Final report

Pasture mixes to finish lambs in East Gippsland - Nexus Involve & Partner

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Abstract

This project demonstrated the use of mixed species pastures to finish lambs in East Gippsland. Two grazing trials (winter and summer) were completed comparing pasture and animal production from single and multi-species mixtures in 2023/24 at the Gippsland Agricultural Group research farm near Bairnsdale. Results from the grazing trials were used to calculate total greenhouse gas emissions and emissions intensity of production. In the winter trial, lamb growth rates were higher on the multi-species pasture (0.33 kg/day) compared to the single species pasture (0.26 kg/day). Estimated greenhouse gas emissions from the trial showed that the emissions intensity of production was slightly lower on the multi-species pasture (8.5 kg CO_2e/kg liveweight) compared to the single species pasture (8.7 kg CO_2e/kg liveweight). In the summer trial, the differences in lamb production between the two pastures was smaller with 0.29 kg/day on the multi-species and 0.24 kg/day on the single species pasture. The project hosted four workshops and numerous other extension activities, engaging with 350 farmers and 188 service provides across these events. These results support the notion that productive pastures and systems can reduce greenhouse gas emissions per unit of production (emissions intensity) which is an important message for livestock producers.

Executive summary

Background

There is interest in the use of multi-species pastures to achieve production and environmental benefits but little direct evidence to support their adoption. This project compared single and multi-species pastures in lamb finishing systems in East Gippsland to determine lamb growth rates and greenhouse gas emissions. The trials and results were used to engage producers and service producers in the region in discussions about the role of productive pasture systems in achieving production and environmental outcomes.

Objectives

The objectives of the project were to investigate the production and greenhouse gas emissions in two lamb finishing trials (one in winter and one in summer), simulate impacts of pasture on soil carbon and engage producers and service providers in workshops and other events to discuss these topics. All objectives were achieved in full.

Methodology

The two grazing trials were conducted at the Gippsland Agricultural Group research farm near Bairnsdale. The winter trial compared an annual ryegrass single species pasture with a multi-species pasture consisting of annual ryegrass, brassicas, cereals and clovers. The summer trial compared a forage brassica single species pasture with a multispecies pasture consisting of forage brassicas, plantain, chicory and clover. Each pasture was grazed by 50 lambs, with lambs weighed at regular intervals. Results from the trials were used to estimate total greenhouse gas emissions and emissions intensity of production using the MLA calculator.

Results/key findings

In the winter trial, lamb growth rates on the multi-species pasture were higher than the single species pasture (0.33 and 0.26 kg liveweight/day respectively) but the differences between the multi-species and singles species pasture in the summer trial were less pronounced (0.29 and 0.24 kg liveweight/day respectively). In both trials, total greenhouse gas emissions from the lambs grazing the two pasture types were similar, but emissions intensity was slightly lower for the multi-species pasture because of the larger amount of weight gain achieved.

Benefits to industry

These results support the notion that productive pastures and systems can reduce greenhouse gas emissions per unit of production (emissions intensity) which is an important message for livestock producers.

Future research and recommendations

The project supports the recommendation for use of muti-species pastures although the differences were larger for the winter trial compared to summer. Both grazing trials were restricted in duration due to extreme climate conditions (dry winter and wet summer) so repeating the trial under a broader range of seasonal conditions would be beneficial. The linking of the pasture and animal production measurements with implications for greenhouse gas emissions was a successful way to engage producers in these topics.

Table of contents

1. Background

This project was conducted as the "Involve and Partner" activity for the Nexus project (P.PSH.1248) at the University of Melbourne. The involve and partner activity was designed to demonstrate one of the adaptation and/or greenhouse gas mitigation strategies discussed in the project. In discussion with the East Gippsland regional reference group for the Nexus project and other industry stakeholders including the Gippsland Agricultural Group, the idea to explore mixed species pastures was identified. The focus of this project was on pastures/forage crops used as special purpose lamb finishing systems and/or as part of pasture renovation phase. Anecdotal evidence in the region is that livestock grazing on mixed species annual pastures can achieve higher rates of daily gain compared to traditional single-species pastures, but there is little research that directly compares the two pasture types in this region. Benefits of mixed species pastures could include: having a range of species that can grow under different climatic conditions (adaptation to climate variability), higher animal growth rates (increased productivity) and earlier turnoff times for animals (adaptation to climate variability and avoided greenhouse gas emissions).

In a review of the potential benefits of pasture mixes in the Australian dairy industry, Pembleton et al. (2015) identified that diverse pasture mixtures have the potential to increase pasture production and utilisation by extending the growing season (e.g., deep-rooted, summer active species, such as lucerne) and improve nutritive characteristics of pasture such as lowering neutral detergent fibre (e.g., by including legumes into mixtures with grasses), leading to improved animal production. There are also opportunities for diverse pasture to contribute to improved environmental outcomes such as using deep-rooted species to reduce nitrate leaching (Pembleton et al., 2015). Other research has pointed out the value of using plants with secondary compounds (such as tannins found in legumes including leucaena and birdsfoot trefoil) to reduce methane emissions, but they may also restrict dry matter intake depending on the inclusion rate (Eckard et al., 2010). Despite the potential benefits, managing diverse pastures often increases management complexity, because different species have different grazing management and fertiliser requirements.

Use of mixed species pastures has been shown to achieve production and environmental benefits compared to single species pasture in livestock production (Carmona-Flores et al., 2020). These authors showed that diverse pastures, including birdsfoot trefoil that contains condensed tannins, increased milk production and reduced methane production per kilogram of dry matter consumed in dairy production. In sheep meat and beef production systems, higher animal production may result in earlier turnoff times which can reduce the methane production over the lifetime of the animal (Eckard et al., 2010).

Research and demonstrations of suitable pasture mixtures are required to quantify the production and environmental benefits of mixed-species pastures in lamb finishing systems in East Gippsland and understand the management trade-offs.

2. Objectives

By the 30 April 2024, the participant will have:

1. Established a MER (monitoring, evaluation and reporting) and communications plan.

   Achieved. The completed MER is provided alongside this report.

2. Co-designed (with the Gippsland Agricultural Group) demonstrated the use of multi-species pastures in summer lamb finishing systems and evaluated (via modelling) the potential long term impacts on soil carbon

   Achieved. The summer lamb finishing trial is described in this report.

3. Co-designed (with the Gippsland Agricultural Group) demonstrated the use of multi-species pastures in winter lamb finishing systems and evaluated (via modelling) the potential long term impacts on soil carbon.

   Achieved. The winter lamb finishing trial and modelling is described in this report.

4. Conducted four workshops with farmers and service providers in the region with a focus on:

   A. 'Boosting animal performance to reduce carbon footprint';

   B. 'Comparing Cost/Benefits of summer multispecies verse monoculture brassica';

   C. 'Comparing Cost/Benefits of winter multispecies verse monoculture ryegrass; and

   D. 'Boosting farm productivity/efficiency to reduce carbon footprint'

   E. Reviewing future climate scenarios and outcomes from the central Victorian Nexus case study site.

   Achieved. The four workshops were completed, although the focus was adapted to utilise the results of the grazing trials to understand greenhouse gas emissions.

5. Conducted a minimum of two field days to engage a broader group of producers from the region – This also includes promotion of the opportunity for pursuant participation in the MLA profitable grazing systems and producer demonstration site programs.

   Achieved. Two field days were held and several other extension events.

6. Submitted a producer case studies for use in print media e.g. the MLA Feedback magazine.

   Achieved. The case studies are provided in this report (see Appendix 8.1).

3. Methodology

3.1 Winter and Summer grazing experiments

3.1.1 Experimental details

The winter and summer grazing trials were conducted to demonstrate the potential of mixed species pastures to finish lambs in East Gippsland. The trials were located at the Gippsland Agricultural Group research farm near Bairnsdale (https://gippslandag.com.au/). The experiments were conducted between May 2023 and February 2024.

The winter lamb finishing demonstration trials was established with 3.4 ha of a control pasture and 2.5 ha of multispecies pasture. Fifty composite breed lambs were used in each pasture type to provide a realistic semi-commercial scale. The species and cultivars used are shown in Table 1. The trial was grazed with 50 lambs per pasture type for 38 days between 26 June to 3 August 2023. Prior to entering the trial, lambs were grazing on unimproved pastures on the same property.

The summer lamb finishing demonstration trials was established with 3.3 ha of a control pasture and 3.0 ha of multispecies pasture. The species and cultivars used are shown in Table 1. The trial was grazed with 50 composite breed lambs per pasture type for 35 days from 28 November 2023 to 1 February 2024.

Table 1. Pasture species, sowing rate and seed costs for the single and multi-species pasture mixtures in the winter and summer trials.

Pasture mix	Species	Sowing rate (kg/ha)	Seed cost ($/kg)
	Winter trial		
Single species	Vortex annual ryegrass	25	4.15
Multi-species	Leafmore rape	2	4.35
	Tillage radish	1	
	Express oats	15	
	Shaftal persian clover	6	
	Dictator 2 barley	8	
	Fuze annual ryegrass	5	
	Summer trial		
Single species	Leafmore forage brassica	3	11.90
Multi-species	Leafmore forage brassica	1.5	13.30
	Falcon leafy turnip	0.5	
	Laser persian clover	2.5	
	Commander chicory	3.5	
	Captain plantain	2.0	

Pasture and animal measurements were made throughout the trials. These measurements included:

- Pasture mass, species composition and quality (including neutral detergent fibre (%), digestibility (%), metabolizable energy (MJ ME/kg DM), crude protein (%)). Pasture measurements were made on the day that lambs commenced grazing on the trial. Pasture mass was measured in three quadrats (0.25m^2) per treatment by cutting pasture to ground

level, then drying a sub-sample to determine the dry matter percentage. Pasture species composition was determined using the pasture stick method with 50 recording per treatment. The pasture nutritive characteristics of one bulk sample per treatment were determined by NIR at the FeedTest laboratory at Werribee, Victoria. The nutritive characteristics measured were crude protein (%), acid detergent fibre (%), neutral detergent fibre (%), digestibility of dry matter (DMD, %), digestibility of organic matter (DOMD, %), estimated metabolisable energy (MJ/kg DM), fat (%) and ash (%).

- Animal measurements – individual animal liveweights were measured on entry and exit from trial and at 6-14 day intervals in between. The lambs were weighed using a Te Pari Racewell HD3 Sheep Handler (Te Pari, Epping).

Animal ethics approval from University of Melbourne was obtained prior to the trials commencing (Ethics id: 2023-25305-38183-4, Title: 'Comparing the effect of single and mixed-species pastures on lamb meat production in the East Gippsland region of Victoria').

3.1.2 Climate conditions

The climate conditions during the period of the trials were challenging. For the winter trial, the conditions for pasture establishment were good but the duration of the grazing trial was limited to above average winter maximum temperatures (Fig. 1) and low winter rainfall (Fig. 2) resulting in low soil water content (Fig. 3). By contrast, rainfall during October-December 2023 was much greater than average (Fig. 2) creating saturated soils (Fig. 3) that delayed sowing of the summer trail and restricted pasture establishment.

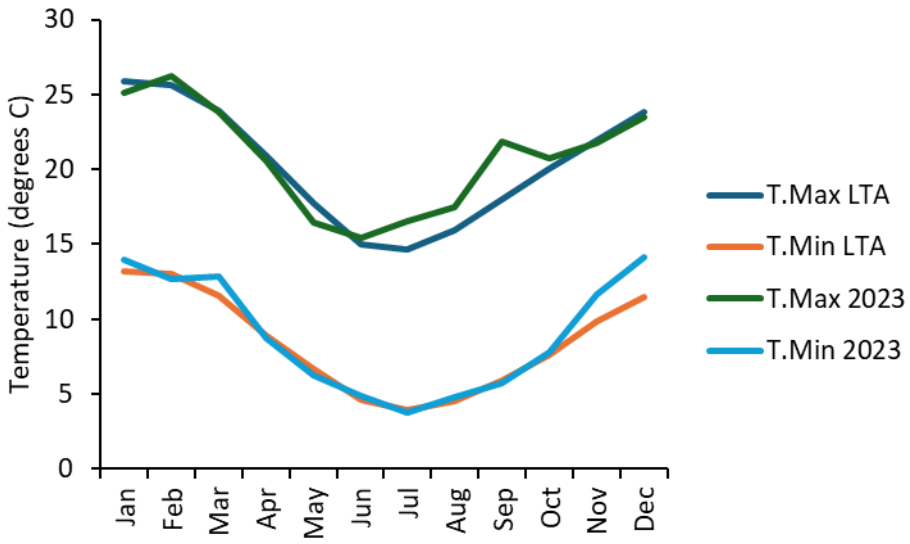

Figure 1. Long-term average (LTA, 1980-2023) monthly minimum (T.Min) and maximum temperatures (T.Max;°C) at Bairnsdale airport weather station (85279) compared to 2023. Source: https://www.longpaddock.qld.gov.au/silo/point-data/ (accessed 26 April 2024).

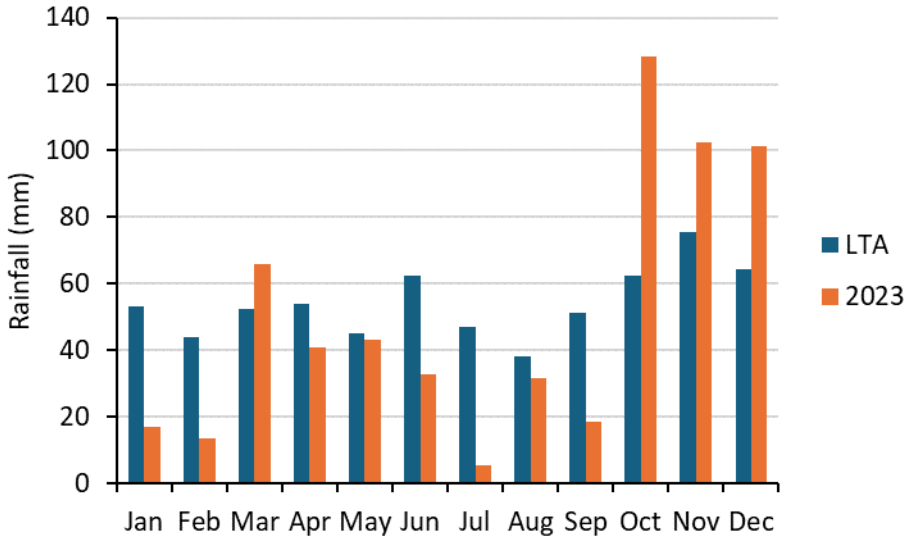

Figure 2. Long-term average (LTA, 1980-2023) monthly rainfall (mm) at Bairnsdale airport weather station (85279) compared to 2023. Source: https://www.longpaddock.qld.gov.au/silo/point-data/ (accessed 26 April 2024).

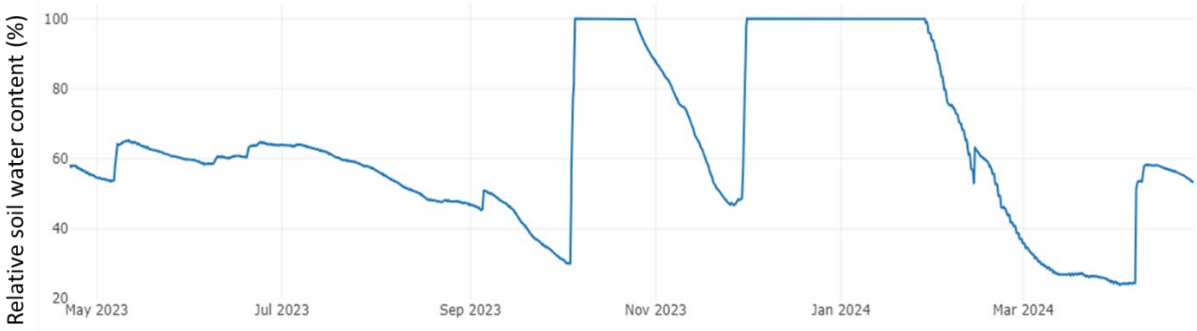

Figure 3. Relative soil water content (%) under perennial pasture at Bairnsdale from May 2023 to April 2024. Source: https://extensionaus.com.au/soilmoisturemonitoring/Bairnsdale-permanent-pasture/ (accessed 26 April 2024).

3.1.3 Greenhouse gas emissions

The animal and pasture data collected in both winter and summer grazing trials was used to estimate intake and total greenhouse gas emissions (t CO_2e) and emission intensity of production (t CO_2e/t lamb liveweight produced) from the pasture types using the Sheep and Beef Greenhouse Accounting Framework (https://www.piccc.org.au/resources/Tools) which is consistent with MLA and Australian government methodologies.

The GHG emissions were calculated as if the lambs were trade lambs that were purchased onto the trial (including the pre-farm emissions for purchased stock), grazed for the duration of the trial and then sold at the end of the trial. Due to the short-term trial data used in this study, only the emissions from the livestock were included so Scope 2 (energy use) and Scope 3 other than purchased livestock (eg. fertiliser applied to the paddocks) were not included in the analysis. The

methane emissions from livestock (Scope 1) make up the largest source of emissions in sheep production systems (eg. Weidemann et al., 2016), so the approach estimates the majority of the emissions from the trials.

3.1.4 Benefit:cost analysis

The costs and benefits of the pasture types were estimated for each pasture type and grazing trial. Due to the short-term nature of the grazing trials, the only costs included were seed costs. The seed costs and sowing rates are provided in Table 1. Benefits were estimated from the lamb liveweight gain on the grazing trials assuming a dressing percentage of 45% and a price of 800 c/kg carcass weight. The Profit (income minus seed costs) and Benefit:Seed Cost (income divided by seed cost) were calculated.

3.2 Soil carbon modelling

The short-term pastures used in the trials were not suited to modelling soil carbon change, so the effects pasture types on soil carbon were modelled using two perennial pasture systems. Two representative pasture types were modelled. They were a traditional pasture consisting of perennial ryegrass and white clover, and a multi-species mixture consisting of perennial ryegrass, white clover and chicory. Chicory is a summer-active herb, so it represented a different plant functional group in the pasture.

The two pasture types were modelled using the Sustainable Grazing Systems (SGS) pasture model (version 4.8.16). The modelling was conducted based on the Gippsland Agricultural Group research farm (same site as the grazing trial), using the climate data from the Bairnsdale airport weather station (station number 85279). The two pasture types were modelled using a rotational grazing system with livestock grazing the pastures when pasture mass reached 2.7 t DM/ha and grazing it to 1.4 t DM/ha with variable rotation lengths typically from 20-65 days depending on pasture growth rate. The stock density was set so that the pasture was grazed to the residual mass in 1-2 days. For each pasture type the SGS Pasture model was run from 1980 to 2023 to allow the model initial conditions to stabilise, then the simulation was re-run for the same time period. Soil carbon levels in the final year of the simulation (2023) were used to show the amount of carbon in the soil. Average monthly pasture growth rates were also reported to show the different pasture growth patterns for the two pasture types.

4. Results

4.1 Winter trial

4.1.1 Pasture measurements

The pastures established well (Fig. 4) and the lambs commenced grazing on the single and multi-species pastures on 26 June 2023. At the commencement of grazing, pasture mass in the single species paddock averaged 920 kg DM/ha and in the multi-species was 1798 kg DM/ha (Fig. 5). The species composition measurements demonstrated that the multispecies pasture successfully established with forage brassica, ryegrass, barley and oats being the major species (Fig. 6). Analysis of nutritive characteristics of the two pastures showed that they were both high quality (Table 2).

Observations of feed availability throughout the trail showed that multi-species pastures consistently had more feed on offer compared to ryegrass pastures.

(a) Single species pasture

(b) Multi-species pasture

Figure 4. The single (a) and multi-species (b) pastures prior to grazing of the winter trial.

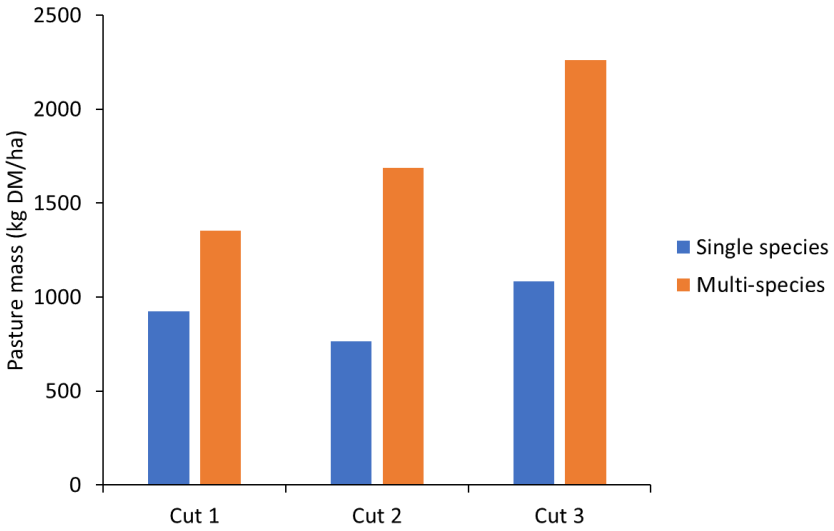

Figure 5. Pasture mass (kg DM/ha) in three quadrats in the single and multi-species pastures on 26 June 2023.

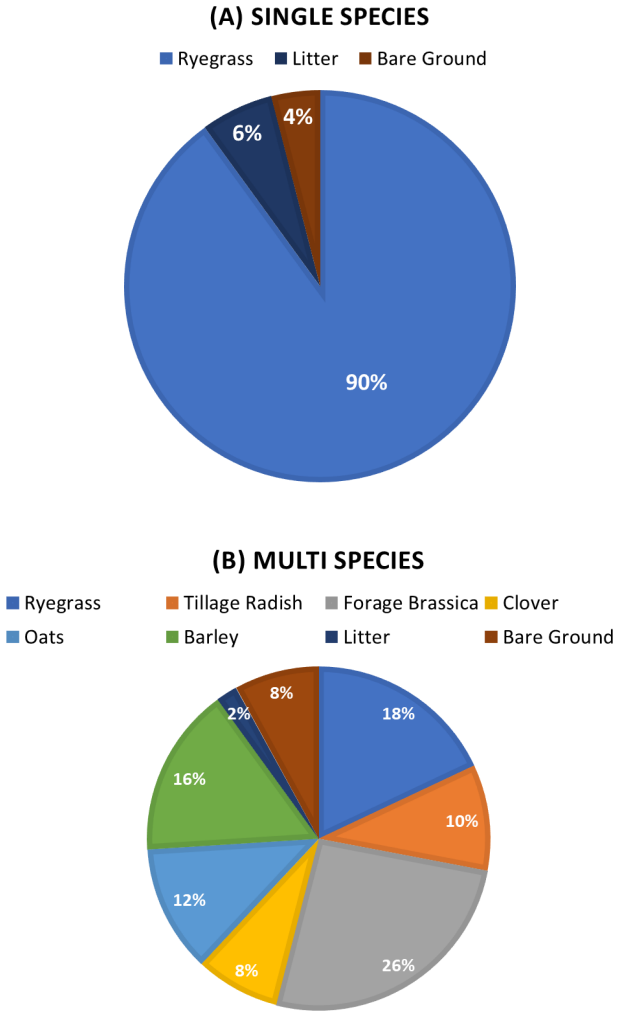

Figure 6. Pasture species composition (%) in (a) single species and (b) multi-species pastures on 26 June 2023.

Table 2. Pasture nutritive characteristics measured by FeedTest from pasture sampled on 26 June 2023.

Nutritive characteristic	Single species pasture	Multi species pasture
Dry matter (%)	14.9	11.6
Crude protein (%)	23.9	24.2
Acid detergent fibre (%)	19.6	18.5
Neutral detergent fibre (%)	38.6	35.1
Digestibility (DMD, %)	80.4	80.9
Digestibility (DOMD, %)	74.9	75.4
Est. Metabolisable energy (MJ/kg DM)	12.2	12.3
Fat (%)	6.1	5.8
Ash (%)	12.8	12.5

4.1.2 Animal production

Lamb weights throughout the trial are shown in Fig. 7. Lambs on the multi-species pasture added 12.6 kg liveweight over the 38 days of grazing (growth rate of 0.33 kg/day), while lambs on the single species pasture gained 9.9 kg liveweight over the 38 days of grazing (growth rate of 0.26 kg/day).

Observations of lambs in the mixed species pastures indicated that they were selecting a diet all of the species present in the pasture, although this was not formally measured (Fig. 8). Lambs presented noticeably better (eg did not have scours) on the multi-species pastures compared to ryegrass.

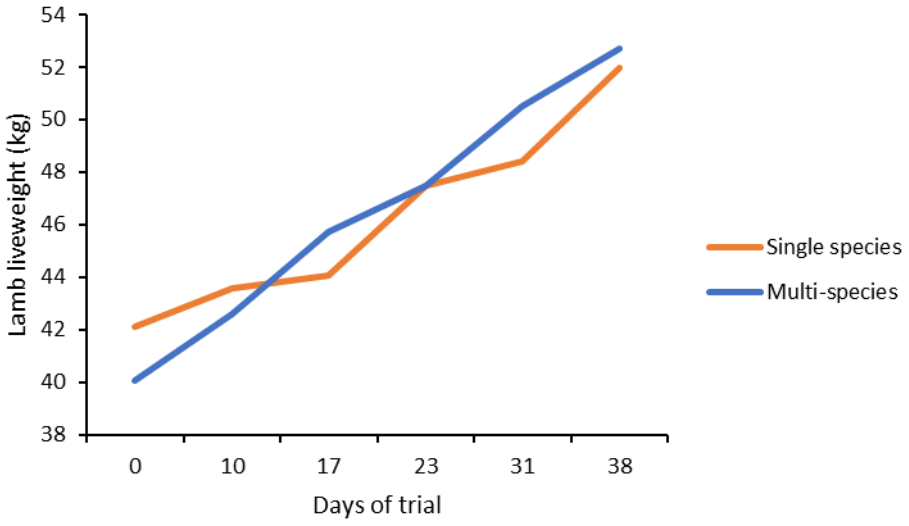

Figure 7. Lamb liveweights (kg) on the single and multi-species plots at the 6 measurement times through the 38 day winter grazing trial.

Figure 8. Lambs grazing on the single species pasture in the winter trial.

4.1.3 Greenhouse gas emissions

The grazing trial data, including the number of sheep, liveweight and rates of liveweight gain, were used to estimate total greenhouse gas emissions and emissions intensity using the "Sheep and Beef GHG Accounting Framework" excel spreadsheet which is available at: https://www.piccc.org.au/resources/Tools. Due to the short-term trial data used in this study, only the emissions from the livestock were included (eg. fertiliser applied to the paddocks was not included). The GHG emissions were calculated as if the lambs were trade lambs where they were purchased onto the trial (including the pre-farm emissions), grazed for 38 days, and then sold at the end of the trial.

While there was a small difference between the lamb liveweight of the two groups of lambs on the different pastures at the start of the trial (Fig. 7), it was assumed for the greenhouse gas emissions estimation that the 50 lambs from both groups were 41 kg liveweight when they arrived on the trial. This assumption was made because the purchased weight of the lambs is closely related to the amount of pre-farm greenhouse gas emissions, with high lamb weight having higher emissions, and the pre-farm emissions made up a large proportion of the emissions in this study because of the short-term grazing trial. So if different lamb weights were used at the start of the trial, it would obscure the effect of the different lamb growth rates achieved in the trial. The lamb growth rates over the 38 day grazing trial were the same as those achieved in the trial (Table 3).

	Single species	Multi-species
Lamb weight at start of trial (kg)	41	41
Growth rate (grams/day)	260	333
Liveweight at end of trial (kg)	50.9	53.6
Total GHG emissions (kg CO_2e)	2000	2003
Emissions intensity (kg CO_2e / kg liveweight)	8.7	8.5

Table 3. Lamb liveweight and growth rate data used to predict the total GHG emissions and emissions intensity from the mixed species and single species grazing trial.

The total GHG emissions from the lambs on both pastures was estimated to be very similar (Table 3). The scope 3 (pre-farm) emissions were 95% of the total emissions. This was a high proportion of the total because the lambs were only kept on the experiment for a short period of time so the emissions from livestock grazing were low.

The emissions intensity of production (kg CO_2e/kg liveweight) was 0.2 units lower for the lambs on the mixed species pasture compared to single species pasture (Table 3). This was because there was more lamb liveweight produced on the mixed species pasture, so the emissions per kg of lamb was diluted. Larger differences in emissions from the two pasture types would be expected if the trial was continued for longer.

4.1.4 Seed costs and benefits

The seed costs and income from livestock production for the winter trial are shown in Table 4. The multi-species pastures had higher seed costs, mostly due to the higher sowing rate. The higher lamb growth rates on the multi-species pasture led to higher income and higher profit (income – seed cost), however the benefit:seed cost for the multi-species was only slightly higher than the single species pasture.

Table 4. Summary of benefit and costs analysis of the winter trial.

	Single species pasture	Multi-species pasture
Area of paddock (ha)	3.4	2.5
Seed cost ($/kg)	4.15	4.35
Sowing rate (kg/ha)	25	37
Seed cost ($/ha)	104	161
Total seed cost for trial ($)	353	402
Number of lambs	50	50
Liveweight gain (kg/day)	0.26	0.33
Liveweight produced over 38 days of trial (kg)	494	627
Income from liveweight produced ($, assuming 45% dressing and 800c/kg carcass weight)	1778	2257
Profit ($, Income – Seed cost)	1426	1855
Benefit:Seed Cost (Income/Seed cost)	5.0	5.6

4.2 Summer trial

4.2.1 Pasture performance

The forage brassica single species pasture faced significant challenges, including competition from volunteer ryegrass and adverse weather conditions. The pastures were sown following the driest winter on record and then substantial rainfall which hindered crop emergence, and subsequent pest infestation by cabbage moth further impeded growth. These factors collectively contributed to the

struggle of the rape crop to establish and thrive during the trial period. In contrast, the multi-species pasture exhibited robust growth and provided a greater quantity of feed compared to the forage brassica single species pasture. Lambs grazing on the multi-species pasture had access to approximately 2.5 weeks more feed on offer, leading to better weight gains during the trial period. In addition, the multi-species pasture maintained its feed availability for an extended period, sustaining lamb performance even after the monoculture rape crop ceased growing.

4.2.2 Animal production

In the summer trial (Fig. 9), lambs on the multi-species pasture added 10.1 kg liveweight over the trial (growth rate of 290 g/day) while lambs on the single species pasture gained 8.2 kg liveweight (growth rate of 240 g/day).

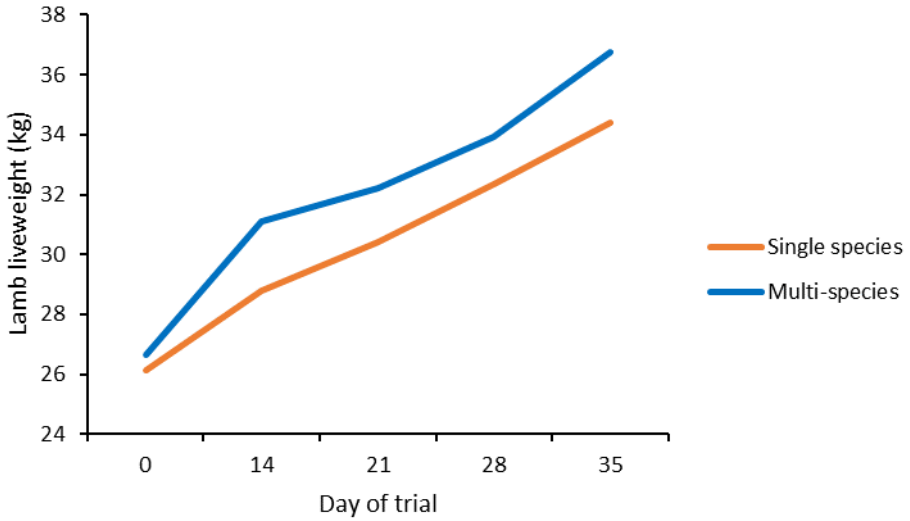

Figure 9. Average lamb liveweights (kg) on the single and multi-species pastures during the summer trial.

4.2.3 Greenhouse gas emissions

The greenhouse gas emissions were calculated using the same approach as described for the winter trial. In the summer trial, the emissions intensities of lamb production for the single and multi-species pastures were 7.4 and 7.1 kg CO_2e/kg lwt respectively. The lower emissions intensity on the multi-species pastures were because more lamb liveweight produced, so the emissions per kilogram of lamb was diluted.

Table 5. Lamb liveweight and growth rate data used to predict the total GHG emissions and emissions intensity from the multi-species and single species in the summer grazing trial.

	Single species	Multi-species
Lamb weight at start of trial (kg)	26	45
Growth rate (grams/day)	235	289
Liveweight at end of trial (kg)	34.6	36.5
Total GHG emissions (kg CO_2e)	1288	1289
Emissions intensity (kg CO_2e / kg liveweight)	7.4	7.1

4.2.4 Seed costs and benefits

The seed costs and income from livestock production for the summer trial are compared in Table 6. The multi-species pasture had higher seed cost. The multi-species pasture had slightly higher liveweight gain, and higher predicted income. However, the profit of the single and multi-species pastures were similar (income minus seed cost) but the Benefit:seed cost was higher for the single species pasture because of its lower seed cost.

Table 6. Summary of benefit and costs analysis of the summer trial.

	Single species pasture	Multi-species pasture
Area of paddock (ha)	3.3	3.0
Seed cost ($/kg)	11.9	13.30
Sowing rate (kg/ha)	3	10
Seed cost ($/ha)	35.7	133
Total seed cost for trial ($)	118	399
Number of lambs	50	50
Liveweight gain (kg/day)	0.24	0.29
Liveweight produced over 38 days of trial (kg)	420	508
Income from liveweight produced ($, assuming 45% dressing and 800c/kg carcass weight)	1512	1827
Profit ($, Income – Seed cost)	1403	1428
Benefit:Seed cost (Income/Seed cost)	12.9	3.6

4.3 Soil carbon modelling

Simulated pasture growth rates showed that the multi-species pasture (ryegrass, white clover and chicory) had higher growth rates than ryegrass/white clover only pasture in the months November to March, but lower growth rates from May to July (Fig. 10). This was due to the summer-active species (chicory) in the multi-species mix. Annual average production for the ryegrass-clover pasture was 9.0 t DM/ha (range 3.6-14 t DM/ha) compared to 10.3 t DM/ha for the multi-species pasture (range 5.6-15.7 t DM/ha).

Despite the differences in pasture production, there was no difference in the simulated soil carbon levels in the two pasture types (Fig. 11). In the 0-30 cm depth, the ryegrass/clover has 100 t C/ha compared to 102 t C/ha in the multispecies pasture. This difference is very small compared to the variation that would be expected due to spatial variation and sampling practices.

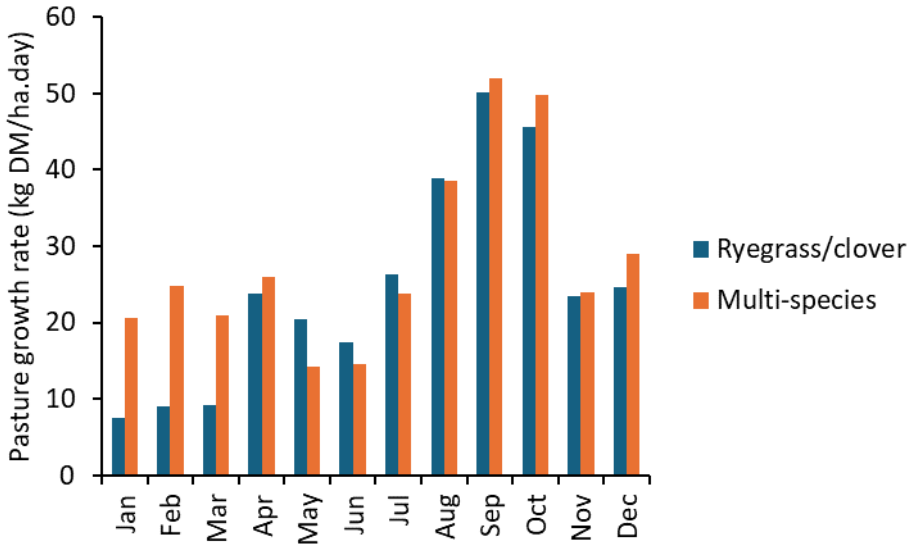

Figure 10. Simulated (2000-2023) average monthly pasture growth rate (kg DM/ha.day) for the ryegrass/cover and multi-species pastures.

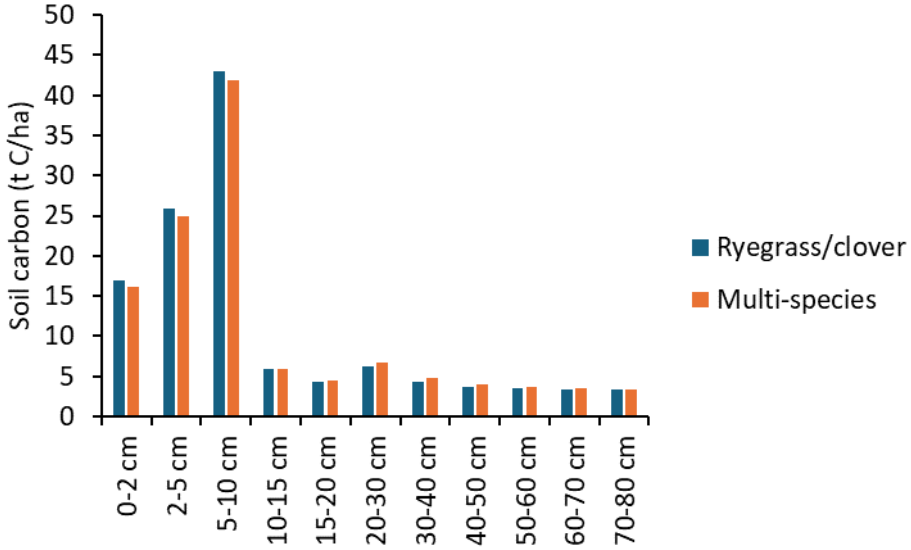

Figure 11. Simulated soil carbon (t C/ha) after 44 years at depth intervals for the ryegrass/white cover and multi-species pastures.

4.4 Project workshops and events

The project had very strong engagement with farmers and service providers in the East Gippsland regions through the four project workshops and numerous other events conducted. These events are summarised in Table 7 and also provided in the MER spreadsheet for the project. Evaluations for the four project workshops are provided in Appendix 8.2.

A major theme of the project workshops and extension events was linking together the pasture comparisons, animal production and greenhouse gas emissions analysis. This was a very effective way to engage participants in discussions about greenhouse gases emissions and ways to reduce emissions intensity. For example, the attributes of pasture species and the rates of lamb liveweight gain were discussed, and then the data was put into the greenhouse gas emissions calculator to see the impact total emissions and emissions intensity.

A notable achievement of the project was the enhancement of technical and social capacity among service providers in the region (see Appendix 8.2). Equipped with the necessary knowledge, confidence, and skills, these providers are now better positioned to lead meaningful conversations and learning events focused on the Red Meats Industry Target of CN2030. Moreover, the emergence of several local champions underscores a keen interest in understanding and managing emissions within farming systems, both from a practical standpoint and through a financial lens.

Table 7. Summary of the project workshops and extension events conducted.

Date	Event	Location	Number attending	
			Farmers	Service providers
	Project workshops			
19/7/2023	Winter trial project field day and workshop	Bairnsdale	20	6
9/11/2023	'Know your number' workshop	Genoa	20	8
5/12/2023	'Know your number' workshop	Gelantipy	20	13
24/2/2024	'Know your number' workshop	Benambra	30	8
	Other project events			
29/08/2023	Gippsland Red Meat Conference	Bairnsdale	80	50
11-15/10/2023	Gippsland farmers research bus tour	Gippsland	20	7
26/10/2023	Gippsland Ag Group - Spring field day	Bairnsdale	70	40
23/11/2023	MLA update	Bendigo	20	20
15/02/2024	Livestock and Fodder day	Bairnsdale	30	13
15/02/2024	Gippsland Ag Group Results dinner	Bairnsdale	30	13
26/3/2024	Carbon accounting workshop	Sale	10	10

Figure 12. Discussing the attributes pasture species used in the winter trial at the July 2023 field day and workshop.

Figure 13. Participants discussed greenhouse gases from livestock systems in the "Know your number" workshop at Genoa.

Figure 14. Brendan Cullen presented the project at the MLA Updates event in Bendigo.

5. Conclusion

5.1 Key findings

In the grazing trials, the lambs on the multi-species pasture had higher rates of liveweight gain and this contributed to a slightly lower greenhouse gas emissions intensity of production but the difference was more pronounced in the winter trial than the summer trial. The winter grazing trial demonstrated clear advantages of multi-species pastures over ryegrass pastures in lamb weight gains and feed availability. The summer grazing trial highlighted the challenges faced by monoculture crops, such as forage brassicas, particularly in adverse weather conditions and with pest pressure. In contrast, multi-species pastures demonstrated resilience and provided a consistent source of feed for grazing animals, resulting in better lamb performance overall. While the difference in lamb weights was less pronounced compared to the winter trial, the benefits of multi-species pastures in terms of feed availability and sustainability remained evident.

Together, these results support the notion that productive pastures and systems can reduce greenhouse gas emissions per unit of production (emissions intensity) which is an important message for livestock producers.

5.2 Benefits to industry

This project encountered a multitude of practical and social challenges, ranging from adverse weather and rainfall patterns to fluctuating livestock prices from Spring 2023 to Summer 2024. The weather challenges significantly affected the ability of the trial to be delivered according to scope and the market challenges placed immense pressure on farmers, hindering their ability to prioritize off-farm learning initiatives and afford additional labour to facilitate their engagement in such activities. However, through active partnership between the University of Melbourne and the Gippsland Ag Group the project was able to navigate these challenges effectively, adapting project approaches as needed to address evolving circumstances.

Despite the obstacles faced, the project yielded remarkable outcomes in engaging producers. The organizational information gleaned from the regional NEXUS study, coupled with research findings from the Lamb Grazing Trail, served as effective tools for producer engagement. This valuable information now resides within the repository of the regional grower group, poised for further dissemination and extension.

A notable achievement of the project has been the enhancement of technical and social capacity among service providers in the region. Equipped with the necessary knowledge, confidence, and skills, these providers are now better positioned to lead meaningful conversations and learning events focused on the Red Meats Industry Target of CN2030. Moreover, the emergence of several local champions underscores a keen interest in understanding and managing emissions within farming systems, both from a practical standpoint and through a financial lens.

The groundwork laid by this project bodes well for the region's ability to engage with emerging trends in emissions management and agriculture. By fostering a community of informed and empowered producers, the project has established a strong foundation for continued collaboration and innovation in addressing the challenges and opportunities facing the agricultural sector in the wake of the emerging emissions economy.

6. Future research and recommendations

Based on the results of this trial, the adoption of multi-species pasture systems for winter grazing to finish lambs in the East Gippsland region is recommended. However, it is important that the multi-species pasture mixture used is designed to take into purpose of the pasture, soil and environmental conditions. Future studies could explore the use of winter multi-species pastures over a broader range of environmental conditions. In this study the dry winter conditions lead to a short grazing trial so further information could be gleaned from repeating the trial under different seasonal conditions in particular to investigate the performance of the pasture through to the mid/late spring. The economic and environmental benefits associated with multi-species pastures could also be further investigated, providing valuable insights for sustainable livestock management practices. Moving forward, further research and implementation of multi-species pasture systems could offer significant benefits to livestock producers in terms of animal health, welfare, emissions intensity and productivity.

This project suggests that further exploration of summer multi-species pasture systems for summer grazing operations is required before they can be confidently recommended. This includes investigation of integrated pest management strategies should be employed to mitigate pest pressure on monoculture crops, ensuring better crop establishment and performance in challenging conditions.

7. References

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8. Appendix

8.1 Producer case studies (objective 6)

Nexus Engage and Partner Producer case study 1 – Alfred and Amy Rogers

Butchers ridge in East Gippsland

1000 hectares

1400 cross breed ewes

300 cows and replacements

Alfred and Amy Hacket, stewards of a picturesque sheep and cattle grazing operation spanning 1000 ha of pristine high country in Victoria's Far East, have embarked on a consistent journey toward understanding their position in the at times hard to understanding carbon and emissions economy by accessing the offerings from Melbourne University's Engage and Partner program, which was recently delivered by local farming systems group Gippsland Ag in their region

With a flock of 1400 crossbred ewes and a keen eye for innovation, Alfred and Amy were interested by the possibilities outlined in the "Pasture Mixes to Finish Lambs in East Gippsland project." Traditionally, their spring sowing routine consisted of mono-species crops, predominantly rapes or chicories. However, recent demonstrations at the Gippsland Research Farm and workshops have illuminated the multifaceted benefits of incorporating diverse pasture mixes. Beyond enhancing animal performance and bolstering profitability, mixed pastures promise to fortify soil health and significantly reduce emissions intensity. Eager to embrace these newfound insights, Alfred and Amy are keen to mix up the species in their upcoming spring sowing program.

The journey towards understanding the emerging carbon and emissions landscape in the red meat industry took a pivotal turn with their attendance at the "Know Your Number" workshop delivered in a neighbouring town of Gelantipy. While the workshop provided invaluable insights, Alfred and Amy hungered for a deeper understanding. Alfred, ever the hands-on farmer, ventured into the

paddocks, leaving Amy to delve into the intricacies of carbon accounting at a workshop facilitated by the farmers trusted advisor on all things carbon Richard Eckard. Armed with newfound knowledge and fortified by confidence, Amy emerged from the workshop with a firm grasp of their emissions profile, firmly within the MLA target range for their enterprise.

But the quest for improvement did not end there. Driven by an insatiable thirst for improvement, Amy turned her attention to their 300-cow self-replacing beef enterprise. With a microscope trained on their heifer joining program, Amy meticulously examined every facet, identifying opportunities to optimize and refine their practices. Altering joining dates emerged as a promising strategy to further curtail emissions intensity and enhance the profitability and sustainability of their farming systems.

Even with a successful track record of achieving commendable growth and reproductive rates in their crossbred ewe enterprise, Alfred and Amy recognized the untapped potential for further advancement. Armed with the MLA carbon calculator tool, they embarked on a journey of continuous improvement, scrutinizing every aspect of their operation to identify opportunities for efficiency gains and emissions reduction.

The fruits of Alfred and Amy's Labor were soon evident. A recent meeting with a processor they supply highlighted the growing importance of understanding emissions intensity right along the supply chain in the marketplace. During a routine audit they were able to offer their emission intensity number gain for the workshop and unpack ways to differentiate their products in the marketplace, they are confident in suring up market access in the future.

Alfred and Amy remain somewhat aware of the broader industry challenges and change need for the Australian Red Meat industry to meet emissions targets, but their energy is firmly fixed in on control what they can in their farming system and ensuring they are profitable, sustainable and have market access for the red meat and wool products they produce.

Alfred Hacket and Gippsland Ag team member Josh Ronalds taking pulling up soil cores and unpacking soil carbon

Nexus Engage and Partner Producer case study 2 – Ken and Nicole White

Ken and Nicole White, running a beef enterprise in Hillside East Gippsland, are actively involved in efforts toward carbon neutrality despite their initial scepticism about achieving it without substantial government intervention and support for agroforestry. Their farm spans 820 acres with an additional 120 leased acres, supporting 170 self-replacing Angus breeders and some trade cattle.

Ken's dual roles as a farmer and owner of a local accounting firm fuel his interest in carbon neutrality. He recently participated in a Carbon Neutral Agriculture Short Course at Melbourne University, led by Richard Eckard and other workshops delivered from the Nexus engage and partner program to better understand his Carbon Emissions number from his farming system alongside peers from the Gippsland Agricultural Group. Ken envisions that his accounting firm's future tasks will involve guiding farming clients in compliance activities related to emission intensity measurement and reporting.

Although Ken and Nicole harbor doubts about achieving carbon neutrality without significant external assistance, they have actively engaged in practical projects and workshops facilitated by their local grower group Gippsland Ag and Melbourne University'. These initiatives have deepened their understanding of carbon dynamics and emission intensities within their farming system.

Their involvement led them to join Agriculture Victoria's On-Farm Emissions Action Plan Pilot. This initiative, aligned with the Victorian Government's emissions reduction pledge for the agriculture sector, aims to collaborate with up to 250 farm businesses statewide to assess On-Farm emissions profiles and devise strategies for emission reduction while ensuring productivity and profitability.

Motivated by their participation, Ken and Nicole aspire to present their farm as a case study to their local grower group. They intend to openly share their baseline emission numbers and their strategies involving genetics, pasture composition, and potential agroforestry initiatives over the coming years. This transparent approach underscores their commitment to contributing to broader agricultural sustainability efforts while also fostering knowledge-sharing within their farming community

Oliva and Lucas White, learning about boosting soil carbon with plant species

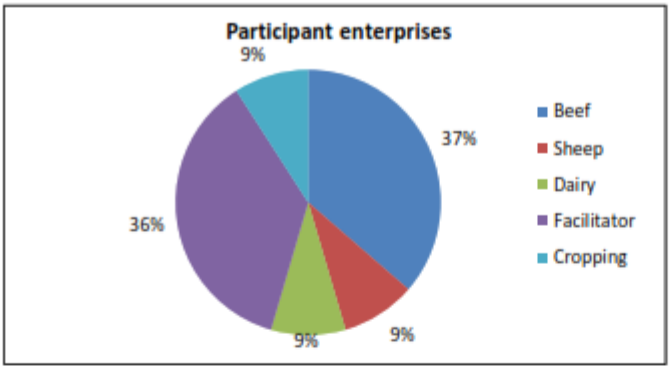
Angus Cattle Grazing multispecies crop, whites are using multispecies crops to renovate paddocks, increase soil carbon and prepared the ground for deep rooted perennials

The White property prior to their acquisition has 400 acres of blue gum plantations. A significant program of annual cropping with multispecies crops with the aim of renovating back to deep rooted perennial pastures is underway.

Accountant during the week and farmer at the weekend Ken White is readying his farm and his accounting firm for the emerging emission economy in Agriculture

8.2 Project workshop event evaluation sheets

Understanding Livestock Emissions Event Evaluation

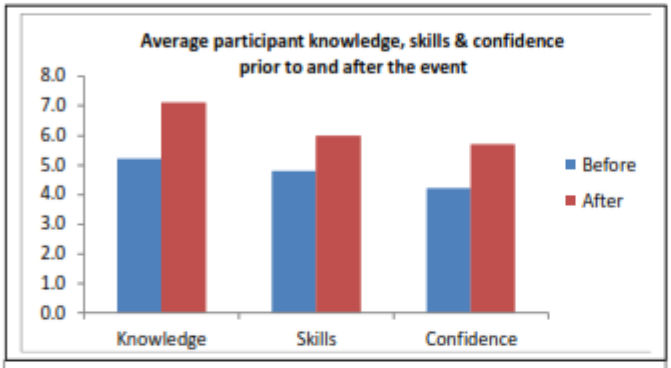


Event Details

26 attendees including farmers collectively managing 2,630 ha of farming land

38% response rate

Held on 19.7.2023



0-2: Nil 3-5: Basic 6-8: Moderate 9-10: High

Comments/Changes

"It is a changing space, the Carbon Calculator useful for gathering data"

"Interesting results in the multi species (crop)"

"Carbon is only one part of green house emissions"

"Continue pasture improvement with multi species"

"Mixed species (crops) are a possible choice for low carbon"

"More data/discussion on feed quality, intake and output of product, as live weight gain is highly hinged on quality/composition of feed source"

"Will consider planting multi species crop and comparing weight gains to previous years"

"Need more understanding"

"Seek more information"

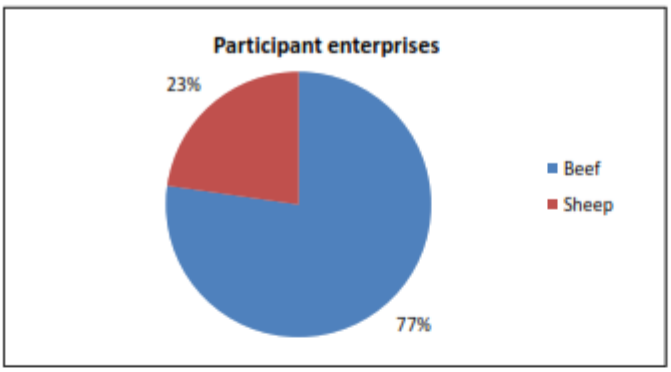
Intent to adopt change

63% of surveyed participants plan to and 18% are already seeking further information and advice

27% of surveyed participants want to trial activities on their own farm in 2023-24

44% of surveyed participants consider it a high priority to action change

Dry Time Farming - Genoa Community Event Evaluation



Event Details

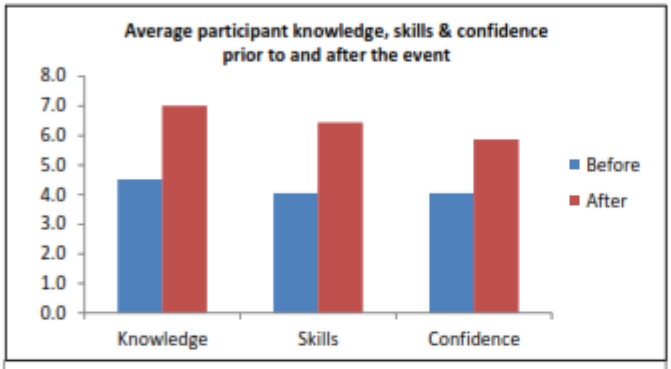
28 attendees including farmers collectively managing 5,425 ha of farming land

82% survey response rate

Event held on 9.11.2023

Attendee Locations

Wingham River
Genoa
Bendoc
Tonghi Creek
Wallagaraugh
Mallacoota



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Comments/Key Take Away

"Improve pastures"
'Soil testing"
"Lucerne production"
"Great insight into the benefits and ways to improve your soil"
"Good overall event"
"Growing & managing the right grasses for the right time"
"Great event for the community"
"Learning from others in a different environment"
"Get soil tests done"
"Always have a plan in place"
"Check soil at depth"
"Plant some winter crops"
"Services that are available
"Summer crop advice"
"All very interesting"
"Great environment"
"More soil testing is the key"

Intent to adopt change

63% of surveyed participants plan to seeking further information and advice

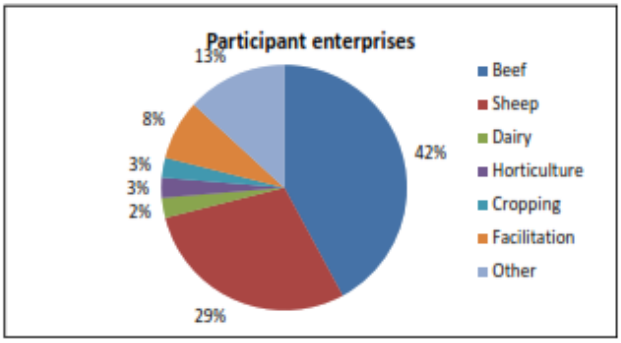
42% of surveyed participants want to trial activities on their own farm in 2023-24

23% of surveyed participants consider it a high priority to action change

Support Agencies

East Gippsland Shire Council
Rural Financial Counselling Service
Agriculture Victoria
Better Beef Network
Catholic Care
Southern Farming Systems
Gippsland Agricultural Group
Far East Victoria Landcare
East Gippsland Catchment Management Authority

Digging Deeper - Gelantipy Community Event Evaluation

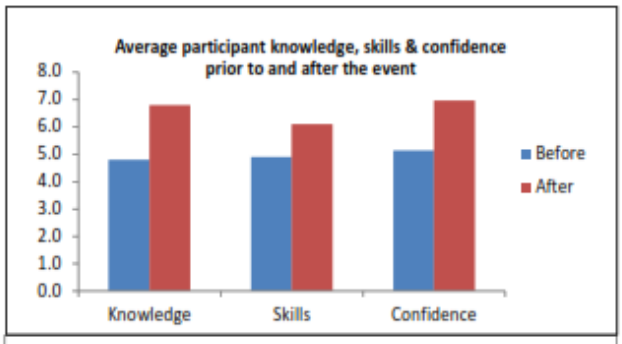


Event Details

33 attendees including farmers collectively managing 7,416 ha of farming land

88% survey response rate

Event held on 5.12.2023



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Attendee Locations

Gelantipy	Wulgulmerang
Buchan	Buchan South
Butchers Ridge	Hillside
Bairnsdale	Nicholson
Black Mountain	Tambo Crossing
East Buchan	Kalimna West
Walpa	Maffra
Murrindal	Paynesville
Lakes Entrance	Tynong

Intent to adopt change

68% of surveyed participants plan and 12% are already seeking further information and advice

46% of surveyed participants want to and 11% are already doing trial activities on their own farm in 2023-24

48% of surveyed participants consider it a high priority to action change

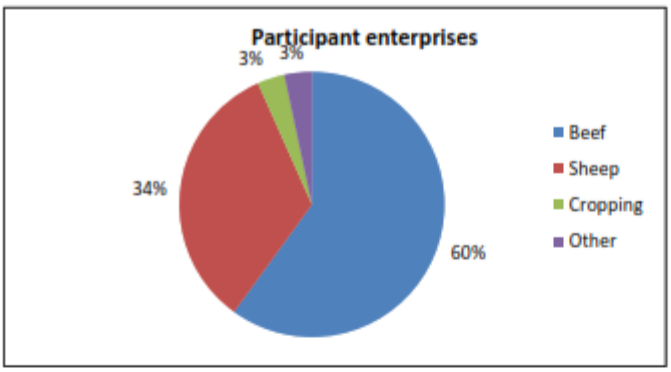
Support Agencies

East Gippsland Shire Council
Agriculture Victoria
Southern Farming Systems
Gippsland Agricultural Group
Far East Victoria Landcare
East Gippsland Catchment Management Authority
Better Beef Network
Gibsons Ground Spread
Caithness Fertilisers
East Gippsland Landcare Network

Comments/Key Take Away

"Great insight"
"Very helpful"
"Research before doing upgrades to pastures"
"Better use of fertilisers to keep levels within optimum range"
"Knowledge sharing"
"More careful selection of lime type"
"Lots of info to digest"
"Deep soil testing"
"Soil test the property and see what it needs"
"Do more soil testing before spending money on cultivation and fertiliser"
"Do regular soil tests"

Business of Farming – Benambra Event Evaluation



Event Details

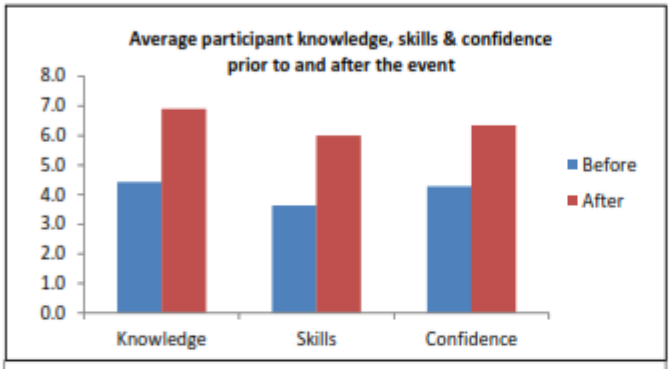
38 attendees including farmers collectively managing 68,058 ha of farming land

50% survey response rate

Event held on 24.2.2024

Attendee Locations

Tambo Crossing	Bengworden
Benambra	Omeo
Hinnomunjie	Ensay



0-2: Nil 3-5: Basic 6-8: Moderate 9-10: High

Comments/Key Take Away

"Capital gains rebates and sale of property"
"Seek the advice of a finance advisor – definitely do this ASAP"
"Financial planning advice regarding exit strategy from farming"
"Future financial planning re: CGT"
"Succession planning"
"Carbon tax"
"Plan ahead"
"Be proactive"
"More financial planning"
"Need to see RFCS"
"Need to increase my knowledge"
"Seriously consider the children and succession planning"
"Seek appropriate financial advice"
"Exit plan"
Succession plan"
"Succession does take planning"
"Exit costs and taxes"
"Structural development of the business"

Intent to adopt change

58% of surveyed participants plan and 11% are already seeking further information and advice

42% of surveyed participants want to and 16% are already doing trial activities on their own farm in 2024

68% of surveyed participants consider it a high priority to action change

Support Agencies

Southern Farming Systems
Gippsland Agricultural Group
Rural Financial Counselling Service
Rabo Bank
Benambra Neighbourhood House