RMCG

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Agricultural technology training needs for Tasmania

Skills Tasmania, Department of State Growth

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Summary

This report provides a comprehensive review of all feedback received on agricultural technology (agri-tech, digital ag) skills needs during interviews conducted for “North West Agricultural Workforce Plan Consultancy Project” (the NW Ag Workforce Plan). It includes information from related studies where required to highlight relevant challenges and possible solutions.

The intention of this study was to identify the specifics of agricultural technology training needs in Tasmania, and to address the questions of:

- ‘What agricultural technology skills and knowledge are needed in Tasmania?’ (Section 3.2)
- ‘What is the market size for the VET training component of the need?’ (Section 4)
- ‘What are the priorities for agricultural technology training?’ (Sections 3 and 5).

While the review did not include any further primary research i.e. interviews, we have examined the feedback for the relevance for all of Tasmania and found that, given our work in other regions, and the national context referred to above, outcomes from this review are relevant for the entire state. We also included information on agri-tech training needs from related work RMCG have been conducting since finalising the NW Ag Workforce Plan. For the discussion of findings, we applied our knowledge of technology in agriculture and understanding of agricultural production systems in Tasmania.

This review of agricultural technology training needs for Tasmania concludes that there is a need for more investment in training in digital ag/agri-tech to underpin the growth of agriculture required to achieve the Agrivision target of $10 billion farm gate value in 2050.

Training is not only important to upskill staff and managers, but it also is a vital element of staff attraction and retention. Given the current competitive market conditions for labour, agricultural businesses need to work hard to attract and retain as many staff as possible to enable growth. Training and a focus on technology is a way for business to demonstrate to their team and potential new staff that they are valued and have a future with the organisation and can have a rewarding career.

Advancing training in agri-tech/ digital ag is also important for reducing the reliance on labour in some areas e.g. via automation and robotics. Agri-tech training can attract people from related and other professions into agriculture, if designed, promoted and delivered to do so.

Any digital ag/agri-tech training developed as a response to an immediate need will become an increasingly important part of agricultural training in the future.

The overall priority for agri-tech training is digital literacy. GIS operations/variable rate application of inputs, soil, crop and water monitoring, with sensors, combined with weather monitoring are expected to attract the highest numbers of students and digital literacy is a prerequisite for all of these application. Digital literacy skills training would also be required as a basis for skilling up for the use of specific digital software platforms (e.g. for farm safety and logistics, record keeping).

The first two steps on a digital ag/agri-tech training pathway are therefore considered the most viable training offers to start with.

1. Digital literacy as a foundational skill needed to work with all digital ag/agri-tech tools, and
2. Using the tools and equipment for all types of production systems, and in packing/processing operations.

Suitable VET training by skilled trainers is vital to develop and deliver this training to enable agricultural businesses to utilise the required, available tools across a range of farming operations and remain profitable and sustainable. We suggest mainly targeting people already working in agriculture or related industries such as viticulture or forestry to upskill for digital agriculture (agri-tech). Within the existing workforce, there would be a need for beginner, intermediate and advanced courses and delivery that suits employed people (e.g. timing, style, relevance to the work). Project based courses would be effective if the new skills could be directly applied to the job.

As mentioned, the topics currently most in demand by the greatest cohort of people, estimated being at least 4000, are GIS applications and sensor based monitoring systems as well as use of record keeping platforms. Appendix 5 therefore provides a case study that gives insights into the use and value of these tools for potato production. Section 6 list further examples relevant to agri-tech/digital ag.

Upskilling of the existing workforce should consider when and where people in the workforce are available, which is mostly outside work hours. Short courses (micro credentials, skill sets) offering a practical component may be the most effective format. Having these courses counting towards qualifications is desirable.

TasTAFE is considered the most suitable RTO to develop and deliver the training, being the largest provider of agriculture education at the VET level in Tasmania, working with UTas on training pathways and having the new training facility at Freer Farm as well as access to the TIA research farms.

1 Introduction

The North West Agricultural Workforce Plan Consultancy Project (the NW Workforce Plan), produced by RMCG for Skills Tasmania in 2021, provides background to this review of agri-tech training needs for Tasmanian agriculture.

Landholder and agribusiness interviews for the NW Plan highlighted that new technology (agri-tech, digital ag) is leading to changes in the skills needs of jobs in agricultural industries. For example, technologies applied to precision agriculture are already changing the nature of jobs on farms. The pace of technology development in agriculture is accelerating. Technology applications that soon will become mainstream include for instance the internet of things (IoT), artificial intelligence (AI), automation and robotics. Digital literacy is an important foundation for agri-tech training. Survey responses suggest that, in addition to new technology and digital skills, many traditional skills, including technical/mechanical skills, usually taught in agriculture courses are lacking now and will remain in demand in the future.

Given the current shortage of relevant skills in the Tasmanian agricultural industry, the immediate focus should be on upskilling the existing workforce, starting at Certificates II, III and IV level. The ability to develop and provide the required training will also set the foundations for training new entrants to the industry such as school leavers and people wanting to move into agriculture from other professions. Providing the foundational training will be an important start to career development for many and accelerate the uptake of agri-tech across agricultural industries.

It is important to highlight that industry survey findings underpinning the NW Plan are in line with other regional, industry-specific[1] and national reviews such as the "National Agricultural Workforce Strategy literature review"[2] which highlights the following relevant aspects:

The future agricultural workforce will likely to be influenced by technologies and digital solutions that will either augment or automate the way people work, including navigation robotics, process automation and decision support tools. However, there is an accelerating lack of proficiency in operating these digital technologies and devices. New research by the CSIRO suggests the key influences on the agriculture workforce going forward will be regional development and the extent technology advances are taken up by agricultural businesses.

In the agricultural machinery sector, as vehicles become more advanced, the diagnostic equipment used to maintain them progresses, including the use of remote and on-board diagnostics and software tools to manage parts inventories and service histories. This is raising the bar for technician roles in agriculture significantly.

In the food processing sector, computerisation and advancements in technology are delivering more efficient food processing operations requiring skills in operating digitalised screens and equipment. ***The food processing sector is an important part of agriculture in Tasmania.***

In the forestry industry, advanced technologies, including biotechnology (clonal propagation, marker aided selection and breeding); geospatial technologies (remote sensors, drone technology and new generation satellite imagery) and robotics, automation and scanning technologies (log-measuring and cutting optimisation systems, remote-controlled felling are requiring the development of digital skills and capabilities. ***This statement is largely applicable to the agricultural industry as well.***

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1 Refer to Appendix1 for just some regional and industry examples.

2 Department of Agriculture, Water and the Environment 2020, National Agricultural Workforce Strategy literature review, Canberra, February. CC BY 4.0. ISBN 978-1-76003-259-3. This publication is available at: haveyoursay.agriculture.gov.au/national-agricultural-workforce-strategy.

2 Synopsis from the NW Ag Plan

The “North West Agricultural Workforce Plan Consultancy Project” (the NW Workforce Plan) identified a currently low level of training delivery in the NW region, reflecting the state-wide situation, especially for horticulture. The reason given for this lack are low registration rates for agricultural Cert and Diploma courses. Dairy industry training is an exception. The report outlines the main reasons for low registration rates, such as:

- Lack of course promotion i.e. potential students cannot easily find out about course offerings and how they may connect to career paths
- Barriers and attitudes of employers, potential students and their parents (towards training and or agriculture)
- Timing and length/location of training not being aligned with industry requirements and availability
- Lack of experienced and trained teachers and relevant teaching resources
- Training content often does not meet the needs of industry.

Part of the problem is a disconnect between industry and training providers due to a lack of communication and mutual understanding of requirements, opportunities and challenges.

Training was valued more highly by those who had experienced training themselves, highlighting the importance of providing training opportunities to owners and managers of businesses not just employees. In general, the larger the business, the more highly training was rated and supported across the workforce (time and budget). However, small and medium size businesses (SMEs), which are the in the majority, found it hard to release staff and or owners to conduct training, especially if it was for an extended period of more than 1 day at a time.

All farming businesses needed training to take place outside of the main late spring - summer – early autumn production season. In addition, livestock producers requested training to occur outside of calving/lambing periods.

According to the NW Ag Plan, 33% of agricultural employees in NW Tasmania are permanent or have fixed-term contracts, apprentices or farm owners and family (the most likely recipients of training). This equates to a pool of employed, potential users of VET technical skills and agricultural technology (agri-tech) courses of 1456 people in the northwest and 4684 people in all of Tasmania. Short courses (micro-credentials) and flexible delivery during times that are not busy on farms was named as the preferred training for this cohort.

Therefore, the greatest immediate need and opportunity for the training sector is to develop technical/technological skills in current farm owners and managers, their permanent employees and also contractors, field officers and agronomists who support farmers. These individuals are employed and need new skills to build on the ones they already have if they want to stay competitive in their business and/or advance their career. The training that will be developed for the current workforce will also be relevant for new entrants to agriculture. A training focus on new technologies may actually attract a cohort that traditionally would not be interested in a career in agriculture.

Most technical jobs in agriculture are still performed by men. However, there is an opportunity to target women into these skill areas. Programs from the forestry (https://forestworks.com.au/networks/wftn/), mining (http://iminco.net/women-in-mining/), or supply chain (https://wayfinder.org.au/) industries may be used as examples of how to approach this.

In addition, school leavers, people from related professions wanting to move into agriculture and/or people currently employed in agriculture under ‘casual’ contracts could benefit from technical skills and or agricultural technology training to gain or maintain employment or start a career. This training could be delivered as short courses, compliance courses (‘tickets’) or introductory/employability courses, as suggested by the NW Ag Plan.

RMCG conducted research into culturally and linguistically diverse (CaLD) workforce gaps in agriculture for Agriculture Victoria. Some insights from this work may apply Tasmania, given that some people well-trained in their home country are part of this cohort.

2.1 WHAT TECHNICAL/TECHNOLOGY SKILLS ARE NEEDED?

The NW Ag Plan identified the following major trends in the industry:

- Increasing mechanisation to reduce the number of labourers (and associated costs)
- Increasing availability of farming technologies, and
- Increasing reliance on seasonal workers from overseas or interstate for manual work that cannot be replaced by technology.

Training to improve skills in on-farm technologies was most frequently wanted by industry according to the NW Ag Plan. This included operating drones, GIS/GPS applications, pasture monitoring, precision ag applications, irrigation technologies, use of sensors, predictive tools, operation of technical machinery including robotics and use of spatial data.

The report identified a need for:

- Specialist tradespeople trained in new technologies such as robotics, automation, high-tech equipment and farm and processing machinery development and maintenance
- Agronomists (not sales agronomists) with training in or an understanding of relevant on-farm technologies and how to use them so they can support farmers
- Professional services, including contractors, and
- Proficient teachers of technical and technology skills.

While many of the mentioned skills require university-level training, there can be an equivalent offering in the VET sector that includes pathways to higher degrees.

The NW Ag Workforce Plan mentions that the low level of literacy, numeracy and digital skills in some students and existing workers in the agriculture sector would make it more challenging to lift the level of complexity in training offered in farm technologies.

2.1.1 WHY ARE TECHNICAL/TECHNOLOGY SKILLS IMPORTANT?

The future of economically and environmentally sustainable agriculture relies on the clever use of technology. Tasmania must not be left behind in training people in relevant skills now and in the future. This is vital for achieving the Tasmanian Government's ambitious goal of increasing the annual value of the agricultural sector to $10 billion by 2050. To reach $10 billion, the sector will need to grow at more than double the growth rate experienced over the past 20 years. This means Tasmania needs to develop the relevant skills in the agricultural workforce to support this ambition.

Training is essential not only to upskill staff and managers, but also to be a vital element of staff attraction and retention. Given the current competitive market conditions for labour, agricultural businesses must work hard to attract and retain as many staff as possible to enable growth. In addition, training and a focus on technology is a way for businesses to demonstrate to their teams, and potential new staff, that they are valued and have a future with the organisation and can have a rewarding career.

Advancing training in agri-tech/ digital ag is also important for reducing the reliance on labour in some areas e.g. via automation and robotics. Agri-tech training can attract people from related and other professions into agriculture, if designed, promoted and delivered to do so.

3 Agri-tech training needs in detail

The following sections of this report provide a comprehensive review of all feedback received on agricultural technology (agri-tech, digital ag) skills needs during interviews conducted for “North West Agricultural Workforce Plan Consultancy Project” (the NW Ag Workforce Plan).

The intention was to identify the specifics of agricultural technology training needs in Tasmania and to address the questions of:

- ‘What agricultural technology skills and knowledge are needed in Tasmania?’
- ‘What are the priorities for agricultural technology training?’
- ‘What is the market size for the VET training component of the need?’

While the review did not include any further primary research i.e. interviews, we have examined the feedback for the relevance for all of Tasmania and found that, given our work in other regions, and the national context referred to above, outcomes from this review are relevant for the entire state. We also included information on agri-tech training needs from related work RMCG has conducted since finalising the NW Ag Workforce Plan. For the discussion of findings, we applied our knowledge of technology in agriculture and understanding of agricultural production systems in Tasmania.

3.1 APPROACH

Our approach has been to:

- Review the raw data gathered for the NW Agricultural Workforce Plan with a focus on the responses related to agri-tech and technical literacy skills requirements
- Collate this information by industry/production system and technology type and identify:
  - Whether the technology relates to in-field production or packing, processing and supply chains
  - Where there is overlap across industries or where particular needs are more specific.
- The data review was conducted with other categorisations we captured in mind, such as:
  - Business size and employee numbers
  - Whether business owners or staff require training
  - The type of technology, for example, spatial data, remote sensing, automation, equipment and machinery, information technology, IT.

Alongside the skills review, we re-examined the survey data relating to training availability and accessibility only to cover the agri-tech related responses received.

This report also includes a training market analysis using published economic data combined with the needs assessment to establish the total potential market for the agri-tech training across Tasmania. We assumed there have been no significant changes in the AHC training package or what RTOs have in scope and delivery in Tasmania since the NW Ag Workforce Plan survey was completed.

Our experiences from other projects informed our recommendations and gap analysis in the report. While we have been requested to exclude general office and business management software skills, there was a necessary overlap when looking at technologies that collect data critical for successful production and business planning/management (e.g. spatial data, remote sensing data, data from autonomous systems). Most agri-tech systems collect data that feeds into smart devices and/or computers for analysis.

In addition, we provide key case studies on the use of agri-tech from different ag industries (including cropping, livestock production and dairy) within the state, highlighting training needs. These case studies would be from businesses that have been utilising agri-tech on-farm and can provide guidance on where there are gaps in available training for their type of production system and farm businesses.

The information provided can be used to inform prioritisation of the development of units of competency that can be delivered as separate short courses, as part of an Agri- Tech Skill Set or as part of a higher-level qualification, catering for existing employees and suitable for new entrants to agriculture (school leavers, people from related professions wanting to move into agriculture, casual employees).

3.2 TRAINING NEEDS IDENTIFIED

This section answers the question of what agricultural technology skills and knowledge are needed in Tasmania according to industry feedback.

3.2.1 AGRI-TECH/DIGITAL AGRICULTURE

Definition: Digital agriculture is a term used for agri-tech applications; it is the use of digital technology to integrate agricultural production from the paddock to the consumer. These technologies aim to provide the agricultural industry with tools and information to make more informed decisions, improve productivity and/or reduce the reliance on labour. 'Data Farming' is a term often used for the on-farm aspect of digital agriculture. Refer to Appendix 2 for a glossary of frequently used terms.

Refer to Appendix 3 for the national potential economic impact of fully applying all aspects of digital agriculture to make decisions.

Many responses from the NW Ag survey referred to the future skills and knowledge needed in the area of technology. Many did not elaborate on the type of technology, but those who did referred to different aspects of 'digital agriculture'.

Table 3-1 provides an overview of digital agriculture technologies requiring training for Tasmanian agriculture. This is based on survey feedback as well as learnings from related studies and trends, opportunities and challenges with digital technology in agriculture, which are summarised below.

The use of digital technology is essential for the future of agriculture

While the demand for food, fibre and nutraceutical products is expected to grow given an increasing world population, agricultural businesses are facing the challenges of a changing climate and its impacts on productivity. Increased temperatures, changes in rainfall patterns, and more frequent extreme weather events are already having an impact on agriculture. Given this situation, combined with the finite land area suitable for agricultural use, agricultural businesses, including supply chain partners, must continue to innovate to maintain and or improve productivity. Digital technologies have the potential to provide agricultural businesses with the information and ability to meet the abovementioned challenges. They can also contribute to farm safety in the areas of biosecurity, prevention of theft or vandalism and disaster warning (e.g. floods, fire), the reduction of food waste and resource use efficiency (water, nutrient inputs, energy, chemicals).

In addition to multiple challenges facing agriculture, many consumers want to be more informed about the products they buy. They demand high quality and sustainably produced food and fibre and want to know more about where their products come from. Digital technologies can enable improved traceability of agricultural products.

Digital agriculture can also support regional communities. Younger generations are keen to work with technology. Through the increasing use of digital technology, agriculture can attract, connect and retain younger generations to live and work in regional and rural communities. It is a critical enabler for retaining and growing regional populations as well as attracting start-ups and other businesses.

The Australian Government's Accelerating precision agriculture to decision agriculture project[3] found that digital agriculture could lift the gross value of agriculture production in Australia by $20.3 billion, or 25 per cent, compared to 2014–15 levels.

Digital agriculture will be one important tool supporting the Tasmanian Government's Agrivision 2050 plan and AgriGrowth strategy, which aims to increase the value of the agriculture and agri-food sectors in Tasmania.

Some examples

- GIS (satellite and drone imagery) and multiple sensor technologies are used to measure crop vigour and health to inform decisions about irrigation, pest and disease management, and fertiliser applications
- Equipment programmed for variable seeding rates and depths based on e.g. soil property and moisture data can lead to higher yields, increased resource use efficiency and reduced waste
- Integrated digital animal health sensors and electronic identification devices enable farmers to rapidly respond to animal stress or disease, improving livestock health and productivity
- Robotics are increasingly introduced and further developed for dairy, poultry and beef farming industries as well as horticulture and broad acre cropping. Applications include, for instance:
  - Autonomous feeding and milking, egg collection and sorting, autonomous cleaning, on-farm transport, crop monitoring and harvesting and packing or processing operations
  - Supporting highly precise crop nutrition and irrigation as well as early detection and treatment of pests, weeds, diseases (precision crop management), forecasting and other types of decision support.

Often these technologies rely and build on one another and in particular GIS data is required for effective utilisation of other technologies. One important local example is drainage mapping and the use of a land plane. This uses highly detailed GIS information to create a new drainage plan for a paddock. The land plane then uses precise adjustments to the blade to sculpt the paddock to match the digital GIS plan.

Barriers to adoption of digital agriculture technologies

Despite the potential benefits, agriculture is still Australia's least digitised industry. One reason is the quantity and complexity of processes in a wide range of production systems that could be targeted and potentially the perceived market size. Still, AgFunder, an internationally active foodtech and agtech Venture Capital company, reported for 2021: 'Venture capital investors pumped $51.7bn into agrifood technologies in 2021; an 85% increase over 2020.'

Some barriers to greater uptake of digital technologies in agriculture include a lack of training (for agrifood businesses and trainers), but other challenges are just as relevant:

- **Digital literacy** – Many agricultural producers have not had opportunities for practical learning and exposure to technology to identify the right technology options for their farm or how to reliably and profitable use it
- **Training** – Digital literacy training for both trainers and people in agriculture is lacking
- **Trust** – There are instances where owners/managers do not trust other staff members to use technology/machinery. This has been seen in the Melbourne Uni research with the Birchip Cropping

[3] Perrett, E., Heath, R., Laurie, A. and Darragh, L. (2017). Accelerating precision agriculture to decision agriculture – analysis of the economic benefit and strategies for delivery of digital agriculture in Australia. Australian Farm Institute and Cotton Research and Development Corporation. For the complete set of reports, including a landholder survey, refer to: https://www.crdc.com.au/accelerating-precision-decision-agriculture#:~:text=The%20Accelerating%20Precision%20to%20Decision%20Agriculture%20(P2D)%20project%20was%20supported,Rural%20R%26D%20for%20Profit%20program

Group that identified overworked owner-managers that were not utilising available staff to spray because they did not trust them with the (highly sophisticated) machinery

- **Connectivity** – Appropriate connectivity is fundamental to digital agriculture, with digitised farms needing widespread and reliable coverage, including for training
- **Interoperability of data sets** – It is currently difficult for producers to analyse data generated from multiple technologies. It is not even clear which ones should be analysed together and which ones are compatible and which are not. Incorporating diverse datasets into a shared platform would allow greater insights and benefits from digital technologies
- **Cost and investment rationale** – The value of digital agriculture has not been proven to producers; demonstration of return on investment is needed to boost adoption rates. A way to 'try before you buy' e.g. via training would be valuable
- **Data sharing** – There is a lack of confidence in data privacy and security among producers; agreed data sharing protocols and governance arrangements are required to encourage data sharing across the value chain. Also, refer to AgriFutures project: "Workshop facilitation for autonomous solutions in agriculture" (in progress) and the previously mentioned producer survey conducted as part of the Precision to Decision project[4].

Possible Actions to remove barriers to digital agriculture

- **Skills and education** – A program to address skills gaps in agriculture should focus on enabling the adoption and use of digital technology. One approach would be demonstrating the capability of AgTech to schools and people in other industries to promote technology-based careers in agriculture. This needs to be underpinned by 'fit for purpose' training services (refer to NWAg report). Boosting capability from paddock to plate via formal learning opportunities is required for:
  - Teachers and trainers (high priority to be able to deliver on the next points)
  - Those already working in the sector (upskilling)
  - People entering the agriculture sector from schools and other industries.
- **Take on feedback from the NW Ag Plan** – Training has to be relevant, delivered at the right time, preferably when people are not at work or during a busy part of the season, is in a suitable location, has a practical component and is delivered by knowledgeable trainers
- **Research and development** – Partnering with industry early in the development of solutions to test new technology and innovations and demonstrate the value of digital technologies to producers and supply chain partners (commercial 'proof of concept' and commercialisation plans to be part of R&D)
- **On-farm adoption** – Addressing barriers to farmers and those in supply chains to using digital technologies (e.g. showcasing technologies on commercial farms and supply chain businesses)
- **Digital government** – Using technology to streamline state and regional government processes and leadership in data management. All levels of government have a role to play and should take the lead in fostering the adoption of digital technologies. For instance, regulatory frameworks need to keep track of innovative farm businesses and processes. Government should actively work with industry and regulators to achieve this. It may include exploring opportunities for regulators to use digital technologies to improve regulatory outcomes and reduce red tape for industry.

[4] Zhang A, Baker I, Jakku E and Llewellyn R (2017) Accelerating precision agriculture to decision agriculture: The needs and drivers for the present and future of digital agriculture in Australia. A cross-industry producer survey for the Rural R&D for Profit 'Precision to Decision' (P2D) project. EP175936, CSIRO, Australia.

In Table 3-1, reference to certain industries or production systems is made if the requirements are not applicable to all industries. The type of people the training should focus on is included in the last three columns. The more intense the shading of cells, the higher the priority of training according to feedback. The training pool has been carefully estimated as one learner per agricultural business for skills relevant to all agriculture sectors. While many of these skills are transferable to forestry, numbers for this sector have not been included. It is expected that some small businesses may not participate in agri-tech training and that the 'shortfall' will be made up by numbers from larger businesses that will require training for more than 1 person. Refer to section 4 for further information on the market size for training.

The number of people in the agricultural workforce that can actually be attracted into agri-tech training will greatly depend in how the delivery meets their needs i.e. accessibly (timing, location), cost, relevance to their work, and quality of trainers (knowledge of the topic and adult learning principles). The numbers in Table 3-1 refer to people in the agricultural workforce only. As indicated earlier, much of the training would also be relevant to forestry, school leavers and people from other sectors who want to work in agriculture. Another vital aspect of attracting people into training is to promote attractive courses, jobs and career opportunities (refer to section 4.2 for agri-tech career pathways). Easy access to relevant information in everyday language is vital. The information should highlighting transferable skills that could be used to in other sectors than agriculture, for instance in forestry and viticulture.

An important consideration has to be that developing agri-tech/ digital ag training for the current workforce is a starting point for 'upgrading' agricultural training in Tasmania to meet future needs. It is not a one-off need but rather a requirement for enabling agriculture to grow and prosper in Tasmania and remain nationally and internationally competitive. Another consideration is that progressive training in agri-tech/ digital ag has the potential to attract students to Tasmania (e.g. the Centre of Excellence), especially if remote learning options can be included and career pathways are clear.

Table 3-1: Overview of digital agriculture training needs

REQUIREMENTS	RATIONALE, DESIRED OUTCOME	ESTIMATED TOTAL TRAINING POOL	NEED BY BUSINESS SIZE, EMPLOYEE NUMBER		
			SME	LARGE SCALE	SERVICE PROVIDERS
Relevant skills for all agriculture sectors, transferable to forestry					
Digital literacy, digital and wireless technologies for data collation and analysis	Pre-requisite for all digital ag including data analysis, using decision support systems, digital platforms etc Good decisions are based on good data	4580	**All**	**All, may focus on some employees**	**All**
GIS based operations, satellite imagery and drones, satellite guidance / autosteering (via GPS receivers)	Precision, variable rate applications of fertilisers and water, variable seeding rates and depths geospatial monitoring of crops and animals, data merging across platforms	4580	**All**	**All, may focus on some employees**	**All, may focus on some employees**

REQUIREMENTS	RATIONALE, DESIRED OUTCOME	ESTIMATED TOTAL TRAINING POOL	NEED BY BUSINESS SIZE, EMPLOYEE NUMBER		
			SME	LARGE SCALE	SERVICE PROVIDERS
Soil moisture, EC, pH, nitrate monitoring (sensor technology)	Irrigation scheduling, precision, variable rate applications	4580	**All**	**All, may focus on some employees**	**All, may focus on some employees**
Weather prediction and monitoring	Irrigation scheduling, pest and disease forecasting	4580	**All**	**All, may focus on some employees**	**All, may focus on some employees**
Field robotics (integrating satellite guidance and sensors, link to data collection platforms)	Tractors, transport applying abovementioned sensor technologies	4580	**Owner/ manager**	**All, may focus on some employees**	**All, may focus on some employees**
Cropping and horticulture/viticulture, applicable to plantation forestry and pasture production					
Digital infra-red light and heat sensors combined with geographic information system technology in drones	Soil moisture monitoring, irrigation scheduling, disease, pest and weed monitoring, fertiliser applications, monitoring crop development and forecasting harvesting.	3760	**All**	**All, may focus on employees**	**All, may focus on some employees**
Livestock, dairy					
Animal monitoring	Location, health, calving, lambing, geofencing	3570	**All**	**All**	**All, may focus on some employees**
Autonomous/robotic systems	Feeding, milking, monitoring	3570	**All**	**All as required**	**All, may focus on some employees**
Supply chains, food & product processors					
Farm and food safety monitoring systems (link to data collection platforms)	WH&S, Biosecurity, vandalism, spoilage	4580	**Owner/ manager**	**Employees**	**All, may focus on some employees**

REQUIREMENTS	RATIONALE, DESIRED OUTCOME	ESTIMATED TOTAL TRAINING POOL	NEED BY BUSINESS SIZE, EMPLOYEE NUMBER		
			SME	LARGE SCALE	SERVICE PROVIDERS
Digital platforms	Connects farmers, distributors, wholesalers and retailers directly with logistics companies Connect input providers, agronomists, farmers (e.g. AgWorld) Farm record keeping and management LEAN management	4580	**All**	**All as required**	**All, may focus on some employees**
Robotics and automation in packing and processing operations e.g. fruit, vegetables, meat (link to data collection platforms)	Vision sorting, carcass assessment, palletising, packing (eggs, fruit), cleaning	182[5]	**Owner/ manager**	**All as required**	**Some segments of the Service providers.**

Table 3-1 shows that the skills that appeal to all sectors of the ag industry, and most likely forestry, will be more popular across the ag sector than those targeted to just dairy or horticulture.

The top priority for agri-tech training is digital literacy. GIS operations/variable rate application of inputs, soil, crop and water monitoring, with sensors, combined with weather monitoring are expected to attract the highest numbers of students and they require digital literacy. In addition, digital literacy skills training would be the basis for skilling up for the use of specific digital software platforms (e.g. for farm safety and logistics, record keeping).

Section 4.2. provides information on how agri-tech training needs may be met, i.e. what is relevant for VET or University training and the possible pathway. Non accredited, informal training, which mainly consists of workshops or short courses (max 1-2-days), has not been included. The reason is that businesses access this type of training as and when it is offered. The informal training sector reacts to upcoming or perceived needs and can do this with very short lead up times compared to RTOs. This type of training is often coordinated and delivered as part of funded, industry specific extension projects (e.g. by Dairy Australia, Meat and Livestock Australia, Hort Innovation).

[5] The training pool for processing businesses is estimated as two employees for processing business at the end of June 2021.

3.2.2 COMPLIANCE, TECHNICAL AND MECHANICAL TRAINING

While this review focuses on agri-tech/digital ag training, an overview of training needs for compliance, technical and mechanical competencies in agriculture is included because of the feedback received from farmers. Also, technical and mechanical training may be a prerequisite for employees to become interested in agri-tech upskilling or to be able to participate.

Definition: Compliance, technical and mechanical training for agriculture covers all machinery, equipment, vehicle operations and technical areas for which operators need a training Certificate of Competency or Operator License.

Every business operating machinery, equipment and vehicles that require a 'ticket' need to have adequately trained staff. In smaller operations, usually, the owner(s)/manager(s) have or need relevant training. Some 'tickets' only require an initial course or sign off prior to operation, but others may be accessed more regularly for upskilling e.g. ChemCert (AHCSS00074 Agricultural Chemical Skill Set). While legislation often only requires initial training or no training to be completed, some quality assurance programs require it, or business owners will repeat this training to stay across regulatory changes and want staff to complete it.

In Tasmania, farmers increasingly use contractors to control pests, weeds and diseases. Contractors who operate a business that provides a commercial spraying service must hold a Commercial Operator Licence and be trained accordingly. In addition, those who apply agricultural chemical products for a commercial spraying business, must hold a Certificate of Competency that is relevant to the type of work they do[6].

This type of compliance training is mentioned here because the NW Ag survey feedback from all industries highlighted a lack of capable, adequately trained people with 'technical' 'mechanical' or 'machinery operator' skills and or 'tickets'. There are not enough people with the required 'tickets', and it appears from feedback that some people who do have a 'ticket' still cannot operate machinery or equipment safely nor do a good job. The issue around the capability of people commonly referred to 'operator tickets'. An overall lack of people with trade certificates was mentioned by interviewees from all backgrounds. It was also mentioned that some licensed 'tradies' do not understand the special requirements of agricultural equipment and machinery.

Table 3-2 provides an overview of the requirements. As businesses' size and employee number are positively correlated, SME implies a small to moderate number of employees and, according to the NW Ag report, often less structure and a lower level of training in the business than in large scale businesses. Larger scale businesses may value training more highly and have training plans and budgets. The type of people the training should focus on is included in the last columns. The more intense the shading of cells there, the higher the priority of training according to feedback.

Possible Actions to address challenges in training for compliance & machinery units

- **Delivery options –** While 'competency training' options are well established, there needs to be a range of delivery options available to potential students. Training needs to be delivered by knowledgeable trainers who can meet industry expectations. They need to take into account the time available for the students to spend at the course, and travelling if required. Regional and or on-farm delivery should be considered as well at times when farming businesses are busy, if employees are the target
- **Flexibility –** The course delivery needs to be flexible. Agriculture can have shifting work needs and flexible delivery will ensure that students are able to complete their courses even when impacted by factors beyond their control. Flexibility means for instance on-line or weekend options and being able to defer or repeat training

[6] https://nre.tas.gov.au/agriculture/agvet-chemicals/licences-and-certificates/ground-spraying-and-pest-management-licences#TrainingRequirements%C2%A0

- **Quality** – There is a concern from industry that these courses often are 'box ticking' exercises. Farmers have commented that employees with the correct 'ticket' were unable to use the machinery or equipment in the workplace. The training needs to ensure that students can do the work they are accredited to do well. This may require external assessment i.e. not by the trainer who delivered the course
- **Additional Support** – In areas where there are 'thin training markets' but significant economic value from agricultural producers in a region, additional investment support for training delivery will be required to maintain the capability, operations and economic benefits to the region.

Table 3-2: Overview of key compliance, technical and mechanical training needs

REQUIREMENTS	LICENSE OF CERTIFICATE DETAILS	NEED BY BUSINESS SIZE, EMPLOYEE NUMBER	
		SME	LARGE SCALE
'Operator Tickets' for farm vehicles, machinery and equipment	e.g. Tractors. ATVs, quad bikes, forklifts, trucks, spray equipment, chainsaws	All	Employees
'Operator Tickets' for machinery and equipment commonly used in civil construction, often required by agricultural businesses	e.g. Backhoe, bobcat, dozer, excavator, loader, telehandler; larger scale businesses usually require trained staff to operate the equipment	Contractors, employee or owner for some	Some employees, contractors
Trade certificates (esp. relevant to agriculture)	e.g. Electrical, refrigeration, building and construction, diesel mechanic, automotive inc., electrical, industrial instrumentation, engineering and mechanical trade	Contractors	Some employees, contractors
'Commercial Operator Licence' and 'Certificate of Competency' to apply agricultural chemicals	e.g. Broadacre agricultural spraying, Forestry spray contracting, Roadside weed spraying, Insect, disease or weed control in lawns and gardens or Insect and rodent control in and around homes and buildings (applicable to processing and packing operations).	Contractors and their employees	N/A

3.3 CURRENT COURSE OFFERINGS

The main weakness identified in the Ag Workforce Plan by 46% of interviewees was that training on offer was of considered 'poor quality' leading to poor outcomes. Reasons given were lack of (technical/technology) teaching resources and trainer knowledge. Currently there are limited technology components offered in VET courses. The lack of agri-tech training on offer may deter students from agriculture courses which in turn creates a decreasing pool of skilled people in the workforce.

TasTAFE is not the only RTO in Tasmania offering training for the agricultural industry; some other operators area delivering relevant courses. Still, TasTAFE has the largest cohort of agriculture students in the state at the target training level of Cert II and III. With their existing presence in this market and the development of the Freer Farm site as a Centre of Excellence in Agriculture it is considered worthwhile to focus on encouraging and supporting TasTAFE so they can provide relevant agri-tech training to a large and growing cohort of students. It is expected that other RTOs will continue to offer relevant competency training; however, they will

most likely not be able to embed their courses within a more extensive offering of qualifications or apprenticeships in the same way that TasTAFE can incorporate them or offer clear pathways into university courses.

The current agriculture courses and skill sets offered by TASTAFE at the Cert III, IV and Diploma levels do currently not include units that teach agri-tech, apart from compliance courses in equipment operation. Only a small proportion of agri-tech has so far been contextualised for Vocational Education and Training (VET).

Current AHC packages include units that would allow Agri-Tech to be included in the Cert courses, such as:

- AHCMOM311 Operate Precision Control Technology
- AHCWRK302 Monitor Weather conditions
- AHCLPW410 Produce maps for land management purposes
- AHCAGB521 Select and use agricultural technology
- AHCNRM507A Manipulate and analyse data within geographic information systems.

In other States, some courses are tailored to, e.g. Agriculture Outdoor Power Equipment, Agriculture Machinery Technology and Rural Operations, which select some units from the current automotive course offerings of use in the agriculture sector. TasTAFE does not offer automotive courses in the Northwest, and none on offer elsewhere are tailored for the agriculture sector.

Skill sets that enable short courses (competencies, micro-credentials) in technical subjects would be ideal for upskilling the current workforce. They could also be used to increase the complexity and relevance of offerings provided in Certificate and Diploma level courses. Still, there are some risks in building courses/units that might not attract students, especially if ignoring the research findings around skills needs provided by The NW Plan and failing to:

- Deliver the training at times that suit agricultural businesses
- Build flexibility into the training (e.g. face to face and or online delivery, length of courses)
- Make it count towards a qualification
- Have well-trained trainers (in the technology and principles of adult learning)
- Promote the relevance and benefits of the training offered.

4 Training market analysis

This section provides findings from an analysis of the likely existing market size for the VET component of the agri-tech/digital ag training need.

4.1 THE MARKET SIZE FOR TECHNICAL/TECHNOLOGY VET TRAINING

4.1.1 PEOPLE IN THE AGRICULTURAL WORKFORCE IN TASMANIA

There were 4580 businesses operating in agriculture in Tasmania at the end of June 2021. These businesses employ 14,828 FTE across the state; 10,815 FTE working in agricultural production (73%). Considering a small proportion of part-time and casual workers the number increases to 10,964 people employed in agriculture in the state.[7]

Current skill/educational level in agriculture

ABS census data provides insight into the current level of training of people employed in the agricultural industry in Tasmania. Table 4-1 shows the percentage split for three education levels.

Table 4-1: Split of education level in the agricultural workforce

EDUCATION LEVEL	PERCENTAGE OF EMPLOYEES	NUMBER OF EMPLOYEES (BASED ON 2021 NO.)
University (Bachelor degree or higher)	11.3%	1,239
Cert III – Diploma	29.5%	3,234
Cert I or II, Secondary School or less qualified	51.6%	5,657
Undeclared	7.6%	834

Based on the split in educational levels, we estimate that at least 40% of people working in agriculture would require training in technology and technical skills to ensure Tasmanian agriculture is not left behind. This is a conservative estimate as, while the majority of employees are at a Cert II level or lower, there will not only be employees in the Cert II cohort but also many in the higher qualification categories who would require some additional technical and or agri-tech/ digital ag training. The estimated training pools detailed in Table 3-1 align with the above estimate.

Business size will impact on the number and proportion of each level of training required. Small enterprises would have an owner/manager and may have staff at the mid-level skill level. Small to medium enterprises will also be likely to engage service providers to assist with the data gathering and especially interpretation and decision making. Therefore, some service providers require training in new digital ag developments to support their clients. Larger enterprises would have job level proportions more in line with Figure 4-1 where there are larger numbers of entry level skill workers, and waning numbers along the training pathway.

[7] https://economy.id.com.au/tasmania

4.1.2 SCHOOL LEAVERS IN TASMANIA

Department of Education data shows reducing enrolments in years 11–12 across the state. 2016 ABS Census[8] data indicates that there is a small increase in the number of people getting to workforce entry age. There is increasing competition from other sectors such as forestry, mining, aged care and health, for attracting and employing school leavers as the pool of available leavers is getting smaller. In addition, many school leavers are looking for employment or further education in other states which reduces the available pool of new entrants for agriculture even further.

4.2 AG TECH TRAINING AS A PATHWAY

Training programs must consider the learners and their ability to apply technical solutions on-farm using the latest technology. A common barrier to accessing training is often the level of digital literacy of learners, and their ability to both use the technology as such, apply it in the field, maintain it and make adjustment as conditions change.

Training needs are different for differing levels within an organisation and education levels. To ensure a progression is available for learners, agri- tech training should follow a pathway consistent with other skill sets. A barrier to training can result from trainers and RTOs 'pitching' their courses at the incorrect level or using delivery formats that do not appeal for instance because of the required time commitment, location, focus on traditional classroom style delivery or perceived relevance. Utilising a pathway model for agri- tech training would ensure that existing skills are built upon and that learners are capable of the required baseline prior to moving to more advanced topics. Figure 4-1 details how a pathway could look.

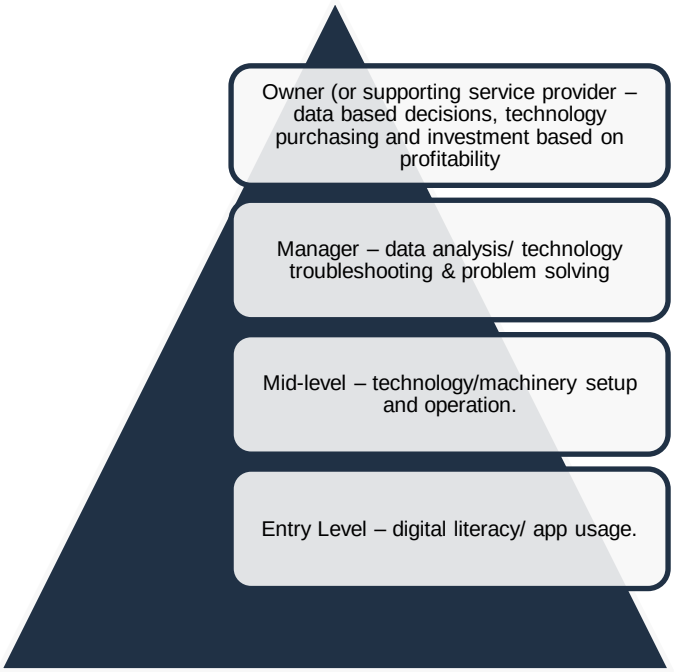


Figure 4-1: Ag Tech training pathway

Using GIS data usage as an example of this pathway process, the training details required would vary depending on the role of the learner once they complete the training. This aspect should be covered at VET level, but also by universities. VET course work would look at fundamentals around the type of data, what it represents and how to access it on computers, smart devices, tractors and other hardware. The higher-level

[8] https://profile.id.com.au/tasmania/service-age-groups?BMID=30

training should cover this, but also include training around interpreting data, making decisions and utilising data to apply these decisions in the field.

Table 4-2 details the differing pathway levels, educational levels and who provides the training. The vendor for the equipment will have a role within the training, but this may be more passive through online resources rather than course delivery. In some cases, the vendors require training as well. A project-based delivery style can ensure that learners can apply what they learn straight away.

Table 4-2: Agri-tech pathway and job roles

PATHWAY LEVEL	EDUCATIONAL LEVEL	TRAINING PROVIDER	JOB TASK EXAMPLES
Owner (or supporting service provider – data-based decisions, technology purchasing and investment based on profitability	Bachelor Degree or higher	University Vendor	Use device and record data as needed. Complete additional setup eg. New paddock maps Troubleshoot issues as they arise. Incorporate information to assist in planning and decision making,
Manager – data analysis/ technology troubleshooting & problem solving	Diploma or higher	University/TAFE or other RTO Vendor	Use device and record data as needed. Complete additional setup e.g. new paddock maps Troubleshoot issues as they arise.
Mid-level – technology/machinery setup and operation.	Cert III or IV	TAFE or other RTO Vendor	Use device and record data as needed. Complete additional setup e.g. new paddock maps
Entry Level – Digital Literacy/App Usage	Cert II or lower	TAFE or other RDO Vendor	Use device and record data as needed.

This approach illustrated in Table 4-2 also applies to other technologies identified in this report. There is as level of training required for people to be able to set technical equipment up, ensure it is working well and apply basic trouble-shooting techniques. There is a further level of training required around using the data from these technologies to inform decision-making. While vendors provide some of this information (often just information rather than training) it is usually only at the time of purchase and support quickly diminishes. Some vendors who are sales staff are not able to provide the required training

Training must reflect the current practise and application in the market including the use of specific types of technology and software platforms. Given some technology is proprietary and not open source, training is often provided by the vendor and limits the scope of training that spans multiple vendor platforms. This currently is a major impediment to the productive use of digital technologies on farms. Still, training could be structured so that learners will be equipped to make better choices in the use of digital technology. Even being able to identify the best platform for them, would be an advantage.

5 Conclusions and priorities

There is a need for more investment in training in digital ag/agri-tech to help underpin the growth of agriculture required to achieve the Agrivision target of $10 billion farm gate value in 2050.

The overall priority for agri-tech training is digital literacy. GIS operations/variable rate application of inputs, soil, crop and water monitoring, with sensors, combined with weather monitoring are expected to attract the highest numbers of students and digital literacy is a prerequisite for all of these application. Digital literacy skills training would also be required as a basis for skilling up for the use of specific digital software platforms (e.g. for farm safety and logistics, record keeping).

The most viable training to start with therefore are the first two steps in the digital ag/agri-tech training pathway (Figure 4-1). Appropriate VET training by skilled trainers is vital to develop and deliver this training to enable agricultural businesses to utilise the required, available tools across a range of farming operations and remain profitable and sustainable. Training promotion and engaging delivery formats are important for attracting the highest possible numbers of trainees/students.

Table 3-1 identifies the topics currently most in demand by the greatest cohort of people are GIS applications and probe-based soil and weather monitoring systems.

Any digital ag/agri-tech training developed as a response to an immediate need will become an increasingly important part of agricultural training in the future.

We suggest initially targeting training for compliance, technical and mechanical training mainly at new entrants (school leavers and people from related industries). Upskilling of the existing workforce should occur where there is demand.

- Job ready (and ag taster) courses e.g. as put together with TasTAFE by the Burnie Training Hub and short courses (micro credentials, skill sets) that can count towards a qualification
- Short courses e.g. for tradies to be able to switch to or include agriculture machinery and equipment (field, factory, packing shed).

We suggest mainly targeting people already working in agriculture or related industries such as viticulture or forestry to upskill for digital agriculture (agri-tech). Within the existing workforce, there would be a need for beginner, intermediate and advanced courses and delivery that suits employed people (e.g. timing, style, relevance to the work). Project based courses would be effective if the new skills could be directly applied to the job.

6 Agri-tech / digital agriculture examples

6.1 TASMANIAN EXAMPLES

https://www.premier.tas.gov.au/releases/precision_farming_to_boost_production

Appendix 4 provides an overview of the 8th Ag Innovation Expo (formerly Precision Ag Expo), 2022

ON-FARM ADOPTION – MICHAEL NICHOLS, REDBANK FARM, SISTERS CREEK (VARIABLE RATE FERTILISER AND NUTRIENT MAPPING)

https://www.landcaretas.org.au/tassie_farm_wins_national_award2

https://ausveg.com.au/articles/soil-health-practices-land-tasmanian-farmer-national-award/

https://ms-my.facebook.com/LandcareTasmania/posts/have-a-listen-to-michael-nichols-chat-with-abc-rural-about-some-of-the-technolog/4822722551089430/ (Audio file)

https://farmsadvice.com.au/zl-podcast/farming-in-tasmanias-record-breaking-soils-michael-nichols/ (Audio file)

Key industry case study: Appendix 5

GENERAL

Precision Agriculture Tasmanian RD&E project
https://www.soilwealth.com.au/imagesDB/news/PAgfactsheetfinal.pdf

Automation in the vegetable industry
https://static1.squarespace.com/static/56cbdd3e20c647ad15b4d92f/t/5c662643ec212dd1afdef950/1550198423962/Mechanisation+2018+08+30+MA.pdf

TestLab https://www.utas.edu.au/news/2021/4/26/1131-testlab-links-agriculture-with-smart-technology/

Drones on farm
https://www.abc.net.au/news/2017-07-27/drone-technology-on-farms/8746272

Automation and variable rate irrigation
https://www.dairyaustralia.com.au/dairytas/land-water-and-climate/water/irrigation/automation-and-variable-rate-irrigation#.Yru57RVBw2w

6.2 GENERAL AND NATIONAL EXAMPLES

https://www.soilwealth.com.au/resources/global-scan-and-reviews/veg-and-tech-science-fiction-or-the-future-of-farming/

https://www.soilwealth.com.au/resources/articles-and-publications/weathering-the-storm-with-precision-ag/

https://www.soilwealth.com.au/resources/webinar-recordings/using-drones-to-generate-farm-insights-drone-basics-and-operations-including-weed-mapping/

https://www.soilwealth.com.au/resources/case-studies/agtech-trial-turns-up-the-heat-on-weeds/

https://www.soilwealth.com.au/resources/videos-and-apps/uniformity-of-nutrient-availability-continues-to-improve-in-2020/

https://www.soilwealth.com.au/resources/videos-and-apps/soil-health-a-big-winner-from-precision-ag-trial/

https://www.soilwealth.com.au/resources/fact-sheets/crop-management/variable-rate-application-is-it-right-for-your-farm/

https://www.soilwealth.com.au/resources/webinar-recordings/adoption-of-precision-systems-technology-in-vegetable-production/

https://www.soilwealth.com.au/resources/articles-and-publications/use-of-remote-sensing-technology-in-vegetable-weed-control-and-yield-prediction/

https://www.soilwealth.com.au/resources/videos-and-apps/innovations-from-john-deere-at-hort-connections-2021/

https://www.soilwealth.com.au/resources/global-scan-and-reviews/remote-sensing/

https://www.soilwealth.com.au/resources/case-studies/exploring-the-application-of-precision-agriculture-koo-wee-rup- demonstration-site-case-study/

6.3 THE BIG PICTURE – INVESTMENT INTO DIGITAL AG

Agrifutures' evoke ag agrifood tech event, attracting the entire farmers, innovators, researchers, corporates, government and investors
https://evokeag.com/events/?gclid=EAIaIQobChMInOGgrMiX-AIVBZlmAh18Sgg9EAAYAiAAEgIzZfD_BwE&gclsrc=aw.ds

Aigen is one example of the development of solar - powered, autonomous robots using computer vision to perform tasks like weeding: https://www.aigen.io/

Hwy Haul is an example of a digital platform that connects farmers, distributors, wholesalers and retailers directly with truckers https://www.hwyhaul.com/

Appendix 1: RMCG project examples

▪ Research, Education and Training needs of the Tasmanian food industry (UTAS, 2013)
▪ Vegetable Industry Education and Training Initiative: VegPRO, Horticulture Innovation Australia (2016-2019)
▪ Vegetable Industry Education and Training Gap Analysis, Horticulture Innovation Australia (2015)
▪ Nursery Industry Career Path Development Strategy, Horticulture Innovation Australia (2019)
▪ Dairy Australia National Regional Workforce Support Dairy Australia, ongoing
▪ Department of Jobs, Precincts and Regions - Understanding food manufacturing skills shortages in the Goulburn Valley (2019)
▪ National producer skills and training needs analysis, Meat and Livestock Australia (MLA, 2015)
▪ Design and delivery of Skilled Workforce Solutions for GV Fruit Industry (Stage 1) Workshop, Department of Economic Development, Jobs, Transport and Resources (2017)
▪ Skills issues in the horticulture industry of the Riverina, Regional Development Australia Riverina (2017)
▪ Identifying opportunities and challenges for culturally and linguistically diverse (CALD) communities to address workforce gaps in Victoria's agriculture sector, Department of Jobs, Precincts and Regions (Victoria, 2020) ▪ Implementation assistance (2021/22)
▪ Career Pathways Guide and for the Fruit Industry, Department of Jobs, Precincts and Regions (Victoria, 2020)
▪ Workforce Strategy, Australian Pork Limited (APL, 2020)
▪ Tasmanian Forrest Industry Workforce Development Plan Tasmanian Forestry and Forest Products Network (TFFPN) (current)
▪ Conducting Skills Audit for Emerging Industries, AgriFutures Australia (2022)

Appendix 2: Glossary

TERM	MEANING
AgTech	Commonly used in the investment community to describe digital technologies used in agriculture.
Big data	Any collection of datasets so large and complex that it becomes difficult to store, process and analyse using current technologies. Big data comes from many sources (e.g. text, image, audio, social media etc.) at an alarming velocity, volume and variety, which adds to this challenge.
Decision agriculture	Conclusion or action resulting from the application of knowledge and/or information that may be derived from digital agriculture.
Digital agriculture	Digital agriculture typically involves both the collection and analysis of data to improve both on-farm and off-farm decision making, leading to better business outcomes.
Digital disruption	Digital and associated technologies that 'disrupt the status quo, alter the way people live and work, rearrange value pools, and lead to entirely new products and services', often in a relatively short period of time.
Information and communication technologies (ICT)	ICT is a broad term used to refer to technologies that involve the use of computers, computer networks, telephone networks and internet networks to manage data and information.
Internet of Things (IoT)	Devices such as sensors, machine and other digital instruments which are connected to each other and the internet so that they are able to collect and exchange data with each other.
Open data	Data that is: • Freely available to download in a reusable form. Large or complex data may be accessible via a service or facility that enables access in-situ or the compilation of sub-sets. • Licensed with minimal restrictions to reuse. • Well described with provenance and reuse information provided. • Available in convenient, modifiable and open formats; and • Managed by the provider on an ongoing basis.
Precision agriculture (PA)	Farming practices that involve precise spatial management through the use of Global Positioning System (GPS) or machine vision technologies. Involves the observation, impact assessment and timely strategic response to fine-scale variation in causative components of an agricultural production process.[ii] This can include variable rate seeding and fertiliser application, yield mapping, and animal location and analysis.

[i] Manyika, J., Chui, M., Bughin, J., Dobbs, R., Bisson, P., & Marrs, A. (2013). Disruptive technologies: Advances that will transform life, business, and the global economy (Vol. 180). San Francisco, CA: McKinsey Global Institute.

[ii] Precision Agriculture Laboratory, What is Precision Agriculture? Sydney University available at - https://sydney.edu.au/agriculture/pal/about/what_is_precision_agriculture.shtml

[9]

[9] Source of above table: Perrett, E., Heath, R., Laurie, A. and Darragh, L. (2017). Accelerating precision agriculture to decision agriculture – analysis of the economic benefit and strategies for delivery of digital agriculture in Australia. Australian Farm Institute and Cotton Research and Development Corporation

Further terms:

TERM	MEANING
Mechanisation	Using machines / mechanical device to reduce or replace human labour
Automation	Operational or process control by highly automatic means, for instance via electronic devices, reducing human intervention to a minimum
Robotics	Using computer-controlled devices to perform manual tasks, replacing labour, e.g. on a production line
Machine learning	The capacity of a computer to process and evaluate data beyond programmed algorithms, through contextualized inference.

Appendix 3: Potential economic impact

Potential economic impact of fully applying all aspects of digital agriculture to make decisions (= decision agriculture)[10].

	Sector	Baseline sector value (GVP) 2014-2015 ($M)	Estimated potential benefit to the sector		Estimated potential benefit to the economy
			GVP[a] Increase ($M)	GVP Increase (%)	GDP[b] Increase ($M)
	Rice	260	78	30	46
	Grains[c]	11,522	5,930	51	1,821
	Cotton	1,413	394	28	692
	Sugar	1,257	291	23	660
	Horticulture[d]	1,018	403	40	951
	Beef	10,461	1688	16	4,219
	Sheep meat	2,988	516	17	1,316
	Wool	2,550	452	18	1,128
	Pork	1,084	55	5	429
	Dairy	3,343	497	15	1,298
	Eggs	729	180	25	128
	Chicken meat	2,084	503	24	371
	Wine	5,865	706	12	630
	Forest and wood products	14,864	5,511	37	7,484
	Livestock exports	1,601	72	4	179
	Red meat processing	14,533	2081	14	2,438
	Fisheries and aquaculture	2,132	928	44	855
	Total	**75,331**	**20,285**	**25**	**24,645**

[a] *Gross Value of Production (GVP)* measures the actual production output of an establishment or sector.

[b] *Gross Domestic Product (GDP)* is a summary indicator of economic activity, and measures the sum of the gross value added through the production of goods and services in individual sectors of the economy.

[c] Including oilseeds and pulses.

[d] Leafy greens, brassicas, and carrots only.

[10] Source: Perrett, E., Heath, R., Laurie, A. and Darragh, L. (2017). Accelerating precision agriculture to decision agriculture – analysis of the economic benefit and strategies for delivery of digital agriculture in Australia. Australian Farm Institute and Cotton Research and Development Corporation.

Appendix 4: Ag Innovation Expo

Ag Innovation Expo (formerly Precision Ag Expo) – 8 years of profiling emerging technology and innovation in Agriculture.

The 8th annual Ag Innovations (formerly Precision Ag) expo was held this year on the April 28, with a fantastic attendance from across the agricultural industry. While this was the 8th expo it was, in many ways, a year of firsts.

The Tasmanian Agricultural Productivity Group (TAPG) has delivered this expo over the past 7 years but were pleased to welcome the Tasmanian Farmers and Graziers Association (TFGA) to the share the hosting duties this year. “We were pleased to be invited to co-host the Ag Innovation Expo as it gives the industry to gather, network and have a look at the latest innovations coming into agriculture.” Said acting TFGA CEO Marcus McShane.

Terry Brient, Executive Officer for TAPG commented; “While our members are drawn from differing parts of the Agricultural Industry, the issues they face have more in common than those that separate them. The collaboration between TAPG & TFGA is born out of the reliance we have with one another in Tasmanian agriculture, and that we will need to be working together to succeed.”

This year was also the first opportunity to welcome the new Minister for Primary Industries and Water, Hon. Jo Palmer MLC, to one of these events. Minister Palmer reiterated the government’s commitment to agriculture in the state and the 2050 target of $10 billion of farmgate value in the state and was able to confirm that the state is still tracking ahead of the required growth rate. Minister Palmer was also able to confirm that this year’s expo was the first of an additional four years of support from the state government for this event ensuring that this event can build on this year’s success and continue to bring more innovative technologies to the state.

Minister Palmer also highlighted the student program that has been in conjunction with the Hagley Farm School Agricultural Learning Centre, as a fantastic way for kids to get excited about a career in Agriculture. As a former city kid herself she was pleased to see opportunities for kids in urban areas to get out and learn more about Agriculture. TAPG was pleased to announce that due to some COVID related changes in the student program, there will be funding available to support more high school groups in getting to the Agricultural Learning Centre throughout the year. This year’s program hosted 16 students on the day prior to the expo where they heard from the Hagley team and Industry experts about a range of topics. In its second year this student experience has been well received by both those students and teachers who attended.

This year’s keynote speech was delivered by Warren Young of the Elphinstone group. His talk gave us a fascinating insight into the challenges surrounding heavy vehicle manufacture and the use of these machines in an underground environment. His talk detailed some of the challenges & opportunities their team are facing as they convert to electric vehicles. While each electric vehicle in a mine could save that mine up to $100k in ventilation costs, they are still careful to ensure they get the same productivity from each vehicle and avoid manufacturing ‘Green Elephants’ (vehicles that are clean and green but underperform and are scrapped).

The afternoon was then devoted to the exhibitors present. With some unique machines and implements on show it was a great opportunity to see what will be available for growers and industry into the future. The expo also hosted a large number of indoor exhibitors who were from a range of providers and industry associations.

The Expo organising committee brings together a range of people from across the industry and everyone’s contribution ensured that this year was another great event and the start of a fantastic collaboration between TAPG & TFGA.

Appendix 5: Precision ag case study

UNDERSTANDING SPATIAL VARIABILITY IN TASMANIAN POTATO CROPS

INTRODUCTION

Site-specific crop management (SSCM) aims to use data from a range of crop production parameters, measured using new sensing technologies, to determine their impacts on crop yield and spatial variability within fields.

A study, titled *Understanding spatial variability in potato cropping to improve yield and production efficiency* by The University of Sydney and Simplot Australia Pty Ltd, (Hort Innovation, 2015) evaluated the potential for site-specific crop management to be used within the Tasmanian potato industry. While the study focussed on potatoes, the findings are also relevant for other vegetable crops. This fact sheet summaries the findings from that study.

The study examined variance within fields by measuring elevation, apparent soil electrical conductivity (ECa) and crop reflectance which was used to calculate the Normalised Difference Vegetation Index (NDVI) within 16 paddocks across two growing regions (North and Midlands) across two seasons (2014 and 2015). It's important to note the study took on-ground soil and plant physical and chemical measurements at various points within fields to ground-truth and calibrate the sensor produced data.

STUDY OBJECTIVES

The objectives were:

1. **Assess and ground-truth sensor data** – The project aimed to determine how the data produced from new-sensing technologies correlates with soil physical characteristics and moisture, and plant physical and chemical characteristics. This was done by ground-truthing and calibrating the sensor-derived data with on-ground measurements. A harvesting-sensor was also used to determine within-field yield variations, and this was used to correlate yield with the other sensor-derived measurements
2. **Determine how data can be used for management decisions** – The study also sought to determine how these measurements could be used to develop variable-rate input application to match crop requirements within paddocks. Using variable application of inputs has the potential to increase

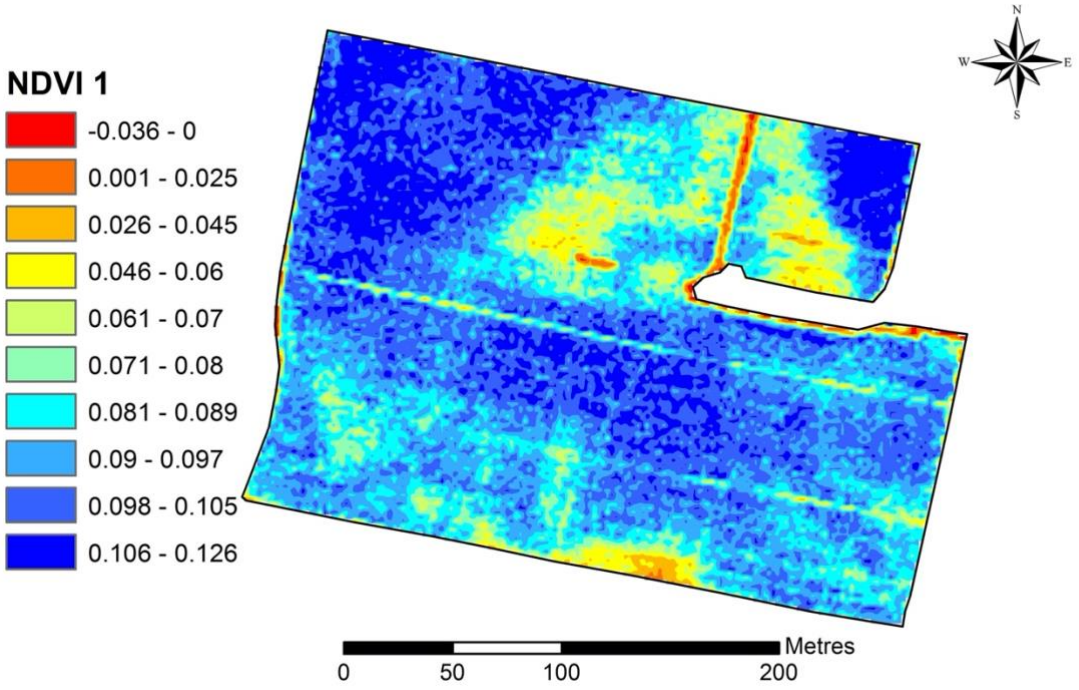
production efficiency and profitability by reducing. The benefits of this could be two-fold: increased yields (by targeting areas of input deficiency), and reduced input costs in areas where additional application of inputs are not required. Reduced excessive application of inputs also carries sustainability benefits.

SENSOR TECHNOLOGIES USED

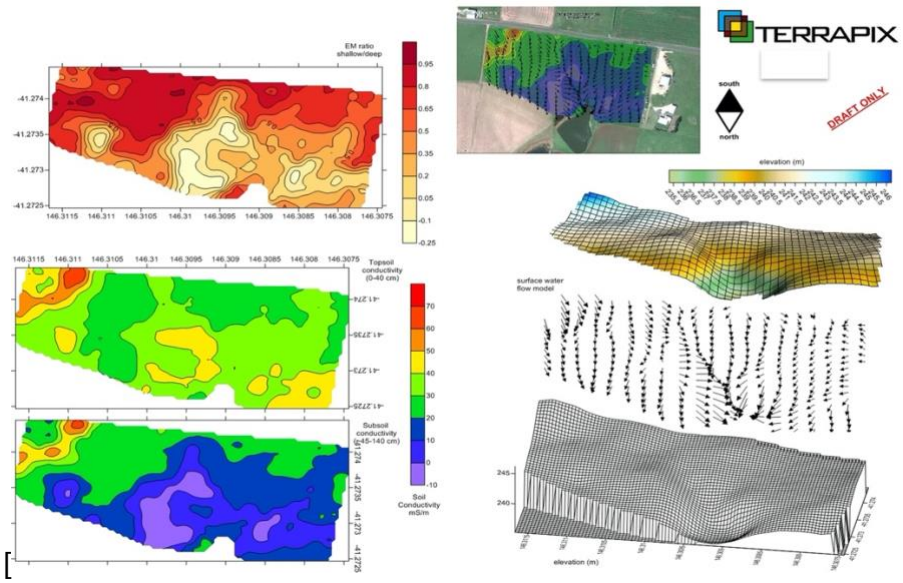
Soil ECa sensors measure the apparent electrical conductivity of soil, which from previous studies is known to correlate with several physical soil parameters, including soil texture and moisture. Soil ECa sensors were used to map soil conductivity across fields and provide an indication of soil structure and soil moisture variation within fields. These sensors were vehicle mounted to provide fine-scale data.

Yield monitors - A harvester-mounted sensor system was used to measure crop yields at individual points within a field. Crop yield data within-fields was then combined with other information such as ECa (soil moisture levels), elevation and crop reflectance/NDVI (plant biomass) to determine potential yield impact. This knowledge could be useful as information beneficial to help inform management decisions for future seasons.

NDVI - Crop reflectance sensors were calibrated in this project to measure plant biomass production. Reflectance is converted to NDVI to produce a measure of crop greenness, vigour/health. The sensors were mounted on an aircraft; however, it was noted there is potential for these sensors to be vehicle mounted in future, which could reduce costs. Crop reflectance provided an indication of crop growth variability across the paddock, information which could be used within seasons to influence input application.



High resolution elevation data was used for each individual paddock and combined with the outputs of other sensor-derived data. This data was collected using an ATV fitted with an electromagnetic induction instrument, which also measured apparent soil conductivity simultaneously. On average, yields were greater in areas of higher elevation.



SOIL PATHOGEN DNA DATA

Soil samples were also collected on-site and tested for quantities of various pathogen's DNA to determine specific soil-borne pathogen load and their impact on yields. The results were varied: the presence of some pathogens (*Pratylenchus penetrans* and *Pratylenchus crenatus)* had a negative impact on yield, whilst others (*Pratylenchus neglectus, Meloidogyne hapla and Powdery Scab)* were correlated with higher yielding areas – this may indicate in these cases pathogen loads are beginning to build where yield was greatest but are not yet at damaging levels.

For more information on soil DNA testing refer to the fact sheet: 'Better Managing soilborne Diseases with Pathogen DNA Testing' available on the Soil Wealth and Integrated Crop Protection website.

Combining data produced by the above technologies ultimately would allow for more efficient use of inputs, such as fertiliser and irrigation.

KEY FINDINGS

SENSOR	FINDINGS	RECOMMENDATIONS
ECa (apparent soil conductivity)	▪ Results suggested there may still be a significant negative impact on yield from temporary waterlogging, caused by within-field variation in soil water holding capacity.	▪ Variable-rate irrigation should be explored based on the changes in soil type identified using apparent soil conductivity (ECa) surveys, or early-season aerial imagery.
	▪ Areas of higher elevations were found to have lower ECa readings and higher yields.	▪ If irrigation management is likely to be a focus, a pre-season survey for ECa and elevation would be valuable, to identify potential areas with low soil water holding capacity.
	▪ Using this data to implement variable-rate irrigation would be useful in reducing any negative yield impacts and crop quality (and therefore price) associated with temporary waterlogging.	▪ Matching variable rate irrigation application to soil water holding capacity should be explored further. Potential benefits include better crop quality (e.g. less rots) and thus better returns.
	▪ Early season measurements of crop reflectance primarily responded	▪ There is potential for identifying areas with high levels of soil-borne pathogens

SENSOR	FINDINGS	RECOMMENDATIONS
NDVI (crop reflectance)	significantly to soil properties and soil-borne pathogen load which impact crop growth, rather than plant physical and chemical differences.	following sowing. This information is useful for crop management and also risk management when selecting paddocks for future crops.
	▪ Increased crop reflectance was found to be significantly correlated with greater concentrations of plant N and P from week 14 onwards.	▪ Mid-season crop reflectance measurements could be used to identify within-field deficiencies of major macro-nutrients.
Yield (within-field)	▪ There was a three-fold variation of potato yield on average within-fields (mean 64.3 t/ha, S.D. 17 t/ha).	▪ Combining within-field yield data with other sensor data can provide additional insights for future years.

KEY MESSAGES:

- Yield data
  - There was a greater than 3-fold variation in potato yield, (mean 64.3 t/ha, S.D. 17 t/ha), demonstrating the need for further investigation improvements in the allocation of inputs to the potato production system
  - Yield data (e.g., collected using load cells on harvesters) and viability within paddocks, is essential for adopting SSCM.
- Aerial NDVI imagery
  - Early-season aerial imagery use could be used to detect build-up of soil-borne pathogen load and warrants further investigation
  - Mid-season aerial imagery is useful for the early identification of within field deficiencies in the major macronutrients (N,P,K)
  - NDVI imagery can be useful for crop management and risk management; timing of imagery needs to be considered.
- Irrigation management
  - Results suggested there may still be a significant negative impact on yield from temporary waterlogging caused by within-field variation in soil water holding capacity
  - Variable-rate irrigation should be explored based on the changes in soil type identified using apparent soil conductivity (ECa) surveys, or early-season aerial imagery
  - Combining data produced by a range of technologies and tools
  - Data can be combined from a range of technologies and tools e.g. yield data, aerial imagery, soil borne pathogen DNA soil testing, grid soil sampling
  - This could ultimately allow for more efficient use of inputs, such as fertiliser and irrigation, which in turn can increase returns e.g. through better crop quality (less disease from waterlogging), reduced fertiliser costs and/or increased yield.

REFERENCE

Hort Innovation (2015). Understanding spatial variability in potato cropping to improve yield and production efficiency. The University of Sydney and Simplot Australia Pty Ltd. Hort Innovation Project Number PT13000. Authors: Brett Whelan and Frank Mulcahy.

https://www.horticulture.com.au/globalassets/laserfiche/assets/project-reports/pt13000/pt13000-final-report-6283.pdf

Appendix 6: Third party support/ vendor organisations in Tasmania

Drones

- https://www.tazdronesolutions.com/
- https://www.facebook.com/dronestasmania/

GIS

- https://www.rmcg.com.au/service/geographic-information-systems-gis/
- https://nre.tas.gov.au/land-tasmania/the-list/listmap

NDVI

- http://www.bom.gov.au/climate/austmaps/about-ndvi-maps.shtml
- http://www.aerialimageworks.com.au/about-us.html

EM38 Soil mapping

- https://aglogic.com.au/PAg.html
- http://groundspec.com.au/conductivity-surveys/

Soil Monitoring

- https://www.nutrienagsolutions.com.au/precision-technology/crop-monitoring-services
- http://agassist.net.au/variable-rate-fertiliser-application/
- https://www.soiltestingtasmania.com.au/
- https://analyticalservices.tas.gov.au/our-services
- https://agvita.com.au/
- https://serve-ag.com.au/divisions/consultancy-tech-services/

Weather Monitoring

- https://aglogic.com.au/Monitoring.html
- https://acescientific.com.au/weather/
- https://www.specmeters.com/weather-monitoring/
- https://monitorsensors.com/

Appendix 7: On farm adoption

(https://ausveg.com.au)

25 NOV 2021

Soil health practices land Tasmanian farmer national award

Each year, the National Landcare Awards acknowledge and celebrate local Landcare achievements at state and territory level as well as nationally. In 2021, Tasmanian farmer Michael Nichols from Redbank Farm took home the Australian Government Innovation in Agriculture Land Management Award. VegNET – Tasmania Regional Development Officer Ossie Lang speaks to Michael about the operation's innovations and his recent achievements.

Michael Nichols runs a 165-hectare farming operation at Sisters Creek in north-western Tasmania. Redbank Farm has a five to six year cropping rotation with onions, potatoes, peas, poppies, wheat and corn. Michael also fattens beef steers and has some pine plantations. This type of mixed farming is typical for many vegetable producing businesses in Tasmania.

Additionally, he owns a grain dryer and silos on-site where he takes in grain from local growers – as well as his own – and markets it to local dairy operations.

The corn has been a relatively recent addition to the rotation, and Michael is still trialling varieties to determine what suits his growing conditions. The corn, when blended with the wheat, is a useful lead feed alternative for his dairy clients. Corn is a good rotational crop with other vegetables.

(https://ausveg.com.au/app/uploads/2021/11/Michael-Nichols-award-scaled.jpg)

Acting Landcare Tasmania CEO Peter Stronach (left) and Board Chair Jonathan Lord (right) present Michael Nichols with the state's 2019 Innovation in Agriculture Award. Image courtesy of Amy Brown and Landcare Tasmania.

Michael also regularly uses cover crops, not only to avoid erosion and suppress weeds, but also as a biofumigant. Alongside this, Michael's father runs an extensive chicken hatchery operation on the property.

Celebrating innovation

On 5 August 2021, Michael took home the Australian Government Innovation in Agriculture Award at a function held in Hobart. This followed the state award that he received in 2019 at the Landcare Tasmania awards.

While Michael is innovative in a number of ways, the national award was for the work he undertook in adopting precision ag approaches, reducing his yield variation through soil mapping and variable rate applications of fertiliser and other inputs.

Michael had his land sampled and soil tested with two tests per hectare. The analyses included soil pH and nutrients potassium (K), calcium (Ca), magnesium (Mg) and phosphorous (P). Michael then used this information to create variable rate maps for his various inputs, lime to adjust pH and single super to adjust P variability issues.

Michael has also combined this variable rate approach with in-season monitoring to vary his Nitrogen (N) applications to match crop needs. He has done this using NDVI imagery – either by satellite or drone –through the growing period to check for variation between areas of lighter and darker green foliage in the crop.

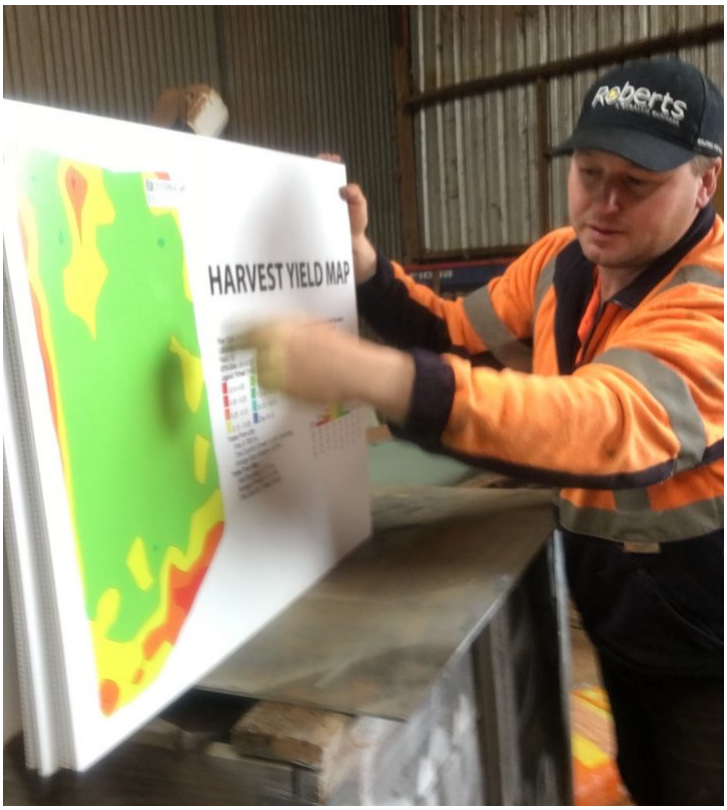
Positive outcomes

The success of this variable rate management has been confirmed in those crops where Michael is able to monitor the yield across the paddock.

"Before commencing this program, we would see a (within field) yield variation of around 40 per cent. We've been able to reduce this down to around 20 per cent using variable rate technologies," Michael explains.

The variable rate approaches have also paid off in reduced fertiliser costs.

"In one instance, I was able to scale back the rate to around a quarter of the recommended rate in certain areas. This reduced fertiliser cost was achieved while getting a yield increase from the crop," Michael says.



(https://ausveg.com.au/app/uploads/2021/10/IMG_2664-cropped.jpeg)

Michael Nichols talks to the horticulture students about his yield maps.

Several other benefits, which are a result of a more consistent crop across the paddock, aren't as easy to pin a dollar figure on. A more even crop makes spray application, nutrition, and other crop management decisions much easier to get right, as there is less variation in the plant growth stage and vigour.

Michael has also seen reductions in disease incidence as the areas with high nutrient loads, lush growth and other favourable conditions for diseases have decreased.

So, what next for Redbank Farm?

"At the moment, irrigation decisions are being made for a paddock based of a single probe or data point. I'd like to apply a similar area sampling type method to moisture monitoring and irrigation to better inform irrigation decisions," Michael says, adding he is also interested to see how sap testing across a paddock could back up the variable rate nutrition decisions.

Find out more

For further details about how to use variable rate approaches, please contact Ossie Lang via email at ossiel@rmcg.com.au (mailto:ossiel@rmcg.com.au) or on 0430 380 414.

Follow us on social media: Facebook: @VegNET.Tas (https://www.facebook.com/VegNET.Tas) and Twitter: @VegNET_Tas. (https://twitter.com/VegNET_Tas)

VegNET 3.0 is a strategic levy investment under the Hort Innovation Vegetable Fund.

This project has been funded by Hort Innovation using the vegetable research and development levy and contributions from the Australian Government.

Project Number: VG21000

Cover image: *Michael Nichols pictured discussing his operation with horticulture students. Images courtesy of Theresa Chapman.*

Tassie Farm Wins National Award

05 Aug 2021 - This evening, over 2,000 people from across the country came together online to watch the 2021 National Landcare Awards - and Tassie has a winner!

Image: Michael Nichols (centre) Accepts the Award, with Landcare Tasmania's Peter Stronach A/CEO (left) and Director Jonathan Lord (right).

Tasmania's Redbank Farm (https://www.landcaretas.org.au/9693) won the Australian Government Innovation in Agriculture Award (https://landcareaustralia.org.au/project/australian-government-innovation-in-agriculture-land-management-award/) for their pursuit of precision agricultural techniques that address crop variability and resource-use efficiency.

"This award is presented to a primary producer or enterprise for demonstrating innovation in agriculture land management through leadership or application that delivers improved natural resource management and farm productivity outcomes." - Landcare Australia

Michael Nichols owns and manages a family property at Sisters Creek, Redbank Farm. Redbank Farm is a 380 hectare property in north-west Tasmania that has been operated for over 20 years by the Nichols family.

Images: The picturesque Redbank Farm Landscape

Redbank farm balances profitability and sustainability with almost a third of the farm dedicated to natural bush, wetlands and revegetation areas. The 100 hectares of native bushland contains some of the most pristine remnant forest in the region, including white gum forests, blackwood stands and valuable old habitat trees. The farm also hosts a family of wedge-tailed eagles, and the threatened freshwater lobster and burrowing crayfish live in local creeks.

The Nichols family use a range of innovative and best practice initiatives to run their farm sustainably.

Image: The expansive Redbank Farm property

It is an incredibly diverse farming business. They crop potatoes, onions, carrots, processing peas, buckwheat, pyrethrum, poppies, mustard, wheat, canola, beef steers, plantation radiata pine saw logs. He has built and manages a grain pooling facility, supporting local growers to store grain and on sell to the dairy industry. He works collaboratively with Nichols chickens, hosting a hatchery on-site, along with Hill Farm Preserves, a unique processing and exporting business.

Michael also owns and operates his own oil press for oilseed processing, producing oil and meal. If all this weren't enough for him to be getting on with, he has embarked, over the last few years, on a pursuit of **precision agricultural techniques** to address crop variability and resource use efficiency.

To keep atop of their crops, the farm employs a mixture of state-of-the-art agricultural practices including **grid soil sampling**, **satellite NDVI (Normalised Difference Vegetation Index)** imagery and **yield mapping** to ensure maximum **sustainable output** and **soil regeneration**.

Image: Redbank Farm owner and manager Michael Nichols accepting the 2019 Tasmanian Landcare Award © Natasha Mulhall

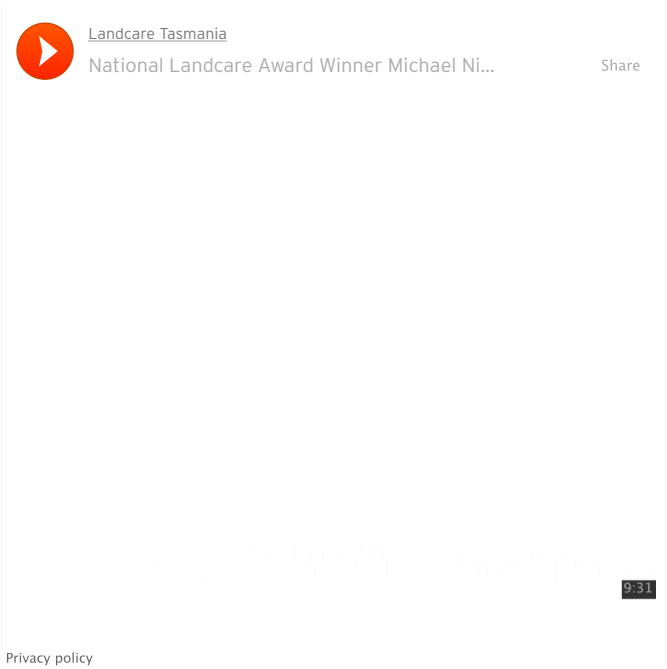
Michael is a careful and thorough operator, and is showing that **planning and attention to detail** and the use of a suite of **innovative tools and technology** can have great results for profitability and Landcare outcomes. He has a meticulous mind and is keenly observant and cares deeply about his land. He is an inspiration and pioneer in innovative agriculture, congratulations Michael!

Peter Stronach Acting CEO Landcare Tasmania has said:

"Winning this award gives us, as a community driven organisation, the momentum to continue to support those willing to strive for a more sustainable future. It's fantastic to see the innovative agriculture practices being undertaken on a Tasmanian farm be recognised and celebrated on a national level."

Landcare Tasmania hosted a celebratory dinner (https://www.landcaretas.org.au/2021_national_landcare_awards_gala_dinner) to watch the live streamed event, bringing together a broad network of Tasmanian Landcare legends. The 9 national finalists (https://www.landcaretas.org.au/conf19saturdayawardsprogram) from our 2019 State and Territory Awards are from a variety of groups from Tasmania and came together to share in the State's first national win in 6 years.

Featured On ABC Rural: National Landcare Winners Recognised For Their Passion, Environmental Excellence (Https://Www.Abc.Net.Au/News/Rural/2021-08-05/National-Landcare-Winners-2021-Recognised-In-Virtual-Awards-/100349072)



The 2021 National Landcare Awards and 2021 National Landcare Conference are delivered by Landcare Australia through support from Australian Government's National Landcare Program.

Landcare Australia

Australian Government

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