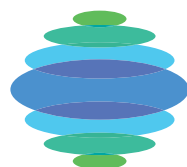


Grapevine management guide 2025–26

NSW PRIMARY INDUSTRIES MANAGEMENT GUIDE



Compiling author: Penny Flannery



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Grapevine management guide 2025–26

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Introduction

The *Grapevine management guide* is one of NSW Department of Primary Industries and Regional Development's (DPIRD) flagship publications. Such publications are a crucial means of providing information to viticulture and wine industry professionals.

It is with great pleasure that I invite you to read and benefit from the insights and information presented in the 2025–26 edition.

Vintage 2025 saw an 11% increase in tonnage compared to 2024 ([Wine Australia 2025](#)). Despite this rise, both red and white varieties remained below the 10-year average. Given the ongoing challenges of oversupply and purchasing constraints within the industry, this trend is likely to persist. Chardonnay yields were particularly affected by a severe spring frost in the warmer inland regions, contributing to a higher proportion of red crush this season. Some regions had an earlier and more rapid harvest, and the dry conditions helped ensure the fruit quality remained high.

I would like to extend my sincere thanks to the following people for their valuable contributions to this edition:

Alison Fattore (Technical Officer) for the update on the resting vineyard trial – returning to production ([page 59](#)).

Rachael Young (Communication and Engagement Specialist), **Jane Kelley** (Acting Project Manager) and the CVA team for their work on growing Chardonnay wine grapes in NSW: preparing for a changing climate ([page 84](#)).

Clare Belfield (Agtech Specialist – Mixed Farming) for agtech in vineyards: data-driven decision making ([page 94](#)).

Matthew Jessop (Executive Officer, NSW Wine) for the article on new digital tools for NSW grape growers ([page 96](#)).

Dr Mary Retallack (Retallack Viticulture Pty Ltd) for helping us get to know the predatory arthropods commonly found in and around Australian vineyards ([page 98](#)).

Dr Meena Thakur (Research Horticulturist – Entomology) for her continued work with Riverina growers on managing scale insects and mealybugs ([page 104](#)).

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Leonie Martin (Plant Biosecurity Officer) provided an update on one of our major biosecurity threats, *Xylella fastidiosa* ([page 122](#)).

A special thanks to **Dr Amanda Warren-Smith** (Development Officer – Information Delivery), whose dedication made this guide possible.

I also wish to acknowledge the generous contributions of time, expertise, and support from members of the NSW, Australian, and New Zealand wine communities and their involvement in case studies, workshops, and conferences mentioned in this guide.

Ben Crossing, James Crossing and Stephen McKenzie – Angullong Wines

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Jamie Conway – Belmont Vineyard

Jeremy Cass – Riverina Winegrape Growers

Justin Jarrett and Monica Gray – See Saw Wine

Liz Riley – Vitibit Pty Ltd

Mark Allen – Allen Vineyard Advisory NZ

Marty Gransden – Tamburlaine Organic Wines

Mark Bourne – NSW Wine

Michael Bynon – Corang Estate

Tom and Georgie Ward – Swinging Bridge Wines

Wayne and Jennie Fischer – Fischer's Vineyard

Feedback please

NSW DPIRD is committed to providing relevant and practical information to help you grow and strengthen your business. Your feedback, whether positive, negative, or neutral, is invaluable in shaping future editions of the *Grapevine management guide*. Please do not hesitate to share your thoughts and suggestions with me.

Thank you,

Penny Flannery

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The Rootlings Network

Wine judging workshop

Penny Flannery, Development Officer – Viticulture, NSW DPIRD

The NSW Rootlings Wine Judging Workshop, hosted by the NSW Department of Primary Industries and Regional Development (DPIRD) and NSW Wine, brought together young wine professionals and enthusiasts for a day of education and sensory exploration at **Mortimer Wines** in Orange, NSW.

The workshop commenced with a welcome dinner ([Figure 1](#)) held at **Stockman's Ridge Wines** in Orange NSW, giving the attendees a chance to network and speak to the judges before the session.



Figure 1. Some guests at the dinner at Stockman's Ridge Wines.

On Monday 5 May, the attendees were welcomed by **Monica Gray** ([Figure 2](#); Winemaker, See Saw Wine, Orange NSW) and **Penny Flannery** (Development Officer – Viticulture, NSW DPIRD). Then **Jeff Byrne** ([Figure 2](#); Winemaker/Owner of Byrne Farm, Orange NSW) introduced the wine show system and scoring, and explained how wines are evaluated in professional settings. Jeff discussed the time spent on each wine (no more than 2 minutes) and the ability to make nice, consistent notes about each wine.

Mastering the art of judging

The morning sessions featured a series of engaging presentations from:

- **Louella Matthews** ([Figure 2](#); Sommelier of Trippas White Group, Sydney, NSW) delved into the characteristics that define a gold medal wine. As an associate judge, if you love a wine, you need to articulate really well why you love it and why you class it as a gold medal wine. Louella indicated she does not give below an 80 in the scoring system unless the wine is clearly faulty. Louella said she works on 5 wines at a time, deems which is her favourite of those 5 wines, brings it forward and then works on the next 5. Once all the wines are completed, she comes back to the wines she brought forward.
- **Steve Flamsteed** ([Figure 2](#); Senior Consultant and Director at Wine Network Consulting Pty Ltd, Yarra Valley, Vic) guided participants through the process of judging a bracket of wines, emphasising sensory analysis and scoring techniques. Steve indicated brackets tend to have around 30 wines, but can have up to 50–60, so you need to stick to 2 minutes maximum per wine. Steve brings forward the wines he deems as silver or gold.



Figure 2. Left to right, Monica Gray, Steve Flamsteed, Jeff Byrne, Louella Matthews and Ellis Matthews.

Tasting brackets: a journey through varietals

Participants had 4 structured tasting brackets (Figure 3 and Table 1), each followed by in-depth discussions. Each bracket was carefully curated by Monica Gray to highlight the particular aspects of the varietals, encouraging participants to refine their palates and engage in collaborative critique.



Figure 3. Participants judging the white (left) and red (right) wines.

Table 1. The tasting results from the judges and participants.

Wine identifier	Year	Region	Judges' average	Participants' average
Semillon 01	2024	Hunter Valley	95.0	88.3
Semillon 02	2024	Hunter Valley	88.7	88.6
Semillon 03	2024	Hunter Valley	92.3	87.8
Semillon 04	2015	Hunter Valley	94.3	86.1
Riesling 01	2024	Mudgee	89.3	92.7
Riesling 02	2024	Canberra	95.0	89.8
Riesling 03	2023	Clare Valley	88.3	90.2
Riesling 04	2022	Henty, Victoria	92.0	88.8
Chardonnay 01	2023	Orange	91.7	92.7
Chardonnay 02	2023	Beechworth	93.7	91.1
Chardonnay 03	2023	Coal River Valley, Tasmania	93.0	88.1
Chardonnay 04	2023	Margaret River	94.0	89.9
Chardonnay 05	2023	Yarra Valley	89.3	91.9
Chardonnay 06	2023	Tumbarumba	94.7	93.1
Chardonnay 07	2022	Hunter Valley	92.3	91.5
Pinot Noir 01	2024	Geelong	91.0	85.8
Pinot Noir 02	2023	Mornington	92.7	89.8
Pinot Noir 03	2023	Yarra Valley	93.0	92.1
Pinot Noir 04	2023	East Coast, Tasmania	94.7	91.7
Pinot Noir 05	2022	Adelaide Hills	91.3	90.5
Pinot Noir 06	2019	Orange	90.0	89.8
Shiraz/Syrah 01	2023	Hunter Valley	93.0	89.8
Shiraz/Syrah 02	2023	Canberra	94.7	90.9
Shiraz/Syrah 03	2022	Yarra Valley	95.0	90.4
Shiraz/Syrah 04	2022	Barossa Valley	89.3	89.9
Shiraz/Syrah 05	2022	McLaren Vale	94.0	89.7
Shiraz/Syrah 06	2022	Orange	88.7	85.6
Shiraz/Syrah 07	2021	Mudgee	89.0	90.3
Shiraz/Syrah 08	2019	Great Southern, WA	86.3	89.1

Reflections and networking

The workshop concluded with comments from the judges, who also facilitated a Q&A session. The attendees and judges continued discussing the different techniques of judging and what works for them, as well as the differences in the results. The day ended with a chance for attendees to network (Figure 4) and reflect on the insights gained.

Feedback from participants was very positive, with everyone saying they would love to attend more workshops such as this one. The workshop had a relaxed feel and discussion sessions that gave everyone the opportunity to put their decision forward as well as ask questions. Suggestions for future events included having a session on international or alternative wines.



Figure 4. Some of the attendees at the Rootlings wine show judging workshop.

Acknowledgements

NSW Rootlings is part of the Greater NSW–ACT Regional Program delivered by NSW DPIRD in partnership with NSW Wine. The Regional Program is supported by funding from Wine Australia. Wine Australia invests in and manages research, development, and extension on behalf of Australia's grape growers and winemakers and the Australian Government and is proud to support the next generation.



Conference: cultivating the future of NSW wine

Penny Flannery, Development Officer – Viticulture, NSW DPIRD

The Rootlings Network continues to grow as a vital initiative under the Greater NSW-ACT Regional Program delivered by NSW DPIRD in partnership with NSW Wine. In 2025, the conference was held in Griffith, NSW, for a dynamic two-day event designed to inspire, educate, and connect the next generation of wine industry professionals.

A warm welcome to Griffith

The 2025 Rootlings event started on Sunday 15 June with a welcome dinner at **Limone Dining**, where attendees met fellow participants (Figure 5). **Luke Piccolo**, owner of the restaurant, opened it exclusively for this welcome dinner. Penny Flannery (Development Officer – Viticulture) ensured a mixed table seating so participants could network with people from other regions.



Figure 5. Rootlings members at the welcome dinner at Limone Griffith.

Day one: immersive industry experiences

Monday 16 June began with an early departure for attendees to have a day of hands-on learning and behind-the-scenes access to some of the Riverina's most influential wine businesses.

Casella Family Brands (Figure 6) hosted the morning session, offering insights into viticulture, product development, sustainability, and brewing. Attendees toured the winery and heard from several Casella employees about the operation including **Nic Schirrippa** (Grower Services Manager), **Greg Short** (Brewing Distillation and Packaging Operations), **Ross Webster** (Water Waste Garden Manager), **Jessica Dunstan** (Product Development Planner) and **Joey Sergi** (Sustainability), as well as several winemakers including **Michael Slater**, **Sally Carusi** and **Daniel Rogato**.

The group then travelled to **Yarran Wines** (Figure 7), where **Sam Brewer** (Winemaker/Owner), **Luke Beltrame** (Winemaker), **Katie Alpen** (Marketing and Cellar Door Manager) and **Melinda Bonetti** (Cellar Door Operations) guided participants through vineyard operations, winemaking, and cellar door marketing strategies for their small business.

The afternoon continued at **De Bortoli Wines** (Figure 8) with a **Noble One** tasting and a discussion focusing on legacy, innovation, and premium wine production led by **Darren De Bortoli** (Managing Director) and **John Coughlan** (Senior Winemaker).

The day concluded with an industry dinner at **Calabria Family Wines**, with remarks from **Mark Bourne**, President of NSW Wine, and further networking opportunities with industry leaders and Rootlings members.



Figure 6. Rootlings members at Casella Family Brands (left) and touring the winery (right).



Figure 7. Rootlings members at Yarran Wines, touring the winery (left) and cellar door tasting (right).



Figure 8. Rootlings members at De Bortoli Wines hearing from Darren De Bortoli, Managing Director (left) and John Coughlan, Senior Winemaker (right).

Day two: technical insights and future pathways

The second day (Tuesday 17 June) offered a blend of technical sessions and personal development. The morning began at the NSW DPIRD Griffith Centre for Irrigated Agriculture site (Figure 9), where Penny Flannery (Development Officer – Viticulture) showed participants the vineyard and discussed the resting vineyard trial, the effect of frost, pruning and canopy strategies.

Kristy Bartrop (Figure 10; Viticulturist and Technical Manager of Southern Premium Vineyards) spoke about her career leading into her current role of managing over 3,000 ha of vineyards.

Jeremy Cass (Figure 11; Chief Executive Officer of Riverina Winegrape Growers) and local young growers **James Cremasco** and **Jared Bianchini** (Figure 12) discussed viticulture trends and challenges.

Dr Meena Thakur (Figure 13; Research Horticulturist – Entomology, NSW DPIRD) spoke about common pests in viticulture.

Andrew Calabria discussed domestic and international sales strategies used at Calabria Family Wines (Figure 14 and Figure 15).

The group then visited Piccolo Family Farm for a tour of the vineyard and farm, as well as some tasting (Figure 16 and Figure 17). **Luke Piccolo** discussed alternative varieties, sustainable farming and business practices, and further networking occurred.

The event concluded with lunch and closing remarks from Penny Flannery, who celebrated the connections made and the knowledge shared.



Figure 9. Rootlings members at the NSW DPIRD session.



Figure 10. Kristy Bartrop with a map of the Southern Premium Vineyard locations.



Figure 11. Jeremy Cass discussing the region's statistics.



Figure 12. The young grower panel with James Cremasco and Jared Bianchini.



Figure 13. Dr Meena Thakur, Research Horticulturist – Entomology, NSW DPIRD.



Figure 14. Andrew Calabria of Calabria Family Wines. Photo: Jenna Vaughan, Rootlings Wine Industry Youth Network.



Figure 15. Rootlings members at Calabria Family Wines session. Photo: Jenna Vaughan, Rootlings Wine Industry Youth Network.



Figure 16. Rootlings members at the final stop, Piccolo Family Farm.



Figure 17. Rootlings members at Piccolo Family Farm in the vineyard with Luke Piccolo (left) and at lunch (right).

Feedback

Participants reported they found the conference informative and valuable. Many attendees are looking forward to the NSW 2026 conference to be run by the Rootlings Wine Industry Youth Network, with Jenna Vaughan as the National Project Officer.

Looking ahead

The Rootlings Wine Industry Youth Network was officially started in July 2024, and the program's mission will continue to empower young professionals in the wine industry through immersive learning, mentorship, and community building. Some attendees at this year's conference came from interstate, including South Australia, Victoria and Tasmania, to see how NSW DPIRD presented the conference. With a strong focus on sustainability, innovation, and inter-generational knowledge sharing, this year's agenda reflected the evolving needs of the industry and the passion of its future leaders.

If you are under 35 and an active participant in the wine industry, please join the [Rootlings Wine Industry Youth Network](https://www.rootlings.com.au/) (<https://www.rootlings.com.au/>) to see that these worthwhile events continue to support and promote the future of the NSW and Australian Wine industry.

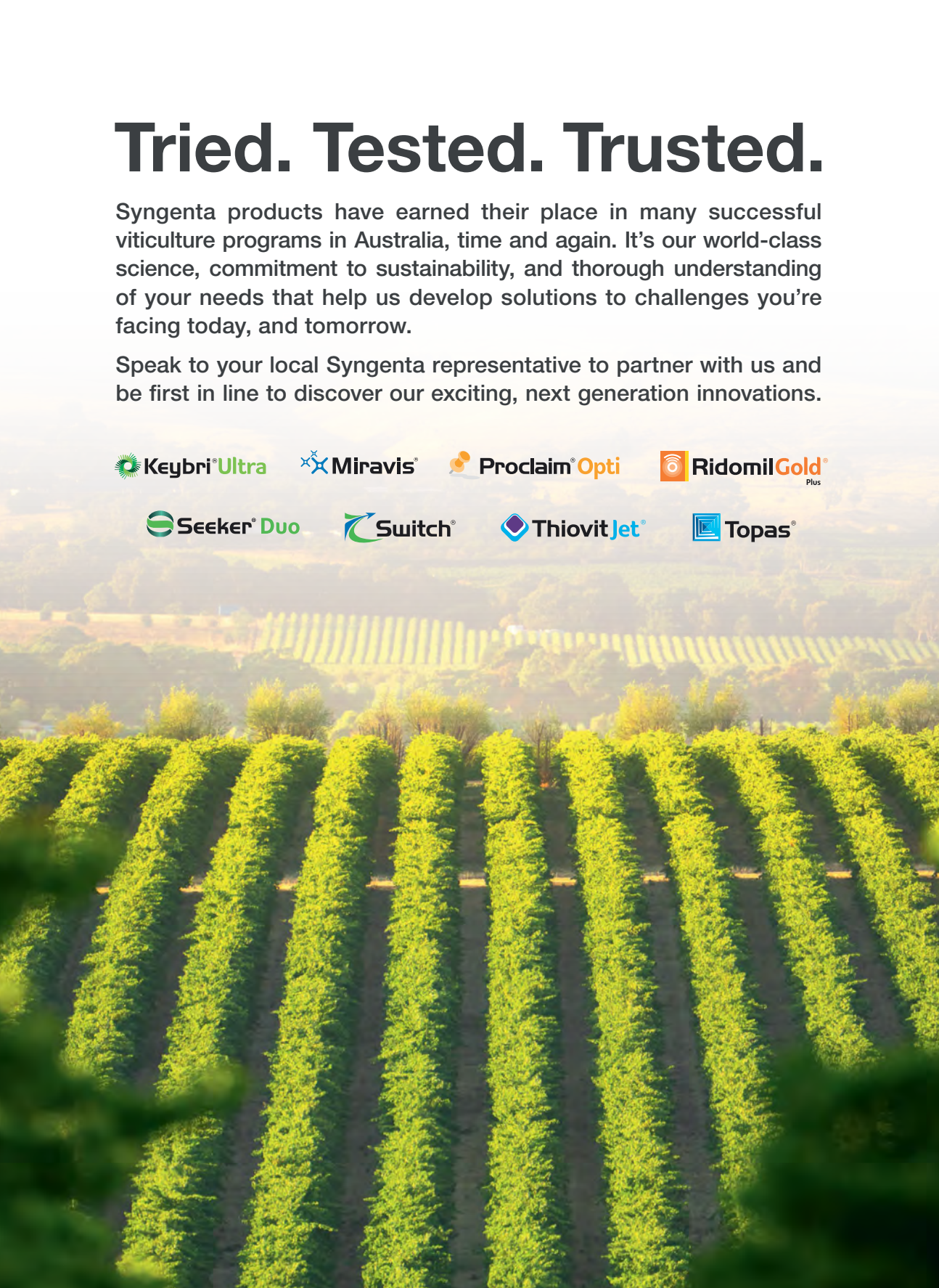
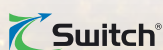
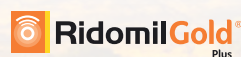
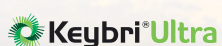
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Mechanical shaking for rot reduction

Penny Flannery, Development Officer – Viticulture, NSW DPIRD

As the wine industry faces increasing pressure from managing disease and rising costs, mechanical shaking is proving to be a game-changing technique for reducing botrytis and other bunch rots. In November 2024, a demonstration to show how mechanical shaking can improve fruit quality and mitigate the risks associated with grapevine rot was hosted by Angullong Vineyard in Orange, in collaboration with NSW DPIRD. The demonstration, which featured insights from experts **Mark Allen** of Allen Vineyard Advisory (NZ), **Stephen McKenzie** of Angullong Vineyard and **Liz Riley** of Vitibit, showed how this technique can improve grape cleanliness and reduce the incidence of botrytis (grey mould) and other bunch rots during the critical preharvest period.

The video taken at the demonstration is on the NSW DPIRD [Agriculture YouTube](https://www.youtube.com/watch?v=XaAtlTYQwo) channel (<https://www.youtube.com/watch?v=XaAtlTYQwo>).

The purpose of mechanical shaking for rot reduction

The primary aim of mechanical shaking is to reduce excess debris, such as leaves, stems and unformed berries, that accumulates in the grape bunches during the growing season. If left in the bunches, these materials can trap moisture and create the perfect environment for diseases such as botrytis, particularly as harvest approaches and conditions become wetter. Shaking the vines after berry set and before bunch closure removes the debris from the canopy, leaving the bunches clean, significantly lowering the likelihood of botrytis infection, especially in seasons with high humidity or rainfall.

Insights from experts: Mark Allen and Stephen McKenzie

Mark Allen, author of [Mechanical shaking for rot reduction](#) and an experienced viticulture consultant from Marlborough, New Zealand, shared his expertise on mechanical shaking. Having first been involved with this technique in 2010, Mark emphasised how it evolved from bunch thinning to become a critical tool for botrytis control. After years of trials, he and his team have perfected the settings to optimise the reduction of botrytis pressure. This method is now widely adopted in Marlborough vineyards after fruit set and before bunch closure.

According to Mark, mechanical shaking significantly reduces botrytis risk, particularly in high-pressure seasons. 'We have found that after fine-tuning the equipment, we can achieve up to a 50% reduction in botrytis in certain varieties. This method has proven to be a highly effective and cost-efficient way to control the disease', he said.

Stephen McKenzie, Vineyard Supervisor at Angullong Vineyard, guided the group through the machine set-up process. He explained the key parameters for the Pellenc harvester ([Figure 18](#)), including beater speed, amplitude, travel speed, and acceleration. 'The settings we use on our Pellenc harvester have been refined over the past few seasons. The optimal speed for the harvester is about 5.5 km/h, with the beater speed set to around 480 rpm. These adjustments allow us to efficiently shake the debris from the bunches without damaging the fruit.'

Fine-tuning the mechanical shaking process

The team at Angullong Vineyard uses a careful, trial-and-error approach to fine-tune the machine settings for each vineyard and variety. 'We start with a baseline and adjust parameters such as beater speed, amplitude, and acceleration. It is a gradual process of refining the settings based on the specific conditions of the season', Stephen said.



Figure 18. A Pellenc pull-behind harvester is used to shake the Pinot Gris vines.

It is also essential to measure the correct height for the rods in the harvester (Figure 19). Mark said they needed to be 500 mm away from the fruiting zone to reduce the risk of accidental bunch thinning or removal. At Angullong Vineyard, they have used a single set of rods on the trunk side and 2 sets of rods above the fruit zone (Figure 20).



Figure 19. Mark Allen of Allen Advisory measures the correct height for the rods, which is usually 500 mm from the fruiting zone.



Figure 20. Mark Allen and Stephen McKenzie (left) discuss the set-up with harvester operator Anthony Smith (right). The harvester rod set-up is in the background (red arrows).

Results

One of the ways to assess the effectiveness of mechanical shaking is to place white trays under the vines to catch any debris shaken loose from the canopy (Figure 21). The amount of debris collected on these trays indicates how much material is being dislodged from the bunches (Figure 22). This information also helps with adjusting the machine settings to achieve the optimal amount of debris removal. The grape bunches were noticeably cleaner after mechanical shaking, showing it is a useful technique for reducing rot.



Figure 21. The harvester passes over white trays under the vine to gauge how much debris is removed by the shaker.

A follow-up assessment at preharvest in February 2025 showed that untreated grapes had much more debris than treated grapes (Figure 23).

After the Pinot Gris harvest, Stephen reported 0.2% botrytis in the mechanically shaken rows and 0.5% botrytis in the control rows. This result fits with his estimated 40–50% reduction in botrytis. Stephen emphasised that no row would be missed in future seasons. While 2025 conditions were not highly conducive to bunch rot, the remaining debris in untreated grapes suggests that, in a wet, cool season, botrytis and bunch rot levels could be significantly higher.

Angullong Vineyard's fruit is used for its own label, but a large portion is sold under contract to various wineries. These wineries set strict limits on rot levels at harvest, and exceeding these specifications could substantially reduce the price per tonne.

Economic benefits of mechanical shaking

Mark also highlighted the cost-effectiveness of mechanical shaking, particularly when compared to the potential costs of botrytis-related crop losses. 'A single pass of the harvester at 5 km/h is a relatively inexpensive way to control botrytis risk. In years with higher disease pressure, the results can be considerable. For a relatively low cost, fruit quality at harvest can be significantly improved.'

The cost of using the harvester is minimal compared with the potential losses caused by botrytis. For many vineyards, mechanical shaking has become a vital tool in managing disease, especially during seasons where fungal pressures are high.



Figure 22. The type of debris that is shaken out of the bunches.



Figure 23. The amount of debris collected from 20 bunches each that were not shaken (left) and shaken (right).

Challenges and considerations

While the economic and agronomic benefits of mechanical shaking are evident, there are several challenges to consider.

- **Vineyard suitability:** mechanical shaking is most effective in flat or gently sloped vineyards with adequately spaced rows. Steep terrain or narrow vine spacing might prevent mechanical harvester use. Additionally, certain delicate grape varieties might not respond well to mechanical shaking for rot reduction.
- **High initial investment:** mechanical harvesters are a significant investment, and their high upfront cost could be a barrier for some, but using contractors could be an option.
- **Machine calibration and training:** proper calibration of the harvester is critical to avoid damage to the vines or fruit. Vineyard managers need to ensure proper training and regular maintenance to avoid costly mistakes.

The future of mechanical shaking in viticulture

With the increasing pressure to reduce costs and improve efficiency, mechanical shaking is expected to become more widespread in the wine industry. As technology advances, autonomous harvesters and advanced data-driven systems that optimise shaking settings could make the process even more efficient and precise.

For growers and contractors with mechanical harvesters, using this machinery for an additional purpose, such as enhancing fruit quality, is a great advantage. Ongoing research into botrytis management and vineyard strategies aims to further refine the practice, ensuring it becomes a standard tool for disease management and improved fruit quality in NSW wine regions.

A mechanical shaking demonstration is planned for the Hunter Valley in November 2025. This ongoing project will continue to explore the potential of mechanical shaking as an effective and low-cost solution for managing botrytis and improving overall grape quality.

Key points

- While all floral debris are potential sources of infection, Rob Beresford (Plant and Food Research NZ), found the small aborted green berries that are encapsulated in the bunch at bunch closure are the most significant source. They later detach and become dead material within the tight bunch, acting like a time bomb.
- Pinot Gris is the most responsive to shaking. In some blocks, botrytis was reduced by 80%.
- Using shaking as a cultural control can reduce the reliance on synthetic botryticides, delaying or avoiding resistance from developing. In a small trial comparing total reliance on shaking without any synthetic botryticide treatments and using synthetic botryticide treatments, the result was the same.
- White trays are the absolute best!

Conclusions

Mechanical shaking for rot reduction is proving to be a valuable tool for viticulturists looking to minimise the risk of botrytis and other bunch rots and improve harvest quality. As demonstrated at Angullong Vineyard, this technique offers a low-cost method for reducing disease pressure and improving the cleanliness of grape bunches before harvest. With further research and refinement, mechanical shaking could become a standard practice in vineyards, offering both economic and agronomic benefits.

Acknowledgements

This demonstration is part of the Greater NSW–ACT Regional Program, funded by Wine Australia and delivered by the NSW Department of Primary Industries and Regional Development (NSW DPIRD) in partnership with NSW Wine. The demonstration was part of a wider effort to show viticulturists how to use existing machinery in innovative ways to manage pressing challenges such as disease and crop quality.

Reference

Allen M (2019) *Mechanical shaking for rot reduction*. Bragato Research Institute, Blenheim, NZ, <https://bri.co.nz/2019/06/01/mechanical-shaking-for-rot-reduction/>



Under-vine ground cover updates

How pasture species established in Orange, NSW

Penny Flannery, Development Officer – Viticulture, NSW DPIRD

Under-vine cover crops improve vineyard sustainability by enhancing soil nutritional and microbiological status as well as weed suppression. Following the initial trial in the Hunter Valley in 2021, another trial site was established at Nashdale Wines in Orange, NSW, in October 2023 to see how the pasture species perform in a different region. This article includes the visual, nutritional and microbial results from the site at Orange.

Aims

- Evaluate pasture species for establishment, weed control and vineyard sustainability.
- Enhance soil biological, physical, and chemical properties.
- Improve soil moisture retention and biodiversity.
- Reduce herbicide use.
- Encourage beneficial insects within vineyard ecosystems.

Methods and treatments

Site

- Location: Nashdale Wines, Nashdale, NSW.
- Variety: Pinot Gris (Clone D1V7) planted in 2008 (Block 4A). Vine cordon reworked in winter 2024.

Treatments

- Control (no pasture sown): rows 1, 2, and 11.
- Dichondra (*Dichondra repens*): rows 3 and 4.
- Creeping fescue (*Festuca rubra*): rows 5 and 6.
- Annual ryegrass (*Lolium multiflorum*) and sub clover blend (*Trifolium subterraneum*): rows 7 and 8.
- Red clover (*Trifolium pratense*): rows 9 and 10.

Results

Visual analysis

The annual ryegrass and sub clover ([Figure 24](#)) blend is performing well in the under-vine area. Annual ryegrass grows upright initially but then tends to dry out and lie flat over the irrigation lines when temperatures rise, so it does not invade the fruit zone. Red clover thrives in wet, cool conditions and typically dies back in hotter weather. However, by December 2024, red clover was well-established ([Figure 25](#)) due to the unique combination of wet and warm conditions that season. These conditions also helped pasture grow naturally in the control rows ([Figure 26](#)).

Dichondra has developed into patches of large-leafed growth beneath established pasture grasses ([Figure 27](#)). This growth pattern differs from the Hunter Valley trial, where dichondra has a ground-cover habit. In the Hunter Valley, dichondra has become too competitive and requires weed control measures to stop it from competing with vines for water and nutrients. In Orange, the less vigorous establishment of dichondra is preferred, as it integrates well without excessive competition.

Creeping fescue did not establish well ([Figure 28](#)).

During the next few years, we hope to determine which species are suitable for weed suppression, soil moisture retention, and reduced herbicide use in the vineyard.

Nutritional analysis

The red clover rows had the highest levels of ammonium nitrogen and nitrate nitrogen ([Table 2](#)). The dichondra rows had the lowest nitrate nitrogen and shared the lowest ammonium nitrogen levels with the control, creeping fescue, and the annual ryegrass-sub clover blend.



Figure 24. Annual ryegrass (*Lolium multiflorum*) and sub clover blend (*Trifolium subterraneum*) blend.



Figure 25. Red clover (*Trifolium pratense*).



Figure 26. The control row (no pasture sown).



Figure 27. Dichondra (*Dichondra repens*).

The highest levels of phosphorus and potassium were in the creeping fescue rows, although creeping fescue itself was not visible. The annual ryegrass–sub clover blend ranked second for phosphorus, while dichondra was second for potassium. The control rows had the lowest phosphorus levels, and annual ryegrass had the lowest potassium.

The sulfur content was highest in the red clover and lowest in the creeping fescue. Organic carbon was most abundant in the red clover rows and least abundant in the control and dichondra rows.

The ideal soil pH (CaCl_2) range for nutrient availability is 5.0–5.5. Soil with a pH closer to 7 is less acidic, which can reduce nutrient adsorption. The pH in the soil was too high for optimal nutrient uptake in the dichondra.



Figure 28. Creeping fescue (*Festuca rubra*).

Soil conductivity was low in all samples (normal range is between 0.8 and 1.8), reflecting a generally low nutrient content. The soil under the red clover had the highest conductivity, followed by the annual ryegrass–sub clover blend. The soil under the dichondra had the poorest conductivity results.

Table 2. The nutritional results of the soil in the under-vine areas.

	Rows 1 and 2	Rows 3 and 4	Rows 5 and 6	Rows 7 and 8	Rows 9 and 10
Colour	BRGR*	BRGR	GRBR	GRBR	BRGR
Gravel (%)	0	0	0	0	0
Texture	3.5	3.5	3.5	3.5	3.0
Ammonium nitrogen (mg/kg)	2	2	2	2	4
Nitrate nitrogen (mg/kg)	7	2	5	3	20
Phosphorus Colwell (mg/kg)	9	11	25	16	14
Potassium Colwell (mg/kg)	164	185	235	160	181
Sulfur (mg/kg)	7.8	8.2	7.3	8.3	15.7
Organic carbon (%)	0.93	0.93	1.50	1.22	1.65
Conductivity (dS/m)	0.038	0.032	0.039	0.056	0.069
pH level (CaCl ₂)	5.1	5.0	5.0	5.7	5.1
Ph Level (H ₂ O)	6.2	6.0	6.1	6.3	5.9

* BRGR = brown-grey, GRBR = grey-brown (Cook 2020).

Microbial activity analysis

Soil microbial activity in all treatments was generally below optimal levels but was higher in all treatment rows than in the control row (Table 3). This suggests that having some under-vine pasture is more beneficial to the soil than having the under-vine bare.

The red clover treatment had the highest microbial activity, closely followed by the annual ryegrass and sub clover blend. The dichondra treatment had the lowest amount of microbial activity. Therefore, at this site in Orange, NSW, the red clover treatment gave the best results.

Although there was no significant difference in microbial activity between the rows, having an under-vine pasture is better for weed control, reducing herbicide use to control non-desirable species and nutritional improvement, especially for clover establishment.

Table 3. The soil microbial activity results from Microbiology Laboratories Australia.

	Microbial activity indicator (ideal: 80.0)	Potential microbial activity indicator (ideal: 668)	Soil microbial biomass carbon (ideal: 4,000)	Assessment
Control	42.4	380	2,280	Fair microbial activity. Suggestions include adding organic soil conditioners and other organic material to manage the carbon-to-nitrogen (C:N) ratio.
Dichondra	39.8	358	2,159	Fair to low microbial activity. Recommendations include improving carbon and nitrogen levels to balance the C:N ratio to boost microbial health.
Creeping fescue	41.3	371	2,230	Fair microbial activity. Organic amendments to carefully manage the C:N ratio are recommended to enhance microbial activity.
Annual ryegrass and sub clover blend	41.3	388	2,322	Fair microbial activity. Adding organic soil conditioners and nitrogen fertilisers is advised.
Red clover	43.4	450	2,672	Good to fair microbial activity. Adding organic soil conditioners and nitrogen fertilisers is advised.

Lessons learned

1. **Seasons:** autumn sowing aligns better with pasture species' requirements, reducing establishment challenges.
2. **Species selection:** compatibility with regional conditions was improved by adjusting the species mixes, such as:
 - Replacing desert fescue with creeping fescue as the desert fescue grew into the fruiting zone.
 - Replacing crimson clover with red clover as crimson clover could not be purchased in Orange.
 - Adding ryegrass to the mix with sub clover, as ryegrass is extremely competitive and can control weeds, especially kikuyu infestations, improve soil aeration, soil structure and organic carbon levels.
3. **Microbial enhancement:** incorporating organic amendments to optimise the C:N ratio is critical for microbial health.

Recommendations for future trials

Species diversity: explore additional species combinations for greater resilience to varying climatic conditions. Consider other clover species in this region as grass species establish naturally.

Key points

- The under-vine cover crop trial at Orange NSW (Nashdale) shows that species selection can improve nutrient levels and microbial activity, and therefore improve sustainability. It can also provide weed control, reducing the need for intensive labour practices. By refining species selection and microbial management strategies, future efforts can enhance soil health, weed control, and overall vineyard resilience, ultimately resulting in more sustainable grape production.
- Red clover seems to be the most beneficial species, giving better results for increasing nutritional and microbiological content in the soil and reducing the need for herbicide use.

Acknowledgements

This demonstration site is part of the Greater NSW–ACT Regional Program, funded by Wine Australia and delivered by the NSW Department of Primary Industries and Regional Development (NSW DPIRD) in collaboration with NSW Wine. The demonstration was part of a wider effort to show viticulturists how to look at different under-vine pasture species for different purposes in the vineyard.

Reference

Cook A (2020) *SARDI soil characteristics*. Government of South Australia, <https://airep.com.au/wp-content/uploads/2023/08/2020-EP-Soil-Characterisations.pdf>



Nashdale Lane Wines, Orange, NSW

Penny Flannery, Development Officer – Viticulture, NSW DPIRD

On Monday 16 December 2024, 8 attendees visited Nashdale Lane Wines ([Figure 29](#)) to see how the under-vine pasture species were establishing as part of an NSW DPIRD trial.



Figure 29. Penny Flannery (right) going through the first year results of the trial with attendees.

The following species were planted in October 2023:

- Rows 1, 2 and 11 – control (bare ground now natural pasture species, [Figure 30](#))
- Rows 3 and 4 – dichondra (*Dichondra repens*, [Figure 31](#))
- Rows 5 and 6 – creeping fescue (*Festuca rubra*, [Figure 32](#))
- Rows 7 and 8 – annual ryegrass (*Lolium multiflorum*) and 2 species of short-season sub clover (*Trifolium subterranean*, [Figure 33](#))
- Rows 9 and 10 – red clover (*Trifolium pratense*, [Figure 34](#) and [Figure 35](#))



Figure 30. The control rows with no pasture sown.



Figure 31. The dichondra (*Dichondra repens*) rows.



Figure 32. The creeping fescue (*Festuca rubra*) rows.



Figure 33. The annual ryegrass (*Lolium multiflorum*) and 2 species of short-season sub clover (*Trifolium subterranean*) rows.



Figure 34. The red clover (*Trifolium pratense*) rows.



Figure 35. Participants looking at the red clover establishment in rows 9 and 10.

Feedback from attendees

Growers expressed interest in adopting the locally sourced red clover species due to its strong development. They plan to return in 12 months to assess whether re-seeding is required. They also valued the potential to reduce tractor passes for herbicide application and soil compaction. Additionally, they preferred species that help manage vine vigour and improve access to the fruit zone. Some growers suggested testing fruit to determine the effect of different under-vine species on Baume, pH, and acid levels.

Key points

- Red clover was the best under-vine pasture species to establish. The annual ryegrass also established well and has grown up to the irrigation line as expected at this time of year (December).
- Dichondra established in patches under the pasture grasses, which is a good result as dichondra is a vigorous species that can take over, as it has in the Hunter Valley trial and now needs to be controlled with herbicide.

Acknowledgements

This trial is part of the Greater NSW–ACT Regional Program delivered by NSW DPIRD in partnership with NSW Wine. The Regional Program is supported by funding from Wine Australia.



Tawarri Vineyard, Merriwa, NSW

Brent Hutton, Vineyard Manager, Tyrell's Wines, Hunter Region

Summary

To reduce herbicide and synthetic fertiliser use, vineyard operating costs and carbon emissions, enhance beneficial insect populations, and moderate vineyard temperatures during the growing season, a cover crop trial is being conducted at Tawarri Vineyard near Merriwa in the Hunter region. Various annual clover species were planted as under-vine cover crops in a 25-year-old Shiraz vineyard. Initial findings highlight the success of crimson clover (*Trifolium incarnatum*), prompting further investigation into other clover varieties, including shaftal Persian clover (*Trifolium resupinatum*), turbo clover (hybrid), berseem clover (*Trifolium alexandrinum*), and arrowleaf clover (*Trifolium vesiculosum*), with a control row (no cover crop planted) for comparison.

Introduction

Using cover crops in viticulture has become a sustainable practice to improve soil health, reduce environmental impact, and enhance vineyard resilience. At Tawarri Vineyard, a unique site characterised by its rich basalt clay soil, temperate/continental climate, and altitude of 450 meters, an under-vine cover crop trial was initiated to overcome multiple agronomic and economic challenges.

Previous attempts to identify a suitable cover crop were unsuccessful, with perennial clovers proving persistent and competitive with grapevines for water and nutrients due to their inability to die back and fix nitrogen into the soil. However, annual clovers, particularly crimson clover (*Trifolium incarnatum*), showed great promise by growing through winter, dying back during the grapevine growing season, and contributing to soil nitrogen levels without competing for resources.

The trial at Tawarri Vineyard aimed to compare 5 annual clover varieties with a control to determine the most effective species for:

- **reducing herbicide use:** natural weed suppression from cover crops should minimise the need for chemical weed control.
- **reducing synthetic fertiliser use:** nitrogen fixation by annual clovers should improve soil fertility.
- **reducing costs:** sustainable practices should lower overall vineyard management expenses.
- **reducing carbon emissions:** decreased tractor passes for weed control and fertiliser application should reduce fuel consumption.
- **moderating temperature:** maintaining a living mulch under the vines should mitigate heat stress in the vineyard and canopy.
- **increasing beneficial insect habitat:** increased populations of predatory and pollinating insects should enhance natural pest management.

Site description

Tawarri Vineyard is a 25-year-old Shiraz vineyard in a distinctive microclimate within the Hunter region, approximately 27 km north-northeast of Merriwa and 10 km from the top of the ranges. The site's unique environmental conditions make it an ideal candidate for testing cover crop performance under temperate/continental conditions in a commercial viticulture setting.

- **Soil:** rich basalt clay, known for its fertility and water-holding capacity, provides a robust foundation for establishing cover crops.
- **Altitude:** 450 meters above sea level (masl), contributing to cooler nights and moderate daytime temperatures.
- **Aspect:** north-western with a gentle slope and central gully, influencing drainage and sunlight exposure.
- **Row direction:** north-south, optimising vine exposure to sunlight throughout the day.
- **Latitude:** 31° 53' 54.88" S
- **Longitude:** 150° 26' 46.09" E

- **Climate:** temperate/continental, characterised by warm summers, cold winters, and moderate rainfall, with distinct seasonal transitions being ideal for annual cover crops.

Trial objectives

The primary purpose of this trial was to identify the most suitable annual clover species for the under-vine area at Tawarri Vineyard, balancing agronomic benefits with operational efficiency. Specific objectives included:

- **weed suppression:** assess the ability of each clover variety to outcompete weeds, reducing reliance on herbicides.
- **nitrogen fixation:** evaluate the contribution of each clover to soil nitrogen levels following dieback.
- **vineyard microclimate:** measure the effect of cover crops on soil and canopy temperatures during the growing season.
- **insect activity:** monitor beneficial insect populations (e.g. ladybugs, parasitic wasps, and pollinators) attracted to each clover type.
- **operational effect:** quantify reductions in tractor passes, fuel use, and input costs associated with each treatment.

Experimental design

Six rows were each assigned a different treatment:

Row 1 – control: no cover crop planted; managed with standard herbicide and fertiliser applications.

Row 2 – shaftal Persian clover (*Trifolium resupinatum*): an annual clover known for rapid establishment and high biomass production.

Row 3 – turbo clover: a hybrid or branded clover variety selected for vigour and adaptability.

Row 4 – crimson clover (*Trifolium incarnatum*): a proven performer at the site, included as a benchmark for comparison.

Row 5 – berseem clover (*Trifolium alexandrinum*): an annual clover valued for its nitrogen-fixing capacity and suitability to temperate climates.

Row 6 – arrowleaf clover (*Trifolium vesiculosum*): an annual clover with potential for weed suppression and soil improvement.

Each row spans the length of the vineyard block, with the clover sown under the vines using a broadcast method in late autumn to align with the winter growing season. The trial makes use of the natural dieback of annual clover during spring–summer to minimise competition with grapevines during their active growth phase. Data collection will include soil nitrogen, weed density, temperature (soil and canopy), and operational metrics (e.g. tractor passes and herbicide applications).

Methods

1. **Pre-seeding herbicide application:** to ensure a weed-free environment for planting, a suitable herbicide (glyphosate 570 g/L, e.g. Roundup UltraMAX®) was applied in all rows before seeding.
2. **Removing canes and leaf matter:** following the herbicide treatment, all rows were thoroughly cleared of canes, leaf litter, and other organic debris. This involved raking to remove any remnants of previous vegetation or plant material that could interfere with seed placement or germination. The cleared material was collected and removed from the site to prevent decomposition from affecting soil conditions or encouraging weed regrowth.
3. **Removing weeds manually:** after raking, the rows were inspected to identify and eliminate any remaining weeds that survived the herbicide application. A chip hoe, a precision tool designed for shallow cultivation, was used to carefully chip out these persistent weeds.
4. **Hand broadcasting seeds:** with the rows prepared, seeds were sown by hand using the broadcast method. This involves evenly distributing the seeds over the surface of the rows, ensuring uniform coverage. The quantity of seeds was calculated based on the recommended seeding rates for the specific crop. Care was taken to promote consistent growth in the rows by avoiding any clumping or uneven distribution.

5. **Light soil covering with a rake:** a light layer of soil was raked over the seeds to provide coverage and protection. Using a rake, a small amount of soil was gently pulled over the seeds to a shallow depth, sufficient to shield them from environmental factors such as wind, birds, or excessive sunlight, while still allowing for germination. This step was performed with precision to avoid burying the seeds too deeply, which could hinder sprouting, ensuring optimal conditions for successful crop establishment.

Preliminary observations

Early observations show crimson clover (Row 4, [Figure 36](#)) demonstrated vigorous winter growth, effective weed suppression, and timely dieback, aligning with the grapevines' seasonal needs. Other varieties, such as shaftal Persian clover (Row 2, [Figure 37](#)), turbo clover (Row 3, [Figure 38](#)), and arrowleaf clover (Row 6, [Figure 39](#)), show promising establishment. However, their performance in nitrogen fixation and temperature moderation requires further assessment. Berseem clover did not establish ([Figure 40](#)). The control row (Row 1, [Figure 41](#)) highlights the baseline challenges of weed pressure and higher input reliance, underscoring the potential benefits of cover cropping.



Figure 36. A panel of crimson clover.



Figure 37. A panel of shaftal Persian clover.





Figure 38. A panel of turbo clover.



Figure 39. A panel of arrowleaf clover.



Figure 40. A panel of berseem clover.



Trial progress

Excluding the berseem clover, all species provided healthy green ground cover until mid-December. Flowering heads were still present to attract pollinators up until mid-December. It will be interesting to see the level of self-seeding for the following season.

During December and early January, the cover senesced and provided a layer of mulch over the soil that continued to suppress weed growth through summer. By late February to early March, the mulch had disintegrated into the soil, but the soil remained bare. Very little grass growth was observed, even on bare soil, late in the season.

Overall the ground cover provided impressive weed suppression with no herbicide application required at all during the growing season. Additionally, no mowing or hand weeding was required. After the initial preparation work before bud burst, it has been 'hands-off' all year.

Next steps

The trial will continue through the 2025 growing season, with data collection scheduled for:

- **Soil sampling:** pre- and post-dieback nitrogen levels.
- **Temperature monitoring:** soil and canopy temperatures during peak summer heat.
- **Insect surveys:** beneficial insect populations in late spring.
- **Cost analysis:** input and labour costs compared between treatments.

Results will be compiled into a final report, with recommendations for the most effective clover variety in Tawarri Vineyard and potentially other sites in the Hunter region.

Conclusion

The cover crop trial at Tawarri Vineyard represents a proactive effort to integrate sustainable practices into viticulture. By trialling shaftal Persian clover, turbo clover, crimson clover, berseem clover, and arrowleaf clover compared with a control, this experiment aimed to optimise under-vine cover cropping for environmental, economic, and agronomic benefits. Early indications suggest that annual clovers, particularly crimson clover, align well with the trial's objectives, offering a pathway to reduce herbicide use, enhance soil health, and lower vineyard costs while adapting to the site's unique conditions.

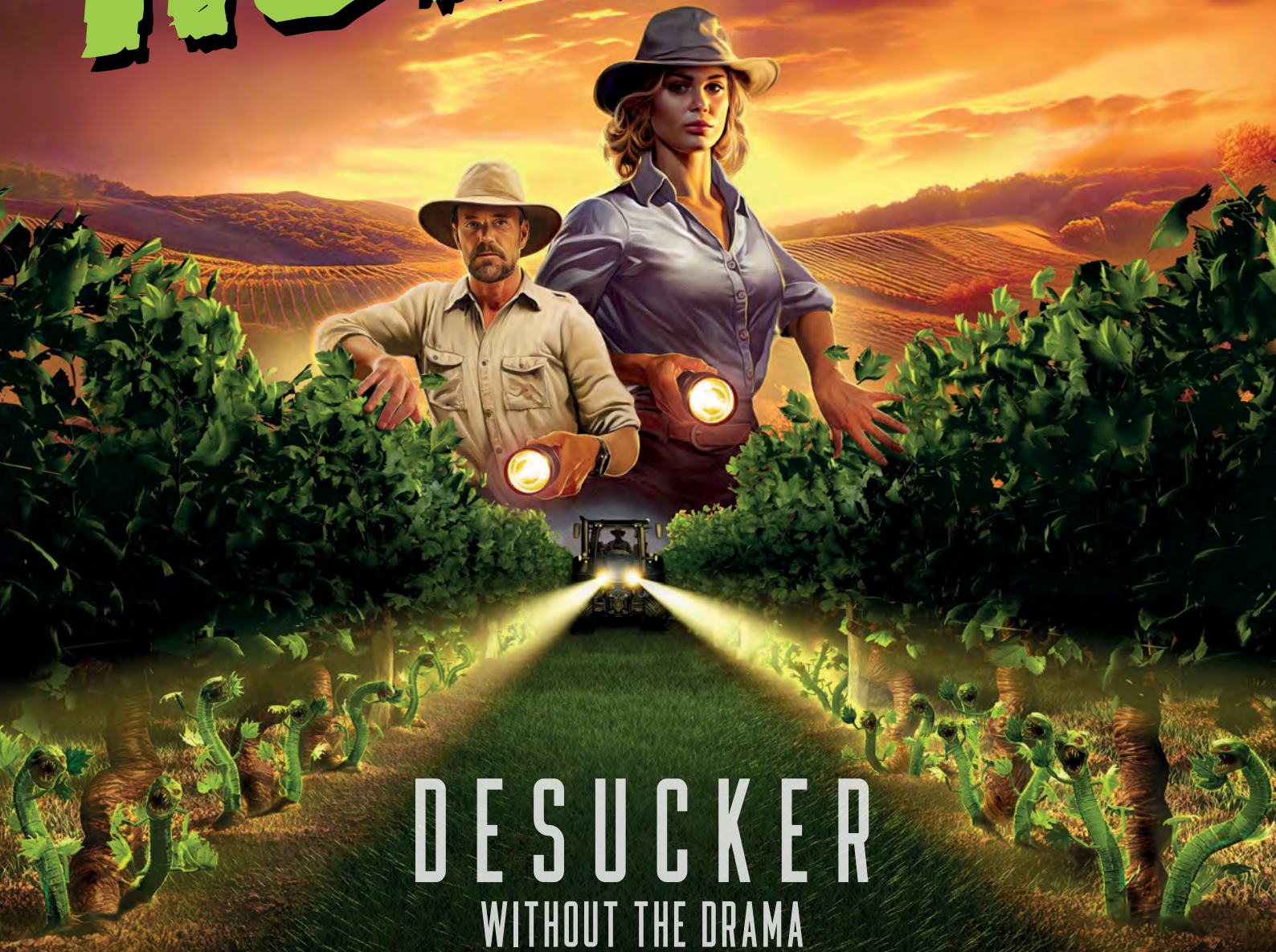
Acknowledgements

This demonstration site is part of the Greater NSW–ACT Regional Program, funded by Wine Australia and delivered by the NSW Department of Primary Industries and Regional Development (NSW DPIRD) in collaboration with NSW Wine. The demonstration was part of a wider effort to show viticulturists how to look at different under-vine pasture species for different purposes in the vineyard.



Figure 41. The control row, where no under-vine cover crop was planted.

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Grazing sheep in vineyards: case studies

Belmont Vineyard

Jamie Conway, Owner/Vigneron, Belmont Vineyard, Orange region

7 hectares of vineyard, with Sauvignon Blanc, Riesling, Chardonnay, and Merlot.

Overview of sheep integration

Jamie has been grazing sheep (Figure 42) in Belmont Vineyard for 4 years. This decision was driven by the desire to reduce labour costs, manage vineyard growth and vigour more sustainably, and enhance biodiversity within the vineyard. With a focus on soil health and reducing herbicide use, sheep have become a valuable part of the vineyard's holistic management system.

The role of sheep in vineyard practices

At Belmont Vineyard, sheep are primarily used for shoot removal and weed control. The sheep graze throughout the year and are usually restricted to a two-hectare vineyard block. They prevent vine growth from becoming unruly by shoot thinning and de-suckering, and they help manage weed growth, reducing the need for herbicides.

Key benefits include:

- **Shoot removal:** sheep remove hanging shoots from the canopy and suckers from the trunk, helping to control vine growth and vigour. This helps manage the canopy and reduce disease incidence by increasing airflow under and within the vines.
- **Weed control:** even small numbers of sheep help maintain grass and weed growth (Figure 43), particularly along the vineyard's fence lines.

Breed selection and grazing practices

Jamie selected **Babydoll Southdown** sheep to graze in his vineyard as they are a stocky breed, usually weighing around 80 kg, with short legs and necks. They are an ideal size for grazing in the vineyard and are less likely to jump or rear up and damage the vines than some other breeds.

Jamie is considering potential crossbreeding options, including combining Babydoll Southdown with **Cheviot** to breed sheep with clean legs and faces to prevent the wool from becoming matted with burrs. This would hopefully combine the Babydoll's stocky nature with the Cheviot's efficiency and greater fertility.



Figure 42. Babydoll sheep at Belmont Vineyard.



Figure 43. Top, a vineyard row after sheep have been grazing and bottom, a non-grazed row showing the under-vine pasture and sucker vigour.

Jamie is also exploring the possibility of working with the Finn breed, which offers improved grazing efficiency and higher twin birth rates.

Originally there were 20 sheep, and electric fencing was used to divide the vineyard into smaller grazing areas. Currently, 2 sheep have free rein over a 2-hectare section.

In the early stages, Jamie experimented with keeping the sheep in smaller sections, about a quarter hectare at a time. This required setting up and moving poles and wires along the mid-rows weekly, which became quite cumbersome. He found it much more practical to allow the sheep to graze on 1 hectare at a time, with a low fence along the vine rows splitting the 2-hectare block into 2 sections. The sheep were rotated every 1 to 2 weeks during the growing season: after spraying one side of the vineyard, they were moved to that side, and then the other side was sprayed where they had previously grazed. This process helped avoid the need to move the sheep out of the way for spraying.

During the off-season, the sheep were left to graze freely. After drenching, they were moved to a smaller area for a few weeks. Over winter, they were relocated to another block for a few months to rest the Riesling block before returning to it for the spring flush.

When the flock grows to more than 20 sheep, the plan is to rotate them through 6 to 7 areas every few months to help manage grazing more effectively. The sheep are sold for meat when they are at the appropriate size.

Vineyard management adjustments

To accommodate sheep grazing, Jamie has made several adjustments to his vineyard. Initially, there were 20 sheep rotating through the vineyard, but he has reduced this to 2 sheep in the Riesling block due to concerns about copper toxicity and preventative control of the worm population in the sheep and soil.

Key modifications to the vineyard include:

- **Raising the irrigation lines** from 200–300 mm to 500–600 mm so the sheep can walk under them.
- **Raising the cordon height** to 1.1 meters so the sheep cannot reach the vines ([Figure 44](#)).
- **Using portable electric fencing** ([Figure 45](#) to [Figure 47](#)), although more permanent fencing ([Figure 48](#)) is needed with increasing sheep numbers.



Figure 44. Babydoll sheep grazing in the Belmont Vineyard. Note the height of the irrigation and cordon.



Figure 45. Electric fence holders in the vineyard.



Figure 46. Excess electric fence tape.



Figure 47. The electric fence used to divide the vineyard for grazing rotation.



Figure 48. The established fencing to keep sheep within the block.

Economic and environmental benefits

Grazing sheep in the vineyard has led to **labour savings** as they help with de-suckering vines, a task that normally requires significant manual labour. The sheep's effect on **vine yield** has been less clear. While the yield is slightly lower, Jamie has observed improved **fruit quality**, with his **Riesling winning** recognition at the Orange Wine Show.

Grazing sheep in the vineyard has benefited **soil health** and **erosion control**. While the specific effect on biodiversity remains uncertain, Jamie has noticed reduced weed pressure and **improved blackberry control** along the vineyard's fence lines (Figure 49).



Figure 49. Having sheep graze along the fence lines helped with blackberry control.

Challenges and considerations

One of the challenges at Belmont Vineyard is managing the potential for copper toxicity in the sheep. The high copper levels in the soil, particularly in the Riesling block, required careful monitoring and management of the sheep. Fortunately, adding sodium molybdate and sulfur to the water supply (Figure 50) has helped mitigate copper-related health risks.

Other challenges include the need for **increased fencing** as sheep numbers grow, particularly around the irrigation system. Managing sheep during **veraison** (the onset of ripening) is also critical, as sheep will eat the grapes if allowed.



Figure 50. Sodium molybdate and sulfur were added to the sheep's water to mitigate the effects of copper toxicity.

Looking ahead

Despite the challenges, Jamie plans to **increase the number of sheep grazing the vineyard** to 20–30, rotating them through different vineyard blocks. This will require more permanent infrastructure, such as fencing and gates, to manage grazing effectively. Additionally, Jamie is exploring crossbreeding the Babydolls with other breeds to increase grazing efficiency and ensure the sheep remain manageable for the vineyard's needs.

Jamie's insights for others considering grazing sheep in vineyards include:

- **Sourcing sheep from phylloxera-free regions** to prevent potential pest contamination.
- **Quarantine new sheep** away from vineyards for at least 2 weeks to ensure they do not introduce diseases or pests.
- **Carefully monitor** sheep grazing habits, particularly during the fruit ripening stages, to make sure they are calm and not damaging the grapes.

Conclusions

Jamie's experience shows that grazing sheep in a vineyard can offer a range of environmental and economic benefits, including enhanced vineyard health, better fruit quality, and reduced labour costs. Although there are challenges, particularly around copper toxicity and managing grazing behaviour, the careful selection of sheep breeds and the thoughtful management of grazing practices can help mitigate risks. As more vineyards look to adopt sustainable farming practices, Jamie's experience offers valuable lessons on the effective use of livestock for vineyard management.

Acknowledgements

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Fischer's Vineyards

Wayne and Jennifer Fischer, Managers, Fischer's Vineyard, Canberra region
15 hectares of vineyard and 205 hectares of sheep and cattle farming.

Overview of sheep integration

Wayne and Jennifer Fischer have been grazing sheep in their vineyard for approximately 20 years. Sheep are primarily used for pasture control, particularly when the vines are dormant, with the sheep grazing from April to September. This helps control pasture growth and reduces the need for mechanical mowing, which in turn provides economic benefits, including reduced labour and fuel costs. Grazing sheep in the vineyard has also enhanced soil health, although the exact effect on vine yield is still uncertain.

Sheep breeds and management

- **Primary breed:** Merino sheep are preferred because of their calm temperament, they do not cause damage to vineyard infrastructure or vines, and they are suited to wool production.
- **Trialled breed:** Wiltipoll sheep were trialled but were more flighty and prone to browsing on the vines, which led to some concerns about damage to foliage.

Grazing practices

- **Seasonal grazing:** sheep are given free run of the vineyard during dormancy, with 100–200 sheep typically grazing during this period.
- **Set stocking** is used, which means sheep graze specific areas for an extended period. The sheep help manage weeds ([Figure 51](#)) and this reduces the reliance on herbicides and machinery.
- **Careful attention** is given to preventing damage to vines and infrastructure. For example, dogs are kept out of the vineyard so they do not chase the sheep, and efforts are made to ensure sheep do not become excited and cause damage.

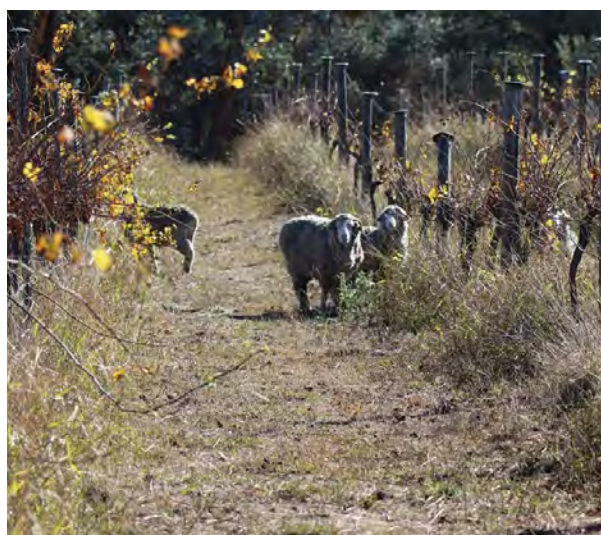


Figure 51. Merino sheep grazing the vineyard inter-row for weed control.

Vineyard management adjustments

- Grazing sheep in the vineyard has required some adjustments to fencing and management techniques. Sheep are allowed free access to vineyard blocks during winter but are carefully monitored to prevent them from causing damage.
- Irrigation controllers were covered to avoid potential damage from the sheep.

Economic benefits

- Grazing sheep in the vineyard has resulted in **significant savings** in mowing costs, fuel consumption and herbicide use. Sheep provide a natural alternative to mechanical mowing, reducing the need for machinery and resources.

- **Reduced labour costs:** grazing sheep for pasture control during dormancy has minimised the need for labour-intensive mowing and weeding practices.
- **Profitability:** grazing sheep contributes to improved profit margins, particularly by providing a clean paddock for weaner sheep (less worm burden).

Environmental benefits

- **Soil health:** grazing sheep is believed to be beneficial for soil health by reducing reliance on herbicides and providing natural nutrient cycling.
- Sheep contribute to better **pasture management** by keeping the land well-maintained and preventing overgrowth.

Effect on vine yield and quality

While the influence of sheep grazing on vine yield and grape quality has not been quantified, the economic benefits, such as the reduced need for mechanical mowing and the reduced reliance on herbicides, have led to a reduction in costs.

Challenges and considerations

- Grazing on foliage and grapes during the growing season remains a concern. If sheep are not checked, they might graze on vines, particularly younger or tender vines.
- Grazing during dormancy is optimal for pasture control, as year-round grazing could result in the sheep damaging foliage and grapes.

Plans and considerations

- **Expansion plans:** Jennifer is considering year-round sheep grazing, but challenges with grazing on foliage and grapes must be managed first.
- **Ideal sheep breed:** Jennifer suggests a wool-shedding breed that does not browse on vines would be the ideal choice for smaller vineyards, offering both low-maintenance care and profitability. However, Merinos are still favoured for their calmer nature, despite requiring more maintenance.

Key insights and advice

Jennifer's experience with grazing sheep in small vineyards has shown that Merinos can be highly beneficial for pasture control and have the added benefit of wool production. However, she cautions that Wiltipoll sheep, although suitable for grazing, might pose risks for vine browsing. When planning to expand the sheep grazing program, finding a breed that does not damage the vines while providing wool or meat would be ideal.

For other small vineyard operations considering sheep integration:

- **Focus on breed selection:** a wool-shedding breed might offer lower maintenance and profitability, with less browsing on vines.
- **Infrastructure investment:** careful management of fencing, vineyard height, and grazing schedules is essential to prevent damage to the vines and reduce grazing risks during the growing season.

Conclusion

Grazing sheep in Fischer's Vineyard has proven to be a valuable practice for pasture control, reducing costs and improving overall vineyard efficiency. While challenges remain, particularly with grape and foliage grazing, Jennifer has managed to incorporate sheep into vineyard management in a way that benefits both the environment and the bottom line. By continuing to refine how the sheep are managed, the Fischers are keen to continue with the benefits of sheep grazing in their vineyard.

Acknowledgements

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Freeman Vineyards

Dr Brian Freeman, Freeman Vineyards, Hilltops, NSW

200 hectares of vineyard, 300 hectares of other enterprises (including sheep farming).

Overview of sheep integration

Dr Brian Freeman has been grazing sheep at Freeman Vineyards for 15 years. Sheep play a key role in the vineyard, primarily helping to reduce weeds and trim shoots. Sheep grazing is flexible, adapting to the seasonal conditions and the specific needs of different vineyard blocks. Typically, the sheep are moved in and out of vineyard blocks based on vine growth cycles. The sheep are removed from the vineyard when legumes are seeding, as under-vine legumes are essential for adding nitrogen to the soil, which can promote vine health.

Breed selection

- **Current breed:** Wiltipoll was chosen for its easy-care characteristics and ability to self-shed wool.
- **Previous breed:** Old English Southdown sheep were phased out due to issues with wool, flies, lice, and the need for regular shearing.

Grazing practices

- Sheep are grazed in a varied pattern, depending on seasonal conditions. This requires flexibility when moving between vineyard blocks to prevent damage to vines during critical growth periods.
- The typical flock size can vary, with 300 sheep currently in a 20-hectare vineyard block. However, in early December, the sheep will be moved to neighbouring paddocks as part of rotational grazing.
- Sheep selectively graze, which can result in problem weeds such as couch (*Elymus repens*) and red grass (*Bothriochloa macra*) becoming dominant. Couch and red grass are C4 plants and are very competitive with the vines for nutrients and water.
- All grazing is carefully monitored to prevent overgrazing, especially when legumes are seeding.

Vineyard management adjustments

- Sheep graze up to about 1.3 m so a cordon of 1.1 m is too low to keep sheep in the vineyard all year. The sheep are in the vineyard during winter, introduced again when the fruit has set and then removed just at veraison. It is important to monitor the sheep closely to prevent damage to the vines (Figure 52).
- A cordon at 1.2 m is ideal for erect varieties such as Shiraz, Cabernet Sauvignon and Grenache when the vines are grown east-west without foliage wires. Sheep will eat the leaves off low-hanging shoots and long shoots that hang down (Figure 53 and Figure 54).



Figure 52. Older vines (left) next to retrained vines (right) where the sheep were allowed to graze excessively.



Figure 53. Leaves eaten from shoots under the cordon.



Figure 54. Leaves eaten off retrained vines where the cordon is at 1.2 m, while bunches are not eaten.

Economic and environmental benefits

Grazing sheep in the vineyards has:

- reduced the need for mechanical mowing and weeding (Figure 55), herbicide use and vine trimming, which has led to labour and cost savings.
- reduced costs associated with machinery use, particularly diesel for mowing, spraying, and de-suckering.
- improved soil health due to the reduced need for mechanical intervention and herbicide use; however, the exact effect on soil health is still being studied by analysing microbiology, nutrition and pasture species.
- provided additional income from meat production: sheep are raised primarily for meat, which is sold through sale yards.



Figure 55. Wiltipoll sheep and the single cordon at 1.2 m height in the background.

Challenges

- Fencing in some areas is still being improved to help manage sheep movement and protect young vines and replants.
- Seasonal conditions significantly influence grazing schedules. Sheep must be removed from vineyard blocks with low cordons (1.1 m) at certain times, particularly during the growing season when the vines are more vulnerable, as sheep tend to like grazing on young vines.
- Merlot vines have been challenging, as the sheep tend to prefer grazing them. These blocks have been fenced off to prevent damage.
- Due to sheep selectively grazing, it can result in problem weeds becoming dominant.
- During drought conditions, when there is insufficient vegetation between the vine rows, the sheep will climb the vines and remove too many leaves, so it is important to monitor the vines carefully in dry seasons.

Vineyard-specific practices and challenges

- **Corvina block:** Brian has retrained the vines to a 1.3-m height with closely planted rows (1 m apart). This has helped improve grazing management, as closely planted vines are less vigorous and have less foliage.

- **Shiraz and Cabernet blocks:** the Shiraz vines are maintained at 1.1 m and the Cabernet vines at 1.2 m. The older Cabernet vines (planted in 1998) are less prone to grazing due to their height and maturity, whereas young vines are more susceptible to grazing and are protected by fencing.

Additional considerations

- **Wiltipoll sheep:** these sheep are self-shedding and require minimal maintenance compared to other breeds, which can be advantageous for managing grazing in the vineyard. However, managing grazing height is crucial, especially with younger vines.

Looking ahead

- **No immediate changes:** while no immediate changes are planned for sheep management practices, continued improvements in fencing and better management of grazing areas are planned to optimise sheep integration.
- **Continued research:** Brian is interested in further exploring the effect of sheep grazing on soil health and vine quality, particularly to assess the benefits of reduced herbicide and pesticide use.

Conclusions

Brian's experience with integrating sheep into the management of Freeman Vineyards demonstrates the economic and environmental benefits of this approach. With significant savings in labour, herbicide use, and vineyard maintenance, the sheep have contributed to both the sustainability and profitability of the vineyard. While challenges remain, particularly with grazing management, fencing, and protecting vulnerable vine varieties such as Merlot, the overall benefits of grazing sheep continue to support the vineyard's regenerative farming practices. Plans to refine sheep grazing schedules and improve infrastructure will likely enhance these benefits even further. Alternative easy care sheep breeds will also be trialled, e.g. Aussie Whites.

Acknowledgements

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See Saw Wine

Justin Jarrett, Owner/Vigneron, See Saw Wine, Orange region
140 hectares of vineyard, multiple sites, mixed varieties.

Overview of sheep integration

Justin Jarrett of See Saw Wine has been grazing sheep in his vineyard for over 20 years. This practice is not only part of his sustainable management strategy but also contributes directly to operational efficiency and ecological diversity. The goal at See Saw Wine is to reduce mechanical weed control, lower carbon inputs, and promote diverse soil microflora through targeted grazing rotations.

The role of sheep in vineyard practices

At See Saw Wine, sheep play an integral part in under-vine management, especially in controlling weeds and reducing the number of mechanical slashing passes required throughout the season. By grazing rotationally, the sheep help with:

- **Weed control:** targeting annual weeds and minimising the need for herbicide or mowing.
- **Microbial diversity:** grazing stimulates a richer soil biome, contributing to long-term soil health.

Operational efficiency: slashing passes have been cut by half, significantly lowering diesel use and labour hours.

Sheep are introduced postharvest and rotated through vineyard blocks for approximately 6 months of the year.

Breed selection and grazing practices

Justin currently runs **Dorper sheep** (Figure 56), a breed selected for its hardy, extensive grazing habits and minimal husbandry requirements. As a shedding breed, Dorpers do not require shearing, making them ideal for a low-maintenance viticulture environment. Previously, Merino wethers were used, but due to the upkeep of shearing infrastructure, the decision was made to change to Dorpers. Approximately 400 Dorper ewes are rotated through the vineyard. To accommodate grazing, fencing and irrigation have been adapted, such as:

- Dripper wires were lifted.
- Trellis and foliage wires were adjusted to avoid vine damage during grazing.
- Some blocks were subdivided with additional fencing.

Grazing is timed to align with vineyard phenology, with sheep moved between varieties such as Chardonnay and Pinot Noir based on bud burst timing. Sheep are also moved to alternative vineyard sites during bud burst.



Figure 56. Six-month-old Dorper lambs in the vineyard at See Saw Wine.

Vineyard management adjustments

As sheep numbers increased, adjustments were necessary. These included:

- Installing new fencing to manage rotations more efficiently.
- Elevating irrigation lines to allow sheep passage.
- Not lowering the canopy wires until after the sheep are removed.

There were no major modifications to spray programs, although careful scheduling ensures sheep are rotated around spray intervals.

Economic and environmental benefits

Introducing sheep grazing in the vineyards has offered both direct and indirect benefits, such as:

- **Cost savings** from fewer slashing passes and reduced reliance on fossil fuels.
- **Income diversification** through meat sales, with animals sold directly to abattoirs.
- **Carbon footprint reduction** by cutting tractor passes and improving ground cover.
- While direct effects on yield are hard to quantify, Justin notes an observable **increase in plant diversity** and a **reduction in annual weed pressure** (Figure 57).

Challenges and considerations

Challenges have included:

- Trellis damage in some sections, although this is managed by adjusting fencing and wire height.
- Fencing investment, particularly in areas requiring precision grazing.
- Initial infrastructure, such as sheep yards, which are being upgraded (e.g. putting a roof over them).

Despite these, the benefits outweigh the costs, and Justin is committed to continuing and expanding the program. His long-term vision includes sowing mid-row cover crops to enhance weight gain in the sheep and fencing the entire vineyard to allow full-block grazing flexibility.

Looking ahead

Justin encourages others to embrace the integration of sheep in vineyard systems.

'Just do it. The returns are there, financially and environmentally.'

He plans to expand the sheep operation, emphasising a systems-based approach where each block can be independently grazed based on seasonal needs and vine development stages.

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Figure 57. The left side of the fence is where the Dorper lambs have been grazing.



Tamburlaine Vineyard

Marty Gransden, Viticulturist, Tamburlaine Vineyard, Orange, NSW
Three vineyards spanning 500 hectares.

Overview of sheep integration

Marty Gransden, who manages Tamburlaine Vineyard, has been grazing sheep in his vineyards for 15 years as they provide weed control (Figure 58) and an additional income source. Sheep grazing is both seasonal and rotational, focusing on postharvest and dormancy periods to maximise efficiency and minimise potential damage to the vines.

The role of sheep in the vineyard

At Tamburlaine Vineyard, the key benefits of sheep grazing include:

- **Weed control:** reducing the need for excessive mechanical slashing and herbicide applications.
- **Biodiversity:** contributing to the biodiversity of mid-row swards, promoting a healthier vineyard ecosystem.



Figure 58. Sheep control the weeds between vineyard blocks (left) and rows (right).

Breed selection and grazing practices

The primary breed used at the Boomey site (500–600 meters above sea level [masl]) is Merino, as they have a good temperament for vineyard grazing and provide effective weed control without damaging the vines. Marty noted that other breeds tend to be less respectful of fencing and potentially rougher on vineyard infrastructure. At the Borenore site (900 masl), crossbred Poll Dorset sheep are used. At the Bellevue site (700–800 masl), sheep from the neighbouring farm are used, with an agistment agreement in place.

Tamburlaine uses a cell grazing system with 2,000 sheep. Where the sheep graze is managed with fencing to prevent sheep access to sensitive areas. Grazing schedules are adjusted based on seasonal conditions and pasture availability.

Additional insights

- Seasonal flexibility is very important and depends on the pasture conditions. For example, currently the pasture at Borenore is very good, so there are more sheep per hectare than at the Boomey site, where it is much drier and there is less pasture.
- Agistment agreements vary: at Boomey, a flat monthly rate is agreed upon regardless of sheep numbers, while at the Borenore and Bellevue sites, it is typically a per-head-per-week arrangement.

Vineyard management adjustments

To accommodate sheep grazing, several adjustments have been made to the vineyard, including:

- **Fencing:** installing fencing to manage grazing areas and prevent sheep from accessing sensitive parts of the vineyard.

- **Grazing schedule:** implementing a seasonal and rotational grazing schedule to align with postharvest and dormancy periods, ensuring optimal weed control and minimal vine damage.
- **Altitude considerations:** the 3 Tamburlaine vineyards range from 500 masl to 1000 masl, influencing grazing and vine management strategies.

Economic and environmental benefits

Grazing sheep in the vineyard has resulted in significant savings as well as economic and environmental benefits, including:

- **Cost savings:** reduced need for mechanical slashing and herbicide applications, leading to cost savings in labour and materials.
- **Additional revenue:** earning extra income from agistment and reducing overall vineyard costs and inputs.
- **Environmental benefits:** improved biodiversity, soil health and reduced weed pressure, contributing to a healthier vineyard ecosystem.

Challenges and considerations

While the integration of sheep has been successful, there are also some challenges to consider:

- **Grazing management:** the sheep need to be monitored and managed to ensure they do not graze on the vines, particularly during the growing season.
- **Infrastructure:** investment in fencing and other infrastructure to manage grazing areas effectively.
- **Breed behaviour:** some breeds are harder to manage due to temperament and fencing issues.
- **Vine biosecurity risks with agistment:** be cautious about the livestock's history, i.e. avoid agisting sheep that have grazed in phylloxera-infested and risk zones. Watch for weed transfer and agrochemical residues from previous grazing areas. Ensure strict farm-gate hygiene: always check that delivery trucks are free of soil, plant material or contamination. To help protect your vineyard, keep agistment records to track where livestock have been.

At Tamburlaine, the sheep are quarantined to a paddock away from the vineyard for 4 weeks before entering the vineyard to prevent any weed transfer or agrochemical residue in the vineyard.

Plans

Marty plans to continue grazing sheep at Tamburlaine Vineyard, focusing on refining grazing practices and exploring additional benefits. The goal is to maintain the economic and environmental advantages while managing any challenges that arise.

Marty continues to refine sheep integration by:

- Exploring additional case studies and comparisons with other vineyards, especially in the region.
- Continuing collaboration with researchers and viticulture networks to share insights and improve practices.

Key points

Grazing sheep at Tamburlaine Vineyard has proven to be a sustainable, cost-effective practice for weed control and improving overall vineyard efficiency. While challenges remain, particularly with managing grazing areas, Marty has successfully incorporated sheep into vineyard management in a way that benefits both the environment and the bottom line. As the sheep are from a neighbouring farm this also reduces the biosecurity risk associated with agisted sheep. With careful management and breed selection, agisting sheep can be an asset in vineyard operations. With continued refinement in sheep management, Tamburlaine Vineyard is well-positioned to continue with the benefits of sheep integration.

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Options for vineyards: reworking, top-grafting, replanting, and removal

Penny Flannery, Development Officer – Viticulture, NSW DPIRD

Vineyard managers and viticulturists face critical decisions when it comes to maintaining the longevity and productivity of their vineyards. With many Australian vineyards ageing, coupled with market saturation and changing climate conditions, decisions must be carefully considered.

Previous guide updated

In 2021, NSW DPIRD published *Options for vineyard reinvestment: reworking, replanting and top-grafting*. This guide has now been updated to include 4 options: reworking, top-grafting, replanting, and removal, helping vineyard operators select the best approach for their conditions.

The guide has been revised with extensive industry collaboration, drawing on insights from vineyard managers, viticulturists, and research institutions. It provides practical, evidence-based recommendations to give growers the knowledge to make informed decisions for their vineyard.

The guide will be available in 2026 to growers on the [NSW DPIRD website](https://www.dpi.nsw.gov.au/agriculture/horticulture/grapes) (<https://www.dpi.nsw.gov.au/agriculture/horticulture/grapes>), ensuring they have access to the latest information for their vineyard.

Case studies

On the following pages are case studies of vineyard rejuvenation techniques including:

Reworking: enhancing vine longevity

Reworking ([page 48](#)) is a long-established viticultural practice aimed at restoring vine productivity by modifying the existing vine structure. This involves removing and replacing old cordons or retraining new shoots from the trunk. Reworking is particularly beneficial for vines affected by trunk diseases such as Eutypa dieback and Botryosphaeria.

Key considerations for reworking

- Best suited to vines with minimal trunk disease spread.
- Enhances vineyard longevity without complete replanting.
- Requires careful assessment of vine health and infrastructure condition.

Top-grafting: rapid variety transition

Top-grafting ([page 51](#)) is a cost-effective way to change grape varieties without the need for replanting. By grafting a new scion onto the existing vine trunk, new varieties with better market potential, disease resistance, or improved wine quality can be introduced.

Key considerations for top-grafting

- Suitable for vineyards with healthy root systems and minimal trunk disease.
- Requires post-grafting management to ensure graft success.
- Offers a faster transition to new varieties than full replanting.

Replanting: a fresh start

Replanting ([page 54](#)) involves removing old vines and planting new ones, either with own-rooted or grafted vines. While costly and time-intensive, replanting allows improved rootstocks and varieties suited to changing market demands and environmental conditions to be selected.

Key considerations for replanting

- Ideal when vine health is severely compromised.
- Requires investment in soil preparation and infrastructure upgrades.
- Best suited for long-term vineyard sustainability.

Vineyard removal: strategic land use change

In some cases, vineyard removal ([page 56](#)) is the most viable option. This could be due to economic constraints, unmanageable disease pressure, or shifting land use priorities. Vineyard removal enables landowners to repurpose their land for other agricultural ventures.

Key considerations for removing

- It should be planned carefully to minimise the environmental impact.
- Removal costs vary, but materials such as posts and wire can be resold.
- It provides an opportunity for diversification and alternative revenue streams.

Making the right decision

Choosing between reworking, top-grafting, replanting, or removal depends on factors such as vineyard age, disease presence, market trends, and financial feasibility. A thorough assessment of vineyard performance, soil health, and infrastructure condition is essential. In many cases, a combination of these strategies might be necessary to maximise vineyard productivity and economic viability. By strategically planning vineyard reinvestment, managers can ensure their operations remain competitive and sustainable for future generations.

The case studies provide further information to help decide which option might be best for your vineyard.

Acknowledgements

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Reworking vines: case study

Daniel Mortimer, General Manager, Mortimer Wines, Orange, NSW

Background

Planted in 1996, our Shiraz vineyard had been one of the most consistent and reliable, producing high-quality fruit since the first harvest in 2001. The north–south-facing vines thrive in the granite-based soil and ideal microclimate of gentle slopes adjacent to a lake. For over 25 years we spur-pruned the Shiraz block, focusing on shoot positioning and maintaining a premium and manageable yield. In the years leading up to 2022, yield declined, fungal outbreaks of mildew and botrytis increased, and we noticed a slight decline in wood quality, with evidence of trunk diseases such as Eutypa dieback and Botryosphaeria. Our experience suggests that 25+ years of spur pruning might have contributed to the presence of fungal pathogens through the open wound sites accumulated from years of clustered cutting points. Following the 2022 harvest, we decided to renovate the Shiraz block by cane pruning the 1.1-hectare vineyard and laying down 1-year-old canes that would become the new cordons.

Reasons for the change

- **Declining yield** over recent years despite consistent management.
- **Increased fungal diseases** (Eutypa dieback, botrytis, downy and powdery mildew).
- **Degraded wood quality** and signs of trunk disease, such as Eutypa.
- **Long-term spur pruning** created chronic wound sites, promoting pathogen buildup.
- **Desire to improve vine health**, longevity, and disease resistance.

The goal was to improve vine health by removing existing Eutypa and old wood, thereby promoting vine longevity and increasing disease resistance. We anticipated grape quality and yield would improve.

Methods used

As expected, the 26-year-old cordons had swallowed sections of the trellis, all of which had to be removed with the cordons. Armed with wire cutters, mechanical pruners and a reciprocating saw, we began the mammoth job of cutting out and disposing of the old existing cordons. Several factors were considered when selecting the ideal cane to tie down, including its position near the crown, direction of growth, and cane size. We decided that both shoot position and direction were most important to ensure vineyard structure and longevity were not compromised, even if it meant we took a small hit in yield in the next year.

After selecting which canes would become our new cordons, we cut the fruiting wire in a few places to expedite the process and used a reciprocating saw to cut the cordons as close to the crown as possible. Bay by bay, we dragged the wires with cordons attached to the end of the rows, and with a trailer in tow, took them down the paddock and well away from the vineyards. We then ran a new fruiting wire along each row and gently rolled down the selected canes, securing them with cable ties (Figure 59). We finished by applying a copper-based sealant to the large cuts to protect them from infection (Figure 60).

Results

Since the renovation:

- **Yield increased:** 41.6% higher in 2025 than in 2022 (Table 4).
- **Fruit quality improved:** better bunch weight, more balanced growth.
- **Disease incidence dropped:** no fungal infections were recorded post-renovation.
- **Operational benefits:** reduced need for spraying and tractor passes.
- **Sustainability gains:** healthier soil and reduced chemical use.

It is worth noting that we handpick everything on the ‘Chestnut Garth’ vineyard and the numbers represent fruit picked (not just yield). There was no harvest in 2020 due to smoke taint.



Figure 59. A Shiraz vine that was renovated by changing from spur pruning to cane pruning.



Figure 60. An open wound on the Shiraz vine treated to prevent trunk diseases and healthy canes are now developing.

Table 4. Harvest tonnages during the last few vintages, spur-pruned (2019–2022) and then cane-pruned (2023–2025).

	Year	Total tonnage (1.1 hectare)	Tonnes per hectare
Pre-renovation	2019	6.50	5.90
	2020	0.00	0.00
	2021	5.05	4.59
	2022	5.92	5.38
Post-renovation	2023	6.28	5.91
	2024	8.58	7.80
	2025	10.12	9.20

Reflection

There is no doubt this renovation required a significant time and labour commitment. However, we believe the benefits were almost immediate, with higher yields, superior bunch weight and fruit quality. There were also benefits in reducing the need for reactive sprays and additional tractor passes. This reduced associated costs and will ultimately benefit our soil health and sustainability.

We have been encouraged by the improvement of our Shiraz block, and we plan to renovate our Chardonnay block this coming winter.

Conclusion

While 2020 to 2022 were certainly more challenging growing seasons in all our vineyards, records show that harvest consistently and significantly increased after the renovation. Yield in the most recent vintage (2025) was up by 41.6% from 2022. Even more noticeable was the quality and weight of the bunches. Bunch count increased due to the higher bud proportion on the younger canes and the higher number of fruit-bearing shoots.

Where the old cordon had inconsistent growth patterns due to 20+ years of pruning and gnarled spurs, the new shoots were visually more balanced, resulting in even growth and ripening. While seasons and vintages are always difficult to compare due to the ever-changing conditions, we believe the increased yield and quality can almost certainly be attributed to the improved vine health. By removing the old cordons, the accumulated pathogens in the old wood were also removed. Eutypa dieback was completely cut out, along with botrytis and mildew spores, which establish themselves in chronic wound sites and gradually infect the cordons. Younger canes have superior natural resistance and more robust cuticles that resist infection, along with far fewer wounds for spores to spread.

Even more noticeable than the improved yield, size, and quality was the near absence of disease after the renovation. While the growing conditions from 2023 to 2025 were better and disease prevalence was reduced in the region, the Shiraz vintages post-renovation have been immaculate. We maintained the same spray program and our records show a significant reduction in disease. In the 3 years since the renovation, there has been no record of mildew, botrytis, or other fungal infections in our Shiraz. In comparison, the Chardonnay, Pinot Noir, and Cabernet blocks still showed signs of fungal infection, albeit minimal, given the favourable growing conditions. Selective spraying and manual extraction were used to control this. It is also interesting to note that the yield on these blocks has remained relatively consistent over the same period.

Key points

- The renovation was labour-intensive but highly effective.
- Immediate benefits in yield, quality, and vine health.
- Encouraged by success, they plan to rework other blocks (e.g. Chardonnay).



Top-grafting vines: case study

Penny Flannery, Development Officer – Viticulture, NSW DPIRD

Background

Corang Estate ([Figure 61](#)), located in a maritime-influenced region just outside the Canberra District, sits at 600 m elevation and receives approximately 650 mm of rainfall annually. Michael and Jill Bynon originally planted the vineyard with Shiraz in 2018. In response to shifting climate conditions and evolving market demand, they undertook a significant project in November 2024, top-grafting Riesling (clone D2V2 GM198) onto Shiraz rootstock ([Figure 62](#) and [Figure 63](#)). This decision was motivated by the need for a more climate-resilient and commercially viable variety.



Figure 61. Overview of Corang Estate with Tempranillo in front and Shiraz top-grafted to Riesling at the back.

Reasons for the change

The decision to top-graft vines rather than replant was motivated by several factors:

- **Climate adaptation:** increasingly variable weather, including drought in 2020 followed by wet seasons from 2021 to 2024, prompted a reassessment of varietal suitability. Riesling, known for thriving in cooler, wetter climates, was deemed more appropriate than Shiraz for the site.
- **Market demand:** Riesling has shown strong consumer appeal in the Southern Tableland Canberra region, and they wanted to balance their white wine offerings to meet this demand.
- **Clone selection:** the opportunity to graft a slow-ripening, premium Riesling clone (D2V2 GM198) allowed them to fine-tune the wine profile and quality.
- **Vineyard maturity:** the vines were already well established, making it an easy decision to top-graft with a new variety rather than replanting.

Methods used

The top-grafting process was carefully planned and executed to ensure vine health, operator efficiency, and long-term success:

- **Grafting:** the vines were cane pruned to allow plenty of buds to remain and still burst, which draws carbohydrates up through the vine, helping the grafts to take and burst. Grafts were placed on the trunks between 400–600 mm off the ground on a flat, easy-to-work location. This was done in early November 2024, about one month after bud burst. The vines had good shoot coverage and ample sap flow.
- **Cutting vines:** vine tops were cut carefully about 200 mm above the graft to avoid disturbing them. This was done about 2 weeks after grafting, just as grafts started to take and burst.

- **Tying trunks:** each vine was supported by a 1.2 m bamboo stake inserted into the ground and tied to the 1 m fruiting wire. This stabilised the trunk (now headless) and the graft shoot, allowing the new graft shoots to quickly climb the stake to the wire and become established.
- **Grow guards:** specially designed tubes were installed over old trunks to:
 - protect developing shoots
 - suppress weeds
 - improve vine establishment.

Note: the grow guards added an extra cost of \$550 per hectare, plus installation.

Despite strong initial success (only 17 of 850 failed to shoot), approximately 50 vines were lost to wind damage. These were regrown with Shiraz trunks and are scheduled for re-grafting in November 2025. Michael chose to use a professional grafter to ensure a greater success rate for the cost of the outlay.



Figure 62. Riesling grafted to Shiraz rootstock.

Results

Costs and considerations

- Grafting cost: approximately \$2.75 per vine plus GST.
- Budwood and treatment: \$825 for 300 four-bud sticks, including heat treatment and certification.
- Total cost: just under \$4 per vine for the vineyard.

Benefits of reworking

- Preserving established root systems: avoided the time and cost of replanting and re-establishing vines.
- Faster return to production: vines can be back in production within a year, compared to 3–5 years for new plantings.
- Clone and variety control: enables precise selection of desired clones and varieties.
- Improved vineyard health: top-grafting was paired with soil improvement strategies, including cover cropping, applying lime, gypsum, and organic matter, which raised the soil pH from 5.5 to 7.0.

Challenges

- Loss of one year's vintage: a necessary trade-off for long-term gains.
- Labour-intensive management: requires meticulous and constant de-suckering, training, and disease monitoring. For example, failing to eliminate all the shiraz suckers can result in the vine having both Riesling and Shiraz growing on it at the same time.
- Weather vulnerability: young grafts are susceptible to wind and mechanical damage.

Viticultural practices

- Cane pruning: adopted for better disease control and yield consistency, especially for temperamental varieties such as Tempranillo.
- Sustainable practices: integrated pest management, minimal copper use, and alignment with Sustainable Winegrowing Australia standards.
- Sheep grazing: used in winter for weed control and natural fertilisation, contributing to a closed-loop system.

Key points

- Wind protection is critical: secure shoots early to prevent wind damage and reduce replacement costs.
- Top-grafting is efficient: it allows for a faster return to production than replanting.
- Cost-effective: reworking is significantly cheaper than full vine removal and replanting.
- Vine health matters: only attempt reworking on vines free of trunk disease.

Conclusion

Corang Estate's reworking initiative is an example of a proactive, sustainable approach to vineyard management. By selecting the variety to suit climate trends and market demand, and by using existing vine infrastructure, the estate has been reset for longer business resilience and premium wine production.

Acknowledgements

This case study is part of the Greater NSW–ACT Regional Program delivered by NSW DPIRD in partnership with NSW Wine. The Regional Program is supported by funding from Wine Australia. Wine Australia invests in and manages research, development, and extension on behalf of Australia's grape growers and wine makers and the Australian Government.



Figure 63. The top-graft growth in March 2025, 6 months after it was done in November 2024.



Removing, reworking and top-grafting vines: case study

Penny Flannery, Development Officer – Viticulture, NSW DPIRD

Background

The team at Tamburlaine Vineyards, an organic wine producer in Orange, implemented a series of vineyard management strategies motivated by evolving market demands, climate variability, and long-term sustainability. This case study, based on interviews with Vineyard Manager Marty Grandsden, explores the motivations, methods, and financial implications of removing, reworking and top-grafting practices at Tamburlaine. Currently, there are 700 hectares of vineyards in the Orange region, and Marty is looking to reduce this to around 400 to 500 hectares due to the current oversupply, market demands and to diversify business into another profitable agricultural enterprise.

Reasons for the change

Several key factors influenced the decision to rejuvenate the vineyard blocks, such as:

- **Declining yields and grape quality** in ageing or underperforming varieties.
- **Market shifts**, such as reduced demand for Merlot and increased interest in varieties such as Prosecco under the Tamburlaine brand.
- The need for varieties with better **climate resilience** as the region becomes hotter and drier, and **disease resistance**, especially for powdery mildew.
- **Business sustainability goals**, including diversification and improved vineyard efficiency.

Methods used

To rejuvenate vineyard blocks, a combination of techniques was used.

Top-grafting: existing vines were grafted with new varieties, allowing the retention of established root systems while changing the grape output. As the demand for Merlot is currently zero and Chardonnay demand has significantly reduced over recent years, Pinot Noir was grafted onto Merlot rootstock and Sauvignon Blanc was grafted onto Chardonnay rootstock. Marty obtained the services of an expert to complete the grafting to ensure a good strike rate.

Reworking: vines were restructured by training suckers or removing cordons to stimulate new growth. This produced a quicker turnaround for fruit production. As the vines were over 30 years old, the tonnage and quality had changed, so reworking these vines to stimulate better fruit production was required. The Tamburlaine staff carried out the reworking, which was as simple as cutting off the vines ([Figure 64](#)), removing them ([Figure 65](#)) and placing them in a pile for burning. Then a new sucker was reworked to a new cordon wire from the trunk.

Full removal: where vines were no longer viable, entire blocks were removed and either replanted or repurposed for pasture. Infrastructure will be completely removed from around 200 hectares. Removal and replanting are usually done for market demand, not necessarily because of disease pressures, so more of the vineyard will be removed than replanted with another variety.

Contractor engagement: specialised contractors were brought in for tasks such as grafting and vine removal, ensuring professional execution, strike rate and efficiency.

Results

Cost analysis

The financial implications of each vineyard management practice were carefully evaluated ([Table 5](#)):

- Top-grafting/reworking: approximately \$10,000 to \$15,000/ha.
- Vineyard removal: approximately \$10,000 to \$15,000/ha.
- Vineyard replanting: approximately \$20,000 to \$25,000/ha.

These costs include labour, materials, wound treatment, training, and necessary infrastructure adjustments.



Figure 64. Vines ready to be reworked.



Figure 65. A tractor was used to collect the vine material.

Table 5. The costs involved with each of the options.

Top-grafting/reworking		Vineyard removal		Vineyard replanting	
Operation	Cost (\$)	Operation	Cost (\$)	Operation	Cost (\$)
Cordon removal	1.50	Cordon removal	1.50	Cordon removal	1.50
Chainsaw vines	0.50	Vine removal	3.00	Vine removal	0.50
Wound treatment	0.40	Wire removal	0.50	New cordon wire	1.50
Sweep mulch	0.05	Post removal	1.50	New vine cost	8.50
Top-grafting	3.00	Dripper removal	0.50	Vine guards	0.20
String	0.12	Cultivation	0.20	Cultivation	0.20
De-sucker × 3	0.45	–	0.00	Training passes	0.90
Training pass × 3	0.75	–	0.00	–	0.00
Total per vine	6.77	Total per vine	7.20	Total per vine	13.30
Total per hectare	11,285.59	Total per hectare	12,002.40	Total per hectare	22,171.10

Key points

- **Adaptability:** top-grafting and reworking allow rapid response to market and environmental changes.
- **Efficiency:** reworking or top-grafting can be more cost-effective than full vineyard removal and replanting.
- **Sustainability:** maintaining productive root systems reduces environmental impact and supports organic practices.
- **Strategic planning:** informed decisions based on vineyard health and business goals enhance long-term profitability and market demands.

Acknowledgements

This case study is part of the Greater NSW–ACT Regional Program delivered by NSW DPIRD in partnership with NSW Wine. The Regional Program is supported by funding from Wine Australia. Wine Australia invests in and manages research, development, and extension on behalf of Australia's grape growers and wine makers and the Australian Government.



Vineyard removal: case study

Penny Flannery, Development Officer – Viticulture, NSW DPIRD

Background

Justin Jarrett, owner of See Saw Wine – Annangrove Vineyard, located in the Orange wine region, has implemented significant vineyard restructuring in response to changing market dynamics, climate variability, and long-term sustainability goals. Originally managing over 40 hectares of vines, See Saw has reduced its vineyard by 7 hectares, focusing on varieties and practices that align with its business viability.

Reasons for the change

The decision to remove large sections of the vineyard was motivated by several factors, such as:

- **Market oversupply:** a saturated market, particularly for Shiraz and Chardonnay, led to unsustainable grape prices (as low as \$150–\$175 per tonne).
- **Increased disease pressure:** in recent years, powdery mildew was observed in older spur-pruned Chardonnay blocks. As the cordon was embedded in the wire (Figure 66), the vines were completely removed. This reduced the quantity of Chardonnay produced and also reduced or removed the disease pressure.
- **Vine age and health:** many blocks were over 20 years old and productivity was declining. Structural issues, such as cordons swallowing wires, were evident. Justin found it easier to remove these vines than trying to rework them.
- **Strategic reinvestment:** Justin aimed to replant with more saleable varieties, such as Prosecco on vigorous rootstocks, explore disease-resistant clones and reduce the saleable quantity.

Methods used

A systematic and efficient approach using in-house labour and equipment was used.

- **Two full-time employees** were dedicated to the task, completing the work as an after-harvest project.
- **Raising the irrigation line** was essential (Figure 67) before removing the vines, otherwise, it would have been damaged in the removal process. Justin is retaining the infrastructure, posts, wires and irrigation for future plantings of Prosecco and other varieties.
- **An excavator, tractor, and trailer** were used to pull vines out and manage debris. Appropriate attachments were used on the tractor (Figure 68 to Figure 70), including a squeeze lift and removal head for removing the vines and then a grab attachment to collect vines and place them in the trailer.
- **The estimated removal rate** was approximately 1,100 vines per day, which is very efficient and cost-effective.



Figure 66. Having cordons with embedded wires was one reason for changing to cane pruning.



Figure 67. Irrigation lines were raised before the vines were removed.



Figure 68. The tractor with a vine grab attachment to remove the vines.



Figure 69. The head of the tractor with a squeeze and lift removal action.

Results

Costs

- Labour: \$640/day (2 workers at \$40/hour)
- Machinery: \$800/day (excavator and tractor)
- Total daily cost: approximately \$1,400
- Estimated cost per vine: \$1.27–\$1.50

Infrastructure management

- Cordon and vine wood was removed (Figure 71) and burned for biochar production and to destroy any remaining disease.
- Wire will be collected and sold to local scrap metal recyclers.
- Posts were retained where possible, especially if they were untreated wooden posts. Justin had a mix of wood and steel posts on the site.

Environmental and operational considerations

- Biochar potential: Justin was considering using the removed vine wood for biochar to reuse in the vineyard to improve soil carbon and reduce waste.
- Wire recycling: wire was separated and sold to local scrap metal dealers, minimising landfill waste. By burning the vines, the wires are easily collected from the embedded vines.
- Disease management: removing and burning the old cordons will eliminate any disease pathogens. Changing to cane pruning (from spur pruning) for the remaining vines has significantly reduced powdery mildew pressure.

Strategic outcomes and plans

- Replanting strategy: new plantings will be of Prosecco and potentially disease-resistant varieties due to the increase in fungal pressure, mainly powdery mildew.
- Rootstock selection: all new vines are being planted on vigorous, phylloxera-resistant rootstocks. Although Orange is currently a phylloxera-free zone, vines in the area are retained for 20 years and the potential for phylloxera to come to the region still exists.



Figure 70. Vines on the ground are being taken away by employees at See Saw Wine.



Figure 71. Stacked vines are ready to be burned for biochar and to destroy any residual disease pathogens.

Key points

- Removing old vines and cordons can reduce disease pressure and improve vine health. By cane pruning the remaining vines, the incidence of powdery mildew is further reduced.
- Environmental impact, using biochar and recycling are integral to sustainable vineyard management, as the old vine material is reused on the vineyard and the wire can be extracted for recycling.
- Self-managed removal: can be cost-effective for vineyards with the scale and equipment to support it, especially by using the existing staff.
- Strategic removal and replanting allow vineyard owners to adapt to market and climate realities while maintaining long-term viability in the industry.

Acknowledgements

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Resting vineyard trial update – returning to production

Alison Fattore, Penny Flannery, and Bruno Holzapfel (NSW DPIRD)

We acknowledge Katie Dunne, who established the trial, Robert Hoogers, who assisted, and Paul Petrie (South Australian Research and Development Institute), who was consulted on the trial design.

Introduction

NSW DPIRD researchers trialled vineyard resting methods on a block of Chardonnay grapevines for 2 growing seasons (2022–23 and 2023–24) as part of the Greater NSW–ACT Regional Program, supported by Wine Australia. For a full explanation of the methods, treatments and previous results, please refer to the [Grapevine management guide 2024–25](#).

In most treatments, yield was reduced by more than half in one season. When returning the vineyard to production after being rested for one year, the double pruning and double ethephon treatments had significantly reduced yield compared with the other treatments. The residual effects of these 2 treatments on yield were also measured for the 2025 vintage (the second year back in production).

Objective

To determine the residual effect of double pruning and double ethephon treatments on yield once the vines are returned to production.

Methods

The trial site at the Griffith Institute for Irrigated Agriculture in the Riverina was on a 2.7-ha block of Chardonnay grapevines ([Figure 72](#)). The vines were planted in 2001 on sandy loam and grafted onto Ruggeri 140 rootstock, with 3.0 m row spacing and 2.5 m vine spacing (1,333 vines/ha). Resting treatments were applied as follows:

1. In the 2022–23 season, 3 irrigation treatments (full 100%, reduced 50% and low 25%) were applied with:
 - Control: fruit picked at harvest (as per a normal season)
 - Treatment 5: double pruning (manually pruned with a hedger to mimic commercial hedging by machine)
 - Treatment 9: 100 mL double ethephon (900 g/L; Promote® Plus 900) + 100 mL wetting agent (600 g/L nonyl phenol ethylene; Agral®).
2. In the 2023–24 season, the vineyard was returned to production with 3 irrigation treatments (full 100%, reduced 50% and low 25%).
3. In the 2024–25 season, the vineyard was returned to production at full irrigation (100%).

The full irrigation was managed by a weather-based schedule and soil moisture probes to supply 100% of evapotranspiration requirements. No resting treatments were applied and the site was returned to normal production management techniques.

Yields were measured for the 3 treatments (control, double pruning, and double ethephon) at full irrigation during the 2022–23 and 2024–25 growing seasons.



Figure 72. The Chardonnay block at the Griffith Institute for Irrigated Agriculture in the Riverina.

Results

Yield

The yields during the 2024–25 growing season were lower than those during the 2023–24 growing season in all 3 treatments (Figure 73). Yields were reduced by 8% in the double ethephon treatment, 31% in the double pruning treatment, and up to 38% in the control, compared to yields in the 2023–24 season. A severe frost on 16 September 2024, when a minimum temperature of –2.1 °C was recorded at the Griffith Airport automated weather station (AWS), is suspected of contributing to this result.

Irrigation

The previous reduced (50%) and low (25%) irrigation treatments applied during the 2022–23 and 2023–24 growing seasons showed no evidence of a carry-over effect on yield during the 2024–25 growing season when irrigation was returned to full (100%) levels (Figure 74).

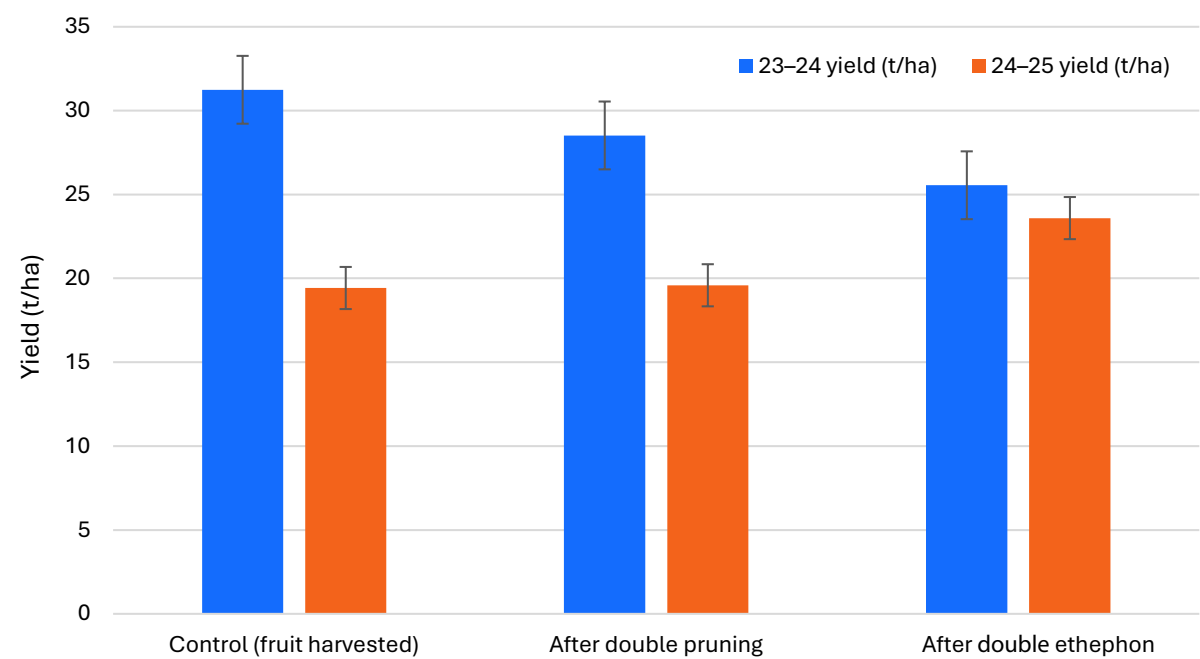


Figure 73. Treatment yields (t/ha) in the 2023–24 and 2024–25 production seasons from the resting vineyard trial in Chardonnay grown in the Riverina when returning to production with full (100%) irrigation after being rested for a year.

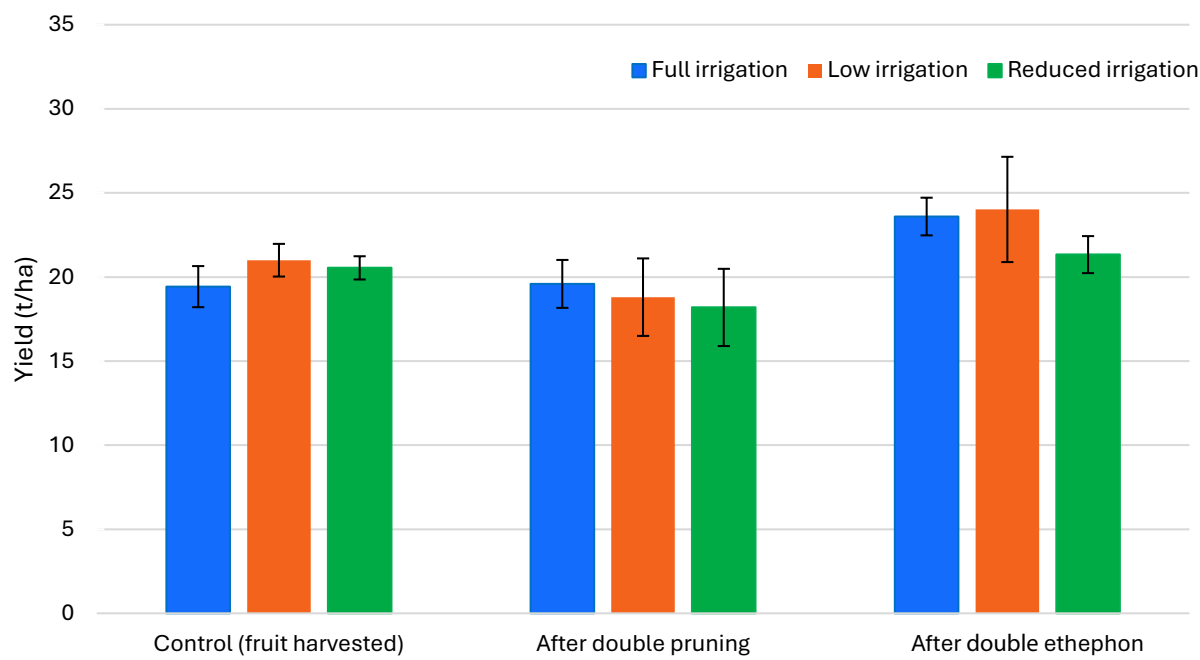


Figure 74. Treatment yields (t/ha) in the 2024–25 production season of the resting vineyard trial in Chardonnay grown in the Riverina with previous (2023–24) full (100%), reduced (50%) and low (25%) irrigation.

Bunches per vine

The number of bunches per vine was 32% lower in the 2024–25 season than in the 2023–24 season in all 3 treatments. The September frost is the most likely cause. There were 23% more bunches per vine in the double ethephon treatment than the double pruning and control, respectively, in the 2024–2025 season. This was not observed during the 2023–24 season (Figure 75). It is possible the double ethephon applied in 2022–23 still had some residual effect in the vines coming into the 2024–25 season. As ethephon is a plant growth regulator, it could have delayed flowering and bud expansion, which reduced their sensitivity to frost compared to the other 2 treatments, which suffered significant damage, resulting in larger yield losses.

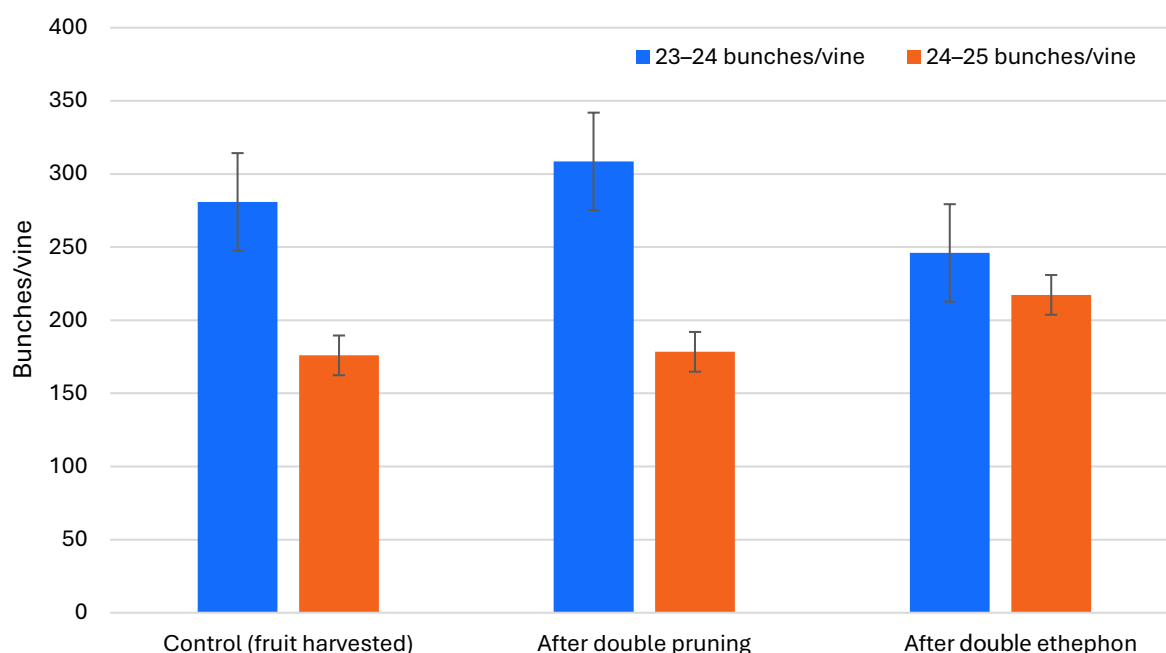


Figure 75. The number of bunches per vine in the 2023–24 and 2024–25 production seasons of the resting vineyard trial in Chardonnay grown in the Riverina with full (100%) irrigation.

Conclusions

There appears to be no residual effect of the double pruning and double ethephon treatments on yield after the second season of returning to production (2024–25). However, the results were affected by a severe frost in September, which reduced yields in all treatments by 27%. When returning to production (2023–24), the double pruning and double ethephon treatments showed a residual effect, resulting in significantly lower yields.

In 2024–25, the double ethephon treatment produced around 23% more bunches per vine than the double pruning and control. This was not observed during the 2023–24 season and could suggest evidence of residual ethephon delaying flowering and bud expansion until after the frost in September.

The reduced (50%) and low (25%) irrigation treatments did not influence yield once the vines returned to full (100%) irrigation the following season.

When deciding to rest a vineyard, consideration must be given to the quantity and duration of fruit yield reduction intended when contemplating the most suitable resting method.

Acknowledgements

This trial site is part of the Greater NSW–ACT Regional Program, funded by Wine Australia and delivered by the NSW Department of Primary Industries and Regional Development (NSW DPIRD) in collaboration with NSW Wine. The demonstration was part of a wider effort to show viticulturists how to adopt practices to rest their vineyards in years of oversupply.



Frost in NSW vineyards

Penny Flannery, Development Officer – Viticulture, NSW DPIRD

In mid-September 2024, a significant frost formed in several wine regions in NSW, affecting yield and crop viability. Considerable losses were reported in the Riverina region, with temperatures dropping to -3°C , causing damage estimated to cost approximately \$35 million or 100,000 tonnes of crop.

Frost damage in vineyards is particularly difficult to recover from, as the effects are often widespread and devastating. While secondary bud shoots might still produce fruit, yields are usually reduced and the fruit quality is often variable.

Immediate damage assessment

In response to the frost and the damage reported, the Australian Society of Viticulture and Oenology (ASVO) held an online community forum.

The Riverina

Jeremy Cass, CEO of the Riverina Winegrape Growers Association, reported this was the worst frost in his 29 years in the area. The damage extended over a large portion of the region, from Leeton and Yanco to Nericon and Tharbogang. Early white varieties, such as Chardonnay, were especially hard-hit, losing up to two-thirds of the crop ([Figure 76](#) and [Figure 77](#)). Other varieties, such as Shiraz and Cabernet, were less affected as they were not fully out. Some vines received complete frost damage down to the cordon, which means they will not produce fruit this year.

Jeremy explained that when vines get burnt down to the cordon, they will shoot secondary buds that are fruitful, but not as fruitful as the primary buds. It is when the frost takes the fruit but leaves some of the green cane that the crop is completely lost without some intervention, such as manually removing the old canes, to force the secondary buds to grow. This is not financially feasible for regions like the Riverina, however, I have seen it done in the Yarra Valley and it worked, although the yield was smaller than the crop that was not frosted.

NSW DPIRD collected frost damage data from Riverina growers using the Primary Industries Natural Disaster Damage Assessment (PiNDDA). This online survey allows growers, NSW DPIRD and Local Land Services (LLS) staff, and agricultural industry representatives to report damage to primary production and livestock caused by natural disasters such as floods, fires and storms. Given the extent of the frost damage, a specific assessment was developed ([Figure 78](#)).

A total of 72 wine growers were affected. The frost covered 4,344 hectares of grapevines, with 2,849 hectares reported as destroyed, leading to an estimated loss of 28,432 tonnes of fruit, or 65% of the total grape area reported was damaged.

In March Jeremy indicated the Chardonnay losses might be closer to 20%, which was not as high as expected. However, this region had hailstorms in December 2024 and February 2025, so it is difficult to determine exact frost damage figures.



Figure 76. Frost damage to Chardonnay vines at NSW DPIRD vineyard in Griffith.

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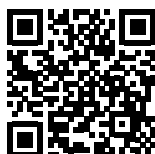
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Canberra

Temperatures dropped to -4.8°C in the Canberra district. Local viticulturist Allan Pankhurst reported mixed results, as the first leaves of Pinot Noir and Chardonnay had already emerged. While it is still too early to assess the full effect, it is hoped that watering before a frost might have helped mitigate some damage, as it has in the past.

During harvest, Allan reported that initial observations after the frost showed significant variability in frost damage along the cordons. At first, it appeared to have caused 2 flowering periods, with less fruit developing on secondary buds. However, the vines responded quickly, with further buds developing and emerging rapidly.

With ongoing warm conditions, spring growth largely evened out. Shoot development and flowering occurred as usual, although 3 weeks earlier than normal. One notable effect of frost damage was the high number of auxiliary shoots, which increased shading and highlighted the importance of shoot thinning and leaf plucking.

The final effect on yield varied for different varieties. Early varieties, such as Pinot Noir and Chardonnay, produced good to high yields. Late varieties, such as Sangiovese, had lower-than-normal yields and showed variability along the row.

Mudgee

Tim Stevens from the Mudgee wine region reported similar frost damage to other regions. In some areas, shoots survived, while others suffered dieback. Whether new shoots will catch up remains uncertain. As a precaution, many growers advise against immediate intervention and always allow the vines to recover before making management decisions.

Other regions

The effects of frost in areas such as the Barossa Valley (SA) varied. While some growers reported losses, others noted their vines recovered after the frost. However, with the potential for more frost this season, the risk of frost damage remains high. In the King Valley, a major inversion frost in 1998 severely affected the cordon, leading to discussions around shoot thinning and proactive sprays, although results have been mixed. Frost fans, commonly used in some areas, are typically effective to about -2°C but are less useful in more severe frost, such as those in Canberra.



Figure 77. Frost damage to Chardonnay vines at NSW DPIRD vineyard in Griffith.

Management and recovery strategies

While frost cannot be fully predicted, there are strategies vineyard managers can adopt to manage the aftermath and potentially reduce future damage.

Assess damage block by block

Each vineyard is unique, and frost damage can vary significantly from block to block. It is crucial to perform a detailed assessment of the damage, from minimal to severe, in the days and weeks following a frost. By doing so, growers can estimate potential yields and adjust their management plans accordingly.

Secondary bud shoots and new growth

After a frost, secondary bud shoots might emerge and bear fruit, although yields are typically lower. These secondary shoots can sometimes produce higher-quality fruit, although the quantity might be less. It is important to let the vines grow out so the new shoots can be assessed before deciding whether to prune or leave them to develop. In some regions, such as the Riverland, vines with minimal frost might still produce fruit from lateral or basal shoots.

Watering and vine management

While watering is not a guaranteed way to prevent frost damage, it has helped mitigate the effects of frost in some areas. For example, in the Canberra region adequate watering seemed to help reduce frost damage. However, excessive watering can also lead to increased vine vigour and foliage development, which might affect fruit quality and overall vine health.

Frost fans and other mitigation tools

Frost fans are commonly used to manage frost risk, especially in areas with milder frosts. However, their effectiveness decreases significantly in extreme cold conditions (below -2°C). In more severe frost, such as those in Canberra and parts of South Australia, frost fans were largely ineffective. Growers should assess whether their investment in frost fans will yield a positive return.

Understanding and managing vine phenology

Understanding the phenology of different grape varieties is essential for predicting how they will respond to frost. Early budding varieties such as Chardonnay and Pinot Noir are more susceptible to frost damage. In contrast, late-budding varieties such as Shiraz are typically less affected. As seen in the Riverina, where Chardonnay vines received severe frost damage, growers should consider the phenology of each variety when assessing damage and making management decisions.

Proactive measures for future seasons

Given the increasing frequency of extreme weather, including frost, growers should look to adopt longer-term strategies for mitigating frost damage. This might include investing in frost fans for areas where they are effective, developing frost-resistant rootstocks, and improving vineyard site selection to reduce vulnerability to extreme weather.

Key points

- **Monitoring and data collection:** more research is needed to understand the effects of frost on specific varieties and to develop more effective frost management strategies. Research bodies such as the Australian Wine Research Institute (AWRI) and regional agricultural departments are gathering data on frost damage and post-frost recovery.
- **Vine recovery:** while frost can be distressing, most vines will recover over time. Growers are encouraged to resist the urge to over-manage or remove vines prematurely, as this can cause additional stress. Regular monitoring and patient observation of vine recovery are essential.
- **Industry advocacy:** the forum highlighted the need for better advocacy and support for affected growers. Regional bodies and industry associations can provide important support and resources for those affected by frost.

Conclusion: preparing for frost

While the September 2024 frost caused significant damage in NSW, the industry has shown resilience and a willingness to adapt. By continuing to share knowledge, assess damage carefully, and refine management strategies, NSW vineyard growers can be better prepared for future challenges.

When a frost occurs, vineyards will require ongoing monitoring in the following weeks, as new shoots emerge and secondary growth develops. By understanding the effect of frost on different grape varieties and adopting appropriate recovery techniques, growers can continue to manage their vineyards effectively.

Background on PiNDDA

The primary industries natural disaster damage assessment (PiNDDA) is a simple online survey that farmers, NSW Department of Primary Industries and Regional Development (DPIRD) and Local Land Services (LLS) staff, and agricultural industry representatives can use to record damage to primary production and animals from natural disasters such as flood, fire and storms.

The PiNDDA survey allows landholders to:

- Complete a simple survey identifying the number of crops, animals, infrastructure and other primary industries damaged in a single event.
- Add photos to the assessment.
- See the severity of damage in the area.

The data collected by the survey are the main source of information used to develop primary industries damage assessments for each Local Government Area (LGA). These are submitted to the NSW Reconstruction Authority, and are assessed along with other community and infrastructure damage information, to determine needs for recovery measures such as technical advice requirements or industry programs, and includes assessment against several criteria when determining if an area will receive disaster assistance.

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Hail and severe storms in vineyards

Dr Aude Gourieroux, Lecturer in Plant Science – Wine Science, Charles Sturt University, Wagga Wagga
Updated by Penny Flannery, Development Officer – Viticulture, NSW DPIRD

Introduction

Storms tend to be brief, localised, and often destructive, with little predictability. In just a few minutes, a storm can devastate an entire crop. This unpredictability poses a major challenge for vineyard managers, as by the time a storm is detected, it is usually too late to implement protective measures. Many storms are accompanied by hail, which can significantly damage vineyards. The impact of hail, particularly the size of hailstones (Figure 78), depends on several factors, including elevation, lower freezing zones, wind shear, and the growth stage of grapevines and grape bunches at the time of the storm.

Hail damage and its effect on grape berries and wine

Extensive research has explored the effects of hail on grapevines, both during the current season and in subsequent years (Dry 1986). However, it can take several years to evaluate the overall effect. Most studies focus on the reduced yield following hail and the resulting financial losses for wineries (Spellman 1999; Grainger and Tattersall 2008). However, detailed information on managing damaged berries is often limited.

Hail can damage the entire vineyard (Krstic et al. 2014), affecting leaves (Figure 79), fruit, shoots (Figure 80), and even trunks. The extent of damage can vary widely, from complete crop loss to relatively minor damage to individual berries (Figure 81).



Figure 78. Hailstone size will influence the severity of the damage to grapevines.



Figure 79. Hail can strip leaves from the vines.



Figure 80. Hail-damaged shoots.



Figure 81. Berries and leaves damaged by hail.

Certain types of storm damage, such as split trunks and arms, can create ideal entry points for *Agrobacterium* sp., one of the many bacteria responsible for crown gall-like symptoms. Although these bacteria are commonly in the environment, they usually remain dormant until conditions become favourable. Once active, they form tumours that disrupt the vine's vascular system, potentially leading to vine death, especially in younger plants. The only effective response is to remove and burn the infected plant parts (Bonai 1984).

Storm damage before flowering

When storm damage occurs during inflorescence, grapevines often respond by producing lateral shoots (Figure 82), which might eventually bear fruit. This delayed development can lead to reduced fruit quality due to limited nutrient availability from damaged leaves and a lower rate of fruit set. Additionally, the phenomenon known as 'second cropping' can introduce further complications, potentially resulting in a decreased yield.

Storm damage before veraison

Storms occurring before veraison can damage the entire plant. Typically, affected berries will either dry out, fall off, or heal naturally (Fiola and DeMarsay 2013). Healed berries might develop irregular shapes but generally continue to ripen normally. Beyond the reduction in yield, a key concern during this stage is maintaining a dry canopy to prevent the onset of diseases such as mildew and various rots.

Storm damage after veraison

Storms during berry ripening often lead to skin splitting (Figure 83), caused by mechanical injury from hailstones or a sudden increase in berry moisture.

Split skins significantly raise the risk of infection by *Botrytis* spp. and other rots. While several vineyard management techniques exist to dry the berries and control infections, their timing is critical. If damage occurs close to harvest, some growers might opt for a sequential harvest, picking damaged bunches early to prevent infection, even if they have not reached full maturity, and harvesting the remaining healthy bunches at the usual time.

If berries remain on the vine after veraison, the exposed sugary pulp and juice from split skins can further attract infection, mainly *Botrytis*, as well as ripe, sour, or bitter rot (Fiola and DeMarsay 2013).



Figure 82. Hail-damaged plants recover by growing laterals that might bear fruit.



Figure 83. Hail can cause skin splitting and this increases the risk of infection.

Limiting the damage

Various preventative measures, such as anti-hail bombs, cannons, and rockets, have been used to mitigate vineyard damage, but none offer complete protection (Bonai 1984). In some regions, silver iodide crystal generators have also been used to reduce hailstone size and minimise their impact.

A more effective approach involves using protective netting to slow down hailstones before they reach the vines. While netting does not completely eliminate damage, it significantly reduces its

severity. However, this method is labour-intensive, as nets must be deployed over vineyard rows before a storm. There is also the risk that nets might be placed on blocks that are not affected by the storm, while other areas are unprotected.

Microbiome

Microbiome refers to the community of microorganisms, such as yeasts, bacteria, and fungi, in a specific environment. A related term, microbiota, describes the microorganisms found in a particular site, habitat, or geological period.

Wine grapes are known to host a diverse array of microorganisms (Barata et al. 2012), which are closely influenced by their growing environment. Many of these microbes play important roles in grapevine health and wine quality. They also contribute to the concept of terroir, the unique characteristics of wine shaped by the region, grape variety, climate, and vine health (Barata et al. 2012; Bokulich et al. 2014).

After a storm, wet and cool conditions can encourage the growth of harmful microorganisms, which require close monitoring. If environmental conditions are not conducive to their development, berry damage is likely to remain limited. It is also worth noting that while terroir is widely believed to influence wine expression, its sensory influence still requires experimental validation.

After the storm

Before veraison

It is important to assess the extent of the damage and remove any injured shoots and buds. This helps tidy the vines, reduces the risk of infection spreading to healthy bunches, and can encourage new growth. Applying a fungicide can further protect the vines by minimising the risk of bunch rot and helping damaged stem tissue to heal.

After veraison

After veraison, options for preventing bunch rot are limited. However, if dry weather persists, it might still be possible to harvest the grapes before significant infection sets in, particularly from common pathogens such as *Botrytis* spp. or *Aspergillus* spp. Removing visibly damaged bunches can help reduce the spread of disease. If a storm occurs within a few weeks of the planned harvest, some growers might choose to sequence the harvest. This means picking damaged bunches early to minimise infection risk, followed by harvesting the remaining healthy fruit at the scheduled time.

At the winery

Once the grapes arrive at the winery, there are limited options for intervention. The first step is to carefully sort the fruit, removing as many visibly damaged berries and bunches as possible to help preserve wine quality. It is important to test for *Botrytis* spp. or *Aspergillus* spp. and then proceed with processing the grapes using standard protocols for handling fruit affected by these pathogens.

Key points

Storms can be damaging and are becoming more frequent

- Recent storms in the Riverina and Orange regions highlight the frequency and severity of storms, with millions of dollars in crop and infrastructure losses reported.
- Localised hailstorms can cause long-term damage, with some vineyards requiring over 2 years to recover.

Early assessment is critical

- Immediately assess the extent of damage after a storm and document it thoroughly.
- Use tools such as the PiNDDA survey to report damage as this supports disaster funding applications and regional recovery planning.

Timing of damage matters

- Before flowering, vines might recover through lateral growth, but fruit quality and yield could be compromised.
- Before veraison, berries might drop or heal with deformities; maintaining a dry canopy is essential to prevent disease.

- After veraison, skin splitting increases the risk of Botrytis and other rots. Consider sequential harvesting to manage infection risk.

Disease management is essential

- Wet, cool conditions after a storm favour harmful microorganisms. Monitor for signs of mildew, Botrytis, and other rots.
- Apply fungicides promptly after early season storms to protect damaged tissue and reduce disease pressure.

Prevention measures have limits

- Anti-hail devices (e.g. cannons, rockets, silver iodide generators) only offer partial protection.
- Netting is more effective at reducing the impact of hail, but is labour-intensive and must be deployed in the correct blocks before a storm.

Postharvest and winery practices

- At the winery, sort grapes carefully to remove damaged fruit.
- Test for *Botrytis* spp. or *Aspergillus* spp. and process accordingly to maintain wine quality.

Insurance and recovery

- Contact your insurance provider as soon as possible after a storm.
- Keep detailed records and photos of damage to support claims and disaster relief applications.

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Orange region storm – January 2025

NSW DPIRD has been working with growers in the Orange region to determine the extent of the damage to orchards and vineyards from storms in the area.

Early in February 2025, the NSW DPIRD primary industries natural disaster damage assessment (PiNDDA) survey was sent to all Orange region growers to collect data to help generate a comprehensive damage assessment. Reports indicate the storm was localised, severely affecting grapes, as well as cherry and apple orchards in the area.

The assessment of Ross Hill Vineyard with James Robson indicated that it would take the vineyard over 2 years to recover from the 15-minute hailstorm. The hail completely stripped the eastern side of the vines (Figure 84 to Figure 86) and caused significant losses in tonnage and fruit quality.



Figure 84. James Robson inspecting the hail damage to the eastern side of the Pinot Gris block.



Figure 85. A view of the rows to compare the damage to the east–west side of the vines.



Figure 86. Damage to the one-year-old Chardonnay vines.

Riverina region storm – December 2024

Riverina Winegrape Growers assisted by distributing the NSW DPIRD primary industries natural disaster damage assessment (PiNDDA) survey to all winegrape growers in the Riverina region (Yenda, Bilbul, Hanwood) to collect data to help assess the damage. Over \$60 million of damage was reported to horticulture industries, however, most growers are liaising with insurance agencies about the significant infrastructure damage. This is in addition to the damage from a substantial frost in September 2024.

The damage report was finalised and submitted to the NSW Reconstruction Authority.

Growers can apply for assistance from the [Rural Assistance Authority](https://www.raa.nsw.gov.au/) (<https://www.raa.nsw.gov.au/>).

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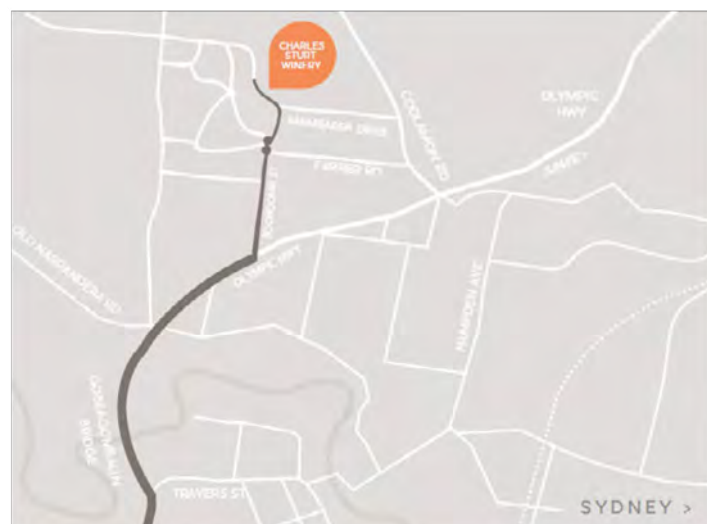
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ASVO Viticulture Seminar on managing vineyards in extreme climatic conditions

Penny Flannery, Development Officer – Viticulture, NSW DPIRD

In September 2024, the Australian Society of Viticulture and Oenology (ASVO) hosted its highly anticipated viticulture seminar in Orange, NSW. The focus was on managing vineyards in extremely wet conditions. With the increase in unpredictable weather patterns, this seminar provided valuable insights from leading experts in viticulture, plant pathology, and vineyard management.

The 2-day seminar brought together industry professionals, researchers, and viticulturists, both face-to-face and online, to discuss strategies for the challenges presented by climate extremes. Here is a summary of the insights and recommendations shared throughout the event.

Welcome and acknowledgements

The seminar started with an opening address from **Nick Dry**, viticulture consultant, founder of Foundation Viticulture, and Director of the ASVO. Nick welcomed attendees from throughout the country. He also expressed gratitude for the support of key sponsors and collaborators, including **Wine Australia, Australian Grape and Wine Incorporated** (Australian Grape and Wine), and **Australian and New Zealand Grapegrower and Winemaker**.

Responding to extremely wet conditions

The first session, chaired by **Tom Ward** (Figure 87; proprietor and winemaker of Swinging Bridge Wines), included presentations from Ian Dry, Nick Dry, and Toni Chapman and delved into the question: 'How to respond to extremely wet conditions in the vineyard?'

Disease resistance and varieties

Dr Ian Dry, a pioneer in grapevine breeding at CSIRO, shared his groundbreaking research on new wine grape varieties being developed to withstand extremely wet conditions. Ian's work

focuses on breeding scions with enhanced resistance to the 2 major pathogens of grapevines: powdery mildew and downy mildew. Downy mildew is a major problem that thrives under wet conditions. His research aims to provide grape growers with more resilient varieties that can withstand disease pressures and environmental extremes.

Ian outlined the science behind breeding new mildew-resistant grapevine varieties, emphasising the shift from older style hybrids (comprising 50% wild species) to modern hybrids with up to 99% *Vitis vinifera* through backcrossing. These newer hybrids retain high wine quality while incorporating resistance genes from wild species. Key resistance loci for downy mildew include Rpv3 (medium resistance strength), and Rpv10 and Rpv12 (high resistance strength), with the latter 2 loci preventing downy mildew sporulation entirely. Field trials show that varieties containing Rpv10 or Rpv12 perform well without chemical sprays, while Rpv3 varieties still benefit from a minimal spray program. However, it is important to note that resistance conferred by a single locus, like Rpv3, can be overcome in the field by mutant downy mildew strains, making it advisable to stack multiple Rpv loci in the same variety for more durable resistance. To maintain effectiveness, minimal spray programs are also recommended to reduce inoculum pressure and delay resistance breakdown.

Grapevine breeding programs are increasingly focusing on enhancing the durability of downy mildew resistance by stacking multiple resistance loci within a single variety. While current hybrids with a single Rpv locus can offer effective control, the emergence of downy mildew strains capable of overcoming single-gene resistance, such as Rpv3, has prompted researchers to develop varieties that combine 2 or more major Rpv loci, e.g. Rpv12 and Rpv3. This gene stacking approach significantly improves resistance durability under high disease pressure with minimal chemical input. Some international breeding programs are now aiming to incorporate up to 3 Rpv loci in a single variety, marking a strategic shift toward more sustainable, low-input viticulture, despite evolving mutant downy and powdery mildew strains.



Figure 87. Tom Ward from Swinging Bridge Wines.

Key point

- Developing disease-resistant varieties is essential for the long-term vineyard sustainability.

Nick Dry (Figure 88) provided a varietal summary based on his 20 years of experience in the vine propagation supply chain. He discussed the performance of various varieties, clones, and rootstocks in extremely wet conditions. Nick advocated that selecting the right combination of rootstocks and varieties is crucial for managing vine health and productivity during challenging weather patterns.

Nick provided a comprehensive overview of disease-resistant grapevine varieties. He emphasised that the viticulture industry is on the brink of a revolution, with numerous breeding programs in Europe (e.g. France's Entav-INRA, Italy's VCR, Germany's PIWI), North America, and Australia (CSIRO) developing varieties that reduce reliance on chemical sprays. These programs are using different strategies for combining resistance loci to enhance durability and control. Nick highlighted the importance of industry engagement, nursery communication, and strategic planning to ensure these varieties are successfully adopted and integrated into Australian viticulture.

The future of disease-resistant grape varieties in Australia is promising but requires immediate action. Within the next decade, Australia is expected to have access to at least 10 such varieties, with second-generation, dual-loci types already in development. These varieties, which are being developed by CSIRO, are being tailored to Australian conditions and offer both environmental and economic benefits. However, Nick stressed the need for proactive industry involvement, communicating with nurseries, planning for long lead times in propagation, and embracing marketing strategies that highlight sustainability. The shift also calls for a cultural change in how wines are marketed, especially to younger consumers, positioning disease resistance as a value-added feature rather than a compromise.

Key points

- Certain varieties and clones are better suited to wet conditions and reduce risks, such as waterlogging and fungal diseases, as they either use the soil's available water or have a natural resistance to fungal disease.
- Vineyard management strategies should include varietal selection, particularly in areas that could have prolonged wet periods.



Figure 88. Nick Dry discussing the CSIRO varieties.

Wet conditions and crown gall

Dr Toni Chapman (Figure 89), Senior Research Scientist at NSW Department of Primary Industries and Regional Development (DPIRD), gave an insightful talk on the relationship between cold and wet conditions and increased crown gall symptoms. Cold conditions can damage cells, which allows bacteria to enter the vines. Crown gall is a bacterial infection that affects grapevines and can be exacerbated by wet conditions, particularly in soil with poor drainage.

The complex and evolving issue of crown gall disease in grapevines is caused by bacteria in the Rhizobiaceae family. These bacteria, particularly *Allorhizobium vitis* and other *Agrobacterium* species, are becoming more prevalent, with increasing submissions to diagnostic laboratories. Toni highlighted the challenges with identifying and understanding the full range of bacterial species involved, as many isolates are new or not yet fully characterised. The disease's complexity is heightened by the presence of multiple bacterial strains within galls, some of which could be non-pathogenic or even beneficial.

To manage crown gall effectively, Toni emphasised the importance of environmental management, including reducing plant wounding, improving drainage, and avoiding sub-freezing conditions. Continued research is essential to determine which bacterial strains are truly pathogenic to grapevines. Diagnostic methods are being refined, including pathogenicity assays and genomic analysis, to better understand the disease's spread and complexity. In addition to the article on

page 114, growers are encouraged to consult fact sheets from [NSW DPIRD](#), the [Australian Wine Research Institute](#) (AWRI), and [Wine Australia](#) for guidance. Ongoing collaboration between researchers, diagnosticians, and growers will be essential to developing more effective management strategies and improving biosecurity responses.

Key points

- Cold and wet conditions can create an environment where crown gall pathogens are more active. When the temperature is $<22^{\circ}\text{C}$, there will be a higher rate of symptoms, but when the temperature is $>25^{\circ}\text{C}$, it is non-existent.
- Improved diagnostic tools are required to detect crown gall early and prevent its spread in affected vineyards.



Figure 89. Dr Toni Chapman from NSW DPIRD.

Managing vineyards when they are too wet

The seminar then focused on case studies from experienced viticulturists who shared their strategies for managing vineyards when extremely wet conditions make it difficult to access the vineyard.

Managing organic and sustainable vineyards

Martin Gransden (Figure 90), a viticulturist with extensive experience managing vineyards in Orange, Mudgee, and the Adelaide Hills, shared his approach to managing organic and sustainable vineyards when heavy rain and wet conditions prevent access. Martin emphasised the importance of soil health, cover cropping, and reducing soil compaction during wet periods.

Marty highlighted the operational difficulties faced by vineyard operators during wet seasons, such as machinery getting bogged, increased disease pressure due to missed sprays, and the physical damage to vineyards, including soil compaction and infrastructure damage. He shared practical experiences and emphasised the importance of adapting equipment and strategies to cope with wet conditions. Marty suggested using lighter machinery, smaller spray tanks, and even custom-built sprayers to access wet areas. He also mentioned the importance of drainage, managing vegetation, and risk assessments to mitigate the effects of excessive moisture.

Marty encouraged growers to plan proactively for wet seasons by identifying vulnerable areas in their vineyards and considering alternative technology, such as drones, for agrochemical application. He stressed the need to understand legal and technical requirements for drone use, including licensing, mapping, and label compliance. While acknowledging that drones might not replace traditional sprayers, he sees them as a valuable early-season tool, especially when ground access is limited. Marty also urged the industry to invest in research trials to establish best practices for drone spraying. Ultimately, he advocated for a flexible, informed approach that balances short-term crop protection with long-term vineyard health, even if it means accepting some temporary damage to ensure overall productivity.

Key points

- Organic practices can be highly effective in building resilience to extreme weather.
- Managing soil compaction by restricting traffic and using cover crops is vital when vineyards become waterlogged.



Figure 90. Martin Gransden, Vineyard Manager of Tamburlaine Wines.

Technical management and adaptation

Kristy Bartrop (Figure 91), Viticulturist/Technical Manager at Southern Premium Vineyards, shared her experiences from the Griffith region, where wet conditions are common. Kristy discussed adaptive vineyard practices that help mitigate the effects of extremely wet weather, such as using more robust rootstocks, adjusting irrigation schedules, and integrating technology for more precise water management.

Kristy discussed the challenges of managing the extremely wet 2022 growing season in Griffith, NSW. She oversees 3,590 hectares on 55 farms with 33 grape varieties. The 2022 season had excessive rainfall and unusually low maximum temperatures, which delayed flowering and harvest by up to 4 weeks. These conditions severely limited access for spraying and increased disease and pest pressure, particularly from downy mildew, snails, mealybugs, and scale insects. Traditional spraying methods could not be used due to boggy conditions, prompting the use of helicopters for foliar applications. Despite logistical hurdles, including restricted road access and the need for aerial spray zones away from populated areas, helicopter spraying proved effective and cost-efficient.

Kristy emphasised several key strategies for future wet seasons. These included securing chemical supplies early, as demand spikes during wet periods, and being prepared with alternative spraying methods such as helicopters, especially during critical growth stages such as flowering. She also highlighted the importance of site suitability for aerial applications and adapting equipment to suit wet conditions. Her experience underscored the need for flexibility, proactive planning, and investment in infrastructure to manage increasingly unpredictable weather patterns.

Key points

- Vineyard monitoring and precision viticulture tools can help manage the vineyard when it is waterlogged.
- Adaptation to changing weather patterns is important to ensure vineyard sustainability.



Figure 91. Kristy Bartrop of Southern Premium Vineyards.

Remediating soil compaction

The second session, chaired by **Monica Gray**, Winemaker at See Saw Wine, focused on remediating soil compaction, a significant issue caused by wet soil and vineyard traffic (e.g. many tractor passes).

Soil health and remediation

Lee Haselgrove, Director of Mure Viticulture and an expert in soil science, concluded the session with a talk on managing soil compaction in vineyards affected by extremely wet conditions. Lee discussed techniques for improving soil structure, such as deep tillage, adding organic matter, and managing vineyard traffic strategically.

Lee's presentation focused on the causes, effects, and management of soil compaction in vineyards, particularly following wet seasons. He explained the physics behind compaction, emphasising how vehicular traffic, tillage, and grazing animals contribute to increased soil density and reduced porosity. This compaction restricts root growth, limits water and nutrient uptake, and ultimately reduces plant resilience and productivity. Lee highlighted the importance of measuring compaction accurately using tools, such as penetrometers, and stressed that most vineyard soil is compacted to some degree. He shared insights from years of fieldwork, showing how compaction affects root zone accessibility and plant health, and presented data demonstrating the widespread nature of this issue in vineyards.

To amend and prevent soil compaction, Lee recommended a combination of remedial and proactive strategies. Key actions include minimising machinery use during wet conditions, using lighter or better-equipped vehicles, improving drainage, and increasing soil organic matter with compost and cover crops. He advocated for subsoil ripping as an effective method to break up compacted layers and stimulate root growth, provided it is done when the soil has the right moisture level. To prolong

the benefits of ripping and delay re-compaction, he emphasised the importance of maintaining high organic matter levels, encouraging biological activity, and using multi-species cover crops. Ultimately, Lee urged growers to be more ambitious about root zone development, recognising it as the foundation for resilient and productive vineyards.

Key points

- Wet soil is more prone to compaction, which can negatively affect root development and vine health.
- Regular soil monitoring and management techniques, such as sub-soiling (deep tillage to disrupt and loosen compacted soil layers), can help improve soil structure and enhance water infiltration.

Responding to frost and hail

Best practices to implement before and after frost

Ken Helm AM (Figure 92), owner and winemaker at Helm Wines, provided valuable insights on what to do before and after frost and hail in the vineyard to minimise damage to vines.

Ken shared his extensive experience as a pioneer of the Canberra wine region, reflecting on 5 decades of viticulture and the challenges of managing hail, frost, and heat. He recounted the early days of vineyard establishment alongside fellow CSIRO colleagues, emphasising the importance of site selection to avoid hail-prone areas. Ken discussed various hail mitigation strategies, from anecdotal methods such as gas guns and skyrockets, to more practical solutions, including permanent hail netting. He also explored the psychological toll of extreme weather on growers and the need for proactive, innovative thinking. Ken also detailed historical patterns of frost and reviewed a range of mitigation techniques, from smudge pots and frost fans to sprinkler systems and vineyard orientation, highlighting both their benefits and limitations.



Figure 92. Ken Helm AM of Helm Wines.

Key points

Ken urged growers to be strategic and adaptive in managing climate-related risks, for example, adopt changes in canopy management or hail nets. He recommended selecting vineyard sites with minimal hail history, considering permanent hail netting for high-value crops, and investing in reliable frost mitigation systems, such as well-maintained sprinklers or wind machines. He emphasised the importance of airflow, soil moisture management, and thoughtful row orientation, particularly east–west alignment, to reduce frost and heat stress. Ken also advocated for late pruning techniques and maintaining backup fruit sources in less frost-prone regions.

To prevent heat stress, especially in Riesling, he advised using appropriate canopy management and close planting to protect fruit from sunburn and preserve wine quality.

His main message was innovation, preparation, and resilience are vital for sustaining vineyard success in a changing climate.

Post-frost pruning

Dr Samantha Scarratt (Figure 93), Vinehealth Australia, presented results from case studies on post-frost pruning. She gave practical advice on how to prune after frost to ensure vine health.

Sam's presentation focused on post-frost summer pruning, drawing from her extensive experience managing frost damage in New Zealand and Australia. Sam emphasised the importance of preparation and site-specific strategies, highlighting the use of frost forecasting systems, weather stations, and post-frost assessment protocols. Sam reviewed best-practice guidelines from

Australian and New Zealand sources, noting that in many cases, doing nothing after a frost can be more economically viable than intervening.

Sam presented case studies from Mount Macedon, King Valley, and Marlborough (NZ), illustrating how damage severity, vine growth stage, and vineyard goals influenced decisions on fertilising, pruning, and salvaging the crop. Her insights underscored the complexity of managing frost damage and the need for tailored responses based on local conditions and vineyard objectives.



Figure 93. Dr Samantha Scarratt of Vinehealth Australia.

Recommendations for growers

Sam advised growers to prioritise frost preparedness through reliable weather and frost forecasting, early damage assessment, and flexible management plans. She recommended using weather stations and digital tools to monitor critical temperatures and trigger timely responses. Sam suggested that growers should consider the severity and timing of damage before deciding on pruning or fertilising, and to focus on preserving replacement canes for future seasons in severe cases. Sam also encouraged growers to document frost and responses to improve future decision-making. Where possible, she advocated for investing in frost protection infrastructure such as fans or sprinklers, while acknowledging their limitations and the importance of system reliability. Ultimately, Sam emphasised that each vineyard requires a site-specific, informed approach to mitigate frost damage effectively.

Flexibility in vineyard management

Liz Riley, founder of Vitibit, discussed how to maintain flexibility in vineyard management when the season changes from wet to dry. Liz highlighted the importance of adaptability and strategic decision-making when weather patterns fluctuate unexpectedly.

Liz's presentation focused on the importance of maintaining flexibility during unpredictable seasonal shifts, particularly when conditions swing from extremely wet to unexpectedly dry. Reflecting on the 2022–23 season, she described the challenges of managing persistent rain, disease pressure, and limited vineyard access, followed by a sudden transition to dry conditions. Liz emphasised the mental resilience required to navigate such seasons, highlighting the need for optimism, adaptability, and open communication with teams and peers. She discussed the importance of prioritising tasks, such as applying fungicides, managing the canopy, and maintaining the floor, based on changing conditions and access. Her insights underscored the value of experience, creative problem-solving, and a willingness to reassess traditional practices in response to evolving vineyard conditions.

Recommendations for growers

Liz encouraged growers to adopt a dynamic approach to vineyard management. She advised maintaining strong ground cover for access, investing in versatile equipment, and being prepared to shift between ground-based and aerial operations when necessary. Growers should prioritise safety, communicate clearly with their teams, and be willing to abandon unviable blocks to preserve resources. As conditions become dry, she recommended reassessing vine health, adjusting irrigation strategies, and modifying canopy and nutrition management to support fruit development.

Liz also stressed the importance of redefining success in difficult seasons, valuing outcomes such as healthy pruning wood, intact equipment, and safe teams as much as harvested fruit. Her main message was flexibility, preparation, and a resilient mindset are essential for managing the unpredictability of modern viticulture.

Pros and cons of complete vineyard covers

Dr Marcos Bonada from Treasury Wine Estates explored the pros and cons of using complete vineyard covers. He discussed how these can influence vineyard management, including temperature regulation, moisture retention, and disease control.

Marcos presented findings from a climate adaptation project in the Barossa Valley, focusing on the use of vineyard shading to mitigate the effects of extreme weather. With climate data showing rising temperatures, decreasing rainfall, and increasing irrigation demands, Marcos outlined the limitations of traditional adaptation strategies such as modified irrigation, canopy management, and varietal selection.

His team trialled a large-scale environmental netting system over 14 hectares to assess its influence on vine performance, water use, and wine quality. Preliminary results from the first season showed that shading slightly increased canopy temperatures but reduced wind speed and solar radiation, delayed ripening, and improved water efficiency by up to 30%. Importantly, wines produced under the netting were preferred by winemakers and received higher quality grades.

Recommendations for growers

Marcos emphasised the potential of vineyard shading as a viable long-term strategy for maintaining yield and quality under increasingly harsh climatic conditions. He recommended further multi-season trials to confirm trends, particularly in hotter and drier years. Growers should consider the trade-offs of shading, such as delayed ripening and potential harvest compression, but also recognise its benefits in reducing water use, protecting fruit from sunburn, and improving wine quality. Marcos highlighted the importance of site-specific evaluation and long-term investment planning, noting that while the infrastructure is costly, its durability and performance could offer significant returns in climate resilience and product value. Continued research and adaptation will be essential for sustaining premium wine production in regions such as the Barossa.

Drought resistance in vineyards

Building drought resistance in vineyards

Matt Partridge (Figure 94), Viticulturist at De Bortoli Wines, spoke about how to build drought resistance in vineyards. His presentation focused on strategies to increase vine resilience for prolonged dry periods, a growing concern in many regions.

Matt's presentation focused on practical strategies for coping with drought in viticulture, emphasising that preparation, adaptability, and informed decision-making are crucial to resilience. He began by exploring the evolving definitions of drought, including the concept of 'flash droughts', and stressed the importance of understanding local climate, soil types, water resources, and vineyard design. Matt highlighted the value of canopy management, vineyard floor practices, and irrigation system maintenance in mitigating the effects of drought. He shared examples such as using lifting wires to shade fruit, applying kaolin-based sunscreen, and maintaining mid-row vegetation to reduce heat stress. He also emphasised the importance of preventative irrigation system maintenance and using data, both from technology and simple tools such as shovels, to guide water use and vineyard decisions.

Recommendations for growers

Matt urged growers to develop flexible, site-specific drought management plans that include clear trigger points for action. He recommended to start planning immediately after vintage, incorporating feedback from the previous season, and aligning with customer expectations. He stressed the importance of early-season irrigation, even in winter, to avoid excessive vegetative growth and ensure vine health. Matt also encouraged growers to use a variety of weather and climate data sources, including long-range forecasts and expert interpretations, while cautioning against media hype. Above all, he emphasised communication within teams and the supply chain as essential for effective drought response.

His main message was proactive planning, continuous learning, and open communication are the foundations of drought resilience in viticulture.

Q&A and audience engagement

Throughout both sessions, attendees were encouraged to participate in Q&A sessions using Slido, a digital platform for submitting questions. The interactive format allowed participants to engage with the experts and gain further insights into the practical challenges of managing vineyards in extreme weather conditions.

Vineyard tours

The second day featured a vineyard tour, allowing attendees to gain hands-on experience and learn about practical vineyard management techniques used in the Orange Region.

See Saw Wine, Balmoral Site

Justin Jarrett from See Saw Wine and **Dr Jason Smith** from Charles Sturt University discussed sustainable vineyard practices and the challenges of managing vineyards in extreme climatic conditions. Topics included grazing sheep in the vineyard, removing and replacing a vineyard, and soil health. Jason also talked about the soil moisture levels at this site (Figure 96).

Tamburlaine Organic Wines, Borenore

Marty Gransden and **Mark Pengilly** (Figure 97) guided attendees through their organic and sustainable vineyard practices, offering examples of how the vineyard is managed during extreme weather. They discussed their recycle spray unit, which conserves water and reuses any chemical water mixture that misses the vines.



Figure 94. Matt Partridge of De Bortoli Wines.



Figure 95. Dr Samantha Scarratt of Vinehealth Australia using a foot bath at NSW DPIRD Head Office.



Figure 96. Dr Jason Smith of Charles Sturt University at a soil pit at See Saw Wine.



Figure 97. Mark Pengilly (left) and Marty Gransden (pointing) of Tamburlaine Organic Wines.

Overall key points

The 2024 ASVO Viticulture Seminar provided a comprehensive look at the challenges of extremely wet conditions in vineyards and how viticulturists can adapt. Key messages included:

- **Soil:** focus on soil health by managing vineyard traffic to prevent compaction and use cover crops to improve soil structure.
- **Disease:** be proactive in monitoring for diseases such as crown gall, which are more prevalent in wet and cold conditions, and implement early detection and management strategies.
- **Varieties:** choose varieties and clones that are better suited to wet conditions, particularly those that are resistant to diseases and pests exacerbated by excess moisture.
- **Adaptation and technology:** use precision viticulture and other technological tools to manage irrigation and monitor vineyard conditions more effectively.
- **Frost and hail:** implement practices for managing frost and hail damage to vines, including preparation and recovery techniques, such as hail nets, canopy and undervine management.
- **Drought resistance:** build vineyard resilience against drought through careful water management, varietal selection, and adaptation practices.

By implementing these strategies, growers can improve the resilience of their vineyards to climate extremes and ensure sustainable production with unpredictable weather.

This seminar was a testament to the collective knowledge and innovation motivating the Australian wine industry. The insights shared by experts will undoubtedly influence vineyard management practices.



Cover crops and grapevine root distribution

Summary by Dr Jason Smith, Senior Research Fellow, Charles Sturt University

Introduction

To identify strategies to improve drought resilience in vineyards, cover crop water use and the effects of irrigation, rainfall, and soil water competition on grapevine root distribution were assessed at 3 Shiraz vineyards in the Orange region (NSW) during the 2019–20 and 2020–21 seasons.

Methods

Soil water content was measured with a manual capacitance probe using 1.5–1.6 m deep access tubes. Plant water status was measured with a pressure chamber to record the stem water potential.

The root depths of grapevines and other plant species were measured, and then this was linked to the water use characteristics of the leaves. Microbial profiling of the root samples showed how cover crop species, irrigation, and soil depth affect root function (Figure 98 and Figure 99).

Results

Soil moisture measurements in winter 2019 showed the profiles had been significantly depleted during the previous seasons to at least 1.6 m. This means the vineyards entered the third and final season of the drought with soil well below field capacity. At 2 of the 3 vineyards, the available water was used by late spring and plant water potential measurements showed the vines were severely water-stressed by the end of December. At the third vineyard, irrigation volumes were sufficient to avoid severe water stress. There were clear signs of water stress at all vineyards, with reduced shoot growth and berry weights, low yeast assimilable nitrogen and rapid increases in juice sugar concentrations. Late summer storms and a return to more average autumn and winter rainfall replenished the water deficits. Three subsequent years of La Niña conditions changed water availability to the other extreme.

During winter in the following seasons, field capacity was estimated to be between 250 and 300 mm, which is how much water could be stored within the root zone at each vineyard. On a volumetric basis, this is equivalent to 2.5–3.0 ML/ha of plant available stored water in the profile when full. This is well beyond most vineyards' capacity to adapt to, even with irrigation in seasons with low winter rainfall and drought.

Root mapping showed that grapevine roots, and those of several ground cover species, were as deep as the soil moisture monitoring probes (1.6 m). Perennial grasses were the dominant species in all vineyards. Tall fescue (*Festuca arundinacea*), paspalum (*Paspalum dilatatum*), red grass (*Bothriochloa macra*) and plantain (*Plantago lanceolata*) roots were between 1.3 and 1.6 m deep. The roots of annuals such as slender wild oats (*Avena barbata*), sub clover (*Trifolium subterranean*) and other species were at least 1 m deep before the grapevines reached bud break. This means that when ground cover plants are established, they can access the same water the grapevine roots use.



Figure 98. A soil core taken at the site.



Figure 99. Dr Jason Smith at Tamburlaine Organic Wines marking out soil core positions.

As some of these plants are active months before the grapevines develop a full canopy, they can use the water before the grapevines can.

Where irrigation was used, grapevine roots stayed mostly in the vine row, while other plants' roots were in the mid-row. Where water was only supplied by rainfall, there were more roots in the mid-row than in the vine row, which were deeper in the profile.

Irrigation and rainfall together helped grapevine roots grow further into the mid-row. However, ground cover species still dominated the topsoil. The root length density in the top 0–100 mm of soil was very high (over 200 mm/1,000 mm³), making it extremely competitive for vine roots and more than enough to use up all the available water in the soil.

Discussion

Planting cover crops that use less water can be challenging in high rainfall areas. Most plants have similar or higher water use than grapevines and can access the same soil water for longer. Many C3 grasses start growing in winter and early spring, using a lot of stored soil water early in the season. C4 and perennial C3 grasses can quickly respond to summer rain.

Keeping permanent ground cover is low maintenance, helps the mid-row handle traffic better, suppresses unwanted weeds, and can reduce plant vigour in wetter seasons. It also benefits the soil's physical and chemical properties.

Preliminary results suggest that ground cover increases beneficial bacteria and fungi. For example, nitrogen-fixing species were more common in roots under permanent ground cover than where herbicides were used, potentially providing nitrogen for vine roots. However, the root pathogen family Nectriaceae was found at all sites and depths but was more abundant where there were more grapevine roots.

Comparing long-term permanent ground cover with bare soil showed slightly higher soil carbon in the mid-row, which can enhance vineyard sustainability.

The Hochschule Geisenheim University (HGU) water balance model was adapted for the southern hemisphere and validated with soil water data. The model showed the relative share of grapevine water use is about one-third at full canopy but only 14–20% over the season due to early ground cover growth and wide row spacing. When the model was run back to 1889, the 2017–2019 drought appeared to be the only time severe soil water deficits extended for 3 full consecutive years.

Having 50% or less ground cover reduces the risk of severe water deficit from bud break to veraison from 19% to between 4% and 5%. Ground cover with a shallow root system, although potentially difficult to achieve, could reduce water competition. Reducing the row spacing from 3 to 2 m did not reduce total water use but could increase yield.

In higher rainfall areas such as Orange, irrigation usually buffers a short drought, but ground cover can deplete soil water in long, dry periods. Alternating mid-row ground cover or using annual species based on water availability could help.

For future vineyards, choosing sites with better water holding capacity, varying row spacing and canopy architecture can help. Increasing root depth and spread with irrigation while the vines are establishing could increase water storage capacity for existing sites. Consider using deep soil moisture probes for long-term monitoring.

Key points

Permanent ground cover in a vineyard is beneficial because it:

- is low maintenance, improves mid-row traffic tolerance, suppresses weeds, and reduces plant growth in wetter seasons.
- increases beneficial bacteria and fungi, potentially providing nitrogen for vine roots.
- increases soil carbon in the mid-row, with long-term ground cover enhancing sustainability.
- provides many soil physical, chemical and biological benefits.

To keep the benefits of ground cover while favouring grapevines during drought conditions,

- select shallow-rooted ground cover species according to their water use traits.
- introduce ground cover to the vineyard in the season or 2 after planting the vines.
- alternate mid-row ground cover or use annual species based on water availability.
- use irrigation to mimic rainfall to encourage greater root exploration.



Growing Chardonnay wine grapes in NSW: preparing for a changing climate

Rachael Young and Jane Kelley, Climate Vulnerability Assessment Team, NSW DPIRD

Climate change is altering the growing conditions for many agricultural commodities in NSW. Primary producers need evidence-based information about the changing climate and the risks and opportunities it might bring. Through its Vulnerability Assessment Project, the NSW DPIRD is enhancing the resilience of primary industries by providing information and data to help the sector better plan for, and respond to, climate change. In this project, the potential effects of climate change on many agricultural industries, including horticulture and viticulture, and important biosecurity risks associated with these industries were assessed, with the aim being to inform sound planning, risk management and adaptation decisions.

Methodology and data

Climate projections were sourced from Climate Change in Australia's application-ready data. This dataset comprises projections from 8 global climate models, each presenting a plausible future climate. The models differ in their projections, generating uncertainty in the modelling, which is reflected in the confidence statements given in brackets in the text. Care should be taken when interpreting these results.

The Vulnerability Assessment Project is intended to highlight potential changes that the industry or regions might need to consider. Intermediate and high emissions scenarios (RCP4.5 and RCP8.5) were used in the assessments, but these are not the only future scenarios possible. The inclusion of climate variables important to the commodities was based on published research, expert knowledge and data quality and availability.

Wine grapes in NSW

NSW is the birthplace of wine grape production in Australia, with the first vines planted in the 1800s. Today, it is Australia's third-largest producing state, behind South Australia and Victoria. Chardonnay represents approximately 70% of NSW's white varietal crush (Wine Australia).

Climate and the wine-growing regions

The current cool (e.g. Orange, Murrumbateman and Tumbarumba) and warm (e.g. the Hunter Valley, Griffith and Dareton) growing regions (Figure 100) are expected to remain highly suitable for producing Chardonnay grapes by 2050 under a changing climate.

The climate suitability is expected to remain very highly suitable for **grape quality** parameters, such as sugar and acid content, in both cool and warm growing regions (high confidence).

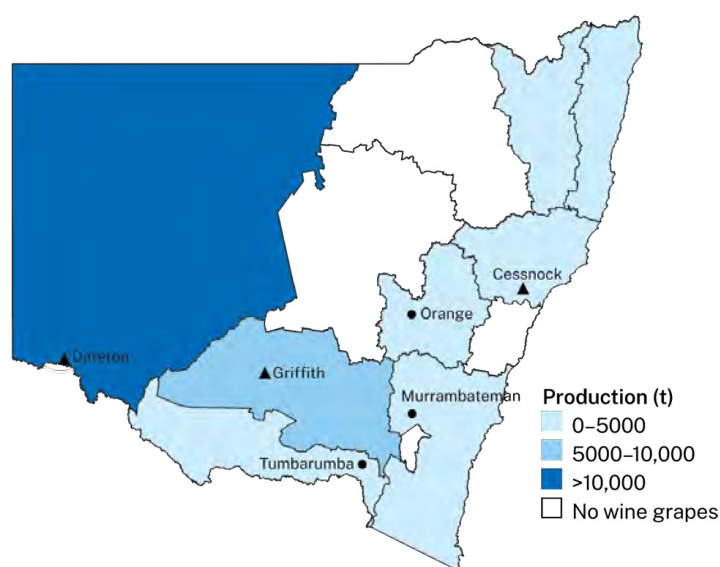


Figure 100. Chardonnay wine grape growing regions in NSW. Darker colours represent higher grape production. Circles indicate cool wine regions, and triangles show warm wine regions.

Climate change risks to the NSW Chardonnay wine grape industry are expected to affect some growth stages differently (Table 6) and include:

- **Extreme heat:** increased maximum temperatures and hot days might affect sensitive growth stages, such as veraison and bloom.
- **Frost:** reduced frost risk could increase suitability in both cool and warm regions, especially during bud burst and shoot growth.
- **Irrigation water requirements:** are likely to increase for cool and warm wine-growing regions (low to moderate confidence). The increase is likely to be greatest under the high emissions scenario.

Table 6. The projected effects of climate change on wine grape growth stages.

Growth stage	Change in climate suitability for cool regions	Change in climate suitability for warm regions
Dormancy	Remain very high, except for Murrumbateman in a high emissions scenario, where it will decrease to high (moderate to high confidence).	Remain high for Griffith and Cessnock and moderate for Dareton (high confidence).
Bud break (bud burst and shoot growth)	Remain very high in Murrumbateman (high confidence). Increase from high to very high in Orange and Tumbarumba due to reduced frost (high confidence).	Remain very high for Dareton and Cessnock. Could increase to very high in Griffith due to reduced frost (high confidence).
Bloom (flowering and berry development)	Remain very high in Murrumbateman and Orange. Could increase from high to very high in Tumbarumba (moderate to high confidence).	Remain very high (moderate to high confidence).
Veraison	Remain very high (moderate to high confidence), but could decrease slightly due to an increase in hot days.	Remain high in Cessnock. Could decrease to low in Dareton and Griffith due to an increase in hot days (moderate to high confidence).
Harvest, maturation, postharvest and leaf fall	Remain very high (high confidence).	Remain very high (moderate to high confidence).

How to adapt

Climate variability, pests and diseases all affect wine grape production. Understanding the likely effects of climate change on each wine region will help with identifying priority adaptation and mitigation strategies, such as:

- Applying organic mulch to the under-vine area will help retain soil moisture and mitigate temperature extremes.
- Applying sunscreen products will help reduce sunburn damage and anti-transpirants will help maintain berry integrity and reduce water loss.
- Installing over-row netting could limit sun exposure during high temperatures.
- New varieties might be better suited to higher temperatures, but these can take up to 30 years to develop and become commercial.
- Modifying irrigation practices, upgrading water infrastructure or adopting new technologies could improve water use efficiency.

For more information, please email vulnerability.assessment@dpird.nsw.gov.au

This work has been produced by the NSW Primary Industries Climate Change Research Strategy funded by the NSW Climate Change Fund.



Future Vineyards 2025: climate, carbon, and cutting-edge tech reshape viticulture

Penny Flannery, Development Officer – Viticulture, NSW DPIRD

The Future Vineyards Breakfast, hosted at the Orange Agricultural Institute on 30 May 2025, brought together growers, researchers, and innovators to explore the future of viticulture in a changing climate. With a focus on sustainability, digital transformation, and ecological resilience, the event showcased groundbreaking research and practical tools to help wine producers adapt and thrive. The day was organised by Liz Davis, Sustainable Agriculture Facilitator from the Central Tablelands Local Lands Services (Figure 101).



Figure 101. Liz Davis, Sustainable Agriculture Facilitator from Local Lands Services.



Figure 102. Rachael Young, Communication and Engagement Specialist (NSW DPIRD).

Effects of climate on Chardonnay by 2050

Penny Flannery and Rachel Young from NSW DPIRD opened the event by discussing the Climate Vulnerability Assessment for growing Chardonnay (Figure 102). Using 30-year climate projections and expert-validated models, they revealed:

- **Cool-climate regions**, such as Orange, are projected to have **increased climate suitability** due to reduced frost risk during bud burst to full shoot growth.
- **Warm-climate regions** such as Cowra and Griffith might have **minimal to moderate decreases in climate suitability** due to extreme heat during veraison.
- There is likely to be increased irrigation needs during all growth stages in most wine regions, particularly under the high emissions scenario. There is also likely to be increased rainfall variability during dormancy.

Adaptation strategies discussed included using mulch, shade netting, anti-transpirants, and transitioning to heat-tolerant varieties.

Mulch

- **Improves water retention, reduces evaporation** from the soil surface and **helps conserve water**, which is critical during droughts and heatwaves. In NSW, mulch can reduce irrigation needs by up to 10%, saving millions of litres of water annually for large vineyards.
- **Helps with temperature regulation**, acting as an insulating layer, lowering soil temperatures by up to 20 °C. This helps vines cope with extreme heat and reduces plant stress.
- **Enhances soil health**: organic mulches (e.g. compost or straw) improve soil structure, increase organic matter, and boost microbial activity. This leads to better water infiltration, nutrient cycling, and carbon sequestration, which are important for long-term sustainability.
- **Reduces erosion and land degradation**: mulch protects the soil surface from wind and water erosion, which is increasingly important as rainfall patterns become more erratic.

- **Helps with weed suppression and reduced chemical use:** a thick mulch layer (about 50–70 mm) can reduce weed growth by over 60%, lowering the need for herbicides and reducing costs.
- **Lowers energy use and emissions:** by reducing irrigation demand, mulch indirectly lowers energy use for pumping water, which also reduces greenhouse gas emissions.
- **Improves grape yield and quality:** trials have shown that mulch can increase grape yields and improve fruit quality, adding economic value to vineyard operations.

Other considerations

While mulch offers many benefits, there are some risks, such as creating a:

- fire hazard in dry seasons
- frost risk due to altered ground temperature
- pest habitat
- operational challenges with machinery.

Shade netting

- **Helps regulate temperature:** shade nets can reduce cluster temperatures by up to 5 °C, helping protect grapes from sunburn and heat stress. This cooling effect is especially important during late summer when ripening grapes are most vulnerable.
- **Delays ripening and improves fruit quality:** by reducing light intensity and heat, shade nets slow down the ripening process, helping preserve must acidity and balance sugar accumulation. This leads to better wine quality, especially for heat-sensitive varieties such as Semillon and Shiraz.
- **Improves water use efficiency:** shading reduces evapotranspiration, allowing vines to use water more efficiently and reducing irrigation needs. This is critical in NSW, where water availability is increasingly uncertain.
- **Protects from extreme weather:** shade nets offer physical protection from hail, wind, and UV radiation, reducing crop losses and damage.
- **Helps stabilise the microclimate:** nets help create a more stable canopy microclimate, reducing fluctuations in temperature and humidity that can stress vines and promote disease.
- **Provides photo-selective effects:** coloured nets (e.g. red, blue, or pearl) can modify the light spectrum, influencing vine physiology and grape composition in targeted ways.

Other considerations:

- **Reduced photosynthesis:** shade can lower photosynthetic rates by up to 40%, which might affect vine vigour if not managed properly.
- **Cost and installation:** shade netting requires upfront investment and maintenance.
- **Varietal response:** different grape varieties respond differently to shading, so trials might be needed to optimise results.

Anti-transpirants

- **Reduce water loss:** anti-transpirants form a thin film over vine leaves and fruit, reducing transpiration while still allowing gas exchange. This helps vines retain moisture during droughts and heatwaves, improving water use efficiency.
- **Delay ripening:** studies in NSW have shown that anti-transpirants can delay grape ripening by reducing sugar accumulation (lower Baumé), which helps manage vintage compression. This is especially useful in warmer regions where grapes ripen too quickly, affecting wine balance and harvest logistics.
- **Improve berry and bunch weight:** trials on Shiraz, Pinot Noir, and Chardonnay showed increased berry and bunch weight after anti-transpirant application, potentially improving yield.
- **Preserve fruit quality:** despite delayed ripening, anti-transpirants did not negatively affect pH, titratable acidity, or phenolics. In some cases, treated grapes produced wines with more fruit-forward aromas and fewer green or vegetal notes.
- **Mitigate heat stress:** by reducing transpiration, anti-transpirants help vines maintain cooler leaf temperatures, reducing stress during heatwaves.

- **Flexible application timing:** anti-transpirants can be applied at pre-flowering, pre-veraison, or both stages, allowing growers to tailor their use to seasonal conditions.

Other considerations

- **Varietal sensitivity:** different grape varieties respond differently to anti-transpirants.
- **Timing is critical:** incorrect timing might affect ripening or wine style.
- **Cost and labour:** application requires careful planning and might add to operational costs.

Heat-tolerant varieties

- **Better adaptation to rising temperatures:** traditional varieties such as Pinot Noir and Riesling struggle in extreme heat, often ripening too quickly and losing acidity. Heat-tolerant varieties, such as Grenache, Mourvèdre, Carignan, Tempranillo, and Nero d'Avola, maintain balance and flavour even under high temperatures.
- **Improve water use efficiency:** many heat-adapted varieties are also more drought-resistant, requiring less irrigation, which is critical in NSW, where water availability is declining.
- **Preserve fruit quality:** heat-tolerant varieties tend to retain acidity and phenolic balance better under heat stress, leading to wines with more stable flavour profiles and ageing potential.
- **Reduce the risk of crop loss:** heat-tolerant grapes are less prone to sunburn, berry shrivel, and yield loss during heatwaves, which are becoming more frequent in NSW.
- **Extend harvest windows:** by planting varieties with different ripening times, growers can spread out harvest, reducing pressure on labour and winery logistics during compressed vintages.
- **Economic resilience:** switching to varieties that thrive in warmer conditions can help safeguard wine production and reduce the risk of shortages or quality downgrades.
- **Encouraging genetic diversity:** *Vitis vinifera* has a wide genetic base, and many cultivars from Mediterranean and arid regions are naturally suited to NSW's evolving climate.

Examples of heat-tolerant varieties being trialled in Australia

- **Tempranillo** (Spain): early ripening, good acidity retention.
- **Nero d'Avola** (Italy): drought-tolerant, rich colour and flavour.
- **Grenache** (France/Spain): thrives in heat, versatile wine styles.
- **Fiano** (Italy): white variety with good heat tolerance and aromatic profile.

Vineyard of the future: data-driven innovation

Mark Bourne (Charles Sturt University, CSU) presented the **Vineyard of the Future** initiative, a flagship program hosted at CSU Wagga Wagga (Figure 103). Key components include:

- a 3-hectare demonstration vineyard integrating agtech and automation
- soil carbon measurement tool tailored for viticulture
- data hub platform offering real-time decision support and AI-driven insights.

Growers were invited to participate in pilot programs involving hyperspectral scanning, satellite yield estimation, and digital twin simulations.

Cool soil initiative: carbon accounting for vineyards

Dr **Cassie Schefe** (Figure 104) introduced the **cool soil initiative**, which aligns vineyard sustainability reporting with global carbon frameworks. Her research highlighted:

- The cool farm tool (CFT) offers better methods of integrating the data on soil carbon than current tools.
- A proposed soil carbon module could significantly improve the accuracy of vineyard emissions reporting.
- A standardised soil sampling protocol is being developed to help both compliance and sustainability claims.

EcoVineyards: biodiversity in action

Brent Hutton, Regional Coordinator for the EcoVineyards Program (Figure 105), shared updates on biodiversity trials and grower engagement in the Orange region. Highlights included:

- A focus on functional biodiversity in 2024–25, following previous work on soil health and cover crops.
- Bat monitoring at Tyrrell’s Wines, which identified 12 insectivorous species, including 4 threatened ones, demonstrates the ecological value of vineyard habitats.
- A call to action for growers to pledge native plantings of up to 100,000 plants in Australia by the end of 2025.



Figure 103. Mark Bourne, Associate Director of Academic and Industry Partnerships – Wine Industry of Charles Sturt University.



Figure 104. Dr Cassie Scheffe from Charles Sturt University discussing the cool soil initiative.



Figure 105. Brent Hutton from EcoVineyards discussing biodiversity trials and grower engagement.



Figure 106. Cam Clifford from Agri Automation Australia demonstrating the Burro Grande options.

BioScout: making the invisible visible

Charles Simons of BioScout showcased their AI-powered system for detecting fungal diseases. Key benefits include:

- Real-time spore detection using robotic microscopy and hyperspectral imaging.
- Up to 50% reduction in fungicide use and 10% yield improvement.
- New tools, such as LeafScout with a patented spray sensor that mimics real leaves, are being used to measure spray coverage and leaf wetness.

BioScout’s regional analysis from New Zealand demonstrated the system’s ability to track spore trends for diseases such as botrytis, downy mildew, and powdery mildew.

Agri-automation: the future is autonomous

Cam Clifford from Agri Automation Australia introduced the Burro Grande, an autonomous platform designed to help with vineyard logistics and reduce labour demands (Figure 106). The Burro Grande is part of a broader push toward automation in viticulture, offering scalable solutions for both large and boutique operations.

A vision for the future

The Future Vineyards Breakfast underscored the importance of collaboration between science, technology, and growers. As climate pressures increase and market expectations evolve, the Australian wine industry is responding with innovation, ecological stewardship, and a commitment to sustainability.

For more information or to get involved in these programs, visit:

- agripark.csu.edu.au
- ecovineyards.com.au
- bioscout.com.au

Acknowledgements

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Sustainable Winegrowing Australia: 2024 update

Source: Sustainable Winegrowing Australia

The data presented in this report are aggregated from individual Sustainable Winegrowing Australia member data (Table 7 to Table 9). The accuracy of data generated by or obtained from the Sustainable Winegrowing Australia member portal depends on data entered by users. The AWRI makes no representation or warranty in relation to the accuracy or completeness of any data presented in this report. Data were accurate on 23 November 2024.

NSW membership statistics

Table 7. NSW membership statistics from Sustainable Winegrowing Australia.

	Total vineyard members	Certified vineyard members	Vineyard area (ha)	Total winery members	Certified winery members	Total members
2019–20	27	4	2,174	5	2	32
2020–21	57	8	5,730	20	4	77
2021–22	64	5	5,890	21	4	85
2022–23	83	25	8,044	28	8	111
2023–24	232	43	23,265	32	12	264

NSW winery statistics

Table 8. NSW winery statistics from Sustainable Winegrowing Australia.

		2019–20	2020–21	2021–22	2022–23	2023–24
Production	Total tonnes crushed	65,921	154,495	149,354	222,626	485,715
Water	Average water use (kL/t crushed)	1.9	3.3	3.6	3.4	3.9
	Average wastewater generated (kL/t crushed)	4.2	2.9	3.0	3.4	3.8
Waste	% of members sending organic waste to recycling	75	76	71	84	90
	% of members sending other waste to recycling	–	–	90	92	94
Energy	Average electricity (kWh/t grapes crushed)	565	444	449	525	508
Biodiversity	% members participating in on or off-site biodiversity projects	75	65	90	84	65

NSW vineyard statistics

Table 9. NSW vineyard statistics from Sustainable Winegrowing Australia.

	NSW total	Canberra	Hunter Valley	Mudgee	Murray Darling	Orange	Tumbarumba	Riverina
Average yield (t/ha)								
Excluding vineyards with no fruit harvested	12.5	5.8	3.8	3.7	21.6	5.1	7.1	13.4
Including vineyards with no fruit harvested	13.7	7.3	4.0	4.3	25.6	6.2	7.2	14.7
Mid-row management (total ha)	1,348	–	101	15	544	14	83	528
	2,482	18	120	141	597	432	20	1,094
	7,207	35	421	8	351	561	39	5,121
	1,846	–	15	69	133	109	79	941
	9,623	–	18	–	4,316	–	–	5,023
Under-vine management (total ha)	1,687	1	23	38	11	1,007	32	55
	21,577	43	612	134	5,635	496	146	12,984
	3,480	–	161	–	448	492	–	2,344
	259	27	20	22	32	128	–	30
	89,504	2	570	127	41,197	326	100	42,189
Total water use by source (ML)	4,913	25	–	181	–	526	–	3,541
	1,877	22	54	31	–	18	–	1,750
	–	–	–	–	–	–	–	–
	535	35	–	–	–	–	–	500
	4,294	–	1	–	547	–	–	3,746
	465	–	15	–	–	–	–	450
	1	1	–	–	–	–	–	–
	4	2	1	1	7	1	1	4
	22,251	45	569	200	5,467	1,114	122	13,118
	256	–	–	–	246	–	–	–
Total irrigation delivery by type (total ha)	152	–	–	–	88	–	20	–
	647	–	–	–	–	–	–	613
	158	8	107	–	–	2	33	–
	2,957	–	21	109	927	21	–	1,538
	21,415,893	21,476	659,971	54,000	9,531,767	958,578	18,257	8,820,708
Total energy use	1,345,176	33,788	185,677	15,740	199,174	21,190	3,099	639,896
	129,395	652	15,388	2,565	63,093	7,116	1,960	24,623
	2,425	–	120	–	600	–	–	1,680
	3,947,703	14,502	168,653	24,905	1,369,946	145,693	24,124	1,923,501
Biodiversity	6,035	54	121	247	4,207	200	73	766
	38	75	68	67	41	85	57	22



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Data-driven decision making

Farms of the Future case study with Tom and Georgie Ward, Swinging Bridge Wines

Overview

- Tom and Georgie Ward have 6 hectares of vineyard on cool, dry slopes at Orange, NSW.
- They have been in the viticulture and winemaking industry for 30 years.
- Wanted to make crop monitoring easier.

Challenges

- Public weather data failed to reflect local conditions.
- No capacity to remotely check pumps or water tanks to confirm successful irrigation.
- Lack of accurate, real-time weather data to inform disease management.

Actions

- Tom decided to explore Agtech, encouraged by consultant Liz Riley.
- He identified goals and challenges through a workshop run by the [Farms of the Future](#).
- He formed a strong relationship with a supplier who talked him through his options.

Solution

Tom and Georgie invested in Wi-Fi connected sensors that synchronise with computer and phone apps. These include:

- Soil moisture probes to measure moisture levels to 1 m deep at 100 mm increments.
- Weather station for real-time local monitoring of temperature, humidity, wind speed and Delta T.
- Water tank monitors to show levels and usage.

The new Agtech, including soil moisture probes, water tank monitors and a weather station, delivers precise, accessible data to help produce premium grapes and wines.



Figure 107. Tom checking a soil probe in the vineyard.

Benefits

- Soil moisture probes and tank level monitors show real-time proof of irrigation (Figure 107).
- Weather station data ensure safe spraying and optimal disease management.
- Mobile apps allow fast, informed decision-making on and off the farm.
- Online data provide peace of mind when travelling or on holiday.

50 hours saved per vintage

20% reduction in water use

\$2,500 saved in chemicals per vintage

'Getting that data onto my phone, that's been the massive improvement. Tech lets me make instant decisions wherever I am.'

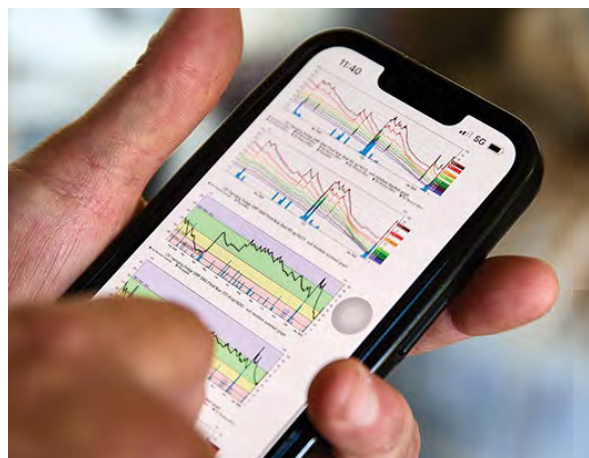


Figure 108. The Agtech dashboard used for monitoring current soil conditions.

Tom's tips

- Do not rush your decision. Get advice.
- The most expensive solution is not always the best one (Figure 109).

Where to from here?

Tom's Agtech wish list includes automation of pumps and irrigation, and more soil moisture probes. He continues to explore how the new data can help refine and shape future wine vintages.

For more information about the Farms of the Future, including additional case studies and education materials, upcoming training events, an online Agtech catalogue and opportunities to visit demonstration sites, visit [Farms of the Future](https://www.agtech.dpi.nsw.gov.au/) (<https://www.agtech.dpi.nsw.gov.au/>).



Figure 109. Agtech in the vineyard provides Tom with real-time data about current conditions.



New digital tools for NSW grape growers

Matthew Jessop, Executive Officer, NSW Wine

A collaboration between NSW Wine, Riverina Winegrape Growers and Wine Australia has developed a suite of new online tools to help NSW grape growers manage their vineyard productivity and profitability. As part of a broader project looking at industry sustainability, a digital weather solution (Weather as a Service) and a grape growing cost calculator are being released to provide businesses with better data so they can make more informed decisions.

Weather as a Service

Weather as a Service (WaaS) has been developed in response to the state's ageing weather station infrastructure and the cessation of services after the 3G Network was switched off nationally. WaaS is a virtual weather station network that uses publicly available data to provide observations and three-day forecasting down to 90 m² (Figure 110). This is a significant improvement on existing weather services and one that can provide compounding benefits over a growing season. WaaS will also integrate disease alerts into its dashboard (Figure 111), providing growers with warnings for botrytis, downy mildew and powdery mildew, adding more value than the previous physical network.

WaaS will provide weather data for 16 key locations in the Riverina (n=5), Hunter Valley (n=2), Orange (n=2), Mudgee (n=2), Canberra District (n=2), Tumbarumba (n=1), Hilltops (n=1) and Southern Highlands (n=1). Having a virtual weather station network will provide more comprehensive and flexible vineyard-specific weather data without the need for physical infrastructure. This will help improve long-term productivity and profitability.

WaaS is now live (<https://www.nswwine.com.au/weather-as-a-service>).

Grape growing cost calculator

The grape growing cost calculator is an intuitive and easy-to-use online calculator that lets growers see the contribution of both fixed and variable costs to growing grapes. This includes the influence of inputs, such as the cost of water, and ultimately shows the user what income is required to break even or make a profit. The calculator is designed for growers in any of the inland regions of Australia, such as the Riverina, Riverland, and Murray Darling–Swan Hill, to help them make more informed business decisions.

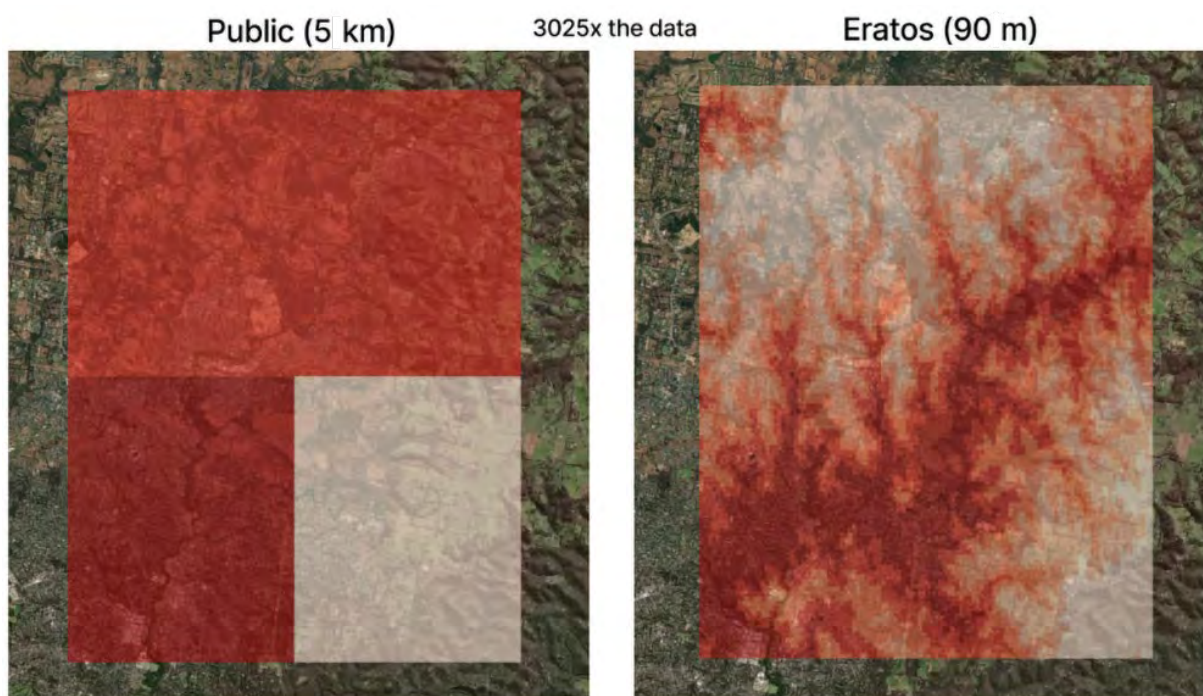


Figure 110. The difference between 5 km resolution and 90 m resolution possible when using the operational tools powered by Eratos.



Figure 111. An example of the Weather as a Service (WaaS) dashboard.

Acknowledgements

Both projects have been delivered with support from Charles Sturt University, NSW Department of Primary Industries and Regional Development and Food Innovation Australia Limited. WaaS is hosted on the [NSW Wine website](https://www.nswwine.com.au/weather-as-a-service) (<https://www.nswwine.com.au/weather-as-a-service>), and the grape growing cost calculator is accessible on the [Wine Australia website](http://www.wineaustralia.com/market-insights/gpcc) (www.wineaustralia.com/market-insights/gpcc).



Getting to know the predatory arthropods commonly found in and around Australian vineyards

Dr Mary Retallack, Retallack Viticulture Pty Ltd

Vineyard biodiversity can be enhanced by including insectary plants, and their benefits can be measured using a surrogate indicator, such as the diversity of predatory arthropods and arthropods found in association, which have a direct effect on pest abundance.

Some terms used:

- **Functional biodiversity** can be assessed by measuring the richness (diversity) and abundance (number) of each predatory species.
- **Predatory species**, such as **arthropods**, which include insects, spiders and mites, contribute to the biocontrol of insect pest species.
- **Morphospecies** refers to visually distinct specimens that can be categorised with a number and possible functional group or family before being identified as genus and species.

Underpinning science

The diversity of predatory arthropods in vineyards was increased more than three-fold when native evergreen shrubs such as sweet bursaria (*Bursaria spinosa*) and prickly tea-tree (*Leptospermum continentale*) were present versus grapevines only. Additionally, predatory morphospecies increased by around 27% when native perennial wallaby grasses (*Rytidosperma* spp.) were planted with grapevines (Retallack et al. 2019a).

Predatory arthropods contribute to the biocontrol of grapevine insect pests.

SNAP

Arthropod habitat comes from insectary plants that provide 'SNAP' (Figure 112), an acronym for **shelter, nectar, alternative prey** and **pollen** (Barnes et al. 2010). Insectary plants can nourish predatory arthropods and encourage their presence (Gurr et al. 1998).

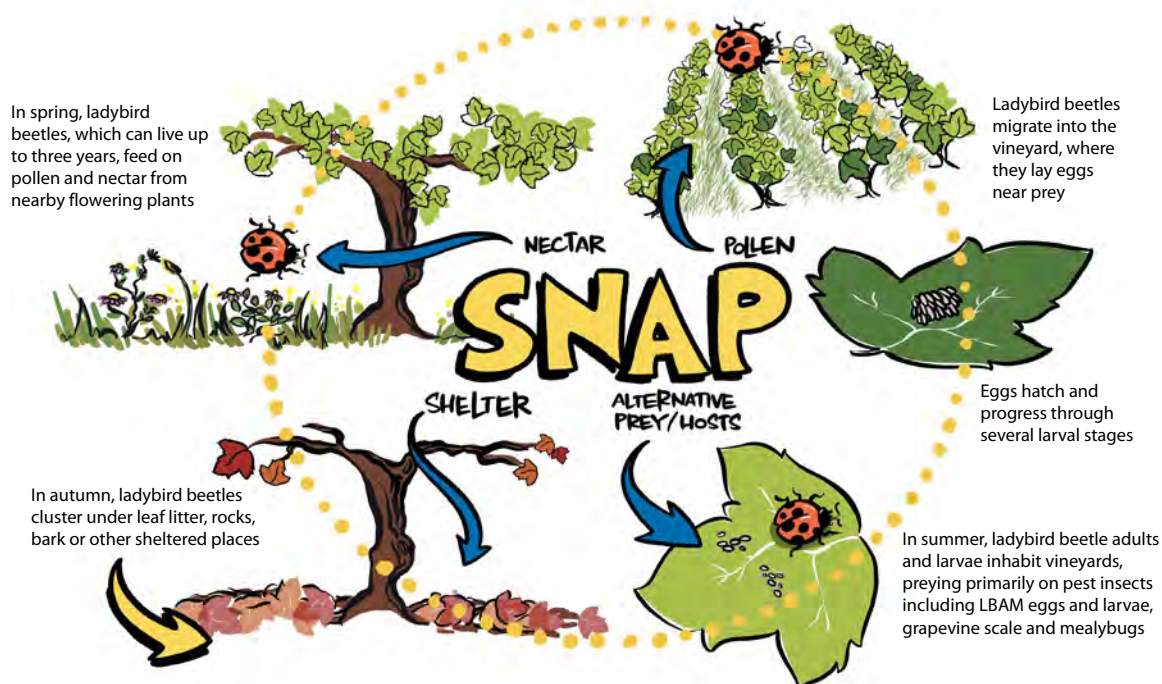


Figure 112. Ladybird beetle life cycle and the role of shelter, nectar, alternative prey and pollen (SNAP).

More than 90% of Australia's flora and fauna species are endemic. Many predatory arthropods are also endemic, having co-evolved with native plants.

Native plants are naturally adapted to the dry Australian conditions. They are also associated with low pest populations and high natural enemy populations. Planting diverse native plants provides a valuable habitat for predatory arthropods. This should give growers the confidence to trial native insectary plants in their vineyards to increase predatory arthropod populations.

Predatory arthropods

Some of the predatory arthropods (including parasitoid wasps) commonly found with insectary plants and on grapevines include:

Predators

Many predators, such as spiders, brown and green lacewings, ladybird beetles, and predatory bugs, are commonly found in vineyards (Thomson and Hoffmann 2007, 2008).

- Generalist predators are often voracious feeders of various pest species' eggs, larvae, and adult stages.
- The main predators of leaf-rollers, such as light brown apple moth (LBAM), include lacewing larvae, spiders, earwigs, ladybirds, carabid and rove beetles, predatory shield and damsel bugs (Hemiptera), predatory hoverflies and robber flies (Diptera), and parasitic wasps (Bernard et al. 2006a; Frank et al. 2007; Paull 2007; Thomson and Hoffmann 2009, 2010; Hogg et al. 2014; Yazdani et al. 2015; Yazdani and Keller 2017).
- Some predators feed on leaf-roller eggs (MacLellan 1973; Danthanarayana 1980; Paull and Austin 2006).

Up to 90% of newly hatched leaf-roller larvae can be killed by predators without toxic chemicals (Helson 1939; Waterhouse and Sands 2001).

Parasitoids

There are at least 28 known parasitoids of eggs, caterpillars, and pupae of LBAM (Paull and Austin 2006; Paull 2007). *Trichogramma* spp. wasps parasitise LBAM eggs (Glenn et al. 1997; Glenn and Hoffmann 1997) but no other life stage. This, along with low levels of parasitism and late-season activity, might limit their ability to control LBAM in isolation (Bernard et al. 2006b).

Young LBAM instars can be consumed by the predatory shield bug, *Oechalia schellenbergii* (Figure 113). They can also be parasitised by a braconid wasp (*Dolichogenidea tasmanica*: Hymenoptera: Braconidae; Figure 114), but parasitism is only possible up to and including the third instar (Yazdani et al. 2015), whereas *Gonozius* spp. (Hymenoptera: Bethyridae) can parasitise third and fourth stage instars (Danthanarayana 1980).

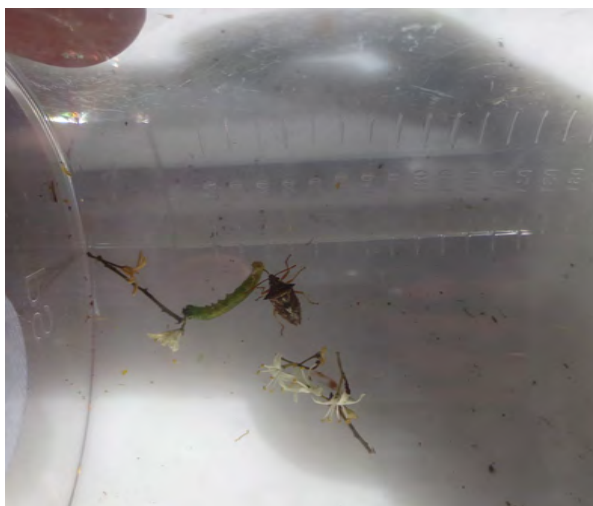


Figure 113. *Oechalia schellenbergii*, a predatory shield bug, consuming a leaf-roller larva. Photo: Mary Retallack.



Figure 114. *Dolichogenidea tasmanica*, a braconid wasp, parasitising a leaf-roller larva. Photo: Michael Keller.

Predatory arthropods found with native evergreen shrubs

The richness or diversity of predator morphospecies in evergreen shrubs was nearly double that found with grapevines alone.

It might be possible to increase the functional diversity of predatory arthropods by more than 3× when native evergreen shrubs are present versus grapevines only (Retallack et al. 2019b).

Sixty-seven predatory arthropod morphospecies were found on sweet bursaria, including brown and green lacewings (Figure 115), spiders (Figure 116), predatory and parasitic wasps (Chalcid, Ichneumonid, Proctotrupoid, Tiphid and Vespid), predatory shield bugs (Figure 117), and many other 'good bugs' (Figure 118; Retallack et al. 2019b).



Figure 115. Brown lacewing adult (*Micromus tasmaniae*) left, and green lacewing larva (*Mallada signatus*) right, ambush their prey. Photos: Mary Retallack.



Figure 116. Jumping spiders (Salticidae) left, and flower or crab spiders (Thomisidae) right, ambush their prey. Photos: Mary Retallack.



Figure 117. Glossy shield bug (*Cermatulus nasalis*, photo: Landcare Research, NZ) left, and predatory shield bug (*Oechalia schellenbergii*, photo: Mary Retallack) right.



Figure 118. Pacific damsel bug (*Nabis kinbergii*) left, and big-eyed bug (*Geocoris* spp.) right. Photos: Mary Retallack.

Prickly tea-tree provides habitat for natural enemies that are attracted to sources of nectar and pollen, such as predatory and parasitoid wasps (Chalcid, Ichneumonid, Proctotrupoid, Tiphid and Vespoid), lacewings, spiders (Figure 119), and other predators (Figure 120). At least 63 predatory arthropod morphospecies were found near prickly tea-trees and many species overlapped with sweet bursaria.



Figure 119. Bird-dropping spider (*Celaenia excavata*) left, and speckled orb-weaver (*Araneus circulissparsus*), right. Photos: Mary Retallack.



Figure 120. Common spotted ladybird beetle (*Harmonia conformis*) left, and orange assassin bug (*Gminatus australis*), right. Photos: Mary Retallack.

Predatory arthropods found with native wallaby grasses

At least 38 predatory arthropod morphospecies were found with wallaby grasses (*Rytidosperma* spp.) in vineyards (Retallack et al. 2019b).

Wallaby grasses provide a habitat for predators. Wolf spiders (Figure 121), earwigs (Figure 121), brown lacewings, glossy shield bugs (Figure 117), carabid beetles, parasitoid and predatory wasps (Ichneumonid, Vespoid, and Sphecidae) and others (Figure 122) are found abundantly in South Australian vineyards (Retallack et al. 2019a).

Predation of LBAM eggs increases when wallaby grasses are present. The difference between predatory and herbivore morphospecies was 2:1 predator: herbivore (Retallack et al. 2019a).



Figure 121. Garden wolf spider (*Tasmanicosa* sp.), left and European earwig (*Forficula auricularia*), right. Photos: Mary Retallack.

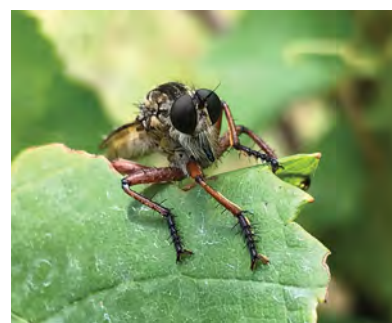


Figure 122. Transverse ladybird beetle (*Coccinella transversalis*) left, minute two-spotted ladybird (*Diomus notescens*) middle, robber fly (*Asilidae*) right. Photos: Mary Retallack.

When are arthropods most active?

Arthropod activity in and around vineyards often peaks from late October to mid-December, with populations declining when conditions become hotter and drier. This will depend on each season. While insectary resources and habitats are available, various predatory arthropods will persist all year and contribute to the biocontrol of grapevine insect pests.

We encourage you to look closely at the insects and spiders commonly found in vineyards during the growing season.

Further reading

For more information, please refer to:

[EcoVineyards best practice management guide on functional biodiversity in Australian vineyards](https://ecovineyards.com.au/knowledge-hub/natural-predators-book/) (https://ecovineyards.com.au/knowledge-hub/natural-predators-book/)

[Natural predators of vineyard insect pests booklet](https://ecovineyards.com.au/wp-content/uploads/Key-predator-of-vineyard-pests-document-internals-V3-RV-full.pdf) (https://ecovineyards.com.au/wp-content/uploads/Key-predator-of-vineyard-pests-document-internals-V3-RV-full.pdf)

The [EcoVineyards knowledge hub](https://ecovineyards.com.au) (https://ecovineyards.com.au).

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Managing mealybugs and scale insects in Riverina vineyards: 2024–25 trials

Dr Meena Thakur, Research Horticulturist – Entomology, NSW DPIRD

Mealybugs (*Pseudococcus* spp.) and soft scale insects (*Parthenolecanium* spp.) have become increasingly problematic pests in many grape-growing regions in Australia. Their ability to reproduce rapidly and form cryptic infestations makes them particularly challenging to manage. Female long-tailed mealybugs (*Pseudococcus longispinus*) can lay between 100 and 200 live crawlers over 2 to 3 weeks, while soft scale insect females can lay up to 2,000 eggs (Camacho and Chong 2015), leading to explosive population growth in warm conditions.

These pests cause direct damage to grapevines by:

- feeding on plant sap, desiccating grape bunches and weakening vines (Rakimov et al. 2015)
- they produce honeydew (Figure 123) that promotes sooty mould growth, which interferes with photosynthesis and fruit development, contributing to bunch rot and poor-quality grapes
- they can transfer the viruses that cause grapevine leaf-roll disease and Shiraz disease
- mealybug contamination at harvest can severely affect wine quality. Their presence in harvested grapes can alter fermentation and organoleptic properties of wine (Bordeu et al. 2012).

According to Wine Australia (2023), mealybugs and scale insects collectively cost the wine industry between \$5 million and \$20 million annually.

Recent grower surveys (2024–25 [Grapevine management guide](#)) suggest infestations are increasing, particularly over the past 5 years, with limited chemical options available and concerns about resistance and secondary pests.

To assess the effectiveness of biological control agents (*Cryptolaemus* sp. and green lacewings) and systemic chemistry (spirotetramat) under commercial conditions in the Riverina, NSW DPIRD conducted 2 demonstration trials during the 2024–25 season as part of the Wine Australia-supported Greater NSW–ACT Regional Program 2023–28. These treatments were selected based on the recommendations for the sustainable management of mealybugs.

Cryptolaemus beetle (*Cryptolaemus montrouzieri*) is a native Australian ladybird beetle used worldwide for biological control of mealybugs and soft scale insects. Its larvae resemble mealybugs (Figure 124), are woolly white, and can consume over 200 mealybugs each. Adults are 5 mm long, black with orange-brown heads, and fly readily to find prey.



Figure 123. A grape bunch with honeydew secretions from mealybugs.



Figure 124. *Cryptolaemus montrouzieri* larva eating black scale insects (left) and an adult feeding on a citrus mealybug (right). Photos: Sonya Broughton, Department of Agriculture and Food, Western Australia, Bugwood.org.

Green lacewings (*Mallada signatus*; Figure 125) are native generalist predators found throughout Australia. Their larvae feed on a range of soft-bodied pests, including aphids, caterpillars, scale insects and mealybugs. Adults, about 15 mm long with large V-shaped wings, are not predatory but feed on nectar and honeydew. Females lay around 600 eggs.

Methods

Two commercial vineyards near Griffith were selected, one with a history of mealybug (Traminer block) and the other with scale insect infestations (Chardonnay block). Treatments included:

1. **Chemical control:** single application of spirotetramat (Movento®).
2. **Biological control:** single release of natural enemies, *Cryptolaemus montrouzieri* (mealybug destroyer beetle adults and larvae) and *Mallada signata* (green lacewing larvae).
3. **Untreated control.**

Monitoring and data collection

Monitoring of scale insect and mealybug numbers was carried out using a combination of visual inspections, double-sided sticky tape on the spurs and canes (for crawler activity), and leaf and bunch assessments. Other general natural enemies, ants, and arthropods were also recorded.

Treatment applications

Spirotetramat was applied at EL stage 19 (24.10.2024) at both demonstration sites (Figure 126) at the recommended rate of 40 mL/100 L, with ethyl and methyl esters of fatty acids (Hasten®) added at 50 mL/100 L to enhance uptake.

At the mealybug trial site, predator releases were delayed due to a lack of visible mealybug activity until late October. Green lacewing (*Mallada signata*) larvae (at 2,000 adults/ha) were released in the final week of October, followed by a combined release of adult and larval *Cryptolaemus montrouzieri* in the third week of November (7 packs of 100 adults and 2 packs of 200 larvae).

At the scale insect trial site, both natural enemies were released (Figure 126) in mid-October as temperatures began to rise and scale insect crawler activity was first observed (Figure 127).

The natural enemies were released at the same rate at both demonstration sites as suggested by the natural enemy suppliers, BugsforBugs.



Figure 125. Green lacewing (*Mallada signata*) adult. Photo: Sonya Broughton, Department of Agriculture and Food, Western Australia, Bugwood.org.



Figure 126. Spirotetramat application (left) and beneficial insect release (right) at the demonstration sites.

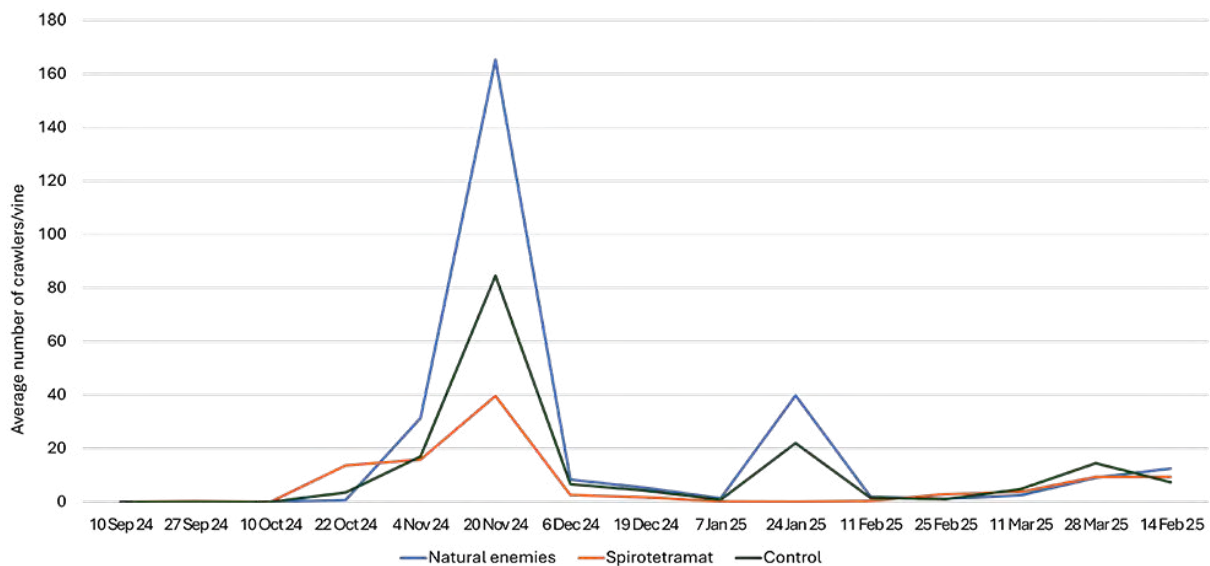


Figure 127. Scale insect crawler activity at the scale insect demonstration site during the 2024–25 season in Yenda.

Results

Mealybug control (Traminer block)

Mealybug activity in the Traminer block remained at almost zero until mid-December, after which populations rose sharply (Figure 128). This cryptic and unpredictable nature of mealybug populations has been noted in other studies (e.g. Lo and Walker 2011; Arturo et al. 2020). The sudden surge highlights the importance of both regular monitoring and timely interventions, particularly in vineyards with a history of infestation.

With this season’s monitoring data showing that mealybug numbers remained negligible until mid-December, the grower avoided unnecessary spraying in the remainder of the block (outside the demonstration trial area). Yield did not decrease and fruit quality was acceptable, highlighting the importance of using monitoring data to guide chemical interventions, rather than applying them on a routine basis.

The crop in this block was harvested early, which might have helped limit the effect of the late-season mealybug activity. Later-maturing varieties or later-harvested blocks might be more affected by similar late population spikes, potentially posing a greater risk to yield and quality. Therefore, growers should always consider both the pest population dynamics and the crop’s phenological stage when making management decisions about cryptic pests such as mealybugs.

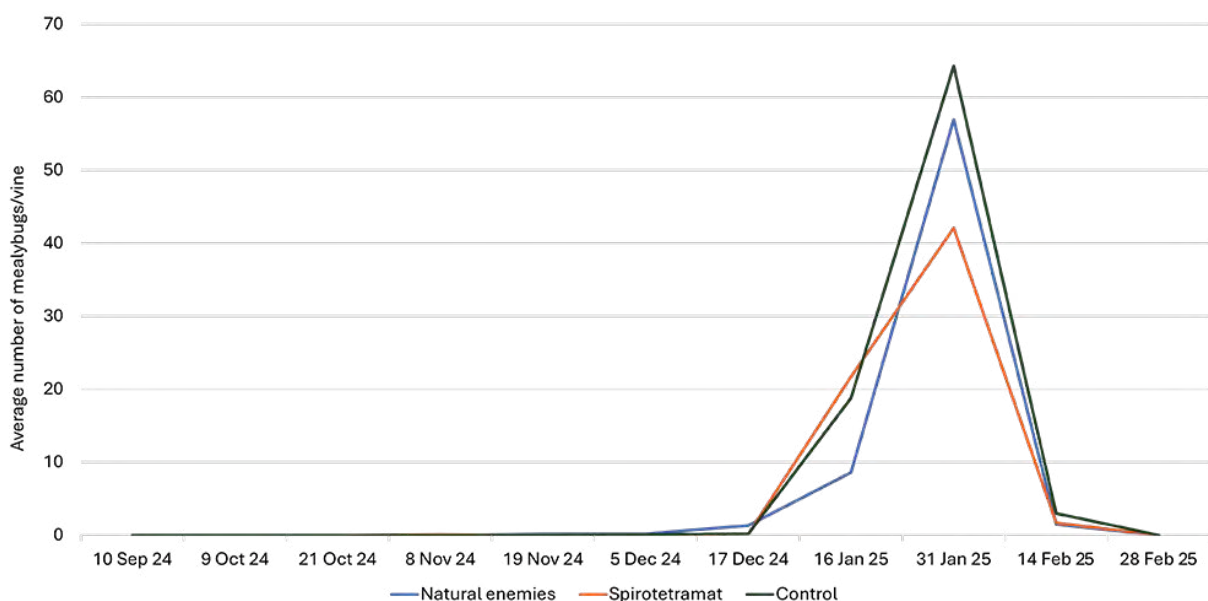


Figure 128. Mealybug activity during the 2024–25 season at the demonstration site in Griffith.

While the biological control and spirotetramat treatments appeared to reduce mealybug populations compared to the untreated control, particularly by lowering the proportion of heavily infested bunches, the differences were not statistically significant (Figure 129). This is most likely due to the relatively low pest pressure in the season and the high abundance of natural enemies, such as spiders and lacewings, in all plots.

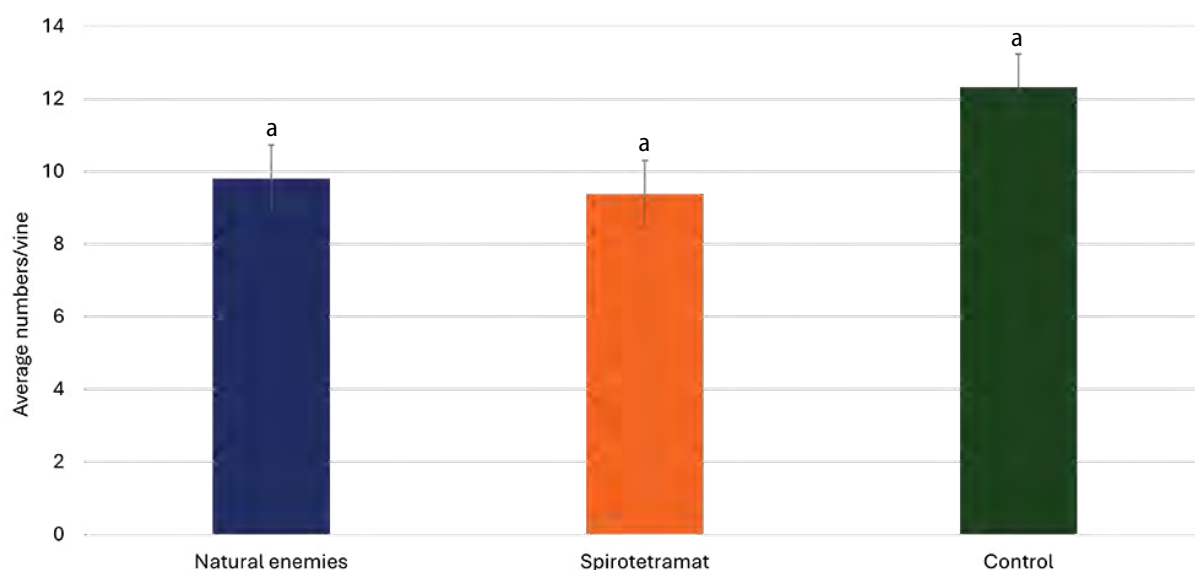


Figure 129. The average number of mealybugs per vine in different treatments. Bars labelled with a common letter are not significantly different ($P > 0.05$).

Mealybug activity was mainly confined to grape bunches (Figure 130), with very few individuals observed on leaves. The population declined once the bunches were harvested. By harvest, 42% of bunches in all blocks had some mealybug residue, with infestation levels ranging from light (≤ 5 mealybugs per bunch) to heavy (≥ 20 per bunch). Only long-tailed mealybugs were observed. In the untreated control, 21.7% of bunches were heavily infested, compared to 13.3% in the biological control block and 14.3% in the spirotetramat-treated block.

Although the biological control block showed a slightly greater reduction in severe infestations, the small plot size and uneven mealybug distribution limited a full assessment of its effectiveness. These results indicate that larger-scale insect trials are needed to fully evaluate the potential of biological control approaches.



Figure 130. A grape bunch (left) and leaf (right) infested with mealybugs.

Scale insect control (Chardonnay block)

In the Chardonnay block, sticky tape monitoring detected scale insect crawler emergence starting in late October, with peak activity in mid-November and a smaller peak in late January (Figure 127). This allowed for timely spirotetramat application (at EL19) and natural enemy releases.

Leaves were randomly collected from the tagged vines and assessed for scale insects at regular monthly intervals until 21 March 2025 (Figure 131). Leaf infestations increased steadily from December onwards in all treatments, but the rate and extent of increase varied. In the biological control rows, leaf scale insect counts continued to rise, peaking in March. In the untreated control rows, infestations also rose sharply but peaked in February before declining slightly by March. In the spirotetramat-treated rows, there was only a moderate increase, with counts remaining relatively low and stable from February onwards. These findings highlight that while crawler monitoring is essential for guiding early-season management actions, it might not fully capture scale insect population dynamics on foliage later in the season. Incorporating direct leaf inspections provides valuable complementary information to guide ongoing management decisions.

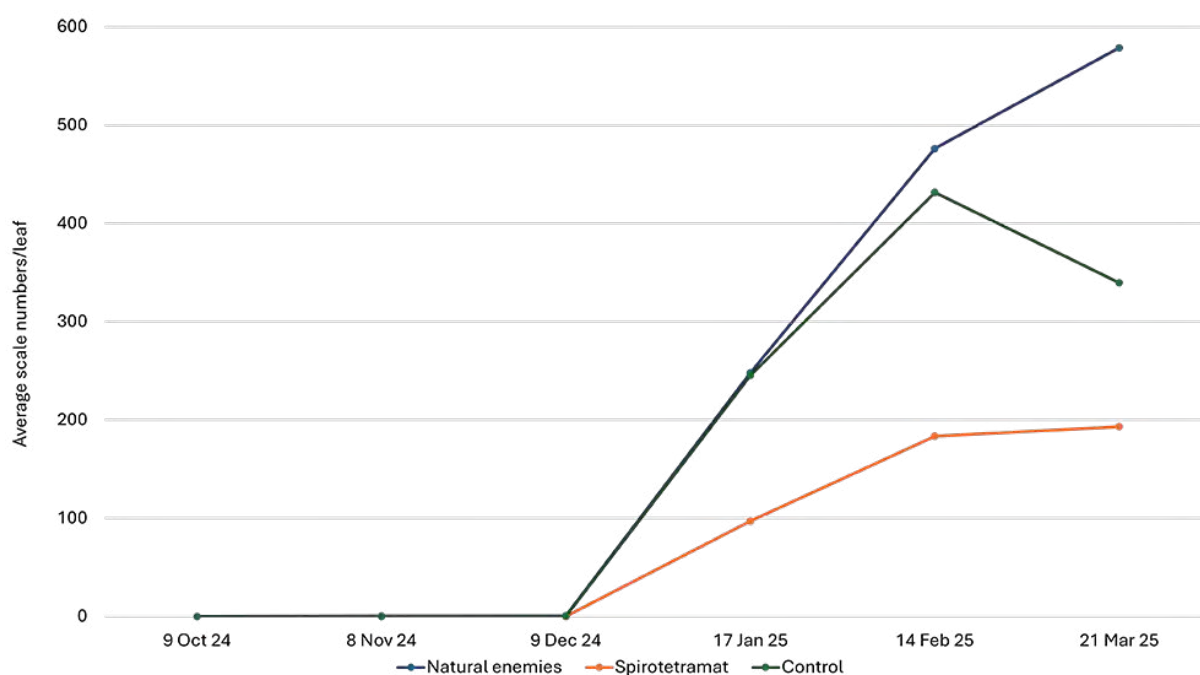


Figure 131. Scale insect counts on leaves at the demonstration site during the 2024–25 season.

Visual assessments confirmed the presence of grapevine scale (Figure 132) and frosted scale.

Despite higher post-treatment scale insect counts in the biological control block than the untreated control (Figure 133), this possibly reflects pre-existing population levels rather than treatment failure. Both treatments reduced scale insect numbers from pre-treatment levels, with spirotetramat achieving the greatest reduction. In the total scale insect counts (recorded during winter) on the trunk, cordons and spurs (Figure 134), spirotetramat reduced scale insect numbers by approximately 60%, while biological control reduced them by around 50%. The untreated control block showed only a modest reduction. These differences reflect the initially uneven infestation levels, as both the biological control and spirotetramat-treated blocks had higher pre-treatment scale insect pressure than the control block. Ant activity was also more prominent in these blocks, especially on heavily infested vines, potentially disrupting predator performance in the biological control rows.



Figure 132. Grapevine scale on grapevines.

In the untreated control, scale insect numbers remained relatively stable, suggesting some level of natural suppression by beneficials or environmental factors.

These results show that targeted treatments in hotspot areas can improve control efficacy against scale insects, reduce unnecessary pesticide use, and support beneficial insect activity.

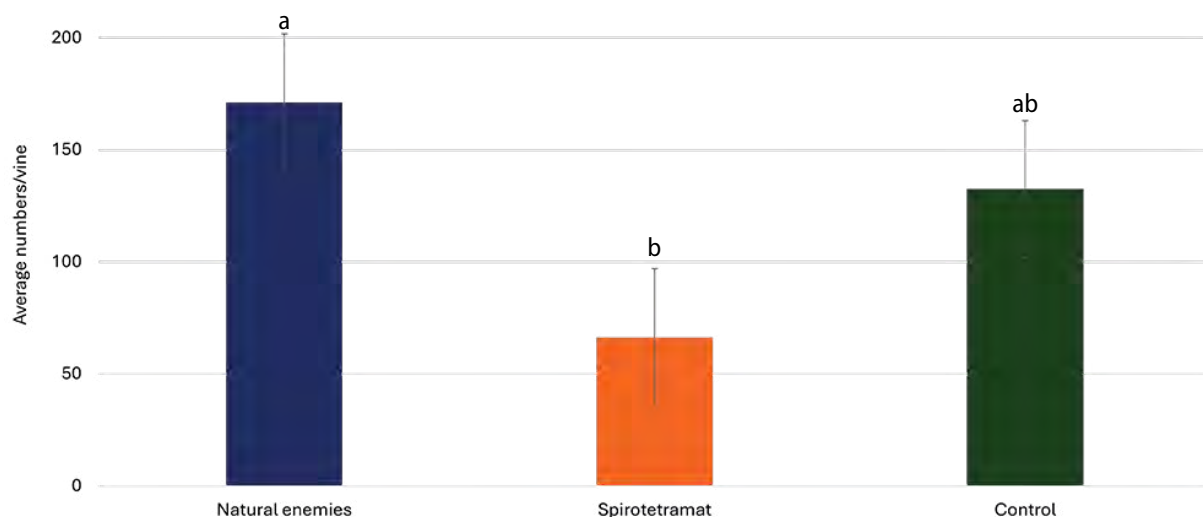


Figure 133. The average number of scale insects per vine in different treatments. Bars labelled with a different letter are significantly different ($P < 0.05$).

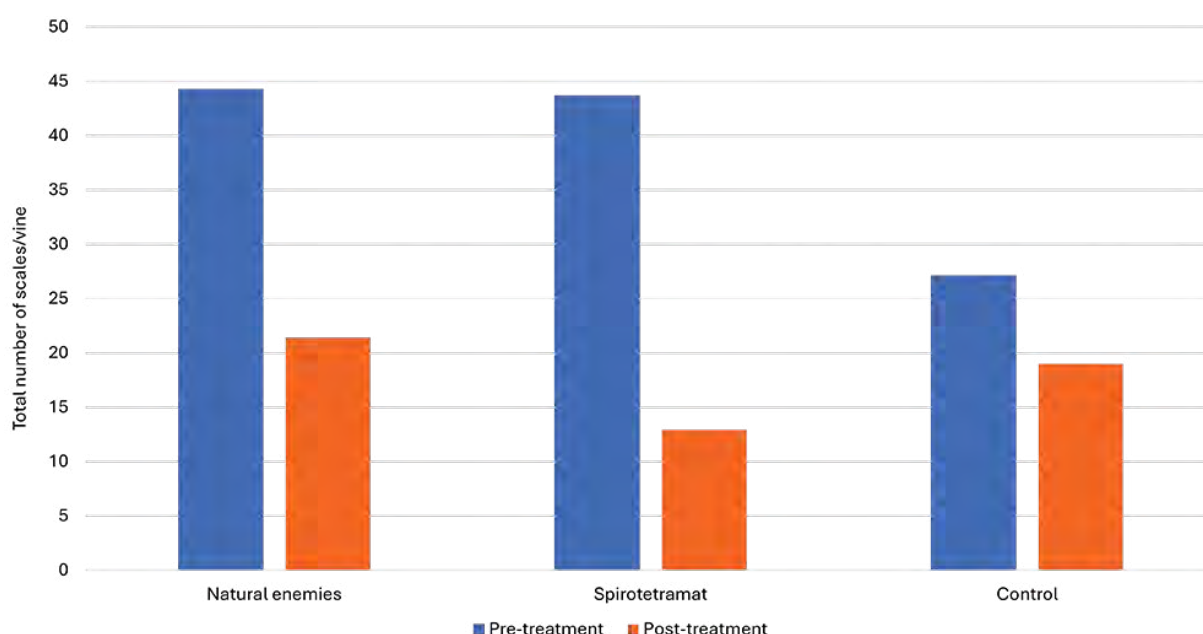


Figure 134. The average number of scale insects per vine before and after the treatments.

Ant activity

At the mealybug trial site, ant presence averaged 8–10 ants per vine. This remained relatively consistent throughout the season, although activity was mostly confined to end-of-row posts and did not appear to overlap with predator release areas, suggesting minimal effect on biological control efficacy. In contrast, ant activity was more prominent at the scale insect demonstration site, with ants observed sheltering under bark during pre-treatment assessments. Ant activity increased as the season progressed, with estimates rising from around 8–10 ants per vine early in the season to approximately 15–20 ants per vine later. Although exact counts were not recorded, higher ant numbers were generally observed on vines with heavier scale insect infestations, suggesting a possible link between ant and scale insect activity, potentially hindering predator effectiveness.

These findings suggest that managing ants, particularly in high-pressure scale insect blocks, could improve biological control outcomes.

Other arthropod activity

In addition to monitoring scale insect and mealybug populations, several other arthropods, both beneficial and pest species, were recorded. Predatory arthropods such as lacewing eggs, spiders, and ladybird beetles were frequently observed, with peak activity in early to mid-summer (Figure 135 and Figure 136). Leafhoppers and blister mites were abundant at the mealybug demonstration site, with leafhopper numbers peaking in November before gradually declining later in the season. Other arthropods occasionally observed included assassin bugs, praying mantises, grapevine moths, katydid nymphs, grasshoppers, grapevine hawk moth caterpillars, damsel flies, parasitic wasps and ground beetles (Figure 137).

At the scale insect demonstration site, beneficial arthropod activity declined after December, although spiders and their webs remained consistently present. During pre-treatment scale insect assessments, a few African black beetles and grubs were also noted on grapevine trunks (Figure 138).

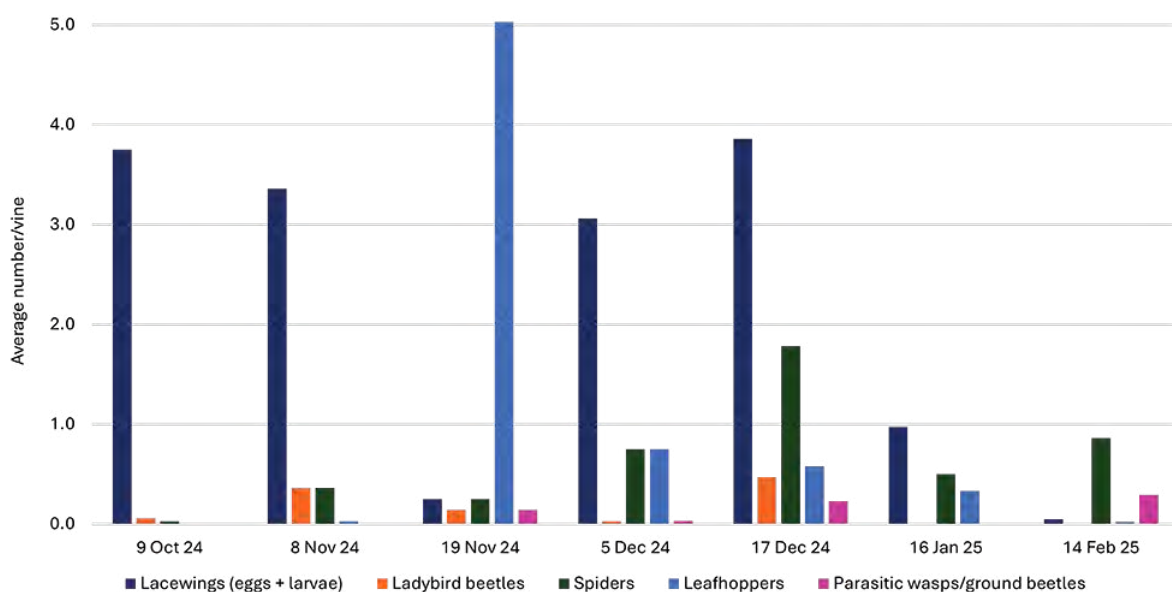


Figure 135. Other arthropods active at the mealybug demonstration site.

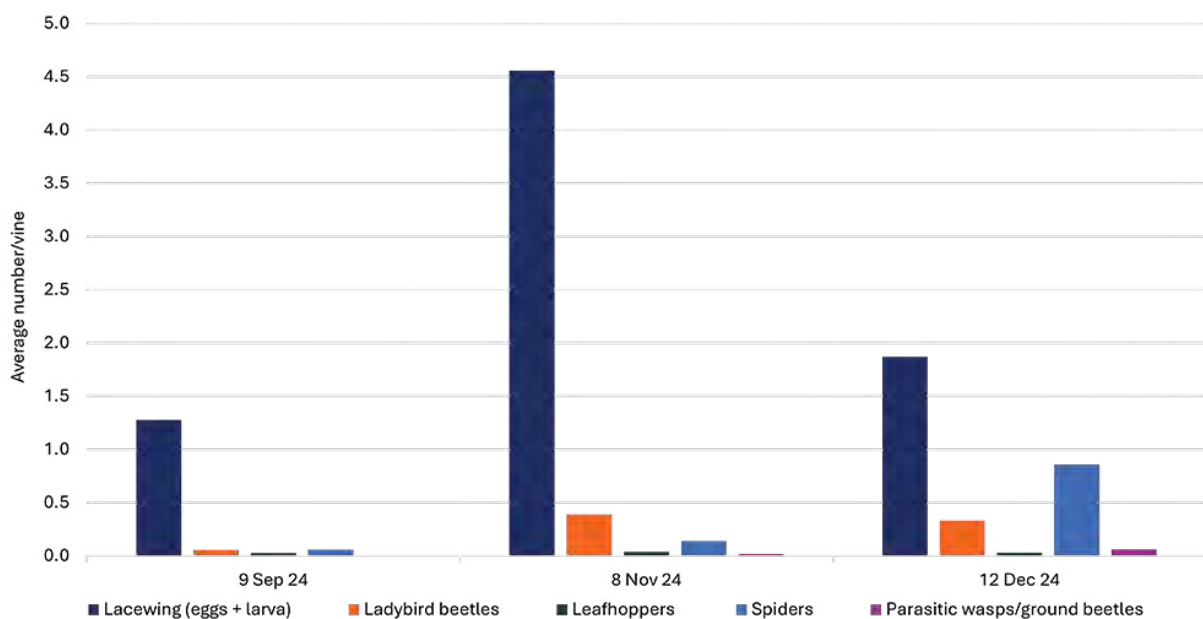


Figure 136. Other arthropods active at the scale insect demonstration site.



Figure 137. Other arthropods active occasionally at the demonstration sites.



Figure 138. Overwintering African black beetles on the grapevine bark.

Conclusions

These demonstration trials confirmed that biological controls, through targeted natural enemy releases, and chemical control using spirotetramat, were effective in reducing mealybug populations in Riverina vineyards. While treatment differences were not statistically significant, most likely due to low overall pest pressure and the limited size of the trial blocks, biological control plots had slightly fewer severely infested bunches, and spirotetramat was more effective in suppressing scale insect populations.

Monitoring results from the Traminer block further demonstrated that mealybug activity remained negligible until early December. This prompted the grower not to apply spirotetramat in the rest of the block (outside the demonstration trial area). Despite the absence of chemical treatment, there was no significant crop loss or excessive infestation at harvest, highlighting the value of monitoring-based decisions and avoiding unnecessary sprays in low-pressure situations. This block was harvested early, which might have limited the effect of the late-season mealybug surge. Later-harvested varieties could potentially be more affected.

These findings reinforce the need to align interventions with both pest pressure and harvest timing.

At the scale insect demonstration site, pre-treatment assessments revealed significantly higher initial scale insect numbers in the treated blocks. This high starting pressure might have reduced the relative effect of predators and underscores the importance of early scale insect detection and intervention in hotspot areas. In these situations, predators alone might not provide sufficient control, and a combined approach is recommended.

Natural enemies such as lacewings and spiders were active throughout the season, probably contributing to background suppression in all plots, including untreated controls. However, ant activity, especially in scale insect-infested vines, might have interfered with predator performance, reinforcing the need to manage ants as part of an integrated biological control strategy.

Recommendations

Release biological control agents early in the season, when pest populations are still low, to give them a chance to establish and suppress developing infestations. Releases should ideally cover entire vineyard blocks, especially in areas with a known history of mealybug or scale insect pressure, to maximise effect and reduce reinfestation risks.

Systemic insecticides such as spirotetramat should be used strategically, particularly in high-pressure blocks, and applied at key phenological stages for optimal uptake and efficacy. In highly infested vineyards, especially where scale insect or mealybug pressure has been consistently high, a postharvest chemical treatment might help reduce residual populations and limit carryover into the next season.

Base chemical intervention decisions for mealybugs on regular monitoring data and consider crop maturity stage when assessing potential risks from late-season pest surges. Avoid routine or calendar-based sprays in low-pressure seasons to conserve beneficials and reduce costs.

Regular monitoring of crawler activity, particularly for scale insects, is essential. However, due to their small size and cryptic nature, crawlers are easily overlooked during field inspections. Using double-sided sticky tape aids detection, but assessment often requires magnification. Engaging trained integrated pest management (IPM) professionals or experienced pest scouts can significantly improve monitoring accuracy and intervention timing for scale insects.

Prioritising treatment in identified hotspot areas, rather than broad-spectrum applications, can reduce overall pesticide use and support beneficial insect populations.

Incorporating ant management into vineyard IPM programs is critical, as ants can disrupt predator effectiveness, particularly in scale insect-infested vines. An integrated approach that combines timely biological releases, selective chemical use, and supportive practices such as ant control, offers the best chance for sustainable, long-term pest management.

Acknowledgements

Special thanks to Wine Australia's Regional Program 2023–2028, the Riverina Winegrape Growers Association, and the participating growers Greg Bonetti, James and Peter Cremasco for generously hosting the demonstration trials on their vineyards. We also acknowledge Kate Smith (Yenda Producers) for her valuable support and collaboration throughout the project.

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Crown gall in grapevines: emerging insights into crown gall-like symptoms in Australia

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Lauren Clackson, Technical Officer, Menangle, NSW

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Summary

Crown gall is a well-known plant disease characterised by tumour-like growths, historically linked to *Allorhizobium vitis* in grapevines. However, recent diagnostic work in NSW has uncovered a more complex picture, with multiple Rhizobiaceae species implicated in cane galls exhibiting crown gall-like symptoms.

Crown gall symptoms

Crown gall typically presents as tumour-like swellings on grapevine canes or at the base of the trunk. However, in the vine samples submitted for testing, the symptoms differed from classic crown gall, often originating internally and progressing to stem swelling, tissue rupture, and vascular damage.

Pathogen background

- Crown gall in grapevine has traditionally been attributed to *Allorhizobium vitis* (formerly *Agrobacterium tumefaciens* biovar 3), a member of the Rhizobiaceae family.
- All known crown gall pathogens belong to the Rhizobiaceae family, a group of bacteria capable of transferring tumour-inducing (Ti) plasmids into plant cells.
- Pathogenic Rhizobiaceae carry a Ti plasmid that integrates the host plant's DNA, triggering hormonal imbalances and opine production, which leads to tumour formation.
- The disease can affect over 600 plant species in 93 plant families.
- While some Rhizobiaceae species are host-specific, many are generalists that can infect a broad range of plants.

Diagnostic investigation 2022–2025

In 2022, NSW DPIRD received initial grapevine samples showing unusual gall-like symptoms (Figure 139 and Figure 140). Over the next 2 years, the number of submissions increased and 272 grapevine cane samples were assessed. Key findings include:

- PCR testing detected the pathogenic form of *A. vitis* in only one sample.
- Isolation and sequencing (*rpoB* gene) from 396 isolates revealed a diversity of Rhizobiaceae, including:
 - *Agrobacterium tumefaciens*
 - *Agrobacterium fabrum*
 - *Agrobacterium pusense*
 - *Agrobacterium radiobacter*
 - *Neorhizobium* spp.
 - *Agrobacterium* spp.
 - *Allorhizobium vitis*



Figure 139. Examples of submitted samples.



Figure 140. Examples of submitted samples.

While multiple Rhizobiaceae strains were isolated from affected tissue, their presence does not confirm pathogenicity. Further testing is required to determine which strains are actively causing disease, as many might be non-pathogenic or opportunistic.

Pathogenicity testing

Carrot disk assays and greenhouse trials on grapevine and sunflower plants were used to assess tumour formation. Results include:

- Several isolates of *Agrobacterium pusense* (Figure 141), *A. tumefaciens* (Figure 142), *A. radiobacter* (Figure 143), and *Neorhizobium* spp. (Figure 144) induced gall formation in pathogenicity assays, although the severity and consistency of symptoms varied between isolates.
- Isolates showed varied virulence; some caused only callus or no symptoms; others caused stem splitting and galling.
- *A. pusense*, *A. fabrum* (Figure 145) and certain *Agrobacterium* sp. (Figure 146; which require further identification) strains appeared particularly aggressive.

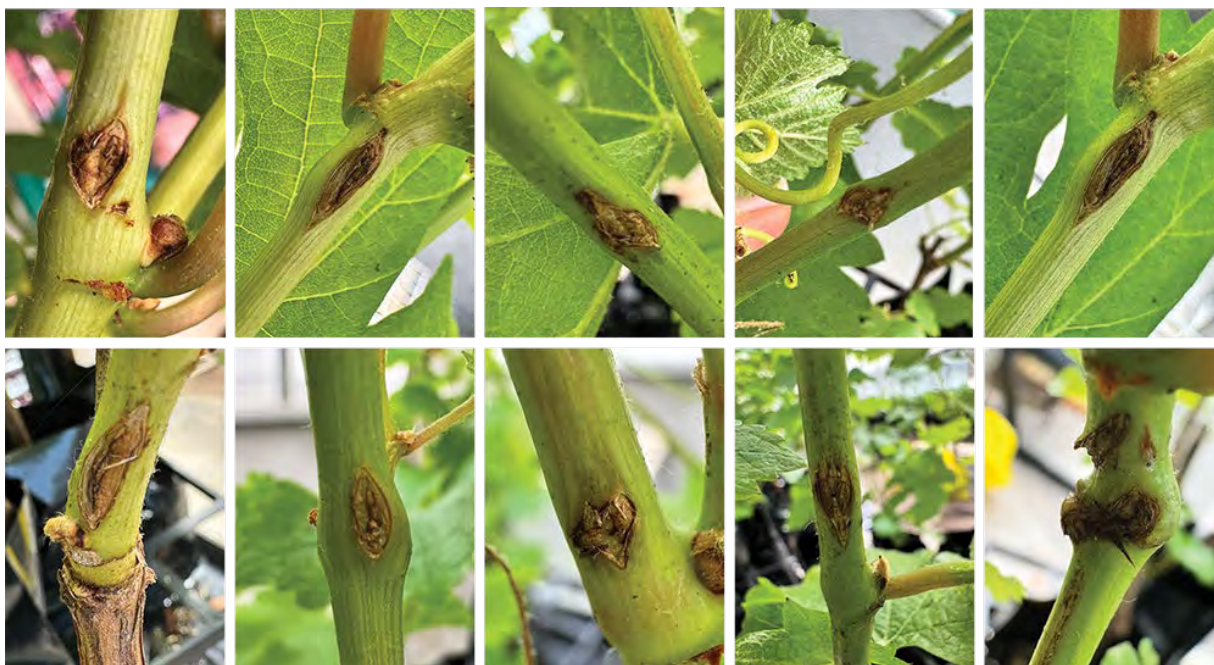


Figure 141. *Agrobacterium pusense*.



Figure 142. *Agrobacterium tumefaciens*.



Figure 143. *Agrobacterium radiobacter*.

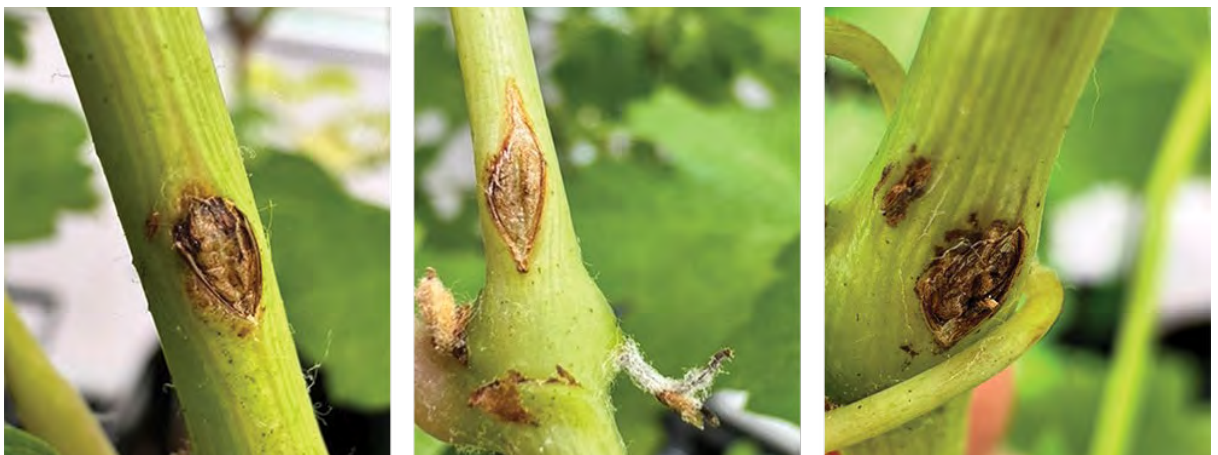


Figure 144. *Neorhizobium* spp.



Figure 145. *Agrobacterium fabrum*.



Figure 146. *Agrobacterium* sp.



Figure 147. *Allorhizobium vitis*.

Key findings

- The pathogenic form of *Allorhizobium vitis* (Figure 147) was detected in only 1/272 samples.
- Four additional *Agrobacterium* species were confirmed to cause gall-like symptoms.
- The taxonomy of crown gall pathogens is evolving.
- Environmental factors might influence disease expression and plasmid activation.

Implications for industry

- Crown gall is emerging as a concern for grapevine health.
- Traditional diagnostics might miss non-vitis pathogens.
- A national reference collection is critical in avoiding unnecessary biosecurity responses.

Next steps

- Ongoing surveillance is essential.
- Further work is required to determine pathogenicity.
- Improved diagnostics and industry awareness will help how the disease is managed.

Acknowledgements

This work was made possible through the collaborative efforts of the NSW DPIRD Plant Health Diagnostic Service, the Molecular Bacteriology Team, NSW DPIRD Plant Pathology and Mycology Herbarium and field officers. Special thanks to technical experts, including Perrine Poitier (CIRM CFBP, INRAE, France) for guidance on media selection and molecular tools and Regina Baaijens (Affinity Labs, SA) for providing primer sequences for testing for *A. vitis* detection.



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Fire ants and viticulture

Ian Turnbull (Invasive Invertebrates Program Lead), Tommy Wainwright (Communication and Engagement Officer) and Robyn Henderson (Policy and Project Officer)

The potential economic and ecological effects of *Solenopsis invicta* (fire ants) on viticulture are largely unknown.

In similar primary production applications, fire ants will:

- attack young trees, damaging roots, bark, and flowers, reducing fruit set
- farm sap-sucking insects, worsening infestations
- nest in plantations, attack workers, and disrupt harvesting operations
- in citrus, they nest around the base of young trees, feeding on bark, new shoots and cambium, often killing trees
- require treatment, which might affect organic export certification
- cause electrical failures in irrigation and farm machinery, increasing costs
- cause millions in annual damage to roads, farm infrastructure, fencing and irrigation systems
- cause public liability issues for retail and tourism operations.

What are fire ants?

- Red imported fire ants (*Solenopsis invicta*) are invasive, destructive and native to South America.
- They are small (2–6 mm; [Figure 148](#)), with different-sized ant workers in each nest. By comparison, the red bull ant can be up to 30 mm long.
- They have a dark reddish-brown with a darker brown-black abdomen ([Figure 149](#)).
- Aggressive, swarming in large numbers and stinging repeatedly when disturbed.
- Nests range from flattish patches to mounds of soil ([Figure 150](#)) up to 400 mm high, with no obvious entry or exit hole.
- Fire ants have the potential to cost Australia \$2 billion annually if they become established.
- In NSW, *Solenopsis invicta* are **prohibited matter** in the *Biosecurity Act 2015*. They are a reportable species and can only be treated by authorised officers.
- Biosecurity is a shared responsibility. Let's work together to stop fire ants by staying vigilant and reporting sightings.



Figure 148. Various sizes of fire ants on a 10 cent coin.



Figure 149. Observing *Solenopsis invicta* (fire ants) in the laboratory at the National Fire Ant Eradication Program headquarters, Berrinba, Queensland.

Biosecurity (Fire Ant) Emergency Order is in place:

The Department published Biosecurity (Fire Ant) Emergency Order (No. 2) 2025 on 13 February 2025.

If you are moving the defined fire ant carriers (see list in the next paragraph) from the parts of QLD and NSW shown in red, orange or yellow on [this map](#), you must comply with the current Emergency Order. View the current [order](#) and [plain English guide](#).

Fire ant carrier materials: heavy vehicles, agricultural and horticultural equipment, earth moving equipment, pallets, packaging, containers and covers, building waste, green waste, mulch, soil, compost and manure, growing media, soil samples, hay silage and chaff, turf, potted plants, including indoor potted plants, excavated plants and stumps, sand, rocks and stones, recycled concrete aggregate (under 20 mm diameter), rocks and stones, recycled concrete aggregate (over 20 mm diameter), and coal fines.

If you suspect the presence of fire ants:

- **Leave it:** do not destroy or treat the nest; fire ants are prohibited matter in NSW.
- **Snap it:** safely take a clear photo or video for identification.
- **Call it:** call the helpline on 1800 680 244 or submit an [online form](#) (www.dpi.nsw.gov.au/fire-ants)

Links

Map: <https://www.dpi.nsw.gov.au/dpi/bfs/insect-pests/rifa/maps-of-infestations-and-zones>

Order: <https://www.nsw.gov.au/departments-and-agencies/dpird/our-agencies/agriculture-and-biosecurity>

Plain English guide: <https://www.dpi.nsw.gov.au/fire-ant-plain-english-guide>



Figure 150. A typical fire ant nest mound. Nests range from flattish patches to mounds of soil up to 400 mm high, with no obvious entry or exit hole.



Xylella fastidiosa – the silent invader

Leonie Martin, Plant Biosecurity Officer – Plant Pest Response, NSW DPIRD

Xylella fastidiosa is a bacterial pathogen that is a significant threat to global agriculture and ecosystems. Known for its ability to infect a wide range of plant species, including grapevines, citrus and olive trees, this bacterium has caused devastating outbreaks worldwide. The first major epidemic in Europe was reported in 2013, affecting olive trees (Figure 151) in southern Italy.

Since then, extensive eradication and containment efforts have been undertaken throughout Europe, including mandatory surveys, vector control strategies, and destroying infected plants.

The International Olive Council (IOC) has been leading these efforts, promoting education and sustainable management practices through projects such as 'Beyond Xylella (BeXyl), an integrated management strategy for mitigating *Xylella fastidiosa* impact in Europe'. The European Food Safety Authority (EFSA) has also conducted scientific reviews and education programs on *Xylella fastidiosa*. In 2024, the EFSA updated the *Xylella* spp. host plant database, with the number of host species now reaching 713 plants.

These collaborative initiatives highlight the importance of early detection, rigorous monitoring, and international cooperation in combating *Xylella fastidiosa* and preventing future outbreaks.



Figure 151. *Xylella fastidiosa* in grapevines at a vineyard in California, 2016. Photo: Smith Collection/Gado/Getty images.

Learning from overseas

Reports from overseas highlight some key issues that need to be considered, which will affect how Australia manages *Xylella fastidiosa*.

Xylella fastidiosa is a serious pathogen of some species, but it can also coexist with many hosts and not cause them harm. Hence, many plants, including natives, ornamentals, and crops, might be long-term sources for vectors to get the pathogen and continue its spread.

Insect vectors have a wide host range and can disperse long distances in short hopping flights. They can be persistent in various climates and often overwinter as adults. Once a vector acquires *Xylella fastidiosa*, it can inoculate plants for the rest of its life as an adult.

There can be a significant lag in detection time, depending on the host species, and some species might not display symptoms. There is no known cure for *Xylella fastidiosa* infection. Once a plant is infected, response strategies are limited to removing or containing the infected host.

The longer it takes to detect *Xylella fastidiosa*, the harder the outbreak will be to manage.

Keeping *Xylella fastidiosa* out of Australia

While Australia remains free of *Xylella fastidiosa*, the threat it poses to agriculture and the environment is significant. The [National Xylella Action Plan](#) (2019–2029) outlines a comprehensive strategy to prevent it from entering and establishing in Australia, as well as to promote investment in research. This plan emphasises the importance of collaboration among stakeholders, including government agencies, agricultural industries, growers and research organisations. Key measures include stringent biosecurity protocols, regular surveillance, and public awareness campaigns to ensure early detection and rapid response.

Education and awareness

Education and awareness are essential to ensure growers and others in the industry are aware of *Xylella fastidiosa* and its implications for their property, vineyard, enterprise, and community.

The first *Xylella fastidiosa* public awareness campaign was run in NSW in March this year to promote the importance of early detection and reporting of suspected symptoms. The *Xylella fastidiosa* awareness week will be held annually, and hopefully, it will become a national campaign to increase people's knowledge of it and highlight some of the management issues that will be faced when dealing with this disease.

To increase collaboration between government and industry on how this disease might be managed, industry workshops will continue. These workshops are designed to provide information about the disease to producers and to help them understand aspects of at-risk plant industries when responding to a *Xylella fastidiosa* outbreak. So far these workshops have been delivered to almond and viticulture growers and have been well received. More will be delivered to different industry sectors.

The most likely ways for *Xylella fastidiosa* to come to Australia include:

- Importing infected plants or planting material such as budwood, cuttings or rootstock; these plants are unlikely to be displaying symptoms at the time of import.
- Insects infected with the disease. Two exotic plant-feeding insects of concern are the glassy-winged sharpshooter (*Homalodisca vitripennis*) and the meadow spittlebug (*Philaenus spumarius*). These are also subject to biosecurity measures to keep them out of Australia.

Preventing *Xylella fastidiosa* from entering your property

Source plants carefully: only buy plants from reputable suppliers who provide plant health certificates. Avoid sourcing plants from regions known to have *Xylella fastidiosa* outbreaks.

Inspect new plants: before introducing new plants to your property, thoroughly inspect them for any signs of disease. Look for symptoms such as leaf scorch, wilting, or dieback.

Maintain good hygiene: clean and disinfect tools and equipment regularly to prevent pathogens from spreading. Ensure that any plant material or debris is disposed of properly.

Implement biosecurity measures: establish biosecurity protocols, such as controlling access to your property and using footbaths or vehicle wash-downs to reduce the risk of introducing the bacterium.

Conducting surveillance for *Xylella fastidiosa*

Regular monitoring: inspect your plants regularly, especially those known to be hosts of *Xylella fastidiosa*, such as grapevines, citrus and olive trees. Ornamentals such as lavender and *Polygala myrtifolia* are also good sentinel species.

Use diagnostic tools: if you notice unusual symptoms on plants that you suspect could be *Xylella fastidiosa*, collect samples and contact NSW DPIRD using the methods outlined below.

Follow survey guidelines: in addition to regularly checking crops, conduct regular sweep netting to check for the presence or absence of potential insect vectors. While *Xylella fastidiosa* vectors, such as the glassy-winged sharpshooter ([Figure 152](#)) and meadow spittlebug ([Figure 153](#)), are exotic and not present in Australia, it is essential to remain vigilant because early detection is our best chance for managing this disease.

Exotic insect vectors



Figure 152. Glassy-winged sharpshooter. Photo: Reyes Garcia III, USDA Agricultural Research Service, Bugwood.org.



Figure 153. Meadow spittlebug. Photo: Anevrisme, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=2542344>.

Report suspect insects or plant symptoms immediately by:

- Calling the Exotic Plant Pest hotline on **1800 084 881**.
- Using the [online form](https://forms.bfs.dpi.nsw.gov.au/forms/9247) (<https://forms.bfs.dpi.nsw.gov.au/forms/9247>)
- Emailing biosecurity@dpi.nsw.gov.au

By following these preventive measures and surveillance strategies, you can help protect your property and contribute to the broader effort to keep *Xylella fastidiosa* out of Australia.



Managing *Xylella fastidiosa* if detected

If *Xylella fastidiosa* were to be detected in Australia, immediate and decisive action would be crucial. NSW DPIRD is currently co-developing a response strategy with industry to provide guidance on the options available in the event of an outbreak. Continued research into potential native insect vectors and improved diagnostic tools is ongoing and will play a vital role in managing a *Xylella fastidiosa* outbreak. Public reporting of suspicious symptoms and adhering to biosecurity measures by farmers, gardeners, and travellers are essential components of the national response.

For more information, including what to look for, refer to the NSW DPIRD publication: [Xylella fastidiosa: on-farm preparedness guide for vineyards](https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0008/1584575/Xylella-on-farm-preparedness-guide-for-vineyards.pdf) (https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0008/1584575/Xylella-on-farm-preparedness-guide-for-vineyards.pdf).

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Xylella case study

Viticulture, California, USA



Background

Xylella fastidiosa was first detected in grapevines in southern California in 1884, known then as Pierce's disease. It took nearly a century to be recognised as a bacterium. Transmission occurs via grafting and insect vectors such as the glassy-winged sharpshooter *Homalodisca vitripennis*.

No formal response was launched to combat *Xylella fastidiosa* in vineyards, given the timing of its detection. Years of investigation have contributed to a greater understanding of the disease and its management options.

Outcome

Infection has led to the decline of more than 14,000 ha of vineyards in southern California. Costs to the Californian industry alone are estimated at US\$100+ million in crop losses and a further US\$50 million in preventative and control measures per year.

Management of *Xylella fastidiosa* in infected areas includes using clean inputs for production systems, management of non-crop hosts, physical and cultural crop management practices and vector control programs (both chemical and biological).

At a glance



Australia exports
621 ML wine



Industry valued at
\$45.5 billion



2156 wineries in
Australia



Vines have a
commercial life of
30 to 50 years

Challenges

- *Xylella fastidiosa* is a key limiting factor for viticulture expansion in the USA.
- Symptom severity varies between cultivars.
- Lag in detection time of several months.

Control options

- Remove/prune infected plants.
- Control insect vectors.
- Manage weeds (vector habitat).
- Hot water treatment.
- Irrigation regulation to deter vectors.

Source: Wine Australia

Australia is the 5th largest wine producer globally with some vineyards dating back to the mid-800s





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Farms of the **FUTURE**



Farms of the Future is dedicated to supporting farmers in adopting technology to enhance productivity, improve market competitiveness, and optimise resource management. By focusing on advancing digital skills in farming, promoting the use of IoT devices, and connectivity solutions, the program aims to boost both productivity and sustainability, while fostering engagement with the Agtech industry.

Training & Education

Our training helps farmers pinpoint the right Agtech and connectivity solutions for their property, assess operations and develop a personalised Monitoring Plan – delivered face-to-face or via our online education platform (short courses, case studies and podcasts). Plus, our Mobile Learning Bus is touring NSW to bring hands-on support directly to regions.

Agtech Demonstration Hubs

Agtech Demonstration Hubs are being established at 10 NSW DPIRD research stations, as well as partner farms and universities. These hubs offer the chance to witness Agtech in action on real farms, managed by a team of Agtech Specialists who provide independent support across the state.

Agtech Toolbox

The Agtech Toolbox is a comprehensive online resource for exploring Agtech products and researching suppliers. This platform also features case studies, blog articles, and information on upcoming Agtech events and training opportunities, offering everything needed to make well-informed decisions for farm businesses. Visit: www.agtech.dpi.nsw.gov.au.

Agtech Events

Across NSW we run Agtech Alley – our headline exhibition at major field days – where leading suppliers demonstrate the latest technologies. We also host targeted field days and Demonstration Hub open days to share know-how and build confidence in Agtech adoption.



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