



What sustainability may look like for the maturing berry industry of Australia

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Executive Summary

Berry production in Australia has evolved significantly since its origins in Tasmania in the early 1800s. Berry production increased to service the jam industry, and it wasn't until the mid-20th century that the commercial fresh berry market emerged. During the later part of the 20th century the popularity of *Rubus* (raspberries and blackberries) and blueberries increased. This period also saw a shift from small, family-owned farms to larger-scale, corporate farming operations.

From the 1990s onward, technological advancements—such as tunnel infrastructure, substrate growing, and improved genetics—enabled a significant lift in production and fruit quality, supporting further market expansion. Growth in the industry continued and between 2013 and 2023, *Rubus* production increased by 498%, and blueberries by 320%, reflecting the sector's rising market relevance.

The 2020s has seen the rate of market growth slow, and the berry industry beginning to consolidate. Challenges like continued increasing volumes, Covid-19 and high inflation have put pressure on the berry sector of Australia, which is now approaching maturity.

The growing system has changed drastically over time. The materials required to grow berries has increased, with the inclusion of pots or bags, growing media and tunnel plastic. Farms have scaled up, intensified growing practices and the market is maturing. Grower's focus has shifted away from supplying ever-increasing volumes and more towards optimising their current systems and profitability.

Sustainability can be categorised into three pillars; economic, social and environment, while they are separate, they are often intertwined. As profitability becomes harder to maintain in the berry industry, the capacity for growers to invest in sustainability is limited. While there is a strong desire among growers to care for the environment, many lack the scale, capital, or knowledge to implement long-term sustainable practices. Consumers indicate sustainability is important, however market research indicates this does not translate to a market opportunity.

Across global markets, sustainability is increasingly driven by policy, supply chain expectations, and market access, rather than direct consumer demand.

Policy can be a useful tool for fast tracking action and may be employed to influence sustainable farming practices. Policy can be beneficial but should not be the primary driver for making sustainability decisions in the berry industry. The definition of sustainability may differ between growing regions. To ensure growers' voices are considered in policy creation, engagement with organisations like Berries Australia, local grower groups, and government bodies is essential.

Sustainability efforts should be grounded in practical experience, local conditions, and shared accountability across the supply chain.

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Australian agriculture must adopt a locally tailored approach to sustainability. Global examples show that poorly aligned or overly prescriptive policies can harm farm viability. Growers must understand their interaction with ecosystems and communities and work collaboratively with supply chain partners to set and achieve practical sustainability goals.

As the industry enters market maturity, it's critical to explore new opportunities, such as export growth and product differentiation, while also addressing sustainability across the supply chain. Collaboration is central to the future of the Australian berry industry. Many of the challenges growers face—such as labour, sustainability, and rising input costs—are not unique to berries. Engaging with other growers, industries, and stakeholders can accelerate problem-solving, reduce costs, and drive innovation.

There is growing recognition of the need for tools to measure biodiversity and ecosystem health at the local level, as well as technologies to improve water and fertiliser efficiency. Investment in decision-making tools, monitoring systems, and innovation will help farms reduce waste and improve environmental outcomes.

The labour-intensive nature of berry farming presents a significant opportunity for technology and robotics adoption. With support from industry and research partners, new technologies can be assessed and brought to market more quickly, helping growers remain competitive and resilient.

The Australian agriculture sector has a reputation for being innovative and adaptable. By embracing collaboration, knowledge-sharing, and continuous improvement, the Australian berry industry can navigate the challenges of maturity and lead in both innovation and sustainability.

Keywords: Berry, Sustainability, Horticulture, Change, Biodiversity, IPM

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Foreword

A love of the outdoors and an interest in science and sustainability lead me to a career in agriculture. Not coming from a farming background, I was first introduced to agricultural science at school in year 11. I participated in a program which illustrated how science, food production, sustainability and working outdoors could all be combined to create an engaging, practical and meaningful career. After college, I studied a Bachelor of Agriculture at the University of Tasmania.

Post my studies I travelled and explored various areas of agriculture. I was drawn to horticulture for its diversity, people and pace. After a stint in the grains industry, I was excited to become involved on farm and get my “hands dirty”, so to speak. I accepted a position with Costa to grow avocados and berries.

Prior to applying for a Nuffield scholarship, I was nearing five years working with Costa. In my role as a horticulturalist, I have been involved in managing the growing system. I have been responsible for overseeing the integrated pest and disease programs, pollination, canopy management, tunnel management, production strategy and capital projects. Over this time, I observed the growing system move away from soil grown production to substrate systems and a change from tunnel plastic being used for a portion of the year to being left up year on year. With these changes the environment within the tunnels began to change.

The 2020's have been turbulent times for the Australian berry industry. Covid-19 brought about labour and logistical challenges. Geopolitical issues impacted supply availability and price. The post-covid period has seen drastic inflation and a significant increase in the cost of living. The berry industry moved from an industry experiencing high growth and technological change to entering maturation quickly. As an early career horticulturalist during this time, it was an interesting time to consider what the priorities for our growing system were and to be a part of a significant step change for our farm.

After several seasons growing in substrate and maintaining the tunnel plastic on all year, the ecosystem was changing. What pasture was growing in the rows died out, the pest profiles were changing, and new pests were entering the system. Black Vine Weevils were now able to have multiple lifecycles in a year, whereas in the open soil environment only one lifecycle per year was evident. Pests like Raspberry Leaf and Bud Mite, Pasture Tunnelling Moth, Western Flower Thrips and Bronze Leaf Beetle entered the system. Mirid populations grew and the need to manage them to prevent fruit losses increased, however not without interrupting the integrated pest management programs in place. Secondary pests like mealy bugs and leaf hoppers began to cause more of a problem.

While I was astutely aware of the economic climate we were operating in, as a grower responsible for the physical environment in which we operate, I felt it was time to reflect on our growing practices. At the time I was beginning to reflect on our system and think about what our future growing goals might look like, the opportunity to undertake a Nuffield Scholarship arose.

Initially I wanted to investigate biodiversity management in intensive horticultural systems. I knew that mandatory reporting for biodiversity on farms had been introduced in Europe, and I thought I may learn direct ways to improve the challenges

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I was seeing in the system I was responsible for. Although, while I was having interesting conversations and field walks with entomologists, agroecologists, researchers and various people employed in sustainability roles; I felt I was missing the grower context and perspective. I changed my area of focus to understand what sustainability, especially environmental sustainability, looks like for growers operating in mature markets.

On my independent travels, I visited California (particularly Watsonville region); The UK- Kent area, midlands and Scotland; Ireland, The Netherlands and Germany. The areas were selected because the markets are mature, and the growing environments are somewhat like Tasmania.

The following report reflects my thoughts throughout my Nuffield journey. While I have learned a great deal through my Nuffield experience, I am writing through a horticulturalist perspective, and I am not an expert in the areas I have covered. It is my hope that the following report is thought provoking rather than instructive and stimulates a conversation around what sustainability might look like for the Australian berry industry.

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Table 1. Travel itinerary

Travel Date	Location	Visits
3/03/2024-9/03/2024	Canberra	Australia Focus Program
10/03/2024-24/03/2024	Brazil	Contemporary Scholars Conference
25/03/2024- 29/03/2024	California	Cassin Ranch, Watsonville Accompanied Diego- Various farm visits around Watsonville TRIC Robotics- Santa Maria
2/06/2024- 7/06/2024	Indonesia	Global Focus Program
8/06/2024- 15/06/2024	France	
16/06/2024-22/06/2024	Denmark	
23/06/2024-01/07/2024	California	
2/07/2024-9/07/2024	Chile	
3/08/2024- 9/08/2024	United Kingdom	Driscolls Offices, Labs- East Malling Driscolls Test Plot- East Malling Berry Gardens Growers Test Plot, Maidstone Clock House Farm, Maidstone Berry Gardens Growers Blackberry Field Day- Scotland Castleton Farm, Aberdeenshire Colbeggie Farm, Blairgowrie WET Centre- East Malling Driscolls plant breeding facility- East Malling
10/08/2024-12/08/2024	Republic of Ireland	Keelings Farms, Surrounding Dublin Dennis Wilson, Delphy Agronomist
13/08/2024- 17/08/2024	Netherlands/ Northern Germany	Legro Facility, Helmond Thivan Van Gennip Farm Koppert, Berkel en Rodenrijs World Horti Centre, Honselersdijk Van der Avroird Trayplant nursery, Bavel Farm visits with Klaas Plaas (Farms visited: Mammen, Beneke, Buhrmann, Poelman, Jong Hoebe, Meinardi, Flevoberry, Hindriksen)

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18/08/2024-23/08/2024	United Kingdom	Angus Soft Fruit, Arbroath, Scotland- Grower sustainability workshop Littiwood Farm, Stafford, UK- Ever bearer and Reyna field day ParkView Farm, Lichfield, UK
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Acknowledgments



Figure 1: Photo illustrating a partial cohort of people I wish to acknowledge (Source: Nuffield Farming)

This incredible opportunity would not have been possible without the unwavering support of my partner, Tom, who held down the fort at home while I was away. He patiently endured my early mornings and late evenings, accommodating meetings with people across the Northern Hemisphere. Tom, thank you for your endless encouragement, your belief in me, your calm demeanour, and your constant support.

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I am sincerely grateful to Nuffield Australia for believing in me and providing the opportunity to learn and grow alongside such incredible scholars. A special and heartfelt thank you to my sponsor, Hort Innovation Australia, not only for their exceptional support of the Australian Berry Industry but also for investing in me and for helping me build connections. Thank you also to the team at Berries Australia for their encouragement throughout this journey and for sharing my updates in the Berry Journal. A special mention to Jane Richter and Ella Roper for their ongoing support.

A huge thank you to the Costa Berry team, particularly to Cameron Folder, Rohan Kile and Steven Welsh for enabling me to undertake the Nuffield program and for their continued support. A special mention to my colleagues—Robert Saggus, Emma Nightingale, Venkatesh Telu, Bradley Anderson, Matthew Archer, and Braiden Aitkin—whose support and willingness to step up and cover for me while I was away has been invaluable. Your help has made this experience possible, and I am deeply grateful.

Thank you to Driscoll's Australia and the Driscoll's Global team for generously sharing their knowledge and connecting me with businesses around the globe. A special

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mention to Sally Kershaw and Paul Keutaneus, who played a key role in connecting me with global contacts.

Thankyou to my colleagues and Wade Mann (2015 Nuffield Scholar) for reviewing my report, asking questions and offering suggestions for improvement.

Lastly, I would like to thank all the generous people who gave me their time and allowed me insight into their businesses and perspective. I hope to repay your kindness in the future.

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Abbreviations

Abbreviation	Extended Form
ABGA	Australia Blueberry Growers Association
AUD	Australian dollar
CAP	Common Agricultural Policy
DAFF	Department of Agriculture Forestry and Fishing
DAFF	Department of Agriculture Fisheries and Forestry
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DEFR	Department for Environment, Food and Rural Affairs
EU	European Union
FTF	Farm to Fork
HIA	Hort Innovation Australia
IPDM	Integrated Pest and Disease Management
IPM	Integrated Pest Management
NIAB	National Institute of Agricultural Botany
NPK	Nitrogen, Phosphorous, Potassium
PE	Polyethylene
PET	Polyethylene terephthalate
R&D	Research and Development
RABA	Raspberries and Blackberries Australia
Rubus	Raspberries and Blackberries
SAI	Strawberries Australia
SDG's	Sustainable Development Goals
SIT	Sterile Insect Technology
SWD	Spotted Wing Drosophila
UC	University of California
UF	University of Florida
UK	United Kingdom
UN	United Nations
UQ	University of Queensland
UVC	Ultraviolet radiation
VPD	Vapour Pressure Deficit
WET	Water Efficient Technologies

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Objectives

- **Objective 1:** Gain an understanding of what mature berry industries look like and assess if there are learnings for the Australian berry industry as it approaches maturity.
- **Objective 2:** To explore emerging agronomic management tools and trends and investigate opportunities for the Australian berry industry
- **Objective 3:** To build an understanding of what sustainability means for businesses operating in mature berry regions
- **Objective 4:** Consider how sustainable change is achieved on a business or industry level and extract learnings for the Australian berry industry.

Introduction

Industry Development

Berry production in Australia began with settlement in Tasmania in the early 1800's. production was focussed in the Derwent and Huon Valley's and serviced small markets. The berry industry grew as jam processing, via IXL, grew throughout the 1800's. (Alexander, 2005) The commercial fresh berry market started growing in the 1950's with migrant families producing in the Yara Valley. The fruit was sold through the Melbourne Markets and eventually expanded into Sydney and beyond (Berries Australia, n.d). During the latter half of the 20th century, the popularity of Rubus and blueberries began to rise.

In the early years of berry production in Australia, all crops were grown in the soil and produced by many small, family-owned farms. As the market transitioned from an emerging market to an established market, the farming model changed toward large-scale farms and saw the introduction of the corporate model and corporations into the industry.

From the 1990's onwards, the technology around berry growing started to spread through Australia. Over the ensuing decades, new genetics, protective tunnel infrastructure, tabletops, substrate growing, and overall agronomic knowledge grew. The changes kicked off a significant growth phase, driven by higher quality fruit leading to an increasing demand.

Market development from grower groups, corporate marketing companies and supermarkets saw continued growth. The hectares under berry production continued to expand throughout Australia. Strawberries were the first berry type to become a regular grocery item in Australian households, while consumption of the other berry types steadily increased and started to take off in the 2010's.

Throughout the 2010's the production of berries continued to grow. Strawberries still dominated the market, however in the 10 years between 2013 and 2023 Rubus production grew from 2,167T to 10,781T (498% increase). In the same period, the blueberry sector expanded by 320% from 6,314T to 20,211T. (HIA, 2015) (HIA, 2024)

Until 2018, each of the berry categories were represented by its own industry group: Raspberries and Blackberries Australia (RABA), Strawberries Australia Inc. (SAI) and the Australian Blueberry Growers Association (ABGA). However, recognising the current and future needs of the respective industries, the peak industry bodies undertook a joint venture and established Berries Australia. Since its formation, Berries Australia has been able to create a berries specific strategic plan which has underpinned growth and research initiatives for the continued development of the berry industry. (Berries Australia, n.d)

The 2020's have been challenging for the berry industry. While growth in the industry was beginning to slow and the market starting to mature, Covid hit Australia. Travel became restricted as much of the world shut down and access to labour became a major challenge for the labour-intensive berry industry. While there was an upswing in demand from health-conscious consumers, many growers could not supply to their full potential.

As Covid settled down, further challenges developed for the berry industry. The consumer demand, which had continued to grow strongly through covid, started to slow down at the same time growers were again able to supply at potential. Labour laws were changed, which amended the way piece rate is managed in Australia, with minimum wage requirements being introduced and weekly minimum hour guarantee for PALM workers.

In post- Covid Australia, like many other parts of the world, inflation begun to spiral. The price of labour increased, and geo-political issues lead to high input costs. There was a necessary shift in the grower mentality to stop thinking about pushing ever more yield into the market, but to begin to focus on profitability. The result of high inflation and softening demand has put the Australian berry sector into a maturation phase.

Sustainability

Sustainability has three main pillars: environment, social and economic. Macro influences, like labour and trade laws influence the economic situation a business operates in. Social sustainability is influenced directly by legislation and regulation and indirectly by social licence. Social licence is an acceptance from the community, employees and other stakeholders that the business is operating in an ethical manner and can be supported. Social and economic sustainability are easily influenced by government because the mechanisms are clear, measurable and uniform throughout Australia.

Environmental sustainability in Agriculture can be more challenging for a government to influence effectively. The environment is complex and the challenges in one growing region or commodity may be vastly different to another. Often data to make good decisions is lacking, particularly when considering complicated ecosystems, where there may also be lack of measuring mechanisms. It is expensive to enforce government regulation and uptake of unsuitable regulation may lead to poorer outcomes for businesses, communities and the environment. There is a lack of understanding of the true impact businesses may have on the environment.

Member states of the United Nations (UN), including Australia, have been collaborating since 1992 to build a sustainable framework for development, which would improve the lives of people and the environment. In 2015, the UN announced 17 sustainable development goals (SDG's), which aim to address poverty, inequality, climate change and promote a sustainable future. The Paris Agreement of 2015, aimed to combat climate change by reducing carbon emissions, the target became NetZero by 2050. (UN, n.d) Australia committed to Net Zero and has created legislation and invested in making this a reality. The key contributors have had the most attention, such as the energy and transport sectors. Agriculture will become a focus area in the future. (DCCEEW, 2025)

The Australian berry industry has been active and innovative in the sustainability space. Horticulture Innovation Australia has commissioned a life cycle analysis for the Rubus industry, which aims to measure the carbon footprint. (Sustainability Matters, 2024) Integrated pest and disease (IPM) programs are widely implemented, where the aim is to build a strong ecosystem and reduce the reliance on broad spectrum insecticides. The industry is actively engaged in research in areas like coir re-use and is open to new innovations like bioplastics as a packaging alternative. (UQ, 2025)

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The berry growing system has changed dramatically in recent history. Large areas are now grown under tunnels, covered in plastic. Instead of growing in soil, growers have been moving to substrate growing systems. While the growing system changes brought about improvements in fruit quality, higher yields, and increased capacity for higher precision growing, there are downfalls. Many of the materials used for growing, do not have reliable sustainable end of life solutions, which are cost effective for growers.

Chapter 1: Market dynamics and sustainability

Sustainability is becoming a buzz word for businesses around the world. It will be found on business websites and in business annual reports. During my travels I wanted to understand what sustainability meant to the various businesses I visited, what the focus areas were, and why they were important.

Consistently, the main drivers for sustainability were, profitability, policy requirements and market access. Many people made comment about the importance of caring for the environment they operated in, though as a business it was primarily important to be profitable. Without being profitable first, there is no possibility of spending money where it would not significantly improve the bottom line.

Supply Chain Influence

Because the Australian berry industry is entering a maturity phase, I wanted to focus on the learnings from the mature berry regions, such as the US and the UK. I learned sustainability measures were driven by external pressure placed on businesses from the consumer. The consumer being the retailer, rather than the end consumer. Retailers, banks and insurance companies globally are under pressure to achieve net zero emissions targets by 2050. Reporting is already underway for scope one and two emissions, but as the focus moves to scope three emissions coming from the supply chain, the pressure to decarbonise will reach growers.

The UN has 17 sustainable development goals and so sustainability is more than decarbonisation and retailers have goals under more than the carbon banner. To attain sustainability targets, retailers are driving their own sustainability initiatives, which can have a powerful impact on grower practices. In the US, a retailer was reported to have banned a list of chemical products of which were registered for use in berries. To sell fruit to the retailer, some growers were required to change growing practices. It was reported that the retailer collaborated with experts to understand the feasibility and impact to growers prior to implementation and offered support to growers. This same retailer had been credited for influencing improvements in water management, with the aim of reducing fertiliser contamination in the environment.

While initiatives may positively impact the sustainability of the supply chain, other initiatives may not be as beneficial. For instance, in the UK, a retailer wanted cardboard packaging to market a fully sustainable product, however in an internal lifecycle analysis, cardboard packing was not supported to be the more sustainable option. In another UK example, a retailer was applying pressure on growers to remove peat and eventually coir from blueberry production. While trials using alternative media are underway, including less sustainable options like rockwool, this was placing a question over the viability of growing blueberries.

When discussing pressure coming from the end consumer, it was coming from a minority of consumers. HIA held a consumer insights webinar that intimated that end consumers were confused about what they should care about. Consumer research indicates that what end consumers value and say they want, does not align with purchasing decision in the market. (Nielson IQ, 2023) This was echoed by growers throughout my travels.

Market Maturity and Trade

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Market maturity puts pressure on businesses and the capacity to be sustainable. When there is high demand for a product and a low supply, growers have more income to reinvest in the business. When the market matures, or the supply matches demand, the value of the product diminishes. With less income for reinvesting, the priority for investing is geared to increasing profitability not necessarily sustainability.

In Europe and the UK, competition from areas where costs of production were lower has been creating downward pressure for growers. Growers in the UK were struggling to compete with imports from Peru, not only from Europe. Concerningly, Chile could not compete with Peru either, because Chilean labour laws govern minimum pay requirements, where a picker must earn USD\$25 per day (pers.comm., 2024). As a result, both the UK and Chile are seeing significant retraction in blueberry hectares due to the low price of fruit coming from Peru.

In Europe, free trade laws increase pressure on growers in wealthier economies, as they are forced to compete with supply from areas with lower production costs. To cope with this pressure, there was a greater focus on purchasing local and a sense of national pride. This was evidenced in Ireland, Northern Germany, and France. This was further witnessed in the UK, despite not being in the EU and is a strategy to remain competitive against neighbouring countries.

During my travels I visited peach growers in California. Sentiments of a peach grower in California:

“Remaining profitable is becoming extremely challenging. Once the answer was to simplify the growing system from growing 20 varieties or crops to no more than four. So, I did that. Before long, things got tight again and the answer became we need to scale up, we need to get big! So that is what I did. That worked well for a time, but again things became tight. The answer now is to cut the cost of production. I’ve been doing that however again things are becoming tight. So, what is next? There used to be 100’s of peach growers in his region, now there are a handful- all aging and with huge farms.”

The Australian berry industry is unique from Europe, the UK and the US in that the fresh berry market does not have competition in the market from neighbouring countries. To maintain market share and profitability, growers in Europe are focusing on marketing and ‘buy local’. UK growers are hurriedly refining their production systems, changing berry types, production hectares and growing practices.

Australia is unique, in that the berry industry has developed without pressure from imports. In Australia, the supply is close to demand and the impact of inflation on the cost of production. Over time farms have scaled up and now growers are looking at ways to decrease production costs and improve the value of the product. Across the globe, marketing businesses are creating product differentiation (punnet size, quality tiers) and have been successful.

Market differentiation is another avenue for the berry industry and Australia may have unrealised export potential. Although I know little on the subject, I saw punnets of raspberries in Indonesia in a boutique market for \$34AUD for a 125g punnet, which had been supplied by California in June. While this was not the standard price when I visited other marketplaces- the opportunity in the market seemed strong and I was left wondering why we were not supplying to such a lucrative market right on our doorstep. Investigating further, I found Berries Australia has been working to open export market

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opportunities, through project MT20004, funded jointly by the 3 berry funds (HIA, 2024).

Inflation

Rapid inflation in the wake of geopolitical tension and Covid have increased the cost of production and in-turn exacerbated the rate of maturity in the market. Inflation has been both negative and positive for improving sustainability in the berry business. Negative because increased production costs have reduced margins for berry businesses. A positive from high inflation saw growers rapidly evaluate ways to decrease production costs, at times investing in new innovations and technologies, often leading to great outcomes. Strategies such as, smarter water and fertiliser use has helped reduce fertiliser losses to the environment. On the other hand, some ecologically conscious growers needed to put more pressure on their systems to remain competitive.

Chapter 2: Effecting sustainable change

Policy can be a useful tool for fast tracking action and may be employed to influence sustainable farming practices. Policy can be beneficial, but poor policy can have considerable unintended consequences. Policy is sometimes viewed as a top-down approach, but oftentimes it reflects the interests of the people.

What sustainability looks like and how it can be achieved is different from one country to another. Governments are responsible for managing the macro environment and for determining what the priorities for the country are. Governments have distinctly different means and power when it comes to creating policy.

In California's San Joaquin Valley, a government policy prohibits farms from burning agricultural waste. (Plevin, 2025) The policy was designed to prevent carbon emissions, improve air quality and promote circular practices with farm waste. While there has been redirection of mulched trees into other uses, it was apparent when driving through Fresno County that the market saturated rapidly. Large piles of organic matter were regularly observed sitting on farms.

Additionally, in California policy conflict was witnessed where policy mandated environmental flows to be retained for river health and biodiversity management. While the river flourished, there was less surface water availability to farmers. With less surface water for irrigation, growers needed to rely on groundwater for irrigation which is leading to significant environmental and economic challenges.

The European Union (EU) has its own governing structure, where representatives from across Europe meet and create goals for member countries to attain. Member countries are then accountable for creating policies to achieve the goals. In agriculture, the EU provides subsidies to growers through Common Agricultural Policy (CAP) funding. The subsidy model is a tool to steer agriculture and begun in post war times, where Europe recognised the need to support food security locally and to protect the way of life of farmers and rural communities.

The EU has a set of initiatives called The Green Deal, which commits to net zero GHG emissions by 2050. Within the deal, there is a farm to fork (FTF) initiative which includes targets to reduce pesticides, increase biodiversity, decrease emissions and improve nutrient efficiency. (Fulbright, 2021). To achieve FTF goals, the CAP eligibility requirements have been refined.

In Ireland, France and the Netherlands, nutrient budgeting for cropping and livestock management is mandated and audited. Farmers need to submit a farm plan, which is reviewed and a nutrient budget provided to the farm, based on, the crop type, soil conditions and the location of the farm. The farm is audited through the supplier invoices and via random shed inspections. If the farm is in breach, the CAP funding will be lost. This did not appear to be in effect for horticultural crops.

In the berry industry there was little mention of nutrient budgeting. When asked, some growers believed it would eventually come- although they believed the industry was not well understood and still regarded as small. When it came to nutrient loss reporting however, there were already some levels of reporting occurring. In the Netherlands, it was mandatory to undertake ground water samples in ecologically sensitive areas or where waterways might be impacted. New developments were required to meet standards, at times meaning a complete wastewater capture and management system.

In France, it was policy to increase the area of agriculture into organic production. This was an interesting target, as it implies certified organic farming is the most environmentally sustainable means of growing. However, organic growing typically has higher costs of production than conventional growing, and growers indicated consumers were not willing to pay a premium for organic produce. One grower suggested, *“the organic growing system should be selected because the philosophy resonated on a personal level, not with the expectation of attaining greater margins.”*

In Denmark there is pressure to not only reduce biodiversity loss, but to increase the wild area of the entire country. (Danish Government, 2014) Historically, Denmark had large areas cleared for agricultural and urban use and has experienced species decline and extinction. There is a Danish Biodiversity Council and a set of policies and funding available to realise this target, which also includes restrictions on fertiliser and chemical use in sensitive areas. Anecdotal, this was said to have put significant pressure onto orchardists, to the point many may become unviable.

In the UK, post Brexit, there is a transition away from the EU subsidy model. Government grants are available to aid businesses to become more sustainable. One grant aided growers to transition to renewable energy sources, alongside an energy buy-back scheme. There was a belief among some growers, that these policies spurred artificial growth in the strawberry industry, which was believed to contribute oversupply challenges in the strawberry market.

At times, incentives or regulatory requirements are unsuitable or cause harm to farming businesses. In the EU, chemicals have been banned, which significantly increase production costs and makes some growing systems unviable due to lack of effective tools to control pests. A grant in the UK sort to encourage growers to plant wildflower strips (UK government, 2024); however, berry production originated in the soil and the farms are typically on highly fertile ground. Lack of specialised equipment and fertile soils meant berry farms were unsuitable for wildflower strips.

An interesting question arises around what sustainability looks like from a grower perspective and what or who the main drivers will be. The subsidy system in Europe does support smaller scale operations to remain viable and in turn, bolsters communities. In areas without significant subsidies, economics has reduced the overall number of farms and increased the farm size. In places like the US and in Australia, this has changed rural communities. Speaking with smaller growers, commitment and passion for the environment was evident, however, small scale operations with a desire for sustainability, may not achieve their goals due to limited scale and capital constraints. Larger scale operations may afford better tools for precision agronomy and harvest management serving to minimise wastewater, nutrient, pesticide and waste fruit.

The co-operative (co-op) farming system in Europe is noteworthy and can be a tool to provide power to the smaller farmers. In France, over 75% of farmers are part of at least one co-op. A co-op can act as a buying or selling entity, where smaller growers may purchase bulk inputs cheaper rather than on their own. There was a machinery co-op, where we saw a very small-scale farmer with access to brand new tractors, that would not make financial sense to buy for that operation.

In Denmark, co-ops are also common. We visited DLF seeds- The largest non-corporation pasture seed producer in the world and the Danish Crown, a hi-tech abattoir able to export around the world. More noteworthy was the Dairy industry,

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which was part of a co-op of which was able to be represented in parliament, and was able to impact the carbon tax rules for all livestock industries while we were in country.

The Australian berry industry does have co-op structures in the fruit marketing space, however there is further scope for co-op structures which could benefit growers. One potential area is in innovation and technology. In California, Denmark and the UK I spoke with people developing innovative technology for use in agriculture and berries. One of the biggest barriers from a developer and a grower perspective is the cost of the R&D stage and early commercialisation. A co-op model could assist to overcome this challenge and result in faster and more efficient technologies for the berry industry. Berry growers should also consider other agricultural sectors as potential co-op partners.

The Australian government does have a part to play in supporting environmental sustainability. I believe legislation will be required in agriculture to meet the net zero by the 2050 target, however I believe the pathway to achieving the goal, should be left to industry. If there is one key learning from my Nuffield experience, it is that collaboration is imperative to success. An industry should be supported by an industry body that can represent the growers. There needs to be a research body, that is driven by industry and there needs to be understanding and commitment to shared goals in the supply chain.

Agricultural policy in regions like the EU and the UK is driven by the voice of the people, more so than in Australia. The EU has a higher population density and urbanisation, and agriculture is entwined. Incidents of poor agricultural management has resulted in human health concerns, which created public pressure and more direct environmental regulation. In contrast, Australia's low population density means the environmental impact of agriculture is less visible, and the pressure to mandate sustainable practices is unlikely to come from public pressure.

In Australia, policy will be a tool to support sustainable outcomes, however, should not be the main driver. Legislation is likely to come to lead Australian agriculture to meet net zero targets, however agricultural sectors need autonomy to find suitable solutions. The priority areas for sustainability are unlikely to be the same between agricultural sectors and will differ between growing regions within the same sector. For instance, the carbon reduction priorities for Tasmanian strawberry growers will be different to Queensland strawberry growers. A strong voice to advocate for the berry industry is required as well as strong collaboration from stakeholders operating within it.

Throughout my travels, the 'who pays?' question kept arising; It is my belief that we are all accountable for paying the bill. As berry growers we need to be proactive in making our businesses sustainable. We need to work together and have open conversations with members of our supply chains to create attainable sustainable goals.

Chapter 3: Emerging tools in integrated pest and disease management

The Australian berry industry has been effective in developing a variety of pest and disease management tools to include in Integrated Pest and Disease Management (IPDM) systems. IPDM aims not to eradicate pests, but to incorporate measures to lessen the economic impact. IPDM is typically characterised into three control groups: cultural, biological, and chemical. An example of cultural control is physically reducing canopy to allow for air movement and reduce disease risk in a crop. An example of biological control is introducing predatory mites to control Two-Spotted spider mite. Chemical control is the most known control type, however in an IPMD program, the aim is to use softer or more selective options.

During my time as a horticulturalist, I have managed IPDM programs, and I know all too well the disappointment of applying best practice management and then a pest comes along that does not have an appropriate IPDM control strategy. In the Rubus space, mirid species are an example of this. In the past few seasons, in the Tasmanian growing region, there seems to be new emerging pests, and I started to wonder what tools, outside of what is currently used, are available to the berry industry.

Biodiversity Management:

The Australian berry industry is beginning to explore biodiversity management as a tool in IPDM programs. I was keen to explore how more developed berry growing regions with pressure from reduced chemical access or significant pest challenges were incorporating biodiversity management into IPDM programs.

In California I spoke with an Agro ecologist, who specialised in developing tools for the organic berry sector. We discussed the idea of push and pull dynamics, where a grower may use tools to push or pull away pests in a growing system. For this to be successful there needs to be good understanding of the biology and behaviour of the target (Khan and Pickett, n.d.) as well as the crop being managed.

The organic strawberry sector in California is incorporating this strategy in several ways. For mirid control, a grower will plant a row of alfalfa (lucerne) around the perimeter of the crop. Mirids are more attracted to the lucerne and are either drawn out of or prevented from entering the crop and then pest mirids can then be managed independently of the crop. Strawberry growers are also interplanting with Sweet Alyssum to create an environment attractive to aphids. The aphids, attract hoverflies which can feed and breed up on the Alyssum and the hover flies are ready to assist aphid management in field.

The Federal and state government of California are encouraging increased sustainability in agricultural systems. Funding is available to growers to establish hedge rows with the aim of increasing insect biodiversity, as well as improving soil and water quality in farming environments. (Long and Anderson 2010) Growers are also taking measures to increase natural pollinators in their system by incorporating Sweet Alyssum along with Buckwheat. When visiting a berry trial site, in the UK, Sweet Alyssum had also been planted in strawberries, however its impact was not being measured.

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In the UK, funding was available to growers to add wildflower strips to support insect and pollinator diversity. In a trial area I visited, the flower strip was thriving and was alive with insects, including pollinator species. The trial manager reported that in the year the wildflowers had been planted, there had been a 40% reduction the amount of beneficials required in the block, when compared with other years. This observation could be tested in the future with formal assessments and replication.



Figure 2: A managed biodiversity strip trial, Kent, UK (Source: Author)

Throughout the UK, biodiversity management was not generally raised in discussions around what sustainability means for growers. Hedge rows were common; however, they were only discussed for their potential negative impacts in harbouring pests. At an industry event I met a grower who had a holistic management philosophy, which included practices aimed at increasing biodiversity for pollinator and pest control strategies. This grower also mentioned that economics and a need to intensify his system is necessitating a change away from his style of growing.

In Europe, the Green Deal requires mandatory reporting of biodiversity on farm from 2025. The growers I spoke with did not currently have systems for measuring biodiversity on farms and were relying on mandatory hedgerows and the utilisation of beneficial insects to satisfy reporting requirements. In France, public places and institutions were being used for increasing biodiversity. This typically meant areas of no mowing and allowing plants to grow and flower freely, though this was oftentimes, what we in agriculture would declare as weed species. At one university we visited, instead of maintaining grassy areas, they had sown mixed flowering species.

In northern Germany and the Netherlands, I met growers with no or low spraying systems. This strategy appeared to be driven from a dislike of chemicals rather than for ecological purposes. The no spray systems were working for the growers; however, I observed elevated levels of fruit damage, from pest and disease, which would incur significant cost to the grower, from lost yield, poor quality and increased harvest costs. The growers I spoke to in this region were mostly selling to smaller shops or through their own shop as fresh and value-added products.

While initiatives exist to support and improve biodiversity in growing systems, I did not feel biodiversity management was a focus area in the growers' minds, when it came to increasing the sustainability of their systems. Growers will make choices if there is a tangible benefit to the operation. Throughout my travels, it was evident that

assessing the physical or economic outcomes of increasing biodiversity needs more attention. Mandatory reporting of biodiversity in growing systems in the EU is in its early stages; the measurement and economic impact of increasing biodiversity may be better understood with time. We, as berries growers, should keep an eye on this in the coming years.

Biologicals and Pollinators

In the EU, some of the chemicals we are using safely and legally in Australian IPM programs have been disallowed. The reliance on beneficial insects is now much higher in some production systems and areas. While beneficial insects have a vital role to play in berry businesses, they are best used in an integrated way and often alongside chemical. When considering chemical use, safety and impact in the environment are important factors to understand and sound science and regulation should guide suitability of any chemical.

In the USA, UK and Europe, most *Rubus* growers were using bumble bee boxes as the managed pollinator. Many growers also had honeybees onsite, particularly when growing blueberries, as the bumble bee was considered too vigorous on the flowers of blueberry and strawberry crops. When discussing pollinators at Koppert, the species of bumble bees used for pollination was matched with the growing region- to the point where in the USA, one side of a mountain range might have a different species to the other. In Tasmania there is an opportunity to investigate the bumble bee, which is now established, as a potential managed pollinator. Although stakeholders do not oppose investigating bumble bees as a pollinator in Tasmania, legislation has prevented any work from commencing.

Koppert operates globally but is not active in Australia. They offer a wide range of biologicals, many unavailable to Australian growers due to strict biosecurity laws. Koppert is developing a new agent for lygus, promising for Australian berries, is one such example. Koppert has also developed unique technology to produce *Persimilis*, a predatory mite, in laboratory conditions, which enables them to produce high-quality, slow-release sachets. As the sole holder of this technology globally for this predator, Koppert presents a potential partnership opportunity for an Australian supplier to bring this innovation to Australian horticulture.

The Australian berry industry is reliant on pollination to produce berries; however, we are reliant almost exclusively on honeybees for managed pollinator services. Other major growing regions have both honeybees and bumble bees. In Australia it is important for growers to understand the role of native pollinators in our systems and encourage their services. Being reliant on one pollinator is a risk for the berry industry, particularly in the wake of varroa mite. Pollination dependent industries in Australia, such as the berry industry, would do well to continue to support research into alternative pollinators.

Cultural and Technological advances:

UK growers are striving to improve profitability by simplifying the production system. They are achieving this by reducing planting densities in *Rubus* and strawberry crops, which decreases plant and harvest costs has had the unintended opportunity to reduce spraying, due to increased airflow through the canopy. Many *Rubus* growers were

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changing their production systems from perennial to annual systems, because the crop remains in a block for a shorter time, creating an opportunity to improve hygiene and decrease the pest and disease pressure.

Spotted Wing Drosophila (SWD) is a pest fly species which pierces soft fruit and lays its eggs inside soft fruit. SWD is one of the most economically significant pests in berry production globally and is found in most berry growing areas, outside of Australia. To combat this, growers are required to use considerable resource to maintain exceptional hygiene in blocks or rely on regular disruptive sprays.

Sterile Insect Technology (SIT) is being investigated for SWD control and early results are looking positive. SIT involves breeding of SWD flies in a laboratory and sorting the flies into male and female populations. The male flies then undergo irradiation, effectively making them sterile. The sterile male flies are then released into the environment, where they can unsuccessfully mate with wild SWD. SIT is used as a tool in Australia for Queensland Fruit Fly management. (DAFF, n.d.)

In the USA, SIT is being taken to the next level, with the use of gene editing. Instead of separating out male and female flies and irradiating the males, the genes are edited so that females can only lay sterile male eggs. The eggs are then delivered directly to the grower, where they hatch but cannot successfully mate. This technology was trialled for the first time in August 2024. (Halladay, 2025)

Mirids or lygus species are economically significant pests for the berry industry worldwide. In conventional growing, there are limited spray options, and many will disrupt an IPM strategy. In California I learned about vacuum technology, which works by sucking the mirid pests out of the crop, which are then physically controlled by hitting the fan or the vent. There are now many options available in the market for soil grown strawberries in California and the technology can be used in conjunction with or separately to trap cropping systems, which have previously described in this report. From my understanding this technology is not available for tabletop strawberries, tunnelled systems or in Rubus.

In California I visited GUSS, a business creating unmanned sprayer units. While there I looked at automatic sprayers that are also equipped with variable rate technology. The machines can apply cover sprays and adapt the spray application to the canopy size. Laws in the US, UK and Australia require people to be physically in attendance with automatic technology of this kind, however a single operator can run an entire fleet, which would reduce labour costs.

Although the automatic sprayer technology, may struggle to pass a return on investment assessment for the berry industry. The variable rate canopy technology may be a potential game changer in perennial horticulture, where crop uniformity may be lost over time. Variable rate technology, that can assess the canopy and calculate the application rate in real time, could be an effective tool in reducing excess pesticide from being released into the environment, while improving the efficacy and agronomic outcome of the application. However, this technology would require changes to the labelling of agricultural chemistry, where rates are calculated to rates per canopy area, instead of per 100L or per hectare.

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Powdery mildew is a significant challenge for strawberry growers. The typical control measures are focused on planting low susceptibility varieties, managing canopy and preventative spray programs. Presently, multiple companies across the world working with ultraviolet radiation (UVC) technology to control powdery mildew.

In California I met with TRIC Robotics and inspected an autonomous machine which was in the early stages of commercialisation. The machine was designed for large scale, soil strawberry production and was equipped with both UVC technology and vacuums, to simultaneously manage powdery mildew and mirids. The team at TRIC Robotics had worked with scientists to understand dosage, exposure length and timing to understand the optimum treatments for managing powdery mildew and limiting plant damage. The technology can only be used at night and plants need time to recover before sunrise. The business was working with scientists to understand if UVC treatment could also be used for managing botrytis.

In Scotland I visited a farm trialling the use of SAGA robots. These machines are semi-autonomous machines adapted with UVC technology to control powdery mildew in strawberries grown on tabletops under tunnels. The robots run through each block twice per week. The trial was taking place in a block that had historically high powdery mildew incidence, which lead to large fruit losses in most years. The grower was thrilled with the performance of the block and noted it had remained in harvest longer than ever before and were excited for the new technology.

Autonomous or semi-autonomous UVC treatment, variable spray technology and spraying robots are new tools which may prove valuable for growers. These tools may reduce pesticide use and losses, improve plant health and yield, or create opportunities, such as new genetics, which may not have been considered, due to powdery mildew susceptibility. Due to the extensive development time and sophisticated equipment, purchasing autonomous machines are cost prohibitive for most growers. To make modern technology more accessible, some robotics companies I came across were using a subscription model during the early commercialisation phase.

Developing innovative technology is expensive and therefore how we support and encourage new technological innovations should be considered. Many people with the ideas, energy, and passion to find innovative solutions are young and do not have significant capital to start. This is in contradiction to the typical needs of a business, who want a technology to be commercially ready. New start-ups rely on grants or private backing, and many are forced to give up before getting started. In the berry industry, we are all facing similar challenges the world over. There is an opportunity to for industry collaboration in this space.

Chapter 4: Water, irrigation and nutrition

A large portion of the global berry industry are growing hydroponically in a soilless medium, typically with coir as the key component. Berry crops are typically fertigated, meaning the nutrition is applied during drip irrigation. Part of standard irrigation management is to maintain uniform moisture in the rootzone and flush out excess salts, this is achieved by irrigating past saturation to achieve drain. After a period of drain, containers are dried back during low moisture use times, such as nighttime, to ensure oxygen (air) in the rootzone and promote a healthy root system.

Growers in a substrate system, have higher capacity to measure and understand the water and nutrient requirements of a crop throughout the lifecycle when compared to soil growers. While the area of berries in production is small compared with other commodities, fertiliser use is a significant part of the sustainability conversation for us all. In some berry growing areas, water access and price can be challenge and so becoming efficient is of high importance. During my travels I wanted to explore ways in which growers are minimising water and nutrient loss to the environment.

Water Capture and Recirculation

There are several technologies available to assist growers in capturing water from the growing system. Growers can access technology, such as tunnel gutters to collect rainwater or drain collection systems. Without pressure to incorporate these technologies, there seemed to be little interest from most growers. Some growers had installed drain capture systems which would capture irrigation run-off, send it through UV treatment, and then use the water, with retained fertiliser, on another crop. Due to the cost of the UV treatment, growers were either not using the system altogether or selecting not use the UV treatment. The technology was more likely to be up taken by glasshouse growers. The tomato industry has large uptake of water re-use systems, if growers are interested in following up on this type of technology.

At Trayplant in the Netherlands, a business that grows millions of trayplants per year, all the infrastructure was fitted with water capture systems. Rainwater was collected from the roof and the drain was collected from plants growing in the glasshouse and run through a sophisticated water filtration system and re-used. The business was, at that time, fully self-sufficient for their water use requirements.

In Northern Germany I visited a grower who was maintaining a multispecies cover crop underneath strawberry tables and running the drain through sprinklers onto the crop. While this may increase risks like powdery mildew, the grower noted greater insect diversity and reduced incidence of VPD issues. Other growers in this region were directly applying drain from berry crops onto arable crops and, at that time, were not required to report the nutrients in the nutrient budget.

Irrigation technology

Growers throughout the UK are incorporating technology from companies such as Soil Moisture Sense or Agri-tech to aid irrigation monitoring and decision making. In essence, the technology is measuring the conditions of the rootzone and sending this back to a computer. Some growers are using the system to trigger all irrigations, while

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others are using it as a guide for irrigation scheduling and as a back-up system. Growers were able to manage crops with as little as 5% drain in periods we would be aiming for 15-20% drain in Australia. This is a direct opportunity to improve water and nutrient efficiency.

In the UK, I visited Dr Mark Else at the Water Efficient Technologies (WET) Centre based at the National Institute of Agricultural Botany (NIAB) facility in East Malling. The centre was created to understand best water and nutrition management in commercial strawberry and raspberry varieties. The outcomes of Dr Mr Else's work highlight some varieties are very susceptible to water stress, while others can withstand water stress conditions with minor impact to yield. The work indicated in some varieties, the standard drain management used by commercial growers may be too high for some varieties and too low in others. Strawberries seemed better able to recovery from a water stress event, whereas raspberries had a measurable decrease in fruit size after 2 weeks and did not fully recover after the water stress had been alleviated.

To increase sustainability in the berry industry, precision nitrogen management as a key area of consideration. At the WET centre, Dr Mark Else has been developing a nitrogen model as a tool for berry growers. The tool works by evaluating the nitrogen uptake in the previous 2 weeks, with destructive testing and using climatic forecasts (light and temperature) to understand the plant demand in the next two weeks. This is in early development, however early results are impressive, with 80% reduction in nitrogen use in strawberries (June bearer) without a yield penalty and up to 90% reduction in nitrogen requirement in some raspberry varieties, but with some yield penalty at this stage. Alongside this technology, a handheld NPK probe is being developed to allow in field analysis for growers and could make this type of tool a viable option moving forward.

The work at the WET centre is exciting and can assist growers to have confidence when implementing precision water and nutrient management. Understanding the requirements for a variety in controlled conditions is useful and can be a good starting point for growers. The 80-90% reduction in nitrogen reported above, may not be attainable targets commercially, when considering the amount of analysis required and the limitations of irrigation systems, but it does suggest there are significant opportunities in water and nutrient management.

For overall irrigation management, most growers in the UK were using Hortimax or would use Hortimax as the preferred irrigation management system if they were to have a greenfield site. PRIVA, which is common in Australia, was less desired because the interface was complicated and the system has ongoing expenses. Netafim systems were used when infrastructure was already in place.

Chapter 5: Energy, resources and waste management

Globally, the berry industry has been moving out of soil production and into a more intensive substrate system. While there are many benefits moving to this system, there are challenges with the resources required to operate the system. Some of the products required are energy intensive to produce, are shipped around the world and do not have reliable sustainable end of life solutions in Australia. While there has been work undertaken in Australia, I was interested to understand how other growing regions manage the plastics, coir, root mass and plant material at the end of life.

Coir and Plant Waste

In berry substrate systems, coir, a coconut product, is used as the primary growing medium. Most of the coconuts are grown in Asia, more specifically in India and Sri Lanka. The rate of growth in demand for coir may put pressure on the environment and communities in these regions. At minimum, growers should ask for sustainability credentials from potential coir suppliers to avoid exploitation of communities and the environment.

Coconuts are typically harvested, washed and dried in the sun, before being shipped around the world to where it will be processed further. The coir is screened (remove large and fine material) buffered, a process of moving out excess salts, and mixed into a final product. The coir is then dried down and shipped and/or trucked to the customer. Coir has high carbon emissions, largely from energy and transport and should be considered when evaluating the sustainability of the system.

At the end of a substrate crop in Australia, growers have large piles of coir, plant material and plastics to deal with. In Australia, soft plastic recycling has been challenging and unreliable and often ends up in landfill. Pots can be recycled at times but has been a challenge because they need to be clean and transported to a recycler, which can be costly. The coir and plant waste material does not yet have cost effective end of life solutions, though opportunities are being explored.

Regarding plant and media waste, growers I spoke with in Europe and the UK were mulching the plant and coir and spreading it onto arable land. Growers reported the act of spreading the mulched material, improves the organic matter of the land and has resulted in measurable improvements. In the Netherlands, there has been discussion about potentially requiring analysis, so the nitrogen can be considered in nitrogen budgeting, however this is not yet practiced. Some growers believed there was unlikely to be an advantage for arable crops, but it did make the organic waste problem disappear, without negative implications for the arable farm.

Some Growers, in the minority, had found other means to manage their plant postproduction. One Grower was turning the mulched material, in addition with other farm biproducts, into compost. The process would take 18months and then it was applied on other non-berry horticulture crops with positive results. By composting the material, it adds value to the product. Another grower reported feeding the entire plant to livestock with success, even with the root ball.

To reduce the cost of planting and get the most out of the materials, some strawberry growers were taking the bag or the entire crop through to a second year. Typically, strawberries are an annual crop. Growers noted a second-year crop had smaller

yields, required more crop work and fruit quality was at times challenging. More commonly, growers were taking the growing bag through to a second year and planting fresh plants.

Projects to re-use coir or explore alternatives have been underway in the UK and, more recently, Tasmania. In the UK, a company called Over-land offers a free service to remove spent coir from glasshouses and is now exploring its re-use in horticulture. The material is steam-sterilised and returned to production. I visited a grower trialling this recycled coir in long cane production; while early signs were positive—healthy plants (30cm tall) with good root movement through the pot—there were high portions of fine particles, which may raise concerns about drainage, rootzone challenges and longevity.

Fruit

Dealing with soft fruit, with a short shelf life and high-quality standards, there is an amount of waste fruit that needs to be managed. I was curious to understand if other berry growing regions had any innovative ideas for waste fruit management. I found that the way in which growers were dealing with waste fruit, depended significantly around what opportunities were available locally.

In some parts of the UK and Northern Germany, there were biodigesters in the region, which presented an opportunity for growers to dispose of waste fruit. At times there were incentives paid to growers, depending on the requirements of the biodigester, while at other time a fee was required. Biodigesters need a lot of material to function and for the typical berry grower, it is not viable to own and operate their own digestors. In the UK, Dyson farms produce berries and does have a biodigester that provides energy to their strawberry glasshouse; however this is supported by significant arable cropping area.

Many growers have a market for seconds' fruit. The customer often creates a value-added product like ice cream, condiments, freeze dried fruit, yogurt, and ingredients to other products. Some growers had their own means of managing the waste, like in on farm shop/cafes or feeding to livestock. While others buried fruit on farm.

Many growers are working on the farming system to become more profitable. In the UK, the common way growers were managing this was by planting annual long canes rather than have perennial crops. Perennial crops produce more waste fruit, partly due to uncontrolled pests. Growers are investigating reducing density to make fruit more visible to pickers. As a result, growers are noticing the fruit waste dropping in their systems.

Most fruit waste was noted to be coming from oversupply issues which forces first class fruit into second markets or into waste.

Fruit quality standards in the market seemed to vary between countries and from what I observed, Australia has the strictest fruit quality standards. This could be an area to review going forward as a full chain approach to sustainability.

Plastic

Soft-plastic recycling is a significant challenge for Australia as a whole, not only for the berry industry. A sizable portion of the fresh market berries grown in Australia is under

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polyethylene (PE) plastic. Presently the end of life for tunnel plastic is into landfill. In America, soft plastic recycling from agriculture did not seem to be occurring, however I was keen to understand how it was being managed in Europe and the UK.

In the UK and Europe, growers can sell soft plastics for recycling, where they're processed into products like tables and chairs. This system works because there's demand for recycled products and government or council support in public projects. Key challenges in Australia include low population density and long distances to recyclers, making viability harder. In Europe, more recycling facilities reduce transport costs. One grower noted the goal is often just to break even on recycling tunnel plastic, with profits or losses depending largely on freight and timing.

Growers were re-using plastic pots until the pot was too damaged to be used again. In the Netherlands during a visit to the Horti Centre, I found cardboard pots. They can be used for up to 18 months. This could be explored as an option for growers, particularly where the production cycle is one year.

Plastic packaging, polyethylene terephthalate (PET) is often discussed in berry sustainability. Though it was an area I investigated, I noted in France and Denmark, plastic packaging was less frequent than in Australia and it was more acceptable to have a cardboard punnet without a lid or plastic covering.

Energy

In the UK and Europe, heating growing areas was common practice to attain early or late season production. A typical way for heating the system is to heat up water and run it through pipes under growbags or pots. Government Incentives were available to growers to replace non-renewable energy to renewable forms. To attain the incentives, the energy had to be clean and produce at least three units of electricity for every unit of electricity put into the system.

In Scotland burning timber is regarded as a renewable energy source if the timber goes through an aging process first. Timber is let dry for 2 years, prior to burning.

In the UK, a grower accessed the incentive and installed a surface water heat pump. The technology allowed the grower to extract five degrees from a local water source. It was described as working the opposite to a fridge, so the water comes out of the river, then condenses and eventually puts water through to the glasshouse through the pipes at 45 degrees Celsius. Prior to this technology, gas was being used to heat the glasshouse.

In the Netherlands, Trayplant Nursery captures hot water out of the glasshouses, that has been heated up passively and stores it in an underground reservoir. After several months, during the cooler periods, the water is then pumped back into the pipes to heat the glasshouse. The Reservoir is in the soil and is not a physical tank as one might imagine. The opposite is also true, to aid in cooling down the glasshouse. The system can work, because the groundwater movement is so negligible, that there are minimal losses through lateral flow.

Biodigester use – Please refer to the fruit waste section on page 26 of this report

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In The Netherlands, where there is high competition for land use (urbanisation, energy and agriculture, there have been trials to investigate combining energy generation and berry production. I spoke with a grower who had trials combining solar panels and berries. It was noted the combination can work, if the grower is aware there will be a yield loss due to less light for the crop. The impact of lack of reduced light, was more pronounced in strawberries than raspberries. The capital required to install solar is significant, though as countries make the move to diversify and decarbonise the energy system, there are many projects exploring the compatibility of agriculture and energy generation. Available land area in the Netherlands is much less than that of Australia and I doubt there will be much incentive for the Australian berry industry to explore this pathway.

The largest sustainability challenge for the Australian berry industry is in transport and energy. Soft fruit need to be refrigerated rapidly after picking and will remain refrigerated until the end of life. Berries are shipped and trucked across Australia to reach distribution centres and markets. Resources like fertiliser, pots and coir are also shipped across the world to reach berry farms. In the supply chain, use of biofuels is being used to decarbonise the supply chain. I spoke with some suppliers of coir who used biofuels in shipping and with Koppert who offsets carbon emissions by investing in biofuels for planes.

Conclusions

The Australian berry industry is entering market maturity at a time the industry has also been impacted by inflation and major increases in the cost of labour. Mature markets like the US, UK and the EU have also experienced these pressures, though are also exposed to additional market competition, from imports from areas with lower costs of production. The aforementioned areas have persisted in the mature market by differentiating the product and market. Australia has been lucky to develop, without external import pressure. As the Australian berry sector matures, stakeholders in the industry have begun differentiating berry products and markets to relieve pressure in the domestic market.

Market maturity places pressure on businesses and limits the capacity for growers to make sustainability a priority, as a business must prioritise being profitable. Growers want to do the right thing for the environment, but many lack the scale, capital, or knowledge to make long-term changes. The pursuit of sustainability in horticulture is increasingly influenced by policy, market access, and supply chain pressures rather than direct consumer demand.

Policy will be a mechanism used to lead Australian agriculture to become more sustainable, particularly as the net zero deadline approaches. The experience across the UK and Europe, particularly under the CAP scheme, demonstrates both the power and limitations of policy-led sustainability. While incentives can drive change, international examples show, poorly aligned sustainability policies can backfire or even harm farm viability. Sustainability is not one-size-fits-all. It must be context-specific, guided by local conditions, practical experience, and long-term thinking.

Agricultural policy in regions like the EU and the UK is driven by the voice of the people, more so than in Australia. In Australia, policy will be a tool to support sustainable outcomes, however, should not be the main driver. Throughout my travels, the 'who pays?' question kept arising; It is my belief that we are all accountable for paying the bill. The berry industry does not need to rely on government policy to increase sustainability. Australia and the berry industry has culture of innovation, resilience, and openness to adaptation and has the potential to be leaders in sustainability.

Australian berry supply chains must collaborate and be proactive in creating achievable sustainability targets. It requires shifting mindsets, investing in relationships across the supply chain, and making decisions grounded in science and shared responsibility. With the right balance of support, knowledge, and ownership, farms and supply chains can become not only more sustainable but also more profitable.

The power of collaboration cannot be emphasised enough when it comes to addressing challenges and creating change. Many of the challenges we face as growers are not unique to one grower in the berry industry and in many cases are comparable to other industries. The Australian berry industry does have a level of collaboration, evidenced by the emergence of Berries Australia which will be hugely beneficial in managing macro challenges similar between berry types. There is further scope for collaboration and co-op structures for berry growers, at all levels, though

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particularly when combating local challenges. Examples may include, technology, waste management, data management, biodiversity metrics and local advocacy.

The Australian berry industry is beginning to explore biodiversity management as a tool in IPDM programs. While in overseas regions, initiatives to improve biodiversity in growing systems exist, growers did not have tools for measuring biodiversity on farms. While berry growers may use techniques like trap cropping in the growing system, the ecosystem surrounding the farm is much larger. Knowledge about the ecosystem we operate in is limited and more information is required to understand how we are interacting within it and what opportunities exist to improve. Regional collaboration and monitoring are required to understand how growing practices within the growing region are influencing the local ecosystem.

The Australian berry sector has a strong emphasis on incorporating IPDM into growing systems, however it is beneficial to stay abreast of emerging technologies or risks to our system. Australia remains free of significant pests impacting production overseas, like SWD, where the agriculture sector has the luxury to watch new technologies emerge, such as SIT and gene editing. Reliance solely on honeybees for managed pollinator services is a risk for growers and supporting natural pollinators in the system and alternative pollinator research is important.

Innovations like UVC treatment and variable rate spray technology are opportunities in early commercialisation, Australian growers can work towards adopting. The green deal in the EU aims to significantly reduce pesticide use and restrict access. With this pressure on agricultural industries, transformations in berry growing may arise and the Australian berry industry should monitor progress.

Berries are increasingly grown in media in pots or bags and fertigated. In substrate systems, technology is available to enable growers to make informed decisions and optimise water and nutrient use in the entire growing system. The capacity to measure what water and nutrient is entering and leaving the system, creates the opportunity to understand how much fertiliser is flowing into the environment. Though we may not be forced to monitor or manage our discharge, as growers responsible for the environment we operate in, we should be accountable for limiting our impact.

In Australia, berry production systems have moved out of the soil and into protected substrate systems. While the growing system has provided the opportunity to improve fruit quality and yield, there are challenges from an environmental sustainability perspective. Each year resources like plastic, pots and coir, which are energy intensive to produce, are shipped across the world to customers. It generates high emissions from energy and transport use and where there are reliable solutions, post farm gate, we should question if there are more sustainable alternatives.

Sustainability is complex and balancing the 3 pillars of sustainability, economic, social and environmental aspects is challenging. The Australian berry industry are not strangers to innovation and adaptation and are well placed to become global leaders in sustainability.

Recommendations

- Collaboration, collaboration, collaboration. The power of collaboration is huge and the opportunities for collaboration are endless. Many of the challenges we face are not unique to berries and growers could look to other industries to help create solutions. There are opportunities to collaborate in the areas of technology development and adoption, management of waste and advocacy.
- Engage with other berry growers, growers and from other industries. Spend time to share experiences and learn and grow together. Be open and share learnings, failures, wins and opportunities. Solutions will be found more rapidly with less cost, if knowledge is shared.
- Acknowledge that we are all accountable for the sustainability of the supply chain, ecosystem and communities we operate in. Definitions of sustainability and priority areas may differ between growing regions. Berry growers should be proactive in identifying opportunities to become more sustainable within their context.
- Build relationships in your supply chain and build achievable sustainability goals together. Own the outcomes of those goals.
- The grower voice needs to be heard by policy makers. To attain Australia's net zero target, legislation will feature in agriculture. Be active in communicating the grower perspective to local government, farmer groups, HIA or Berries Australia. Berries Australia is perfectly aligned for this on a macro level, while other grower groups may be more effective in local regions.
- Sustainability is complex and help is needed to simplify it for growers and consumers. In this area, the berry industry could be supported by the government, universities or HIA. Sustainability credentials are a mechanism which can already be used by growers. Asking for sustainability credentials from suppliers will allow for growers to make informed decisions, with little effort, protecting the community and environment from which the product originates. A good example where this can be readily taken up by berry growers is in coir purchasing.
- The Australian berry industry is entering maturity and is beginning to explore ways to remain competitive, like export and product differentiation. Players in the berry industry should seek to understand the opportunity in export of berries and the challenges of entering the export market in a significant way. Learn from other more experienced exporters, like members of the cherry industry, and learn from their experiences from the grower level up.
- Most growers understand that biodiversity is important, but mechanisms are lacking to enable growers to understand the ecosystem they operate within. Development of measurement tools are necessary, to assist growers and regions in understanding the impact of farming practices at an ecosystem level. The tools need to be local and meaningful and generate data that aims to identify areas for improvement and provide capacity to monitor the impact when farming practices change.
- Aim to be constantly improving in fertiliser and water management. Understand what nutrient is lost in the drain and look to minimise waste. Investigate the suitability of decision-making tools or reuse technology and their suitability in your system.

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- The berry farm is labour intensive and dynamic which creates huge opportunity to incorporate new technology and robotics. Members of the berry industry should keep an eye on new and emerging technologies. Industry funding could be used to assist assessing new technology and fast-tracking technology development to commercialisation.

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