Hort Innovation

Final Report

VegNET - Victoria (South-East, West and Northern Regions)

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Project code:

VG18003

Project:

VegNET - Victoria (South-East, West and Northern Regions) VG18003

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Content

Summary

This project provided research and development (R&D) extension services, products and communication to the Victorian vegetable industry related to:

- Farm productivity
- Resource use
- Business management
- Markets and consumers
- Technology.

It operated in the South-East, West and Northern regions from July 2019 to March 2020 as part of the National Vegetable Extension Network (VegNET). This project was an extension of the original VegNET Victoria (South-East, West and Northern) (VG15048) project which ran from April 2016 to April 2019.

The objectives of the project were to effectively extend R&D information to Australian vegetable growers through the continued delivery of regional VegNET services until the end of March 2020. These services included:

- Deliver regional capacity building services to the vegetable industry in Victoria, excluding East Gippsland (delivered by Food & Fibre Gippsland)
- Increase knowledge of vegetable R&D and facilitate the adoption of R&D by vegetable businesses in Victoria
- Increase the reach of the vegetable R&D program by engaging stakeholders in the vegetable value chain and developing trusted networks at a regional level
- Provide linkages to national vegetable industry communications, knowledge management and industry development services.

The project aimed to build the profile and connection with productivity and R&D with growers and other industry stakeholders.

A summary of the key achievements of the project over the past nine months include:

- Knowledge transfer and events: 7 workshops, grower group / networking events and webinars delivered, 301 one-on-one farm visits and meetings undertaken, and participation, support or co-delivery for 2 industry events
- Extension material: 1 fact sheet, 2 case studies developed (with associated video series)
- Communication material: 9 issues of the project e-newsletter complemented by strong industry e-newsletter and media coverage, project website and Twitter account
- Industry coordination and engagement: 15 trials and linkages to other levy and non-levy funded research projects
- Accomplishment of project outcomes: strong delivery and engagement (360 growers and industry stakeholders), improvement in knowledge and skills relating to improved decision-making (78% of participants) and practice change (33% of participants), while delivering on the identified priority issues and needs of the target audience.

The main project outcomes were:

- Increased reach and knowledge of vegetable levy R&D outputs
- Increased adoption of improved practices and innovation through application of R&D
- Effective and efficient partnerships and linkages established across industry.

Achievement against each of these activities and towards each of these outcomes is discussed in more detail in this report.

The project team consistently participated in the national coordination teleconferences and meetings to improve collaboration between the 10 VegNET regional delivery partners.

The RMCG extension team worked closely with the Food and Fibre Gippsland (FFG), who delivered the Victoria – Gippsland capacity building project, as well as AUSVEG VIC, Hort Innovation, AHR, the national coordinators, and Coutts J&R, the monitoring and evaluation team.

Keywords

Vegetable, extension, regional, network, industry development, awareness, knowledge, adoption, practice change, Victoria.

Introduction

Purpose of project

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Background

VegNET Phase 1 was delivered from April 2016 to April 2019 and encompassed 10 regionally delivered extension projects for the Australian vegetable industry. The VegNET project has been run by RMCG throughout the South-East, West and Northern regions of Victoria since May 2016 and has aimed to build the capacity within the Victoria vegetable industry to adopt levy-funded R&D.

Building on the national network developed during Phase 1, an 'Extension strategy for the Australian Vegetable industry' was completed by late 2019. VegNET Phase 2 is expected to commence in April 2020 informed by the strategy and an implementation plan.

This iteration of the project provided an opportunity to ensure continuity of service delivery for vegetable levy payers through to March 2020 via continuing the Phase 1 projects.

Linkages to industry strategic plans

The intended outcomes of this project was to increase the reach and knowledge of vegetable R&D to Victorian vegetable growers, increase the adoption of improved practices and innovation through application of R&D, and improve the profitability and marketable yield amongst participating growers.

The VegNET project will continue to contribute towards a number of strategies and plans relevant to the vegetable industry. This will primarily include outcome 5 of the Vegetable Strategic Investment Plan 2017-2021:

- Improved capability of levy payers to adopt improved practices and new innovation through improved communication and extension programs, grower innovation support, professional development and workforce building programs, and through improved farm management and information systems.

Key issues for the Victorian vegetable industry

The key R&D-related issues for Victorian vegetable growers identified through an ongoing needs analysis survey and additional consultation by the RMCG project team through the original VegNET project were:

Farm productivity

- Knowledge and experience with growing particular crops
- Biosecurity
- Minor use and access to chemicals
- Pest and disease management

Resource use

- Climate suitability
- Water availability and security

Business management

- Cost of production

Markets

- Knowledge and experience of marketing products

Technology

- Labour saving

The additional agri-political issues that were not directly addressed by this project included:

- Labour supply, access to appropriate skills and industry relations
- Competition from land growth and urban encroachment
- Right to farm.

These continued to be the responsibility of the state industry association, AUSVEG VIC.

Methodology

Project Plan

A detailed Project Plan was developed at project inception. This document contained the:

- Program logic and monitoring and evaluation (M&E) framework
- Risk management plan
- Stakeholder engagement and communication plan
- Project work plan for the period July 2019 to March 2020.

The original Plan is provided in Appendix 1.

Program logic

The program logic forms the high-level framework for the Project Plan and governs the subsequent monitoring and evaluation (M&E) framework. This includes consideration of the hierarchical connection between the project activities and the Vegetable Industry Strategic Investment Plan (SIP) outcomes. This included considering the hierarchy and connection between:

- Relevant SIP outcome(s)
- End of project outcomes: what the project will contribute to after completion
- Intermediate outcomes: within the sphere of influence and measurement of the project timeframe, these include:
    1. Increased reach and knowledge of vegetable levy R&D outputs
    2. Increased adoption of improved practices and innovation through application of R&D
    3. Effective and efficient partnerships and linkages established across industry
- Outputs: a measure of activities achieved
- Activities: undertaken over the 9-month period
- Foundational activities: that will underpin and inform the implementation of annual activities.

The Monitoring and Evaluation Plan for the project is provided as a sub-section of the Project Plan in Appendix 1. Key components of the monitoring and evaluation plan are included as reference in the program design, including the program logic outlined in Figure 1 below.

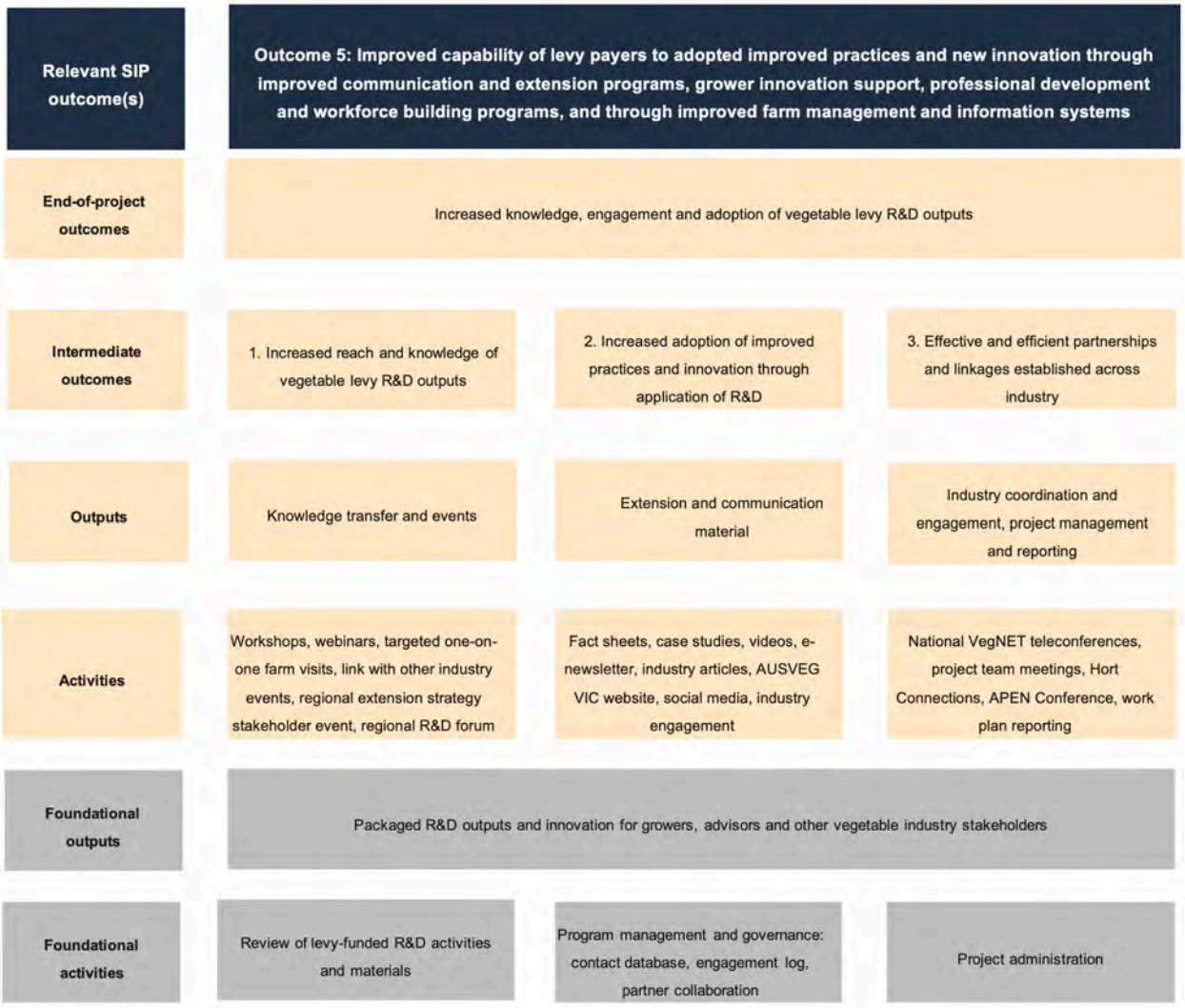

Figure 1: Program logic for the VegNET project 2019-2020

Risk management plan

There were a number of risks that required management for project outcomes to be achieved. The risks identified, range across technical, biophysical, extension, partnerships and internal.

These included:

- Project delivery is not collaborative and/or aligned with other regional capacity building projects in the vegetable industry
- Partnerships not developed with advisors and key influences
- Unable to identify relevant R&D to program objectives to extend to growers
- Producers and advisors not willing and/or able to participate
- Producers are faced with an overload of information
- Loss of key personnel
- Project management risks (budget, time, quality, scope).

The likelihood and consequence of these risks were analysed using a recognised risk matrix. While some risks were rated as having a Major impact when uncontrolled, all risks had a residual treated risk level of below medium. This demonstrated strong project management by the RMCG team.

Stakeholder consultation plan

The key stakeholder groups for this project included:

- **Vegetable businesses:** including progressive, advancing and stable growers
- **Advisors and Agribusiness service providers:** including commercial resellers and agronomists, private agro-chemical companies, specialist advisors, financial and business management providers
- **Industry associations:** including AUSVEG and AUSVEG VIC
- **Researchers:** including consulting firms, Federal Government agencies and universities
- **State Government agents:** including Agriculture Victoria (DJPR), Department of Environment, Land, Water & Planning (DELWP), and relevant Catchment Management Authorities (CMAs)
- **Supply chain participants:** including input providers (e.g. seed companies, fertiliser suppliers), nurseries, processors, packers, businesses providing vegetable growing contracts, contract service providers (planting, harvesting, labour, cool stores and transport, wholesalers and markets, retailers
- **VegNET delivery partners** in the other nine regions around Australia.

These stakeholder groups were considered and analysed further in the Project Plan to determine the most appropriate engagement methods in terms of type, delivery, timing and location. This governed the design of the knowledge transfer and event outputs in particular.

Communication plan

Communication was central to the project activities to deliver regional capacity building services to the vegetable industry in Victoria, excluding East Gippsland, through increased knowledge and adoption of vegetable R&D. It was therefore essential to communicate with people about the topics that interest them, and through platforms where they already seek information.

The communication plan outlined:

- **Target audiences and outcomes:** included the main stakeholder groups outlined in the engagement plan. A desired outcome from communicating with each group was analysed against the International Association of Public Participation (IAP2) framework[1]
- **Mode, tools and purpose:** project communication involved a mix of face-to-face delivery across the regional areas, as well as online, and both soft and hard copy resources. The different tools and purpose within each of these modes was analysed at the start of the project
- **Delivery approach:** administered through a regional extension framework, with contact Field Officers located in each of the core focus regions (Northern, Western, and South-Eastern regions). The Field Officers worked with growers, advisors and industry partners across the regions to deliver regionally targeted services to address priorities and support the adoption of industry relevant R&D.

Work plans

A work plan was developed to guide the operation and delivery of the VegNET project. Evidence of progress and completion of these plans were included in 3-monthy milestone reporting to Hort Innovation.

The completed project work plan is provided in Section 5 of the Project Plan in Appendix 1, as well as updates against the plan in Appendix 2.

[1] See: https://www.iap2.org.au/Tenant/C0000004/00000001/files/IAP2_Public_Participation_Spectrum.pdf

Outputs

A list of outputs delivered from July 2019 to March 2020 is provided below.

Knowledge transfer and events

A total of 59 growers and industry stakeholders were engaged in 7 VegNET events, with an additional 301 one-on-one farm visits and meetings undertaken over the 9 month period (see examples in Figure 2). These numbers exclude the participation, support or co-delivery for other industry events. Further details are provided below.

- Workshops:
    - Establishing Vegetation Insectaries + R&D Project Updates in October 2018 (11 participants)
    - VegNET 2 Strategy Sessions in August 2019 (x2 in Cranbourne and Werribee with 16 participants)
- Grower groups / networking:
    - Precision Agriculture and Soil Wealth Integrated Crop Protection Farm Walk in November 2019 (10 participants)
    - Increasing the Effectiveness of Biological Controls Farm Walk in March 2020 (1 participant)
- Webinars[2]:
    - *Irrigation and Water Management* in December 2019 (11 participants)
    - *R&D Project Updates* in March 2020 (10 participants)
- One-on-one farm visits, meetings and needs analysis undertaken with 301 growers and industry stakeholders (see Appendix 3 for details)
- Participation, support or co-delivery for 2 other industry events:
    - Precision Systems Grower Study Tour (VG16009) in July 2019
    - AUSVEG VIC Annual General Meeting in October 2019.

[2] Note: all webinar recordings are available at https://www.ausvegvic.com.au/communication/video-2/

Figure 2: Examples of knowledge transfer and events – native vegetation insectaries + R&D project updates workshop (top), irrigation and water management webinar (middle), and precision systems growers tour (bottom)

Extension material

- Fact sheets[3]: 1 finalised with extensive peer review and approval from industry experts (provided in Appendix 4):
    - Native Vegetation Insectaries
- Case studies and videos[4]: 2 developed (all provided in Appendix 5):
    - Translating Precision Agriculture Data in Werribee South, Victoria – Fresh Select
    - Effective Integrated Weed Management – Schreuers & Sons (2x video series in addition to a written case study in conjunction with the UNE Strategic Approach to Weed Management and RMCG/AHR Soil Wealth ICP teams)

Communication material

- E-newsletter coverage[5]:
    - Monthly Growing Veg Businesses e-newsletter: 9 issues circulated to 616 subscribers with a 33% open rate (above industry average of 20%) and 6.4% click rate (example provided in Figure 3):
        - Issue 33 – July 2019
        - Issue 34 – August 2019
        - Issue 35 – September 2019
        - Issue 36 – October 2019
        - Issue 37 – November 2019
        - Issue 38 – December 2019
        - Issue 39 – January 2020
        - Issue 40 – February 2020
        - Issue 41 – March 2020
    - AUSVEG Weekly Update: 29 articles in the national industry newsletter
    - VegNET e-newsletters: 9 articles across various national delivery partners
- Media coverage:
    - Vegetables Australia magazine: 2 articles (example provided in Figure 3):
        - *VegNET – Part II* (Spring 2019/20)
        - Creating a permanent habitat for beneficials through insectaries (Summer 2019/2020)
- Victorian project website: significant contribution to the content of www.ausvegvic.com.au. AUSVEG VIC, FFG and RMCG collaborated to curate the content of the website (example provided in Figure 3). An overview of the analytics since the launch include:
    - Users: 6,962 (98% new visitors, 2% returning visitors)
    - Sessions: 8,025
    - Bounce rate: 75%
    - Session duration: 1 minute 05 seconds
    - Most popular pages: Lamattina Family Story, East Gippsland Vegetable Days, Paul Horne IPM Technologies, and Kelly Brothers
- Twitter account: @GrowingVegBizs with 562 followers. Examples of key Tweets and analytics are outlined in the figures below.

[3] Note: all fact sheets are available at https://www.ausvegvic.com.au/communication/veg_mof/
[4] Note: all case studies are available at https://www.ausvegvic.com.au/resources/case-studies/
[5] Note: all past issues are available at https://www.ausvegvic.com.au/e-news/

Figure 3: Examples of communication material – e-newsletter (top left) and Vegetables Australia magazine article (top right).

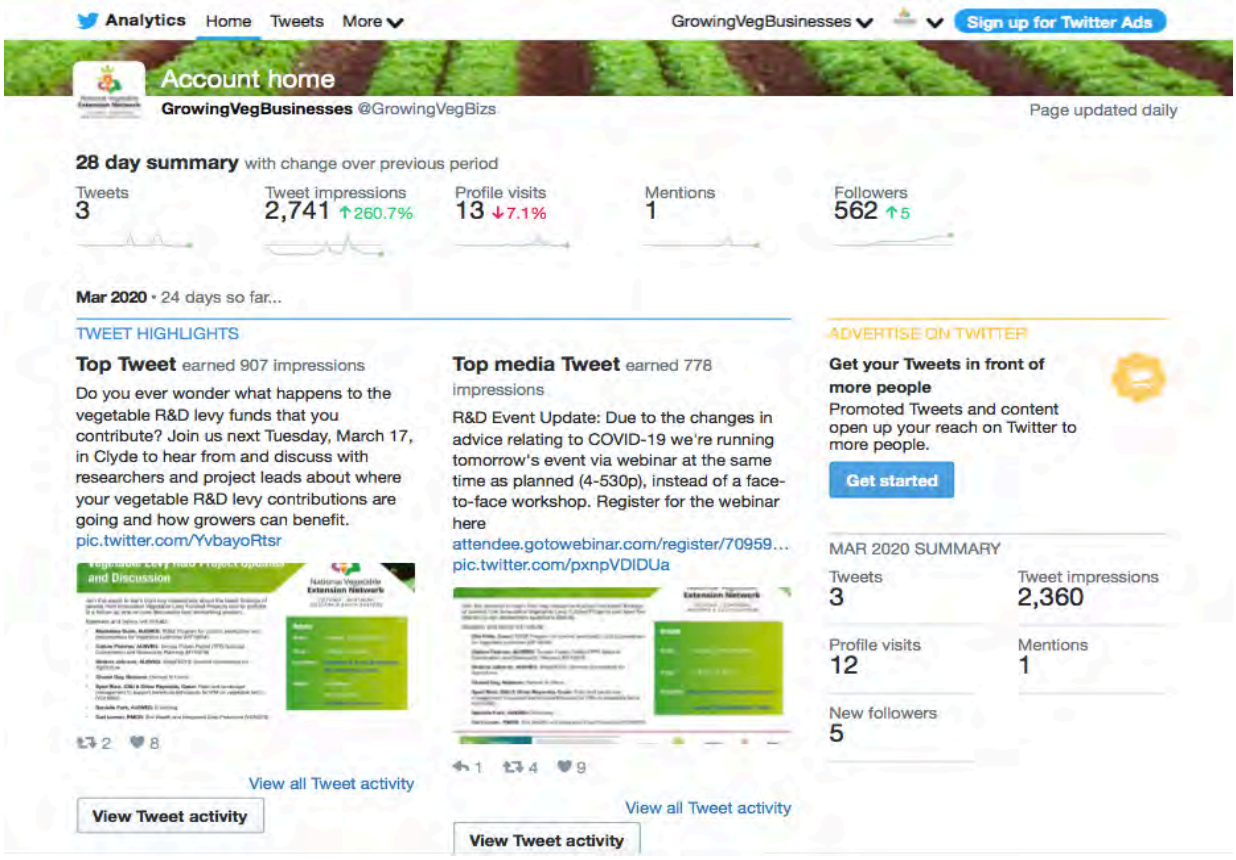

Figure 4: Example Twitter analytics used to engage the Victorian vegetable industry (March 2020)

Industry coordination and engagement

The project consolidated its position as a central point of contact and referral for the vegetable industry in the relevant Victorian regions.

The strong industry coordination and engagement is evidenced by the trials and linkages to 15 other levy and non-levy funded research projects. These have included:

- QDAF adoption of precision agriculture project (VG16009)
- UNE strategic weed management project (VG15070)
- VegNET Gippsland, New South Wales and Tasmania projects in relation to events and resource development
- Area-wide management of insect-vectored viral and bacterial diseases (VG16086) assistance with site visits, communication of outputs and workshop delivery
- Agrichemical Pest Management Needs and Priorities (VG16060) national pest survey
- Soil Wealth and Integrated Crop Protection (VG16078)
- Optimising cover cropping project (VG16068)
- RD&E Program for control, eradication and preparedness for Vegetable Leafminer (MT16004)
- Tomato Potato Psyllid (TPP) National Coordination and Biosecurity Planning (MT16018)
- iMapPESTS: Sentinel Surveillance for Agriculture
- Harvest to Home (MT17015)
- Field and landscape management to support beneficial arthropods for IPM on vegetable farms (VG16062)
- EnviroVeg (VG16063)
- Vegetable Industry Export Program (VG16061)
- Vegetable industry education and training initiative (VegPRO) (VG15028).

Outcomes

The project team continuously monitored and evaluated activities to ensure progress towards the desired outcomes in accordance with the program logic contained in the Monitoring and Evaluation section of the Project Plan (outlined in Appendix 1). Being adaptive with 3-monthly planning cycles with associated verbal milestone reports to Hort Innovation also allowed the project to continue to meet the needs of growers and the Victorian industry.

The end-of-project outcome was *increased knowledge, engagement and adoption of vegetable levy R&D* outputs. The intermediate outcomes that contribute to this outcome that could be directly measured within the project timeframe and geographic region (Victoria – South-East, West and Northern regions) were:

1. Increased reach and knowledge of vegetable levy R&D outputs
2. Increased adoption of improved practices and innovation through application of R&D
3. Effective and efficient partnerships and linkages established across industry.

Evidence of achieving each of these project outcomes is provided below.

1. Reach and knowledge

Increased reach and knowledge of vegetable R&D was a primary focus of the project with concrete evidence that this has been achieved. In particular, there have been positive evaluation results from knowledge transfer and events that directly contribute to this outcome, including:

- There has been strong delivery and engagement over the 9-month project period:
    - 360 growers and industry stakeholders engaged in the project
- Knowledge and skills of the target audience has improved as a result of being involved with the project:
    - Change in knowledge and confidence from 2.0/5 prior to the event to 3.6/5 following the event on average (1 = not very much, 5 = a lot) (32% improvement)
    - 78% of participants have an improved ability to make more informed decisions following the event
    - Practice change: 50% of participants will change farm practices or advice following the events
- The events are highly appropriate and meeting the needs of the target audience:
    - Topic & content: 4.3/5 on average (1 = very poor, 5 = very relevant)
    - Delivery: 4.4/5 on average
    - Relevance to business: 4.7/5 on average
    - Venue location: 4.6/5 on average
    - Catering: 4.6/5 on average
    - Timing (date and time of day): 4.4/5 on average
    - Role of Field Officer (RMCG): 4.7/5 on average
- The project delivered on the identified priority issues and needs of the target audience:
    - Farm productivity: 5 topics, or 71%, in direct project events
    - Resource use: 4 or 57%
    - Business management: 4 or 57%
    - Markets and consumers: 1 or 14%
    - Technology: 2 or 29%.

2. Adoption

Increased adoption of improved practices and innovation has been a major outcome of the project with strong support that this outcome has been met. The VegNET project has directly changed grower, advisor and stakeholder work practices (or advice) and adoption of new technologies over the past 9-months, which is predicted to have a lasting impact beyond the project.

A total of 50% of respondents said they will make changes as a result of the project activities (Figure 5). In addition, one third (33%) were unsure if they were going to make a change. It important that this cohort of growers and industry stakeholders is identified and prioritised for follow up during the potential Phase 2 project over the coming months. This will maximise value and return on levy investment of the VegNET project.

In addition, the extension and communication material developed by the project (listed in the outputs section of this report) will also provide an ongoing legacy accessible to growers and industry stakeholders. This is housed centrally on the AUSVGE VIC website and will also contribute to further adoption of best practice, in conjunction with the necessary advice and support.

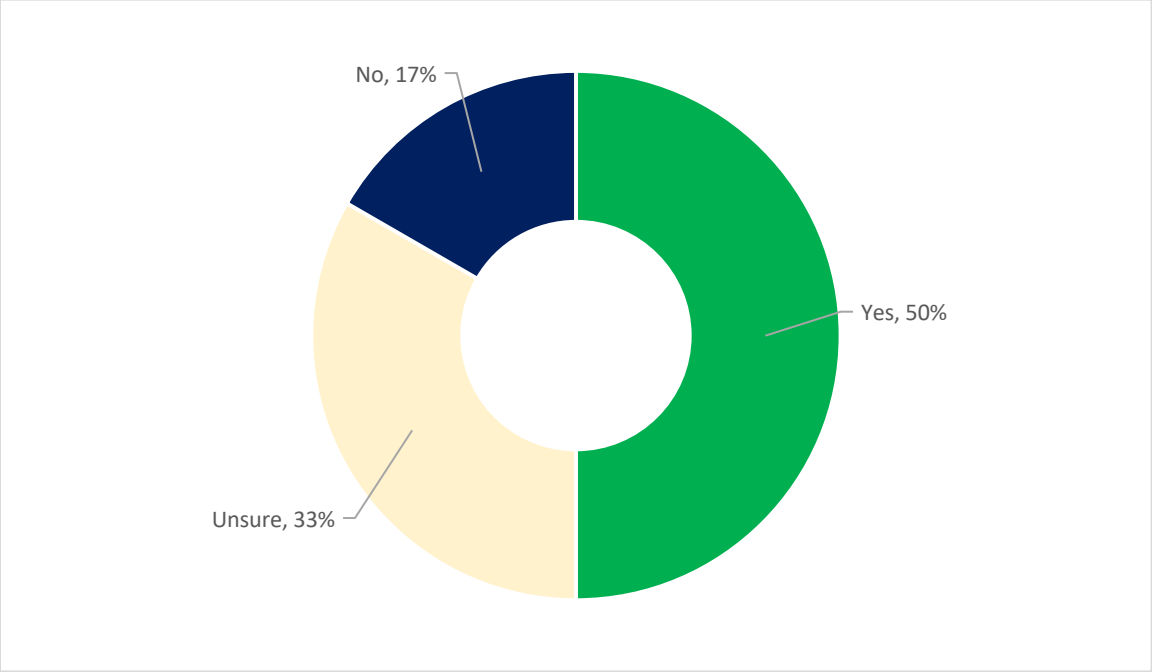

Figure 5: Practice change and adoption of new technology over 9 months as a result of VegNET (South-East, West and Northern) activities.

The project is highly valued by participants as keeping them informed about the latest development in vegetable R&D. In reference to the effectiveness of the VegNET project, one grower noted,

> "Having somebody who can heard the cats on a regional basis is critical. RMCG is doing it."

The VegNET project has assisted several growers in adopting new practices and technologies. One such example saw the VegNET project linking a Werribee grower and to the Adoption of Precision Systems project (VG16009) and the Soil Wealth and Integrated Crop Protection project (VG16078) for synergies between projects. Through these linkages, an EM38 maps and gridded soil samples of a trial plot were taken. From the data collected, a variable rate map was generated to apply a higher rate of gypsum in the most sodic areas. Further, compost is being trialled to mitigate some of the effects of salinity. The EM38 map and gridded soil samples will now provide a detailed foundation of data on which to observe improvements made by future decision-making at the site.

3. Partnerships and linkages

Significant progress has been made in achieving outcome 3 which underpins the achievement of reach and knowledge (outcome 1) and adoption (outcome 2) – effective and efficient partnerships and linkages established across industry. The effectiveness of the partnerships and linkages made through this project is evident through the significant industry coordination and engagement role of the project (outlined in the outputs section of this report), relevance of events held to stakeholders needs as well as the flow-on effects of the linkages. These flow-on effects include:

- Additional regional/local action on an R&D topic catalysed by the project
- Additional funding to progress a topic of need at the regional/local
- Brokering of existing industry networks at the regional/local level (e.g. between growers, advisors/agronomists and researchers)
- Establishment and coordination of new networks at the regional/local level (e.g. between NRM agencies and growers).

Further consolidation and growth of the partnership arrangement between FFG and AUSVEG VIC has improved the delivery of the project. This includes regular meetings between the RMCG and FFG project teams and briefings of the AUSVEG VIC State Manager and feedback from the AUSVEG VIC Executive Committee.

A total of 29% and 71% of respondents said the topic and content of the events were excellent and good, respectively, with no respondent saying adequate or lesser (Figure 6). This demonstrates an excellent understanding of the industry needs, with a focus on quality over quantity for the events run over the 9-months period.

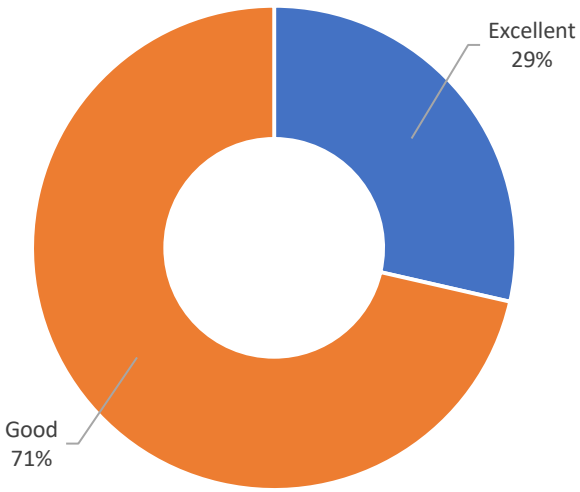

Figure 6: Effectiveness of linkages over 9 months as a result of VegNET (South-East, West and Northern) activities.

A prime example of the effectiveness of the linkages established through the project is the flow-on effects of the Native Vegetation Insectaries workshop. As a result of the workshop, which was originally driven by interest from local Werribee growers, grant funding is being applied for from the Commonwealth Communities Environment Program for Werribee growers to establish native vegetation insectaries along their riparian corridors. The extent of this linkage is yet to be seen, as made evident by the team leader stating

".. it was(is) certainly possible to apply a regional scale corridor if there was (is) multiple benefits for [local utility], growers and the community … if we get the grant for the three growers to 'start up' insectaries on farm, perhaps we can pursue a longer term 'biodiversity' approach once the growers have confidence in the concept.".

This outcome was only made possible through VegNET driven linkages between Port Phillip & Westernport CMA, E.E. Muir & Sons, Charles Sturt University and RMCG.

Monitoring and evaluation

Project monitoring plan

The achievement of the performance expectations, including indicators and measures, set in the M&E Plan to assess the performance of the project in achieving its intended outcomes is provided in Table 1 below.

The analysis of achievement against the intermediate (project) outcomes shows the strongest advances in knowledge and capacity gains, followed by practice change. This is significant as they are the two primary outcomes of the VegNET project both in Victoria, and nationally. The most difficult outcome to measure was indicative impact related to effective and efficient partnerships and linkages established across industry. This is because the results of building these linkages may not come to fruition immediately.

Table 1: Achievement against project monitoring plan

Logic level	What to monitor	Performance expectation (KPIs) and/or Monitoring questions	Data collection - method (e.g. survey) and source (e.g. growers)	Achievement
Foundational activities	Establishment of partnerships	Partnerships established with AUSVEG VIC and other VegNET regions (e.g. extension of statement of intent)	Meeting minutes	**Completed**
Activities and outputs	Number of one-on-one visits Number and types of workshops Number of workshop participants Number and type of engagement activities Number of linked industry events Communicati on articles	Identification of key documented challenges, including R&D uptake trends and barriers 3 workshops # of participants at workshop 9 e-newsletters 1 case study 2 fact sheets with technical notes 1 video/podcast	Project records and documents Feedback from participants (e.g. event survey forms)	**Completed**
Intermediate outcomes	Changes in knowledge, attitudes, skills and aspirations (KASA) around identification and promotion of	Defined roadmap to support increased knowledge, engagement and adoption of R&D outputs in the vegetable industry Increased knowledge / industry support of challenges and strategies in	Observations Feedback from industry stakeholders - formal and informal, qualitative and quantitative (including veg extension strategy	**Completed**

Logic level	What to monitor	Performance expectation (KPIs) and/or Monitoring questions	Data collection – method (e.g. survey) and source (e.g. growers)	Achievement
	R&D outputs	extending R&D outputs in the vegetable industry	development workshop)	
End-of-project and longer-term outcomes	Implementation of strategy to extend R&D outputs further throughout the vegetable industry	Increased uptake rate of innovation within the vegetable industry	Feedback from industry Case studies Final report	**Significant progress** **Two case studies completed**

Lessons learnt

There are a number of lessons for the delivery of regional extension services to the vegetable industry as a result of the VegNET project both in Victoria and nationally, which include:

- **The reputation and awareness of VegNET has consolidated and continues to grow:** it has now grown to become a central point of information provision, industry coordination and connection. Through established networks the RMCG team has been able to build the VegNET brand as a trusted, reliable and well-informed source of R&D findings and information for all growers, advisors and industry stakeholders.
- **Having a 'go-to' contact is important for grower connection:** the RMCG project team had three Field Officer servicing each of the three regions around the state. We will consolidate this local contact for growers by providing a single point of contact through the Regional Development Officer position. All Field Officers were independent, and performance managed in accordance with the Hort Innovation contract, as well as meeting every fortnight to share updates, news and explore issues common to all regions.
- **Continuity is key:** over the past nine months and three years prior, RMCG has built trusted relationships with growers throughout Victoria. Gaining this trust has been key to building connections between growers and other stakeholders as well as ensuring that growers' needs are met. Continuing these relationships are critical to success of Phase 2, particularly in revealing the true needs of growers and ways in which VegNET RDOs can best support these needs.
- **Timing is critical to respond to industry needs:** by undertaking a rolling needs analysis the project team were able to monitor and address the needs of growers in real-time throughout the project term, which will inform the development of the Regional Extension Plan under Phase 2.
- **Extension and industry development continue to be complex:** with growers facing so many changes and emerging issues, it is important that extension efforts keep pace with the needs of the industry. This can be challenging to balance short-term acute issues versus longer-term more strategic matters of importance. The VegNET project was responsive to these changing needs over the 9-month period and the VegNET Phase 2 project is well-placed to build on this strong base. These will be better understood through the Regional Extension Reference Group under Phase 2.
- **Tailored extension approach for different industry segments:** it is important that a needs analysis and segmenting of the industry segments is undertaken early in the project. This includes grower size and location as well as their current preferred sources of information. Stakeholder analysis assists in determining the key issues, where people source their information from, as well as preference in activity type (e.g. workshop setting versus 1:1 farm visit) and communication channels. If undertaken early in VegNET Phase 2, a stakeholder analysis will then allow providers to tailor the delivery of extension to the target audience in each region, which differed considerably (e.g. South-East region had a greater demand for shared learning via workshops and training, with the Northern region preferring individual farm visits and e-news).
- **Partnerships are critical for collaboration and industry cohesion:** significant progress has been made in the collaborative working relationship between RMCG, FFG and AUSVEG VIC. This included continuation of the Statement of Intent that outlined the roles and responsibilities for each organisation and how they worked effectively over the duration of the project, as well as Website Operating Principles (provided in Appendix 6). For VegNET Phase 2, improvements could explore more formal partnerships with deliverers (e.g. event hosting, sponsorship, co-delivery, catering) as well as roles on the Regional Extension Reference Group.

Recommendations

The recommendations below are based on the lessons learnt from the extension of the first phase of VegNET, feedback from industry and other key stakeholders, and an understanding of R&D needs of the Victorian vegetable industry.

1. Continue the VegNET projects nationally into a second phase. This is the subject of a current Request for Proposal (RFP) with RMCG having submitted a proposal on 18 March 2020. The seamless provision and continuity of services to industry in the short-term is critical to ensure that the strategic planning activities early in Phase 2 most accurately capture the Victorian vegetable industry's needs.
2. Build on the lessons learnt from the three Victorian regions for the delivery of VegNET Phase 2. This includes:
    - 'Do the basics well' and provide the opportunity for knowledge exchange and events, extension material, complemented by multiple forms of industry communication channels (e.g. utilising existing industry communication platforms like e-newsletters, responding to biosecurity incursions)
    - Continue to adapt the extension model to meet the ever-changing needs and emerging issues of the vegetable industry (e.g. non-production issues such as marketing may increase in focus in the short-term, increased breadth of issue coverage over the medium to long-term as business management evolves)
    - Explore more formal partnerships with deliverers to further promote collaboration and industry cohesion (e.g. event hosting, sponsorship, co-delivery, catering)
3. There is still the opportunity to scale-up the R&D Adoption Award initially developed at a state level for the 2017 AUSVEG VIC Awards for Excellence with delivery partners in other states. The project team is willing to share experiences and criteria to facilitate this expansion for the benefit of national extension, which should be discussed further with Hort Innovation.

Refereed scientific publications

None to report.

Intellectual property, commercialisation and confidentiality

No IP, commercialisation or confidentiality issues to report.

Acknowledgements

The RMCG team would like to acknowledge the Victorian growers, advisors, researcher and industry stakeholders who contributed their valuable time and expertise to the VegNET project. Your continued support has ensured the project has been a success, and established a strong foundation for future industry development and extension of vegetable R&D.

We acknowledge the Traditional Owners of the Country that we work on throughout Australia and recognise their continuing connection to land, waters and culture. We pay our respects to their Elders past, present and emerging and the Elders of other Aboriginal and Torres Strait Islander communities. Moreover, we express gratitude for the knowledge and insight that Traditional Owner and other Aboriginal and Torres Strait Islander people contribute to our shared work.

Appendices

- Appendix 1: Project Plan, including Monitoring and Evaluation Plan (CONFIDENTIAL)
- Appendix 2: Work plans updates (CONFIDENTIAL)
- Appendix 3: One-on-one farm visits and meeting register (CONFIDENTIAL)
- Appendix 4: Fact sheets
- Appendix 5: Case studies and videos
- Appendix 6: Project partners' Website Operating Principles (CONFIDENTIAL)

Appendix 4: Fact sheets

Native vegetation insectaries – permanent habitat for beneficial insects

National Vegetable Extension Network
VICTORIA - NORTHERN, WESTERN & SOUTH EASTERN

Key messages

- **Planting an insectary of flowering native vegetation for beneficial insects is a simple farm practice that can be achieved at relatively low cost and wihtout impeding production.**
- **Diversity and abundance of beneficial insects is key to building farm resilience, particularly against seasonal variations and new pest incursions**
- **Insectaries are not necessarily regular 'native plantings'; there are much more complex interactions occurring which should be considered when planting an insectary, including species selection**
- **The best way to decide where to carry out your planting and what to plant is to talk to other growers and advisors who have had experience in setting up an insectary**

What's a native vegetation insectary?

On-farm insectaries are areas of flowering plants that attract and maintain beneficial insect populations by providing shelter from highly disturbed crop areas as well as alternative food sources, namely pollen and nectar.

The goal of on-farm insectaries is to enhance diversity and abundance of beneficial insects on your farm to build resilience, particularly against seasonal variations and pest incursions. Acting as a 'fixed home address' for beneficial insects to interact with your crop, they complement cultural and biological control methods of your integrated pest management (IPM) program.

On-farm insectaries provide 'SNAP'[1] for beneficial insects:

- Shelter for overwintering and safety from weather and higher order predators
- Nectar to provide a source of carbohydrate energy
- Alternative prey to maintain beneficial populations until they are needed in the crop
- Pollen which provides the protein necessary for egg

[1] Mary Retallack, Viticulture in South Australia titled Vineyard

The advantages of planting native vegetation compared to non-native vegetation are numerous and include reduced likelihood of harbouring pests and diseases that can affect crops, longer flowering windows, lower maintenance and water requirements, and increased habitat and connectivity that better support native biodiversity including native beneficial insects.

In addition to providing better pest management, insectaries can perform multiple functions and provide multiple benefits, as outlined in Table 1.

Table 1: Pros and cons of native vegetation insectaries

Pros	Cons
Pollination and other ecosystem services (e.g. carbon sequestration, increased infiltration)	Harbouring of pests and diseases (e.g. rabbits or light brown apple moth)
Habitat and food source for insects and other wildlife (e.g. insect corridors, birds)	Upfront costs
Multipurpose design (e.g. shelterbelts/windbreaks, perennial groundcover)	Maintenance (e.g. bushfire management, ocassional irrigation)
Biodiversity values & environmental stewardship (consider offsets in planning applications)	Potential competition for resources with crop
Meet obligations of Environmental Assurance Programs	
Income diversification (e.g. bush food production)	
Long-term cost savings	
Aesthetics	

Hort Innovation Strategic levy investment | VEGETABLE FUND

This project has been funded by Hort Innovation using the vegetable research and development levy and funds from the Australian Government. For more information on the fund and strategic levy investment visit horticulture.com.au

Port Phillip & Westernport CMA

RMCG

Developing an insectary

There are a couple of easy steps to consider when developing an insectary:

1. Locate areas on your property that you can plant an area of flowering plants. You can be creative with what you classify as your insectary, refer to some examples in Table 2.
2. Establish the insectary by selecting the appropriate plant species and location to best achieve your goal(s). Refer to Table 3 for a list of plant species suitable to the Greater Melbourne area developed by the Port Philip and Westernport CMA. Some plants have been referred to as "hero" plants for their remarkable ability to host beneficial insects, for example:

- *Bursaria spinosa* (sweet bursaria) – hosts lacewings, ladybeetles, assassin bugs, spiders
- *Austrodanthonia sp.* (wallaby grass) – hosts brown lacewings, assassin bugs, spiders
- *Leptospermum continentale* (prickly tea-tree) – hosts ladybeetles, lacewings, spiders

3. Consider monitoring the activity of beneficials and possibly pests in and near the insectary using sticky traps, sweep nets or observation

Table 2: Ideas for insectaries with multiple purposes

Examples of multi-purpose design for insectaries
• Container (or banker) plantings at various locations around each block
• Grassy drainage lines – native grasses provide excellent low maintenance groundcover and habitat for beneficial insects
• Embankments – flowering shrubs and native grasses provide good erosion control
• Surrounding a dam for erosion control and water filtration (grasses, sedges)
• Land classes zoned unsuitable for production
• Garden beds
• Existing headlands, buffers, shelterbelts (create understory) and hedgerows

Native vegetation insectary FAQs

Where should I plant my insectary?

- Within 50 m of crop areas (more likely to impact on pests)
- Grass plantings under vines/trees, inter-row or end of row
- Land unsuitable for cropping
- Headlands, buffers or shelterbelts – new plantings or create an understorey
- Container plantings at various locations around each block
- Grassy drainage lines – native grasses provide excellent low maintenance groundcover and habitat for beneficial insects

Which species should I plant? (see Table 3)

- Choose low, middle and upper storey species for diverse habitat
- Maximise flowering time – aim for 'year-round' flowering for a permanently available nectar source
- Select plant species that host beneficials and not pest species – e.g. *Leptospermum continentale* hosts several beneficial insects, but can also host the pest light brown apple moth

How much will it cost?

- An insectary can be established for as little as $200, and can be developed over time
- The main costs are making land available, tube stock or seeds, planting and maintenance (e.g. irrigation and weed control). In some areas fencing may be necessary to protect young plants from browsing animals

Other tips:

- Think about the long-term goals you want to achieve
- Talk to others who have set up insectaries
- Consider planting a small 'test' area before embarking on a large insectary planting – see what grows well and monitor flowering activity and capacity to attract beneficial species

Additional resources

Australian Native Plants Selector APS Query – a program that enables the selection of Australian native plants to suit specific requirements (search for nectar and insects).

http://anpsa.org.au/download.html

Growing Australian Plants – An Australia Government Initiative in partnership with the Australian National Herbarium and the Australian National Botanic Gardens to provide Australians with information on how to grow Australian native plants as well as where to buy them.

https://www.anbg.gov.au/growing-plants/index.html

Landscape diversity and field margin management – a vegetable levy-funded project (VG14047) investigating the role of field margins and landscapes surrounding crop fields in providing resources to beneficial organisms and reducing arthropod pest pressure in vegetable and other crops.

https://ausveg.com.au/app/data/technical-insights/docs/VG14047.PDF

NatureKit – a tool to map Victoria's biodiversity that can allow you to determine what flora (and fauna) are native to your property and local area.

https://www.environment.vic.gov.au/biodiversity/naturekit

Port Phillip & Westernport CMA – have undertaken substantial work in the trials and establishment of native insectaries within the greater Melbourne area. Several Victoria specific resources are available on their website.

https://www.ppwcma.vic.gov.au/what-we-do/sustainable-agriculture/native-insectarium-trial/

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Table 3: Native plants suitable for insectaries in Werribee (Port Philip & Westernport CMA, 2019).

Strata	Species	Common name	Insectary benefit
Upper storey	Eucalyptus sp.	Manna, peppermint, messmate, swamp gum	Food source for beneficials
Middle storey trees	Acacia dealbata	Silver wattle	
Middle storey shrubs	Bursaria spinosa	Sweet bursaria	Highly beneficial nectar producing plant
	Leptospermum continentale	Prickly tea-tree	Highly beneficial nectar producing plant
	Leptospermum lanigerum	Woolly tea-tree	Food source for beneficials
	Melaleuca squarrosa	Scented paperbark, or swamp paperbark	Food source for beneficials (in wet areas)
	Acacia suevoelens	Sweet wattle	Nectar producing
Lower storey shrubs	Epacris gunnii	Heath	Food source for small beneficials
	Mentha australis	River mint	Small nectar-producing flowers, prolific habit, edible
	Helichrysum scorpiodes	Everlastings	Food source for beneficials
	Brachyscome multifida	Cut leaf daisy	Food source for beneficials
	Correa reflexa	Common correa	Food source for beneficials
	Epacris impressa	Common heath	Food source for beneficials
	Stylidium armeria	Common trigger plant	Food source for small beneficials
	Grevillea rosmanifolia	Rosemary grevillea	Food source for beneficials
	Grevillea alpina	Alpine grevillea	Food source for beneficials
	Prosanthera rotundifolia	Round leaf mint bush	Food source for beneficials
	Thryptomene calycina	Victorian laceflower	Food source for beneficials
	Westringia fruticosa	Coastal rosemary	Food source for beneficials
Groundcovers	Dichondra repens	Kidney weed	Food source for beneficials and groundcover habitat
	Kenedia prostrata	Running postman	Food source for beneficials and groundcover habitat
	Acacia brownii	Heath wattle	Food source for beneficials and groundcover habitat, prostrate
Grasses	Austrodanthonia caespitosa	Common wallaby grass	Shelter, breeding habitat for brown lacewing
	Austrodanthonia setacea	Bristly wallaby grass	Habitat
	Microlaena stipoides	Weeping grass	Habitat
	Themeda triandra	Kangaroo grass	Habitat
	Austrostipa	Speargrass	Habitat
Lilies – hard to establish	Arthropodium milleflorum	Pale vanilla lily	Generalist insect attracting
	Arthropodium strictum	Chololate lily	Generalist insect attracting
	Bulbine bulbosa	Bulbine lily	Generalist insect attracting
Semi-aquatic/ aquatic	Amphibromus archeri	Pointed swamp wallaby grass	Riparian insect habitat
	Melaleuca ericifolia	Swamp paperbark	Nectar flowers
	Juncus sp.	Rushes, sedges	Riparian insect habitat
	Ranunculus amphitrichus	River buttercup	Food source for beneficials

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Precision agriculture in vegetable production

National Vegetable Extension Network
VICTORIA - NORTHERN, WESTERN & SOUTH EASTERN

Overview

Precision agriculture (PA) technologies have been widely adopted throughout various agricultural industries in Australia, but what exactly is PA, and what benefits can it provide the Australian vegetable industry? This fact sheet provides information on the different types of technologies that are available, what they do, and how they have the potential to benefit your farming system.

What is precision agriculture?

Precision agriculture (PA) is the use of new technologies in collaboration with existing practices to perform a range of specific on-farm tasks. Also commonly referred to as site specific crop management or SSCM, PA works to better manage practices and inputs to match variations that occur in the environment. As opposed to an 'all-in' approach when applying fertilisers, chemicals, and other inputs, PA aims to assess the needs of specific areas and plants in the field and apply the required inputs accordingly.

As well as better managing inputs, PA technologies also encompass a range of innovative new ways to harvest, manage pests, weeds and diseases, and understand more about the needs of vegetable crops (e.g. irrigation, nutrition). Whilst PA technologies use a range of new technologies to help increase productivity, reduce costs and environmental impact, they still rely on conventional agricultural operations to work. They won't work as a silver bullet and address all problems, but used wisely they have the potential to better manage specific areas of your growing operation. Some of the most widely used PA technologies used in vegetable production include:

- **Global navigation satellite systems or GNSS** (commonly known as GPS) – used as guidance systems for the navigation of tractors, bed formers, and other on-farm machinery
- **Yield mapping/monitoring** – used to understand the variations in crop health in specific areas of a field and provide information for decision-making
- **Nutrient/water monitoring** – used to understand the variations in nutrient/water uptake and flow, and provide information for decision-making
- **Variable rate controllers** – technology that allows varied amounts of inputs to be applied to specific areas needed, such as water and fertiliser.

Key messages

- **Precision agriculture technologies help growers to better manage inputs to meet the needs of vegetable crops**
- **Benefits of precision agriculture include maintaining uniformity across the crop, reduced costs associated with inputs, and greater knowledge of in-field variation to inform decision-making and management**
- **Technologies currently available to vegetable growers include a range of tools that aid in on-farm sensing and monitoring such as variable rate application and controlled traffic farming**
- **Important considerations when thinking of using precision agriculture in your vegetable production system include: i) get the fundamentals right; ii) know what you're going to use the technology for; iii) find technology that operates with your existing equipment; iv) invest time and effort up front; and v) remember not all technologies are right for every farm**

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Benefits of using PA in vegetable production

PA technologies have the potential to benefit a wide range of vegetable production systems through reducing costs associated with labour, being more precise with the application of inputs, and having a greater knowledge of the in-field variation in different parts of your farm. As mentioned, PA shouldn't be thought of as a silver bullet in dealing with all problems, rather as something that will assist you in being more efficient with your current systems. Benefits to production systems can include:

- Increased accuracy of bed formation
- Reduced compaction
- Greater knowledge of drainage patterns
- Greater knowledge of soil structure/types
- Increased input efficiency (e.g. water, fertilisers)
- More effective control of pests, weeds, and diseases
- Increased consistency of crop development
- Increased marketable yield
- Increased hygiene standards.

The use of PA technologies, with existing agronomic knowledge, has the potential to result in a more productive and profitable vegetable business.

CLICK HERE: http://www.abc.net.au/news/2016-02-11/precision-agriculture/7162914 to watch a video on the benefits of PA adoption

Technologies currently available

The advancement technology in recent years has reduced the price and increased the reliability of ag-tech products, making them more easily accessible for vegetable growers and others in the industry.

Since the early 1990s a wide range of technologies have been developed to assist farmers in producing better quality products, at a lower cost, in a more productive manner. There are a wide range of technologies that are now common practice in farming systems around the world that aim to do this. In Australia, the uptake of technologies has been seen in a wide range of agricultural industries all the way from production to packing. The most popular and widely used technologies in the Australian vegetable industry include a range of sensing equipment that are designed to aid in performing tasks like fertiliser application, soil sampling, farm mapping, and yield/nutrient/water monitoring. Generally, the most established of these in Australian vegetable production being variable rate application (VRA) and in-season controlled traffic farming (CTF), with adoption being higher in some vegetable producing regions than others. VRA allows growers to better match inputs with the needs of crops, by applying the required amount of inputs to the specific area it's needed in the crop (e.g. water, nutrients). CTF enables growers to use the same wheel tracks when planting, spraying and harvesting, resulting in reduced compaction and runoff, and potential increases in yield.

CLICK HERE: https://www.youtube.com/watch?v=4JbKaAsyRkI&feature=youtu.be for more information on controlled traffic farming and variable rate application

Many companies have jumped on board, innovating and investing in new technologies for growers. Ag-tech company The Yield has created a range of sensing products that aim to aid growers in completing a range of on-farm tasks. One of their products was developed through a Hort Innovation funded project, which includes data analytics and app technology to guide on-farm irrigation scheduling. The end result of this project was an application, that can be accessed through the app store, which takes data from the Bureau of Meteorology and translates it into relevant on-farm information for growers. The data that's presented in the app includes information on temperature, evapotranspiration rates, water balance and wind activity. This information, which is provided on a regular basis and is specific to your location, has the ability to aid growers in irrigation scheduling and other water management tasks.

CLICK HERE: https://www.theyield.com/products/free-growers-app for more information on The Yield's free app for vegetable growers

Robots in vegetable production

Due to increasing issues with labour availability and rising input costs, there has been a focus to develop autonomous robots to perform a range of weed and crop monitoring, sensing, and harvesting tasks in vegetable production. These technologies have been gaining rapid traction over the past few years, with a range of technologies emerging both in Australia and internationally.

RIPPA (Robot for Intelligent Perception and Precision Application) and its cousin, Ladybird, are autonomous robots that have been designed through the Horticulture Innovation Centre for Robotics and Intelligent Systems (HICRIS) at the University of Sydney's Australian Centre for Field Robotics (ACFR). Funded through Hort Innovation using vegetable industry levies and funds from the Australian Government, these new technologies aim to increase sensing, automation and decision-support on farm. RIPPA, which is currently still under development, has the ability to:

- Identify and mechanically remove weeds
- Detect and remove foreign objects in-field
- Monitor crop and soil health
- Administer precise amounts of herbicides to specific target weeds
- Monitor crop growth.

Similar to RIPPA, there is a long list of robotic systems that have been designed to assist vegetable growers in producing more with less. Large companies like Bosch, Yamaha and John Deere, have been involved in developing new robotic systems, as well as smaller start-up companies like Ecorobotix and Blue River Technologies overseas.

CLICK HERE: https://www.youtube.com/watch?v=klTGHCTmCoY&t=1s for a short video on RIPPA demonstrating its abilities in field

Adoption of PA technology

PA technologies have been used extensively throughout agricultural industries since the early 1990s, however, the rates of adoption have varied across different industries. This variability can be attributed to a range of factors which commonly involve the complexity of the products, interoperability problems with different hardware/software devices, and the initial costs of some of the equipment.

Due to the potential savings on inputs and increased productivity involved with the adoption of PA technologies, there have been initiatives set out to try and increase the adoption rates of PA technologies in Australia. Organisations like the Society of Precision Agriculture Australia (SPAA), have aimed to help growers and others in the industry understand the benefits of PA in agricultural systems. Similarly, a current project run by the Queensland Department of Agriculture and Fisheries aims to focus on adoption rates in Australia by taking commercially available PA technologies and implementing them on vegetable farms. The project, which has demonstration sites located all over Australia, takes a wide range of different technologies based on the needs of different growers, and implements them on-farm to demonstrate how they have the ability to improve production. This includes EM38 mapping to identify soil constraints, variable rate irrigation in centre pivot systems, as well as yield monitoring and mapping in different crops.

CLICK HERE: http://www.soilwealth.com.au/resources/articles-and-publications/adoption-of-precision-systems-technology-in-vegetable-production-highlights-january-june-2018/ for the most recent project highlights.

Important considerations

PA has the potential to benefit a range of growing systems, there are however several important things to consider when thinking of using PA technologies in your production system. When determining whether you need PA technologies for your farm, think back to the basics of production, and work out how you will benefit from using these technologies. Keep in mind that PA technologies won't help solve problems related to the fundamentals of production, rather it will assist in making your current practices more efficient and precise. Remember to follow these important principles:

1. **Get the fundamentals right:** make sure you're doing everything correctly in your production system before you spend money on additional technology.

2. **Know what you're going to use the technology for:** some technology can be expensive, if you have any existing PA technology, make sure you're using it to its full potential before investing in any more. Have a clear purpose.

3. **Try and find technology that is able to interact with one another:** to reduce interoperability problems, make sure the software/hardware you invest in is compatible.

4. **Invest time and effort:** make sure you invest the time and effort into learning how to use the technology, so you get the most out of it. Document information on how to use the technology so it's easier the second time round, and for your employees to use.

5. **Not all technologies are right for every farm:** every production system is different and requires different tools and technologies. What works for one farm may not work for another.

Further information

For further information on precision agriculture in vegetable production watch this 1-hour informative webinar that involves a range of industry professionals and covers a breadth of topics relevant to the vegetable industry: http://www.ausvegvic.com.au/pages/precision-agriculture-technology-in-vegetable-production-systems-webinar-recording/

CLICK HERE: http://horticulture.com.au/hortlink-2018-edition-1/vegetable/ if you'd like more information about current Hort Innovation projects related to PA in vegetable production.

Notes from Clinton:

- Whos who in the zoo fact sheet (ausveg, ausveg vic, rmcg, hort innovation,
- talk about the process of procuring research
- Research service providers progresses through to VegNET (which is targeted at growers),
- then we work with ausveg vic for the website; complimentary but not in direct competition

How the levy system works

On behalf of Australia's primary industries, the Department of Agriculture collects, administers and disburses agricultural levies and charges on rural commodities and products under the authority of Commonwealth legislation. In 2018-2019, the department disbursed $18.2 million in levies, charges and Commonwealth matched payments to Horticulture Innovation Australia Limited (**Hort Innovation**), of which $9.42 million was collected through the vegetable levy.

Hort Innovation is one of the nation's 15 Rural Research and Development Corporations tasked with investing horticulture levies and Australian Government contributions into initiatives that help the industry be as productive and profitable as possible. Together, Hort Innovation and Plant Health Australia (PHA) are responsible for the expenditure of the vegetable levy.

Revenue that is collected from a levy or charge is directed to either biosecurity preparedness, emergency plant pest and animal disease responses, marketing, research and development or residue testing. Hence, primary industries that choose to invest using the levy system, such as the vegetable industry, are often better equipped to respond to the emerging trends and challenges that arise from operating in highly competitive world markets. To find out the levy amount that you pay or what proportion of your levy goes to which initiatives, click here.

What activities does my levy contribution fund?

It's important that the investment of levy funds represents the interests and opportunities of a given industry. To ensure this, in close consultation with industry (**AUSVEG**, in the case of vegetables), Hort Innovation creates and renews Strategic Investment Plans (SIPs) for each industry fund. The SIPs are used by industry-specific Strategic Investment Advisory Panels (SIAP), whom provide advice to Hort Innovation regarding potential levy investments, to ensure that levy investment decisions align with industry priorities. Click here to find out more about this process.

The SIAP acts as an intermediary between growers and Hort Innovation. Growers can submit their ideas for research and development to Hort Innovation through Hort Innovation's online investment idea proposal form. Ideas in line with the Vegetable Fund strategic investment priorities go the Vegetable Fund SIAP whom provide further advice to Hort Innovation on how to translate said idea into a practical project proposal.

Who carries out the Vegetable Levy funded R&D activities?

Project proposals are distributed and made public for potential delivery partners to respond. Responses are assessed, often with assistance from industry, and the best service provider is chosen to undertake the project. Contracts are issued, and the project begins.

Service providers of Hort Innovation levy-funded projects can range from universities and other research institutions, to industry bodies, state agencies, corporates, not-for-profits, independent providers and everyone in between. For example:

- the VG15076 'Creating value from edible vegetable waste' project was delivered by CSIRO
- the VG14048 'Review of current irrigation technologies' project was delivered by Irrigation Australia
- the VG15070 'A strategic approach to weed management for the Australian vegetable industry project is being delivered by the University of New England
- the VG15020 'Strengthened biosecurity for the Australian vegetable industry – stage 2' was delivered by AUSVEG.

Some Hort Innovation projects are too complex for one service provider to undertake the project alone successfully. This may occur for several reasons including geographic constraints, gaps in either expertise or regional connections within a single organisation or timeframes and available manpower. In these cases, service providers can either partner or subcontract to fulfil the requirements of the project proposal.

How do growers benefit from Hort Innovation projects?

A great example of providers partnering to deliver a Vegetable levy-funded project is the National Vegetable Extension Network (VegNET) project. VegNET is an umbrella project for multiple *Regional capacity building to grow vegetable businesses* projects, which fund industry development officers (IDO's) in key vegetable growing regions throughout Australia.

Through VegNET, the IDO's, within their respective regions, are responsible for delivering special events, creating and distributing R&D outcome-related practical materials that are targeted at growers and gathering information to inform future R&D projects. These activities include R&D forums, grower site visits, a monthly newsletter with updates and daily twitter posts. Growers are encouraged to contact their local IDO's to access the latest information and resources generated from the IDO's extension program activities as well as details about events and how to best stay informed.

VegNET Victoria

Victoria has four IDO's, one for each defined region of Victoria. These include:

- South-Eastern region: Carl Larsen (RMCG, carll@rmcg.com.au)
- Gippsland region: Bonnie Dawson (Food & Fibre Gippsland, bonnie.dawson@foodandfibregippsland.com.au)
- Western region: Clinton Muller (RMCG, clintonm@rmcg.com.au)
- Northern region: Ken Orr (ken.orr54@bigpond.com)

To best extend R&D to Victorian growers, RMCG has partnered with the Victorian branch of AUSVEG, **AUSVEG VIC,** in a complimentary role assisting with the distribution of information

and levy-funded research outcomes through the AUSVEG VIC website, one of AUSVEG VIC's distribution channels. On the AUSVEG VIC website growers can find a calendar of events, a library of resources including case studies, videos, reports and fact sheets/technical notes, an archive of VegNET and AUSVEG VIC newsletters and further information about AUSVEG, AUSVEG VIC and VegNET.

Appendix 5: Case studies and videos

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Translating Precision Agriculture Data in Werribee South, Victoria

VegNET and Soil Wealth ICP
February 2020

Precision ag in vegetable production

Precision agriculture (PA) refers to technologies that improve productivity by considering the variability of agricultural land and crop growth at sub-farm, row or plant scale. Also known as 'site-specific crop management', PA can ensure the right crop management strategies are implemented in the right place at the right time.

Despite the theoretical benefits of PA, the rate of adoption by growers of many crops remains low and, in some industries, is negligible.

In Victorian vegetable production, PA is in its early days. Compare this with broadacre systems, in which, for example, EM38 mapping and associated variable rate application of different inputs have been utilised for several decades. Uptake of controlled traffic farming (CTF) and auto-steer technology has also been significant in broadacre over the last decade. In horticulture, the practical application of EM38 mapping to inform decision-making has only begun to be trialled in the past couple of years.

Details of when, why and how precision technologies may be best used in horticulture are still open to interpretation. When is it financially beneficial to use PA in vegetable production? How do we translate data into management decisions? And what are the barriers to more widespread use of PA in vegetables?

One study in Australian grains (2011) measured potential monetary benefit of EM38 mapping (which measures spatial variations in electrical conductivity of the soil) to growers at $14–46 per hectare per year for fertiliser

and $69 per ha per year for gypsum[1]. But how might these figures compare with vegetable production, intensively practiced over much smaller areas with multiple crop rotations?

Case study: soil salts in Werribee South

OVERVIEW

Headquartered in Melbourne's Werribee South region, Fresh Select is one of the largest lettuce and brassica growers in Australia. As a leader in innovation, sustainable farming techniques and responsible practices, they have also been one of the first to trial PA technology in vegetables.

THE PROBLEM

The Werribee South vegetable growing region is challenged by sodic-saline soils arising from historic sodicity and salinity, saline recycled and river irrigation water, and reliance on irrigation due to low rainfall. Prolonged drought has further reduced irrigation water quality and quantity, and dealing with soil salts pose a major issue for vegetable growers in the region.

Sodicity is best measured by exchangeable sodium. Soils with exchangeable sodium greater than 6% are considered sodic, and those greater than 15% strongly sodic. In Werribee South, ESP can measure up to 12%, adversely affecting the soil structure.

Salinity is a measure of all the soluble salts in the soil. Impacts on crop productivity can be particularly challenging during dry periods when irrigation water (sourced recycled water from Western Treatment Plant and river water from the Werribee River) also becomes more saline[2].

The 'double whammy' of sodicity and salinity in Werribee South can cause:

- Surface crusting
- Reduced seedling emergence
- Reduced soil aeration
- Increased run-off
- Low organic matter
- Low microbial activity
- Poor establishment, growth, plant vigour and/or tip burn.

[1] Electromagnetic induction sensing of soil identifies constraints to the crop yields of north-eastern Australia. Y. P. Dang et al. *Soil Research* 49(7) 559-571, 2011.

[2] Southern Rural Water (2009) Western Irrigation Futures Atlas

WHY AND WHAT TYPE OF PRECISION AG?

Management of sodic soils has historically involved input of gypsum to improve soil structure. However, longer-term management strategies are needed.

Management of salinity has generally involved careful fertilisation to mitigate the effects of salinity on the plant by balancing the cation exchange ratio to avoid nutrient deficiencies, and careful irrigation to avoid flushing nutrients out of the system and to maintain stable moisture levels.

Due to the potential variability of sodicity within and between fields, Fresh Select's agronomist, Stuart Grigg, supported by Hort Innovation project Soil Wealth and Integrated Crop Protection, has recently begun to trial PA technologies to improve decision-making regarding soil salts. Starting with EM38 mapping and matched gridded soil samples, with the aim of treating the problem areas with variable rate application of soil ameliorants such as gypsum and compost.

TRANSLATING PRECISION AG RESULTS

Interpretation of EM data can be a complex process, as electrical conductivity measures soil water content, clay content and salts.

The EM38 map of the trial block shows higher EC at the edges (blue/green, Figure 1).

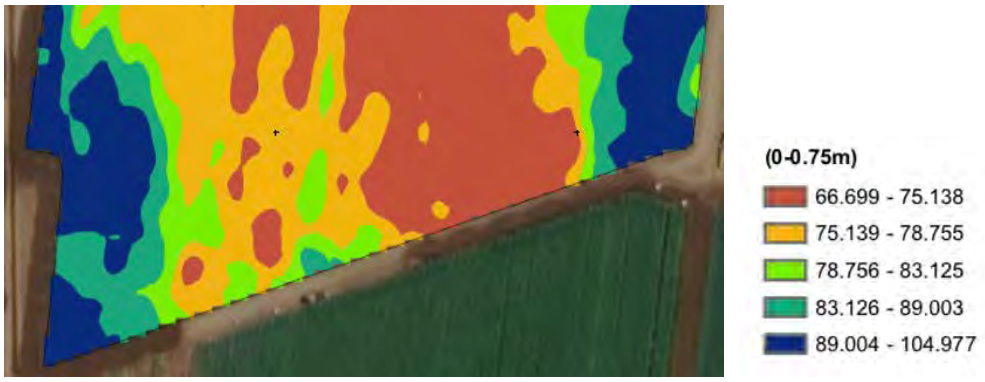

Figure 1: Section of EM38 map – electrical conductivity at 0-0.75 m depth; legend in mS/m. Width of field approx. 230 m.

The gridded soil samples found that the whole field is sodic, and there is some variation in the degree of sodicity. The EM38 map somewhat aligned with exchangeable sodium (Figure 2), but the EC variability was not completely explained by sodicity.

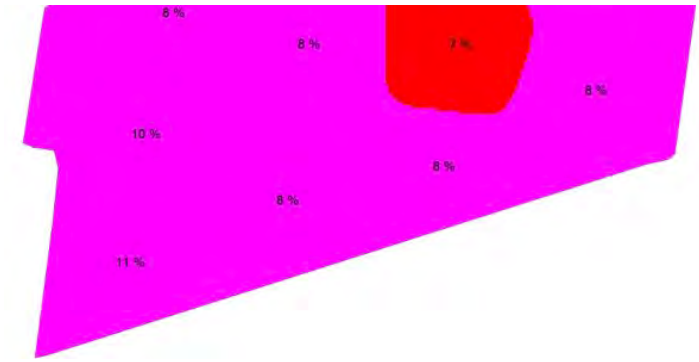

Figure 1: Section of grid sampled exchangeable sodium (0-20 cm depth).

Of the soil sample results (e.g. nutrient levels), chloride aligned most closely with the EM map pattern (Figure 3), likely indicating that salinity (NaCl is one of the most common soluble salts) may be the cause of the higher EC areas on the EM38 map.

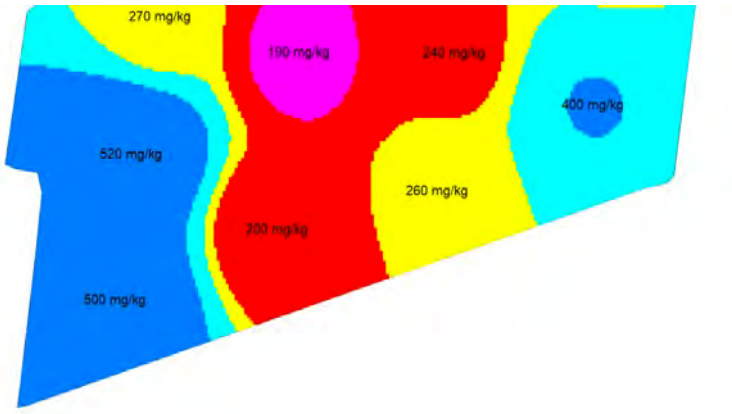

Figure 3: Section of chloride grid samples (0-20 cm depth).

Also, the 'shovel test' showed that the bottom left corner of the field had higher soil moisture, which would also contribute to the EC.

DECISION-MAKING WITH PRECISION AG

In accordance with the data collected, a variable rate map was generated to apply a higher rate of gypsum in the most sodic areas. Further, compost is being trialled to mitigate some of the effects of salinity. The EM38 map and gridded soil samples will provide a detailed foundation of data on which to observe improvements made by future decision-making at the site.

So, what do these early results tell us about PA in vegetable production? Firstly, ground truthing is key. In this case, the gridded soil samples were necessary to identify the likely causes of the EM38 results.

Secondly, PA may not always give you a straightforward answer. To benefit from the use of PA, growers must ensure they have or can outsource the skills or resources required to translate existing PA data into meaningful management decisions.

NEXT STEPS AND LOOKING TO THE FUTURE

The next steps for the Werribee demo site are to test the nutrient levels and plan growth measures to determine whether variable rate gypsum and compost addition have improved the parameters associated with salinity and sodicity.

Into the future, the main gaps in extending the reach of PA in vegetable production include determining how best and when best to use these technologies, including cost-benefit calculations. Other barriers include limited service providers and machinery ownership capacity, and ensuring that the different types of technology are aligned, such as data and mapping programs with tractors and sprayers.

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Effective Integrated Weed Management - Case Study

Managing weed seed banks through stale seed beds and inter-row cultivation

Schreurs & Sons, Clyde, Victoria

INTEGRATED WEED MANAGEMENT

Hort Innovation
Strategic levy investment

VEGETABLE FUND

une
University of New England

Summary

Grower

Adam Schreurs, *Schreurs & Sons*.

Location

Clyde and Devon Meadows, Cranbourne district, Victoria.

Rainfall

Approximately 750 mm annual average.

Soil type

Sandy.

Crops produced

Celery, leek, spinach, rocket, snow pea tendrils.

Major weeds

Common grounsel (*Senecio vulgaris*), mallow (*Malva parviflora*), dwarf nettle (*Urtica urens*), oxalis (*Oxalis* spp.), shepherd's purse (*Capsella bursa-pastoris*), chickweed (*Stellaria media*), wireweed (*Polygonum aviculare*), nutgrass (*Cyperus* spp.).

Integrated weed management strategy

- Post-harvest non-selective herbicide.
- Bed forming cultivation.
- Stale seed bed with multiple weed controls.
- Pre-emergent and/or post-emergent selective herbicide.
- Inter-row cultivation.
- Hand weeding of remaining weeds.

Key benefits

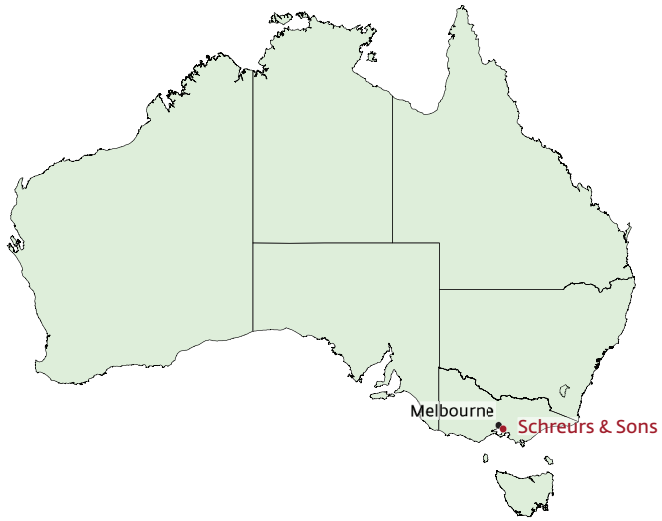
- Gradually reducing the weed seed bank over time, especially of potentially herbicide-resistant weeds.
- Reducing reliance on herbicides, and improving capacity to use herbicides more strategically.
- Minimising weed germination and competition within the crop.
- Reducing weed management costs (especially cultivation and hand weeding) over time.
- Improving soil health through reduced usage of deep cultivation.

Introduction

History

The Schreurs family have been growing vegetables in the Cranbourne district, approximately 50 km south-east of Melbourne, since the 1950s. Originally renowned for introducing Dutch carrots into the Australian market, Schreurs & Sons has now diversified into growing a variety of vegetable crops.

Today, Schreurs & Sons own five farms in the outer Melbourne suburbs of Clyde and Devon Meadows, totalling approximately 550 hectares. Across these farms, approximately 400 hectares are dedicated to vegetable production. The business employs about 180 staff, rotating across the five farm sites depending on need for ground preparation, planting and sowing, crop management, and harvest activities.



Map 1 Location of Schreurs & Sons, Cranbourne district, Victoria.

Adam Schreurs is one of several third-generation members of the family to remain involved in the business, and operates the business alongside his cousins Christopher and Ben Schreurs. Adam has been involved in the vegetable industry his whole working life, and his son is now becoming involved in the family business.

Crops

Today, Schreurs & Sons' most significant crop is celery, with approximately 20,000 tonnes grown each year. Other important crops include leek (Figure 1), spinach, rocket, and snow pea tendrils. Crops are grown intensively year-round, with a winter fallow period.

Figure 1 Planting a leek crop.

Farm characteristics

In this case study, we focus on Schreurs & Sons farm at Fisheries Road, Clyde. This farm was purchased by the Schreurs family in 2000, and today Adam acts as farm manager at this site, in addition to his business-wide responsibilities.

The site was formerly a dairy farm, and the initial weed burden faced by Schreurs & Sons reflected this land use history, including a large grass weed seed bank, as well as capeweed (*Arctotheca calendula*) and clover (*Trifolium* spp.). Over time, this weed seed bank gradually gave way to heavily-seeding annual broadleaf species, favoured by a vegetable production system.

This particular farm features sandy soil, receives an average annual rainfall of approximately 750 mm, and is 100% dedicated to vegetable production.

Former weed management approach

Weed management methods

Until the late 2000s, the weed management strategy used by Schreurs & Sons relied heavily on the following.

- *Regular and relatively deep cultivation passes*, employed post-harvest and during the fallow period to restrict weed growth before the next crop was planted.
- A range of *pre-plant and post-plant selective herbicides* registered for use within their various vegetable crops.
- In some crops, relatively few herbicide options were available, particularly post-emergence.
- *Hand weeding* was used to follow up on surviving weeds.
- *Chemical fumigation* (using metham sodium) was used with considerable success, particularly to reduce the dwarf nettle seed bank, and minimise its impact in rocket crops.

Why did they decide to change?

Reduced herbicide effectiveness

Adam and his team became concerned about reduced effectiveness of the relatively limited range of selective herbicides available to them. Some weeds commonly found on one of their farms, notably common groundsel, seemed to be developing resistance to the herbicides on which the business had heavily relied.

More strategic reliance on herbicides

Schreurs & Sons considered that it would be more effective to be able to utilise the selective herbicides available to them more strategically. This may involve integrating a greater variety of weed management techniques across the crop, post-harvest and fallow periods of the crop cycle, and moving away from a regular 'calendar spraying' approach to more flexible and responsive herbicide use.

A return to previous approaches

Prior to the emergence of the various herbicides which initially made growing most of their crops much easier, Schreurs & Sons had relied quite heavily on cultivation and bed management before, within and after their vegetable crops to help keep on top of weeds. Knowledge of these techniques remained in the family, and the reduced effectiveness of their herbicide options provided an opportunity to shift back to a similar approach.

A desire to reduce costs

As herbicides were becoming less effective, the team observed that cultivation and especially hand weeding costs were increasing. Diversifying the weed control methods used had the potential to reduce these costs over time, particularly if they led to reductions in the weed seed bank and therefore less weeds emerging in the crop.

A desire to improve soil health

Reducing the number of relatively deep cultivation passes during the winter fallow period was also an attractive option to Adam and his team. Their goal was to maintain and improve soil health and structure through a reduced till system, while not compromising the effectiveness of their strategy.

Concerns regarding chemical fumigation

In response to human, animal and soil health concerns regarding chemical fumigation, Adam preferred to move away from this practice.

Growing interest in organic production

Schreurs & Sons are interested in shifting at least some of their land into organic celery production in the longer-term. Looking at ways to reduce the business' reliance on herbicide therefore provided an opportunity to determine how effective alternative techniques may be.

New weed management approach

Since the late 2000s, Schreurs & Sons have grown to rely more heavily on stale seed beds and inter-row cultivation as options for reducing their reliance on regular herbicide application, and potentially reducing the cost of other weed management activities such as hand weeding. Subsequently, both methods have also become increasingly important in compensating for reduced herbicide effectiveness noted on the farm.

This Integrated Weed Management (IWM) strategy suits the large scale of Schreurs & Sons production system, which features a winter fallow period between crops. This period is long enough for multiple cohorts of weeds to germinate and be controlled in the formed beds using the stale seed bed technique, before the next crop is sown or planted.

Inter-row cultivation suits many of the crops produced by Schreurs & Sons, which are grown in rows along the crop beds.

Schreurs & Sons continue to rely on several other weed control methods as part of their overall IWM strategy. Each of the key components of this strategy is summarised below.

Cultivation to form crop beds

Bed preparation cultivation employed by Schreurs & Sons usually involves a single pass using a chisel plough to a depth of 300 mm, followed by two passes with a bed former.

Stale seed bed

A *stale seed bed* involves preparing the crop beds well before the crop is planted. Several cohorts of weeds are allowed to germinate in the beds, and controlled early each time using the broad-spectrum herbicide glyphosate (Figure 2). Shallow tillage of the crop beds may be used in place of broad-spectrum herbicide to control recently germinated weeds in an organic production system.

Schreurs & Sons implement a stale seed bed once each season. From approximately early June, the raised beds for the next crop are formed, and then for about the next six weeks the stale seed bed is in place until the next cash crop is planted.

Usually, the seed bed is irrigated once to encourage a flush of weed germination. Glyphosate is applied to the beds approximately four weeks after the bed has been formed, to control any weeds that have emerged. Additional weed flushes are controlled if time permits. The crop is then planted into the clean beds. Soil disturbance is minimised during planting to limit further weed germination.

Occasionally, the team may implement a shallow cultivation of the crop beds to control weeds rather than using glyphosate. However, this is usually not desirable for Adam as he believes it can open up the top 'crust' of soil and allow soil temperatures to decline. It may also encourage an additional cohort of weeds to germinate. This is not a problem if there is then time to cultivate or spray the additional cohort of weeds. However where the fallow period is relatively short, it can create a weed burden in the following crop.

The length of time a stale seed bed approach can be used by Schreurs & Sons is usually restricted by the amount of land available to about six weeks. Ideally, Adam would like to use longer-running stale seed beds, using a mixture of glyphosate application and shallow cultivation to germinate and control multiple weed cohorts. This may be feasible in other vegetable crops, and may be helpful where weed seed bank levels are very high (e.g. newly used fields).

Figure 2 A stale seed bed, ready for crop planting.

Inter-row cultivation

Inter-row cultivation involves one or more shallow passes in a growing crop, to till the rows between the crops on top of the raised crop bed, and/or in the wheel tracks. Some benefits may be achieved within the crop row itself as well, where inter-row cultivation implements may provide some 'hilling' of the soil, potentially covering and suppressing recently germinated small weeds.

Schreurs & Sons have two implements available to them to carry out inter-row cultivation.

- A 'Weedfix' cultivator using rotating tines (Figure 3).
- A customised cultivator, fitted with Dutch hoes and knives that has been set up specifically to suit the bed and row spacing used on the farm (Figure 4).

Both implements allow cultivation of the crop bed between the rows of crop plants, as well as on the sloped sides of the raised beds. Shallow inter-row cultivation is also completed within the wheel tracks by Adam and his team,using the customised cultivator.

The team usually uses inter-row cultivation twice, at least four weeks prior to harvest, and generally to a depth of 30 to 40 mm.

The Weedfix cultivator is used within less mature crops, and the customised cultivator is used within more mature crops. The relatively mature crops are able to withstand the more significant soil movement that occurs when using the customised cultivator.

GPS technology is not required to complete the cultivation passes. Experienced staff are able to complete each pass by eye at relatively high speed, using crop bed lines and irrigation risers as reference points.

Amongst the crops grown on the farm, celery and leeks are particularly suited to inter-row cultivation because of their relatively upright form. However, inter-row cultivation is used to varying degrees within all crops grown by the business.

Figure 3 A 'Weedfix' inter-row cultivator, used on the farm in less mature leek crops for shallow cultivation within the crop bed.

Figure 4 A customised inter-row cultivator, set up to the specific bed and row spacing used on the farm. The cultivator is being used within a more mature leek crop to cultivate within the crop bed as well as the wheel tracks.

Herbicide

Herbicides remain a critical component of his team's IWM strategy, although Adam believes that herbicides have become less effective in managing key weeds on the farm such as common groundsel.

Herbicides are usually used at rates towards the lower end of the recommended scale, to minimise the risk of damage to the crop. However if a heavy weed burden is observed, the application rate may be increased somewhat.

When are herbicides used in the crop?

Herbicides are used at various stages in the crop life cycle to manage weeds.

Pre-plant herbicides are regularly used where they are registered for the crop grown, primarily to manage broadleaf (dicot) weeds. Depending on the crop, these may be applied at the time of transplant, or a few days later providing each application adheres to label requirements and will not cause any damage to the crop. In some crops, more than one pre-plant herbicide may be used, with the second or subsequent products used in part to manage a wider range of weeds that may survive if only one pre-plant herbicide application was used.

Post-plant herbicides are often applied once within the crops, generally to manage grass (monocot) weed species.

Herbicide options and availability vary across the various crops grown by Schreurs & Sons. For example, multiple selective herbicides are available for use within the celery crop, but none within the snow pea tendril crop.

Rotating between various cash crops allows Adam and the team to employ different herbicide modes of action across growing seasons, allowing them to manage different weeds over time. One of the key benefits of herbicide rotation is in reducing the risk of herbicide resistance developing. When considered alongside the non-herbicide weed control techniques that have become increasingly important to Schreurs & Sons, a key outcome of their IWM strategy is to extend the useful life of the limited herbicides available to use within their crops.

Other herbicide application

The *broad-spectrum* herbicide glyphosate is sometimes applied outside crop periods at the highest registered rate to control nutgrass (*Cyperus* spp.) outbreaks. This is applied at the time of nutgrass flowering to increase the chances of success, by maximising uptake through the actively growing shoots and tubers. However, the level of success can vary considerably, e.g. depending on weather.

Hand weeding

Hand weeding is used to remove weeds that have survived pre-plant and post-plant herbicide application and inter-row tillage. It is less likely to be required in crops such as rocket and spinach which form a relatively thick canopy, compared with other crops produced by Schreurs & Sons such as leeks, which features a relatively upright, open canopy.

A team of 4-5 staff is usually assigned to hand weed, and are accountable for successful removal of weeds in a given area. Usually, hand weeding activity occurs relatively late in the crop. The soil is relatively light and so weeds can be pulled out from the soil easily by hand, without the need for implements such as hoes.

Adam considers hand weeding important in minimising crop contamination, reducing crop processing costs, and in helping to manage the weed seed bank by complementing weed control implemented at other stages of the crop cycle. Weeds that have produced seed are carried away from the field during hand weeding activity.

While hand weeding makes an important contribution to IWM for Schreurs & Sons, Adam considers it to be a last resort and a sign that the preceding weed management techniques were not as successful as desired. Where possible, hand weeding activity is minimised or avoided altogether, for example where the weed burden is considered to be relatively minor. Nonetheless, weed survivors which have flowered are often removed from the paddock by hand to help deplete the weed seed bank.

Benefits of the new approach

The key principle of the Schreurs & Sons strategy is to *minimise the number of weeds that mature and produce seed – particularly those weed species which they believe have started to show signs of resistance to herbicide*.

No matter what IWM approach is used, this principle is applicable to all vegetable farms.

Weed and farm management and impact

- Adam considers that the most significant benefit of the IWM strategy now employed by Schreurs & Sons has been to gradually reduce the weed seed bank.
- By introducing alternative methods (stale seed beds and inter-row cultivation), the team are successfully compensating for reduced effectiveness of the herbicides available to them, and at the same time reducing their overall reliance on these herbicides.
- Herbicides can be used more strategically, and the risk of herbicide resistance becoming a more significant issue on the farm can be expected to be less significant.
- Reduced tillage during the winter fallow and bed formation has been beneficial for soil health and soil structure.

Financial benefits

Despite initially being slightly more expensive than the former, more herbicide-reliant strategy, the IWM strategy now used by Schreurs & Sons has helped improve overall farm profitability.

- Improved crop yield and quality due to reduced weed competition.
- Reduced processing costs.
- Weed management costs are gradually reducing over time, as the weed seed bank is depleted.

Limitations of the new approach

Some weather conditions and stale seed beds

Stale seed beds are used by Schreurs & Sons during the winter, when vegetable crops are usually not grown. However, using a stale seed bed successfully requires a sufficiently dry paddock to be able to drive the tractor along the crop rows while spraying glyphosate.

If the paddock is wet for an extended period, it may be possible for weeds to establish and produce seed. Adam notes that this is particularly true of common groundsel and dwarf nettle, both of which are capable of germinating, growing and producing seed rapidly.

This means that relying on stale seed beds comes with a risk of replenishing the weed seed bank if paddocks are wet for an extended period.

Timing of inter-row cultivation is critical

Inter-row cultivation has been most effective when it is carried out early in the life of weeds – ideally, when weeds have just reached their first true leaf stage.

Waiting until weeds have had the chance to grow much larger than this can reduce the effectiveness of this method. Because inter-row cultivation utilises shallow tillage, larger weeds may not be removed from the soil.

At the same time, larger weeds that are removed can attach themselves to the tines. This is particularly an issue if the soil is relatively moist at the time of cultivation. Under these conditions, the weed may be dragged through the paddock and re-establish elsewhere. Weeds attached to the tines in moist conditions can also cause more soil to bank up against the crop plants, resulting in dirty produce.

Innovation in IWM

Adam's willingness to innovate and continually explore new approaches, or to re-introduce 'old' approaches which are known to work well if used appropriately, is one of the keys to Schreurs & Sons ongoing success, not only in weed management but across the business.

Figure 5 Adam Schreurs (Schreurs & Sons, left) and Carl Larsen (RM Consulting Group, right).

Before he makes a change, in weed management or elsewhere, Adam considers the economic and environmental pros and cons of the proposed change closely. He seeks advice from family members and others involved in the business, and other vegetable growers who have tried the approaches he is interested in. He also reads widely on innovative approaches, listens to relevant industry podcasts, and attends and hosts field events.

With regards to weed management, Adam remains keen to explore alternative options despite the current success of the IWM strategy in place for Schreurs & Sons. Some of the options that have recently attracted Adam's interest include the following.

- Cover cropping, to suppress weeds during the winter fallow and potentially to reduce the weed seed bank through a biofumigant effect.
- Thermal weed management (steam and/or flame weeding) and microwave weed control technology.
- Using a one-off chemical fumigant application, potentially with a product other than metham sodium, but only if the weed seed bank is observed to have increased significantly and weeds were becoming harder to keep under control using the current IWM strategy.
- Organic knockdown herbicides, which he considers are currently quite costly but are still worth bearing in mind as a future option.

Adam's willingness to support innovation in the vegetable industry is reflected by his willingness to host cover crop research led by the Hort Innovation-funded *Soil Wealth Integrated Crop Protection* project.

Carl Larsen from RM Consulting Group and an Industry Development Officer in Victoria for the Hort Innovation-funded *VegNET* project, considers Adam's continued willingness to innovate will allow Schreurs & Sons to keep their weed burden to a manageable level in the longer term. His approach to innovation is suitable to all vegetable farms.

Figure 6 Soil Wealth Integrated Crop Protection cover crop demonstration site, Schreurs & Sons (source: Carl Larsen).

Conclusion

The experience of Schreurs & Sons suggests that **being willing to try different approaches, use successful strategies diligently, and always being on the lookout for new approaches, will have longer-term benefits.**

Although their new IWM strategy was initially a little more costly and time consuming than the previous one where herbicides were more of a mainstay, Adam and the Schreurs & Sons team are now enjoying the rewards of their willingness to try something different, and to continue to innovate.

We are grateful to Adam Schreurs and the team from Schreurs & Sons for sharing their story of successful Integrated Weed Management, and to Carl Larsen (RM Consulting Group) for his thoughts on innovation in vegetable production.

Disclaimer

Descriptions of herbicide use in this guide are not to be taken as recommendations. Herbicides must only be used in accordance with the recommendations provided on herbicide labels. Readers are reminded that off-label use of herbicides may be restricted or not permitted under relevant legislation. Landholders are therefore advised to determine current registrations and legal requirements for herbicides they may be considering, and to consult with their State or Territory government departments regarding the legal requirements they are obligated to adhere to relating to herbicide use and weed control.

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