Final report

PDS MLA Alternate forage crops for Southern Western Australia

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Abstract

Stirling's to Coast Farmers producers identified that their livestock enterprises are limited by the available feed in autumn and early winter. A lack of feed means producers supplementary feed livestock which is not cost-efficient. This project was undertaken to demonstrate the value of alternate high biomass forage crops to increase stocking rates and liveweight gain of prime lambs or beef cattle relative to current systems in the HRZ of Western Australia. Over the three-year project eight core producers hosted a producer demonstration site, five demonstrating the grazing capacity of sheep and three demonstrating the grazing capacity of trade cattle.

Key results included all alternate forages had a higher nutritional value and were able to support a higher stocking rate and produced more liveweight per hectare than their control counterpart. All forages trialled except for millet recorded consistently higher biomass compared to their control.

The benefits to the industry include increased productivity, profitability, and confidence on farm in the producer's own ability to successfully manage a profitable alternate forage crop. The PDS demonstrated an up-skill in producers ability to achieve higher quality and quantity of feed. This improved weight gain in sheep and cattle more effectively, aligning product with market specifications.

Executive summary

Background

Producers have identified that their livestock enterprises are limited by the available feed base in autumn and the early winter due to low surface plant available water and low radiation from the sun in the early winter. Seasonal variability in pasture feed limits producers to their carrying capacity, in poor seasons capacity can be limited to as low as <7 Dry Sheep Equivalent (DSE).

All Western Australian producers experience a lack of feed source over these periods due to our hot, dry summers and a winter dominant rainfall pattern. The cost of supplementary feeding livestock through grain, hay or straw is not a cost-effective strategy. Most producers in the region (approx. 300 enterprises) would benefit from growing alternate forage crops over summer/autumn. However, the producers most likely to grow forage crops successfully are in the High Rainfall Zone (HRZ) with a Median Average Rainfall of 450mm and over.

From the results of this project, producers implementing these demonstration practices, will have more confidence in their feed base over the summer/autumn period, and will be able to increase flock or herd numbers and produce more meat and wool on a consistent basis.

Objectives

AIM: Successfully demonstrate the feed value of alternate high biomass summer forage crops in increasing stocking rates and liveweight gain of prime lambs and beef cattle relative to current systems in the HRZ of Western Australia.

- Six producers demonstrated improved grazing carrying capacity of 10% (as measured by stock numbers supported and weight gain achieved and plant nutritive value results) from the use of summer forage crops. This was achieved with increased carrying capacity of

between 20% and 168% supported by the alternate forage compared to the traditional feed source.

- A cost benefit analysis was undertaken on the alternate forage crops to determine the relative economic performance of the alternate forages compared to the equivalent currently used available pasture and imported feed.
- Through a range of activities (annual field days, digital communications) 100% of core producers and 60% of observer producers have increased their knowledge in and confidence to use summer forage crops. This was achieved successfully as 100% of core and observer producers increased both their knowledge and confidence to varying degrees.

Methodology

Ten Stirling's to Coast members were selected as core producers in which six held sites over the three years from 2020 to 2023. Four core producers demonstrated the grazing capacity of prime lambs on Pallaton Raphno, or Millet. Two core producers demonstrated the grazing capacity of trade cattle on Pallaton Raphno, Sorghum or Winter Wheat. The control for summer grazing was barley stubbles or permanent pastures/dry feed and the control for winter grazing was a permanent pasture consisting of a ryegrass legume mix.

One grazing event was recorded from three PDS each year, except for the final year when only two sites were able to be sourced. Data collected at each site included:

- Plant nutritive value samples were taken prior to each grazing event from both the control and alternate forage crop.
- Biomass cuts. 4 or 6 depending on paddock variability.
- Soil testing
- Important agronomic details were collected at each site. Including sowing dates, fertiliser inputs, crop protection and weather data.
- Stock numbers, live weights and stock classes were assessed prior to grazing events with live weights being measure post grazing also.

Data collected from PDS sites were used to complete an economic analysis and case studies of the grazing benefits obtained from alternate forage crops.

Results/key findings

Demonstration site outcomes

- All alternate forage species recorded a higher nutritional value than their control comparison which was either a stubble or established pasture.
- All except one alternate forage species recorded consistently higher biomass compared to their control. Of the forages trialled only millet consistently yielded less.
- A higher nutritional value partly contributed to all alternate forages being able to support a higher stocking rate than the traditional feed source they were compared to.

- More liveweight per hectare was consistently produced by the alternate forage. However, none more so than Pallaton Raphno, where lamb live weight gain was a staggering 5.35kg/ha/day compared to 1.31kg/ha/day achieved on the ryegrass in year one.

Economic evaluation

Even though the alternate forage consistently produced more liveweight gain per hectare this was not always found to be more economical once costs of implementation (seeding, spraying, fertiliser etc.) were taken into account. With that being said on average a net benefit of $94.2/ha was recorded for the alternate forage crops. It is a tall ask for the alternate forage crops measured to make back the cost of implementation from one grazing event. Especially when the life of the forage often continues for many months. To more accurately record the benefits $/ha from alternate forages more data would be required.

Extension and communication

A great number of extension and communication activities were completed throughout the life of this PDS. From Field days at host farms to presentations at Pasturama in Manjimup, completion of case studies and multiple newsletter articles and yearly trial review articles just to name a few. There were ten core producers involved with the project and over 300 observers were reached through extension and communication activities.

Monitoring and evaluation

Results to come out of the Monitoring Evaluation Reporting (MER) include core producers attaining a 70% increase in knowledge, 51% skill increase and a 14% confidence increase. Whereas observer producers gained a 74% increase in knowledge, 64% skill increase and a 24% increase in confidence. Practice change observed an extra 10% of core producers and an extra 18% of observer producers consider planting an alternate summer forage crop as part of their normal practice.

Benefits to industry

The project results prove growing alternative forage crops can benefit our industry in several ways. Comparing measurements between producing forage crops and a ‘standard’ pasture or feed practice in this project, growing forage crops provided greater nutritional value, livestock weight gain per/ha, and the ability for forage to support a higher stocking rate in all demonstrations.

Future research and recommendations

Alternate forages focused on filling the summer autumn feed gap always require some form of summer rain. To accurately predict and forecast the availability of such events will improve producers confidence to implement alternate forages into their system.

Future research is also warranted into the induction of livestock, particularly cattle onto Pallaton raphno needs to be investigated if it is to be used as a monoculture.

PDS key data summary table

Project Aim:
To demonstrate the feed value of alternate high biomass forage crops in increasing stocking rates and live weight gain of prime lamb or beef cattle relative to current systems in the HRZ of Western Australia.

	Comments	Sheep	Cattle	Unit
Production efficiency benefit (impact)				
Animal production efficiency - kg LWT/ha; kg LWT/DSE, AE or LSU	*Kg/LWT/ha was consistently greater on alternate fodder crops*	6.2-129	17.7-99.8	Kg LWT/ha
Stocking rate – DSE, AE or LSU/ha	*Stocking rate increased from 20-168% on fodder crops*	20-159% 2.3-24.8	78-168% 8.8-25.6	DSE
Pasture productivity – kg DM/ha	*Alternate fodder crop produced more biomass than traditional feed source.* *Except for Millett which yielded less.*	0.82-2.02 -(0.3-2.35)		Kg DM/ha Kg DM/ha
Increase in income	Varied from $67/ha to $702/ha averaging $300/ha	$300		/ha
Additional costs (to achieve benefits)	Costs varied from $90-$517.32 depending on which alternate forage was planted. Averaging $199	$199		/ha
Net $ benefit (impact)	**Varied from a loss of $34.6/ha to a positive return of $427/ha averaging $94.2/ha**	**$94.2**		**/ha**
Number of core participants engaged in project		10		
Number of observer participants engaged in project	300+ have attended project related field walks and events. 13 observers completed a pre-project survey	300+		
Core group no. ha		27205		
Observer group no. ha	13 recorded pre-survey	27987		
Core group no. sheep		41050		hd sheep
Observer group no. sheep	13 recorded pre-survey	38934		hd sheep
Core group no. cattle		1270		hd cattle
Observer group no. cattle	13 recorded pre-survey	1865		hd cattle
% change in knowledge, skill & confidence – core	*Knowledge increase* *Skills increase* *Confidence increase*	70% 51% 14%		
% change in knowledge, skill & confidence – observer	*Knowledge increase* *Skills increase* *Confidence increase*	74% 64% 24%		

% practice change adoption – core	*Grow alternate fodder crops to finish stock on*	10%	
% practice change adoption – observers	*Grow alternate fodder crops to finish stock on*	18%	
% of total ha managed that the benefit applies to	*% of total ha, fodder crop is grown on.*	<25%	
	Key impact data		
Delete lines that are not applicable to your project. **Net $ benefit /ha (impacted ha)**		**$94.2/ha**	

Assumptions include:

Calculating DSE for cross bred lambs a DSE of 1.3 was used and for merino lambs a DES of 0.8 was used (www.lifetimewool.com.au, 2006). Calculating DSE for weaner cattle DSE of 8 was used (MLA Corporate, 2023).

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1. Background

Growing alternate summer crops means producers can potentially grow cost effective feed which will be available to their livestock during the summer autumn period. This offers producers an opportunity to increase profits, by carrying more livestock because they are confident of feeding animals outside the growing season and by having livestock ready for market outside of peak supply times, producers will achieve higher prices. Producers typically calculate whole farm stocking rates based on their ability to carry stock over the autumn period.

The aim of this project is to demonstrate the feed value of alternate high biomass forage crops in increasing stocking rates and liveweight gain of prime lambs or beef cattle relative to current systems in the HRZ of Western Australia. This was achieved through eight alternate forage crop demonstration sites from 2020-2023.

1.1 Alternate Forage crops for Southern Western Australia

SCF producers have identified that their livestock enterprises are limited by the available feed base in autumn and the early winter. This is because of low surface plant available water and low radiation from the sun in the early winter. Due to seasonal variability in pasture feed for sheep enterprises, SCF producers limit their carrying capacity (DSE <7/ha) to make management easier in the poor seasons. Over 90% of the SCF membership run significant livestock enterprises and could, based on the MLA feed base research, run over 10 DSE/Ha (N. Dovey, personal communication, February, 2020).

The buoyant sheep and cattle industries has stimulated local producers to seek transformational changes that will improve their livestock carrying capacity. The potential for new crops to be planted in the spring and survive over summer providing valuable early season feed is massive. Furthermore, our climate is becoming increasingly variable with less winter precipitation and more summer rainfall events occurring. Producers are looking for ways to utilise summer rains to grow feed outside of the traditional winter (May-October) growing season.

Producers want to explore ways of managing the high variability in rainfall distribution to optimize the year in year out feed base. Some parts of the SCF landscape are especially suited to perennials and the balance is potentially highly productive with upgraded rotations of forage and fodder species integrated with high producing annual pastures. If producers have more confidence in their feed base over the summer/autumn period, they would be able to increase flock or herd numbers and produce more meat and wool on a consistent basis.

Growing alternate summer crops means producers can potentially grow cost effective feed which will be available to their livestock during the summer autumn period when feed is normally scarce. The result of this demonstration offers producers an opportunity to increase profits in one of two ways. Firstly, by carrying more livestock because they are confident of feeding animals outside the growing season. Secondly, by having livestock ready for market outside of peak supply times, producers may have an opportunity to then achieve higher prices. Producers typically calculate whole farm stocking rates based on their ability to carry stock over the autumn period. This project aimed to improve producers carrying capacity over this time and therefore increase stock carrying capacity and ultimately profits from increased livestock production.

2. Objectives

By November 2023, in the southern coastal region of Western Australia:

Objective 1. Minimum 3 producers will demonstrate improved grazing carrying capacity of 10% (as measured by stock numbers supported and weight gain achieved and plant nutritive value results) from the use of three summer forage crops or mixes at multiple PDS each year. Ideally 2 years of data will be recorded for each producer.

Objective 1 was achieved successfully as all 5 producers demonstrated a range of improved grazing carrying capacity on alternate forages of between 20% and 168% compared to the traditional feed source determined by stocking rate. There was one exception where 670% increase was observed however this was a crash grazing for a short period of time and not a true representation of a sustainable stocking rate.

Objective 2. Complete a cost benefit analysis of the three summer forage crops or mixes to determine the relative economic performance of the summer forages compared to the equivalent currently used available pasture and imported feed.

Objective 2 was achieved successfully as economic analysis was performed on each alternate forage trialed. The analysis determined the relevant economic performance of each forage calculated to a dollars per hectare figure.

Objective 3. Through a range of activities (annual field days, digital communications) 100% of core producers and 60% of observer producers will have increased their knowledge in and confidence to use summer forage crops.

Objective 3 was achieved successfully as 100% of core and observer producers increased their knowledge to varying degrees and on average 100% of core and observer producers have increased their confidence to grow an alternate forage crop.

3. Demonstration Site Design

3.1 Methodology

This project was implemented by a working group of 11 SCF members who collaboratively established demonstration sites in our region to demonstrate alternate forages and their potential compared to traditional feed sources as follows.

Producer Demonstration Sites:

- Kent Rochester, Many Peaks established Pallaton Raphno in 2020
- Tim and David Pyle, Many Peaks/South Stirlings established Pallaton Raphno in 2020 and 2021
- Ryan Smith, Green Range established Millet in 2020 and 2021
- Tim Metcalfe, Many Peaks/Porongurup established Sorghum and Winter wheat in 2021 and 2022
- Clare Webster, Tenterden established Millet in 2023

In each year three producer demonstration sites were sourced. Except for the final year where only two host sites were attained. Originally we had three sites but with 100mls in November 2022 one of the seeded sites was washed away and with the delays of harvest that followed, no other site was procured. The sites grew an alternate forage of either Pallaton raphno, millet, sorghum or winter wheat with a control comparison of a traditional feed source for that time of year. Control for summer grazing was barley stubbles or permanent pastures (mostly dry feed) and the control for winter grazing was permanent pasture, of a rye-grass-legume mix.

Data collected at each demonstration site included:

- Plant nutritive value samples were taken prior to each grazing event from both the control and alternate forage crop. Nutritive value samples were analysed by Feedtest, Werribee, VIC.

- Biomass cuts. 4 or 6 depending on paddock variability.

- Soil samples at a depth of 0-10cm.

- PDS hosts recorded important agronomic details including - nearest weather station data, time of sowing, seeding rate, and/if fertiliser or crop protection applied.

- PDS hosts recorded stock details including - Stock numbers, stock class and live weights measured pre and post grazing. A subsample of sheep or cattle from all sites were weighed before grazing and then weighed again coming off the respective forages capturing their liveweights.

A pre and post-project survey was created in conjunction with MLA and was collected from SCF members and non members alike to assess current practices and attitudes at the commencement and finalisation of the project. The data captured the current levels of summer crop grazing and the amount of Ha's currently being planted for this purpose. The survey will also aimed to obtain the reasons for producers not growing summer forage crops currently.

A communications plan was created and implemented by the project facilitator throughout the course of the project. Part of this included field walks to showcase the forage crops after or during grazing to illustrate the crops' ability to recover from grazing. Pictures were posted regularly on social media to keep industry informed of progress.

Data collected from the PD sites was used to complete an economic analysis of the grazing benefits obtained from alternate forage crops.

Three case studies were completed of core producer's learning experience from hosting a PDS. Case studies will be made available through SCF website, posting links on Twitter and Facebook and making hard copies available at SCF field days & events.

3.2 Economic analysis

Outline the approach you used to calculate the cost:benefit analysis and/or economic evaluation of this Producer Demonstration Site.

Data was collected and used by Lucy Anderton at LA One consulting who performed the analysis.

This series of analyses puts an economic value to grazing alternative fodder crops. The analysis looks at farmers practice for grazing animals to gain weight.

The analyses for the sheep enterprises use prices from the Katanning Sale yard, downloaded from the Meat and Livestock website. https://www.mla.com.au/prices-markets/. The prices used for the lambs going into finishing were the average three-month (October to December) price for lambs based on weight, shown in Figure 1 using the restockers category. The Processors category prices were used for the finished lambs. The prices used for each year are outlined in Table 1 to 3.

Figure 1. Prices used for lamb at the start of grazing, cents per kilogram cwt (c/kg cwt)

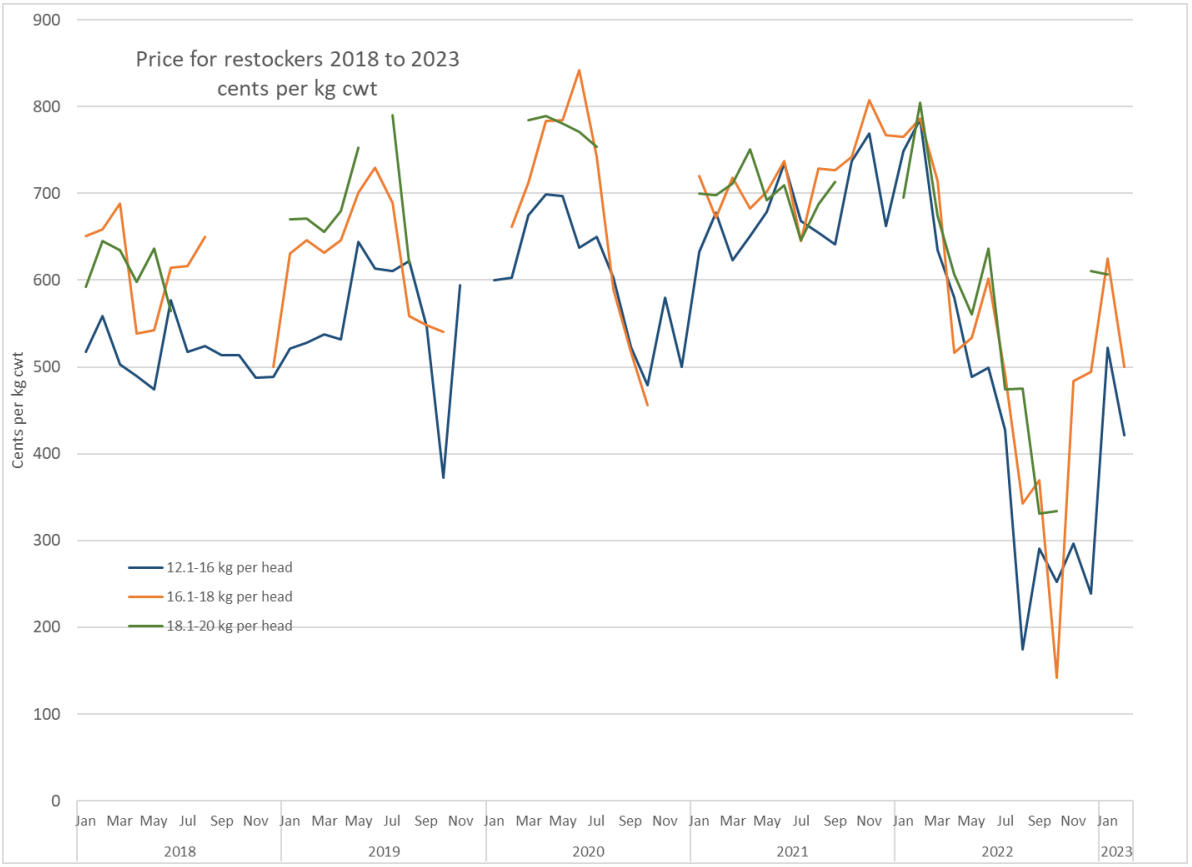


Figure 2. Prices used for finished lambs, cents per kg cwt (c/kg cwt)

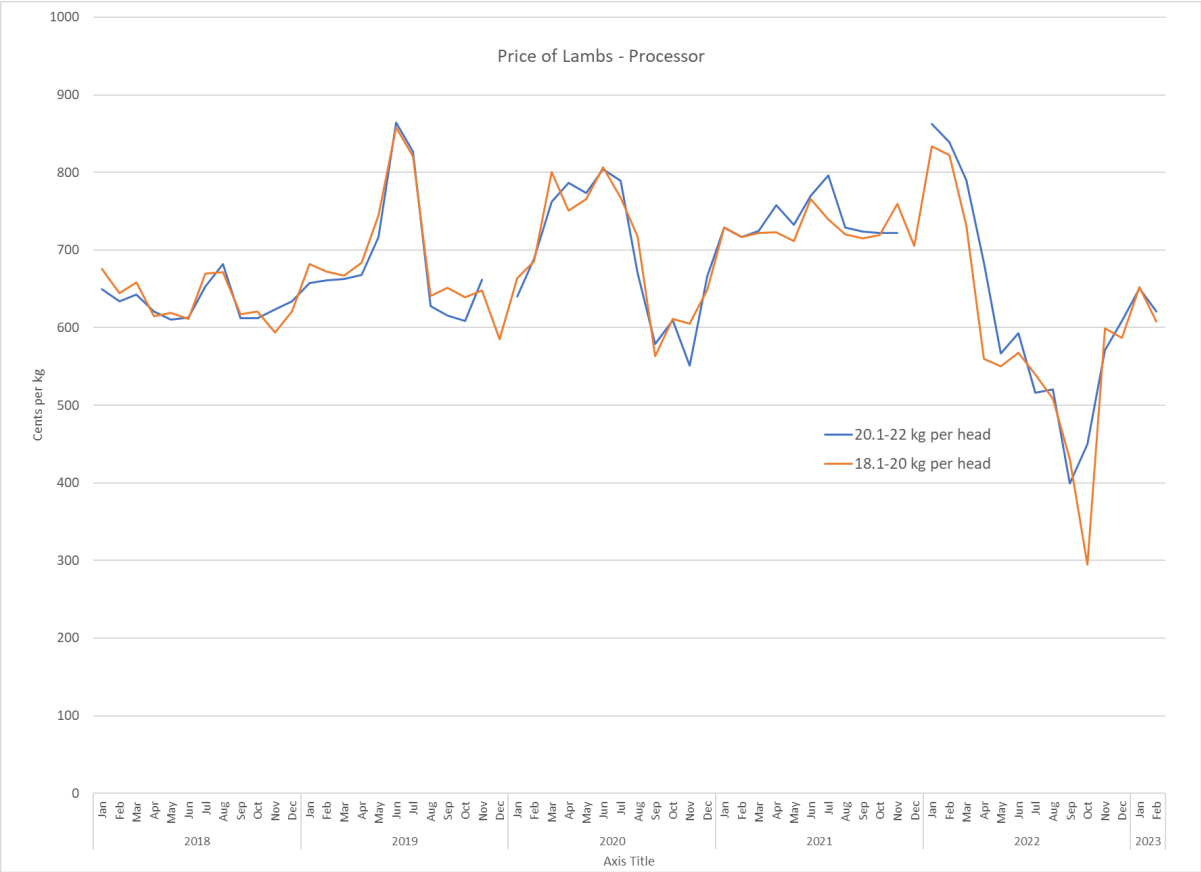


Table 1. Prices used for year 1, cents per kg carcass weight (cwt).

Category of lamb	Month/year	12.1-16 kg	16.1- 18 kg	18.1-20 kg	20.1-22 kg	22.1-24 kg
Restockers	October/2020	478.93	539.25	593.92	562.12	
	November/2020	579.58		605.50	568.89	
	December/2020	500.34	647.20	648.95	666.61	
	Average cents/kg cwt	**519.62**	**593.22**	**616.12**	**599.21**	
Processors	January/2021			729.11	728.83	736.88
	February/2021			716.64	716.95	738.47

Table 2. Prices used for year 2, cents per kg carcass weight (cwt).

Category of lamb	Month/year	12.1-16 kg	16.1- 18 kg	18.1-20 kg	20.1-22 kg	22.1-24 kg
Restockers	October/2021	736.86	697.55	716.06	728.46	666.19
	November/2021	768.97	669.20	756.72	738.95	728.26
	December/2021	662.50		705.26		612.50
	Average cents/kg cwt	**744.07**	**683.37**	**726.02**	**733.71**	**668.98**
Processors	January/2022		826.20	833.70	862.54	862.21
	February/2022		829.41	822.43	838.86	877.90

Table 3. Prices used for year 3, cents per kg carcass weight (cwt).

Category of lamb	Month/year	12.1-16 kg	16.1- 18 kg	18.1-20 kg	20.1-22 kg	22.1-24 kg
Restockers	October/2022	252.11	141.46		344.48	
	November/2022	296.85	483.44	605.91	556.26	
	December/2022	238.69	494.12	555.00	604.68	
	January/2023	522.62				
	February/2023	421.79				
	Average cents/kg cwt	**262.55**	**373.01**	**580.46**	**501.81**	
Processors	January/2023			652.50	650.84	631.90
	February/2023			608.07	620.54	626.00

Prices used for weaner cattle were sourced from MLA National restocker yearling heifer report.

Assumptions include:

* Dressed weight at 43% of liveweight for lambs.

3.3Extension and communication

A Communications Plan was developed to include field days and events, media releases and video creation, SCF website updates, case studies, field walks and fact sheets approved by MLA in milestone 1.

For more specific details see section 4.6. or appendix 16.

3.4 Monitoring and evaluation

A Monitoring and evaluation (M&E) plan was created to include all inputs and outputs expected by the PDS. Including records of all project plans and activities, budgets and data from demonstration sites to be captured in milestone reports, compilation of media activities, copies of case studies and

fact sheets developed along with the number of stakeholders present at events to be reported. Along with pre and post project surveys to capture practice change and changes in knowledge, attitudes, skills and aspirations (KASA).

For more specific details see section 4.7. or appendix 15.

4. Results

4.1 Demonstration site results

4.1.1 Tim and David Pyle, Pallaton Raphno vs Ryegrass, year 1

The Pallaton Raphno had a higher nutritional value than the ryegrass control, with a higher crude protein, digestibility and metabolisable energy as shown in Table 5. Interestingly the Raphno and ryegrass had similar biomass of 3t/ha and 3.8t/ha, respectively as shown in Table 5. Excellent weight gain was achieved on the Raphno with 62.5g/head/ day more than the ryegrass regrowth (Table 4). This was a great result and when it is calculated at kg/ha/day, the Raphno significantly outperformed the ryegrass, producing a staggering 5.35kg lwt/ha/day compared to 1.31kg lwt/ha/day achieved on the ryegrass Table 4. The ability of Raphno to grow under grazing pressure and produce leaf material allowed a much higher stocking density with 1400 lambs on 45ha (31 lambs/ha), compared to 360 lambs on 30 hectares (12 lambs/ha) (Table 4). Once the sheep were removed due to the ryegrass being depleted, the Raphno paddock still had excess biomass, which indicated it could have supported a higher stocking rate than 31 lambs per hectare.

Table 4. Pyle cross bred lamb liveweight gains grazing Ryegrass regrowth compared to Pallaton Raphno at Pfeiffer in 2020

Description	Ryegrass	Raphno
Grazing duration (days)	32	32
Paddock size (ha)	30	45
Stock numbers (head)	360	1400
Stocking rate (lambs/ha)	12	31.11
Weight in (kg lwt) or kg of liveweight	49	42.5
Weight out (kg lwt)	52.5	48
Weight gain (kg lwt) per lamb	3.5	5.5
Average weight gain (grams/head/day)	109.38	171.88
Total weight gain (kg lwt)	1260	7700
Total weight gain (kg lwt/ha)	42	171
Weight gain (kg lwt/ha/day)	1.31	5.35

Table 5. Pyle 2020 forage sample analysis.

NV Analysis (NV	Ryegrass	Pallaton Raphno
Dry Matter (DM)	30.3 %	13.9 %
Moisture	69.7 %	86.1 %
Crude Protein	7.9 % of DM	16.4 % of DM
Acid Detergent Fiber	38.6 % of DM	13 % of DM
Neutral Detergent Fiber	71.5 % of DM	19.3 % of DM
Digestibility (DMD)	51.2 % of DM	88.3 % of DM
Digestibility (DOMD)	50.2 % of DM	81.6 % of DM
Est. Metabolisable Energy	7.2 MJ/kg DM	13.6 MJ/kg DM
Fat	2.4 % of DM	3.8 % of DM
Ash	6.9 % of DM	10.9 % of DM
Dry Matter cuts (DM)	**Ryegrass**	**Pallaton Raphno**
g of 0.1m² quad	30.10	38.30
t/Ha	3.01	3.83

Figure 3. Summary of cumulative rainfall on Pyles property from August 1, 2020 to March 10, 2021 at a nearby GoannaAg digital rain gauge located at the Drawbin and Pfeiffer road T-junction.

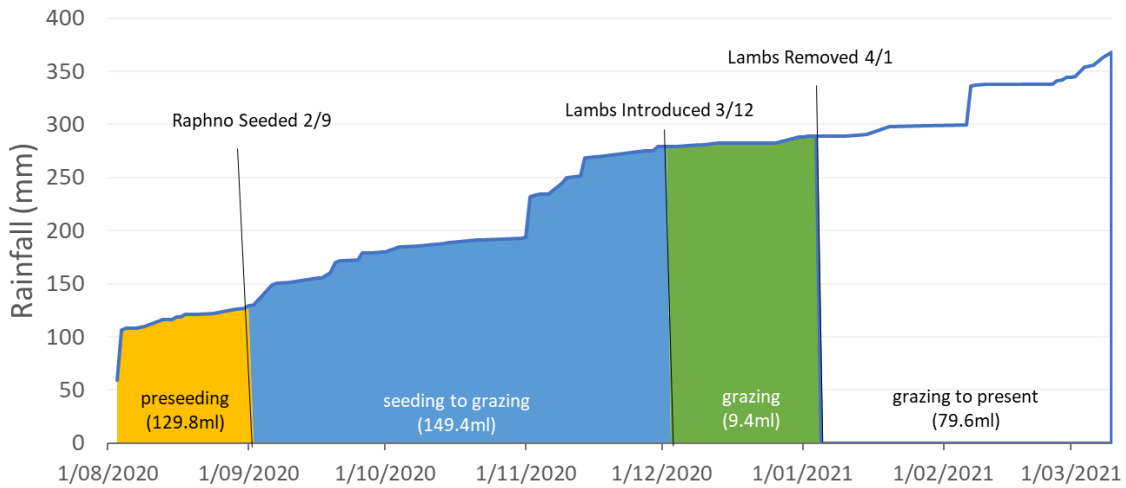


Table 6. Pyle soil sample results taken December 7, 2020.

Site Name	Depth	pH (CaCl2)	Al CaCl2 (mg/kg)	PBI + P Col	P Col (mg/kg)	Texture	Sand (%)	Clay (%)
Raphno	0-10	5.6	0.1	22	32	Sand	98.0	1.0
Rye	0-10	4.5	1.2	20	19	Sand	97.0	1.0

The Pallaton Raphno was sown at 8kg/ha on 2 September 2020. Crop protection Affirm was sprayed on the 2nd November for Diamond back moth (DBM). Fertilizer inputs included 100L/ha of Flexi-N applied on the 3rd November, with grazing commencing on the 3rd of December. No fertiliser inputs or crop protection were applied to the ryegrass regrowth.

4.1.2 Ryan Smith, Millet vs Barley stubble, year 1

The 2020 season was not kind to the Smith's millet as a combination of factors including paddock soil amelioration (ploughing) and rainfall received the month before grazing totalled 17.4ml (Fig. 4). This caused the soil profile to dry out, leading to heat and moisture stress before grazing. This also resulted in variable plant health and biomass, as seen in Figure 5. Pasture cuts revealed a much larger biomass available prior to grazing in the control barley stubble with 3.5t/ha compared to 1.2t/ha of millet (Table 8). Despite the environmental stress the millet had an average daily gain (ADG) of 253g/head, which was over double the 120g/hd/day achieved by the barley stubble (Table 7). The summer crop (millet) had a higher Nutritive Value (NV) than the barley stubble, with higher crude protein, digestibility and metabolisable energy (Table 8). At the conclusion of grazing there was still some grain amongst the barley stubble available suggesting that it was not stocked to capacity over the grazing period. Therefore, the barley stubble weight gain kg/ha/day will be underestimated.

Table 7. Smith cross bred lamb liveweight gains grazing Millet compared to Barley stubble.

Description	Millet	Barley stubble
Grazing duration (days)	30	30
Paddock size (ha)	90	160
Stock numbers (head)	500	588
Stocking rate (lambs/ha)	5.55	3.68
Weight in (kg lwt) or kg of liveweight	41.7	42.4
Weight out (kg lwt)	49.3	46.0
Weight gain (kg lwt) per lamb	7.6	3.6
Average weight gain (grams/head/day)	253.33	120
Total weight gain (kg lwt)	3800	2117
Total weight gain (kg lwt/ha)	42.2	13.2

Weight gain (kg lwt/ha/day)	1.41	0.44

Table 8. Smith 2020 forage sample analysis.

NV Analysis	Barley stubble	Millet
Dry Matter (DM)	87.0 %	18.7 %
Moisture	13.0 %	81.3 %
Crude Protein	2.7 % of DM	21.0 % of DM
Acid Detergent Fiber	47 % of DM	23.7 % of DM
Neutral Detergent Fiber	81.7 % of DM	40.2 % of DM
Digestibility (DMD)	43.4 % of DM	81.3 % of DM
Digestibility (DOMD)	43.6 % of DM	75.7 % of DM
Est. Metabolisable Energy	5.9 MJ/kg DM	12.4 MJ/kg DM
Fat	2.0 % of DM	4.1 % of DM
Ash	5.1 % of DM	8.6 % of DM
Dry Matter cuts (DM)	**Barley stubble**	**Millet**
g of 0.1m² quad	35.53	12.02
t/Ha	3.55	1.2

Figure 4. Summary of cumulative rainfall from September 18, 2020 to March 18, 2021 at the Smith's Metos weather station located on Kojaneerup West road close to the demonstration site.

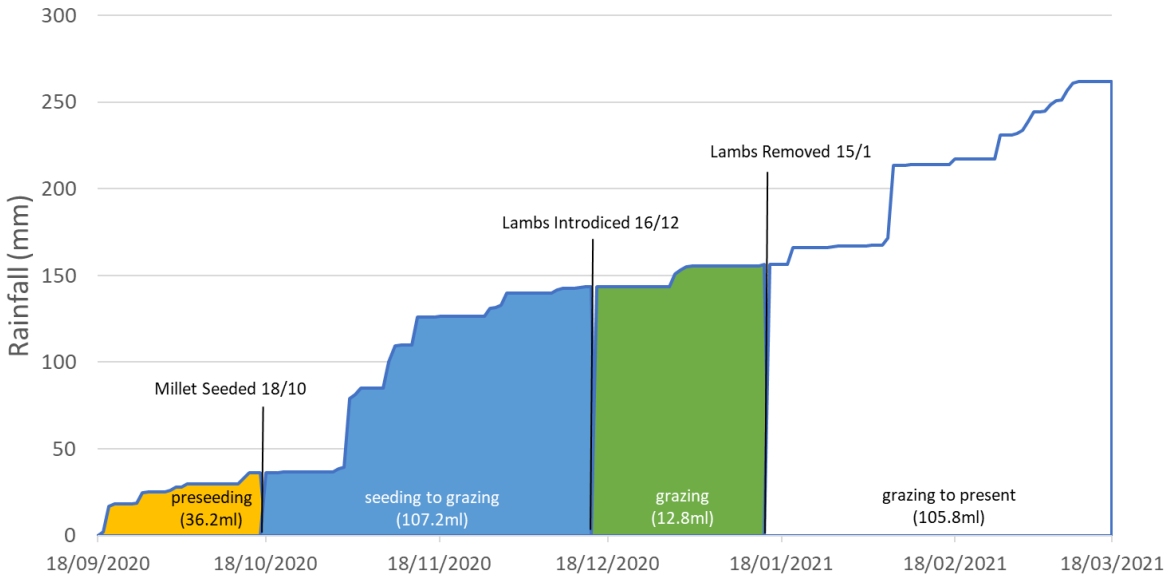
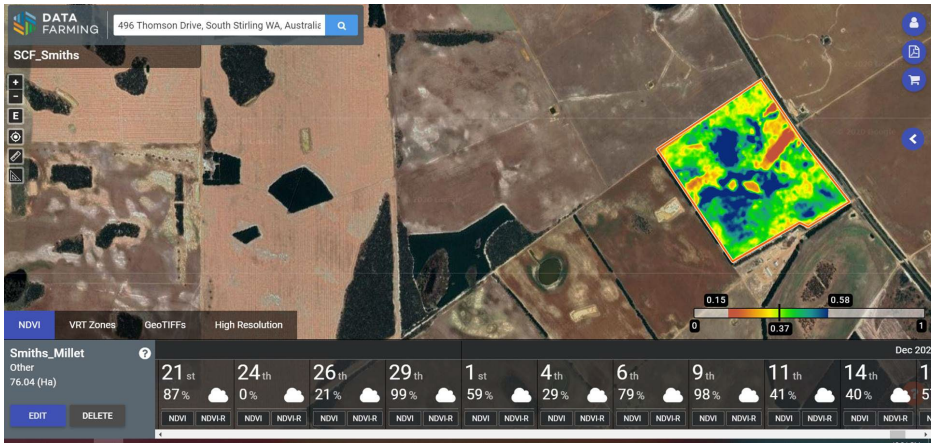


Table 9. Smith soil sample results taken December 15 2020.

Site Name	Depth	pH (CaCl2)	Al CaCl2 (mg/kg)	PBI + P Col	P Col (mg/kg)	Texture	Sand (%)	Clay (%)
Millet	0-10	5.8	0.1	42	22	Sand	94.0	2.8
Barley Stubble	0-10	5.9	0.1	19	14	Sand	95.0	2.5

The Millet was sown on 18 October 2020. The only crop protection used was Estercide and Garlon to kill melons with the crop receiving nil fertilizer inputs. No fertiliser inputs or crop protection were applied to the barley stubble.

Figure 5. Millet, Satellite NDVI image captured on the December 19 2020, showing the variation in plant density and health across the paddock.



4.1.3 Kent Rochester, Pallaton Raphno and Opti-weigh, year 1

In late October, 2019 250 steers with a 325kg average weight commenced grazing the Raphno with ad-lib hay available. Steers visually looked poorer after ten days grazing. After a cross section of the group were yard weighed it revealed an average daily gain (ADG) of only 0.08 kg was being achieved on the Raphno compared to approximately 2kg per day on a previous ryegrass and clover pasture (Table 11). Based on this data, Kent abandoned tracking that group and returned the steers to conventional spring grass. After consultation with an agronomist, an agriculture supplies specialist and a local vet, it appears the cattle were ill adjusted to graze the Raphno crop. Kent received many suggestions on induction strategies to Raphno brassicas for cattle. The remainder of the cells were grazed by dry cows, but no data was collected.

The second attempt to graze growing weaner cattle was with 120 approximately 300kg heifers. After a better induction process and added supplements, an average daily weight gain of roughly 1kg was achieved (Table 11). Moving the heifers on and off the Raphno each day for the first week was the main practice change to the induction period. There was also ad-lib straw and silage available, rather than hay, with Beachport minerals added to the water troughs. By the time 1kg ADG had been achieved, heat, diamond back moth and moisture stress were affecting the forage. Kent believed this was probably affecting palatability and feed quality. Kent's concluding remark on the trial was that Raphno was an amazing plant, with a great ability to survive and grow in harsh conditions and with good feed test data.

The Optiweigh system is instrumental in knowing when ADG has dropped or picked up after adding supplements or changing grazing duration. This knowledge of understanding what happens in the paddock better is key to making quick and timely decisions before they become visually apparent.

Table 10. Rochester 2020 Nutritional value analysis of Pallaton Raphno

NV Analysis	Pallaton Raphno
Dry Matter (DM)	18.9 %
Moisture	81.1 %
Crude Protein	18.6 % of DM
Acid Detergent Fiber	14.2 % of DM
Neutral Detergent Fiber	23.4 % of DM
Digestibility (DMD)	93.1 % of DM
Digestibility (DOMD)	85.7 % of DM
Est. Metabolisable Energy	14.4 MJ/kg DM
Fat	4.2 % of DM
Ash	3.5 % of DM

Table 11. Rochester 2020 average daily weight gain of weaner cattle on Pallaton Raphno and clover/ryegrass pasture.

Date	Time (Days)	Forage	Class of stock	Head	Area (Ha)	Weigh In (Avg kg)	Weight gain (ADG Kg)
Late October 2019	8	Raphno	Green tag steers	250	5	325	0.08
September 2019	8	Clover rye mix	Green tag steers	250	5	305	2.00
Nov/Dec 2019	42	Raphno	Green tag heifers	120	40	300	1.00

4.1.4 Tim and David Pyle, Pallaton Raphno vs Ryegrass, year 2

The Pallaton Raphno at 4.05t/ha produced over 160% more biomass than the canola stubble pasture of 2.54t/ha (Table 13). Nutritive value analysis revealed the Raphno was a much higher feed quality, possessing higher digestibility, metabolisable energy and crude protein than the canola stubble pasture mix (Table 13). It also had less acid detergent fibre (ADF) which is made up of cellulose and lignin which is the percentage that is undigestible.

At the commencement of grazing, lambs recorded average weights of 38.2kg and 40.1kg for the canola stubble and the Raphno, respectively. At the completion of grazing 22 days later, lamb weight gain averaged 145g/hd/day on canola stubble and 286g/hd/day on Raphno. This resulted in an extra 141g/hd/day produced on the Raphno, nearly double the average daily gain (ADG) of lambs on canola stubble (Table 12). There were 670 lambs grazing the canola paddock that equated to 22.3 lambs/ha whereas the Raphno supported 26.8 lambs/ha (Table 12). David Pyle noted that the Raphno paddock was under stocked and ideally the stocking rate would have been above 30 lambs/ha. At completion of the measured grazing period there was still plenty of biomass in the Raphno paddock. Lambs continued to graze the Raphno at a stocking rate of 38 lambs/ha for three weeks. That grazing pressure removed all leaf area from the Raphno. Seven weeks later the raphno had returned to blanket coverage and supported another grazing event mid-March.

Table 12. Pyle cross bred lamb liveweight gains grazing on a canola stubble compared to Pallaton Raphno at Palmdale in 2021

Description	Canola stubble	Pallaton Raphno
Grazing duration days	22	22
Paddock size (ha)	30	59
Stock numbers (head)	670	1580
Stocking rate (lambs/ha)	22.3	26.8
Weight in (kg liveweight) or Kg lwt	38.2	40.1
Weight out (kg liveweight) or Kg lwt	41.4	46.4

Weight gain (kg liveweight)	3.2	6.3
Average weight gain (grams/head/day)	145	286
Total weight gain (kg liveweight)	2,144	9,954
Total weight gain (kg liveweight/ha)	71.5	168.7
Weight gain (kg lwt/ha/day)	3.25	7.67

Table 13. Pyle 2021 forage sample analysis.

NV Analysis	**Canola Stubble**	**Pallaton Raphno**
Dry Matter (DM)	26.8 %	16.1 %
Moisture	73.2 %	83.9 %
Crude Protein	11.4 % of DM	16.6 % of DM
Acid Detergent Fiber	36.6 % of DM	20.4 % of DM
Neutral Detergent Fiber	54.0 % of DM	31.5 % of DM
Digestibility (DMD)	54.8 % of DM	82 % of DM
Digestibility (DOMD)	53.2 % of DM	76.3 % of DM
Est. Metabolisable Energy	7.8 MJ/kg DM	12.5 MJ/kg DM
Fat	3.6 % of DM	4.0 % of DM
Ash	8.3 % of DM	8.1 % of DM
Dry Matter cuts (DM)	**Canola Stubble**	**Pallaton Raphno**
g of 0.1m² quad	25.4	40.48
t/Ha	2.54	4.05

Figure 6. Summary of cumulative rainfall since August 20, 2021 until end of Jan 2022, at Pyles digital rain gauge located in the Raphno paddock.

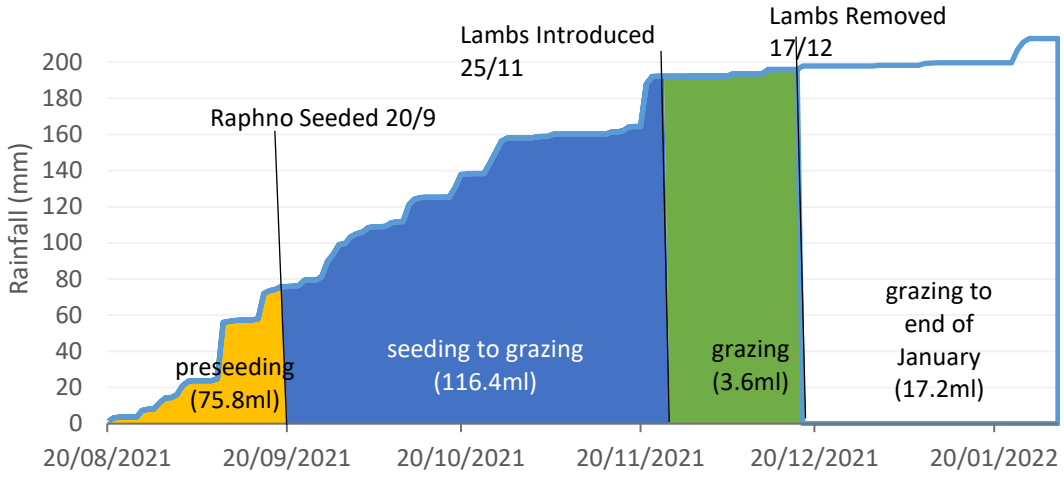


Table 14. Pyle soil sample results taken November 25, 2021.

Site Name	Depth	pH (CaCl2)	Al CaCl2 (mg/kg)	PBI + P Col	P Col (mg/kg)	Texture	Sand (%)	Clay (%)
Raphno	0-10	5.6	0.1	21	23	Sand	97.5	1
Canola Stubble	0-10	5.8	0.1	26	28	Sand	97.5	1

A Pre seeding knock down was applied on the 23rd August 2021. The Pallaton Raphno was sown on 20th September at 8kg/ha. Crop protection Affirm was sprayed on the 29th October for Diamond back moth (DBM). Fertilizer inputs included 50L/ha of Flexi-N applied on the 9th November, with grazing commencing on the 25th of November. No fertiliser inputs or crop protection were applied to the canola stubble and volunteer pasture.

4.1.5 Ryan Smith, Millet vs Barley Stubble, year 2

The 2021 sown millet was seeded into optimum conditions and received 30mm of rain one-week post seeding (Figure 7). However it only received another 17ml for the next 2 months prior to grazing. As a result, the millet showed signs of heat and moisture stress when grazing commenced, resulting in variable plant health and biomass. Pasture cuts revealed a much larger biomass available prior to grazing in the control barley stubble 3.34t/ha compared to 1.66t/ha of millet (Table 16). Nutritive value analysis revealed the millet possessed a much higher feed quality, with higher digestibility, metabolisable energy and crude protein than the barley stubble (Table 16). At the start of grazing, lambs recorded average weights of 42.7kg and 41.6kg for the barley stubble and millet, respectively. On completion of grazing, it was revealed lambs on the barley stubble outperformed lambs on the millet with an ADG of 145g/head/day, gaining an extra 28g/hd/day (Table 15). However, this did not equate to more kg of liveweight per ha with the millet producing an extra 6.2kg lwt/ha than the barley stubble. Higher live weight gain was due to the higher stocking rate and

feed quality in the millet. It was a very dry summer in 2021/22, and more rainfall would have increased the millet production.

Table 15. Smith cross bred lamb liveweight gains grazing on a barley stubble compared to Shirohie millet at Green Range 2022

Description	Barley stubble	Millet
Grazing duration days	42	42
Paddock size (ha)	60	80
Stock numbers (head)	120	300
Stocking rate (lambs/ha)	2	3.75
Weight in (kg lwt) or kg of liveweight	42.7	41.6
Weight out (kg lwt)	48.8	46.5
Weight gain (kg lwt) per lamb	6.1	4.9
Average weight gain (grams/head/day)	145.2	116.7
Total weight gain (kg lwt)	732	1470
Total weight gain (kg lwt/ha)	12.2	18.4
Weight gain (kg lwt/ha/day)	0.29	0.44

Table 16. Smith 2022 forage sample analysis.

NV Analysis	Barley Stubble	Millet
Dry Matter (DM)	73.9 %	25.5 %
Moisture	26.1 %	74.5 %
Crude Protein	3.2 % of DM	11.1 % of DM
Acid Detergent Fiber	42.9 % of DM	30.4 % of DM
Neutral Detergent Fiber	77.0 % of DM	55.7 % of DM
Digestibility (DMD)	47.9 % of DM	66.3 % of DM
Digestibility (DOMD)	47.4 % of DM	63.0 % of DM
Est. Metabolisable Energy	6.6 MJ/kg DM	9.8 MJ/kg DM
Fat	2.1 % of DM	3.2 % of DM
Ash	3.1 % of DM	6.0 % of DM
Dry Matter cuts (DM)	**Barley Stubble**	**Millet**
g of 0.1m² quad	33.35	16.55
t/Ha	3.34	1.66

Figure 7. Summary of cumulative rainfall from October 15, 2021 until mid-March 2022, at a nearby digital rain gauge located off South Coast Highway close to the demonstration site.

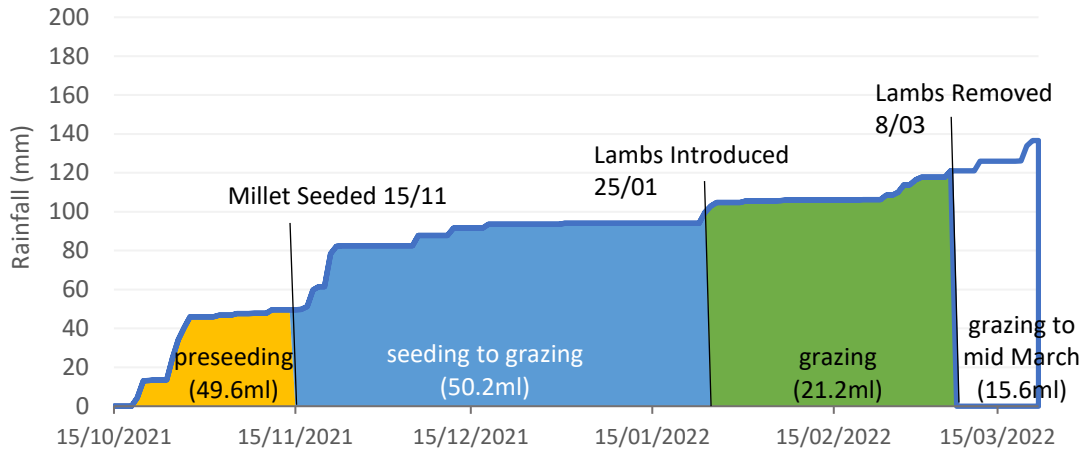


Table 17. Smith soil sample results taken January 25, 2022.

Site Name	Depth	pH (CaCl2)	Al CaCl2 (mg/kg)	PBI + P Col	P Col (mg/kg)	Texture	Sand (%)	Clay (%)
Millet	0-10	5.1	0.7	65	37	Sand	94.5	2.2
Barley Stubble	0-10	4.8	0.9	53	21	Sand	96.0	1.4

The Millet was sown on 15 November 2021, into a failed pasture where volunteer barley had smothered out the clover. Shirohie millet sown at 4kg/ha of 20 inch spacing, sown shallow. The only crop protection used was Estercide and Garlon to kill melons with the crop receiving nil fertilizer inputs. No fertiliser inputs or crop protection were applied to the barley stubble.

4.1.6 Tim Metcalfe, Sorghum vs ryegrass pasture, year 2

The 2021 sown sorghum had an ideal start receiving over 30ml in the first nine days post seeding (Fig. 8). By the commencement of grazing the sorghum was over 1m high across most of the paddock. After grazing, Tim reported the steers on the sorghum had an average daily gain of 1kg/hd/day whereas the steers on the ryegrass had achieved just a little over maintenance with a small gain of 63.5g/hd/day (Table 18). Pasture cuts revealed an extra 1.3t/ha was available on the sorghum paddock with 4.48t/ha available compared to 3.18t/ha in the ryegrass (Table 19). Nutritive value analysis revealed the sorghum was a higher feed quality, possessing higher digestibility, metabolisable energy and crude protein than the senesced ryegrass pasture (Table 19). The sorghum was found to have a nitrate nitrogen level of 220mg/kg of DM, which is within the safe range of < 4500 mg/kg of DM and a prussic acid level of < 2.5mg/kg of DM also within a safe range of < 500 mg/kg (extension.sdstate.edu, 2022). Tim reported another two successful grazing events. Firstly, 93 heifers grazed the 34 Ha paddock between April 27 and May 5. On May 7, Tim placed 383 cross-bred lambs in the paddock, which were trucked to the abattoir on May 17 (data not collected).

Table 18. Metcalfe weaner steer liveweight gains grazing on a senesced ryegrass pasture with supplementation compared to sorghum at Manypeaks 2022

Description	Ryegrass	Sorghum
Paddock size (ha)	46	34
Stock numbers (head)	89	174
Stocking rate (steers/ha)	1.9	5.1
Supplementation bales of hay (2) and silage (4) per week	54	-
Weight in (kg lwt) or kg of liveweight	311	395
Weight out (kg lwt)	315	416
Weight gain (kg lwt) per steer	4	21
Average weight gain (grams/head/day)	63.5	1000
Total weight gain (kg lwt)	356	3654

Total weight gain (kg lwt/ha)	7.7	107.5
Weight gain (kg lwt/ha/day)	0.17	3.16

Table 19. Metcalfe 2021 forage sample analysis

NV Analysis	Ryegrass	Sorghum
Dry Matter (DM)	75.2 %	17.6 %
Moisture	24.8 %	82.4 %
Crude Protein	9.0 % of DM	10.0 % of DM
Acid Detergent Fiber	32.2 % of DM	30.8 % of DM
Neutral Detergent Fiber	61.7 % of DM	55.8 % of DM
Digestibility (DMD)	58.7 % of DM	69.2 % of DM
Digestibility (DOMD)	56.6 % of DM	65.4 % of DM
Est. Metabolisable Energy	8.5 MJ/kg DM	10.3 MJ/kg DM
Water Soluble Carbohydrates	4.0 % of DM	15.2 % of DM
Fat	3.0 % of DM	4.0 % of DM
Ash	3.7 % of DM	8.1 % of DM
Nitrate Nitrogen	-	220 mg/kg of DM
Cyanide (as Prussic acid)	-	<2.5 mg/kg
Dry Matter cuts (DM)	**Ryegrass**	**Sorghum**
g of 0.1m² quad	31.8	44.8
t/Ha	3.18	4.48

Figure 8. Summary of cumulative rainfall since October 13, 2021 until start of May 2022, at Metcalfe's digital rain gauge located next to the Sorghum paddock.

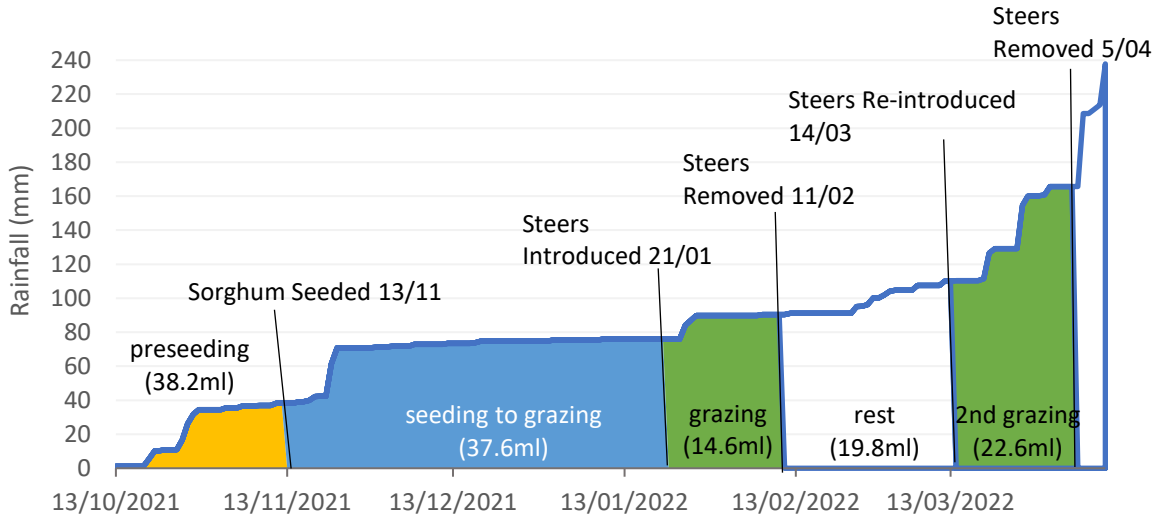


Table 20. Metcalfe 2021 soil sample results.

Site Name	Depth	pH (CaCl2)	Al CaCl2 (mg/kg)	PBI + P Col	P Col (mg/kg)	Texture	Sand (%)	Clay (%)
Sorghum	0-10	5.2	0.1	14	15	Sand	96.6	1
Ryegrass	0-10	4.7	1.6	53	58	Sand	96.8	1

In preparation for sowing a knock down spray was used consisting of - 2L roundup and 1L insecticide pyrinexSuper. The sorghum was sown on the 13th November and nine days later received a 30mm rainfall event (Fig.8). No fertiliser or crop protection was used on the sorghum or ryegrass paddocks.

4.1.7 Tim Metcalfe, Clover / Ryegrass pasture vs Winter wheat (DS Bennet), year 3

The control paddock of clover and ryegrass pasture equated to 1.86t DM/ha across 25.5ha and the Bennett wheat averaged 3.88t/h across 85ha (Table 21). Both feed sources were relatively comparable in quality, with the Bennett being slightly higher quality (Table 22). Both had comparable crude protein at ~20%, with Bennett having ~5% less acid detergent fiber (ADF). ADF is the least digestible component of the plant, so the Bennett has a slightly better digestibility than the clover and ryegrass pasture. The Bennett winter wheat also had a higher metabolisable energy (ME) of 12.9MJ/kg DM compared to 10.6 MJ/kg DM in the clover ryegrass mix (Table 22). This extra biomass and quality allowed the DS Bennett to support a higher stocking rate of 2.5 heifers/ha, compared to the 1.4 steers/ha on the clover rye mix (Table 21). The DS Bennett therefore produced an extra 17kg LWT/ha (Table 21). However, there are other benefits DS Bennett can provide in regard to the versatile options available post grazing. These include to either graze again, lock up for silage or take through to grain production. Tim took full advantage of these options and locked some up for silage and took the better parts through to grain.

Table 21. Metcalfe yearling cattle liveweight gains grazing on a clover ryegrass pasture compared to Bennet winter wheat at Porongurup 2022.

Description	Clover Rye Pasture	Winter wheat (DS Bennet)
Grazing duration days	40	40
Paddock size (ha)	25.5	85
Stock numbers (head)	35	210
Stocking rate (yearling cattle/ha)	1.4	2.5
Weight in (kg lwt) or kg of liveweight	389	385
Weight out (kg lwt)	463	433
Weight gain (kg lwt) per head	74	48
Average weight gain (kg/head/day)	1.85	1.2
Total weight gain (kg lwt)	2590	10080
Total weight gain (kg lwt/ha)	101.5	118.6
Weight gain (kg lwt/ha/day)	2.54	2.97

Table 22. Metcalfe 2022 forage sample analysis

NV Analysis	Clover Rye pasture	DS Bennett
Dry Matter (DM)	18.5 %	14.9 %
Moisture	81.5 %	85.1 %
Crude Protein	20.0 % of DM	21.7 % of DM
Acid Detergent Fiber	22.1 % of DM	17.3 % of DM
Neutral Detergent Fiber	42.5 % of DM	37.9 % of DM
Digestibility (DMD)	71.1 % of DM	84.3 % of DM
Digestibility (DOMD)	67.1 % of DM	78.2 % of DM
Est. Metabolisable Energy	10.6 MJ/kg DM	12.9 MJ/kg DM
Fat	5.6 % of DM	6 % of DM
Ash	9.8 % of DM	9.6 % of DM
Dry Matter cuts (DM)	**Clover Rye pasture**	**DS Bennett**
g of 0.1m² quad	18.63	38.83
t/Ha	1.86	3.88

Figure 9. Summary of cumulative rainfall since March 15, 2022 until August 10, 2022, at a nearby digital rain gauge located close to the demonstration site.

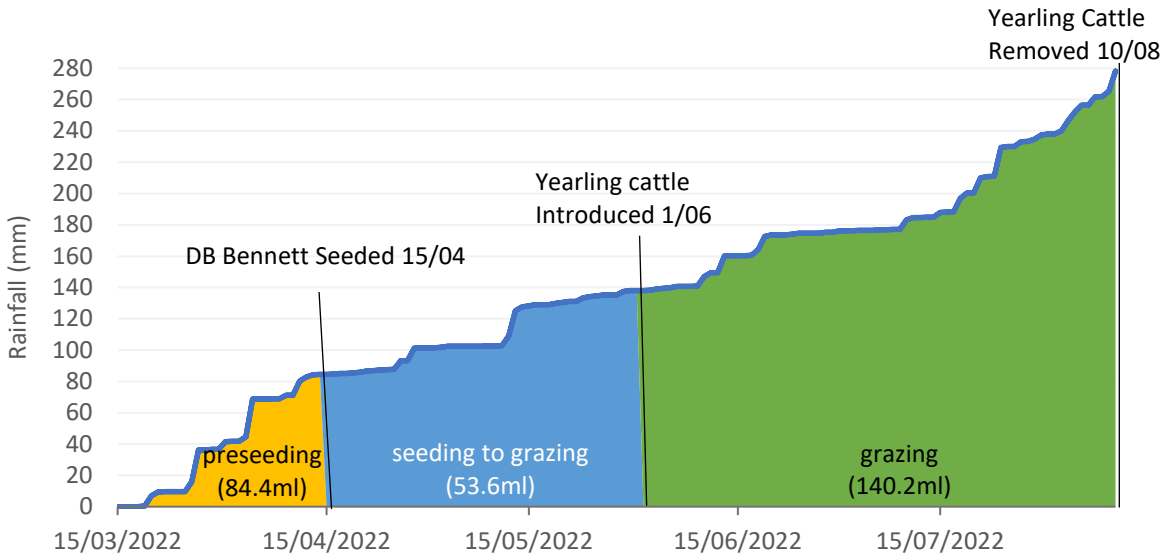


Table 23. Metcalfe 2022 soil sample results.

Site Name	Depth	pH (CaCl2)	Al CaCl2 (mg/kg)	PBI + P Col	P Col (mg/kg)	Texture	Sand (%)	Clay (%)
Clover ryegrass	0-10	4.9	1.4	101	48	Sandy loam	80.8	10.1
DS Bennet	0-10	5.3	0.1	133	64	Sandy loam	81	11.6

In preparation for sowing a double knock down spray was used consisting of - 2L glyphosate and Le-Mat for red legged earth mites (RLEM) followed by Paraquat at 1.5L/ha and Sekura 118g/ha. A Box of gold selective herbicide was applied a few weeks after at 2.5L/ha. The DS Bennett was sown on the 15th April at 115kg/ha. Fertiliser input include 150kg of super potash 3:1 top dressed with 80L of Flexi N per ha.

4.1.8 Clare Webster, Ryegrass clover pasture vs Millet, year 3

The Shirohie millet was sown at 8kg/havon the 26th and 27th October 2022 and received no fertiliser or crop protection. The millet had a much higher feed quality compared to the senesced clover rye pasture (Table 25). Millet oat mix had a 40% higher metabolisable energy and 22% higher crude protein. The millet oat mix also had a higher digestibility of 68.7% compared to 52% in the clover ryegrass pasture (Table 25). Even though the Millet had slightly less dry matter, 1.2t/h compared to 1.5t t/ha for the clover ryegrass pasture (Table 25). The higher feed quality led to increased weight gain of lambs on the millet, averaging 1kg/hd over the 12 days (Table 24). Keep in mind this was a very short crash grazing event due to the millet having stunted growth and showing signs of heat and moisture stress Clare wanted to use the feed before it was lost. Both mobs received a bit of supplementation via lick feeders in their paddocks. The control lambs on the clover

rye pasture received an extra 250g/hd/day of Home n' Dry mix while the millet lambs received an extra 3 bales of oaten hay over the 12 days (Table 24).

Table 24. Webster merino lamb liveweight gains grazing on a ryegrass clover pasture compared to Shirohie millet at Tenterden January 2023

Description	Ryegrass clover pasture	Millet
Grazing duration days	12	12
Paddock size (ha)	20	26
Stock numbers (head)	100	1000
Stocking rate (lambs/ha)	5	38.46
Weight in (kg lwt) or kg of liveweight	30	30
Weight out (kg lwt)	30	31
Weight gain (kg lwt) per lamb	0	1
Average weight gain (grams/head/day)	0	83.3
Total weight gain (kg lwt)	0	1000
Total weight gain (kg lwt/ha)	0	38.5
Weight gain (kg lwt/ha/day)	0	3.21
Supplementation		
oaten hay bales	0	3
Home n' Dry mix (g/hd/day)	400	150

Table 25. Webster 2023 nutritive value analysis of each forage, supplementation and biomass available before grazing.

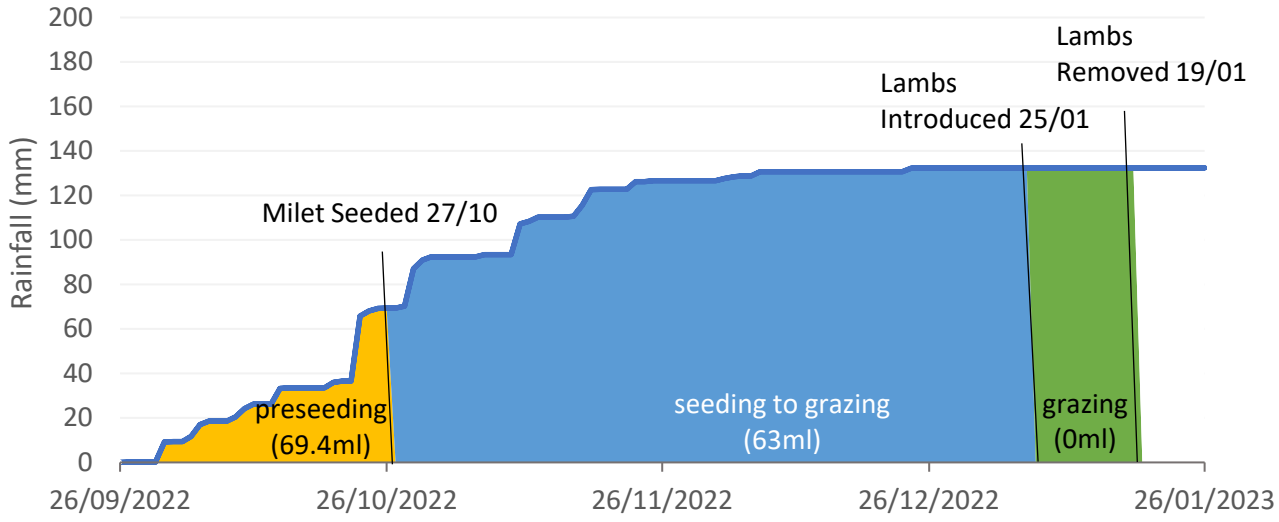
NV Analysis	Ryegrass Clover Pasture	Millet Oat Mix	Supplementation (Home n' Dry mix)	Supplementation Oaten Hay
Dry Matter (DM)	86.7 %	28.6 %	88%	89.9 % of DM
Moisture	13.3 %	71.4 %	12%	10.1 % of DM
Crude Protein	5.9 % of DM	7.2 % of DM	-	5.0 % of DM
Protein (N x 6.25)	-	-	21.6 % of DM	-
Acid Detergent Fiber	35.8 % of DM	26.8 % of DM	-	30.5 % of DM
Neutral Detergent Fiber	70.0 % of DM	54.9 % of DM	-	57.0 % of DM
Digestibility (DMD)	52.0 % of DM	68.7 % of DM	87.9 % of DM	58.9 % of DM

Digestibility (DOMD)	50.8 % of DM	65.0 % of DM	-	56.7 % of DM
Est. Metabolisable Energy	7.3 MJ/kg DM	10.2 MJ/kg DM	13.5 MJ/kg DM	8.5 MJ/kg DM
Fat	2.7 % of DM	4.6 % of DM	-	2.5 % of DM
Ash	7.2 % of DM	7.4 % of DM	2.1 % of DM	2.1 % of DM
Dry Matter cuts (DM)				
g of 0.1m² quad	15.1	11.9		
t/Ha	1.5	1.2		

Table 26. Webster 2023 soil sample results collected on January 12, 2023.

Site Name	Depth	pH (CaCl2)	Al CaCl2 (mg/kg)	PBI + P Col	P Col (mg/kg)	Texture	Sand (%)	Clay (%)
Clover rye pasture	0-10	5.4	0.1	91	80	Sandy loam	76.5	14.5
Millet	0-10	4.7	2.6	71	61	Loamy sand	88.4	5.1

Figure 10. Summary of cumulative rainfall since September 26, 2022 until January 26, 2022, at a nearby digital rain gauge located close to the demonstration site on the corner of Balijup and Nunijup rd.



4.2 Economic analysis

4.2.1 Pallaton Raphno

Table 27. Cost for planting Pallaton Raphno crop, seeding and spraying costs are calculated at contract prices.

	Year 1	Year 2
Description	**Raphno Costs ($/ha)**	**Raphno Costs ($/ha)**
Seeding (contract)	$ 70.00	$ 70.00
Glyphosate ($6/Lt)	-	$ 12.00
Spraying (contract)	$ 8.00	$ 8.00
Seed (8kg/ha Raphno)	$ 285.00	$ 285.00
AMS	-	$0.10
Li 700	-	$0.20
Alpha Cypermethrin 160ml	-	$ 1.32
Hammer 20ml ($900 5L)	-	$ 3.60
Fertilizer pre-seeding (K-Till Extra $ 720 /t) (120kg/ha)	-	$86.4
Flexi N 50L/Ha ($600/t) (1.32t per cubic meter (1000L))	-	$ 39.60
Flexi N 100L/Ha ($600/t) (1.32t per cubic meter (1000L))	$ 79.20	-
Crop protection (DBM spray) ($1470/20L)	$ 11.10	$ 11.10
Total	**$ 453.3**	**$ 517.32**

Table 28. Comparison of the value contributed to the farming enterprise by the Raphno, and ryegrass regrowth, Year 1.

Description	Ryegrass	Raphno
Liveweight kg/hd at the start (dressed weight kg/hd)	49 (21.07)	42.5 (18.3)
Liveweight kg/hd at the end (dressed weight kg/hd)	52.5 (22.6)	48 (20.63)
Value of lambs		
Store lambs (at weigh in) @ 599 c/kg cwt	126	

Store lambs (at weigh in) @ 616 c/kg cwt		112
Finished lambs @ 737 c/kg cwt	166	
Finished lambs @ 728 c/kg cwt		150
Total value	14,400	53,200
Revenue generated per ha	480	1,182
Minus costs for Raphno @ $453.30/ha*		
Profit (calculated per ha)	480	729
Profit (above starting condition)	14,400	32,805

Table 29. Comparison of the value contributed to the farming enterprise by the Raphno, and canola stubble with volunteer pasture, Year 2.

Description	Canola Stubble	Raphno
Liveweight kg/hd at the start (dressed weight kg/hd)	38.2 (16.4)	40.1 (17.2)
Liveweight kg/hd at the end (dressed weight kg/hd)	41.4 (17.8)	46.4 (20)
Value of lambs		
Store lambs (at weigh in) @ 683 c/kg cwt	112	118
Finished lambs @ 827 c/kg cwt	147	
Finished lambs @ 834 c/kg cwt		166
Total value	23,450	75,840
Revenue generated per ha	781	1,285
Minus costs for Raphno @ $517.32/ha*		
Profit (calculated per ha)	781	768
Profit (above starting condition)	23,450	45,312

4.2.2 Shirohie millet

Table 30. Comparison of the value contributed to the farming enterprise by the Millet, and Barley stubble, Year 1.

Description	Barley stubble	Millet
Liveweight kg/hd at the start (dressed weight kg/hd)	42.4 (18.23)	41.7 (17.93)
Liveweight kg/hd at the end (dressed weight kg/hd)	46.0 (19.78)	49.3 (21.2)
Value of lambs		
Store lambs (at weigh in) @ 593c/kg cwt		106
Store lambs (at weigh in) @ 616c/kg cwt	112	
Finished lambs @ 728 c/kg cwt		154
Finished lambs @ 729 c/kg cwt	144	

Total value	18,816	24,000
Revenue generated per ha	117	266
Minus costs for planting Millet @ $90/ha		
Profit (calculated per ha)	117	176
Profit (above starting condition)	18,816	15,900

Table 31. Comparison of the value contributed to the farming enterprise by the Millet, and Barley stubble, Year 2.

Description	Barley stubble	Millet
Liveweight kg/hd at the start (dressed weight kg/hd)	42.7 (18.4)	41.6 (17.9)
Liveweight kg/hd at the end (dressed weight kg/hd)	48.8 (20.98)	46.5 (20)
Value of lambs		
Store lambs (at weigh in) @ 726 c/kg cwt	133	129
Finished lambs @ 862 c/kg cwt	180	172
Total value	5,640	12,900
Revenue generated per ha	94	161.25
Minus costs for establishing Millet @ $90/ha*		
Profit (calculated per ha)	94	71.25
Profit (above starting condition)	5,640	5,700

Table 32. Comparison of the value contributed to the farming enterprise by the Millet, and clover ryegrass pasture Year 3.

Description	Ryegrass clover pasture	Millet
Liveweight kg/hd at the start (dressed weight kg/hd)	30 (12.9)	30 (12.9)
Liveweight kg/hd at the end (dressed weight kg/hd)	30 (12.9)	31 (13.33)
Supplementation	Per head	Per head
Oaten hay bale x 3 @ $50/bale	0	0.15
400g/hd/day home n' dry mix @$350/t	1.68	
150g/hd/day home n' dry mix @$350/t	0	0.63
Total cost for supplementation	**168**	**780**
Costs of planting Millet @ $90 per hectare	0	2,340
Ryegrass clover	0	
Total costs including supplementation	**168**	**3,120**
Total cost per hectare	**8.4**	**120**

Value of lambs		
Store lambs (at weigh in) @ 522 c/kg cwt	67.00	67.00
Store lambs (out) @ 522 c/kg cwt	67.00	69.00
Total income generated		
Revenue generated per ha	0.00	77.00
Net income generated per hectare	-8.4	-43.00

4.2.3 Bunker Sorghum

Table 33. Comparison of the value contributed to the farming enterprise by Bunker sorghum and the ryegrass pasture, year 2.

Description	Ryegrass	Sorghum
Liveweight kg/hd at the start	311	395
Liveweight kg/hd at the end of grazing	315	416
Value @ 490 c/kg lwt*		
Value in	1,523	1,935
Value out	1,543	2,038
Total value	1,780	17,922
Minus costs:		
Hay x 6 rolls @ $75/roll	450	
Silage x 12 rolls @ 110/roll	1320	
Cost of establishing Sorghum @ $90/ha		3,060
Net income generated per hectare	10	437

4.2.4 Winter Wheat (DS Bennet)

Table 34. Comparison of the value contributed to the farming enterprise by the ryegrass clover pasture, and winter wheat, Year 3.

Description	Ryegrass clover pasture	Winter wheat (DS Bennet)
Liveweight kg/hd at the start	389	385
Liveweight kg/hd at the end of grazing	463	433
Value		
Value @ 490 c/kg lwt		
Value of yearling cattle at the start	1,906	1,886
Value of yearling cattle at the end of grazing	2,269	2,122
Total value (above starting condition)	12,705	49,560
Revenue generated per ha	498	583
*Other revenue:		1,292

Minus costs:		
Cost of sowing Bennet wheat @ $90/ha		
Net income generated per hectare	498	1,785

*Other revenue from the Winter Wheat was made up from 290 rolls of silage and 3.6t/ha of grain harvested. The silage rolls were ~700kg each produced from 17 hectares valued at $110 per roll minus $35 cost for mowing, baling, and wrapping equating to $1279/ha. The grain yielded 3.6t/ha on 68 hectares valued at $360 per tonne equating to $1296/ha.

4.2.5 Result of the economic analysis undertaken.

Limitations of this analysis include that the profit is calculated over the measured grazing period only and does not take into account future life of the crop and future grazing opportunities or other streams of revenue. This is particularly important for alternate forage species such as Bunker sorghum, DS Bennet wheat and Pallaton Raphno that after a spell support multiple grazing events and possibly hay, silage or even grain production. It is even more important for alternate forages that have a large outlay such as Pallaton raphno which to seed and establish costs over $450 per/ha.

The alternate forage species consistently produced a greater revenue per ha ranging with an increase from $67-$702/ha compared to the traditional feed source grazed and averaging an extra $300/ha. This did not however reflect a consistently higher net return once cost of establishment had been taken into account. Net return varied from an increase of $427/ha to a loss of -$34.6/ha equating to an average net benefit of $94.2/ha across all sites and years.

It is important to note that all grazing events of alternate forage or traditional feed source were profitable except for one scenario where supplementation was required for the millet and traditional feed source. From the economic analysis performed the alternate forage species outperformed their compared traditional feed source 3 out of 7 times. For two out of the seven times, the alternate forage was within $5 to $13 /ha of the traditional feed source. Pallaton Raphno made $13/ha less than the canola stubble with volunteer pasture, however still produced $768/ha. This is quite an incredible feat seeing as establishment costs were at $517/ha. After this grazing, the canola stubble with volunteer pasture had been completely exhausted and all lambs were combined on the Pallaton Raphno stocked at 38 lambs/ha for another 3 weeks, weights were not recorded so was not included in the analysis.

DS Bennet winter wheat made $5/ha less than the clover rye pasture it was compared to. This did not take into account the extra silage and grain the alternate forage went on to produce creating approximately $1,292/ha of extra revenue. The only alternate forage to record a loss of $43/ha was Millet and the traditional feed source also recorded a loss of $8/ha. This was partly due to the crop experiencing a poorly timed cold front within the first two weeks of seeding that caused stunted growth. With crop also experiencing moisture and heat stress prior to grazing.

4.3 Extension and communication

Table 35. Extension and communication activities undertaken throughout the PDS.

Activity type	Date/Audience	(Number of attendees/engagements)

Initial meeting with producers	Early 2020 - Core producers	10 core producers have all been contacted, project method has been established. First field walk was organised for Friday 31 July 2020.
Field Walk	31st July 2020 - Core producers and observers	Field walk, Topic – How do I get more feed for livestock in the Albany region. 50 people attended the walk. *Refer to appendix 1.*
Field Day	14 May 2021 - core and observer producers	A Livestock Matters forum was held at Manypeaks. This was a WALRC event, but SCF was represented and our report on the year one project results was shared with participants. This forum also visited Kent Rochester's farm, one of the PD sites. ~70 attendees
Event presentation	5th August 2021 – Meatup delegates	Phil Honey presented at MLA Meatup in Perth, 120 attendees. Talked about the MLA project and outcomes.
Field Walk	18th November 2021 – West Midlands Group Student field walk students	Phil Honey had a paddock discussion on importance/benefits of alternative forages – 61 people.
Event presentation	5th May 2022 – UWA students	Phil Honey discussed the importance/benefits of alternate forages – 70 people
Workshop	13th & 14th June 2022 Producer Technology Workshop attendees	Phil Honey talked about the MLA project and outcomes – 33 people
Event presentation	16th August 2022 GRDC Updates – attendees Observer producers	GRDC Moora Updates. Phil Honey discussed the MLA PDS and outcomes observed so far – 32 people
Workshop	26th August 2022 workshop – attendees Observer producers	Climate Sciences Workshop – 12 people Technologies discussed to improve farm management decisions. Pyle PDS site year 2 was an example.
Field Day	22nd September 2022 – core and observer producers	SCF hosted its annual Spring field day. One of the field stops was at Tim Pyles PDS where Tim discussed his 2020 results. Tim Metcalfe also discussed his experience with alternate forages. - 71 people were in attendance.
Event presentation	24th March 2023 - attendees	SCF attend Pasturama in Manjimup in March 2023. Where we presented results from two of the PD sites. Approximately 100 people were in attendance.

		Refer to appendix 2.
video creation	25th March 2021 - SCF producers and other mixed farming enterprises	SCF produced a short video on Pyle's PDS project, summarising the 2020 results. Uploaded to our YouTube channel on 25/03/21. Currently the video has 127 views as of 1/05/2023. https://www.youtube.com/watch?v=AMKTqhW_m8I - Published on our YouTube channel, website, with links posted on twitter and Facebook. - Facebook post had 159 impressions. (18/01/22) - Twitter post had 1468 impressions with 50 engagements. (18/01/22)
video creation	23rd March 2022 – SCF producers, other mixed farming enterprises	SCF produced a short video on Pyle's PDS project, summarising the 2021 results. Uploaded to our YouTube channel on 23/03/22 and had 45 views as of 1/05/23. https://www.youtube.com/watch?v=IZlSC9kDuCg - Published on our YouTube channel, website, with links posted on twitter and Facebook. - Facebook post had 141 impressions. - Twitter post had 474 impressions with 9 engagements.
Case studies	29 May 2023 - Core and observer producers	3 Case studies have been produced. - Sheep on Raphno. - Sheep on Millet. - Cattle on DS Bennet. *Refer to appendix 3,4,5.*
Newsletter article	June 2020 - SCF members, core, and observer producers, and wider audience	Introductory article to MLA PDS project explaining the purpose and aims of the PDS and calling for hosts and core producers published in the SCF Focus Winter edition 2020. *Refer to appendix 6.*
Newsletter article	December 2020 – SCF members, core, and observer producers, and wider audience	Article on the happenings at the Pyle PDS site published in the SCF Focus Summer edition 2020. *Refer to appendix 7.*

Newsletter article	March 2021 – SCF members, core, and observer producers, and wider audience	A news article was published in our SCF Focus newsletter autumn edition 2021 highlighting the Pyle site results. Reach of the newsletter is 215 people. *Refer to appendix 8.*
Newsletter article	December 2021 – SCF members, core, and observer producers, and wider audience	An article was published in our 2021/22 summer newsletter, summarising initial data collected at Pyle's PDS. *Refer to appendix 9.*
Trials Review Booklet 2020	May 2020 – SCF members, core, and observer producers, and wider audience	Three articles, one on each MLA PDS was published in our 2020 trials review book. Distributed to 213 people in the month of May. 120 hard copies were also issued. *Refer to appendix 1.*
Newsletter article	March 2022 –SCF members, core, and observer producers, and wider audience	A news article was published in our SCF Focus newsletter autumn edition 2022 highlighting the Pyle site results. Reach of the newsletter is 230 people. *Refer to appendix 10.*
Newsletter article	September 2022 - SCF members, core, and observer producers, and wider audience	A news article was published in our SCF Focus newsletter Spring edition 2022 introducing the Metcalfe PD site of DS Bennet. Reach of the newsletter is 230 people. *Refer to appendix 11.*
Newsletter article	March 2023 - SCF members, core, and observer producers, and wider audience	A news article was published in our SCF Focus newsletter Autumn edition 2023 highlighting the Metcalfe site results. Reach of the newsletter is 230 people. *Refer to appendix 12.*
Trials Review Booklet 2021	June 2021 - SCF members, core, and observer producers, and wider audience	Three articles, one on each MLA PDS was published in our 2021 trials review book. Distributed to 230 people in the month of June. 130 hard copies were also issued. *Refer to appendix 13.*
Trials review booklet 2022	June 2022 - SCF members, core, and observer producers, and wider audience	Two articles, one on each year three MLA PDS site was published in our 2022 trials review book. Distributed to 230 people in the month of June. 130 hard copies were also issued. *Refer to appendix 14.*

SCF Website	Life of Project - SCF members, core, and observer producers, and wider audience	All newsletter articles, Trial review booklet articles and videos created, relating to the project are uploaded to the project page on the website.
SCF Website - MLA PDS Alternate forages project page	Core producers, observer producers and the wider audience	For the life of the PDS SCF received 275 views the MLA PDS project page on our website. https://www.scfarmers.org.au/alternate-forage-crops

4.4 Monitoring and evaluation

4.4.1 Analysis of Pre and post survey reports:

Pre and post surveys were undertaken to assess core and observer producers' current level of knowledge, attitude, skills and aspirations in regards to the use of alternate forage crops in their enterprise in the South West of WA. The summarised findings of these surveys are presented below.

From the responses collected for the post project survey 10 respondents were core producers and 9 were observer producers. There was an overwhelmingly positive response to the PDS with no one being satisfied less than 6 out of 10 with an average satisfaction rating of 8.3 out of 10 (Fig. 11). Producers felt they got a range of value out of the PDS from between 3 and 10 with an average value of 6.8 out of 10 (Fig. 12).

Figure 11: Producers responses to how satisfied they were with the PDS.

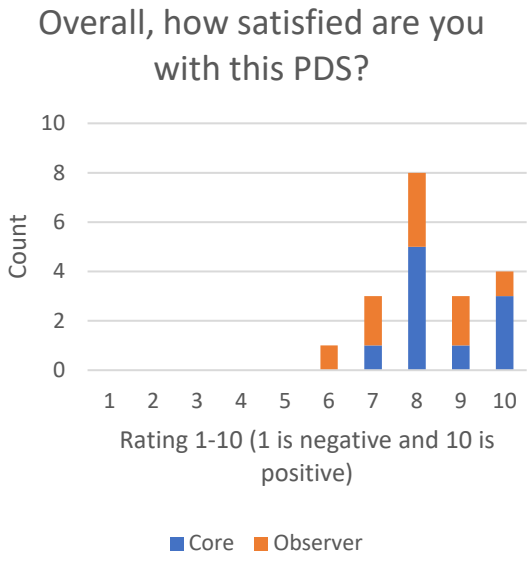
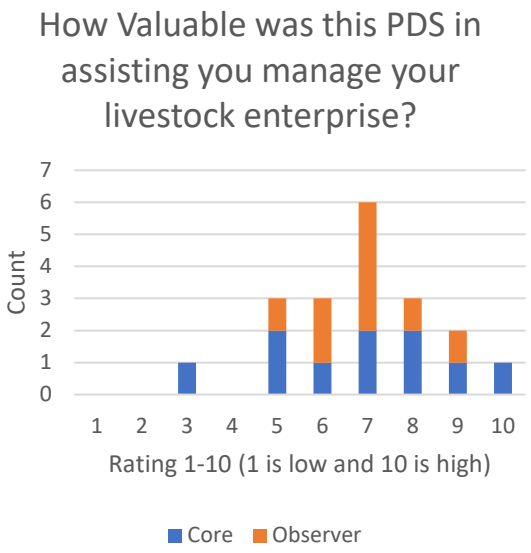


Figure 12: Producers responses to how valuable they found the PDS.



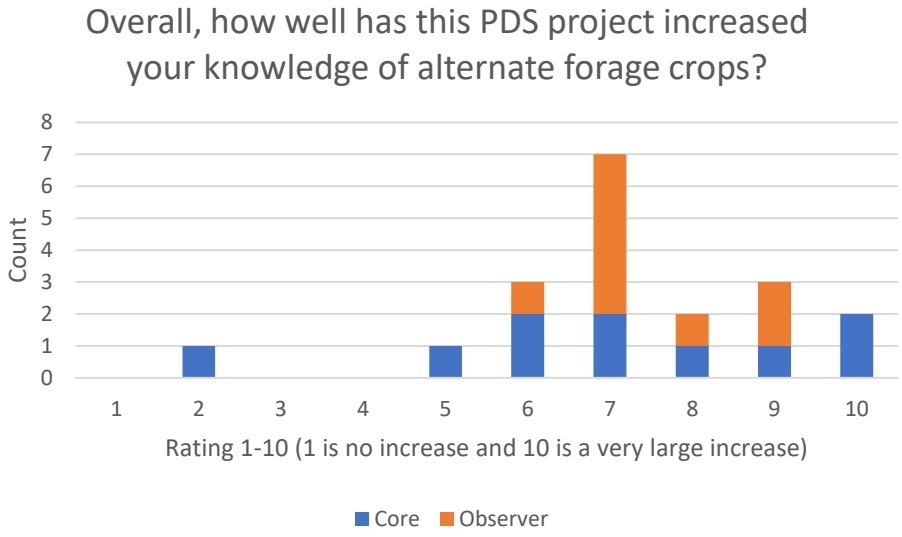
Out of the responses collected for the post project survey there wasn't a producer that would not recommend MLA's PDS program to others.

Table 36. Feedback from core and observer producers to improve the PDS program.

Please provide any feedback to help us improve the PDS program:	
Core	Alternate forages are all good in theory, didn't work for us with the Millet and the weather. There should be a trial of more forage types, but I guess it also depends on what the farmer is doing. Guarantee some rain. (Improve forecasting)
Core	More trials and getting more people to be involved. What worked at Metcalfe's didn't work to the same extent at our place. Need to get a bigger spectrum to see how everyone uses it in their system. More replications.
Core	Great to have relevant data/projects on topics that will improve sheep system. Having to bring sheep in to weigh takes at least 2-3 hours each time. Having walk over weigh stations or another system would make these projects a lot more user friendly.
Core	Access to industry practice gives the producer drive to put the most effort into the project. Only problem was weather conditions that hampered our plantings.
Core	There needs to be some benefit to the host farmers in PDS as there is a time and cost involved
Observer	More demonstration sites in different areas. More scenarios to get more reliable data.
Observer	3 years was a good amount of time to run the trial to capture seasonal variation. It is important to try these things across multiple different seasons.
Observer	I didn't know much about it before.

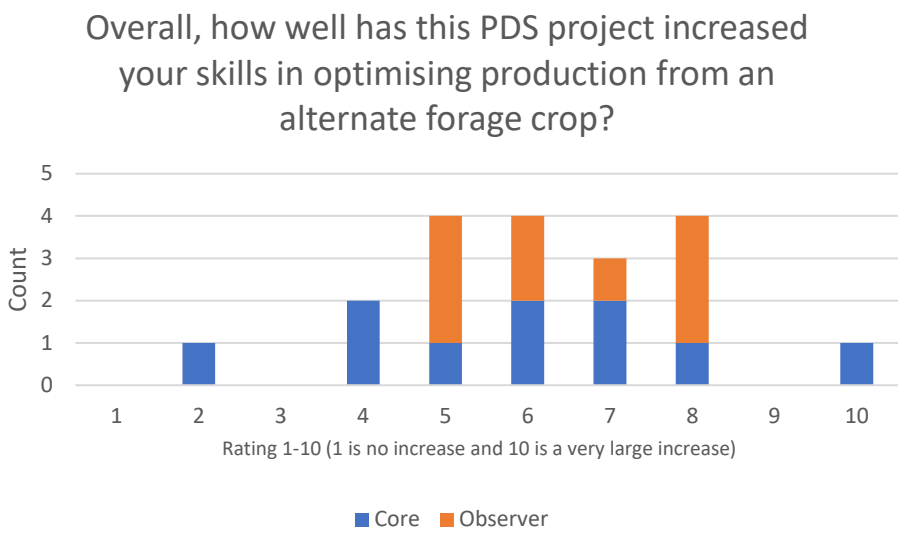
Producers surveyed improved their current knowledge of alternate forage crops from a little (2/10) to a very large (10/10) increase. On average producers felt they had a large increase of 7.2 out of 10 (Fig. 13).

Figure 13. Producers responses to how well the PDS project has increased their knowledge of alternate forage crops.



Overall, producers thought that this PDS project increased their skills in optimising production from an alternate forage crop at a level of 6.2 out of 10 where a rating of 1 is no increase and a rating of 10 is a very large increase Fig. 14.

Figure 14. Producers responses to how well the PDS project has increased their skills in optimising production from an alternate forage crop.



Producer's current level of confidence in growing alternate forage crops in Southern WA can be averaged at 6.9 out of 10 (Fig. 16). compared to an average of 5.8 out of 10 recorded for the pre-project survey (Fig. 15). This shows that on average all core and observer producers have increased their level of confidence to grow an alternate forage crop in Southern WA. When broken down core producers experienced a 14% increase in confidence and observers experienced a 24% increase in confidence to grow an alternate forage crop in Southern WA.

Figure 15. Pre project survey core and observer producers confidence level to establish and manage an alternate forage

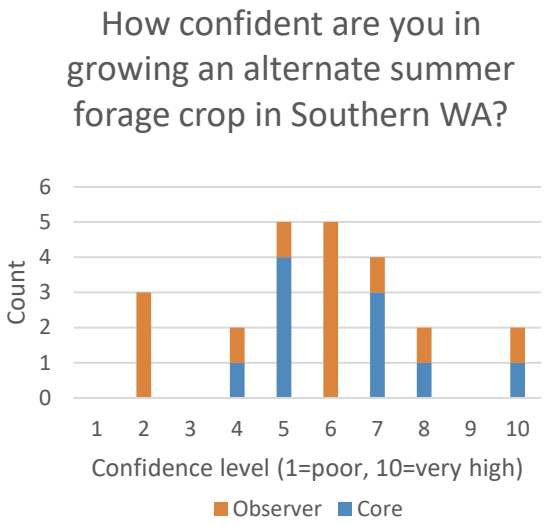
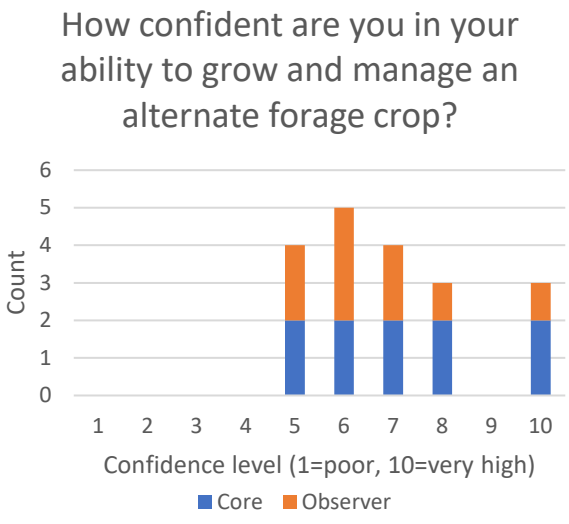


Figure 16. Post project survey core and observer producers confidence level to establish and manage an alternate forage



When it comes to practice implementation 58% of respondents currently implement growing an alternate forage crop, up from 48% in the pre-survey. Another 21% of respondents say they intend to grow an alternate forage captured in the post survey. Similar percentages were recorded for the practice of grazing an alternate forage, with only one respondent who had implemented growing

alternate forages but had not grazed alternate forages prior to 2020. When it came to selling stock as stores or in finished condition, it was found that the practice was either implemented prior to the PDS or the producer had no intention to implement.

For those that plant and graze an alternate forage, 91% have implemented the practice on less than a quarter of their enterprise, with one producer having implemented the practices on 50-75% of their enterprise.

Forty percent of core producers consider planting an alternate summer forage crop as part of their normal practice, up from 30% reported in the pre-survey. An even larger change was witnessed in the observer producers where currently 33% consider planting an alternate forage as part of their normal practice, up from 15% previously. Practice change observed showed an extra 10% of core producers and an extra 18% of observer producers consider planting an alternate summer forage crop as part of their normal practice.

Figure 17: How often core producers use each practice.

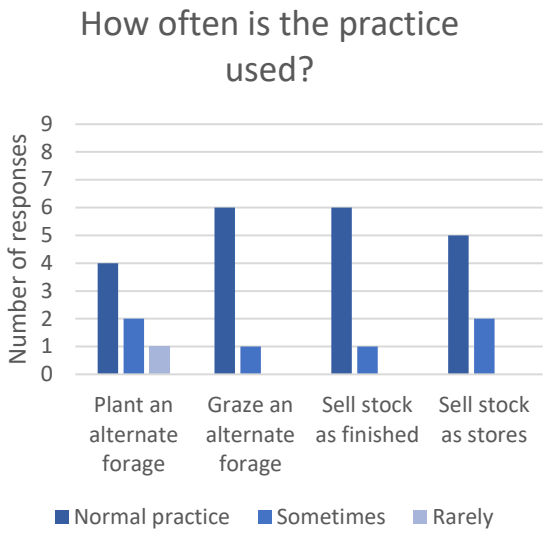
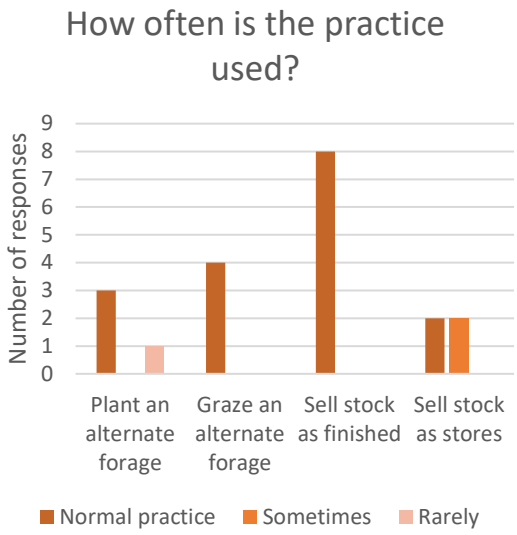


Figure 18: How often observer producers use each practice.



When it came to the reason why certain practices were not implemented the most common response was that there was not a significant need on their property. This reflects the variety of ways a farming enterprise can be run with some producers targeting 100% the store market with others having the ability to finish 100% of their own stock and take advantage of that higher priced market. When it came to growing and grazing an alternate forage crop, 50% and over of producers once again felt there wasn't a significant need on their property. Other reasons include limited rainfall and having tried it without enough perceived benefit to continue the practice. None of the practices were not implemented due to lack of skill, funds or time.

In summary, producer's knowledge has been improved and attitudes are starting to change. As value is observed and knowledge is increased so too is producer's confidence in the practice. On top of the 58% of respondents who currently implement growing an alternate forage crop another 21% of respondents say they intend to. All of the producers surveyed had the skills required to grow or

manage an alternate forage crop. The largest barrier to uptake appears to be the producer's own enterprise setup and their willingness to change. It is easier to remain how they are setup currently and not change their practices without seeing a large benefit to their bottom line to prompt the change. However practice change does occur and over three years we observed an 11% increase in producers confidence and 8 producers (5 core and 3 observer) increased the hectares of alternate forage grown and grazed between 10-250 ha with an average increase of 135ha.

Adoption benefits recorded by implementing the demonstrated practice such as $/hd saved on supplementary feed costs were hard to determine seeing as very few producers actively measure the economic benefits to every practice implemented. Only two producers partly answered the final question where savings were $11.52 for one producer who calculated they saved 300g/day over 120days for 1000ewes at $320/t. Another producer responded that it enabled them to hold off from supplementary feeding lupins for 2 weeks. No changes in stocking rate were observed and no producers actively went out to purchase more animals, with all just grazing the alternate forage with stock on hand.

5. Conclusion

Alternate forage species remain a viable option to increase red meat produced per hectare in southern WA. A contributing factor was the ability for all alternate forage species to support a higher stocking rate than the alternative traditional feed source. All alternate forage species recorded a higher nutritional value than their traditional feed source counterparts along with increased live weight gain per hectare. However, this did not always lead to an increased net profit. It is a tall ask for the alternate forage crops measured to make back the cost of implementation from one grazing event. Especially when the life of the forage often continues for many months. To observe more accurate production benefits for each forage, measurements could be taken either over a full year or for the life of the forage rather than just one grazing event. This, of course was out of the scope of this current PDS project.

Key challenges remain with adoption. The project experienced some success with practice change occurring in 10% core and 18% observer producers now consider planting an alternate summer forage crop as part of their normal practice. Yet more encouragement is required for producers to take the next step of increasing enterprise carrying capacity. Barriers to adoption still exist and the majority of producers perceive there to be no significant need on their property to encourage practice change. In other words, they are happy with where they are, and the system they currently implement works for them.

Knowledge gaps exist around induction protocols for cattle on Pallaton Raphno. There were issues with initial weight gain that were overcome once a slow induction was implemented over the first week of grazing. Further research is required to flesh out the induction protocols for different classes of stock e.g. weaner cattle vs lactating cattle vs dry cows on Pallaton Raphno. The same difficulties around induction were not observed by lambs grazing Pallaton Raphno.

5.1 Key Findings

Four alternate forage species including Pallaton Raphno, Shirohie Millet, Bunker Sorghum and DS Bennet were trialled over three years. Some key findings are presented below.

- All alternate forage species recorded a higher nutritional value than their control comparison which was either a stubble or established pasture.

- All except one alternate forage species recorded consistently higher biomass compared to their control. Of the forages trialled, only millet consistently yielded less.
- A higher nutritional value partly contributed to all alternate forages being able to support a higher stocking rate of between 20-168% than the traditional feed source they were compared to.
- More liveweight per hectare was always produced by the alternate forage. However, none more so than Pallaton Raphno, where lamb live weight gain was a staggering 5.35kg/ha/day compared to 1.31kg/ha/day achieved on the ryegrass in year one.
- The improved weight gain per/ha did not always equal increased profit per ha once establishment costs were taken into account. However, profit was only recorded over the short grazing period measured and a more accurate profit would require measurements being recorded over a year or the life of the alternate forage.
- All core and observer producers have increased their level of confidence to grow an alternate forage crop in Southern WA. Producer's current level of confidence in growing alternate forage crops in Southern WA can be averaged at 6.9 out of 10 (Fig. 16). compared to an average of 5.8 out of 10 recorded for the pre-project survey (Fig. 15).
- Practice change includes an extra 10% of core producers and an extra 18% of observer producers consider planting an alternate summer forage crop as part of their normal practice.

2020 – Pallaton Raphno vs ryegrass

- Pallaton Raphno had a higher nutritional value (NV) than the ryegrass control, with a higher crude protein, digestibility and metabolisable energy.
- Raphno and ryegrass had similar biomass of 3t/ha and 3.8t/ha respectively.
- Excellent weight gain was achieved on the Raphno with 62.5g/head/day more than the ryegrass regrowth.
- The ability of Raphno to grow under grazing pressure and produce leaf material allowed a much higher stocking density with 1400 lambs on 45ha, (31 lambs/ha), compared to 360 lambs on 30 hectares (12 lambs/ha).
- Lamb live weight gain measured in kg/ha/day was a staggering 5.35kg/ha/day for the Raphno compared to 1.31kg/ha/day achieved on the ryegrass.

2020 millet vs barley stubble – Smith

- The alternate forage crop (millet) had a higher NV than the barley stubble, with a higher crude protein, digestibility and metabolisable energy.
- There was a much greater biomass in the control barley stubble 3.5t/ha than the 1.2t/ha of millet.
- Millet growth was highly variable and showed signs of heat and moisture stress before grazing.
- Despite the environmental stress the millet had an average daily gain (ADG) of 253g/head, which was over double the 120g/hd/day achieved by the barley stubble.

2020 Pallaton Raphno vs Opti weigh system

- Successful cattle induction to Raphno was challenging to achieve. Best results were attained when weaner cattle were moved off Raphno onto pasture each day over the first week, slowly introducing them to longer grazing periods on the Raphno.
- Poor induction for the first grazing event saw steers reduce their Average Daily Gain (ADG) from 2kg/day on rye clover pasture down to 0.08kg/day on Raphno.
- Second grazing event by growing weaner cattle received a better induction and heifers slowly built up to and maxed out at 1kg ADG.
- The Optiweigh system is a game changer to better understand different forages and how different grazing systems influence weight gain and pasture utilisation.

2021 Pallaton Raphno vs Canola stubble – Pyle

- Pallaton Raphno had a higher nutritional value (NV) than the canola stubble control. This included a higher crude protein, digestibility and metabolisable energy.
- Excellent weight gain was achieved by lambs on the Raphno with 141g/head/day more than the canola stubble.
- The Raphno at 4.05t/ha produced over 160% more biomass than the canola stubble pasture of 2.54t/ha.
- Lamb live weight gain was 7.66kg/ha/day for the Raphno, which was more than double the canola stubble, at 3.57 kg/ha/day.

2021 Millet vs barley stubble – Smith

- The summer crop (millet) had a higher nutritional value than the barley stubble, higher crude protein, digestibility and metabolisable energy.
- There was a much greater biomass in the control barley stubble 3.34t/ha than the 1.66t/ha of millet.
- Millet growth was highly variable and showed signs of heat and moisture stress before grazing.
- Lambs on the barley stubble outperformed lambs on the millet with an ADG of 145g/head/day, gaining an extra 28g/hd/day.

2021 Bunker sorghum vs ryegrass pasture – Metcalfe

- The Sorghum had a higher nutritional value (NV) than the ryegrass pasture. Including safe levels of nitrate nitrogen and prussic acid.
- Steers achieved excellent weight gain on the sorghum averaging 1kg/head/day.
- A small weight gain of 63.5g/hd/day was achieved by steers on the Ryegrass with supplementation.
- Sorghum's great water use efficiency and ability for quick regrowth allowed for multiple grazing events over Summer and Autumn

2022 DS Bennet (winter wheat) vs clover ryegrass pasture – Metcalfe

- Winter wheat produced more than double the biomass at 3.88t/h across 85ha compared to the clover rye pasture that averaged 1.86t/ha across 25.5ha.
- Total livestock weight gain was 17.2kg/ha higher on the DS Bennet compared to the clover rye pasture.

- DS Bennet benefits extend beyond grazing. With 65ha being taken through to harvest and 17ha being cut for silage yielded 290 rolls at ~700kg equating to 12t/ha.

2023 Millet vs clover ryegrass pasture – Webster

- Millet oat mix had a higher nutritional value (NV) than the ryegrass clover control, with a higher crude protein, digestibility and metabolisable energy.
- Millet oat mix and ryegrass clover pasture had similar biomass of 1.2t/ha and 1.5t/ha respectively.
- Lambs on the millet had an average daily gain (ADG) of 83.3g/head, compared to 0g/head achieved by the lambs on the ryegrass clover mix.

5.2 Benefits to industry

Implementing and extending information on the use of alternate forage crops in this PDS has observed many benefits. These include an increase in stocking rate and an increase of kilograms of liveweight produced per hectare. Implications to the red meat industry include a greater turnoff of red meat with animals being ready for processing sooner. Increased turnover leads to increase profit. In addition, if farms can support a larger stock carrying capacity, an increase in the number of employees could be required. Thereby increasing the number of people employed by the Australian red meat and livestock industry.

Through the application of this PDS, producers have explored ways to manage the high variability in rainfall distribution to optimize the year-in-year-out feed base. If producers have more confidence in their feed base over the summer/autumn period, they would be able to increase flock or herd numbers and produce more meat and wool on a consistent basis. As a result of conducting this PDS, we have started to improve producers confidence in their own ability to grow and manage an alternate forage crop. The next step will be for producers to increase carrying capacity of their enterprise. Key challenges remain with adoption. The project experienced some success with practice change occurring in 10% core and 18% observer producers now consider planting an alternate summer forage crop as part of their normal practice. Challenges to adoption still exist and the main challenge identified, is producers own perception of the need for the practice change to occur.

6. References

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7. Appendix

7.1 Trials Review Booklet Article 2020 - MLA PDS SCF_TRB_2020

7.2 Powerpoint Presentation Alternate forage crops for Southern WA

7.3 Casestudy 1 - MLA Alternate _ Case Study _ Pyle

7.4 Casestudy 2 - MLA Alternate _ Case Study _ Smith

7.5 Casestudy 3 - MLA Alternate _ Case Study _ Metcalfe

7.6 SCF Newsletter Winter 2020 - MLA PDS SCF_Focus_Winter_2020

7.7 SCF Newsletter Summer 2020 - MLA PDS SCF_Focus_Summer_2020

7.8 SCF Newsletter Autumn 2021 - MLA PDS SCF_Focus_Autumn_2021

7.9 SCF Newsletter Summer 2021 - MLA PDS SCF_Focus_Summer_2021

7.10 SCF Newsletter Autumn 2022 - MLA AF SCF_Focus_Autumn_2022

7.11 SCF Newsletter Spring 2022 - MLA AF SCF_Focus_Spring_2022

7.12 SCF Newsletter Autumn 2023 - MLA AF SCF_Focus_Autumn_2023

7.13 Trials Review Booklet Article 2021 - MLAAlternate_SCF_TRB_2021

7.14 Trials Review Booklet Article 2022 - MLA PDS SCF_TRB_2022

7.15 MER Plan Report

MER Plan: Producer Demonstration Sites
Project name - L.PDS.2012 Alternate forage crops for Southern WA

Date: May 2023

Evaluation level[1]	Project Performance Measures	Evaluation Methods	Status 29 May 2023
Inputs – What did we do? *Describe the planned and expected inputs involved in your project*, including *funds, resources, development & projects structures*	• 11 core producers representing 60,000 head of sheep and 30,000 Ha • 85 observers covering 400,000 head of sheep and 250,000 Ha • Project manager appointed • Funds: annually from MLA used for professional fees, travel, and field days / events • Funds: annually in kind contributed to producer's labour, laboratory space, weigh scales unpaid SCF time.	• Records of all project plans and activities • Steering committee notes • Budgets	• 10 core producers, will be involved for three years in this MLA PDS project. 3 producers will host a demonstration site per year. For 2020 we had Rochester, Pyle and Smith. • For 2021 we had Metcalfe, Pyle and Smith. • Samantha Lubcke, appointed as project manager. • Wooldridge had ewes and lambs grazing 970 Canola and hosted our first field walk on 31 July 2020 at this site. Not a suitable stock class to collect weight gains. • 2020, Two demonstration sites have been grazed with all required data collected (Smith and Pyle).

			• 2020, A third site at Rochester's was grazed. • Dec 2021, Pyle- Raphno site has been grazed with all required data collected and analysed. • May 2022, Two demonstration sites have been grazed with all required data collected and analysed (Smith and Metcalfe). • July 2022, Metcalfe- Bennett wheat site has been sampled and grazed by heifers. Analysis of samples Analysed • January 2023, Webster- Millet has been grazed with all required data collected and analysed. • Final site fell through (first site was washed out in November) (second site, farmer became inundated and could no longer host the trial) which led to mid Feb where another replacement site wasn't forthcoming and it was agreed with MLA to report on the data collected so far.
Outputs - What did we do?	• New knowledge & data from the 3+ demonstration sites, e.g. production efficiencies (Kg red meat / area unit), pasture	• Data from demonstration sites in milestone reports • Compilation of media activities	• Pasture samples collected from Brad Wooldridge Hyola 970 canola site 27/07/2020.

Describe the outputs planned/expected from your project, including engagement activities & products from demonstration sites	productivity (kg DM/ area unit), stocking rate (DSE/ha), cost of establishment / production • 2 annual Field days targeting 80-100 agricultural stakeholders • 1 Field walk p.a. • 1 media release p.a. • 2 SCF newsletter articles p.a. • 1 webinar / short video explaining the PDS aims and results • 2 Case studies produced • Producer guides / Fact sheets that outline best management practice (I.e. grazing timing and deferral) including livestock weight outcomes.	• Copies of case studies and fact sheets developed • Number of stakeholders present at events reported.	• An article calling for hosts and core producers was in the Winter newsletter 2020. • All SCF newsletters are available on our webpage under "publications" and all members have electronic copies emailed directly to them upon release. • An article introducing the project and following Pyle's PDS published in our Summer SCF focus 2020 • Field walk on 31 July 2020 had 50 people attend. • We have recorded lamb live weight gain over a month, grazing Pallaton Raphno at Pyles PDS (Dec 3, 2020, to Jan 4, 2021) • Lamb liveweight gain over a month was also recorded at Smith's PDS, grazing Millet (Dec 15, 2020, to Jan 15, 2020) • Pasture and soil samples collected from Pyle's 3rd and 7th Dec 2020 • Pasture and soil samples collected from Smith's 14th and 15th Dec 2020

			• A follow up article from our summer newsletter, summarising Pyle's PDS results published in our Autumn SCF focus 2021. • This article was also shared with WALRC and published in their March newsletter 2021. • 3 articles published in our 2020 trials review book summarising the 2020 results • Distributed to 213 people in May (SCF members). • This was also shared with WALRC to be shared amongst their members. • Produced a 7.5 min short video reviewing Pyle PDS results. Published on our YouTube channel, website, with links posted on twitter and Facebook. From 25/03/21 to the 26/07/21 the video had 61 views. Currently the video has 127 views as of 1/05/2023. • Facebook post had 159 impressions. • Twitter post had 1468 impressions with 50 engagements.

			• 14 May 2021, a Livestock Matters forum was held at Manypeaks. This was a WALRC event, but SCF was represented and our report on the year one project results was shared with participants. This forum also visited Kent Rochester's farm, one of the PD sites. • Phil presented at MLA meetup in Perth 5/08/2021, 120 attendees. Talked about the MLA project and outcomes. • West Midlands Group Student Field Walk 18/11/2021 – Phil had a paddock discussion on importance/benefits of alternative forages – 61 people in attendance. • UWA Students Presentation (5th May 2022) Phil discussed the importance /benefits of alternate forages – 70 people • Producer Technology Workshops (13th & 14th June 2022) Phil talked about the MLA project and outcomes – 33 people • GRDC Moora Updates (16th August 2022) Phil discussed the

			MLA PDS and outcomes observed so far – 32 people • Climate Sciences Workshop (26th August 22) Technologies discussed to improve farm management decisions. Pyle PDS site year 2 was an example.– 12 people • SCF Spring field day 22 September 2021, visited Pyle PD site with Tim discussing his results. Tim Metcalfe also discussed his experience with alternate forages so far. 71 people attended the SFD. • An article was published in our 2021/22 summer newsletter, summarising initial data collected at Pyle's PDS. • A follow up article was published in our 2022 Autumn newsletter, summarising final data collected at Pyle's PDS. • 3 articles published in our 2021 trials review book summarising the 2021 results • Distributed to 230 people in June (SCF members). • This was also shared with WALRC to be shared amongst their members.

			• Produced a 5.5 min short video reviewing Pyle 2021 PDS results. Published on our YouTube channel, website, with links posted on twitter and Facebook. From 23/03/22 to the 11/07/21 the video had 24 views. Currently is has 45 views as of 1/05/23. • Facebook post had 141 impressions. • Twitter post had 474 impressions with 9 engagements. • 1 article published in our 2022 Spring newsletter, introducing Metcalfe's PDS. • 1 article published in our 2023 Autumn newsletter, summarising Metcalfe's PDS results. • 2 articles published in our 2022 trials review booklet • PDS results were presented at Pasturama held at the Manjimup research station 24th March 23. ~100 people attended. • For the life of the PDS SCF received 275 views the MLA

			PDS project page on our website. • Case studies have been completed one focussing on Pallaton Raphno one on Millet and the other based on DS Bennet. • Factsheets about best management grazing practices were not completed due to having insufficient data collected from the PDS. Data required to achieve this would require measuring multiple grazing events at different intensities. More than the 1-3 grazing events that were measured for each forage. •
Changes in knowledge, attitudes, and skills - How well did we do it? *Describe the changes in KASA that you are planning to achieve*.	• 100% of core producers have greater knowledge of the value of alternative forage crops • 90% of core producers have increased their skills and confidence in how to implement / establish a successful alternative forage crop • Key findings	• Pre project surveys – (baseline) and post project survey that assess changes in KASA for both core and observer producers • Case Studies from people involved in the PDS	• Pre-project surveys collected from core and observer producers. Results analysed. • (Re-analysed as observer and core producers separately) • Post-project surveys collected April/May 2023. Analysed in May
Practice changes – Has it changed what people do?	• 70% of core producers, implement an alternate forage crop into their production system	• Baseline surveys (practice change and impact) – as above	• Pre-project surveys collected June 2020 from core and observer producers. Results analysed.

Describe the practice changes that you are expecting to achieve by the end of your project	• 10% of observer producers intend to implement an alternate forage crop into their production system		• Post-project surveys to be collected April/May 2023. Results analysed.
Benefits – Is anyone better off? *Describe the benefits that you are expecting to achieve as a result of the project*	• 70% of core producers, implement an alternate forage crop into their production system and increase production (Kg/Ha) by X% • Determine the relative economic performance of the summer forages compared to the equivalent currently used available pasture and imported feed	• Data from demonstration sites • Cost Benefit Analysis (CBA) at enterprise level	• Economic analysis conducted May 2023
General observations / outcomes – Is the industry better off?	• Alternate forage crops are a viable option for many producers in the HRZ of Australia. Producers need to be up skilled in how and when to grow forage crops to increase production and deliver industry benefits. • This project will assist MLA by increasing the production of red meat / Ha in HRZ grazing systems in Australia.	• Surveys of key personnel at the completion of project to assess key learnings and any unintended consequences • Extrapolation of CBA results to relevant part of the industry	• Reported in Final Report 2023

7.16 Communications Plan and Update

L.PDS.2012 Communications Plan: Producer Demonstration Sites Update
May 2023
Project name: Alternate forage crops for Southern WA

Project overview: To demonstrate the feed value of alternate high biomass summer forage crops in increasing stocking rates and live weight gain of prime lambs or beef cattle relative to current systems in the HRZ of Western Australia.

MLA Program Manager	
Project objectives	By November 2023, in the southern coastal region of Western Australia: 1. Minimum of three producers will demonstrate improved grazing carrying capacity of 10% (as measured by stock numbers supported and weight gain achieved and plant nutritive value results) from the use of three summer forage crops or mixes at multiple PDS each year. Ideally, two years of data will be recorded for each producer. For example: Year 1 – A, B, C, Year 2 - A, B, D Year 3 - A, C, D i. *Pallaton Raphno* ii. Hyola 970 canola iii. Millet, Cowpea or Sorghum 2. Complete a cost-benefit analysis of the three summer forage crops or mixes to determine the relative economic performance of the summer forages compared to the equivalent currently used available pasture and imported feed. 3. Through a range of activities (annual field days, digital communications) 100% of core producers and 60% of observer producers will have increased their knowledge in and confidence to use summer forage crops.

What were/are the deliverables from the project?	1. Collection of data on key metrics from demonstration sites. 2. Collection of data on producer numbers and animals, and area potentially impacted by the project. 3. Entrance surveys of producers to benchmark current practices, knowledge and skills about the subject 4. Exit surveys of producers to enable assessment of changes in (i) knowledge, attitudes, skills and aspirations; and (ii) practices 5. Extent of and impact from communication/extension activities both within and outside of the PDS project participants.
What are the 'outcomes' for producers?	1. Improved knowledge of alternate forage systems and how they will benefit their farm business. 2. Greater confidence and understanding of alternate forage systems. 3. Higher uptake of alternate forage systems by SCF members. 4. Achievement of higher winter and summer stocking rates and therefore profit. 5. Reduce business risk and increase flexibility through more market options from having stock reach sale weight off-peak season.
Measure of success of communication plan and/or activities (KPIs and how measured)	1. Changes in core and observer producer on-farm practices. 2. Adoption by core and observer producers of alternate forage crops. 3. Key communication activities undertaken and reported on time. If changes are required, then communicate these to MLA promptly.
Primary audience (include regions/species)	1. SCF members based in the lower great southern of WA. 2. Sheep and Cattle producers in the southern HRZ of Western Australia
Secondary audience (include regions/species)	1. Agronomists and consultant's in the region. 2. Mixed farmers in other parts of WA 3. Circulation via Farm Weekly and Albany Advertiser depending on press releases.

Communications Plan: Alternate forage crops for Southern WA.

Activity	Responsibility	Target Audience	Key messages and must-have elements	Timing	Estimated reach	Status 31 May 2023
Initial meeting with producers	Samantha Cullen	• Core producers	• Establish the project method, timings, training and extension activities.	• May-June 2020	• Ten producers involved in the project	• 10 core producers have all been contacted, project method has been established. First field walk was organised for Friday 31 July.
Field days and events	Samantha Cullen	• Core producers and observers	• Explain the concept of alternate and summer forage crops and how it can benefit farming systems • Talk about how PDS producers established crops and weight gains/stocking rates achieved. • Progressively provide results from the demonstration sites and discuss implications and costs & benefits • Address the issues that are hindering producer uptake of the concept	• February 2021 – SCF trials review day. • September 2021- SCF annual spring field day- • February 2022 – SCF trials review day • September 2022- SCF Spring field day • February 2023- Presentation of cost-benefit analysis on three years of PDS data.	• Trials review day and spring field day typically 80-100 agricultural stakeholders in attendance. •	• SCF will not be hosting our traditional trials review day in 2021. Instead SCF will produce short videos on each project summarising the 2020 results. To be released by March 31. • SCF produced a short video on Pyle's PDS project, summarising the 2020 results. Uploaded to our YouTube channel on 25/03/21 and had 61 views as of 26/07/21. The video had 95 views as of 18/01/22. Currently the video has 127 views as of 1/05/2023. • A Livestock Matters forum was held at Manypeaks 14 May 2021. This was a WALRC event but SCF was

						represented and our report on the year one project results was shared with participants. This forum also visited Kent Rochester's farm, one of the PD sites. • Phil presented at MLA meetup in Perth 5/08/2021, 120 attendees. Talked about the MLA project and outcomes. • West Midlands Group Student Field Walk 18/11/2021 – Phil had a paddock discussion on importance/benefits of alternative forages with students – 61 people. • UWA Students Presentation (5th May 2022) – 70 people • Producer Technology Workshops (13th & 14th June 2022) Phil talked about the MLA project and outcomes – 33 people • GRDC Moora Updates (16th August 2022) Phil discussed the MLA PDS and outcomes observed so far – 32 people • Climate Sciences Workshop (26th August 22)

						Technologies discussed to improve farm management decisions. Pyle PDS site year 2 was an example. – 12 people • SCF hosted its annual Spring field day 22/09/21. 71 people were in attendance. One of the field stops was at Tim Pyles PDS where Tim discussed his 2020 results. Tim Metcalfe also discussed his experience with alternate forages so far. • SCF 2022 Trials review day in March was cancelled due to covid. A short 5.5min video was produced, where the 2021 results of Pyles PDS were discussed. Uploaded to our YouTube channel on 23/03/22 and had 45 views as of 1/05/23. • Published on our YouTube channel, website, with links posted on twitter and Facebook. • Facebook post had 141 impressions.

						• Twitter post had 474 impressions with 9 engagements. • • SCF planned to attend Pasturama in Manjimup in March 2022. Where we would present out 2 years of data collected so far. The event is hosted by Western Beef to showcase the industry's newest Technology & Innovation, Suppliers and Services along with leading Industry and RD&E experts. Targeted to high rainfall grazing systems in Western Australia. (Event postponed due to covid) • SCF attend Pasturama in Manjimup in March 2023. Where we presented results from two of the PD sites. Approximately 100 people were in attendance.
Media releases and video creation / Webinar.	Samantha Cullen	• SCF producers • Other mixed farming enterprises	• Explain the purpose and aims of MLA funded PDS • Subsequent releases will highlight the main results from producer demonstrations	• June 2023 • June 2022 • June 2021	• Aim for one media article per year. • Produce at least one short video	• June 2023 • June 2022 • SCF produced a short video on Pyle's PDS project, summarising the 2020 results. Uploaded to our

					for YouTube, SCF website, Facebook and Twitter, explaining the PDS aims, results etc.	YouTube channel on 25/03/21. The video had 95 views as of 18/01/22. Currently the video has 127 views as of 1/05/2023. • - Published on our YouTube channel, website, with links posted on twitter and Facebook. • - Facebook post had 159 impressions. (18/01/22) • - Twitter post had 1468 impressions with 50 engagements. (18/01/22) • SCF produced a short video on Pyle's PDS project, summarising the 2021 results. Uploaded to our YouTube channel on 23/03/22 and has had 45 views as of 1/05/23. • Published on our YouTube channel, website, with links posted on twitter and Facebook. • Facebook post had 141 impressions. • Twitter post had 474 impressions with 9 engagements.

Case studies	Samantha Cullen	• (beef on Raphano) (beef on hyola 970 canola) • (sheep on Raphano) • (sheep on winter Canola, sorghum or millet)	• How has adding Palleton Raphano to the feed base benefited stocking rate and weight gain of cattle. • How has alternate forage crops benefitted the sheep enterprise of mixed farming systems?	• September 2023	• 200 + SCF members • + other agronomists and industry people • + other members of the red meat industry.	• 3 Case studies have been produced. • Raphno results. • Millet results. • DS Bennet results.
Website	Nathan Dovey	• SCF members	• Updates every three months on how the PDS sites are progressing	• Summer SCF Focus • Autumn SCF Focus • Winter SCF Focus • Spring SCF Focus • 2021,2022 and 2023 • Trials review book 2021,2022 and 2023	• 200 + SCF members • Have at least two articles in the SCF newsletters per yr.	• Introductory article to MLA PDS project explaining the purpose and aims of the PDS and calling for hosts and core producers published in the SCF Focus Winter edition 2020. • Article on the happenings at the Pyle PDS site published in the SCF Focus Summer edition 2020 • A news article was published in our SCF Focus newsletter autumn edition 2021 highlighting the Pyle site results. Reach of the newsletter is 215 people. • An article was published in our 2021/22 summer newsletter, summarising

						initial data collected at Pyle's PDS. • Three articles, one on each MLA PDS was published in our 2020 trials review book. Distributed to 213 people in the month of May. 120 hard copies were also issued. • A news article was published in our SCF Focus newsletter autumn edition 2022 highlighting the Pyle site results. Reach of the newsletter is 230 people. • A news article was published in our SCF Focus newsletter Spring edition 2022 introducing the Metcalfe PD site of DS Bennet. Reach of the newsletter is 230 people. • A news article was published in our SCF Focus newsletter Autumn edition 2023 highlighting the Metcalfe site results. Reach of the newsletter is 230 people. • Three articles, one on each MLA PDS was published in our 2021 trials review book. Distributed to 230 people in

						the month of June. 130 hard copies were also issued. • For the life of the PDS SCF received 275 views the MLA PDS project page on our website. • Two articles, one on each MLA PDS was published in our 2022 trials review book.
Farm walks or Field walks.	Nathan Dovey	• Core producers and observers	2020 • Show the alternate forage crops established • Producer(s) to explain how alternate forage crops makes them money in their farming system. 2021 • Present data from 2020 sites to explain the costs & benefits of alternate forage crops. Show crops growing successfully in the paddock. 2022 • Highlight costs and benefits using data from 2020 and 2021, and 2022 (so far) from PDS producers. Show	• October/November 2020 • February 2021 • September 2022	• Aim for each event to have 30-50 agricultural stakeholders. • Stakeholders are made up of SCF members (producers), agronomists, consultants and producers (non-SCF members).	• Field walk 31 July 2020, Topic – How do I get more feed for livestock in the Albany region. 50 people attended the walk • Brad Wooldridge explained how alternate forage crops work in his operation. • A Livestock Matters forum was held at Manypeaks 14/05/2021. This was a WALRC event but SCF was represented and our report on the year one project results was shared with participants. This forum also visited Kent Rochester's farm, one of the PD sites. • SCF annual Spring field day was held 22/09/21. 71 people were in attendance. One of the field stops was at

			different crops growing successfully in the paddock.			Tim Pyles PDS where Tim discussed his 2020 results. Tim Metcalfe also discussed his experience with alternate forages so far.

Producer guides / fact sheets	Samantha Lubcke	• Core and observer producers.	• To outline best management practice (I.e. grazing timing and deferral) including livestock weight outcomes.	• September 2023	• 200 + SCF members • + other agronomists and industry people • + other members of the red meat industry.	• Factsheets about best management grazing practices were not completed due to having insufficient data collected from the PDS. Data required to achieve this would require measuring multiple grazing events at different intensities. More than the 1-3 grazing events that were measured for each forage.