# final report

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# Pasture cropping to fill the winter feed gap

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# Abstract

The aim of this farming systems demonstration was to explore the production gains from oversowing an oat crop into a rundown phalaris pasture and grazing it to fill the winter feed gap. The demonstration was undertaken over 2015 and 2016 on five sites provided by the Glenelg BestWool/BestLamb (BWBL) in south west Victoria.

Paddocks were spray topped in the spring preceding sowing and were again sprayed in May to knock out weeds and suppress phalaris. Quoll oats were sown at 100 kg/ha with 100 kg/ha MAP. In 2015, sites were grazed for 14 days with twin-bearing ewes and their lamb birthweight was compared to equivalent lambs from pasture only. The 2016 demonstration measured growth rates over 21 days for ewe weaners and yearling bulls, compared equivalent mobs grazed on pasture only. Grain yields for grazed and ungrazed crop/pasture were compared.

The high feed quality of the crop and higher winter growth rates led to increased livestock performance compared to pasture only sites. Twin bearing ewes that grazed the crop/pasture for 14 days had increased lamb birthweight of 0.7kg (although the sample size was small). Ewe weaners that grazed crop/pasture had higher growth rates (414 g/hd/day) than pasture only (155 g/hd/day at site 1 and 121 g/hd/day at site 2) and weight gains for yearling bulls were (2.27 kg/hd/day) compared to pasture fed equivalents (420 g/head/day), though gut fill was not considered in this result.

Grazing the crop in winter led to grain yield reductions between 0-1.42t/ha. The larger reductions occurred when livestock grazed the crop beyond the recommended growth stage 30 and into early growth stage 31, which can damage the embryo ear. Waterlogging is also likely to have affected the grazed areas more than the ungrazed areas owing to the smaller leaf area and ability of plants to transpire.

Profitability was strongly influenced by grain and livestock prices and seasonal conditions. Accounting for crop expenses and the opportunity cost of lost grazing under crop, the profit margin averaged $89/ha for the winter grazed pasture/ crop sites, with a range of -$79 to $194/ha.

An evaluation with ten group members showed improvements in knowledge, attitude, skills, aspiration and adoption (KASAA). Producers rated their level of KASAA from 1-10 prior to the demonstration and again at the end of the demonstration against seven parameters relating to pasture cropping. The average increase in knowledge across the parameters was 55% (range between 27% increase to 80% increase), attitude was an increase of 30% (range between 26%increase to 37% increase), skills increased by 35% (range between 25% increase to 49% increase), aspirations increased by 25% (range between 17% increase to 35% increase) and adoption increased by 51% (range between 22% increase to 92% increase).

# Executive summary

This demonstration combines two practices; cropping into pasture and winter grazing of cereals. Traditional pasture cropping was pioneered in northern NSW and involves sowing winter crops into a summer active perennial pasture to achieve year-round production. The form of pasture cropping adopted in southern Victoria is different to this – and is based on sowing winter active cereals into perennial pastures to increase winter herbage mass. The cereal crop is then harvested for grain at maturity or can be grazed or cut for hay or silage. Limiting the grazing of the pasture under crop during winter/spring has a regenerative benefit for phalaris plants which undergo both vegetative and reproductive growth phases and replenish energy reserves in root tubers. There is also a commensal relationship between the pasture and crop species as the phalaris uses soil moisture, which can reduce impacts of water logging on crops.

In 2013, the Glenelg BestWool/BestLamb group (BWBL) started a three year 'Land Health' project to demonstrate sowing cereal crops into phalaris pastures. The demonstration was conducted with Agriculture Victoria and funding from the Glenelg Hopkins CMA through the National Landcare Program (NLP).

A year into the project, the group set up a two-year Enhanced Producer Demonstration Site (EPDS) to investigate the opportunity of grazing the crop/pasture in winter to fill the winter feed gap. This project was influenced by Grain and Graze program findings that grazing winter crop during a growth-stage window that avoided crop yield loss, provided valuable winter fodder (Falkiner *et al* 2013). This project was run with Agriculture Victoria and co-funded through Meat and Livestock Australia (MLA). The demonstrations coincided with the region's driest two consecutive years on record (2014, 2015) followed by the wettest winter on record (2016).

Five EPDS sites over 2015-2016 measured livestock production gains though winter grazing. The high feed quality and winter growth in the crop/pasture led to an increase in lamb birthweight of 0.7kg. Ewe weaners that grazed crop/pasture had higher growth rates (414 g/hd/day- on both Sites 1 and 2) than ewes from the same mob on pasture only (155 g/hd/day at Site 1 and 121 g/hd/day at Site 2) and weight gains for yearling bulls were (2.27 kg/hd/day) compared to pasture fed equivalents (0.42 kg/head/day), however gut-fill was not accounted for in this result.

Grain yield reductions between 0-1.42t/ha occurred from grazing the crop/pasture. The larger reductions occurred when livestock grazed the crop beyond the recommended growth stage 30 and into early growth stage 31 and where waterlogging occurred.

Profitability was influenced by grain and livestock prices and seasonal conditions. Excluding all crop expenses and the opportunity cost of lost grazing under crop, the profit margin averaged $89 for the winter grazed pasture/ crop sites, with a range of -$79 to $194.

Four workshop/ field days and two pasture inspection events were held for producers over the two years of the EPDS and attendees indicated they intended to adopt aspects of both sowing cereals into pasture and winter crop gazing, depending on the season.

Key findings:

- You don't need to kill a pasture to grow crop.
- The system offers flexibility (the crop can be winter grazed, harvested, cut for hay or silage or spring/summer grazed and the pasture will be available the following year).
- Crops provided good quality feed and high growth rates in winter.
- Yield reductions can occur from winter grazing depending on the season and timing (don't graze past Growth Stage 30).

- Winter grazing pasture/crop increases the profit margin. (In fact, it is possible to fatten stock in winter)

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# 1 Background

**How it started…**

The Glenelg BestWool/BestLamb (BWBL) group is made up of twenty-six financial members based around the towns of Nareen, Coojar, Casterton, Balmoral and Edenhope in Western Victoria. Collectively the group manage around 75,000 sheep over an area of approximately 40,000 hectares.

The group formed in 2006 with the aim of undertaking learning activities to improve farm business profitability. Since that time, the group has continued to meet six times a year and have covered a range of topics relating to pastures and grazing management, weaner management, genetics, sheep productivity, benchmarking, business management, cost of production, marketing and risk management.

Filling the winter feed gap is a challenge for many livestock producers in Western Victoria. Increasing variability in autumn rainfall and low temperatures in winter contribute to a period of slow pasture growth. In addition to this, pastures grazed down over summer often need time to recover following the autumn break. This means perennial plants can be easily overgrazed leaving areas of bare ground vulnerable to erosion by wind and water. Undesirable annual grass species invade where pastures are grazed hard and ground cover levels are low.

Pasture cropping involves sowing crops into perennial pastures for the purpose of harvesting the crop then grazing the pasture. It was pioneered in northern NSW by Colin Seis, sowing winter crops into summer growing (C4) native pastures. In south west Victoria however, rainfall predominantly falls in winter and pastures are largely made up of winter active species that would potentially compete with the crop.

The group's interest in sowing crop into pasture initially focussed on natural resource management (NRM) and pasture benefits for livestock producers, by encouraging regeneration of degraded phalaris pastures, improved fertility through fertiliser applications at sowing, with the bonus benefit of crop yields. Members of the group had followed research conducted by the Grain and Graze project that trialled over sowing lucerne pastures with winter crops (Falkiner *et al,* 2013). They were keen to test and demonstrate similar concepts in their own environment.

In 2014, prior to participating in the EPDS, the group established a Land Health demonstration, funded by the Glenelg Hopkins CMA and run by Agriculture Victoria. Five perennial pasture sites were over-sown with a cereal crop (Quoll oats) with the aim of rejuvenating the pasture, without the expense and disruption of re-sowing, and harvesting oats.

The Land Health project (which continued for a further two years, alongside the EPDS) specifically aimed to:

- Improve the pasture through resting the phalaris and allowing it to run to head to encourage new shoots and replenish root reserves
- Clean the pasture of undesirable species using a chemical regime that reduced annual and broad leaf weeds
- Maintain ground cover throughout the season and minimise soil disturbance
- Harvest and measure oat yields

The decision to graze the pasture/crop mix in the winter was based on Grain and Graze trials that found that grazing cereal crops in winter provided additional fodder at a critical time of year. The Grain and Graze trials did show some crop yield loss due to grazing, however their focus was more about measuring the impact on cropping system and less about the benefits for livestock enterprises (Falkiner *et al* 2013).

The EPDS sites were established to expand on the knowledge already gained by the group around crop establishment in pastures and focussed on the benefits and costs of grazing crops and the ability to fill the winter feed gap.

The EPDS and Land Health demonstrations were run in tandem for two years. The Land Health project demonstrated crop yields of 2.0-5.5 t/ha in crop/pasture paddocks. There was a slight reduction in the number of phalaris plants after cropping, which was possibly a result of damage at sowing caused by tynes. However, there was a slight increase in phalaris ground cover as plants had a larger basal area after being rested and running to head, and possibly in response to fertiliser applied at sowing and reduced weed competition.

In a survey prior to the demonstration, the BWBL group rated their knowledge of using pasture/crop to fill the winter feed gap at an average of 5.0/10 and their existing adoption at 4.4/10. This indicated that some producers were already adopting some of the practices involved in pasture cropping at times. Their aspiration to use the practice scored 7/10, suggesting reasonable interests, but the gap in knowledge and skill levels was holding them back.

# 2 Project objectives

## 2.1 Measure and compare feed production and quality of crop/pasture

Measure and compare feed quality and production of crop/pasture with pasture alone, in winter at the point of grazing.

## 2.2 Estimate livestock production and economic benefits from grazing crop/pasture

Measure and compare benefits for livestock production from grazing crop/pasture with pasture alone, during winter.

## 2.3 Understand the impact on yield from grazing crop/pasture

Measure and compare yields from grazed and un-grazed crop/pasture.

## 2.4 Increase producer knowledge, skills and adoption of the system

Increase producer knowledge, skills and adoption of pasture cropping to fill the winter feed gap, including the financial and environmental benefits.

# 3 Methodology

The demonstration involved five sites over two years.

## 3.1 Site preparation and management

Agronomic and chemical advice was provided by Darren Scott from SMS Rural in Horsham. The procedure (Table 2) was designed to address issues across all the sites and it is likely that tailoring the agronomic advice to individual paddocks and the weeds present could reduce chemical input. A similar procedure was followed each year, as follows.

- Paddocks were spray topped in the spring prior to sowing.
- In May, paddocks were sprayed again (Table 1), prior to sowing with Quoll oats at 100kg/ha and 100kg/ha MAP.
- Post emergent herbicides were used to remove onion grass and broadleaf weeds.
- Crop yields were measured at harvest.

*Table 1: Activities and chemical regime for sites*

| Date | Activity | Input | Rate |
|---|---|---|---|
| Nov | Spray 1 (spray topping) | Paraquat | 0.8L/ha |
| May | Spray 2 | Sprayseed 250 | 2L/ha |
| | | Diuron 900 DF | 0.3L/ha |
| | | Clincher plus | 0.75L/ha |
| | | Cutlass 500 | 0.16L/ha |
| | | Venom 100 EC | 0.1 L/ha |
| May | Sowing (May) | Quoll oats | 100 kg/ha |
| | | Gaucho seed coating | 120 mL/100 kg of seed |
| | | MAP | 100 kg/ha |
| July | Spray 3 (post emergent) | Glean | 20g/HA |
| | | Tigrex | 0.75L/ha |

## 3.2 2015 grazing methodology

Paired paddock sites were established at Coojar (12 ha site) and at Nareen (37ha site) in south west Victoria.

Twin bearing ewes from the same mob were used to compare livestock performance from animals grazing crop/pasture versus the pasture only paddock.

Quality cuts were taken on the first day of grazing (July 10), from both the crop/pasture and the pasture only paddocks, feed on offer was not measured.

Scanned, twin bearing ewes were condition scored prior to grazing the sites. Ewes had been joined on February 25 at the Coojar site and on March 1 at the Nareen site.

At each site, one-hectare plots of the crop/pasture and pasture only paddocks were separated from the larger area using a three-wire portable electric fence.

Twin bearing ewes grazed the crop/pasture and the pasture only sites at 25 ewes/ha from July 10-24, a total of 14 days and were then returned to the mob for lambing, which started 10 days later. It was originally planned that the ewes would graze the plots for 21 days, but they were removed earlier as it was getting too close to lambing.

The project experienced a setback with the death in the family of the contractor who had been engaged to weigh and condition score all ewes as they came out of the treatments and measure lamb birth weight. A sample of lamb birth weights were collected at Coojar, but not at the Nareen site.

*Table 2: Summary of 2015 livestock comparison*

| | Paddock size | Stock class | Grazing comparison | Grazing time | Measure |
|---|---|---|---|---|---|
| Site 1 Coojar | 12 ha | Twin bearing ewes | 1 ha pasture (25 ewes/ha)<br>1 ha crop/ pasture (25 ewes/ha) | 14 days | -Lamb birthweight<br>-Pasture/ crop pasture quality<br>- Crop yield grazed/ ungrazed |
| Site 2 Nareen | 37 ha | Twin bearing ewes | 1 ha pasture (25 ewes/ha)<br>1 ha crop/ pasture (25 ewes/ha) | 14 days | -Pasture/ crop pasture quality<br>-Crop yield grazed/ ungrazed |

## 3.3 2016 grazing methodology

A simpler methodology was used for the second year of the demonstration. This involved using dry stock (10-month ewe weaners) to graze 1ha of the crop/pasture and a control pasture paddock for 21 days at the same stocking rate at two sites. The control pasture had not been rested but was considered representative of paddocks allocated to dry stock. Livestock were weighed onto and off the pasture and growth rates were measured and compared.

The setback in 2015 and change in stock class to ewe weaners in 2016 (rather than weighing newborn twin lambs) afforded the establishment of a third site at Culla. This site was grazed with young bulls. Table 3 summarises the demonstration setup for 2016.

Stocking rate of 12.5 DSE (Site 1) 10.5 DSE (Site 2) and 12 DSE (Site 3) were relatively low and selected due to the wet conditions. In 2015, 25 twin bearing ewes had grazed the crop/pasture comfortably for 14 days.

*Table 3: Summary of 2016 livestock comparison*

| | Paddock size | Stock class | Stocking rate (DSE) | Grazing comparison | Grazing time | Measure |
|---|---|---|---|---|---|---|
| Site 1 Coojar | 20 | 10-month ewe weaners | 12.5 | 1 ha crop/ pasture<br><br>Pasture only grazed at same DSE | 21 days | -Feed growth and quality<br>-Liveweight gain<br>-Crop yield grazed/ ungrazed |
| Site 2 Nareen | 13 | 10-month ewe weaners | 10.5 | | 21.5 days | |
| Site 3 Culla | 21 | yearling bulls | 12 | | 21 days | |

## 3.4 Calculating profit margins

Profit margins were calculated for grazed and ungrazed crop/pasture for the 2015 twin-bearing-ewe grazing site that measured lamb birthweight, and for the three 2016 sites.

Despite low numbers of lambs weighed, the 2015 livestock production was estimated from an extra 0.7 kg birthweight measured, leading to 4% increase in survival (Ewe Management Handbook (2007) and A. Kennedy (pers. comm. 2017)) at $70 /lamb (an additional $5.60/ ewe). Grain was valued at $270/t, the local value at harvest.

Average livestock weight gain in the 2016 sites was valued at $2.87/kg for lamb and $3.75 for bulls, in-line with August trade prices. Grain was valued at $120/t, the local value at harvest.

Production from stubbles was estimated for each scenario as 30 days of grazing at 30 DSE/ha, valued at $0.80/ha/week agistment rate. The values for liveweight gain did not consider the gut fill, which would have been higher on animals that grazed the crop/pasture than the pasture only.

Lost livestock production was factored as an opportunity cost by estimating the livestock production (meat and wool) that was lost during the time that the crop/pasture could not be grazed, i.e. from sowing until grazing and from the end of grazing until harvest. This cost was highest in 2016 site one as the loss was from a 'good' pasture in a 'good' year. Site two in 2016 was a 'poor' year as the paddock was severely waterlogged, and site three was an 'average' year. Site one 2015 was a poor year owing to dry conditions.

2016 was the wettest winter on record for the district, so an additional scenario was modelled to estimate profit margin under different circumstances. The modelled scenario used 2016 site one liveweight gains, 20 DSE stocking rate during crop grazing (25 twin bearing ewes were carried in 2015), crop yields were 3t/ha grazed and 3.5t/ ha ungrazed and the oat price was the 5-year average ($209).

The profit margins do not include the value to pasture production from spelling the pasture and removing weeds during the cropping phase, as observed on the Land Health demonstration. These benefits would include stronger, larger perennials, fewer weeds and potentially increased pasture longevity (and reduced frequency of resowing); however, they were all difficult to value.

The calculations do not include the benefits of mineralising Nitrogen and making it available for the pasture in the following year, from grazing stubbles.

## 3.5 Planned communication and extension activities

Two paddock walks and two field days were planned over the two years of the demonstration to raise awareness and to demonstrate pasture cropping establishment, management and grazing and its benefits and costs. These were run in conjunction with visits to Land Health sites.

## 3.6 Monitoring and evaluation

### 3.6.1 Event evaluation

Where ever possible, events were evaluated using the project evaluation forms. The forms collect satisfaction data and likely adoption and practice change information.

### 3.6.2 KASAA change

Pre and post questionnaires were conducted with BWBL group members to evaluate their change in Knowledge, Attitude, Skills, Aspirations, Adoption (KASAA).

### 3.6.3 ADOPT workshop

The group were taken through the Adoption and Diffusion Outcome Prediction Tool (ADOPT) process (Kuehne *et al*, 2017) and the final workshop/presentation, to gain a better understanding of the impact of the project as viewed by the BWBL group members. The process was used to predict the extent and speed of adoption of autumn savings.

# 4 Results

Figure 1 shows the different stages of crop/pasture growth throughout a year and the pasture in the year following the demonstration.

*Fig: 1: (Top left) Pasture in May -Coojar, immediately prior to sowing; (Top right) Crop establishment in June; (Middle left) Crop in July at the time of post emergent spray; (Middle right) Crop in November with phalaris heads poking though; (Bottom left) March, phalaris growing back after grazing stubbles; (Bottom right); same site June, two years after cropping. (This was a 2014 Land Health site treated the same way as the EPDS site in the adjacent next paddock. Pasture recovery photos were not available for EPDS sites.)*

## 4.1 Herbage mass and nutritive quality

Table 4 shows the feed quality of the crop/ pasture and the pasture only during both years on the day grazing started. Figure 2 shows the grazed and ungrazed pasture/crop at the end of grazing in 2015. Figure 3 shows the 2016 crop/pasture and pasture only sites the day grazing commenced.

The energy (ME), digestibility and crude protein levels of the crop/ pasture were higher than the pasture only in both years.

Crop/pasture feed quality was higher across the sites in 2015 than 2016. This was probably caused by waterlogging in 2016.

Growth rates were measured in 2016 and were higher in the crop/pasture than pasture only sites. The crop/pasture had a combination of higher quality and quantity winter production.

*Table 4: Crop/pasture and pasture only quality and production for 2015 and 2016*

| Treatment | Year | FOO at grazing (kgDM/ha) | Growth/day kg DM/ha | Digestible dry matter (DDM) | Metabolisable energy (ME) | Crude Protein (CP) |
|---|---|---|---|---|---|---|
| Crop/pasture | 2015 | Not measured | Not measured | 90-92 | 13.8-14.3 | 29.2- 29.5 |
| Pasture only | 2015 | | | 77.6 | 11.7 | 23.5 |
| Crop/pasture | 2016 | 680-1020 | 47-60 | 78-82 | 11.7-12.5 | 18.8-26.7 |
| Pasture only | 2016 | 550-850 | 12 | 70-77 | 10.4-11.7 | 17.8-25.5 |

*Fig. 2: Grazed and ungrazed crop/pasture 2015*


*Fig. 3: Pasture only (top) and crop/pasture (bottom) prior to grazing in July 2016*

*Fig. 4: Crop/pasture site 2016. Top left: July pre-grazing, Top right: Aug post grazing, Bottom left: Aug ungrazed, Bottom*

*right: White wire marks grazed (L)/ungrazed (R) at end of Oct- very little visual difference*

## 4.2 Animal performance

### 4.2.1 Lamb birthweight (2015)

From the twin-bearing ewes in the trial, 17 of the lambs from the crop/pasture treatment and 12 lambs from the pasture-only treatment were weighed at birth and tagged. The low numbers were a result of the contractor being unavailable due to a loss of a family member (see methodology).

Despite low lamb numbers, Table 5 shows the average twin lamb birth weight from ewes that grazed crop/pasture was 0.7 kg heavier than those that grazed the pasture only (triplets were not included). This is likely to be a result of having access to more, better quality feed during late pregnancy.

*Table 5: Lamb birth weight at Site 1 after twin bearing ewes grazed pasture/crop and pasture for 14 days*

| | Crop/pasture | Pasture only |
|---|---|---|
| Total Lamb No. Weighed | 17 | 12 |

| | | |
|---|---|---|
| Average Lamb LW (kg) | 5.2 kg | 4.8 kg |
| No. Twin Lambs | 11 | 12 |
| Av. Twin Lamb LW (kg) | 5.5 kg | 4.8 kg |
| Av. Triplet Lamb LW (kg) | 4.8 | n/a |

*Table 6: Lamb birth weight at Site 1 and potential effect on lamb survival*

| | Pasture only (12 twin lambs) | Crop/pasture (11 twin lambs) | Difference |
|---|---|---|---|
| Birth weight (kg) | 4.8kg | 5.5 kg | 0.7 kg |
| Estimated survival (using Lifetime Ewe data) | 90% | 94% | 4% |

### 4.2.2 Ewe weaners (2016)

Growth rates per day on the crop/pasture (414 g/day) were around triple the growth in ewe weaners on pasture only over the 21 days (Table 7 and Fig. 6).

*Table 7: 2016 Ewe weaner weight gain on crop/pasture and pasture only for 21 days (21.5 days in site 2)*

| | **Treatment** | **Stock** | **Mean wt. in (kg)** | **Mean wt. out (kg)** | **Mean Weight change (kg) measured** | **Mean weight increase/day (kg)** | **Mean weight change (adjusted for 21 days) (kg)** |
|---|---|---|---|---|---|---|---|
| **Site 1** | Crop/pasture | ewe weaners | 46.5 | 55.2 | 8.70 | 0.414 | 8.70 |
| **Site 1** | Pasture only | ewe weaners | 45.5 | 48.75 | 3.25 | 0.155 | 3.25 |
| Site 1 Difference | | | | | | 0.259 | 5.44 |
| **Site 2** | Crop/pasture | ewe weaners | 44.8 | 53.7 | 8.90 | 0.414 | 8.70 |
| **Site 2** | Pasture only | ewe weaners | 46 | 48.6 | 2.60 | 0.121 | 2.54 |
| Site 2 Difference | | | | | | 0.293 | 6.15 |

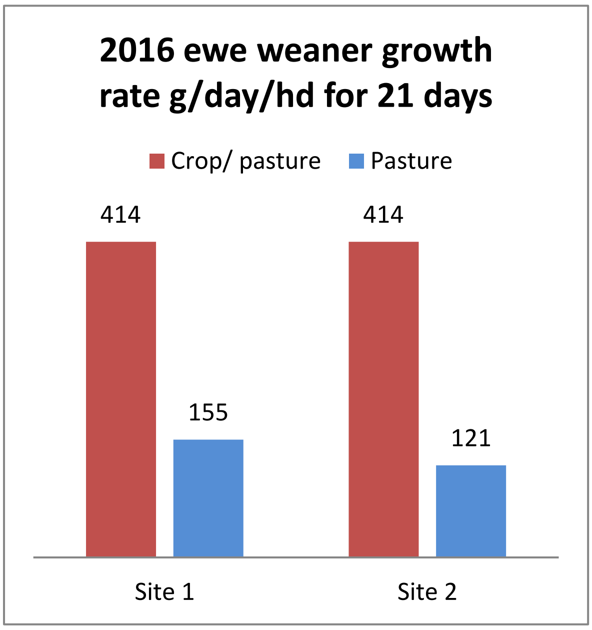



*Fig. 6: Ewe weaner growth rate over 21 days*

**Value of extra ewe weaner liveweight from crop/pasture 2016**

The value of the extra liveweight gain achieved from crop/pasture over pasture only averaged $186.37/ha (Table 8) across the two ewe weaner sites.

*Table 8: Additional livestock value per head and hectare from grazing crop/pasture (compared to pasture) for 21 days*

| Site | Treatment | Additional livestock weight gain (crop/pasture-pasture) (kg/day) | Additional weight gain over 21 days (kg) | LW value/kg | Value of additional weight gain/head | Stocking rate (head/ha) | Value of additional weight gain /ha |
|---|---|---|---|---|---|---|---|
| **Site 1** | Ewe weaners | 0.259 | 5.44 | $2.87 | $15.61 | 12 | $187.32 |
| **Site 2** | Ewe weaners | 0.293 | 6.15 | $2.87 | $17.66 | 10.5 | $185.42 |
| **Average** | | | | | | | **$186.37** |
| *Using 610c/kg CWT for lambs (Aug 2016 trade lamb price) & 47% dressing percentage | | | | | | | |

## 4.2.3 Yearling bulls (2016)

Growth rates for yearling bulls (site 3) were around five times higher on the pasture/ crop than on pasture only over the 21 days (Table 9 and Figure 7) at 2.3 kg/day. However, feed availability in the pasture only paddock was suboptimal for cattle (Feed On Offer 700kgDM/ha), resulting in lower growth rates than desirable (420g/hd/day) and a bigger difference than would be expected had there been more feed available in the comparison pasture.

*Table 9: Livestock weight gain on crop/pasture and pasture for 21 days (21.5 days in site 2) across the three sites*

| Site | Treatment | Stock | Mean wt. in (kg) | Mean wt. out (kg) | Mean Weight change (kg) measured | Mean weight increase/day (kg) | Mean weight change (21 days) (kg) |
|---|---|---|---|---|---|---|---|
| **Site 3** | Pasture only | Yearling bulls | 228 | 236.83 | 8.83 | 0.420 | 8.83 |
| **Site 3** | Crop/pasture | Yearling bulls | 245 | 292.67 | 47.67 | 2.270 | 47.67 |
| Difference | | | | | | 1.850 | 38.85 |

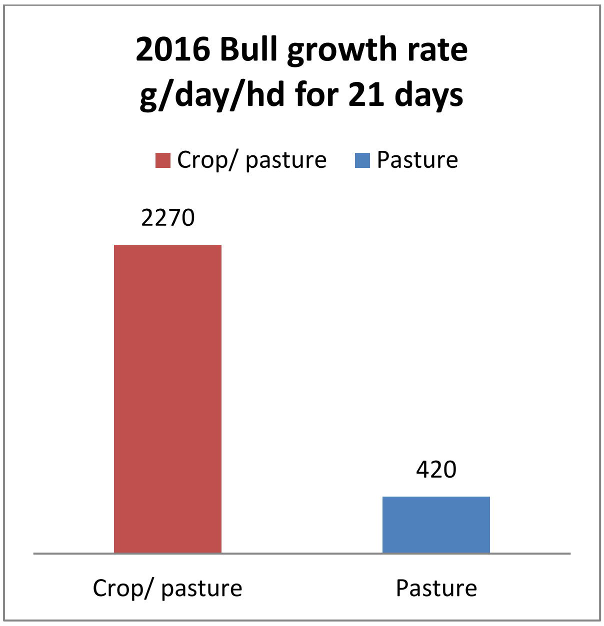



*Fig. 7: Bull growth rate for 21 days*

**Value of extra yearling bull liveweight from crop/pasture 2016**

The value of the extra liveweight gain achieved from crop/pasture over pasture only was $393.36 at the yearling bull site (Table 10).

*Table 10: Additional livestock value per head and hectare from grazing crop/pasture (compared to pasture) for 21 days*

| Site | Treatment | Additional livestock weight gain (crop/pasture-pasture) (kg/day) | Additional weight gain over 21 days (kg) | *LW value/kg | Value of additional weight gain/head | Stocking rate (head/ha) | Value of additional weight gain /ha |
|---|---|---|---|---|---|---|---|
| **Site 3** | Yearling bulls | 1.85 | 38.85 | $3.75 | $145.69 | 2.7 | $393.36 |
| * Using 375c/kg LWT for bulls (Aug 2016 trade steer price) | | | | | | | |

## 4.3 Yields and impact from grazing crop/pasture

There was little difference in grain yields for the grazed and ungrazed 2015 areas (Fig. 8, Table 11). Crop yields were 2.5 t/ha in both grazed and ungrazed areas of Site 1. The ungrazed area of Site 2 yielded 0.8 t/ha higher than the grazed area, which was adjacent to a shelterbelt. Yields for the EPDS sites were higher overall in 2016 than 2015, the result of higher 2016 rainfall compared to the dry winter/ very dry spring of 2015.

In 2016 (Fig. 9 and Table 11), there was a larger variation between the grazed and ungrazed areas of crop averaging 1.26 t/ha higher in the ungrazed area. Producers also noticed very large yield variations across paddocks in 2016, caused by waterlogging in low-lying areas.

It is likely that in 2016, livestock grazed the crop beyond the recommended growth stage 30 and into early growth stage 31, which can damage the embryo ear and reduce yields.

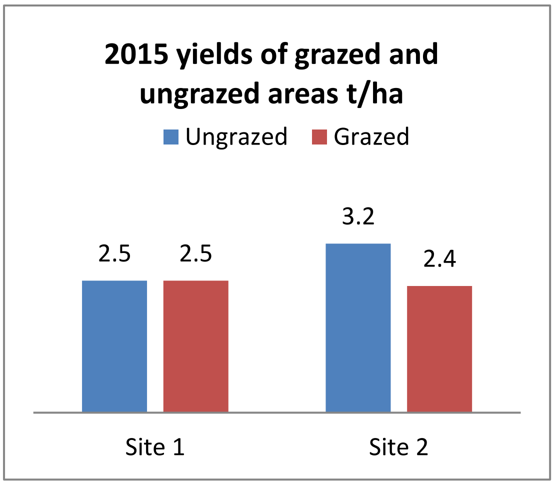



*Fig. 8: 2015 Oat yields from ungrazed and grazed areas*

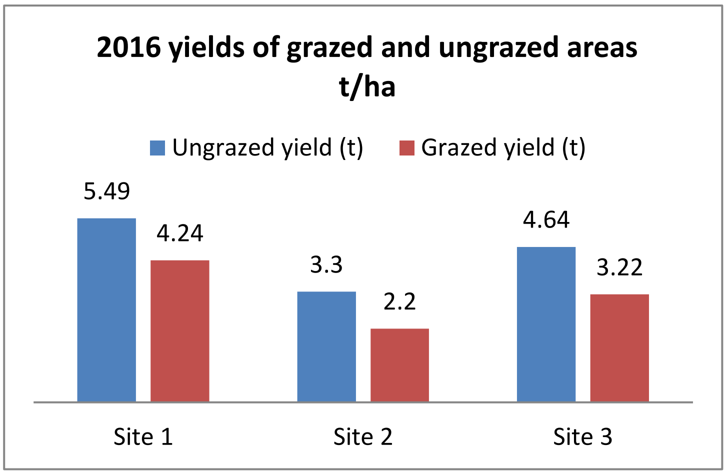



*Fig. 9: 2016 Oat yields from grazed and ungrazed areas*

**Value of crop yield from grazed and ungrazed crop/pasture in 2015 and 2016**

In 2015, the yield difference in harvested grain between the grazed and ungrazed sites produced an average $108 /ha less value for the grazed sites (oats valued at $270/t according to local grain prices at harvest) (Table 11).

In 2016, the yield difference in harvested grain between the grazed and ungrazed sites produced an average $150.80 /ha less value for the grazed sites (oats valued at $120/t according to local grain prices at harvest)(Table 11). This difference would have been even larger if grain prices had been higher, as they were in 2015.

*Table 11: Site yields (t/ha) for grazed and un-grazed areas and the value of those yields*

| Year | Site | Ungrazed yield (t/ha) | Grazed yield (t/ha) | Yield difference (t/ha) | Value of oats | Ungrazed value ($/ha) | Grazed value ($/ha) | Difference Value ($/ha) |
|---|---|---|---|---|---|---|---|---|
| **2015** | **1** | 2.5 | 2.5 | 0 | $270 | $675 | $675 | $0 |
| **2015** | **2** | 3.2 | 2.4 | 0.8 | $270 | $864 | $648 | $216 |
| **2015** | **Average** | **2.85** | **2.45** | **0.4** | | **$754.50** | **$661.5** | **$108** |
| **2016** | **1** | 5.49 | 4.24 | 1.25 | $120 | $658.80 | $508.80 | $150.00 |
| **2016** | **2** | 3.30 | 2.20 | 1.10 | $120 | $396.00 | $264.00 | $132.00 |
| **2016** | **3** | 4.64 | 3.22 | 1.42 | $120 | $556.80 | $386.40 | $170.40 |
| **2016** | **Average** | **4.48** | **3.22** | **1.26** | | **$537.20** | **$386.40** | **$150.80** |

## 4.4 Economics

### 4.4.1 Cost of cropping into pasture

The cost of cropping into the perennial pasture and taking it through to harvest was $298 in 2015 and $306 in 2016 (see Table 12). These costs included labour for the three chemical passes, sowing and harvesting ($125/ha).

*Table 12: Total costs per hectare of cropping into pasture and harvesting*

| **Costs** | **2015** | **2016** |
|---|---|---|
| Seed | $35 | $40 |
| Chemicals | $63 | $66 |
| Fertiliser | $75 | $75 |
| **sub total** | **$173** | **$178** |
| Operating/ labour | $125 | $125 |
| **Total** | **$298** | **$306** |

### 4.4.2 Profit margin results

There was a large variation in profit margin between the sites, ranging from $194 to a loss of $79 in the grazed sites and $33 to a loss of $209 in the ungrazed sites. These values were based on liveweight gain, which did not consider the gut fill.

Of the demonstration sites, the highest income was achieved in 2016 Site 3 cattle grazing ($194), owing to high cattle prices. The 2015 twin bearing ewes achieved the second highest value ($173/ha) although this calculation was based on little data. Site 1 2016 achieved the third highest income ($78), followed by Site 2 2016 (-$79).

The variation in grain price and yield reductions caused by late grazing and waterlogging (2016) had a large impact on profit margin.

Grazing the crop/pasture resulted in higher profit margins at each site than not grazing, despite the yield reduction caused by late grazing and waterlogging in 2016.

Adding the lost income from grazing while the crop was establishing was a considerable expense that reduced profitability.

The gross margin of the modelled scenario was nearly $400/ha grazed and $10 ungrazed. The higher stocking rate (assuming drier conditions than 2016) and stronger grain price made the practice very viable.

*Table 13: Profit margins per hectare for the ungrazed and grazed sites in 2015, 2016 and a modelled scenario*

| | Additional Benefits (Income) | | | | Additional Costs | | | **Additional Gross Margin** |
|---|---|---|---|---|---|---|---|---|
| | Additional livestock production | | Grain production | *Total gross income* | Lost livestock production | Crop operating expenses | Total costs | |
| | (from 21 days grazing) | (from stubble grazing) | Yield x oats price | | (from unavailable pasture) | (establishment/contractor etc) | | |
| **2016 Site 1:** (8.7kg/head liveweight gain over 21 days, 12 DSE//crop yields; 4.24t/ha grazed, 5.29t/ha ungrazed) (grain price $120/t) | | | | | | | | |
| Pasture oversown oats- winter grazing 21 days ewe weaners | $300 | $96 | $509 | *$904* | $520 | $306 | $826 | **$78** |
| Pasture oversown oats- no winter grazing | | $96 | $659 | *$755* | $520 | $306 | $826 | **-$71** |
| **2016 Site 2:** (8.7kg/head liveweight gain over 21 days at 10.5 DSE// crop yields; 2.20t/ha grazed, 3.30t/ha ungrazed) (grain price $120/t) | | | | | | | | |
| Pasture oversown oats- winter grazing 21 days ewe weaners | $262 | $96 | $264 | *$622* | $395 | $306 | $701 | **-$79** |
| Pasture oversown oats- no winter grazing | | $96 | $396 | *$492* | $395 | $306 | $701 | **-$209** |
| **2016 Site3:** (47.67kg/head liveweight gain over 21 days at 2.7h/ha // crop yields; 3.22t/ha grazed, 4.46t/ha ungrazed) (grain price $120/t) | | | | | | | | |
| Pasture oversown oats- winter grazing 21 days yearling bulls | $483 | $96 | $386 | *$965* | $465 | $306 | $771 | **$194** |
| Pasture oversown oats- no winter grazing | | $96 | $535 | *$631* | $465 | $306 | $771 | **-$140** |
| **2015 Site 1 results:** (0.7kg increase in liveweight=$5.60/head at 25h/ha //crop yields; 2.5t/ha grazed, 2.5t/ha ungrazed) (grain price $270/t) | | | | | | | | |
| Pasture oversown oats- winter grazing 14 days twin bearing ewes | $140 | $96 | $675 | *$911* | $440 | $298 | $738 | **$173** |
| Pasture oversown oats- no winter grazing | | $96 | $675 | *$771* | $440 | $298 | $738 | **$33** |
| **Modelled scenario** (8.7kg/head liveweight gain over 21 days, 20 DSE//crop yields; 3 t/ha grazed, 3.5 t/ha ungrazed) (grain price $209/t) | | | | | | | | |
| Pasture oversown oats- winter grazing 21 days ewe weaners | $499 | $96 | $627 | *$1,222* | $520 | $306 | $826 | **$396** |
| Pasture oversown oats- no winter grazing | | $96 | $732 | *$828* | $520 | $298 | $818 | **$10** |

## 4.5 Extension activities during the demonstration

The following extension activities were held over the demonstrations with additional activities promoting the results in the year following the demonstration.

2015

- Workshop March 2015 to discuss the history and effectiveness of pasture cropping, with Colin Seis
- Group inspection to promote/ create awareness about pasture cropping Aug 15 (30 producers)
- Field day conducted to generate awareness of demo and results Oct 15 (8 producers)

2016

- Media (radio) used to promote demo and awareness of progress results Feb 16
- Presentation at Bendigo Bank night- Edenhope Aug 8 (around 100 participants)
- Group inspection during grazing to create awareness about pasture cropping Aug 16 (8 producers)
- Open field day (beyond the group) to present results of 2 years of pasture cropping data and promote benefits of pasture cropping practice Nov 16 (16 producers)
- Radio interview with site host on ABC country hour (Dec 16)

2017

- Group workshop covering full analyses of Years 1 & 2 data, KASA and practice change evaluation, unintended outcomes, adoption profile Feb 17 (10 producers)
- Three presentations (170 participants in total) at the 2017 BWBL conference
- Article in SheepNotes (circulated to all Victorian sheep producers)

## 4.6 Monitoring and evaluation

### 4.6.1 Changes in knowledge, attitude, skills, aspirations and adoption

Glenelg BW/BL producers were asked to rate their knowledge, attitude, skills, aspirations and adoption of aspects of cropping into pasture and grazing the crop in winter, before the EPDS demonstration and again at the end of the demonstration.

Both times, the producers rated themselves out of 10 against the following parameters (NB 5&6 relate to the Land Health demonstration).

1. Ability to establish, manage and harvest a cereal crop sown over an existing perennial pasture.
2. Ability to fill the winter feed gap using pasture cropping.
3. Ability to recognise and monitor growth stages of cereal crops.
4. Understanding the impact on yield of grazing pasture-crop compared with not grazing the pasture-crop.
5. Ability to use pasture-cropping to manage ground cover.
6. Use of pasture cropping to improve perennial pastures (through removal of annual grasses and resting perennials).
7. Ability to profitably manage pasture-cropping.

Producers’ knowledge, attitude, skills, aspirations and adoption for each of the seven aspects had increased markedly at the end of the demonstration (Figures 10-14). The greatest changes were in adoption (92% increase) and knowledge (80% increase) of how to establish, manage and harvest cereal crops sown into pasture. Aspirations and attitude had the smallest shift as the group already had high, positive ratings for these attributes.

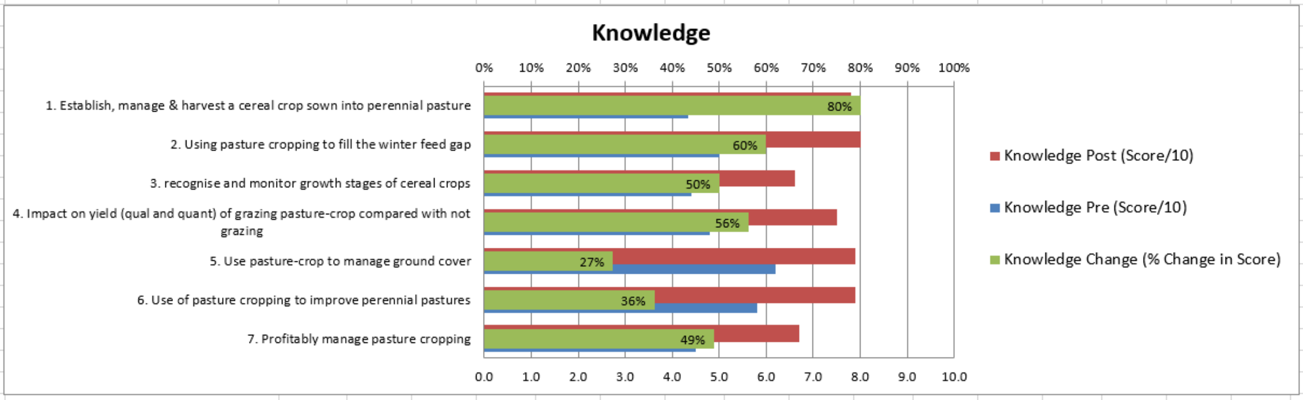



*Fig 10: Producers' changes in knowledge on all parameters, pre and post the demonstration*

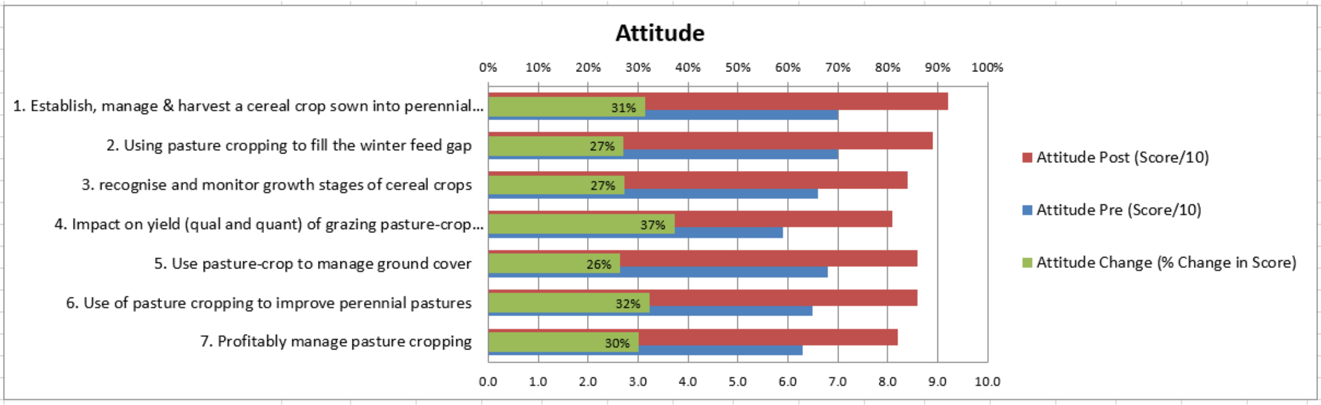



*Fig 11: Producers' changes in attitude on all parameters, pre and post the demonstration*

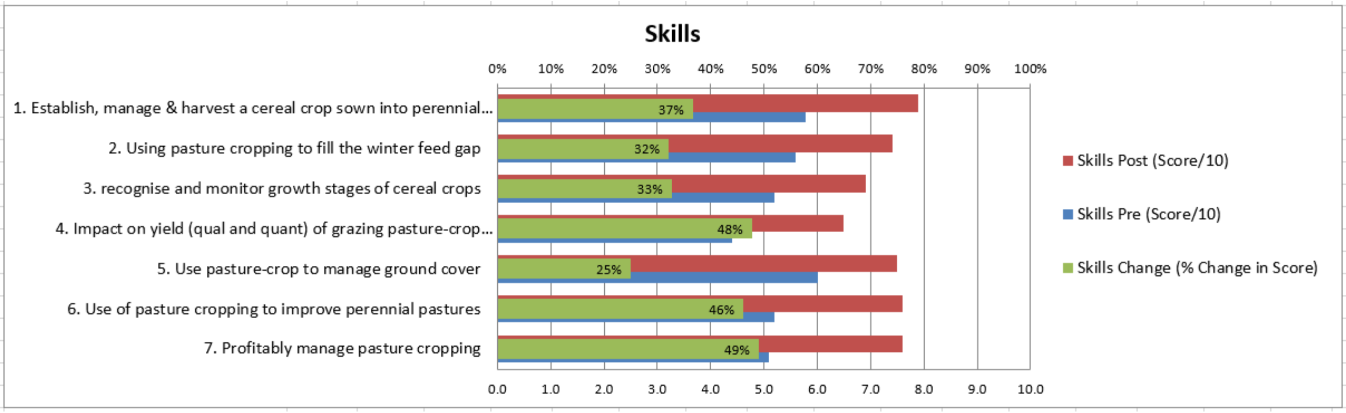



*Fig 12: Producers' changes in skills on all parameters, pre and post the demonstration*

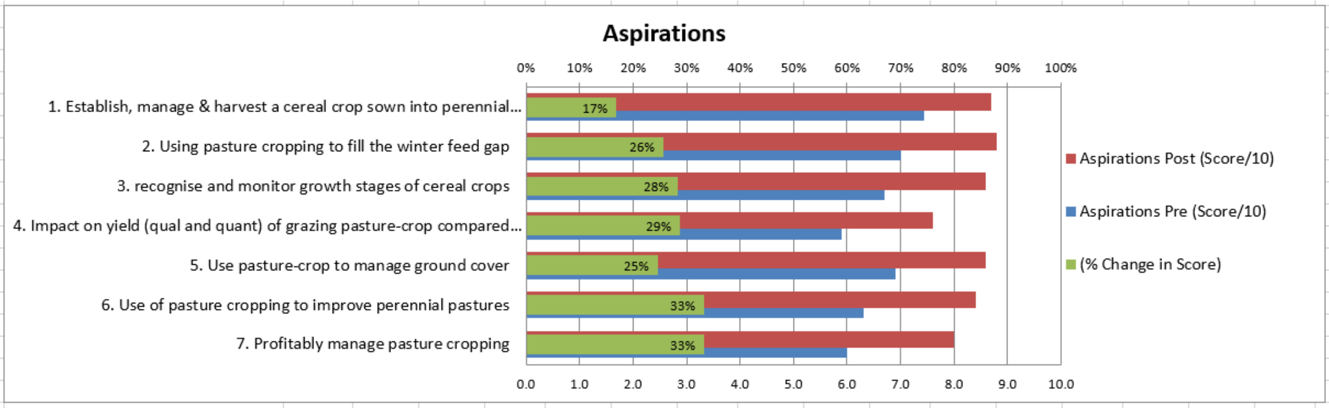



*Fig 13: Producers' changes in aspirations on all parameters, pre and post the demonstration*

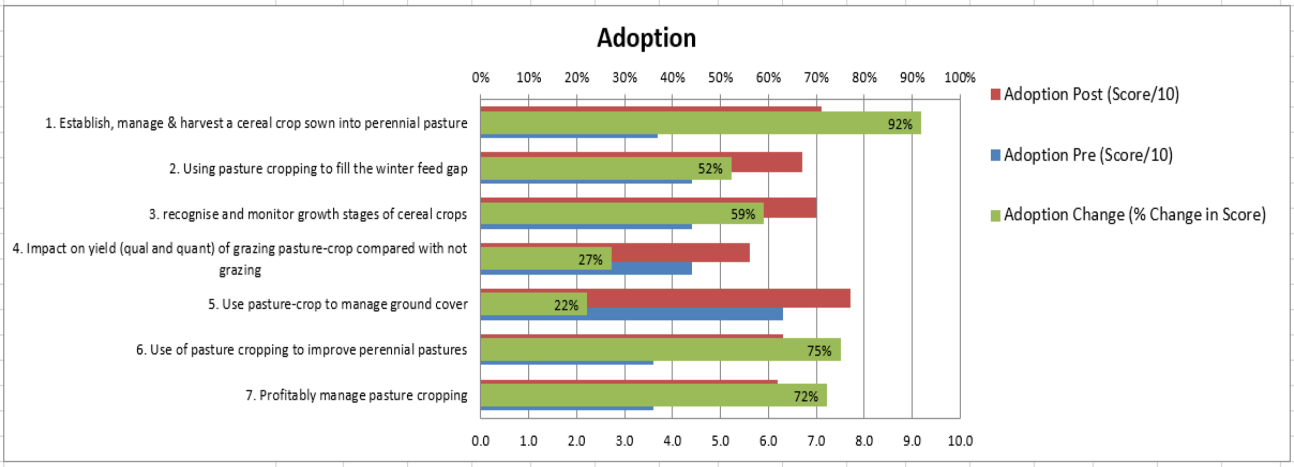



*Fig 14: Producers' changes in adoption on all parameters, pre and post the demonstration*

### 4.6.2 Adopt Model

The CSIRO Adopt Model was run at the final producer workshop. The Adopt Model is an excel tool that predicts the likely level of adoption and diffusion of agricultural technologies and practices.

The group identified that this system of cropping into pasture and grazing for winter feed was applicable for all livestock producers in the >500mm rainfall zone. The model identified a maximum adoption of 53% of producers in this zone could be reached in 13 years. This is quite a high level of adoption.

*Figs. 15: Coojar Site in November 2016*

# 5 Discussion

## 5.1 Difficult seasonal conditions

Winter and Spring 2015 were dry for producers in the Glenelg BWBL group producing a decile 1 growing season (Figure 16). Low spring rainfalls meant that grain yields were lower than forecast at all sites.
In contrast, the 2016 growing season was the wettest on record for the district (Figure 17) and waterlogging impacted on yield, particularly in low-lying areas.

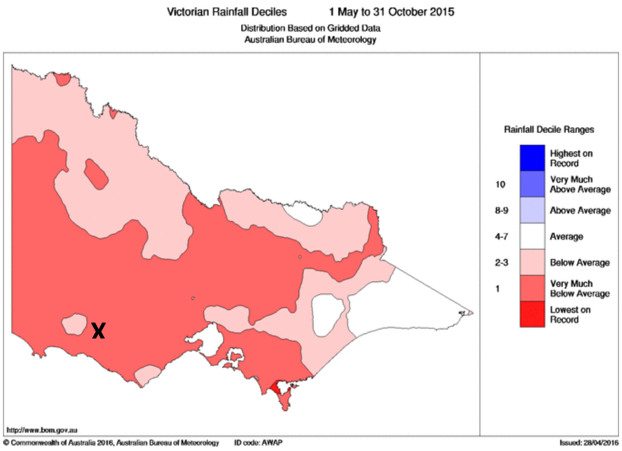



Fig. 16: Rainfall decile for the 2015 growing season

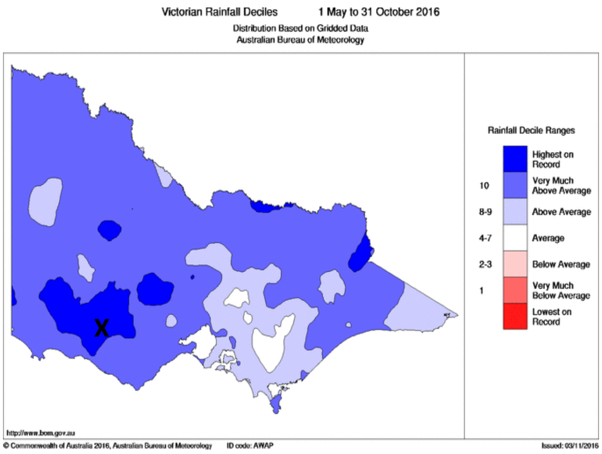



Fig. 17: Rainfall decile for the 2016 growing season

## 5.2 Herbage mass and nutritive quality

The crop/pasture growth rate was measured in 2016 at 47-60kgDM/ha/day (Table 4), 4-5 times the growth rate of the pasture only sites (12kgDM/ha) in winter. This was consistent with findings from Nicholson *et al* (2016), who suggest that the greatest upside with grazing crops is the additional high-quality feed available in the winter period, particularly around 8-weeks from sowing in cereals.

The demonstration found that the crop/pasture not only produced larger amounts of herbage mass in winter, but that feed was of higher quality than pasture sampled at the same time. This was also consistent with Nicholson *et al* (2016) findings, that winter crops offer high quality feed equivalent or higher than typical pastures at the same time of year. Their summary of 137 observations of crop nutrient quality suggest a digestibility of oats around 78%, metabolizable energy around 12 MJ/kg and crude protein around 18% at late vegetative stage. These are similar to the demonstration results in 2016, however the nutrient quality in 2015 under dry conditions was slightly higher (Table 4).

Given the space between the crop rows, the feed on offer (FOO) benchmarks for pastures do not apply to winter crops, which have a lower FOO at any height. The crop is however more available for animals.

## 5.3 Animal performance

The combination of higher herbage mass that was taller and more available, plus the higher nutrient content offered by the crop/pasture led to increased animal performance compared to pasture only, in winter. These benefits would also apply to crop only situations in mixed livestock/cropping systems. No negative animal health side effects were seen throughout the demonstration, however Nicholson *et al* (2016) provide useful information on issues (and how to prevent them) such as scouring and mineral deficiencies that can occur, particularly when crop is grazed for extended periods.

### 5.3.1 Twin bearing ewes and lamb birthweights

Despite low numbers to support the finding, the 2015 twin bearing ewes produced an average 0.7kg higher birthweight in the twin born lambs weighed (triplets excluded).

Ewes in better condition at lambing produce bigger lambs (Figure 18) and birth-weights are most sensitive to changes in ewe condition in late-pregnancy (Ferguson *et al*, 2007). Ewe nutrition in late-pregnancy can influence the birth-weight of lambs by up to 0.5 kg per ewe condition score for both single and twin lambs (Ferguson *et al*, 2007). This is consistent with findings from the demonstration, where a late burst prior to lambing in ewe nutrition from grazing the crop/pasture coincided with higher lamb birthweights than the lower quality and quantity of the pasture only treatment.

Lamb survival is mostly explained by differences in lamb birth-weight, with optimum birth-weight for lamb survival between 4.5 and 5.5 kg, (though this is influenced by lambing environment and whether they are a single or twins) (Ferguson *et al*, 2007). An increase in lambing birth weight from 4.8 kg to 5.5 kg results in an estimated 4% increase in survival (Figure 19) (Ferguson *et al* (2007) and A. Kennedy (pers. comm. 2017)). In fact, an increase of 0.7kg birth weight would have resulted in a greater increase in survival if the birth weight of the lambs were lower. The higher lamb birth weights of both control and treatment lambs is indicative of the good ewe management of the demonstration site managers.

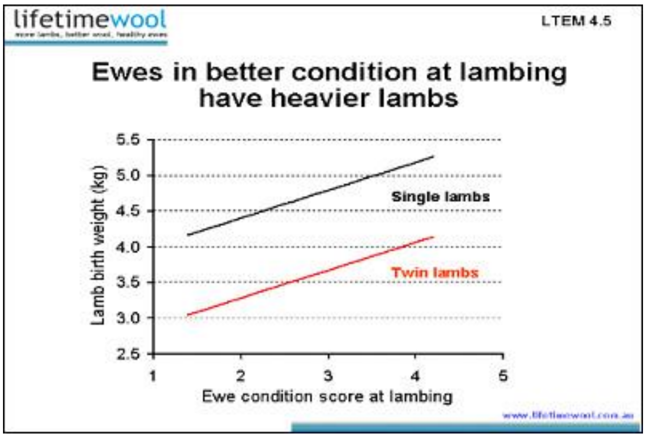



*Fig. 18 Impact of ewe condition at lambing (Source: Ewe Management Handbook 2007)*

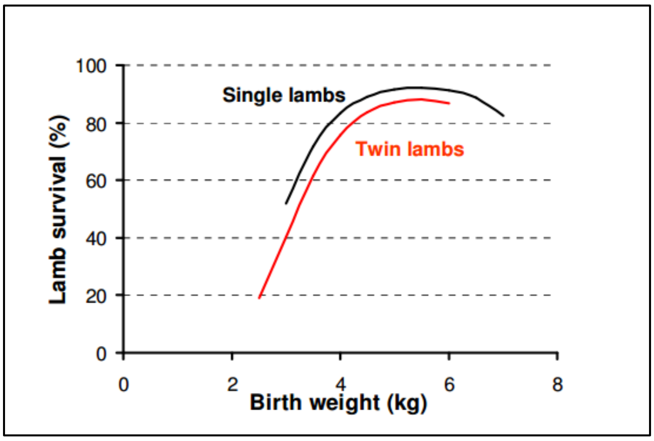



*Fig. 19: Impact of birth weight on lamb survival (Source: Ewe Management Handbook, 2007)*

This extra 4% survival equates to an extra eight lambs per hundred ewes. At $70/ lamb, this results in an extra $560 income per one hundred ewes – or $5.60/ ewe.

This is an important result and warrants further investigation with higher numbers of ewes and lambs. Potentially, crop/pasture within the farming system can offer a source of high quality and quantity feed for twin bearing ewes prior to lambing, that can lead to increased lamb birthweights and survival.

### 5.3.2 Weight gains for ewe weaners and yearling bulls

The higher growth rates of the ewe weaners and yearling bulls on the crop/pasture compared to the pasture only, also reflects increased nutrition from higher quality and quantity feed. The growth rates for ewe weaners averaged 259 g/day higher at Site 1 and 293g/day higher on Site 2 on the crop/pasture than the pasture only, while the yearling bulls averaged 1.85kg/day more than the pasture only paddock. However, the FOO in the pasture only paddock was suboptimal for bull growth (700kgDM/ha) by the end of the 21 days of grazing, resulting in low (420g/day) weight gains and making the difference more pronounced.

Nicholson *et al* provide graphs of anticipated liveweight gains for different classes of livestock grazing winter crops, developed using GrazFeed. The demonstration achieved higher weight gains in ewe weaners (averaging 276g/head/day) than was predicted by the graph (175g/head/day). Yearling bull weight gain (2.27kg/day) was also higher than predicted (1.1kg/head/day) for steers- the closest livestock class. It is possible that sheep genetics and testosterone in the bulls played a part in these results. It is also possible that the crop/pasture quality or growth rate was higher than was used in the Grain and Graze modelling.

It is also very likely the higher than modelled livestock weight gains were in part contributed to by a portion of 'gut fill' associated with animals grazing on areas of increased herbage mass – and that at the suboptimal pasture only FOO of 700 kgDM/ha, daily feed intake was limited by low availability.

The project team recognises the limitations in trying to accurately determine changes in liveweight within a commercial setting. Due to commercial realities we were unable to utilise curfewed liveweights as we did not want to compromise animal production. Had curfewed weights been available issues associated with gut fill would have been addressed. Furthermore, only start and finish liveweight were determined. Undoubtedly, a more accurate change in liveweight would have been achieved had we been able to obtain midpoint weights as well.

Importantly, the high growth rates achieved in both the ewe weaners and yearling bulls suggest that crop/pasture has the capacity to fatten livestock in winter.

### 5.3.3 Yields and impact of grazing

Grain yields of crop sown into perennial pasture varied from 2.4-5.49 t/ha across the five ungrazed areas. Unfortunately, no crop-only areas were grown to compare yields and the impact of sowing into an existing pasture. However, observations during the Land Health demonstration suggested that higher amounts of phalaris competed with the crop and reduce yields, particularly in dry seasons.

Grazing the crop/pasture resulted in minor reductions in crop yield in 2015, particularly at site 1. The 0.8t/ha reduction in yield at site 2 was believed have been caused by a shelterbelt adjacent to the grazed area of crop, that robbed the crop of moisture during the dry spring.

In 2016, the yield reductions in the grazed areas were higher, ranging from 1.10-1.42 t/ha. The lower yield in the grazed sites was probably the result of waterlogging and more significantly, a miscalculation in grazing time. Waterlogging will affect the grazed areas more than the ungrazed areas owing to the smaller leaf area and ability of plants to transpire. Inspections in July and August had identified areas of yellowing at these sites.

It is highly likely that in 2016, livestock grazed the crop beyond the recommended growth stage 30 and into early growth stage 31, which can damage the embryo ear and reduce yields (Figure 19).

Nicholson *et al* (2016) found that cereal grain yield declined under grazing most of the time crops were grazed (78%). Although the severity of the decline varied, a yield decline of less than 250 kg/ha was most commonly seen. However, they also found yield increases in 22% of cases of up to 250 kg/ha attributed to less leaf disease through removal of early growth. Large losses in grain yield were recorded in 24% of cases.

The factors involved in the large losses are listed in Table 14. It is likely that factors 1 and 2 caused the large yield losses in 2016 grazing sites. Figure 20 shows some crop in 2016 after grazing, where the growth stage appears beyond the inset growth stage 30 photo.

Nicholson *et al* (2016) also provide useful insights into when to begin grazing, for how long and when to finish grazing, to minimise impacts on crop yields.

*Table 14: Important factors observed to adversely affect grain yield (Source: Nicholson et al 2016)*

| Factor | Effect |
|---|---|
| 1. Growth stage of crop at end of grazing | Grazing after growth stage 30 may remove elongating grain ears and leave insufficient time for recovery before flowering. |
| 2. Stressful environmental conditions after grazing and before flowering | Heat, moisture stress or waterlogging can hamper crop recovery and result in a loss of tillers and grains per ear. |
| 3. Intensity and duration of grazing | Grazing that removes too much leaf may hamper adequate crop recovery reducing the |

| | |
|---|---|
| | potential for complete grain fill. |
| 4. Variety maturity pattern too long for the growing environment | Grazing will delay maturity and may expose ripening crop to heat and moisture stress. |


*Fig. 20: 2016 Growth plant after grazing and (inset) growth stage 30 (source: GRDC Cereal Growth Stages Guide)*

## 5.4 Profit margin

There was a large variation in profit margin between the sites, ranging from $194/ha to a loss of $79/ha in the grazed sites and $33/ha to a loss of $209/ha in the ungrazed sites. The variation between sites was largely due to waterlogging causing reduced stocking rates and impacting on yields. Price of oats and livestock also had a big impact on profit margin. This indicates the sensitivity of this system to seasonal conditions and grain and livestock prices (see Appendix 1 for a detailed cost and benefit analysis).

The very low 2016 oat price ($120) resulted in low profit margins from crop, despite the higher yields achieved than in 2015. Also, the strong cattle price of 2016 (in addition to large weight gains for the bulls) meant that the cattle site came out ahead of the lamb sites.

The 2016 twin bearing ewe site had the second highest profit margin (after the cattle site), however this was largely due to the higher grain price in 2015. The value from livestock production was lower than the 2016 sites. This site also had a very small sample size.

Grazing the crop/pasture resulted in higher profit margins at each site than not grazing, despite the yield reduction caused by late grazing and waterlogging.

Genetics and potential growth rates of animals also drives profit margins and the composite ewe weaners and yearling bulls achieved significant daily weight gains.

The difference between 2016 Site 1 and Site 2 indicates the importance of paddock selection to match the season. A large portion of the site two paddock was severely waterlogged and required a lower stocking rate for winter grazing. It also incurred a large yield reduction and the producer observed a range in yield across the paddock from 0 to 7t/ha. The result was a production loss estimated at -$79/ha grazed, compared to the $78 gross margin of Site 1.

The gross margin of the modelled scenario was nearly $400 grazed and $10 ungrazed. The higher stocking rate (assuming drier conditions than 2016) and stronger grain price made the practice very viable.

## 5.5 Overall costs and benefits

Sowing crop into an existing pasture produced faster growing, higher quality winter feed than pasture only. This resulted in very high liveweight gains (414g/day ewe weaners and 2.27kg/day yearling bulls) over the winter grazing period; far greater than on pasture only. While some reduction in crop yield occurred through grazing, this could be minimised by early sowing and early grazing to ensure stock are removed before the crop reaches growth stage 31.

On livestock and yield measurements alone, sowing crop into pasture and grazing it in winter is extremely favourable. However, the value reduces when the cost of lost grazing (around $395 - $520/ha) is considered (Table 13).

Profit margins between sites and years were highly variable, which was largely caused by the extremes in rainfall (2014 and 2015 were the two driest consecutive years on record, followed by the wettest year on record, 2016) and variation in grain price.

All things considered, cropping into an existing pasture with winter grazing stacked up as a good option for the group. Table 15 weighs up the costs and benefits of cropping into pasture and grazing the crop/pasture and includes some of the benefits demonstrated in the Land Health project.

The group indicated that there was little risk in this in the system, given the flexibility to graze or harvest the crop depending on the season and grain price, and the fact that there was reduced need to re-sow the pasture once stubbles had been grazed owing to the phalaris component.

Yield reduction from grazing the crop encountered in 2016 could be reduced considerably by better timing the grazing.

Planning is vital, and it is important to consider the seasonal outlook before deciding to crop into pasture and select the right paddock for the forecast conditions. Good drainage is a priority in wet winters to maximise both crop yield and winter grazing potential. Crops are more likely to recover from grazing if spring is favourable (Nicholson *et al* 2016).

In years of low grain price, it could be more valuable to graze the crop/pasture rather than harvest it, particularly if livestock prices are strong. One producer in the Land Health demonstration made silage from his crop/pasture site, which he felt was more valuable than harvesting oats given the dry spring and low yield predictions for his 2014 crop.

Further investigation into grazing with different classes of livestock and for different lengths of times would be worthwhile.

### 5.5.1 Additional benefits measured on the Land Health demonstration

Natural resource management (NRM) benefits were observed and measured during the Land Health demonstration. Pasture improvements from cropping into pasture were difficult to quantify and value, however the group indicated that they were considerable. Cleaner pastures were observed (though not measured) and a slight increase in phalaris groundcover was measured as a result of plants becoming reproductive and shooting from the crown, fertiliser application and weed removal. There is also a valuable contribution to pasture in the year following crop from mineralised Nitrogen, achieved by grazing stubbles (Hunt *et al,* 2016).

*Table. 20: Weighing up the system of sowing cereals in crops and winter grazing (costs/ income $/ha)*

| Practice | Costs and benefits | Cost/ha | Benefit/ha |
|---|---|---|---|
| **Cropping into pasture** | **Inputs** (chem, fert, seed, contractors) | $306 | |
| | **Lost production- crop establishment** (meat, wool) | $455 | |
| | **Oat yield** (Av of EPDS sites) | | $566 |
| | **Pasture improvement** (less weed, strong perennials) | | ✓ |
| | **Increased longevity** (less re-sowing) | | ✓ |
| | **Grazing stubbles** | | $96 + N mineralisation |
| | **Soil health** (groundcover) | | ✓ |
| **Grazing crop/pasture in winter** | **Risk** (maintaining pasture) | | ✓ |
| | **Winter grazing** (Av of 2016 sites) | | $296 |
| | **Oat yield reduction** (Av of EPDS sites) | $108 | |
| Totals | | $869 | $958 ✓✓✓✓ |

## 5.6 Evaluation

### 5.6.1 KASAA survey

The KASAA evaluation measured changes in the knowledge, attitude, skills, aspirations and adoption of the BWBL group. These measures were assessed against the following parameters: (NB 5&6 relate to the Land Health demonstration). Figures 10-14 show the pre, post and change results.

1. Ability to establish, manage and harvest a cereal crop sown over an existing perennial pasture.

2. Ability to fill the winter feed gap using pasture cropping.
3. Ability to recognise and monitor growth stages of cereal crops.
4. Understanding the impact on yield of grazing pasture-crop compared with not grazing the pasture-crop.
5. Ability to use pasture-cropping to manage ground cover.
6. Use of pasture cropping to improve perennial pastures (through removal of annual grasses and resting perennials).
7. Ability to profitably manage pasture-cropping.

'Ability to use pasture cropping to manage ground cover' had the smallest increase in KASSA across of all parameters. This was an objective from the Land Health demonstration that was difficult to achieve. Overall, knowledge and adoption had the biggest increases from the demonstration.

**Knowledge**
Producer knowledge increased across all parameters between 27 and 80%. Knowledge of 'establishing and managing cereal sown into pasture' and 'using pasture cropping to fill the winter feed gap' had the biggest increase.
**Attitude**
Producers had high initial scores for their attitude towards all parameters, and these increased further between 26-37%.
**Skills**
Producer skill level increased on all parameters by 25-49%. The highest increase was for 'profitably managing pasture-cropping' and 'understanding the impact on yield from grazing pasture crop'.
**Aspirations**
Aspirations pre-demonstration were received a high rating and increased between 17-35%.
**Adoption**
Producers indicated high levels of adoption (22-92%), particularly for 'establishing, managing and harvesting a cereal crop sown over an existing perennial pasture,' 'use of pasture cropping to improve perennial pastures, and 'ability to profitably manage pasture-cropping'.

### 5.6.2 ADOPT

The ADOPT model was used to identify likely adoption of a system of cropping into pasture and grazing for winter feed by producers in the >500mm rainfall zone. Results predicted a maximum adoption of 53% of producers in this could be reached in 13 years.

These predictions indicate high adoption over a relatively short period of time for the tested innovation.

The practices may seem achievable to producers that were involved in the demonstrations, however there are several things that producers need to consider to achieve a good result, such as; seasonal conditions, paddock selection, chemical regime, stock class for grazing, grazing period and crop growth stage and stubble management. Without initial advice or assistance, producers may be put off by these factors.

## 5.7 Producer involvement and feedback

At the final field day, producers rated the relevance of the demonstrated practices at 8.8/10 for their business and the value of the demonstration for helping them to understand the practices at 8.9/10.

All producers indicated that they planned to make at least one practice change because of the demonstration. The following are examples of planned changes and benefits expected from participants who attended extension activities associated with the demonstrations:

**Example of planned changes**

- Improve pasture and crop management
- Graze oat stubble with cows;
- Try more pasture cropping;
- Graze all crops;
- Use grain crops to fill feed gap in winter;
- More grazing of cereals in winter;
- More grazing of crop in July/Aug
- Try sowing cereal into perennial pasture;
- Will definitely try putting cereal though existing light pasture and graze it,
- Start grazing crops,
- Plant grazing oats next year,
- Have started trialling it,
- More intensive short grazing crops,
- More cereals into perennials and grazing,
- Will start recommending the system,
- Recommend to other clients if they have phalaris stands

**Predicted benefits from making changes**

- Pasture renovation with grazing benefits,
- Improved pasture management;
- Better soil health;
- Better pasture after crop;
- More winter feed;
- Condition going on stock.
- Prolong the growing rate of crops past frost times;
- Increasing lamb and cow yields;
- Increased DSE/ha= profit;
- Growth of stock and spell pasture when grazing crops
- Winter feed at a lower cost,
- Grow & use more dry matter/ha,
- More kg weight gain,
- Increased stocking rate & fewer weeds/improved pastures,
- Less costs for partially renovating pasture,
- Increase stocking rate with winter feed

Feedback was positive from those who attended the field days; however, there was some difficulty attracting numbers to some of the events, owing to unseasonal weather conditions impacting on work plans. It is also possible that the group (which had attended several earlier Land Health demonstration events) felt that they had already learnt about the concepts.

Generally, the group members were happy to host demonstration sites. The involvement of the group co-ordinator, agronomist, and Agriculture Victoria as a team worked well towards managing and promoting the demonstration. The Glenelg Hopkins CMA, funders of the Land Health demonstration, also provided a wider audience and additional sites and results, which complimented the EPDS.

## 5.8 Objectives and outcomes

### 5.8.1 Measure and compare feed production and quality of crop/pasture

Feed quality was measured for two years and feed production was measured in year two. Crop/ pasture was higher in ME and CP both years and had a much higher winter growth rate than pasture (Table 7).

### 5.8.2 Estimate livestock production and economic benefits from grazing crop/pasture

Livestock production was estimated in year 1 by measuring twin lamb birth weight, and in year 2 by measuring lamb and bull growth rates over 21 days (Table 9, Fig 9 & 10). The profit margins and economic implications were also measured.

### 5.8.3 Understand the impact on yield from grazing crop/pasture

Yield reductions from grazing were measured for two years. In the second year, the larger yield reduction was attributed to waterlogging and early sowing/late grazing (into early GS 31).

#### 5.8.4 Increase producer knowledge, skills and adoption of this system of cropping into pasture and using the crop to fill the winter feed gap

Four field day/ workshops and two paddock inspections were held. All producers surveyed at these events indicated they would adopt a practice as a result of attending. Additionally, 170 producers attended the 3 BWBL conference presentations and the project was promoted through two radio interviews.

Producer surveys indicated an increase in knowledge, skills and adoption after the demonstration.

## 5.1 Extension messages

### 5.1.1 You don't need to kill a pasture to grow crop.

The group estimated that yield reductions of 10-25% occurred by sowing into an existing pasture (though this was not measured). However, maintaining the pasture underneath the crop is a risk management strategy that means regardless of what happens though the season, there will still be a pasture for next year.

### 5.1.2 Crops provided good quality feed and high growth rates in winter.

The crop/pasture considerably outperformed the pasture only sites in feed quality and growth rates in the middle of winter. The impact was seen in the increased livestock growth rates during grazing. Short grazing is considered a good option to minimise animal health impacts from grazing crops.

### 5.1.3 Yield reductions can occur from grazing depending on the season and timing (don't graze past Growth Stage 30!)

Measured yield reductions in 2016 were probably a result of grazing waterlogged crop and grazing into early growth stage 31. Monitoring un-grazed areas (using a pasture cage) can optimise grazing time and prevent potential crop damage. Short, sharp grazings are important and will minimise trampling.

### 5.1.4 Winter grazing pasture/crop increases the profit margin.

Crop/pasture grazing results from 2016 showed that stock were able to be fattened in winter with liveweight gains of 414 g/day for ewe weaners and 2.3 kg/day for yearling bulls. With these growth rates, there is potential to tap into strong out-of-season livestock prices. Grazed sites had a higher gross margin than ungrazed (despite reduced yield).

### 5.1.5 The system offers flexibility.

The crop can be harvested (yields ranged from 2- 5.5 t/ha across the Land Health and EPDS sites), cut for silage (one producer did this and found it to be very valuable), cut for hay, or grazed as a crop. Three producers grazed their oats during the dry 2015 spring/summer, reducing harvest costs. This is a good option when low yields or grain prices are predicted.

**The following complimentary extension messages were produced through the Land Health demonstration that ran in tandem with the EPDS.**

### 5.1.6 The system is useful for pasture cleaning and increasing perennial plant size.

Weed content of pastures was not measured, however all producers in the Land Health demonstration indicated that the system left them with cleaner pastures, particularly where onion grass was a problem. This is a result of chemical applications that targeted particular weeds. Phalaris groundcover increased probably due to the combination of resting plants and allowing them to run to head, weed removal and from fertiliser at sowing.

### 5.1.7 Consider the phalaris density before deciding whether or not to crop.

While phalaris ground cover increased slightly in most pastures, it was felt that less than 10% phalaris prior to cropping was insufficiently to adequately thicken up. Chemical applications cleaned pastures of annual and broad leaf weeds and onion grass, however without adequate perennials and clover, the pasture was susceptible to weed infestations again the following year. Re-sowing is probably a better option for these pastures with low perennial counts. The group also felt that the crop was outcompeted in pastures with very dense phalaris.

### 5.1.8 The system was useful for maintaining groundcover (stubble management is important)

While it was not possible to identify soil health improvements, this system provided an option for improving pastures with minimal soil disturbance. Stubble trash is also likely to have benefitted soil health to some extent. It was noted that at stubbles were overgrazed at some sites, exposing soil and potentially damaging the pasture.

# 6 Conclusions

Overall, the group was very optimistic about the potential of sowing cereals into pastures both for winter grazing opportunities and pasture improvement. The high growth rates and high nutritional value of crops in the depths of winter when there was little pasture growth, was a useful resource. It produced very high livestock growth rates which provides potential to tap into strong out-of-season livestock prices. Furthermore, the practice has the potential to increase twin lamb birthweight when ewes are grazed during late pregnancy, increasing lamb survival rates.

Originally, the idea to demonstrate sowing cereals into pastures was focussed on resting and rejuvenating old, rundown phalaris pastures whilst producing a crop yield (Land Health demonstration aims). However, the EPDS showed that grazing the pasture/crop in winter dramatically increases the profit margin per hectare with minimal crop yield penalty; except under waterlogged conditions and when grazed past GS30.

The demonstrated benefits of grazing the crop/pasture in winter also apply to crop only situations in mixed livestock/cropping systems.

## 6.1 Future R&D

The group identified different sowing methods that they felt were worth testing. Producers suggested that sowing the crop with tynes caused some damage to phalaris plants, which may not have occurred if discs were used and plants were sliced rather than pulled out. There was also discussion about sowing new phalaris pastures with row spaces that would allow inter-sowing of cereals.

The demonstration has opened the group up to the idea of sowing oats into an existing pasture and grazing it for winter feed. Since participating in the demonstration, some members of the group have started experimenting with different crops sown into pastures and with grazing different crop varieties. Further trials in using crops to fill feed gaps would be welcomed by the group or could encourage adoption in other regions.

## 6.2 Application to the red meat industry

The Land Health demonstration (that started a year prior to this demonstration) showed the benefits from sowing a cereal crop into an existing pasture to 'clean' and rejuvenate the pasture whilst producing a crop yield. This practice is applicable where phalaris pastures are declining, with high weed content and reducing phalaris numbers.

This EPDS demonstrated the benefit to livestock systems from having the crop/pasture available as high quality and quantity feed in winter. The implications of this demonstration are broader reaching and apply to any cereal crops that potentially offer winter grazing benefits. The project demonstrated that grazed sites had a higher gross margin than ungrazed (despite a reduced yield).

The crop/pasture grazing results from 2016 showed that stock can able to be fattened in winter (with liveweight gains of 414 g/day for ewe weaners and 2.3 kg/day for yearling bulls) and that there is potential to tap into strong out-of-season livestock prices.

## 6.3 Activities to increase adoption

Development and promotion of a factsheet about the demonstration is recommended to increase awareness and adoption of the innovation. The project was presented at three concurrent sessions at the 2017 BWBL conference and appeared in SheepNotes newsletter. Further presentations and/or a webinar could also encourage adoption.

The practices involved in the innovation are not complicated, however a degree of technical knowledge is required, such as knowing when to graze, how long to graze and when to stop grazing. The Grain and Graze project has run many trials on this topic and offer extremely useful publications (listed below) that can provide producers with the information and confidence to graze crops. Promoting these publications to livestock and mixed grain/livestock producers may also increase adoption.

# 7 Acknowledgements

Thank you to the three host producers involved in the demonstration over the two years.

Valerie Little, Sally Cunningham and Ralph Cotter from Agriculture Victoria each worked on this demonstration at different stages of the project.

# 8 Bibliography

Falkiner S., Paridaen A., Nicholson C., Kreeck G. (March 2013) Grazing Crops chapter, Workshop notes, Grain and Graze Program.

Falkiner S., Watson D., Nicholson C. (March 2013) Pasture cropping chapter, Workshop notes, Grain and Graze Program.

Ferguson M., Thompson A., Gordon D. (2007) Ewe Management Handbook- optimising Merino ewe nutrition to increase farm profit. Lifetime Wool.

Hunt J.R., Breust P.D., Swan A.D., Peoples M.B., Kirkegaard A.K. (2016) Sheep Grazing on crop residues increase soil mineral N and grain N uptake in subsequent wheat crops. pp. 31- 41, Farmlink Research Report.

Nicholson C., Frischke A., Barrett-Lennard P. (2016) Grazing Cropped Land- A summary of the latest information on grazing winter crops from the Grain and Graze Program.

# 9 Appendix

## 9.1 Appendix 1: Costs & benefits in pasture cropping (over-sowing) to fill the winter feed gap

# Costs & Benefits in Pasture Cropping (Over-sowing) to Fill the Winter Feed Gap

Prepared By: Paul Deane, Farm Business Economist, Agriculture Victoria.
Bindi Hunter, Extension Officer, Agriculture Victoria.

Published Date: Dec 2017

**Problem:** Livestock grazing systems typically have a shortage of pasture feed in late winter. Some farms also have older perennial pastures (phalaris), where preferred pasture species are low in South West Victoria. Is there a short-term strategy that can help mitigate these problems?

**Solution:** Depending on the whole farm system, seasonal conditions and commodity prices, a farmer could implement a strategy of over-sowing a winter (oat) crop into older, less productive pastures. Once the pasture/crop is sown around May, livestock are removed until late winter where grazing occurs briefly (21 days). Livestock are removed again to avoid damage to the oat crop embryo ear and allow development for grain. The stubble is then available for grazing post-harvest.

**Question:** Is it profitable to over-sow oats into sub-optimal perennial pastures in South West Victoria and graze sheep or cattle over winter before harvesting for grain?

**Benefit Cost Analysis:**

The following example is based on a partial budget economic analysis and identifies the *additional* benefits and costs relative to the status quo (pasture grazed normally) from an MLA funded Enhanced Producer Demonstration Site (EPDS) in Western Victoria (2016 Trial 1 Coojar site). Further details are available in the MLA report "Pasture Cropping to Fill the Winter Feed Gap" by Bindi Hunter (Agriculture Victoria) and Tim Leeming (Paradoo Primary).

The main costs are: i/ sowing, fertilising, spraying and harvesting the oats crop; ii/ and the value of the lost livestock production from restricting access to the pasture/crop for most of the year. The main benefits are: i/ additional pasture availability and livestock grazing during late winter and post-harvest (stubble); ii/ and the value of grain production. The benefit cost presented is based on a one-year gross margin. The economic analysis does not look at changes to profits for the whole farm system or at any changes beyond the first year. Not quantified in this analysis is the performance of pasture over-sown with oats in the following year from lower grazing frequency (resting), greater weed control and potentially more mineral nitrogen available following the grazing of stubble[1].

**2016 Site 1 Results:**

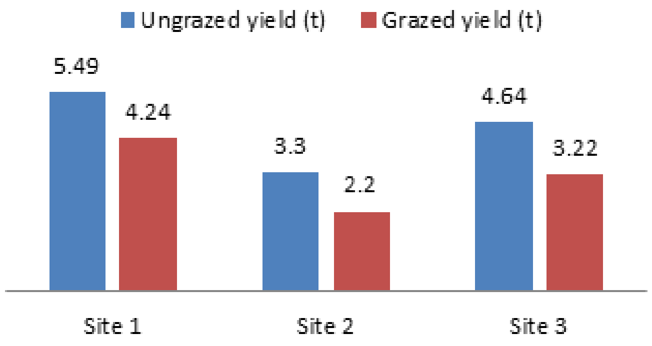
**2016 Trial: Harvested Oats Yield**

Benefit Cost Analysis compared to Pasture Grazing Only (baseline) – Year One Only.

| **Trial 1: Pasture Over-sown with Oats** | **Additional Benefits (Income)** | | | | **Additional Costs** | | | **Gross Margin** |
|---|---|---|---|---|---|---|---|---|
| | Additional Livestock Production | | Grain Production | Gross Income[#] | Lost Livestock Production | Crop Operating Expenses | Total Costs | |
| | Winter Grazing | Stubble Grazing | Yield x Oats Price | | Pasture Unavailable | Sowing & Harvesting | | compared to baseline |
| | $/ha | $/ha | $/ha | $/ha | $/ha | $/ha | | $/ha |
| 1a. Winter Grazing (21 days) | $230 | $95 | $510 | $860 | $520 | $305 | $825 | +$35 |
| 1b. No Winter Grazing (0 days) | $0 | $95 | $660 | $775 | $520 | $305 | $825 | -$50 |

Notes: Assumes no new capital requirements.

[#] Includes an amount "saved" by not applying maintenance fertiliser where crop is over-sown.

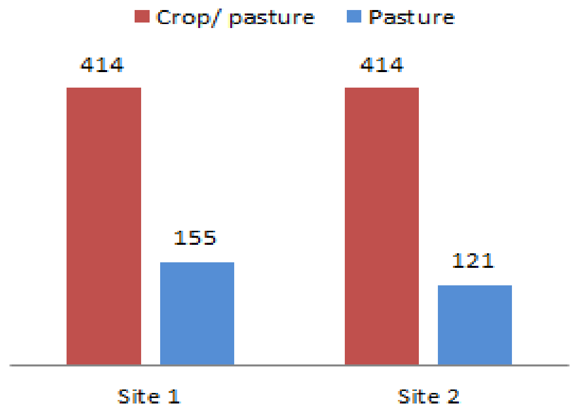


# Costs & Benefits in Pasture Cropping (Over-sowing) to Fill the Winter Feed Gap

**Benefit Cost Scenario Analysis:**

**2016 Lamb Growth Rates for 21 days Grazing**

**(g/day/hd)**




Site 1 (2016) Results 1a. Winter Grazing 21 days – Additional Gross Margin ($/ha) compared to Pasture Only (baseline).

| Price Oats (Farm Gate) | Weaker Lamb Prices | | | 5 Year Average | Stronger Lamb Prices | | |
|---|---|---|---|---|---|---|---|
| $/tonne | 3.25 $/kg cwt | 4.00 $/kg cwt | 4.75 $/kg cwt | 5.10 $/kg cwt | 5.50 $/kg cwt | 6.25 $/kg cwt | 7.00 $/kg cwt |
| 120 | +$145 | +$115 | +$85 | +$70 | +$55 | +$25 | -$5 |
| 140 | +$230 | +$200 | +$170 | +$155 | +$140 | +$110 | +$80 |
| 160 | +$315 | +$285 | +$255 | +$240 | +$225 | +$195 | +$165 |
| 180 | +$400 | +$370 | +$340 | +$325 | +$310 | +$280 | +$250 |

**Key Decision Drivers:**

1. Over-sowing pasture with oats and restricting livestock access for much of the year means the strategy is substituting animal production income for grain production. The absolute and relative prices of oats and lamb are key.

2. The better the pasture being over-sown and/or the higher the lamb price, the greater potential opportunity cost in pasture cropping and the greater likelihood the strategy will not be profitable. For example, when lamb prices rise, the opportunity cost increases from the foregone animal production from the pasture/crop being unavailable for much of the year. A higher relative oat price and/or yield is then needed to breakeven compared with the status quo (not changing).

3. Time and timing of when the pasture/crop is grazed is critical. Grazing too late can have larger yield penalties for the grain harvest. When lamb prices are high and grain prices low, the longer the pasture/crop can be grazed during winter the more profitable the strategy may be. Increasing the winter grazing period in trial one from 21 days to 28 days and achieving the same daily weight gain would have increased the *additional* gross margin to $110/ha.

4. Genetics and potential growth rates of livestock grazed is important. In trial one, if weaners had only achieved daily weight gains of 250g/day/hd for the 21 days, the pasture/crop grazing option economics fall to breakeven.

Crop establishment in pasture (Top); Crop in November with phalaris heads poking though (Middle); same site June, two years after cropping (Bottom).

5. Profitability may be higher if the benefits to winter grazing are of higher value than assumed in the trial. For example, in a farming system where winter grazing is utilised by twin-bearing ewes to achieve higher ewe lambing percentages and/or greater lamb survival[2] , the income benefits may be higher than grazing weaners.

References: [1]Hunt, J.R., et.al. (2016). 'Sheep grazing on crop residues increase soil mineral N and grain N uptake in subsequent wheat crops'. FarmLink 2016 Research Report.

## 9.2 Appendix 2: Chemical regime and establishment costs

### Chemical regime and establishment costs 2016

| Input | Timing | Rate | Cost/ha |
|---|---|---|---|
| Paraquat | Spray 1 (Oct) | 0.8L/ha | $ 5.50 |
| Spray seed 250 | Spray 2 (May) | 2L/ha | $ 22.00 |
| Diuron 900 DF | Spray 2 (May) | 0.3L/ha | $ 4.20 |
| Clincher plus | Spray 2 (May) | 0.75L/ha | $ 10.00 |
| Cutlass 500 | Spray 2 (May) | 0.16L/ha | $ 2.40 |
| Venom 100 EC | Spray 2 (May) | 0.1 L/ha | $ 1.50 |
| Strike Out 500 EC | Spray 2 (May) | 0.3L/HA | $ 3.00 |
| Glean | Spray 3 (July) | 20g/HA | $ 1.60 |
| Tigrex | Spray 3 (July) | 0.75L/ha | $ 11.25 |
| 3 spray operations | | $15/ha | $ 45.00 |
| MAP | | 100kg/ha | $ 75.00 |
| Gaucho seed coating | | 120 mL/100 kg of seed | $ 4.20 |
| Quoll oats | | 100kg/ha ($40/ha) | $ 40.00 |
| 1 pass- sowing | | $40/ha | $ 40.00 |
| 1 pass - harvest | | $40/ha | $ 40.00 |
| | | **Total Chem** | **$ 65.65** |
| | | **Total Seed** | **$ 40.00** |
| | | **fertiliser** | **$ 75.00** |
| | | **Operating** | **$ 125.00** |
| | | **Total** | **$ 305.65** |