final report

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SFS/BWBL – Dual-purpose crops

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Executive Summary

Dual purpose cropping is a tool for mixed enterprise producers. It provides livestock grazing opportunities when there are feed deficits and grain income. It allows producers to take two bites of the cherry but at what cost?

The aim of the project is to assist decision making of producers about the value of spring sown crops by proving the net benefits and risk evaluation (climate and waterlogging) for a range of different years, soil types and water management methods that are reliable, repeatable and representative of the High Rainfall Zone (HRZ) in Victoria. This project forms part of MLA's Producer Research Site (PRS) program that is part of the southern Feedbase Investment Plan and supports the MLA-funded project *B.GSM.0008, Step changes in meat production systems from dual-purpose crops in the feed-base*.

The project recorded the grazing benefit to a mixed farming system including the opportunity to generate feed in pastures over summer and at the autumn break, hence providing producers an increased carrying capacity of the whole farm system.

The dual purpose crop that was selected to be researched was spring sown winter habit canola. This opportunity crop can be planted in the HRZ in spring, crash grazed at least three times from December to May, then locked up and grown to produce grain. Winter habitat canola varieties can be used in this way as they require a cold vernalisation period for the plant to become reproductive to produce grain. The growing season for this crop is then increased to 15-18 months creating opportunities for grazing and grain.

This project found for optimum crop production the key requirements for spring sowing winter habit canola are the same for autumn sown canola; preparation, good paddock selection, supply of adequate nutrients after grazing and early sowing in mid Sept-Oct.

Once established it was very tough and could handle heavy grazing, although grazing should stop mid to end of May allowing the plants to recover enough biomass to optimise grain production. It produced a high quality feed source that can grow lambs for sale or to bring them up to weight to be joined and enabled producers to rest pastures and provide a green containment area over the summer/autumn period. For optimal production with the crash grazing method it would be advisable to have two paddocks to rotate the sheep in and out of or strip graze.

The feed value in this project averaged over all sites and seasons was $467/ha based on market replacement with feed barley. In the worst case scenario grazing spring sown canola decreased grain income by $175/ha and in the best case scenario it increased grain income by $158/ha when compared to non-grazed spring sown canola.

The main risk associated with this cropping system are related directly to the timing of rainfall events at key crop stages of establishment, grazing, winter and grain fill. Drainage of paddocks helped reduce waterlogging risks, but in extremely wet years like 2016 waterlogging still occurred and killed plants and reduced crop yields.

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

The group recommends that further research be done into dual purpose crops around better varieties that may cope better with waterlogging, regional set of rules around grazing timing and when to lock up the paddock for grain production and a better understanding of the plant phenology in regards to vernalisation triggers.

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1 Background

1.1 Southern Farming Systems (SFS) & Cavendish BestWool/BestLamb (BWBL)

Both the Hamilton branch of SFS and the Cavendish BWBL worked together on this project as the two groups had overlapping members with similar motivations. Fifteen farm businesses have been directly involved with the project covering 13,398ha and 96,540 head of sheep and cattle.

The wider Southern Farming Systems group has a membership base of 600 and has been active in the Hamilton region since 1996. It first pioneered the use of spring sown canola in 2012. SFS focuses on designing and creating profitable farming systems for the high rainfall zone.

The Cavendish Best Wool Best Lamb group has been active for several years with a focus on sheep production. Many south West Victorian producers run mixed enterprises of livestock and cropping.

By working together and utilising producers expertise it has allowed the PRS group to research how the livestock and cropping systems can be integrated to add value to one another.

1.2 Why dual purpose cropping?

The group was motivated to get involved with the participatory research program with this topic to increase **feed production**, in particular to extend the window of grazing over summer (spring sown canola) and to address the autumn / winter feed deficit, both directly by using the crop but also so pastures can be spelled to build a feed wedge at the start of autumn.

This additional feed would reduce supplementary feeding and/or allow for manipulation of stocking rates so they can better utilise excess feed at different times of the year e.g. higher stocking rate for the spring flush. However the value of that feed would vary for each producer, depending on the type of farming system they operate.

The producers believe grazing dual purpose crops could become common practice in their farming system. It provided an opportunity worth exploring and there were many knowledge and confidence gaps that needed addressing. These knowledge gaps were around establishing the 'value' of the grazing component compared to other choices. Producers wanted to understand the trade-off between using the feed for livestock production or keeping it for grain. This is because the value of the Dry Matter (DM) varies throughout the year and the trade-off will depend on relative prices of grain and meat, their enterprise goals, how busy they are and what is sacrificed or gained to spring sow canola.

The type of questions and issues producers had with spring sown winter habit canola were:

- Seasonal variation/risk in relation to waterlogging and dry spring sowing.
- Where does it fit in the farm rotation/system?
- Could it be better to establish canola in the spring compared to the autumn? (especially focussed on the slug issues in the Autumn)
- Will grazing open up opportunities for more weeds?
- What are the fertiliser / nutritional requirements (and potential nutrient transfer) given the crop is growing for a longer period of time and involves grazing?

- Do we have enough mouths to graze the crop evenly if the season is favourable and we also have ample pasture feed? If we graze crops in a good year, do the pastures get out of hand?
- What are the potential issues with chemical residues e.g. withholding periods, plant back periods, minimum slaughter intervals etc.?
- Will there be pest and weed issues that carry over from the previous pasture phase that we should be aware of?
- How to assess if the crops are safe to graze.
- Assessing if the feed on offer is balanced so the animals will perform (i.e. not overloaded with protein or energy, low fibre, nitrate etc.)
- Formulating the appropriate nitrogen and weed strategies when growing a crop for 15 to 18 months, especially the nitrogen requirement in spring sown canola.
- Assessing when and how hard to graze a crop before grain yield loss occurs.
- Designing equipment that would allow spring sowing of canola into existing crops.

1.3 Producer management prior to the research

The main ways producers filled the summer autumn feed gap prior to the research trial was by:

- supplementing livestock
- grazing crop stubbles
- use of feedlots
- growing summer fodder crops or lucerne
- destocking to reduce demand.

If the season allowed some producers did graze their early autumn sown crops, but found this difficult in managing when to stop grazing and found it penalised their yields.

2 Project Objectives

This project forms part of MLA's Producer Research Site program that is part of the southern Feedbase Investment Plan and supports the MLA-funded project *B.GSM.0008, Step changes in meat production systems from dual-purpose crops in the feed-base*.

The project objectives were to:

1. Determine the net benefits (the total benefits minus the total costs) of spring sown canola or cereals compared to a perennial pasture livestock system across:

- At least 4 sites with 2 on basalt soils and 2 on red gum soils in each year
- Multiple years of observation starting in January 2014 and finishing in December 2016 with a 15-16 month growing season from October to December.
- Multiple water management options including subsurface drainage, raised beds surface drains and no drainage.

2. Determine the risk of growing spring sown crops in south-western Victoria.

3 Methodology

3.1 Research sites and treatments

The group sourced sites from producers who were willing to plant spring sown winter habit canola on basalt and red gum soil types with or without drainage and supply a production pasture paddock for monitoring. Entire paddocks were used as a research site.

The pasture paddocks were used to show what would normally be available to livestock at the same time and to determine if a feed wedge can be built in the system from resting the pasture paddock whilst the stock are grazing on the canola; allowing both paddocks to produce at their optimum. Each producer had their own way of managing the crop that fitted in with their system. The risk they chose to take on was their own decision.

Over the course of the 3 year project there were a total of 9 producer sites that provided a canola paddock and a comparison pasture paddock totalling 18 paddock sites. The sites listed with same number are the same producer, but different paddocks on their property. See Table 1 and 2 for basic details of the sites.

In the first year the group had a full complement of sites, two on Basalt soil type, drained and undrained and two on Red gum soil type, drained and undrained. In year two the group could only source 3 sites, two on basalt soil types and one on red gum soil type all undrained due to the 'risk' associated with sowing in a dry spring (Decile 1). See Fig. 2 for deciles for Western Victoria. The group again faced the same issue in sourcing sites in Year 3 with Western Victoria experiencing a Decile 2 winter which transitioned into a Decile 1 spring. The group established only two sites, both on red gum soil type, one drained and the other undrained. Having fewer sites enabled group co-ordinator Michelle McClure, SFS and Laura Garland, AgVic to provide extra assistance to the producers when collecting the livestock data.

Producers sowed the canola crop to their own specifications and kept records of all treatments, including in crop fertilizer and herbicide applications, grazing periods, livestock performance and crop yields.

The project ran over a range of seasons (see Fig 2). In a snapshot:

2014 – Decile 2 year. After a reasonable start to the season, it was a tight finish to fill grain before moisture ran out (decile 1 August, September and October).

2015 – Decile 1 year. After a reasonable start to the season, it was another tight finish (decile 1 August, September and October).

2016 – Decile 9 year. The break came late with most of April being very dry. The rest of the year was wet (decile 9), waterlogging was common.

Fig 1 Site 4, 29 May 2014 Lambs at the start of the final 3rd grazing period.

Table 1 Canola research paddock information from 2014 to 2016

Year	Site	Location	Soil Type	Drainage	Growing Season Rainfall (mm) Sept - Dec (16 months)	Rainfall Data Source	Crop Type & Variety	Sowing Date
2014	1a	Cavendish	Basalt	Raised Beds	665	BOM Cavendish	Canola - Hyola 971	27/10/2013
2014	2	Lake Linlithgow	Basalt	None	791	BOM Dunkeld	Canola - SF Brazzil	2/11/2013
2014	3	Gatum	Red gum	None	665	BOM Cavendish	Canola - Hyola 971	7/11/2013
2014	4	Mirranatwa	Red gum	Raised Beds	739	BOM Mirranatwa	Canola - Hyola 971	7/11/2013
2015	1b	Tarrington	Basalt	None	559	BOM Hamilton	Canola - Hyola 971	1/10/2014
2015	2	Lake Linlithgow	Basalt	None	614	BOM Dunkeld	Canola & Lucerne mix - CB Taurus & Lucerne 20%	1/11/2014
2015	3	Gatum	Red gum	None	522	BOM Cavendish	Canola- Hyola 971	7/10/2014
2016	1c	Gatum	Red gum	Sub Surface Drains 25m apart	905	BOM Cavendish	Canola - SF Edimax CL	23/09/2015
2016	3	Gatum	Red gum	None	905	BOM Cavendish	Canola - SF Edimax CL	16/09/2015

Table 2 Pasture research paddock information from 2014 to 2016

Year	Site	Location	Soil Type	Drainage	Growing Season Rainfall (mm) Sept - Dec (16 months)	RF Data Source	Crop Type & Variety	Sowing Date
2014	1a	Cavendish	Basalt	None	664.7	BOM Cavendish	Pasture - Sub clover, Ryegrass & Phalaris	2010
2014	2	Lake Linlithgow	Basalt	None	791	BOM Dunkeld	Pasture - Phalaris & Tall Fescue	2010
2014	3	Gatum	Red gum	None	664.7	BOM Cavendish	Pasture - Ryegrass & Clover	old pasture 10-15yo
2014	4	Mirranatwa	Red gum	None	739.2	BOM Mirranatwa	Pasture - Phalaris & Sub clover mix	2009
2015	1b	Tarrington	Basalt	None	559.2	BOM Hamilton	Pasture - Perennial pasture Phalaris dominant	Unknown
2015	2	Lake Linlithgow	Basalt	None	614	BOM Dunkeld	Pasture - Holdfast/Australian Phalaris: Resolute/Quantum Fescue	2013
2015	3	Gatum	Red gum	None	521.8	BOM Cavendish	Pasture - Ryegrass & Clover	old pasture 10-15yo
2016	1c	Gatum	Red gum	None	905.1	BOM Cavendish	Pasture - Phalaris, Clover and Plantain	2014
2016	3	Gatum	Red gum	None	905.1	BOM Cavendish	Pasture - Phalaris & Ryegrass	Unknown

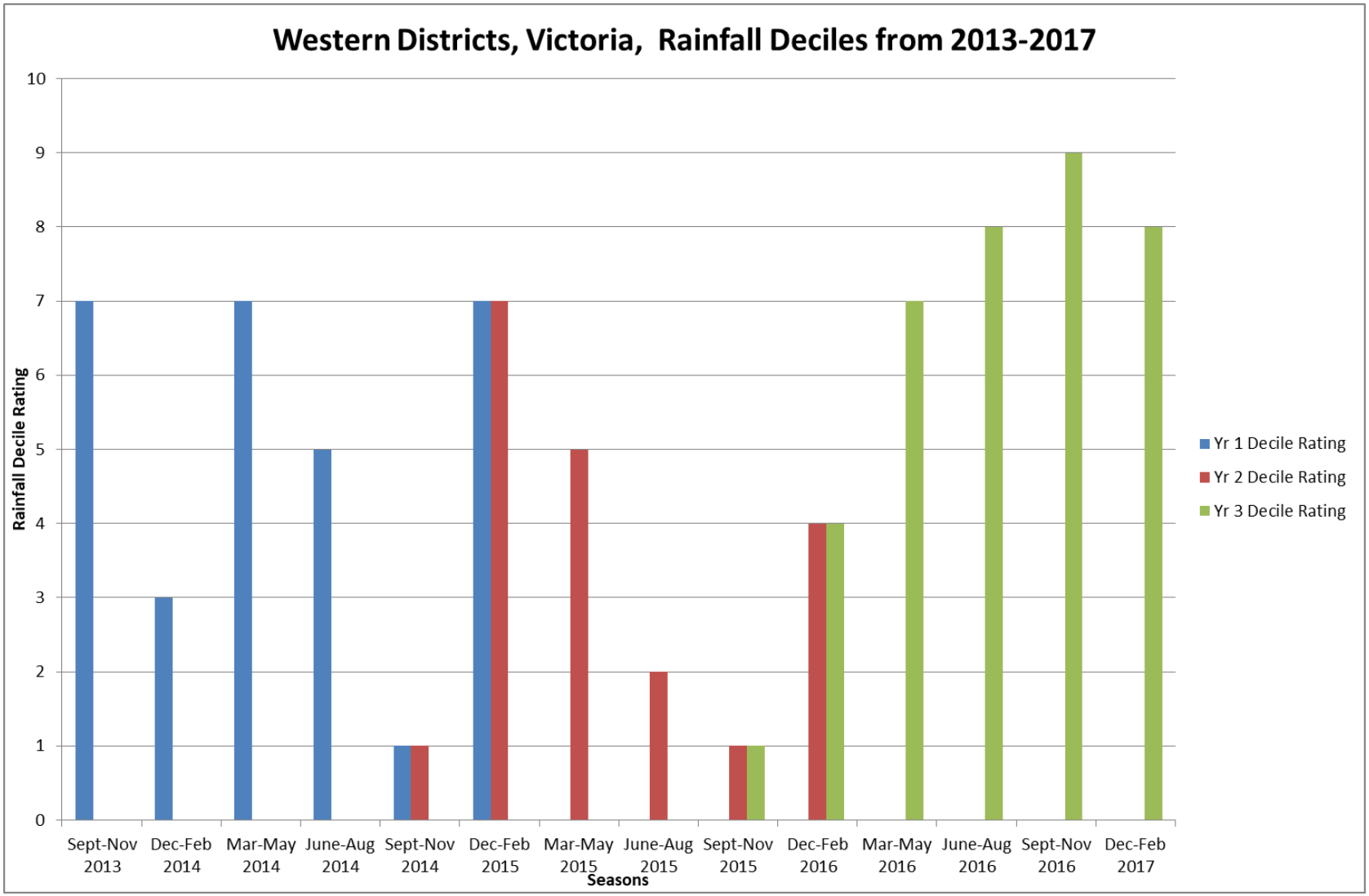

Fig.2 Victorian Western Districts, Rainfall Deciles from 2013-2017

3.2 Monitoring

3.2.1 Site characterisation

Site characterisation and soil tests (0-10cm) were completed at each site and is available in the minimum dataset Meta data file.

3.2.2 Dry matter yield and plant counts

In the canola crop, 10 measuring plots (2m x 5m) Fig 3 were randomly placed throughout the paddock. Dry matter (DM) yield cuts and plant establishment counts were taken at the start of each grazing period (1, 2 and 3). Tissue samples were taken and tested for nitrates to ensure it was safe for stock to graze following sowing (12 to 15 weeks). A feed test was taken to evaluate the nutritional value of the feed.

In the comparison pasture paddock, 6 measuring plots (2m x 5m) Fig 4 were randomly placed throughout them. On the first visit, DM yields and feed test samples were taken. On each subsequent visit, DM yields were again collected, however, if there was not enough growth to collect a DM sample this was estimated using pasture height measurements and converted to biomass.

Fig 3 Site 1a Canola measuring plot

Fig 4 Site 1a Pasture measuring plot

3.2.3 Livestock monitoring

Livestock monitoring was done by the producers except for Site 1c in the final year, which was completed by Michelle McClure and Laura Garland.

Livestock performance was monitored in the canola paddock according to Lifetime Ewe Management (LTEM) methodologies where a sample of lambs were weighed and condition scored by the producer before they entered the canola paddock and again when they left the paddock.

In the pasture paddock the producer kept the records of all livestock movements in and out of the pasture from this time forward until the end of the Canola Grazing period when it was locked up for grain.

3.2.4 Winter monitoring

After the last grazing and winter, plant counts were done and the monitoring plot pegs removed and Deep Nitrogen soil samples taken.

3.2.5 Canola crop harvest

In year one the producer's harvested measured out crop areas with large scale farm machinery and weighed the grain yield with a weigh trailer.

In year two in an attempt to get better harvest data the group decided to hand harvest 6 random 1 m² plots per canola paddock and compare to the producer collected the whole paddock yield. There were some discrepancies in the two sets of yield data and the representation and randomness of individual plots questioned as it is very difficult to physically move through a full grown canola crop to collect hand harvests. Hence this data has been omitted from this report, but is available in the meta data file.

In year three we concluded that the farmer collected yield was the most accurate and the producer harvested the paddock and recorded the yield.

At harvesting canola seed was collected and quality tested.

3.3 Economic and risk considerations of spring sown canola

The economic analysis has been compiled by Zoe Creelman, SFS Research and Extension Officer with input from the group. The group found when compiling the economics that it was very hard to do a whole farm system economics and it was near impossible to compare sites as each site had a different farming system. Whilst the crop component could be valued relatively easily through yield, the grazing component consisted of many small benefits which need to be considered collectively.

Risk analysis was also carried out using @risk software which used Monte Carlo simulations to show possible outcomes from the group's spreadsheet model and told you how likely they were to occur.

3.4 Extension and communication

The SFS/BWBL group had their first project meeting in December 2013 to discuss the project topic and to seek agreement with AgVic researcher (Maggie Raeside) on participatory R&D activities, what research questions were to be investigated, and plan how the project might proceed.

Annual review meetings with the researchers and producers, focussing on the progress of the project, were held in 2015, 2016 and 2017.

Wider communication of results occurred through:

- at least one crop walk each year involving visiting one or two PRS sites to get an update on the progress of the project and what the research was indicating. These crop walks also provided feedback on the direction of the project.

- Agrifocus – is Southern Farming Systems annual October field days and a poster on the project was displayed 2014, 2015 and 2016 with Michelle McClure available to discuss the project with producers.
- Hamilton Sheepvention August– Southern Farming Systems exhibit each year at Sheepvention a poster display on the project and Michelle McClure was there to discuss with producers the project results to date.
- Media articles were written each year and published in the local media and Stock and Land.
- The project featured in each Southern Farming Systems hard copy newsletter that is posted to all SFS members.
- Southern Farming Systems annually publishes a trial results book and this project featured in 2014, 2015 and 2016 editions. This assisted the group to interpret and evaluate the results each year.

Fig 6 Crop Walk 8-10-2014 Site 1 a.

4 Results

4.1 Canola and pasture results

4.1.1 Crop plant establishment and plant numbers after grazing

The crop plant establishment numbers affect all crop outputs from dry matter production to grain yield. Table 3 shows a summary of the plant numbers at crop establishment and after the end of grazing and winter looking at the median plant numbers for each season and all 3 seasons. The crop variety, sowing rate and fertilizer regimes have all been included as they also affect crop performance.

The average plant loss over the 9 sites and 3 years was 25%.

Table 3 Median canola plant establishment and loss at each research site

Year	Site	Sowing Date	Variety	Rate kg/ha	Fertilizer at Sowing	Other Fertilizer Applications	Median Plants/m²		Average Plant Loss %
							Start of Grazing	End of Grazing	
	1a	27/10/2013	Hyola 971	3.25	100 kg/ha MAP	70 kg/ha Urea & Blend 170kg/ha N28:S6:K12	53	35	33
	2	2/11/2013	SF Brazzil	3	70 kg/ha MAP	150 kg/ha Urea	34	19	44
	3	7/11/2013	Hyola 971	3.2	80 kg/ha MAP	225 kg/ha Urea & 80 kg/ha SOA	14	16	#0
2014	4	7/11/2013	Hyola 971	3	140kg/ha 70:30 MAP:SOP	100 kg/ha MAP/SOP/S/CU/Zn & 120 kg/ha Urea	28	19	31
						Season Median	31	19	32
	1b	1/10/2014	Hyola 971	4	50kg/ha MAP	110 kg/ha Urea & 140 kg/ha SOA1:2Urea Blend	31	20	37
	2	1/11/2014	CB Taurus	6	120kg/ha MAP	90 kg/ha Urea	11	9	20
2015	3	7/10/2014	Hyola 971	3.5	30kg/ha MAP	50 kg/ha Potash & 60kg/ha Urea & 40kg/ha SOA	10	12	#0
						Season Median	11	12	20
	1c	23/09/2015	Canola	2.2	None	50 kg/ha MOP, 260kg/ha Urea	10	8	25
2016	3	16/09/2015	Canola	2.7	Shallow	100 kg/ha Urea	6	5	17
						Season Median	8	6	21
						All Seasons Median	14	16	25

Please note error in count due to plant branching & re-sown bare patches

4.1.2 Canola crop grazing

The canola crop was heavily crash grazed at each grazing. Some producers fed supplementation whilst grazing the canola as their lamb's rumens had adjusted to the supplement and producers wanted to maintain this in case they needed to return to it. Sites where supplementation was used is marked in Fig 8. Fig 7 shows a summary of the average DSE/ha over the grazing period for each site, the cumulative amount of grazing days of each grazing period and the total FOO DM kg/ha measured at the start of each grazing from our measuring plots.

Four of the nine sites only had two grazings.

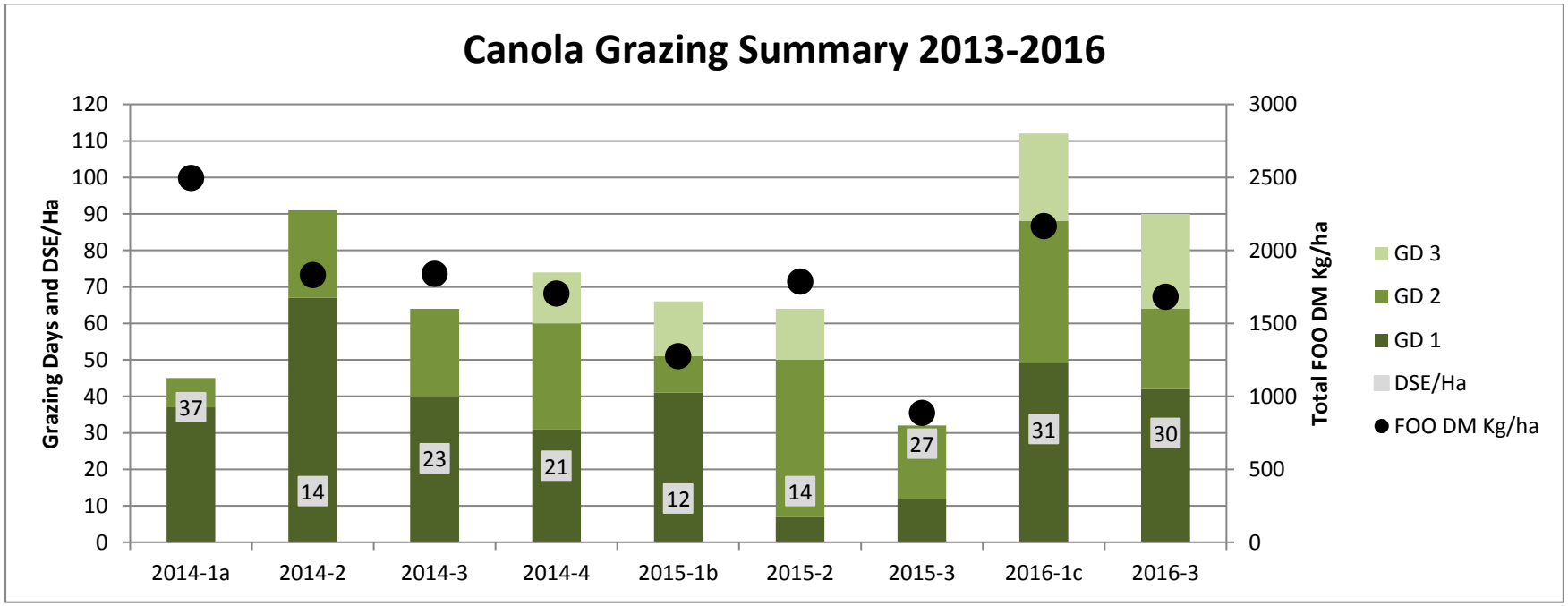

Fig 7 The total number of grazing days on the Canola at an averaged DSE/ha and the total amount of DM measured in plots.

Fig 8 shows the daily growth rates of the livestock on the canola for each grazing period. There were some rumen adjustment issues to canola reported at 2 sites (sites 2014-2 and 2016-1c 2nd grazing). Only one site (2014-3) recorded a weight gain decline. The average weight gain was 150 g/day. The average

grazing days was 69 days across all the sites and years. The weight gains at site 2014-1a with maiden ewes enabled weight gains so that the ewe weaners could be joined early. Livestock data wasn't collected for sites 2014-4 1st grazing as it had happened before the project had started, 2015-1b 2nd and 3rd grazing due to timing of grazing and other farm practices and 2015-3 all grazings due to the tight season and poor crop establishment at site 3.

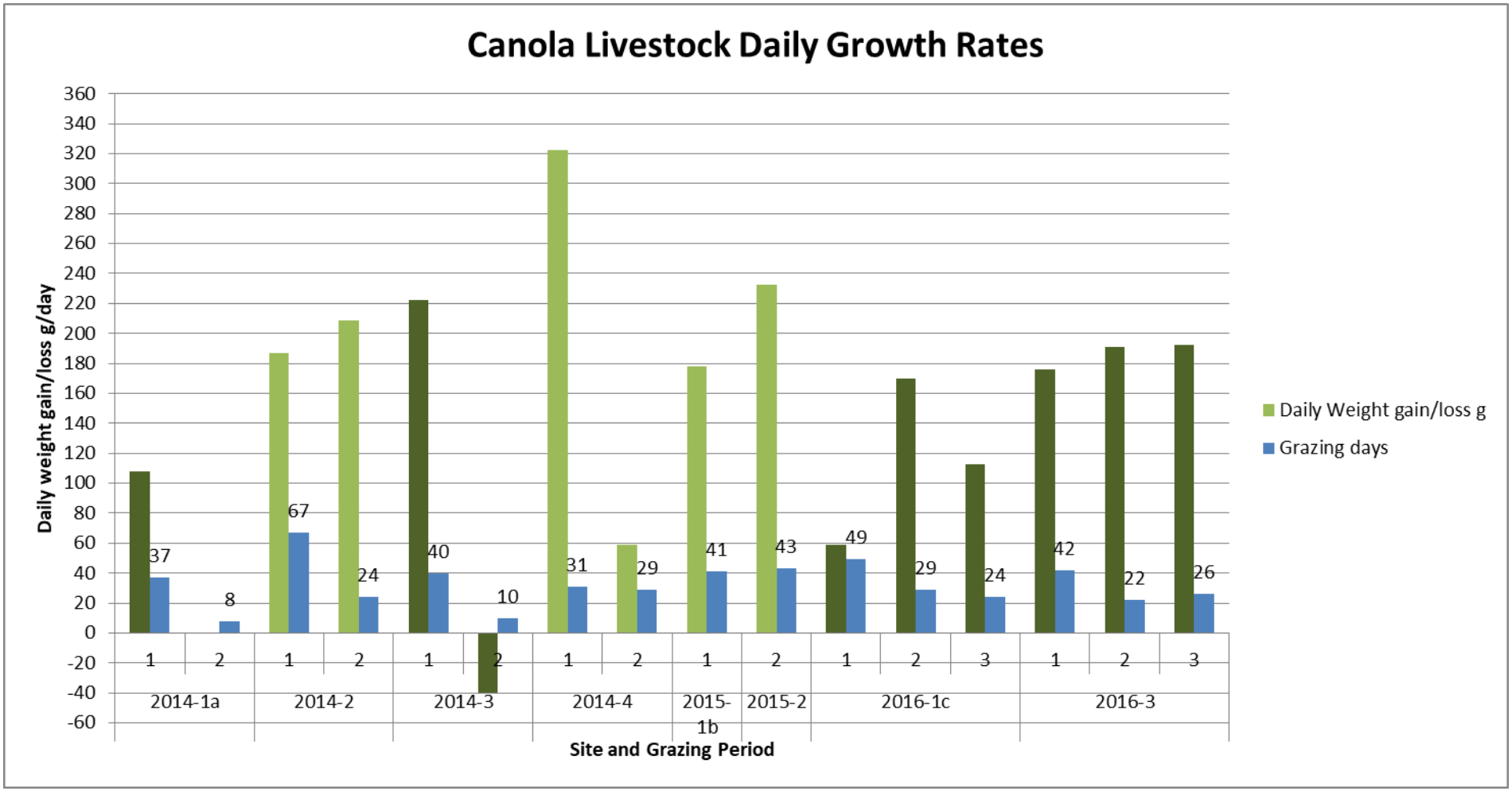

Fig 8 Daily growth rate of the livestock on the canola and the number of days for each grazing period. The dark green bars represent the growth rates that had additional supplementation.

Table 4 shows the livestock condition scores at the start and end of each grazing. In Merino lambs the change in condition score ranged from 0 to 1 at four sites. In crossbred lambs the condition score change ranged from 0 to 0.5.

Table 4 Sheep condition scores at the start and end of each grazing period on the canola and the change in their condition.

Site	Grazing	Grazing days	Stocking Rate	Livestock Type	Condition Scores			Feed Supplementation
					Start	End	Change	
2014-1a	1	37	37	Maiden Ewes	3	3.5	0.5	1.5kg/hd/week Barley for 4 weeks (19/1-15/2)
	2	8	37	Maiden Ewes	3.5	3.5	0	3kg/hd/week Barley
2014-2	1	67	18	1st Cross Prime Lambs	2.9	3	0.1	
	2	24	9	1st Cross Prime Lambs	3	3	0	
	2	29	30	1st Cross Lambs	2.7	2.7	0	
2015-1b	1	41	15	Merino Lambs	3	4	1	
2015-2	2	43	16	Dorset Dohne Cross Lambs	3	3.5	0.5	
2016-1c	1	49	22	Merino Lambs	2.7	2.8	0.1	610g/hd/week Barley & ad- lib Straw
	2	29	21	Merino Lambs	2.7	2.8	0.1	1.22kg/hd/week Barley & ad-lib Straw
	3	24	31	Merino Lambs	2.8	2.8	0	1.22kg/hd/week Barley & ad-lib Straw
				Averages	2.63	2.81	0.18	

4.1.3 Pasture grazing and quality

The pasture was monitored at the same time as the canola crop grazing periods. Fig 9 shows the average stocking rate over the measuring period, the amount of grazing days and the FOO DM kg/ha measured from plots at the start of each canola grazing period. Most of the time there wasn't enough

regrowth in the pasture to cut and so height was measured. All of the livestock in the pasture paddocks were supplementary fed. Site 2015 – 1b wasn't grazed and rested for the whole period hence there was no data collected.

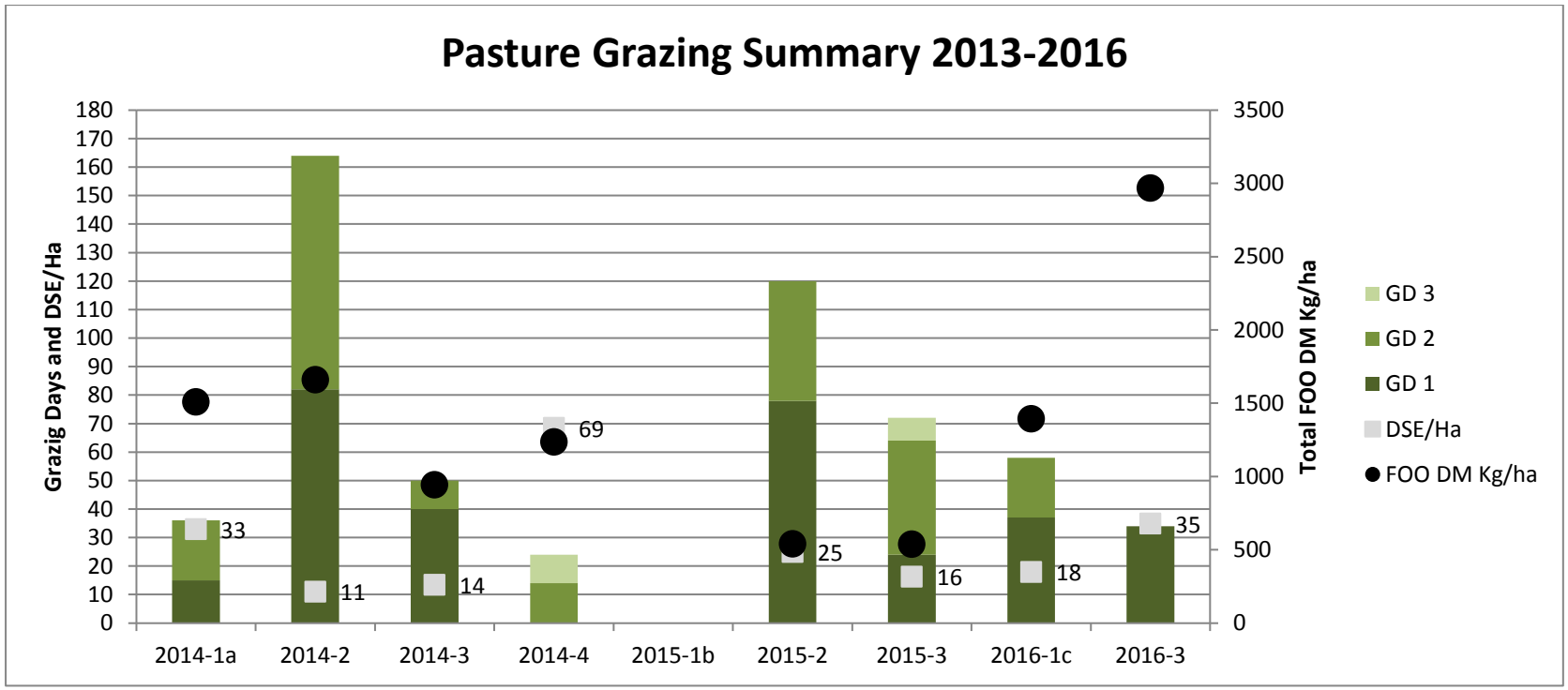

Fig 9 The total number of grazing days, average DSE/ha and total amount of measured DM on the pasture monitoring paddock during the same period as canola grazing.

Table 5 shows the quality of feed measured through feed testing at the start of the project at each site (December or January) for both the canola and comparison pasture paddock. The energy content of canola was about double that of the pasture and the crude protein was triple. The majority of pastures were low quality during grazing and the animals required supplementary feeding.

Table 5 The quality of feed on offer in both the canola and pasture sites.

	Canola		Pasture	
Site	**ME MJ/kg/DM**	**Crude Protein % DM**	**ME MJ/kg/DM**	**Crude Protein % DM**
2014-1a	14.1	15.3	10.2	14.2
2014-2	13.4	23.2	5.3	3.7
2014-3	12.7	27.7	7	7.1
2014-4	14.2	19.4	0	0
2015-1b	13.6	13.9	7.6	8.9
2015-2	13.9	25.3	0	0
2015-3	11.7	11.8	5.9	8.3
2016-1c	14.7	19.6	8.6	8.2
2016-3	13.6	19.5	6.7	5.4
Average	13.5	19.5	5.7	6.2

4.1.4 Canola crop yields

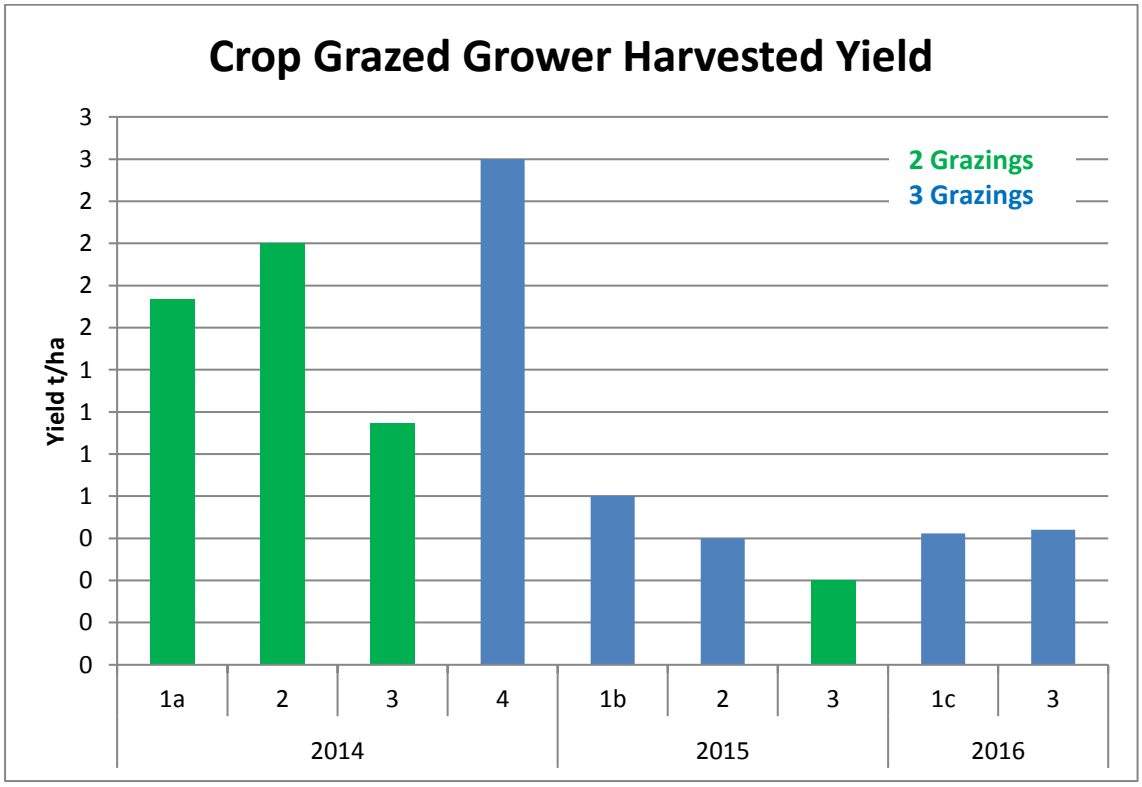

Fig 10 Grower recorded crop Yields (t/ha) at each canola site.

The crop yields were measured by the grower using large scale farm equipment. Some producers did windrow their crop before harvest and some direct harvested their crop. Crop yields ranged from 0.5t/ha to 3.0t/ha. As a general observation, in 2014, crop yields were comparable to producer's autumn sown crops. In 2015 and 2016 the yields were less than the Autumn sown counter parts due to poor establishment and its' inability to tolerate waterlogging.

4.1.5 Grazing canola risks

Aside from the usual yield risks of growing canola such as waterlogging, shattering and disease (all of which were issues in the years the project ran), there were two risks specific to dual purpose canola.

Sowing in spring rather than autumn. There was almost the same chance of grain yield increasing as decreasing with spring sowing. The risk is that the ***range*** of potential yields is greater, not so much that yields will decrease, shown in Fig 11 the red curve being wide and flat. This shows that this is the riskier of the two decisions in that there is a large spread in the potential changes to grain income.

Grazing crop. Grazing canola causes both a decline in plant number and increase in plant branching. The deceased plant number reduces yield potential, while branching increases potential. The blue curve Fig 11 shows grain income decreased 57% of the time with grazing. This suggests the plant loss has more of an affect than the canopy branching. The change from grazing crop impacted grain income to a lesser extent than spring sowing in that the range of change was less. The risk with grazing crops was that there was a greater chance of grain income decreasing than increasing.

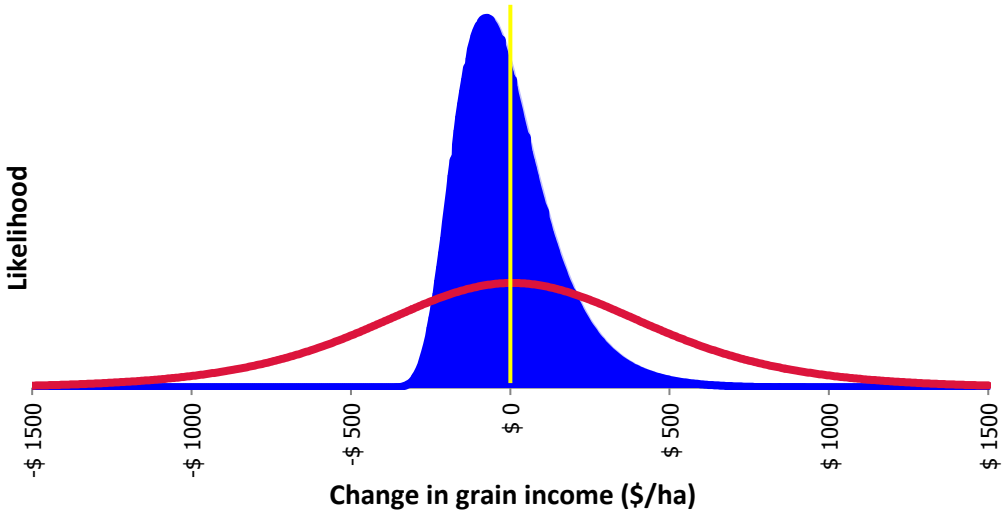

Fig 11. Likelihood of change to canola grain income if it were sown in spring rather than autumn (red line), or sown in spring and grazed rather than leaving it ungrazed (blue line). The vertical axis shows the likelihood or probability of a certain change in grain income (horizontal axis).

4.2 Extension and communication

A summary of communication activities is shown in Table 6 and 7. There were 5 producer group workshops and 17 field days/farm walks and seminars activities were carried out involving 380 people. Materials produced included poster displays at 5 events, 16 newspaper articles/trial results reports and 2 factsheets.

Table 6 Extension days and participants.

Date	**Event/ Activity**	**No of people**
16 December 2013	Project planning initial meeting	16
21 February 2014	Summer Crop walk	11
June 2014	Meeting: Presentation of photos to Cavendish BWBL group	20
8 October 2014	Dual purpose crop walk	24
15 & 16 Oct 2014	Agrifocus talk, Agrifocus poster display	15
16 March 2015	SFS/BWBL MLA Annual Review Meeting	11
2015	Paul Mibus in Friday Feedback	
17 June 2015	BWBL meetings where project update is given	21
24 August 2015 & 15 October 2015	BWBL meetings where project update is given	29
10 August 2015	Project Committee meeting	6
7 October 2015	SFS Hamilton Branch Spring Crop Walk	
1 July 2016	Annual review/field day April 7, 2016	15
7 April 16	Crop Walk and Annual review	16
June 2016	National MLA PRS Workshop, Attwood	65
25 January 17	Extension extraction meeting 25/1/2017	7
June 15 2017	SFS/BWBL MLA Annual Review Meeting	12
September 2017	GSSA annual conference presentation & paper	120

Table 7. Extension materials produced in the project

Date	Type of extension material	Circulation
8 March 2014	Hamilton Spectator News article, Southern Farming Systems crop walk spreads ideas, p31	6390
March 2014	SFS Bi-annual Newsletter	600
June 2014	SFS Weekly Update article	600
August 2014	Sheepvention - Poster display	100
October 2014	Warrnambool Standard news article (AgVic)	1500
2014	Factsheet snapshot. For MLA website.	5000
Jan-2015	SFS Newsletter Biannual Summer	600
March 2015	SFS 2015 Trial Results book article	600
1 June 2015	SFS Newsletter Biannual Winter	600
2015	Paul Mibus in Friday Feedback	
13 June 2015	Hamilton Spectator article	6390
August 2015	Sheepvention Poster of Results on display	
14 August 2015	MLA Friday Feedback E newsletter	
26 September 2015	Pre Spring Crop Walk Media, Hamilton Spectator	6390
14 & 15 October 2015	SFS Agrifocus poster display	300
March 2016	SFS 2015 Trial Results book article	600
January 2016	Summer SFS newsletter Jan 2016	600
26 May 2016	Stock and Land Article - After Harvest May 2016	
12 & 13 October 2016	Agrifocus poster display, October 2016	
1 & 2 August 2016	Sheepvention poster display	
May 2017	SFS 2016 Trial Results book article	600
June 2017	Stock and Land Article, Dual purpose crops – What happens when the season goes from drought to waterlogging?	

5 Discussion

5.1 Outcomes in achieving objectives

Sowing canola in late spring/summer is another option for filling the summer autumn feed gap. Spring sown canola is typically sown in October/November; before the commencement of harvest in the high rainfall zone. This atypical operation timing means it either fits as an opportunistic management option, or a new enterprise which has a new set of opportunities and risks.

The aim of the project was to assist decision making of producers about the value of spring sown crops by proving the net benefits and risk evaluation (climate, weed invasion, soil structure decline, nutrient transfers) for a range of different years, soil types and water management that are reliable, repeatable and representative of the HRZ in Victoria.

The project recorded the grazing benefit to a mixed farming system including the opportunity to generate feed over summer and at the autumn break, hence providing producers an increased carrying capacity of the whole farm system.

5.1.1 Risks

Spring sown canola has such a long growing period of 15-18 months which makes it highly susceptible to the season and looking at Fig 2 with the rainfall deciles for the entire project grouped into the seasons, explains how this crop performed from establishment in Sept-Nov, grazing Dec-May, potential waterlogging June-Sept, to grain fill Sept-Oct and ultimately grain harvest. With the majority of the 'risk' factor associated with climate and timing of rainfall events.

Waterlogging is a large risk for growing canola in the HRZ which can be reduced through paddock selection or the use of drains or raised beds. Initially the group thought that spring sown canola should tolerate waterlogging better as the plants would be well established and even hoped that it might even dry out the soil profile reducing the risk of waterlogging. The group had been keen to evaluate the use of canola with and without drainage to see if spring sown canola was a less risky option than autumn sown canola.

In 2016, rainfall peaked to decile 9 in Sept-Nov and paddock 2016-1c where there was subsurface drainage every 25m apart, waterlogging occurred between the drains and the spring sown plants died. Canola whether sown in spring or autumn does not tolerate waterlogging.

It was thought that the large root system of spring sown canola may be more susceptible to waterlogging than the smaller root system of autumn sown canola plants as they tend to have their majority of roots growing above the saturated soil layer. Waterlogging tolerances may also occur between spring and autumn types although is a less likely factor.

Another perceived risk was whether grazing would lead to more weeds which was not the case. Where there was high plant density numbers the canola was observed to supress the weeds. Grazing didn't increase the weeds as they were also eaten when crash grazed. Through this project

most producers selected Clearfield Canola varieties to allow them more herbicide options to spray weeds. Producers also did a winter spray after the last grazing, during the drier winters which meant paddocks were trafficable.

Sowing in spring was considered to be a riskier than sowing in autumn as the newly sown plants have to establish quickly to survive hotter and drier conditions. Plant establishment has been a big issue for this crop as it has been directly associated with the season. The first year of establishment Table 3 was within the recommended plant density range for canola grain production of 30-40 plants/m² where the Western Districts experienced a good winter and then a Decile 7 average spring (Fig. 2). The other 2 years of the project weren't so lucky experiencing a Decile 1 spring at establishment, reducing plant numbers by 80% in Year 2 and by 83% in Year 3 in comparison to Year 1 (see Fig 12).

In 2014, site 3 had poorer establishment than other sites. This was thought to be due to low moisture at sowing. Crop establishment had followed a hay crop without time for a fallow period to build up moisture. This led to the group recommending to sow into surface moisture in spring where the soil forms a bolus in top 5 cm.

Analysis of risk modelling showed that the decision to sow in spring is riskier than sowing in autumn as it caused a large spread in the potential changes to grain income.

Fig 12. Canola measuring plots over the 3 years (Sites 1a, 1b, 1c) showing the decreasing plant numbers at establishment.

5.1.2 Benefits/costs of spring sown canola

Over the 3 seasons at all sites the average measured FOO over summer/autumn and early winter was 1.7 t/ha of Dry Matter with an average energy content of 13.6 MJ ME/kg DM. In comparison, the perennial pasture at the same time of year contained 6.8 MJ ME/kg DM. If energy in the canola crop had been bought in as feed barley, the value of the canola crop for feed would be $467 per hectare[1] across the trial sites ranging from $201 to $616 per hectare.

[1] Calculated as feed barley having 12 MJ ME/kg DM, with a historic average price of $225/t and some wastage is taken into consideration

However, 1.7 t/ha of DM given animal production likely underestimates what the crop produced. In hindsight the trial protocol was flawed and didn't take into consideration the behavior of sheep which selectively grazed and bared out measuring plots as they tried to regrow. A more accurate FOO was tried to be estimating using animal weight gains, but the results were too inconsistent to include in this report. The grazing days and the DSE/ha for the grazing period are more trustworthy figures which represent production.

Five out of the nine sites had 3 grazing periods with the first grazing being the longest grazing. The total average grazing days of all sites was 69 days, nearly 10 weeks from late Dec-May, with an average of 23 DSE/ha. This is equivalent to 777 merino lambs or 480 cross bred lambs on a 27 ha paddock. Canola proved to be a very useful feed source when compared to the pasture based sources available at the same time.

An alternative to carry lambs through summer with supplementary feed is to sell them earlier in the season when they are lighter and before feed is limiting. One producer estimated that in 2014 he received an additional $30 per head for each of his lambs by carrying them over the summer and turning them off heavier. For the total mob, this equated to a difference of $7,110.

The feed quality of the canola was extremely high with the ME ranging from 11.7 to14.7 MJ/kgDM and crude protein of 11.8 to 27.7% (see table 5). This quality coupled with feed availability produced good live weight gains. Live weight gain during grazing of spring sown canola is a key reported advantage. In the current study, animal weight change ranged from -40 g per day[2] to 323 g per day, but mostly sat around 150 g per day. The weight gains[3] were valued between $346 and $55 (average $106) per hectare.

There were minor issues of scouring occurring on 2 of the 9 sites, this may have been caused by the Low Neutral Detergent Fibre % (NDF) around 20-22% at these sites; other sites had higher NDF's. Like all green feed sources at this time of year there needs to be ad-lib good quality roughage available and allowances made for rumen adjustment. Eight out of the nine sites had to allow for the livestock to readjust to the green feed in each grazing period. It was only at Site 1a in the first year that the lambs went from the canola to a paddock of plantain; hence the lambs were going from one green feed source to another.

The grazing component of canola has varied across sites and years and is summarized in Fig 7. The canola crop produced some interesting outcomes especially site 2016 - 1c which produced FOO dry matter levels comparable to those produced in 2014. This site achieved the most grazing days with a total of 112 (16 weeks) at 31 DSE/ha over 3 grazing periods with a plant density of only 10 plants/m². This was in comparison to site 2014 - 1a producing FOO of 2500 DM kg/ha with a plant density of 53 plants/m². This indicated that once established if the plants receive rainfall they have the ability to produce a large amount of feed.

A concern to the group was the issue of nitrate poisoning to the sheep and how early should you graze the canola? There was no experience at any sites with issues of nitrate toxicity. At Site 2014-4

[2] Animals were only on the paddock for 10 days which did not allow adequate time for rumen adjustment and weight gain
[3] Valued at $1.70 per kg LW as per Sprague et al. (2015)

the canola was grazed as early as 7 weeks but the majority of sites were around the 12 week mark which is recommended. The group concluded that producers shouldn't be afraid to graze plants early. If the plants are well anchored it is best to utilize the green feed available over the summer, otherwise they can defoliate (drop leaves) during hot periods and valuable livestock feed is lost.

Producers believed spring sown canola could be used to rest pastures in autumn and thus create a feed wedge in their system they could later utilize. The trials found that this could only be achieved if the final canola grazing in the March to end of May period coincided with rainfall to support pasture growth. Rainfall events in April 2014 and 2016 of the project occurred but in 2014 the producer had stopped grazing, hence the producer didn't produce a potential feed wedge.

Producers will value the crop and grazing benefits differently depending on prices and their enterprise objectives. This trade off period between whether to reap the continued benefits of canola grazing or lock up the crop for grain production is a key decision that needs to be made and has been the number one question across all grain and graze type trials in Australia.

In 2014 there weren't clear messages about when to stop grazing and lock up for grain production. Two sites finished grazing at the start of April missing out on that extra 3rd grazing but one site continued grazing until 7th June as this producer had experience in grazing canola from the year before and was not overly concerned about a grain yield penalty.

The initial thought behind the lock up time was it should be the same time as planting an autumn crop; hence the spring crop would develop at the same rate from a heavy crash graze. However the crop recovers a lot faster than an autumn sown crop establishing and by finishing the grazing in early April producers missed out on 2-3 weeks' worth of grazing at a crucial time for pastures that could benefit the whole farm system. The group learnt from this and in the following 2 years of the project the lock up date became the end of May to early June and 3 grazing periods were achieved.

John Kirkegaard, CSIRO found the yield potential of any grain crop is related to the biomass (leaf area) at anthesis (beginning of flowering period) to support grain fill. From their research they have calculated you need 2.5t/ha of residual biomass for recovery for a target yield 2.5-3 t/ha (Kirkegaard et al, 2016). To get the required biomass regeneration, producers need to take into consideration their local environment (season, soil type and soil temperatures) as this influences how quickly the canola can regrow during winter.

There are many factors that affect grain yield, especially with a crop that has a long growing season. In the 2014 season yields were comparable to autumn sown crops in the district but in 2015 & 2016 the yields fell below 1t/ha (see Fig. 5). These yields were penalised by season through poor establishment, a dry spring at grain fill in 2015 and waterlogging in 2016. There is not enough data to conclude whether grazing did or didn't affect the yield but information from other research trials suggested the paddock lock up dates were appropriate for reducing yield penalties. In the worst case scenario grazing spring sown canola decreased grain income by $175/ha.

All sites received appropriate levels of fertilizer to achieve greater yields. Soil tests were conducted and supplied to the site producer who consulted their own agronomist to work out how much nitrogen they would apply after grazing. In 2015 site 1b was the only site that made a urea

application in summer (16/1/15) to try and boost the crop along, however this had no effect, with the lack of soil moisture being the reason behind the nil response.

The only other site that made any urea applications before the end of the grazing period was site 1c in 2016 in between the 2nd and 3rd grazing in April. This decision was made as there had been no fertilizer used at sowing as the soil test results had shown adequate levels of nutrients, but greater than 1.4t/ha of DM from the crop had been removed by grazing and the plants showed signs of nutrient deficiency. This nitrogen application may have increased biomass growth for the third grazing.

The current recommended fertilizer applications for spring sown canola are the same as autumn sown canola. A rule of thumb is for every 1t/ha of target grain yield you need 70kg/ha of nitrogen.

The costs of inputs for growing a spring sown canola crop are similar to an autumn sown crop (~$290 per hectare). There are three main areas for potential saving with spring sown canola namely:

- Reduced need for slug bait as plants are cabbaging by the time slugs are active in the autumn, giving capital savings of around $30 per hectare in baiting, and reducing the risk of losing the crop to slugs.
- With one sowing, there is the dual benefit of early feed and grain that otherwise would have required two sowings. Hybrid seed required for spring sowing is more expensive (~$25/kg) than open pollinated canola (~$14/kg) and fodder rape (~$10/kg) but with the slug bait saving, the input costs end up about the same.
- Reduction in labour from not having to supplementary feed over the summer-autumn.

5.2 Promotion of research results and its effectiveness

There were many different types of promotion of this project as listed in 4.2 Extension and Communication. Fifteen farm businesses have been directly involved with the sites. However, the wider membership base of Southern Farming Systems (600), the Cavendish Best Wool Best Lamb Group and community have been engaged through paddock walks, media articles, newsletters, SFS results book publications and major fields days in the area such as Sheepvention and Agrifocus. All were successful in informing producers of this opportunity crop.

At the start of the project the concept of using a winter habitat canola as a spring sown crop, grazed and grown onto grain was relatively new and only adopted by the early innovators who had seen research by SFS in 2010-2011. The first initial barrier producers had with this concept was fitting it into a typical grain growers paddock rotation. Leaving a paddock out of production (fallow) from autumn to spring was seen as a waste. As the concept was further developed producers thought of ways or opportunities where this crop would fit, for example a failed autumn sown cereal crop, an opportunity to better control weeds, pasture renovation.

The other knowledge gap was around when to finish grazing without a grain yield penalty. In the first year of the project producers focused more on locking the crop up early to avoid a penalty. In the drier years the focus changed towards utilising the feed and the grain yield was a bonus even if it was penalised. The results from the project can give producers confidence and understanding of where this crop fits in their system and awareness of it's' limitations/risks before adoption.

Through producer discussions, the appeal and benefits of spring sown canola varied depending on if they were mainly a grazier or a grain producer. Producers felt grazing canola better fitted a livestock focussed enterprise than a cropping dominated system where crop yield is king and activities that put yield at risk are not adopted. The benefits the producers identified are listed below:

Grazier's main benefits

- Increases winter pasture growth rates by allowing it to rest whilst grazing the crop.
- High quality summer green feed is valuable for livestock production and reducing supplementary feeding costs.
- Enables to finish lambs to specifications rather than selling before Christmas.
- Offers another income stream (i.e. crop) from a livestock perspective.
- Increased Gross Margin/ha.
- Can be used to get ewes ready for joining.
- Used as part of a pasture renovation program (e.g. level paddock, build fertility, incorporate lime) and generate income.

Cropper benefits

- Opportunity to get a crop in a failed autumn sown paddock.
- Capitalise on summer rainfall, e.g. think about sowing in summer if paddock has been harvested and there has been adequate rainfall.
- Opportunity to control two seed sets of weeds by getting double knockdown.
- Frees up time to do other autumn sowing, so takes pressure off.
- Reduced slug issues when sown in spring at establishment.
- More efficient as only one sowing.
- Cover option over summer after cutting silage.

Of the 6 producers present at the final PRS review, five had used spring sown canola since the start of the project. One had been waiting for the results of the project because they had no drains and had hoped that spring sown canola could be used where their paddocks were not well drained enough for autumn sown canola.

Other practice changes that producers said they would do were:

- Careful paddock selection.
- "Was worried about sowing too early (in September) because of vernalisation but now I will sow as soon as I can get on."
- Manage better, so stock goes from green feed to green feed as it's an advantage. (No rumen adjustment issues).

Many cropping paddocks were unable to be autumn sown in 2017 in the HRZ due to the ground becoming too wet to sow. The project co-ordinator had many enquiries regarding the use of spring sown canola to take advantage of the fallow ground. This provides an example of practice change that will occur given that this is an opportunistic tool for generating both income from cropping and livestock.

Attitude changes identified by the producers were:

- Fits better in a mainly grazing system

- You need to weigh up the risk of establishment as the grazing part is okay provided lock up time is adhered to.

Producer knowledge changes included:

- A big mature plant doesn't mean it handles waterlogging better than a small autumn sown plant.
- Use clip grazing from May onwards.
- Manage potential seasonal cut out of canola by continuing to supplementary feed with grain.
- There is lower cost from one sowing in terms of labour and convenience rather than having to sow a fodder crop and then another crop.
- Canola provides similar feed advantages to a rape fodder crop.
- You need drainage.
- Could sow a winter type in Feb/March sowing after 100 mm of rainfall and get grazing.
- Perception that the spring sown canola would yield much better than autumn sown canola but it didn't happen.
- Sow spring winter habit canola for opportunistic feed production and grain yield.
- Time of sowing has to be as early as practical but minimises vernalisation risk to maximise summer grazing opportunities.
- Select suitable paddocks, they must be well drained and have surface moisture at sowing (form bolus in top 5 cm).

Feedback received following the Grassland Society conference from agronomists was that the data would be valuable for them to put a case forward for producers to use.

5.3 Effectiveness of the participatory research process

Producers were kept engaged through the annual review meetings, crop walks, newsletters and the SFS result book articles. The group worked well as there were mixed enterprise producers with differing focusses, those who were more grain orientated with livestock and those who were more livestock focussed with grain crops, which diversified the project discussions and thoughts.

The extension activities created an opportunity to share and learn from each other through discussion of how this crop can be used in the industry and provide real farmer results. The research was also very valuable to have been tested over several different seasons, soil types and drainage options.

The main feedback to the researcher were the real world issues of crop failure to establish in the dry and its' intolerance to the wet conditions mirrored by both PRS and FIP projects. Also one PRS site did join ewes safely up to weight earlier providing supportive data to the AgVic FIP project.

Future areas of research identified through the annual review process that would make adoption easier:

- Waterlogging tolerant varieties bred or identified.
- Virtual fencing for easier grazing.

- Seed coating of canola seed which allows it to be sown with the autumn cereal but prevents it from germinating until late spring.
- Identifying the optimum percentage of farm area that could go into dual purpose crops
- Clear decision making process to know if crops should be grazed or not and a date of when to stop.
- Guidelines on managing feed adjustment, balancing fodder, so animals maximise production from the high quality feed.
- Tools to help decision making in whether to harvest the crop or continue to graze it. E.g. sliding scale of yield reduction with continued grazing.

The PRS process has been a very positive experience; it has allowed producers to try something new with the support of industry researchers and consultants through data collection to validate their gut feelings and discussion with peers within their community. The other important part of the process was it took place in their backyard where they didn't have to travel long distances to be involved and it was relevant to their area and the results can easily represent their own farm. Research trial data doesn't always get the same results on farm and doesn't take into account the other factors of managing a large more complex farm system.

6 Conclusions/ Key Messages /Recommendations

6.1 Conclusion

Dual purpose canola is an opportunity crop that can be planted in the HRZ in the spring, crash grazed at least three times from December to May, then be locked up and grown on to grain.

The whole farm system benefits from the provision of a significant high quality feed source that can be used to grow lambs for sale or to join and enables the producer to rest pastures and provide a green containment area.

For optimum crop production the key rules for spring sowing winter habit canola is the same for autumn sown canola; preparation, good paddock selection, early sowing (mid Sept-Oct) and supply of adequate nutrients. Once established it is very tough and can handle heavy grazing, but grazing should stop mid-end of May allowing the plants to recover enough biomass to optimise grain production. Drainage of paddocks helps reduce waterlogging risks but in wet years like 2016 waterlogging can still occur and kill plants and reduce crop yields.

6.2 Key messages

- Winter habit canola sown in spring in the HRZ is a good option for producers with a mixed enterprise when looking for a summer and autumn feed with the added income of a grain yield.
- Good crop establishment is essential to optimise results.
- Don't be afraid to graze plants once they are well anchored and utilize the green feed available over summer, otherwise the plants defoliate themselves during hot dry conditions and valuable livestock feed is lost.
- Waterlogging kills canola whether planted in spring or autumn and the use of drainage helps to reduce the risk but not eliminate it.

- For optimal animal performance have two paddocks to rotate the sheep in and out of or strip graze to avoid rumen adjustment issues of going from green feed to dry feed and vice versa.
- Time of sowing has to be as early as practical but minimises vernalisation risk to maximise summer grazing opportunities.
- Select suitable paddocks, they must be well drained and have surface moisture at sowing (form bolus in top 5 cm).

6.3 Recommendations

The group recommends that further research be done into dual purpose crops around better varieties that may cope better with the wet and dry, a clear set of rules around grazing timing and when to lock up the paddock for grain production. A better understanding of the plant phenology in regards to vernalisation triggers and its inability to handle waterlogging.

7 Bibliography

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