iMapPESTS wraps up after six years of cross-industry research, development and extension

From 2018 -2023, Australia's plant industries joined forces to explore how a national, cross-industry plant pest surveillance program harmonised across many stakeholders, agencies, and programs might operate. Six project teams investigated state-of-the art technologies for components of surveillance, diagnostics and adoption of the data generated.

SHAKIRA JOHNSON REPORTS ON THE OUTCOMES OF IMAPPESTS: SENTINEL SURVEILLANCE FOR AGRICULTURE.

Above. Sentinel 4 at Thorndon Park Produce.

In a unique collaboration using the latest technologies, Australia's agriculture and horticulture industries worked together to develop a national surveillance system capable of rapidly monitoring and reporting the presence of airborne pests and diseases for multiple agricultural sectors, including viticulture, grains, cotton, sugar, forestry and horticulture. The iMapPESTS: Sentinel Surveillance for Agriculture project has delivered a suite of new surveillance and diagnostics tools driven by industry needs following extensive research and development into a flexible, cost-effective system.

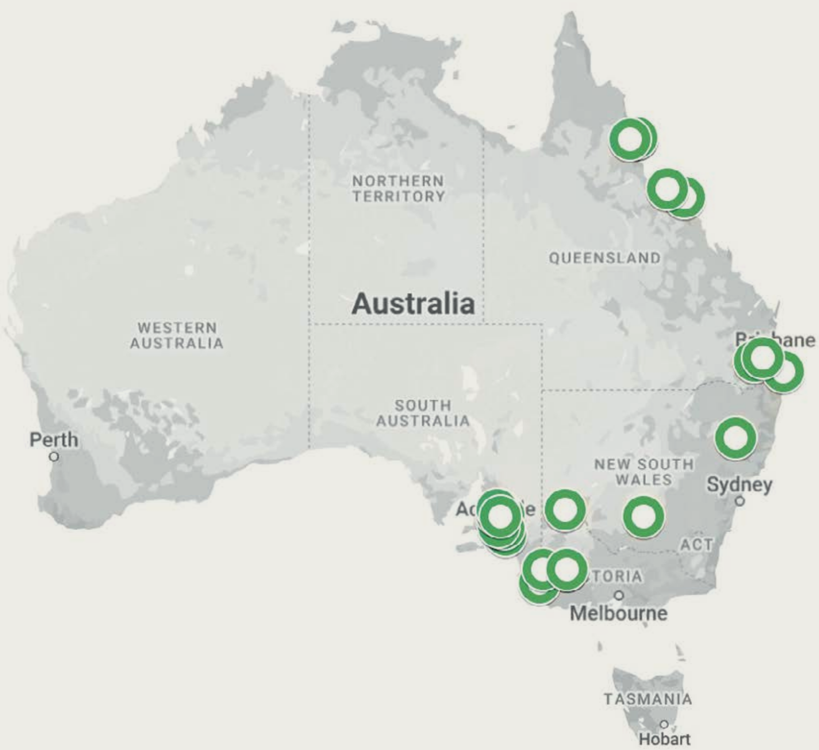
Originally, the program aimed to deliver a mobile, cross-industry surveillance network to monitor the presence of pests that threaten major agricultural sectors across Australia, with the aim of covering surveillance diagnostics and forecasting with producers, industry and government. Data would include timely and accurate information about pests in their region to assist with management decisions, reduce pest resistance and demonstrate pest-free status to export markets.

As the project progressed, it became evident that to meet the needs of Australian producers and plant surveillance knowledge/practice gaps, the work needed to pivot slightly. The project therefore pivoted to focus on the design, testing and validation of:

- Advanced surveillance technologies, such as automated trapping and sampling for detecting and monitoring a wide range of established and exotic pests and diseases;
- Fast, reliable and cost-effective means to detect and report pests and diseases, such as advanced molecular diagnostics.

The collaborative efforts of the six project teams in the iMapPESTS project was a proof-of-concept sentinel surveillance system for Australian agriculture that aimed to lay the foundations for a national, cross-industry surveillance system that can deliver actionable information to primary producers, industries, and governments on established, trade-sensitive and exotic pests and diseases.

FIGURE 2. SENTINEL DEPLOYMENT LOCATIONS



This information should be used by stakeholders to guide the direction and intensity of scouting efforts and pest control actions. The system should also facilitate a rapid, co-ordinated response during incursions, including use in delimiting systems and proof-of-freedom claims.

At the heart of this system are the mobile surveillance units, known as sentinels (*Pictured - Sentinel 4 at Thorndon Park Produce*). Each sentinel contains a weather station (monitoring temperature, rainfall, and humidity) and suction traps to collect airborne insects and fungal spores. What makes the sentinels different from existing suction traps used for pest monitoring are the automatic carousels, which change the sample pots daily. The sentinels can be monitored remotely and need fewer man hours to operate than many monitoring systems. Samples are collected once per week, and program a new sampling regime.

From September 2019 to August 2022 this component of the iMapPESTS project developed twelve sentinels and implemented 44 field deployments across South Australia, Queensland, New South Wales, and Victoria (See *Figure 2*). These surveillance activities came to a total of 3,902 sampling days capturing airborne pests and pathogens at these locations.

While the sentinels sampled airborne pests and pathogens, researchers trialled new and emerging diagnostic tools that aim to speed up the delivery of accurate information on what exactly is captured. iMapPESTS included the development of diagnostic tests using next-generation sequencing by AgVic, Sugar Research Australia and University of Queensland. In addition to speeding up accurate reporting of target pests, the iMapPESTS diagnostics collaboration is exploring high throughput sequencing (HTS) to investigate ways of reporting on a wider range of insects captured, including targets of biosecurity concern. This is because the HTS approach takes a sample of insects or fungi captured by the trap and sucks out all the genetic code, resulting in a 'DNA soup' that can be scanned using a reference tool, or database, of known DNA codes for hundreds of thousands of different insects or fungal species. If a particular species was trapped, its DNA code will be present in the soup and flagged by the reference database, indicating its presence in the trap. These techniques have the potential to detect many targets in one test and identify biosecurity threats early, allowing for a more effective response to an incursion.

To further investigate the impact of this new diagnostics method and how it might work in the iMapPESTS surveillance system, a selection of insect samples from the sentinels were processed at Agriculture Victoria Research's AgriBio using their HTS diagnostic method.

The research found that metabarcoding is a semi-quantitative means of high-throughput sample analysis, with the resolution of insect biodiversity increased through a greater number of traps per site. The combination of sentinel traps and subsequent processing by metabarcoding provided a high resolution (compared to other methodologies of sample collection and analysis) of insect species diversity across time and space. Further, the combination of sampling and analytical methods recorded insect groups that would otherwise go undetected and not be targeted, therefore presenting an opportunity to enhance integrated pest management approaches.

The team also found that combining traditional ground and wind sampling methods with the sentinel sampling unit yielded superior results than any alone, but the sentinel units collected a greater diversity of samples than either traditional sampling technique (*Figure 3 is an example of the diversity of samples collected at a sample site*).

The prospect of at least some of these collaborations continuing is high - a case for an iMapPESTS 2.0 (ie, a second project to continue the work of this project) is already underway. The project delivered such positive outcomes, and proof of concept for the potential for modernised surveillance technology and methodologies that iMapPESTs 2.0 is seen as a logical and necessary action.

AUSVEG established an extension network to raise awareness, build support and promote adoption of the program's outputs and outcomes across each industry. Key stakeholders were encouraged, engaged, and supported to use the information through a range of communication and engagement activities, such as workshops and events.

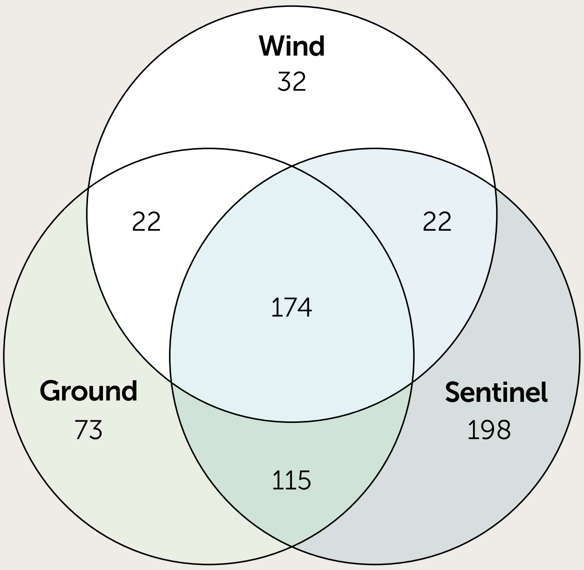


FIGURE 3. VENN DIAGRAM DEMONSTRATING THE DIFFERENT NUMBERS OF SPECIES SAMPLED BY EACH TRAP TYPE.

FURTHER INFORMATION

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Further details can be found at the iMapPESTS website imappests.com.au.

The program (2017-2023) was supported by Horticulture Innovation Australia Limited, through funding from the Australia Government Department of Agriculture, Water the Environment as part of its Rural R&D for Profit Program and Grains Research & Development Corporation, Sugar Research Australia, Cotton Research & Development Corporation, Wine Australia, AgriFutures Australia, and Forest and Wood Products Australia.

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Scan to view iMapPESTS website

Above. Sentinel 7 at Tapanappa Wines.

These activities extended the research and development to practical applications. The team coordinated with key industry contacts to collaborate on the publication of 63 project progress articles, ranging from extensive results-based articles in industry publications to short online news communications and newsletters. In addition, the team delivered or facilitated the delivery of 44 information sessions at R&D forums, field days, conferences, and workshops. All communication outputs were heavily dependent on project partners supplying correct and up-to-date information on the surveillance initiative progress to AUSVEG.

There are clear opportunities to build on the achievements accomplished through the RD&E program of iMapPESTS, particularly in building regional capacity and continued cross-industry collaborations.

> The need for a diverse communications and extension network driven by cross-industry regional industry engagement personnel is essential to drive the adoption of the surveillance network and encourage contributions from primary producers.

Central coordination of activities linking research and development to extension drives efficiencies and supports the identification of capacities and opportunities across all stakeholders of a plant pest surveillance network. Integrating end-user perspectives throughout all stages of program development. From proposal to co-design to evaluation and adaptive management processes, will lead to a successful, sustainable system that will strengthen Australia's plant industries into the future.

From an industry perspective, a data management system and user interfaces that enable two-way information flow should be developed to improve access to surveillance results in a way that is relevant and easy to understand for end-users.

The benefits from the collaboration have included:

A legacy of collaboration

iMapPESTS represented a collaboration between different agricultural industries which was unique in this domain and beneficial in solving problems in different sectors. It encouraged researchers to 'think outside the box,' in developing suitable traps - for example, highlighting that forestry requires insect trapping to reach the canopy.

Improved cross-industry communication and information flows

The program helped in getting the message to different industries such as cotton, grains, sugar, and wine.

Good exposure for the sugar industry in terms of surveillance and transferable information from other industries. Many sugar farmers are mixed cropping enterprises.

Direct benefits to State Governments

To date, funding for iMapPESTS has come from federal funds and a consortium of RDCs. In addition, traps have been provided to State Departments at no cost, during the program.

Prioritisation

The program prioritised species that would have the most impact across multiple industries (e.g. green peach aphid).

Developing interest

The collaboration and engagement have fostered an interest in ongoing collaboration and support for further development.