak debt for these options were high ($9,297) occurring in year 1

for a single treatment and $11,848 incurred in year 2 for two years of treatment, mainly due to the affect of the treatment on slowing pasture growth causing a considerable loss of winter production (more in the first year than the second due to the presence of more barley grass). The return on investment (at a base discount rate of 8%) was an annuity of $35/ha but this rose to $109/ha when the paddock was treated for two consecutive, making it definitely worth considering.

Part of the reason for the better returns with the use of spray topping with Gramoxone is that it is not applied until late spring when the barley grass is seeding and there is more feed present rather than the use of Shogun which impacts on winter feed production which can be in short supply. Barley grass provides useful high quality winter feed but becomes more of an issue to stock in spring when it rapidly loses quality and produces a seed head which can impact on stock health.

Producers were impressed with these low costs options. In comparison the economic analysis done early in the project showed that a full renovation would cost approximately $475/ha (including lime applications at sowing), with a breakeven time at year six *(*Lee Beattie*, pers. comms).*

5.2 On farm trial results and their effectiveness

Through the on-farm trials producers became aware of the following factors that influence perennial ryegrass persistence:

- Weed presence – weeds take resources away from plants, particularly nitrogen and make ryegrass weaker, so that it can't compete and thins out
- Fertility, especially low soil potassium can add drought stress to the plant, limit seed production and reduce its growth, making it weaker.
- The ability of the plant to regenerate new tillers and/or new seedlings to replace old plants that died is important
- Potentially low soil pH contributing to high aluminium levels down the soil profile may be limiting root extension of the PRG plants. However this did not seem to be a significant factor in affecting persistence of PRG at least in good rainfall years.
- Perennial ryegrass has shallow root systems (approximately 30 to 50 cm) and struggles to survive long hot summers and insect attack.

<u>Herbicide Interventions of early germinating weeds (Barley grass & silver grass)</u>

This intervention works by ryegrass filling in the gaps and plants increasing in size and number. The results can be devastating if you don't have the ryegrass plants in the pasture to fill in the gaps as there will be open spaces in the pasture through the winter, which quickly fill up with opportunistic weeds in the spring.

<u>Barley grass</u>

- Barley grass interventions that are done two years consecutively produced the best results. This can be seen in the results in section 4.3 but more importantly for farmers was very easy to see visually.
- Barley grass control using Shogun 200 ml/ha (mid to late May) worked better than spray topping with Gramoxone, especially if there was rain after the spray topping treatment which happened in year 1 as the Barley grass sent up a second seed head following the rain but as discussed above the treatment with Gramoxone was better in the economic analysis that the Shogun treatment.

- Shogun kills seedlings – this was demonstrated when Avalon SE was over sown as a strip across all sites at the Joseph site in year 2. It's registered to kill annual ryegrass and has some residual, so should not be used in new pastures.
- Shogun slows the growth of ryegrass and there is a huge variety of cultivar and species tolerances which is still being understood. It is known that you can't use it on Cocksfoot and whilst Australian Phalaris tolerates it easily, Holdfast is not so tolerant.
- You need to ensure that you have a reasonable population of PRG prior to using Shogun to remove Barley grass. It is very effective at removing the Barley grass and will leave bare ground which ideally will be filled by PRG plants but in the short term will leave feed shortages.

Spray topping with glyphosate was not used as a technique due to concerns that it may kill or weaken perennial ryegrass or affect seed set even with the low rates used. Paraquat is known to be safer also on clover seed set than glyphosate. Barley grass has uneven seed head emergence and can be difficult to get the timing right as seen in this trial, when late rainfall allowed the barley grass to send up a new tiller which ultimately set seed. Glyphosate is more flexible in its timing and remains another option.

Silver grass

- Silver grass has a detrimental effect on clover production through competition for space and alleopathic toxins that can significantly decrease the clover content in pastures it invades. This means less nitrogen is available for PRG.
- It was voted by the group as the weed which most causes concerns in pastures.
- It is not seen as having the feed quality benefit that barley grass offers in winter and early spring.
- There wasn't enough silver grass in the control (2.5%) to compare to but where silver grass was 14% and 15% in treatments three and four it was reduced to 0% but PRG did not notably increase.
- There was a paddock next to the trial paddock that had a severe silver grass infestation and this paddock was used as a demonstration at the field day to demonstrate the effectiveness of silver grass control with simazine.
- Although the economics suggested early intervention to maintain production, it is probably not worth treating silver grass if there is less than 10% in the pasture.
- There are questions about defining when to act or intervening early or the need to treat two years in a row.
- Simazine has a 14 day grazing withhold so the winter treatment had to be applied in July so that it fitted in with August lambing set stocking requirements.
- Like Shogun, it is also reduces the amount of feed available at a time when feed is in short supply.

Spraytopping is not seen as an effective control of silver grass because it sets enormous amounts of seed (over 1 million/m^2) and even if spray topping is 90% effective, 10% can still set seed and return similar plant numbers in the following year.

Oversowing perennial ryegrass

Avalon SE was chosen for over sowing because it was bred locally and is mid to late seeding. It fitted the growing season and should be able to set seed before the season cut out. The endophyte would help protect against insect attack but was safe for stock (will not cause staggers).

- Over-sowing perennial ryegrass without controlling early germinating weeds like barley grass doesn't work because barley grass is an early germinating weed and as it is highly competitive, will quickly establish in any bare ground.
- The over sown treatment in the Price trial did not have a clear effect of increasing PRG content.
- There was no observable difference where Avalon SE was sown across all sites in the Barley grass trial. In fact in paddock 2 when the site was treated with Shogun for the 2nd year the young Avalon SE seedlings all died so it is not recommended that Shogun is used on new pastures.
- Direct drilling into existing pastures was not found to be an effective strategy for increasing PRG content.

Often the strategy to over sow pastures with PRG recommends that it be done at the break with continual hard grazing to prevent existing pastures from swamping out the sown pastures. However any grazing could potentially impact newly emerged seedlings which are not yet anchored.

Strategic spelling of ryegrass:

In 2004 the Victorian Agriculture Department at Hamilton research farm developed a recipe for improving perennial ryegrass persistence in paddocks selected for seedling recruitment. This recipe involved removing stock from mid November to mid January to allow seed heads to mature and seed to fall, grazing trash to 1000 kg DM/ha by the break and then spelling the pasture at the break ideally until the three leaf stage to preventing overgrazing of new ryegrass growth and newly recruited ryegrass plants.

The trials found this to be a successful technique in Victorian perennial ryegrass but the group questioned if it could be equally successful in other more productive cultivars. The producers also felt that locking a paddock up for a period of 2 months was difficult to manage in a highly stocked system. Therefore the group looked to hasten the seed drop after ripening by dragging the pasture with mesh behind a motorbike so that the pasture could be returned to grazing earlier.

Although this method was crude, it was successful and the group discussed the potential use of other readily available machinery to do this such as tedders. Some producers felt that intensive rotational grazing achieved seed drop but there was concern by others that grazing stock if given the opportunity would eat the seed.

There was some conjecture about the necessity of the autumn spell for ryegrass regeneration. It may not be needed for seedling recruitment as the current advice for over sowing is to keep grazing but it would allow strengthening of existing plants.

It is difficult to suggest which activity leads to biggest improvements between spring spelling creating more daughter tillers, autumn spelling allowing plant recovery and increase in carbohydrate stores or seedling recruitment but the technique showed that altogether there was an improvement of ryegrass plants in the treatment compared to the control.

Although there was minimal interventions the length of the strategic spelling in both spring and autumn meant that in the economic analysis this worked out as one of the lowest returns on investment at $46 annuity per ha (at a base discount rate of 8%) when compared to the interventions for barley grass or silver grass for improving PRG composition.

Also seedling recruitment had a relatively high peak debt and longer payback period because it involved a pretty sharp jump in stocking rate, due to the pasture improvement, from 12 to 17

DSE/Ha. Assuming the stocking rate on the rest of the farm is maintained, theoretically additional stock would be purchased (or retained from sale) to provide those extra DSEs so that incurred a considerable capital cost. The extra profit from this intervention wasn't high so it took longer to recover that initial capital outlay hence the four year payback period.

It was interesting to see in the results (Figure 3) that the seed counts between the control and treatment did not differ greatly but the seedling counts was much higher in the treatment compared to the control (Figure 4). This difference could be attributed to the fact that shutting up the treatment areas allowed full seed maturity where as in the control, whilst setting seed, the plant was also grazed and the seeds whilst present were not viable.

In lower stocking rate situations when there is excess feed in spring it could be argued that the cost of spelling the pasture is exaggerated in these calculations however in high stocking rate enterprises when all spring pasture is utilised then the cost of spelling incurred would definitely need to be included as a considerable expense in this intervention to improve PRG content. By far the biggest expense in this calculation though, was the cost of purchasing stock to utilise the increase in feed production from the intervention.

Whilst strategic spelling was effective in improving PRG in the pasture it is not a practice many producers use as it is difficult in a high stocking rate prime lamb operation to destock an area in the critical spring growing period when areas may also be closed up for fodder conservation. The economic analysis shows that other interventions would be more cost effective in these situations.

The cost of locking up pasture in spring was also feed quality decline of 11.5 MJ ME to 9.5, so 2 MJ ME equating to $130/ha worth of feed value, assuming it was 100% utilised which it wouldn't be due to trampling and wastage and potentially having excess feed available at that time.

Strategic spelling would be a useful tool for some producers but they need to be able to recognise when to use seedling recruitment. It is of little use if there are weeds present as they will also set seed, so there is a need to have clean paddocks. However it would worth considering, depending on the management, for following weed interventions to use the recruitment strategy to strengthen up the pasture base to prevent further weed infestations and lengthen the life of the pasture.

One of the reasons for persistent Victorian perennial ryegrass pastures is its ability to set seed through its long flowering time. The original sown ryegrass plants themselves have not survived but its ability to set seed during hay making or low stocking has allowed it to keep regenerating. Some commercial productive PRG varieties have been bred for shorter flowering times for harvestibility of seed but may increase the risk of viable seed not hitting the ground through seasonal factors or clashing with grazing periods. For this technique to work cultivars must be selected that readily produce seed within the growing season.

Many of these interventions are not annual requirements but strategies that could be employed every three to five years depending on the pasture composition.

Producer's feedback on what's in it for me included:

- 'Cheap techniques to improve productivity'
- 'We are all struggling with costs and we need to use interventions to keep profitable'.
- 'There's no one way for everyone'.

- 'You have control over when you use these strategies and you need to be flexible as seasons vary and the state of pasture deterioration varies'.
- 'We all have different ryegrass and different finishing systems, so chose the technique that works for you'.

5.3 Promotion of research results and effectiveness

One of the most successful extension activities were the farm walks involving the producer group and wider public. The events were always held where there were visual results of the trials to see. Results handouts (site reports – see **Appendix 11**) were provided and there was good discussion around the topics. Producers were kept engaged in the research because not only was it of high relevance to them, but because there was always something to learn. It was notable at events, that topics of immediate relevance to producers were often also raised with producers seeking input from others to discuss management issues such as dealing with cattle pugging damage or how to use animals to create seed fall and trampling.

The group had always been excited about the potential of the research to improve production. SWPLG members were quite knowledgeable, with good skills at the beginning of the project and post project these areas have increased by about a 0.5 unit score. Importantly confidence in using the techniques had also increased (0.5 unit score) making adoption more likely. At the planning workshop, producers had mentioned that their use of interventions was minimal.

At the end of the project five of the producers mentioned using herbicide interventions, mainly techniques they were familiar with e.g. spray topping, use of simazine. Two mentioned stopping seed set of weeds two years in a row and one three years before sowing new pasture. One producer was going to do test strips on the farm to evaluate the impacts of Shogun before using it. Another thought that in their situation capeweed was a bigger priority than silver grass or barley grass. When asked which weeds the group thought that had the greatest impact on production? The group ranked them in order of highest to lowest impact as 1 Silver Grass, 2 Capeweed and 3 Barley Grass. Some individual producers had different priority weeds such as capeweed.

Only one producer expressed interest in using the strategic spelling of ryegrass to increase seedling recruitment and they plan to use it opportunistically when it's the right spring. Two producers were still unsure and wanted to weigh up the costs and benefits to decide whether it's more beneficial just to re-sow.

Generally the techniques were highly regarded as they didn't cost too much and were shown to improve perennial ryegrass density. Producers were even surprised at the results. Below are some of their comments:

- 'Cheap fix for a lot of benefit'.
- 'Techniques, should enhance productivity- won't have to spend as much money'.
- 'Be able to maintain high quality ryegrass pastures for longer'.
- 'Perennial grass recruitment worked better than I expected'.
- 'The barley grass research paddock had tipped over the edge and I thought of it required re-sowing but the Shogun treatment has completely rejuvenated it'.
- 'It doesn't cost a lot to control silver grass, so return on investment is high'.

Potential adoption of the techniques was likely higher from the group seeing such visual differences between treatments:

- 'Good to see it in the paddock, not a brochure – makes it more memorable'.

- ‘Amazing how much ryegrass there is when you remove the weeds’.
- ‘Opened up the possibilities, barley grass control was visually very different’.

There was evidence of producers starting to think how they would use the techniques and even start to combine them:

- ‘You could do the weed control, then recruitment to get a really good paddock’.
- ‘Keen to use technique with short term ryegrasses (eg Barberia three to five year lifespan) and use the technique strategically to avoid total re-sowing but keep topping up the paddocks with own seed production’.
- ‘Lots of opportunity to use the recruitment technique, as it’s unlikely that farmers would use all the feed at that time (spring)’.
- ‘It wouldn’t have to be done every year, but strategically to rejuvenate thinning out paddocks’.
- ‘We accept the presence of these weeds but maybe we don’t need to’.
- ‘I have focused on persistence but it could be about production (if you make them more productive they are likely to be stronger plants so more persistent)’.

There were a number of risks identified by the group for using PRG:

- The main risk included those based on economics. The risk of sowing new productive varieties and they either don’t establish or persist and so they don’t get a positive result for their investment. They described it as wanting a Thoroughbred but getting a Clydesdale.
- That they invest time and money in chasing ‘persistent’ varieties but under set stocking they are never going to survive.
- There is also a risk that they don’t access the “right” people and so they continue to make decisions based on incorrect or incomplete information.
- There is also the risk with pursuing persistent perennial ryegrass that staggers can occur and cause major inconvenience every five years or so.

Producer’s main concerns with the interventions were around costs of losing pasture production and withholding stock from grazing whilst strategies are being implemented, but farmers were already thinking of ways to manage or minimise losses:

- ‘Maybe only do 20% a year or dependent on season and how much feed you have got & what damage is being done’.
- ‘Lose about 20 to 30% production in June or July by spraying using Simazine, then could go in ten days later with nitrogen to increase growth or could apply late August but need higher rates of Simazine’.
- ‘Don’t like to spray early as it suppresses growth at a time you need it, but from an agronomy point it’s the best time’. (Weeds also suppress growth).
- ‘Could work on one paddock per month to ease feed shortage’ (Shogun use).
- ‘Only in spring is barley grass a problem as it is nutritious over winter and you could need it for winter feed’.

Implementing the weed control strategies highlighted some concerns and issues:

- ‘Happy to do repeat sprays (i.e. two consecutive years) as long as it is cost effective’.
- Concerns about herbicide resistance being created, ‘I like to only use herbicides on the cropping paddocks and keep away from herbicides on the pasture paddocks’.
- Identification of weeds correctly is important so that you utilise the right technique, especially when weeds are in the seedling stage. (Producers need to inspect paddocks either in the spring before or when actively growing as identification of issues in

autumn when pastures are dry or when plants are seedlings will be hard to identify or judge).

- For perennial ryegrass persistence, spray top using Gramoxone at full head emergence rather than glyphosate because at even light rates of glyphosate combined with moisture stress could kill perennials.
- Barley grass re-tillering after spray topping produced a seed head, particularly in low lying areas with more moisture but also on rises following rainfall.
- Shogun has got a three day withhold period so you need to get stock off the paddock and sometimes you can't.
- Farmers don't like using Gramoxone (not farmer friendly).

Some concerns about the techniques being perceived as complicated in terms of picking when to best apply them:

- 'Need to be able to pick the years when you will get the most benefits from recruitment'.
- 'Lots of variables. How many weeds are there, how much feed you have got, it's complicated, you need good advice'.
- 'The timing of lock up will depend on species as each has different flowering times. Having a late flowering plant might fit in better as farmers would prefer to lock up in October when there is plenty of feed compared to September'.

Appears to be some perceptions that the recruitment technique wouldn't fit some farming system or wasn't working:

- 'I wouldn't use it, I get these benefits from rotational grazing and prefer to use animals to knock down seed'.
  (A downside to rotational grazing would be that animals would still be grazing and eat seed and timing could be out depending on rotation. Also that rotational grazing ryegrass may not automatically improve persistence as you could put pressure on the plant at a sensitive time eg when recovering from summer autumn drought.)
- 'I don't produce as much excess spring feed as others and so I couldn't afford to not eat the feed at that time'.
- 'Because it was a good year, I hadn't thought what I had done mattered, but the numbers showed it did.' (The results of perennial ryegrass grazing/recruitment intervention may not be visually apparent, you can't see an obvious difference (i.e. seed set, seedling establishment) but the measurements show the improvements).

5.4 Effectiveness of the participatory research process

There was not a FIP research project on pasture persistence but this group added value to existing research by:

- Helping to establish the importance of profitable persistence rather than treating persistence and production separately.
- Modifying the seedling recruitment spelling strategy to increase its appeal to producers.
- Trying to quantify the costs and benefits of different interventions. Generally only the product costs of the intervention are reported (eg Herbicide application costs) and the costs of lost grazing or reduction in pasture growth are not accounted for.
- Unpacking the implications of the interventions and identifying where they fit within a whole farm context.

The group benefited from participation in the PRS program because it allowed them to trial techniques of interest to them that addressed a problem they were concerned about. The SWPLG had focused previously on animal production related projects and this was their first feed base project. This project allowed them to buy in pasture expertise to help in the pasture assessment and measurement and trial design. It's unlikely the producers in the group would have had time to be able to do this without support. Having researcher Kevin Smith, Professor of Pasture Agronomy (Plant Breeding), Department of Agriculture and Food Systems involved in the project assisted the group to design the project and provided insights into the issue of persistence.

Future areas of work that were identified by the group to further help develop this topic that would make adoption easier were:

- Greater skills development for producers to assist them to understand when and how to manage weeds and to allow seed set and regeneration of ryegrass for persistence.
- The management skills and know how to intervene to extend the life of the pasture. It would help to be able to pick when and how to implement grazing management strategies that could increase longevity of pastures across different stocking systems such as strategic spellings or opportune rotational grazing.

The group's knowledge gaps were identified in the initial workshop and could help frame future extension material regarding this topic included:

1. Understanding the impact of plant stresses on persistence:
    - Grazing management stresses
        - The amount of root mass that's needed for survival. Are they keeping them too short by set stocking and is this impacting on plant survival. They question if they let them build root mass in the first year or sometimes strategically use rotational grazing could it lead to better survival not only in the first year but ongoing survival.
        - Do dairy management systems increase persistence i.e. intensive rotational grazing systems?
    - Insect & pest stress
        - How much are insects and pests damaging the plant and affecting persistence?
    - Nutrient stresses:

- What is the fertility that's needed to maximise persistence, both in establishment and later, particularly nitrogen, phosphorus, potassium and sulphur, and also pH?

Seasonal stresses:

- Does the length of the dry period and age of the plant impact (a matrix of factors) affect persistence?
- What years or conditions suit persistence rather than weeds?
- What PRG varieties are best suited to their growing seasons so that they flower and produce well before the season dries off?

Weed stresses:

- How much of a role do establishment methods affect persistence by allowing weeds to reinvade? Does a full renovation with two years cropping remove weed seeds and reduce the time taken for pastures to be reinvaded with weeds?

2. Understanding the economics of persistence to make better decisions of when, what and how to sow:

- Can they use cheap methods of establishment (over sowing vs full renovation with summer fodder crops) so they could sow more often and then persistence wouldn't be such an issue as they would have a quicker pay back.
- Understanding how long pasture persist and produce for under different methods of establishment.

3. Management Interventions

- Can we intervene in the pasture to prolong its persistence?
- Does shutting up paddocks and allowing seeding increase regeneration with the newer varieties of PRG or is it just Victorian Perennial ryegrass?

6 Conclusions/Key messages/recommendations

6.1 Conclusions

- The longer a pasture persists at its peak production the more profitable is the initial investment.
- Early intervention weed control in a PRG based pasture can extend the peak production of the pasture – the earlier the intervention the more profitable the outcomes.
- All interventions for managing barley grass, silver grass and strategic spelling to improve PRG content had a positive annuity per ha at a base discount rate of 8% ranging from $35 to $137 depending on the intervention so it was shown that all interventions were worth implementing.

6.2 Key messages

- Maintaining the level of peak production for as long as possible with early interventions improves the profitability of the initial investment.

- You need to measure and understand your perennial ryegrass and weed content in autumn (and soil conditions) so you can manage to keep perennial ryegrass productive. One recipe may not fit all, you need to assess your pasture and understand where the interventions best fit it into your system.

- Generally weed interventions work best if done two years consecutively to get rid of dormant seeds, particularly if the weed content is high in the first year.

- Use perennial ryegrass recruitment strategy not every year but strategically when numbers start to decline or the year following a poor spring.

- Over sowing/direct drilling without weed control proved to be of no value as weeds out competed the new seedlings.

6.3 Recommendations

Future areas of work that were identified by the group to further help develop this topic that would make adoption easier were:

- Greater skills development for producers to assist them to understand when and how to manage weeds to allow seed set and regeneration of ryegrass for persistence.
- The management skills and know how to intervene to extend the life of the pasture. For example being able to pick when and how to implement grazing management strategies that could increase longevity of pastures across different stocking systems, such as strategic spellings or opportune rotational grazing.

The group identified a range of extension products that might help achieve this including:

- You tube video
    - Showing visual seed knockdown, how to check for seed viability.
    - How to check when seed is viable.
    - Producer discussing and fleshing out variables, which paddocks they do and which ones they don't what information they base the decisions on, telling the story.

- Develop a range of tools for different seasons, scenarios and life stages of pastures with details demonstrating when and how to use them.

- Decision tree to help you select which pathway for which type of season, time of year and system.

- App to help with decision making.

- Plant identification, - need to be able to identify weeds and pasture seedlings in autumn (focussing on major weeds only).

- Access to good trained advisors that can help people develop skills and implement producer demonstration sites and discussion groups.

7 Bibliography

Waller R, (2008). Productive persistent perennial ryegrass. EverGraze Action Fact sheet. [Online] (Available on-line with updates at http://www.evergraze.com.au/wp-content/uploads/2013/06/Evergraze-Action-ryegrass-A4.pdf (Verified 16 November 2017)

8 Appendices

Appendix 1: Questionnaire for members

Appendix 2: Program for initial workshop

Appendix 3: Assumptions for first economic analysis

Appendix 4: Soil test results - Joseph site

Appendix 5: Paddock diary - Joseph site

Appendix 6: Paddock diary - Frawley site

Appendix 7: Soil test results - Frawley site

Appendix 8: Soil test results - Price site

Appendix 9: Paddock diary - Price site

Appendix 10: Assumptions for economic analysis of interventions

Appendix 11: Site report handouts developed for field days

Appendix 1

Questionnaire (Using clicker technology)

To address:

- *what methods of establishment and manipulation techniques used and the impact this has on persistence*
- *the methods used or not used and for what reasons*

As we will be using clicker technology all responses will be anonymous

1. Do you regularly oversow/direct drill into old pastures? **Yes** or **No**
   Only those who answered 'no' answer next Q
   If **No** then why?
   a) Tried and it doesn't work
   b) Seasons too unreliable
   c) Lack of equipment
   d) Prefer full renovation
   e) No suitable species
   f) Not sure how or when to do it
   g) Cost

   If **yes** then why:
   a) Pastures starting to run out
   b) Old rundown pastures
   c) To improve species
   d) Cheaper than full renovation
   e) Annuals for short term feed

2. Do you do a full renovation and resow at least one paddock **every year**? **Yes** or **No**
   Only those who answered 'no' answer next Q
   If **No** then why?
   a) Tried and it doesn't work
   b) Seasons too unreliable
   c) Lack of equipment
   d) Prefer to just oversow
   e) No suitable species
   f) Cost

   Only those who answered 'yes' answer next Q
   If **yes** then why?
   a) Old rundown pastures
   b) Fodder crop part of system
   c) Poor persistence of species
   d) To sow new species
   e) To sow new cultivars

3. For pasture establishment do you use the following methods?
   a) Spray and direct drill **Yes** or **No**
   b) Full renovation from pasture **Yes** or **No**
   c) As part of crop rotation **Yes** or **No**
   d) Undersow a crop **Yes** or **No**

4. Following is a list of management practises:
   i. Shutting up pasture to allow reseeding
   ii. Strategic resting of pasture
   iii. Putting stock in a containment area
   iv. Spray grazing
   v. Cultivar options
   vi. Endophyte options
   vii. Oversowing annuals

   Rank the above practises in order of importance 1-7 where 1 is most important

   Rank your confidence to do each of the practises listed above 1 – 5 where 1 is very confident and 5 is have no idea how to do it

The last question to be addressed in the survey is opportunities for modifying grazing systems to include strategic spells of PRG which leads to increased persistence. This will be addressed by Kevin as part of the discussion of the questionnaire.

Appendix 2

Program

Date: Thursday 12th March 2015
Venue: PVI, Mt Napier Rd, Hamilton
Time: 9.30 for tea/ coffee
10.00am – 3.00 pm

10.00 am	Welcome/Introduction to day (Leo Cummins)
10.10 am	Prof Kevin Smith " How do we get out of the mess we are in thanks to no spring last year?"
10.40 am	Andrew Speirs Importance of soil nutrition and results from MLA trials
11.10 am	Lee Beattie An economic analysis to define profitable persistence under six different real farm scenarios.
11.40 am	Discussion led by Kevin Smith on mornings speakers
12 pm	Lunch
12.30 pm	look at 'lucerne for lambs' trial
1.00 pm	Questionnaire and discussion (Kevin Smith)
1.45 pm	Bindi Hunter Outline trials we thought we would do and what will be required
2.15 pm	Discussion of project (Kevin Smith) • Modifications to trials • Sites for trials • Other issues
3.00 pm	Close

Appendix 3

SUMMARY OF ASSUMPTIONS FOR PASTURE PERSISTENCE OPTIONS

It has been assumed that a 50 hectare paddock on the representative farm has been utilised for each of the pasture persistence options evaluated. The key assumptions associated with each option are described below.

Option 1: Full Renovation

Assumptions

- One cultivation: $45
- Sowing cost: $60
- Knockdown: $35 (15 spraying 20 for chemical)
- Lime applied 2.5 t/ha: $88
- Small amount of capital P: $105
- Seed sub and grasses: $140
- Total cost: $473.00 (rounded up to $475)
- Assume base stocking rate of 8 DSE and post renovation peak stocking rate of 16 DSE, taking 3 years to reach the 16 DSE carrying capacity.
- Loss of grazing for 12 weeks in the autumn winter in first year - 8 DSE by 25 cents per week per DSE.
- Assume this pasture should last 10 -12 years.
- Carrying capacity begins to decline from year 7 onwards back down to 8 dse at end of pasture life.
- No additional annual maintenance costs required post renovation above what was already being spent annually before renovation.
- Assume 10% chance of failure where re-sowing is required.

Option 2: Full Renovation - spring sowing

Assumptions are the same as option 1 above except loss of grazing for 6 weeks.

Option 3: Spray topping (control of Silver grass or Barley grass)

Assumptions:

- Production down by 20 % for early intervention.
- Removing silver grass dramatically increases legume content and hence growth rates but often SR is similar, so have assumed no change in stocking rate.
- Cost per ha is $22 per ha needs to be done 2 years in a row. Loss of production by spraying nil often a small increase.

- Year 2 legume component improves increasing lamb growth rates by at least 50 grams per day. Have assumed an additional 50g day growth over two months, and also assume finish an extra 20% of lambs pre-Christmas (so only 20% of lambs carried over).
- Intervention required every 5 – 7 years.

Option 4: Winter cleaning for silvergrass

Assumptions:

- Production down by 40 %.
- Control needs to happen two winters in a row. Cost per ha $22 per year chemical and contractor. Expected loss of winter production of 6kg DM/Ha/day for 8 weeks @ 10 MJ ME/kg DM valued at 2 c per MJ ($67/Ha).
- Increase productivity by 20 % per year for two years.
- Again legume quantity will increase same rules as spray topping . Assumed 20% increase in legume content increases lamb growth rate by 50g day over two months and a 20% decrease in carryover lambs, results in an increase in gross margin per DSE of $5.06 after two years.
- Intervention required very 5 -7 years.

Option 5: Spray topping and then direct drilling Ryegrass only

Assumptions:

- Base stocking rate of 8 dse increases to 13.3 dse/ha by year 2 (production down by 40%).
- Paddock is level and no capital fertiliser is required.
- Costs $22 spray top spring prior, seed 12 kg at $8 = $96/ha. Direct drilling contract cost $60/ha. Loss of grazing for 8 weeks, agistment at 25 cents per DSE per week .
- Pasture should last 7-8 years, with carrying capacity beginning decline year 5.
- Assume 5% chance of failure where re-sowing is required.
- No additional annual maintenance costs required post renovation above what was already being spent annually before renovation.

Option 6: Over sowing - dry sowing grass only no weed control

Assumptions:

- Base stocking rate of 9.5 dse increases to 15.8 DSE/ha by year 2 (production down by 40%).
- Costs, seed 12 kg at $8 = $96/ha. Direct drilling contract cost $60/ha.
- Loss of grazing for 4 weeks, agistment at 25 cents per DSE per week .
- Intervention required once every 6 years, with carrying capacity beginning to decline year 4-5.

- Assume 15% chance of failure where re-sowing is required.
- No additional annual maintenance costs required post renovation above what was already being spent annually before renovation.

Option 7: Seedling recruitment of the ryegrass seedlings

Assumptions

- Base stocking rate of 8 dse increases to 11.4 DSE/ha by year 2 (30% production loss).
- Very low cost mainly a loss in pasture quality - assumed 2 ME by 2 tonne of dry matter. ME valued at 2c per MJ, total cost of loss in pasture quality $80/Ha.
- Stand off for 4 weeks post the break in the next year, agistment at 25c per DSE/week.
- Full production reached in year 2, decline in carrying capacity begins in year 3.
- Intervention once every 5 years.
- No ongoing annual pasture maintenance costs post seedling recruitment above what was already being spent pre-recruitment.

SUMMARY OF ASSUMPTIONS FOR REPRESENTATIVE FARM SYSTEM

General

Farm Area: 500 ha

System Type*:* 70 kg average weight self replacing composite ewe system.

Main lambing month: August

Ram joining rate: 1.5%

Lamb weaning % = 125%

Stocking rate = 16 dse/ha

Sheep Trading

Ewe replacement rate = 17.5%

Cull ewes: 50% sold in Nov and 50% in Feb. Average cull ewe price of $50/hd.

Ram replacement rate: Keep rams for 3 years.

Cull rams: Sold Apr valued at $25/hd.

Replacement rams: Purchased Nov for average of $1,000/Hd

Lamb sales: 60% sold in Dec @ 45kg LW 45% dressing %. Rest sold in Feb @ same LW (45kg).

Sheep selling costs: 4.5% commission and MLA levy is 2% to a max of $1.50 for lambs and 20c for mutton and state levy of 12c per head – both are transaction levies.

Sheep freight: $2/hd

Lamb price: $4.55/kg CW based on CPI adjusted Eastern States Trade Index Lamb Indicator (2003-2013).

Skin price: $8/Hd

Deaths: Ewes = 3%

Replacement ewe weaners = 3%

Carryover lambs = 4%

Rams = 1%

Wool Production

Carryover lambs are shorn: Av. cut/hd of 1 kg greasy.

Replacement ewe weaners: Av. cut/hd of 2 kg greasy.

Ewes/Rams: Av. cut/hd of 4 kg greasy.

Micron/Yield: Average 32 micron and 70% yield.

Wool selling costs: Wool tax 2%. Commission/warehouse/testing charges = $39/bale, wool cartage = $18/bale, wool packs = $13/bale. Assumed av. 200kg per bale.

Shearing/crutching costs:

Shearing

ewes	$5.89/hd
weaners/lambs	$5.89/hd
rams	$8.50/hd

Crutching

ewes/weaners	$1.04/hd
rams	$1.95/hd

Wool price: $4.51/kg clean based on average CPI adjusted southern micron guide for 32 micron wool (2003-2013). Assumes 85% of clean fleece value across entire clip to account for discounted lines.

Animal Health

		$/app	No. apps	$/hd
Broad spectrum	ewes	0.65	2	1.30
	lambs	0.33	3	0.99
Narrow spectrum	ewes	0.45	1	0.45
Lice treatment	ewes	1.16	1	1.16
Fly control (long acting)	weaners	1.55	1	1.55
Vaccination (6 in 1)	ewes	0.27	1	0.27
	lambs	0.27	1	0.27
Marking	lambs	1.55	1	1.55
Scanning	ewes	0.80	2	0.80

Enterprise Costs

Animal health, freight, and shearing/crutching costs as above. Other general expenses at FMP value of $0.76/dse (this would cover miscellaneous things such as ear tags, dog expenses).

Supplementary feed: 13/14 FMP supplementary feed costs for prime lambs - $2.90/dse.

Pasture costs: Have assumed 0.8 kg P per DSE via SS valued at $320/T (5 year CPI adjusted average Vickery's SS price).

Other pasture maintenance costs = $13/Ha based on FMP data for farms similar to your average farm system.

Overhead Costs

I've loosely based these on average FMP data and also considering data from individual FMP farms that most closely resemble SWPLG average system:

Admin = $16/ha

Elec/insurance = $12/ha

R & M = $21/ha

Rates = $9/ha

Depreciation = $25/ha

Fuel & vehicle = $15/ha

Other = $2/ha

Labour

Assumed one full time labour unit is required to manage the system (allowing 4 weeks holiday annually). Use FMP owner/operator labour allowance of $62,541 per FTE which is based on the Pastoral Industry Award.

Assumed no employed labour other than contract labour for shearing/crutching and scanning.

Asset Values

Land value = $5,000/ha

Plant & equipment value = $125,000

Average adult ewe value = $130/hd

Average replacement ewe weaner value = $100/hd

Appendix 4

MERIDIAN Agriculture

Client: Kate Joseph
Address:

Sample : 150441 51 52
Received:
Despatch: 21/05/15
Interpretation: Peter Flavel

Job Comment: **CLIENT:** Pdk No 2

ANALYSIS		UNITS	Laboratory Identification: 150441	150451 10-20cm	150452 20-30cm			
Phosphorus	(Olsen)	mg/kg	29.5					
Phosphorus	(Colwell)	mg/kg	62.0					
Phosphorus Buffering	Index	PBI	93.2					
Phosphorus	(Total)	mg/kg						
Potassium	(Colwell)	mg/kg	235.0					
Sulphur	(KCL40)	mg/kg	11.8					
pH	(1:5 water)		5.7	5.9	5.7			
pH	($CaCl_2$)		4.9	4.9	4.8			
Salinity (EC)	(1:5 water)	dS/m	0.21	0.02	0.04			
Salinity (ECse) calc	(Sat Ext)	dS/m						
Chloride (ECse)		mg/kg						
Soil Texture								
Organic Carbon		%	3.51					
Total Nitrogen		%						
Nitrate		mg/kg						
Ammonium		mg/kg						
Trace Elements:								
Copper	(DTPA)	mg/kg	0.8					
Zinc	(DTPA)	mg/kg	1.1					
Manganese	(DTPA)	mg/kg	4.7					
Iron	(DTPA)	mg/kg	293.0					
Boron	(Hot)	mg/kg	0.77					
Calcium	(Exch)	meq/100 g	7.14	1.93	3.38			
Magnesium	(Exch)	meq/100 g	1.06	0.28	0.41			
Sodium	(Exch)	meq/100 g	0.21	0.06	0.08			
Potassium	(Exch)	meq/100 g	0.60	0.06	0.08			
Aluminium	(Exch)	meq/100 g	0.16	0.36	0.31			
Calculations								
Sum of cations	(CEC)	meq/100 g	9.17	2.69	4.26			
Calcium/Magnesium ratio			6.7	6.9	8.2			
Sodium % of cations	(ESP)		2.3%	2.2%	1.9%			
Aluminium % of cations			1.7%	13.3%	7.3%			

Comments:
Sub soil Al % will be limiting perennial ryegrass persistance.
Subsoil potassium is very low.

Caution re check surface potassium values later in season -some fertilizer potassium maybe be picked up.

Appendix 5 Paddock diary for Joseph Site

Date	Location/ Paddock/ Treatment	What was done (e.g. spray/ graze)	Rate	Who
28/4/15	All trial	Set up sites and monitored BG & RG in paddock 2 (ran out of time). Soil tested.		AS & BH
18/5/15	All trial	Fastac 11ml (cockchafers) 1L MCPA + 0.05l Lontrel (thistles)	spot sprayed	TCS
22/5/15	Treatment 2	200ml Shogun/ha & 500ml Kwicken / 100l water		TCS
19/5/15	All trial	Monitored barley & rye grasses		BH
21/6/15	All trial	1L MCPA + 0.05L Lontrel	Spot-sprayed	TCS
3/9/2015	All trial	Monitored barley & rye grasses		BH & Peter
27/10/15	Treatment 3	Spray topped with 400 ml gramoxone at 120L/ha		
11/2/2016	All trial	Checked sites/ photos. Big difference between control and shogun. Some difference between spray-top and control. Crickets needing to be sprayed. Second germination of barley grass in spray-topped paddock resulting in viable seed should have had second spray. Lots of standing barley grass in the control and Shogun site had been eaten out by sheep. * Rises haven't as much 2nd gen barley grass.		AS & BH
15/3/16	All trial	Inspection. Significant difference between control		all

		and shogun and some difference between spray-top and control. Soil profile showed roots penetrating >30cm		
7/4/16	All trial	All site top dressed 118kg/ha 3-5-25-2		
27/4/16	All trial	7 runs of seeding using 20kg/ha Avalon across all treatments in the middle of both paddocks		TCS
12/5/16	All trial	Monitored barley & rye grasses		
14/5/16	All trial	All of both paddocks sprayed with 1.35L MCPA 750, 400ml Ecopar and 300ml Alphascud per ha		TCS
20/5/16	Shogun treatment in paddock 2 only	Sprayed with 200ml/ha Shogun with Kwickin at 500ml/100L		TCS
22/9/16	All trial	Monitored barley & rye grasses		
26/11/16	Treatment 3, paddock 2 only	Spray topped with 400 ml gramoxone at 120L/ha		TCS
30/6/17	All trial	Monitored barley & rye grasses		

Appendix 6 Diary for Frawley site

Date	Location/ Paddock/ Treatment	What was done (e.g. spray/ graze)	Rate	Who
29/10/15	Both sites	Site setup		AS & BH
30/10/15	Treatment	Locked up treatment site & feed tested		
22/12/15	Treatment	Meshed treatment to get seed fall & feed tested both sites		CF
22/12/115	Both sites	Grazed with cattle for seed soil contact then continued grazing with sheep		CF
11/2/16	Both sites	Seed counts & photos & soil testing		AS & BH
Mid April TBC	Treatment	Locked up treatment site to allow seedlings to reach 2-leaf stage		CF
25/4/16	Both sites	Ecopar & MCPA 750 Fastac	400ml each 100 ml	CF
12/5/2016	Both sites	Seedling counts & photos		AS & BH
28/5/2016	Treatment	Gate opened to allow grazing (2-leaf stage)		CF
22/9/16	Both sites	Percentage PRG measured and photos		BH & AS
5/11/16	treatment	Locked up for seed set		CF
4/1/17	Treatment	Meshed		CF
5/1/17	Treatment	Grazed with cattle for soil/seed contact, then sheep		CF
24/2/17	Treatment	Locked up for seedling establishment		CF
23/3/2017	Both sites	Seed counts and photos		BH & AS
24/4/17	Both sites	Seedling counts and photos		AS&BH
24/4/17	Treatment	Grazing		CF

Appendix 7

MERIDIAN Agriculture

Client: C & J Frawley
Address: 156 Koornong Estate Rd
Branxholme, VIC 3302

Sample : 150556/57/58
Received: 23/07/2015
Despatch: 5/08/2015
Interpretation: A Speirs

Job Comment: **CLIENT:** C and J Frawley

ANALYSIS		UNITS	Laboratory Identification: 150556 0-10cm	150557 10-20cm	150558 20-30cm			
Phosphorus	(Olsen)	mg/kg	9.3					
Phosphorus	(Colwell)	mg/kg	25.0					
Phosphorus Buffering Index		PBI	85.5					
Potassium	(Colwell)	mg/kg	150.0					
Sulphur	(KCL40)	mg/kg	9.0					
pH	(1:5 water)		5.7	5.6	5.8			
pH	($CaCl_2$)		4.9	4.8	4.9			
Salinity (EC)	(1:5 water)	dS/m	0.07	0.04	0.04			
Salinity (ECse) calc	(Sat Ext)	dS/m						
Chloride (ECse)		mg/kg						
Soil Texture								
Organic Carbon		%	3.29					
Total Nitrogen		%						
Nitrate		mg/kg	8.0					
Ammonium		mg/kg	13.0					
Trace Elements:								
Copper	(DTPA)	mg/kg	0.7					
Zinc	(DTPA)	mg/kg	1.1					
Manganese	(DTPA)	mg/kg	6.9					
Iron	(DTPA)	mg/kg	189.0					
Boron	(Hot)	mg/kg	0.75					
Calcium	(Exch)	meq/100 g	5.45	3.54	2.98			
Magnesium	(Exch)	meq/100 g	0.83	0.78	1.07			
Sodium	(Exch)	meq/100 g	0.11	0.09	0.10			
Potassium	(Exch)	meq/100 g	0.36	0.13	0.11			
Aluminium	(Exch)	meq/100 g	0.18	0.37	0.35			
Calculations								
Sum of cations	(CEC)	meq/100 g	6.93	4.91	4.61			
Calcium/Magnesium ratio			6.6	4.5	2.8			
Sodium % of cations	(ESP)		1.6%	1.8%	2.2%			
Aluminium % of cations			2.6%	7.5%	7.6%			

Comments:
Soil pH and Aluminium in 0-10cm are good, in the 10-20 and 20-30cm Aluminium is elevated and in dry periods may affect roots of Perennial grasses. Soil Potassium in the 0-10cm is just adequate, in the sub soil Potassium levels are low and responsive. Soil Phosphorus levels are high and adequate.

Cheers, Andrew

Appendix 8

MERIDIAN Agriculture

Client: E Price
Address:

Sample : 150490 491
Received:
Despatch: 16/07/15
Interpretation: Peter Flavel

Job Comment: **CLIENT:**

ANALYSIS		UNITS	Laboratory Identification: 150490 10-20cm	150491 20-30cm				
Phosphorus	(Olsen)	mg/kg						
Phosphorus	(Colwell)	mg/kg						
Phosphorus Buffering	Index	PBI						
Phosphorus	(Total)	mg/kg						
Potassium	(Colwell)	mg/kg						
Sulphur	(KCL40)	mg/kg						
pH	(1:5 water)		5.8	6.3				
pH	($CaCl_2$)		4.8	5.2				
Salinity (EC)	(1:5 water)	dS/m						
Salinity (ECse) calc	(Sat Ext)	dS/m						
Chloride (ECse)		mg/kg						
Soil Texture								
Organic Carbon		%						
Total Nitrogen		%						
Nitrate		mg/kg						
Ammonium		mg/kg						
Trace Elements:								
Copper	(DTPA)	mg/kg						
Zinc	(DTPA)	mg/kg						
Manganese	(DTPA)	mg/kg						
Iron	(DTPA)	mg/kg						
Boron	(Hot)	mg/kg						
Calcium	(Exch)	meq/100 g	2.95	2.25				
Magnesium	(Exch)	meq/100 g	0.56	0.53				
Sodium	(Exch)	meq/100 g	0.15	0.13				
Potassium	(Exch)	meq/100 g	0.17	0.13				
Aluminium	(Exch)	meq/100 g	0.48	0.17				
Calculations								
Sum of cations	(CEC)	meq/100 g	4.31	3.21				
Calcium/Magnesium ratio			5.3	4.2				
Sodium % of cations	(ESP)		3.5%	4.0%				
Aluminium % of cations			11.1%	5.4%				

Comments:
Sub soil Al % will be limiting perennial ryegrass persistance.
Subsoil potassium is very low.

Caution re check surface potassium values later in season -some fertilizer potassium maybe be picked up.

HiFERT HIGH ANALYSIS FERTILIZERS ms&a Australia's Growing Edge Advisors to Agriculture & Small Business

Analysis Report Shallow Soil

Client	E Price	**Sample Number**	100SS4079MSA
Address		**Dealer**	
Town		**Dealer Number**	
State		**GPS (Easting,Northing)**	,
Postcode		**Sample Date**	
Phone		**Report Date**	Friday, 15 May 2015
Mobile		**Billing**	
Paddock Name	Trial Pdk		
Enterprise Type	SHEEP_BEEF	**DSE**	16.00

Nutrient Analysis

Nutrient	Result	Adequate Range		Classification	Comments
Ammonium (N) [mg/kg]	**30**	0	20	High	Guide only
Nitrate (N) [mg/kg]	**16**	20.01	60	Marginal	Guide only
Phosphorus (P) [BSES mg/kg]	**0**	0	0		
Phosphorus (P) [Olsen mg/kg]	**28.10**	12.01	18	High	
Phosphorus (P) [Colwell mg/kg]	**64**	30.01	45		
Potassium (K) [mg/kg]	**123**	140.0	250	Marginal	Production may be limited
Nitric (K) [me%]	**0**	0	0	Not Tested	Not Tested
Sulphur (S) [KCl40 mg/kg]	**10.80**	8.01	12	Adequate	
Chloride (Cl)	**0**	0	0	Not Tested	Not Tested
Exc K [meq/100gm]	**0.31**	0	0	No Standard Found	No Standard Found
Organic Carbon [%]	**5.00**	...		High	High
Conductivity [dS/m]	**0.17**	...		High	Production losses of greater than 10% are likely.
pH [CaCl2]	**4.40**	...		Strongly acidic	Acidity will be limiting growth. Consider liming to reduce acidity.
pH [H2O]	**5.40**	...		Strongly acidic	Acidity will be limiting growth. Consider liming to reduce acidity.
Aluminium (Al) [CaCl2 mg/kg]	**0.00**	...		Not Tested	Not Tested
Free Lime		...		Not Tested	Not Tested
Texture	**1.5**	...		LS	Loamy/Sand
Phosphorus Buffering Index (PBI)	**118.0**	...		Low	Soils require moderate phosphorus inputs to build soil phosphorus. Leaching losses unlikely to occur
Grass Tetany	**0.05**	...		...	Grass Tetany risk is low.

Trace Elements

Nutrient	Result	Adequate Range		Classification	Comments
Zinc [DTPA - mg/kg]	**1.03**	0.8	1.5	Adequate	Guide only
Copper [DTPA - mg/kg]	**0.77**	0.7	1.5	Adequate	Guide only
Manganese [DTPA - mg/kg]	**6.20**	2.0	4.0	High	Guide only
Iron [DTPA - mg/kg]	**450.09**	30.0	500.0	Adequate	Guide only
Boron [Hot CaCl2 - mg/kg]	**0.68**	0.2	2.0	Adequate	Guide only
Silicon [Sulphuric - mg/kg]	**0.00**	0	0	not set	not set
Silicon [Cal Chloride - mg/kg]	**0.00**	0	0	not set	not set

HiFERT HIGH ANALYSIS FERTILIZERS ms&a Australia's Growing Edge Advisors to Agriculture & Small Business

Analysis Report Shallow Soil

Client	E Price	Sample Number	100SS4079MSA

Cation Exchange Capacity (CEC)

Nutrient	Result	CEC %	Adequate Range (CEC %)		Classification (CEC %)	Comments (CEC %)
Calcium [Meq/100 gms]	**4.84**	70.14	65.0	80.0	Adequate	Adequate
Magnesium [Meq/100 gms]	**0.91**	13.19	10.0	15.0	Adequate	Adequate
Potassium [Meq/100 gms]	**0.31**	4.49	3.0	10.0	Adequate	Adequate
Sodium [Meq/100 gms]	**0.25**	3.62	0.0	5.0	Adequate	Adequate
Aluminium [Meq/100 gms]	**0.59**	8.55	0.0	5.0	High	Check soil pH, liming should be considered
Calcium:Magnesium Ratio	**5.32 : 1**					Soil surface structure is unlikely to respond to soil ameliorants.
Total CEC [Meq/100 gms]	**6.90**				**Adequate**	**Good capacity to hold nutrients**

Nutrient Requirements

Nutrient	Requirement (unit)	Comments
Nitrogen Required	**0 kg/ha**	Is not required. Conditions and Warnings must be observed when applying Nitrogen to grazed pastures.
Phosphorus Maintenance	14 kg/ha	Is required and has been calculated.
Phosphorus Build Up	0 kg/ha	Is not required.
Phosphorus Required	**14 kg/ha**	Is required and has been calculated.
Potassium Maintenance	12 kg/ha	Is required and has been calculated.
Potassium Build Up	0 kg/ha	Is not required.
Potassium Required	**12 kg/ha**	**Is required and has been calculated.**
Sulphur Maintenance	16 kg/ha	Is required and has been calculated.
Sulphur Build Up	0 kg/ha	Is not required.
Sulphur Required	**16 kg/ha**	**Is required and has been calculated.**
pH Adjustment	**0 t/ha**	**Has not been calculated.**

Product Recomendations

Apply 3 t /ha lime and 30 kg/ha potassium as discussed

Appendix 9

Paddock diary Price site:

Date	Location/ Paddock/ Treatment	What was done (e.g. spray/ graze)
5/6/15	All sites	Sites set up and monitored/ photos & soil testing
7/15	Treatments 3, 4,5	600g Simazine 900DF
3/9/15	All sites	Sites monitored
29/10/15	All sites	Inspection & DM cuts Control 1.85 tonne DM, Simazine treated 2.95 tonne note there must have been tank contamination as the clover was also lost in all Simazine treatments
6/11/15	Treatment 1a	Sprayed 500ml gramoxone/ ha
11/2/16	All sites	Photos/ inspection: Big difference between Simazine / control and also gramoxone/ control
27/4/16	Treatments 2 & 3	Dry-sown with Avalon SE at 20kg/ha
12/5/16	All sites	Sites monitored
22/9/16	All sites	Sites monitored
23/6/17	All sites	Sites monitored

Appendix 10

Assumptions for economic analysis of interventions

A model of a representative farm for members of the SWPLG was developed. The major assumptions for the farm were based on consultant knowledge, Victorian Farm Monitor Project data, MLA and AWI market pricing data and from input provided by Kate Joseph and Leo Cummins. The key parameters for the representative farm are listed below:

General

Farm Area: 500 ha

System Type*:* 70 kg average weight self replacing composite ewe system.

Main lambing month: August

Ram joining rate: 1%

Lamb weaning % = 125%

Stocking rate = 16 dse/ha

Sheep Trading

Ewe replacement rate = 17.5%

Cull ewes: 50% sold in Nov and 50% in Feb. Average cull ewe price of $110/hd.

Ram replacement rate: Keep rams for 3 years.

Cull rams: Sold Apr valued at $75/hd.

Replacement rams: Purchased Nov for average of $1,000/Hd

Lamb sales: 60% sold in Dec @ 48kg LW 45% dressing %. Rest sold in Feb @ same LW (48kg).

Sheep selling costs: 4.5% commission and MLA levy is 2% to a max of $1.50 for lambs and 20c for mutton and state levy of 12c per head – both are transaction levies.

Sheep freight: $2/hd

Lamb price: $4.38/kg CW based on CPI adjusted Eastern States Trade Index Lamb Indicator (2012-2016).

Skin price: $8/hd

Deaths: Ewes = 3%

Replacement ewe weaners = 3%

Carryover lambs = 4%

Rams = 1%

Wool Production

Carryover lambs are shorn: Av. cut/hd of 1 kg greasy.

Replacement ewe weaners: Av. cut/hd of 2 kg greasy.

Ewes/Rams: Av. cut/hd of 4 kg greasy.

Micron/Yield: Average 32 micron and 70% yield.

Wool selling costs: Wool tax 2%. Commission/warehouse/testing charges = $39/bale, wool cartage = $18/bale, wool packs = $13/bale. Assumed av. 200kg per bale.

Shearing/crutching costs:

Shearing	
ewes	$5.89/hd
weaners/lambs	$5.89/hd
rams	$8.50/hd

Crutching	
ewes/weaners	$1.04/hd
rams	$1.95/hd

Wool price: $5.03/kg clean based on average CPI adjusted southern micron guide for 32 micron wool (2012-2016). Assumes 85% of clean fleece value across entire clip to account for discounted lines.

Animal Health

		$/app	No. apps	$/hd
Broad spectrum	ewes	0.65	2	1.30
	lambs	0.33	3	0.99
Narrow spectrum	ewes	0.45	1	0.45
Lice treatment	ewes	1.16	1	1.16
Fly control (long acting)	weaners	1.55	1	1.55

Vaccination (6 in 1)	ewes	0.27	1	0.27
	lambs	0.27	1	0.27
Marking	lambs	1.55	1	1.55
Scanning	ewes	0.80	2	0.80

Enterprise Costs

Animal health, freight, and shearing/crutching costs as above. Other general expenses at FMP value of $0.79/dse (this would cover miscellaneous things such as ear tags, dog expenses).

Supplementary feed: 10 year CPI adjusted average FMP supplementary feed costs for prime lambs - $4.31/dse.

Pasture costs: Have assumed 0.8 kg P per DSE via SS valued at $322/T (5 year CPI adjusted average Vickery's SS price).

Other pasture maintenance costs = $13/Ha based on FMP data for farms similar to your average farm system.

Overhead Costs

I've loosely based these on average FMP data and also considering data from individual FMP farms that most closely resemble SWPLG average system:

Admin = $16/ha

Elec/insurance = $12/ha

R & M = $21/ha

Rates = $9/ha

Depreciation = $25/ha

Fuel & vehicle = $15/ha

Other = $2/ha

Labour

Assumed one full time labour unit is required to manage the system (allowing 4 weeks holiday annually). Use FMP owner/operator labour allowance of $65,637 per FTE which is based on the Pastoral Industry Award.

Assumed no employed labour other than contract labour for shearing/crutching and scanning.

Asset Values

Land value = $5,000/ha

Plant & equipment value = $125,000

Average adult ewe value = $155/hd

Average replacement ewe weaner value = $100/hd

The key outputs for the representative farm are summarised below.

Table 1: Key profitability indicators for representative farm 1 - Composite Self replacing system.

KPI	Composite
Gross margin per hectare	$400
Gross margin per DSE	$24.88
Cost of production ($/kg CW)	$4.12
Profit per kg ($/kg CW)	$1.46
Operating profit per hectare	$169
Return on assets	2.7%

For some perspective, the 46 year Farm Monitor Project average prime lamb enterprise gross margin is $32 per DSE and $427 per hectare, and the 2013/2014 average gross margin was $31.92 per DSE and $497 per hectare.

The pasture persistence options identified for evaluation for this project have been evaluated using discounted cash flow analysis. The following standard assumptions were used:

Table 2: Key general assumptions used for the economic evaluation of pasture treatments.

Variable	Value
Capital cost of livestock ($ per DSE)	$70

Opportunity cost of invested capital (discount rate)	8.0%
Marginal tax rate	15%
Interest on borrowed funds	6.0%
Interest on investment funds	4.0%

The results of the economic evaluation are presented using the following investment criteria results:

Table 3: Investment criteria used for economic evaluation of pasture treatment options.

Investment criteria	Definition
Equivalent annual annuity	The equivalent additional net income per year over the life of the pasture that has a present value equal to the total NPV over the pasture life. Choose the investment with the highest equivalent annuity.
Peak debt and year incurred	Highest negative cumulative additional cash flow and year incurred.
Break-even year	Year when cumulative additional cash flow becomes positive.

A net present value (NPV) for each treatment was calculated as the difference between the present value of the future annual flow of incomes and the future annual flow of costs over the life of the intervention. Given that the treatments evaluated have different lives, the equivalent annual annuity approach was used to translate the net present value for each option into an equivalent annual rate so that all treatments can be assessed on equal terms.

Appendix 11 Site Report field day handouts

AGRICULTURE VICTORIA

Producer Research Site: Pasture persistence trial- Managing barley grass

Site location: Tyrendarra, Vic

Host Producer: Kate Joseph and Trevor Smith

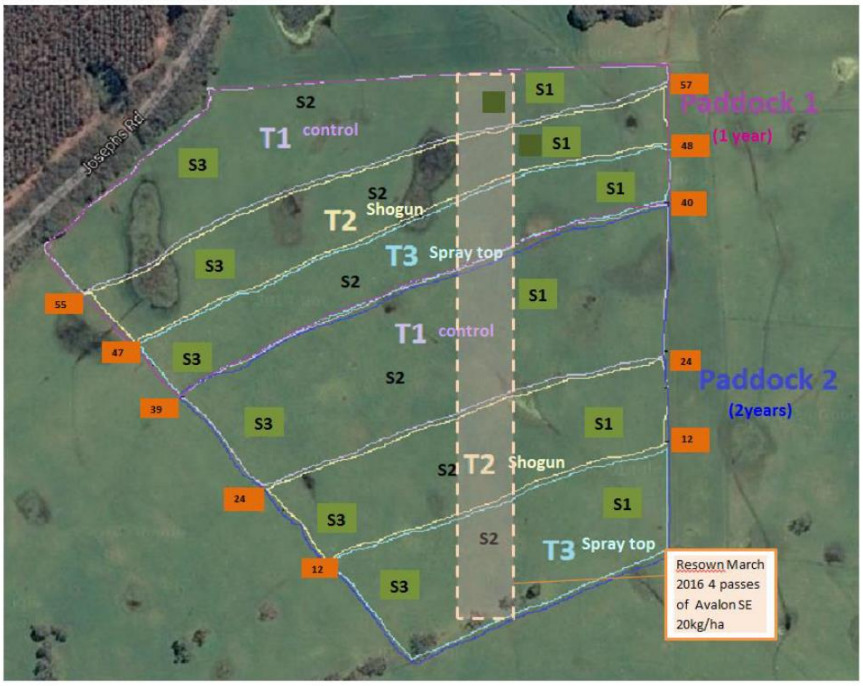
Producer Group: South West Lamb Group

Duration: 2015 - 2017

Site Focus: This site investigates chemical options for managing barley grass to regenerate an older perennial ryegrass pasture. There are two paddocks with three treatments in each - winter cleaning with Shogun, spray topping with Gramoxone and a control. Paddock 1 had one year of treatment and Paddock 2 had two years of treatment.

ABOUT THE SITE: The paddock has a good history of PRG but overgrazing had led to infestations of barley grass and slender thistles. There is evidence of reasonable PRG.

Treatments (descriptions below)



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Results to date:

Table 1: Results summary. % PRG and barley grass over time for treatment 1, treatment 2 and control

	19/05/2015		3/09/2015		12/05/2016		22/09/2016		23/06/2017	
Paddock 1 (1 year)	% PRG	% Barley	% PRG	% Barley	% PRG	% Barley	% PRG	% Barley	% PRG	% Barley
Treatment 1 Control	16	5	18	4	24	11	5	44	12	13
Treatment 2 Shogun (autumn)	10	7	13	0	16	6	43	0	23	7
Treatment 3 Spray top (spring)	8	26	7	6	9	18	12	37	14	13
Paddock 2 (2 years)										
Treatment 1 Control	16	14	12	12	13	41	16	51	27	13
Treatment 2 Shogun (autumn)	23	6	20	1	26	2	44	0	58	1
Treatment 3 Spray top (spring)	12	5	16	13	16	39	27	47	48	3

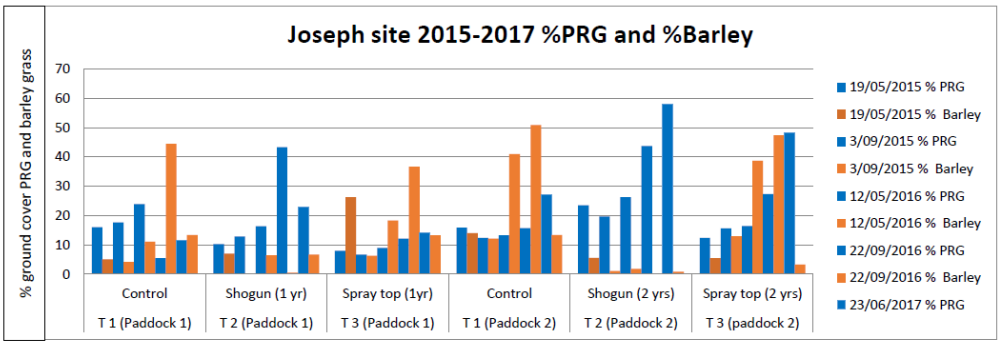


Figure 1: . % PRG and barley grass over time for treatment 1, treatment 2 and control

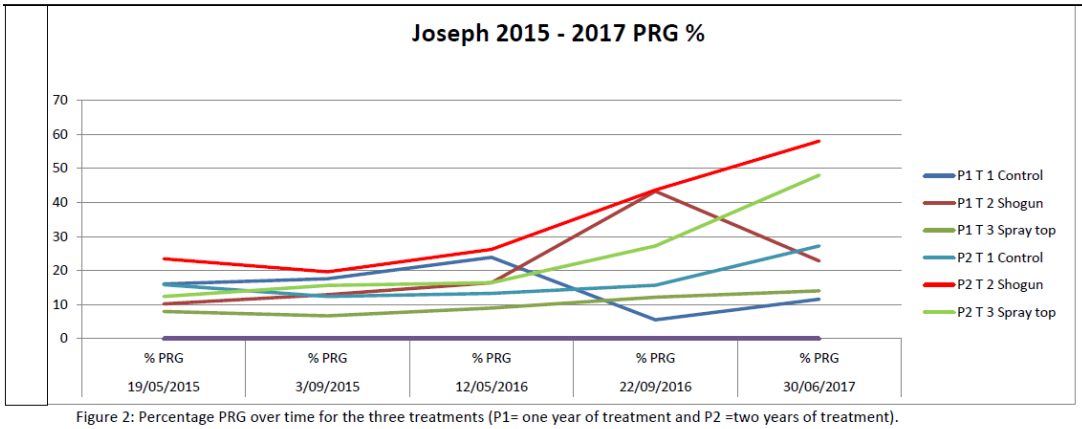


Figure 2: Percentage PRG over time for the three treatments (P1= one year of treatment and P2 =two years of treatment).

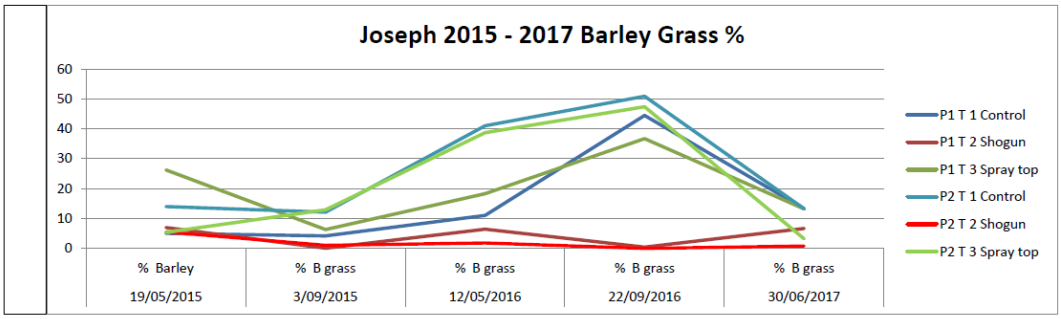


Figure 3: Percentage barley grass over time (P1= one year of treatment and P2 =two years of treatment)

Treatment 1: Control treatment. Managed according to Kate and Trevors' regular pasture management.
Treatment 2: Winter cleaned with Shogun.
Treatment 3: Spraytopped with Gramoxone in spring when grasses come into head and flower. The aim is to reduce the production of viable seed and the seedling population in the following year.

Paddock 2 –two years of treatment

Treatment 1: Control treatment.
Treatment 2: Winter cleaned with Shogun.
Treatment 3: Spraytopped with Gramoxone in spring.

Paddock diary

Date	Location/ Paddock/ Treatment	What was done (e.g. spray/ graze)	Rate	Who
28/4/15	All trial	Set up sites and monitored BG & RG in paddock 2 (ran out of time). Soil tested.		AS & BH
18/5/15	All trial	Fastac 11ml (cockchafers) 1L MCPA + 0.05l Lontrel (thistles)	spot sprayed	TCS
22/5/15	Treatment 2	200ml Shogun/ha & 500ml Kwicken / 100l water		TCS
19/5/15	All trial	Monitored paddock 1		BH
21/6/15	All trial	1L MCPA + 0.05L Lontrel	Spot-sprayed	TCS
3/9/2015	All trial	Monitored barley & rye grasses		BH & Peter
27/10/15	Treatment 3	Spray topped with 400 ml gramoxone at 120L/ha		
11/2/2016	All trial	Checked sites/ photos. Big difference between control and shogun. Some difference between spray-top and control. Crickets needing to be sprayed. Second germination of barley grass in spray-topped paddock resulting in viable seed should have had second spray. Lots of standing barley grass in the control and Shogun site had been eaten out by sheep. * Rises haven't as much 2nd gen barley grass.		AS & BH
15/3/16	All trial	Inspection. Significant difference between control and shogun and some difference between spray-top and control. Soil profile showed roots penetrating >30cm		all
7/4/16	All trial	All site top dressed 118kg/ha 3-5-25-2		
27/4/16	All trial	7 runs of seeding using 20kg/ha Avalon across all treatments in the middle of both paddocks		TCS
14/5/16	All trial	All of both paddocks sprayed with 1.35L MCPA 750, 400ml Ecopar and 300ml Alphascud per ha		TCS
20/5/16	Shogun treatment in paddock 2 only	Sprayed with 200ml/ha Shogun with Kwickin at 500ml/100L		TCS
26/11/16	Treatment 3, paddock 2 only	Spray topped with 400 ml gramoxone at 120L/ha		TCS

Producer research site
Strategic Spelling of Perennial Ryegrass

Site location: 'Wirra', Branxholme, Vic

Host Producer: Colin and Jill Frawley

Duration: 2015 - 2017

Site Focus: The trial investigates whether strategic spelling can be used to recruit perennial ryegrass seedlings to extend the life of perennial ryegrass pastures.

About the site:

The paddock used is approximately 14.2 ha, of which about 10 ha was sown in April 2015 with Barbaria perennial ryegrass. The trial takes place in the area of Barbaria perennial ryegrass.

Treatments:

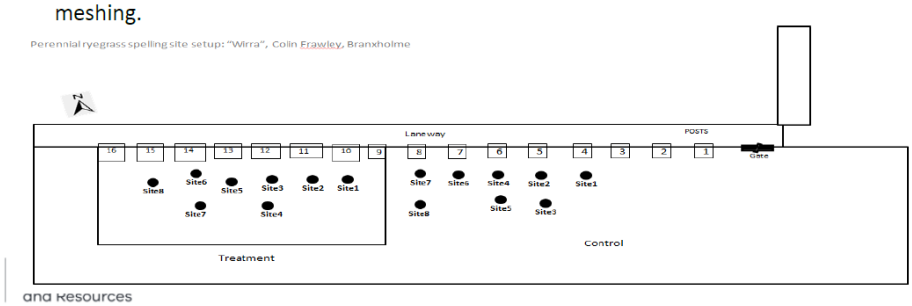
The strategic spelling treatment is based on the management advice in the ***EverGraze*** publication 'Productive, persistent perennial ryegrass', which advocates allowing ryegrass to flower and set seed with strategic grazing according to season. The strategic spelling treatment is compared to a control treatment. Each have eight monitoring points and will use an ***Evergraze*** grid to count seedling recruitment.

Strategic spelling treatment:

- Livestock are removed from late October/early November until December to allow flowering, seed set and maturation.
- Once seeds are mature (December), mesh is dragged across the treatment area to ensure seeds fall, and sheep or cattle are be put in to establish seed-soil contact.
- In Autumn, the treatment site is grazed down to 1000 kg DM/Ha before the break.
- At the break, grazing is deferred until seedlings reach the 2-leaf stage to encourage seedling establishment.

Control treatment:

- The control area is managed according to the Frawley's usual pasture and grazing management program.
- The control will not be locked up, seed head maturity will not be encouraged and there will be no meshing.



Paddock diary:

Date	Location/ Paddock/ Treatment	What was done (e.g. spray/ graze)	Rate	Who
29/10/15	Both sites	Site setup		AS & BH
30/10/15	Treatment	Locked up treatment site & feed tested		
22/12/15	Treatment	Meshed treatment to get seed fall & feed tested both sites		CF
22/12/115	Both sites	Grazed with cattle for seed soil contact then continued grazing with sheep		CF
11/2/16	Both sites	Seed counts & photos & soil testing		AS & BH
Mid April TBC	Treatment	Locked up treatment site to allow seedlings to reach 2-leaf stage		CF
25/4/16	Both sites	Ecopar & MCPA 750 Fastac	400ml each 100 ml	CF
12/5/2016	Both sites	Seedling counts & photos		AS & BH
28/5/2016	Treatment	Gate opened to allow grazing (2-leaf stage)		CF

Results:

Table 1: Monitoring results: Seed counts, seedling establishment and %PRG

	Mean				
	Seed count	Mean Seedling count/m2	%PRG	Seed count	Mean Seedling count/m2
Date	11/2/16	12/05/2016	22/09/2016	23/3/17	24/04/2017
Control	1.38	6/m2	23%	1.08	60/m2
Treatment	1.56	211/m2	52%	1.17	288/m2

Seed count/square	Seed numbers/m2
0 -5 = 1	0 -500 = 1
5 -10 = 2	500 -10000 = 2
>10 = 3	>10000 = 3

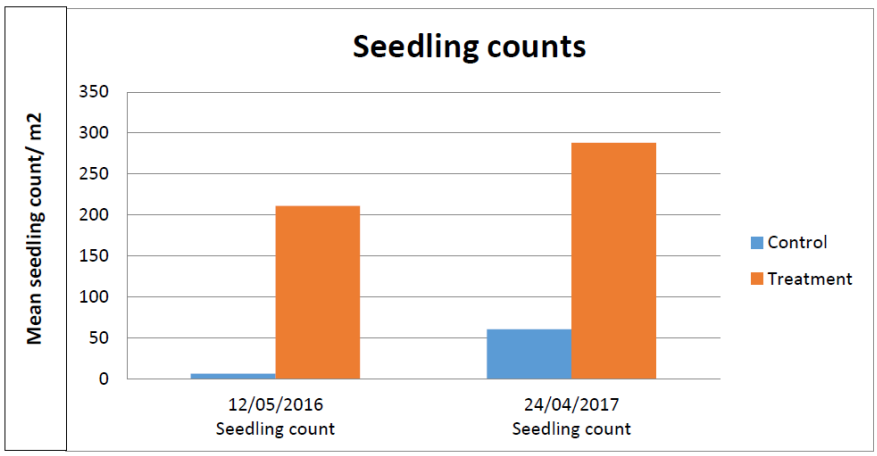


Figure 1: Mean seedling count per m2

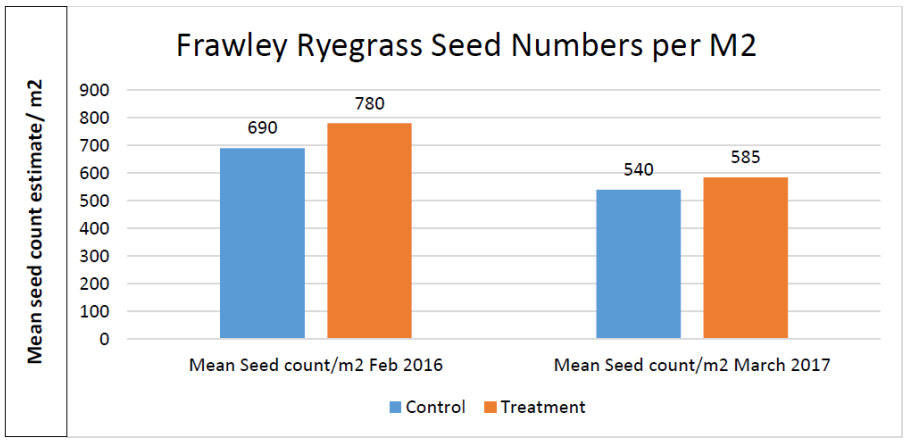


Figure 2: Mean seed count per m2

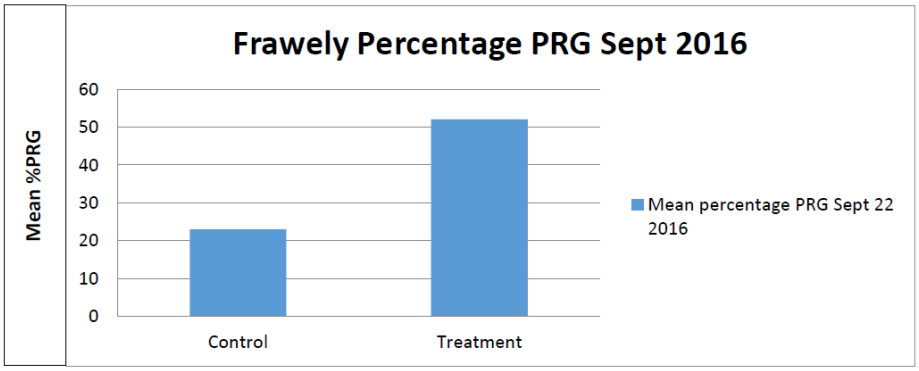


Figure 3 Percentage PRG after one year of treatment (September 2016)

Producer Research Site: Pasture persistence trial- Controlling silver grass

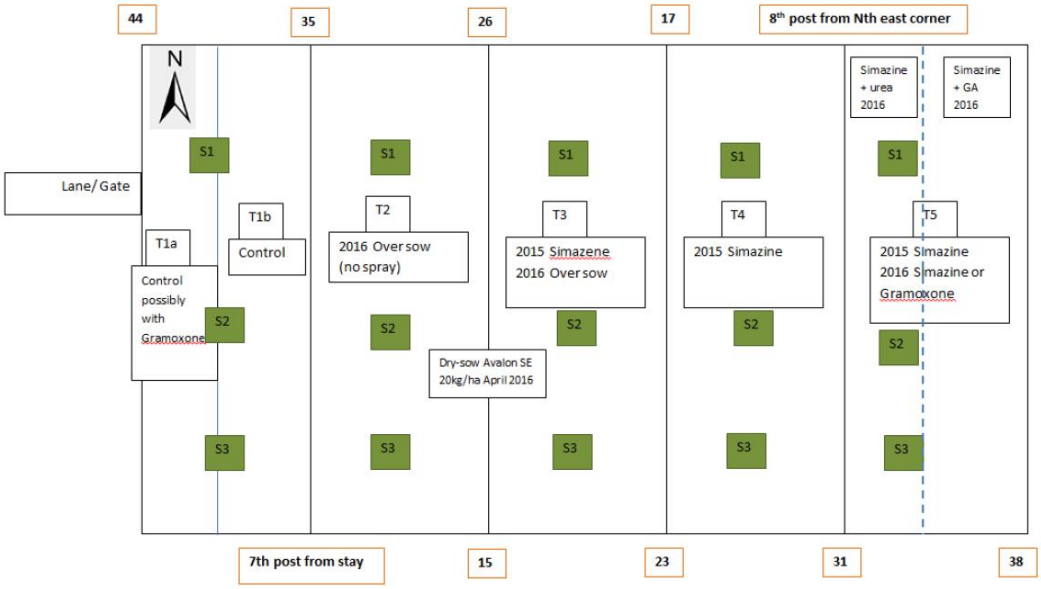
Site location: Heywood, Vic

Host Producer: Ewan Price

Duration: 2015 - 2017

Site Focus: This site investigates options for controlling silver grass to rejuvenate an older perennial ryegrass paddock.

About the site: The paddock was sown in 1980 and retains a good perennial ryegrass pasture, with some silver grass infestation.



Treatments:

T 1: Control treatment – managed according to Ewan's regular pasture management. Treatment split into:

- T1a – Nov 2015 Gramoxone application
- T1b – control

T 2: Oversown only – dry sown in April 2016 with Avalon SE at 20kg/ha

T3: Winter cleaning with Simazine 2015 and oversown April 2016 with Avalon SE at 20kg/ha

T4: Winter cleaned Simazine 2015

T5: Winter cleaned with Simazine in 2015 & 2016

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Paddock diary

Paddock Diary- Ewan's place (sown 1980!!)

Date	Location/ Paddock/ Treatment	What was done (e.g. spray/ graze)
5/6/15	All sites	Sites set up and monitored/ photos & soil testing
7/15	Treatments 3, 4,5	600g Simazine 900DF
3/9/15	All sites	Sites monitored
29/10/15	All sites	Inspection & DM cuts Control 1.85 tonne DM, Simazine treated 2.95 tonne note there must have been tank contamination as the clover was also lost in all Simazine treatments
6/11/15	Treatment 1a	Sprayed 500ml gramoxone/ ha
11/2/16	All sites	Photos/ inspection: Big difference between Simazene / control and also gramoxone/ control
27/4/16	Treatments 2 & 3	Dry-sown with Avalon SE at 20kg/ha

Results:

Table 1: Results summary for percentage PRG and silver grass across treatments

		5/06/2015		3/09/2015		12/05/2016		22/09/2016		23/06/2017	
		% PRG	% Silver	% PRG	% Silver	% PRG	% Silver	% PRG	% Silver	% PRG	% Silver
Treatment 1	Control	48	3	27	1	39	0	58	0	49	0
Treatment 2	oversown May 2016	48	4	27	3	45	0	71	0	50	2
Treatment 3	Simazine July 2015 & sown May 2016	30	14	60	0	39	0	28	0	52	4
Treatment 4	Simazine July 2015 only	31	15	50	1	24	0	51	0	53	1
Treatment 5	Simazine July 2015 & gramoxone Spring 2016	34	6	58	2	25	1	34	2	29	5

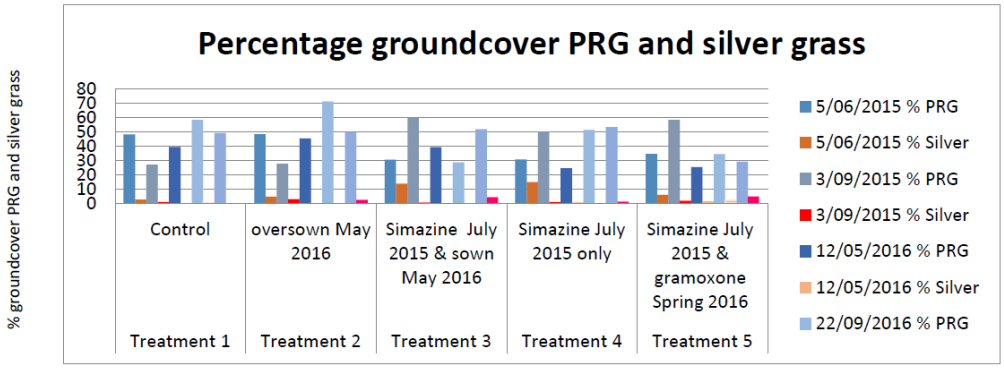

Figure 1:Percentage groundcover PRG and barley grass across treatments 2015- 2017