



PLANT BIOSECURITY
science foundation

National Masterclasses to Improve Biosecurity for Management of Soil- borne Diseases on Strawberry Farms

January 2020

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1. Executive Summary

This project delivered Masterclasses to Australian strawberry growers to increase their awareness and adoption of farm biosecurity practices. Growers provided quantitative and qualitative feedback about their biosecurity risks and ability to mitigate those risks. Growers considered most of the farm biosecurity practices discussed at the Masterclasses as 'easy' to adopt, particularly those that were not costly or time consuming to implement (e.g. erecting biosecurity signs). One month after the Masterclass, survey results showed that 75% of participants adopted one or more of the biosecurity practices on their farms. Many growers reported that they educated their staff about farm biosecurity (>45%) and adopted cleaning of equipment (>25%) to minimise the spread of infested soil. Growers urgently need a manual to better educate their staff and visitors about farm biosecurity. We recommend that the Australian Plant Biosecurity Science Foundation (APBSF) funds additional work to develop a farm biosecurity manual for strawberry growers, using information from the Masterclass series.

As a result of this project, industry has funded work (approved for 2020) to determine the wider adoption of biosecurity practices and to survey crops for soil-borne diseases on every strawberry farm in Victoria. Overwhelmingly, growers think their biosecurity efforts are wasted due to the unwillingness of utility and labour providers to follow their protocols on strawberry farms. Growers in other agricultural industries (e.g. vegetable and potato) have similar issues with these providers (Callum Wilson, AUSVEG, personal communication). There is a strong opportunity for the APBSF to lead and fund education programs on farm biosecurity to utility and labour providers who operate in agricultural industries to reduce the spread of soil-borne pathogens and other pests.

2. Introduction

Major soil-borne diseases such as charcoal rot (caused by *Macrophomina phaseolina*) and Fusarium wilt (caused by *Fusarium oxysporum* f.sp. *fragariae*) are killing strawberry plants in Australia (Figure 1). These diseases have increased in importance since the withdrawal of the soil fumigant methyl bromide in 2005-2006. In 2017, the Victorian Strawberry Industry Certification Authority (VSICA) conducted a survey across the Victorian strawberry industry to determine the distribution and severity of charcoal rot. The survey found that over 80% of growers' properties had soil that was infested with *M. phaseolina* and that strawberry plants on 60% of farms were affected by charcoal rot. Overall, the Victorian strawberry industry suffered an estimated loss of AU\$20M due to charcoal rot.

Farm biosecurity is a set of practices designed to protect a property from the entry and spread of pests, diseases, and weeds (<https://www.farmbiosecurity.com.au/>). Farm biosecurity practices can decrease the spread of soil-borne diseases by reducing the movement of infested soil between and within properties. Most growers in the strawberry industry were unaware and had not implemented practices to manage farm biosecurity because of their earlier reliance on methyl bromide, which was highly effective in controlling all soil-borne pests. Following the withdrawal of methyl bromide, the importance of farm biosecurity has increased, and there is a strong opportunity for strawberry growers to adopt these practices to reduce the impact of soil-borne diseases on their crops.

3. Aims

The primary aims of this project were:

- 1 To increase Australian strawberry growers' knowledge of the spread of soil-borne pathogens and the importance of farm biosecurity in minimising their movement on their properties.
- 2 To increase adoption of farm biosecurity practices on Australian strawberry farms.
- 3 To assist with the professional development of Dr. Dylan McFarlane and capacity building of the industry to manage the soil-borne diseases.

4. Methods/Process

Masterclasses on farm biosecurity for management of soil-borne diseases were delivered to small groups of strawberry growers (12-30 participants) at regional areas in the Granite Belt (QLD), Yarra Valley (VIC), Toolangi (VIC), Adelaide Hills (SA) and Wanneroo district (WA) (Figure 2). Local agronomists, extension workers, scientists and chemical resellers also attended the Masterclasses. Invitations to the Masterclasses were made through the strawberry e-newsletter 'The Punnet', local Industry Development Officers in the strawberry communication project, and APBSF networks. The key learnings from a PBCRC project 'Perceptions and behaviours towards biosecurity risks across Vietnamese farming communities in Australia' were incorporated into the Masterclass at Wanneroo, since the audience included many Vietnamese growers. Truyen Vo, from Vegetables WA, attended the Masterclass to translate material into Vietnamese, and to facilitate the group discussions. The Masterclasses followed educational and participatory approaches with growers (see below). The aim was to provide growers with information on farm biosecurity and guide them in making their own decisions about adoption in a way that was relevant to their specific farms and businesses.

Educational Approaches

Growers were asked to consider the layout of their farms at the Masterclass, and the critical control points for managing the spread of infested soil. Dr McFarlane gave a PowerPoint presentation containing a series of farm biosecurity practices that growers could use to mitigate the spread of soil-borne diseases on their properties (see supplementary material). The biosecurity practices included:

Property access: Limiting the number of freely accessible entry points (e.g. unlocked gates) to a property. This practice provides greater control over who and what enters the property, where they enter the property, and the risk of contamination they pose.

Signage: Growers were encouraged to erect farm biosecurity signs at the entry points of properties. The use of clear instructions and relevant contact details on the signs allows visitors to contact the grower. Growers were informed on where to purchase signs and the option of having signs translated into other languages was discussed.

Visitor and employee carparks: The use of designated, gravelled car parks helps to contain any infested soil that enters the property on a vehicle away from production zones.

Clean on-farm equipment and vehicles: Growers should clean their farm equipment and vehicles between use, as often as possible. This practice will reduce the risk of spreading infested soil around the property.

Property zoning: Dividing a property into zones where visitors can access, and other areas where only growers and their staff can enter, will help to contain any infested soil that enters the property to specific zones.

Paddock zoning: The order that growers conduct work activities on their properties is important in managing soil-borne diseases. Starting farm operations at paddocks with low disease and working towards paddocks with high disease is an effective method for minimising the amount of infested soil that spreads to clean paddocks.

Employee and visitor hygiene: People can carry infested soil on their hands and footwear. Growers should provide hand washing facilities, foot baths and/or footwear (e.g. boot covers, shoes, etc.) to visitors and employees to minimise the risk of people carrying infested soil around the property.

Removal of strawberry plants and weeds: Dead plants and weeds may carry the pathogens that cause disease. Therefore, removing dead strawberry plants and weeds from production sites and destroying them can also remove these pathogens from the property.

Certified strawberry runners: Certified planting material is tested and inspected for pathogens in the nurseries. Therefore, growers should only plant Certified strawberry runners on their properties.

Staff and visitor inductions: Inducting staff and visitors in biosecurity practices will improve adoption and adherence across the farm.

During the presentation, growers were asked to identify the opportunities and/or barriers to adopting each specific practice for managing farm biosecurity. They were asked to rate each practice based on the ease of adoption, on a scale ranging from “very easy” to “very difficult”. Their responses were collected anonymously and in real-time using response cards (Turning Technologies). Results were presented to the audience, which allowed growers to discuss their individual responses with each other to facilitate co-operative learning experiences. This approach followed the strategy of integrated stakeholder engagement proposed by Cathy Robinson (Plant Biosecurity Co-operative Research Centre 4115: Collaborative planning and shared decision making amongst stakeholders in plant biosecurity risk management).

Participatory Approaches

Several participatory activities were used at the Masterclasses to engage growers in interactive processes about farm biosecurity, including:

Microscope demonstrations of soil-borne pathogens: Growers examined different soil-borne pathogens under the microscope, including *M. phaseolina* and *F. oxysporum* f.sp. *fragariae*. These demonstrations emphasised the biology, size and scale of pathogens, and the mechanisms by which they could move in infested soil.

Demonstrations on the use of different tools for managing farm biosecurity: Farm biosecurity tools are important for managing soil-borne diseases on strawberry. Growers observed how foot baths and foot covers reduce the spread of soil-borne diseases on farms.

Quizzes on ‘what soil-borne disease is this?’: Growers were asked to identify different soil-borne diseases of strawberry, based on photos of symptomatic strawberry plants. This exercise emphasised the need for the use of correct diagnostics, including plant and soil tests, to identify soil-borne diseases of strawberry.

Soil column demonstrations: Growers participated in a soil column experiment on how to control pathogens more effectively with fumigants and improved plastic mulches (i.e. totally impermeable films). The experiment also facilitated a discussion on how to reduce the re-colonisation of treated soils by pathogens using farm biosecurity practices.

Evaluation

One month after the completion of individual Masterclasses, attendees were contacted by telephone and asked if they had adopted any farm biosecurity practices. The key results of the project were presented at the International Methyl Bromide Alternatives Outreach conference in San Diego, California (2019).

5. Achievements, Impacts and Outcomes

Results

Seventy-three Australian strawberry growers, representing approximately 28% of the industry, attended the Masterclasses. All strawberry runner growers in Victoria attended the Masterclass. Growers considered most of the biosecurity practices discussed at the Masterclasses as ‘moderately easy’ to implement (Figure 3). This was because: (i) they were cheap, (ii) they did not require much of their time and/or (iii) they were already conducting them. For example, all strawberry growers used Certified planting stock and understood the value of the pathogen-tested Certification schemes (Figure 4). Similarly, many growers had already erected biosecurity signs (all fruit growers in South Australia and all runner growers), while others reported that they could easily put them in place (Figure 3). Despite the perceived ease of adopting many measures, growers at every Masterclass strongly expressed their concerns about utility and labour providers not understanding or not adhering to their farm biosecurity practices.

The practices that growers considered “difficult” to implement included the removal of old strawberry debris and weeds. The major barrier to adopting these practices was their high cost in labour (Table 1). Despite this, some growers started experimenting with the use of potato/carrot harvesters to remove old plants and reduce labour costs following the Masterclasses. Most of the growers stated that they could not provide footwear or foot covers to their staff and visitors, due to the high cost and effort required (Figure 5). Instead, growers preferred the concept of providing foot baths and washing facilities for removing soil.

One month following the completion of the Masterclasses, 75% of participants reported they adopted one or more of the farm biosecurity practices discussed at the events. All growers were aware of the concept of farm biosecurity for managing soil-borne diseases. The farm biosecurity practices adopted by growers included educating staff (>45%), providing either footbaths, foot wear and/or foot cover (>30%), cleaning equipment between operations (>25%), property/paddock zoning (>25%), and several others (Figure 6).

Achievements/Outputs

1. National Masterclasses to improve biosecurity for management of soil-borne diseases on strawberry farms:

Wanneroo, Western Australia: February 2019

Audience: 12 strawberry growers, 3 scientists, a Vietnamese translator and the Western Australian industry development officer.

Yarra Valley, Victoria: June 2019

Audience: 30 strawberry growers, 2 agronomists, 4 scientists, 5 chemical-resellers, 1 utility provider and the Victorian and Queensland industry development officers.

Adelaide Hills, South Australia: September 2019

Audience: 13 strawberry growers, 3 scientists, 1 extension officer, 3 chemical resellers, 2 agronomists.

Stanthorpe, Queensland: September 2019

Audience: 10 strawberry growers, 5 scientists, and 2 agronomists.

Toolangi, Victoria (strawberry nursery growers): November 2019

Audience: 8 strawberry growers, 5 scientists, 1 extension officer.

Outputs: One PowerPoint presentation at each Masterclass (see supplementary material). Practical demonstrations, including microscope demonstrations on soil-borne pathogens, demonstrations on the use of different farm biosecurity tools, quizzes on soil-borne diseases and soil column demonstrations.

2. Masterclasses to improve biosecurity for better management of soil-borne diseases of strawberry: Western Australia report: April 2019

Audience: All growers in Australian strawberry industry (260 growers) and members of allied industries.

Outputs: One magazine article in the Australian strawberry industry newsletter Simply Red.

3. MBOA Fumigation and alternatives for production, storage and trade conference:
November 2019

Audience: 300 individuals, including scientists, strawberry growers, members of allied industries, government representatives and fumigation company representatives.

Outputs: One PowerPoint presentation (Masterclasses to facilitate the adoption of farm biosecurity for soil-borne pathogens of strawberry) (https://mbao.org/static/docs/confs/2019-sandiego/papers/14_mattner.pdf) and one conference paper (https://mbao.org/static/docs/confs/2019-sandiego/papers/14mattner_scott.pdf).

4. Project summary: February 2019

Audience: General audience.

Outputs: One internet article (<https://www.apbsf.org.au/national-masterclasses-to-improve-biosecurity-for-control-of-soil-borne-diseases-on-strawberry-farms-pbsf013/>).

Impacts and Outcomes

1. All growers attending the Masterclasses (28% of the industry) became aware of farm biosecurity and its importance for managing soil-borne diseases. Seventy-five percent of the growers participating in the Masterclasses adopted at least one farm biosecurity measure (20% of growers in the Australian industry). The increased adoption by growers of (i) farm biosecurity practices from this project, and (ii) better control measures identified through the National Charcoal Rot Project (HIA Project BS15005) is expected to reduce the spread of soil-borne pathogens of strawberry across the industry, including *M. phaseolina* and *F. oxysporum* f.sp. *fragariae*. This outcome will be further evaluated and quantified in a disease survey across the strawberry industry in Victoria (see below).
2. Based on the interest amongst growers generated by this project, the Victorian strawberry industry has recently invested AU\$100,000 into a charcoal rot disease survey in 2020. The survey will assess the adoption of farm biosecurity practices and relate this to the incidence and severity of charcoal rot, compared with data from 2017. The results will provide a further evaluation of the impact of this project.
3. This project has enhanced the professional development of Dr McFarlane. This is the first project that Dr McFarlane has conceived, applied for, and conducted since completing his PhD funded through the PBCRC. Through the current project, Australian strawberry growers and international researchers now recognise Dr McFarlane as an expert of charcoal rot and farm biosecurity for managing soil-borne diseases of strawberries. Dr McFarlane has been invited to speak at several industry-run events since this project began. Dr McFarlane's paper at the International MBOA was the first presentation on improved farm biosecurity practices for managing soil-borne diseases delivered at the conference in its 20-year history (Figure 7).

Consequently, he has been contacted by international researchers from the USA about collaborative project opportunities, including the investigation of different pathotypes of *F. oxysporum* f.sp. *fragariae* to improve diagnostic protocols for strawberry growers.

4. For the first time, a strawberry fruit business (Strawberry Springs' Luciano and Heather Corallo) won the Farm Biosecurity Producer of the Year for 2019, which is part of the Australian Biosecurity Awards presented by the Department of Agriculture and Water Resources (<https://www.farmbiosecurity.com.au/the-2019-farm-biosecurity-producers-of-the-year/>). Luciano and Heather attended two Masterclasses and were leading adopters of farm biosecurity practices and advocates of this project.

6. Discussion and Conclusion

There were high rates of attendance by strawberry growers at the Masterclasses (approximately one third of the national industry) compared with other industry events (personal communication, Victorian Strawberry Industry Development Officer). Conducting the workshops at centres close to growers and the use of translators where English was a second language were important factors in achieving high attendance rates. Prior to the Masterclasses, our survey results showed that growers prefer to receive extension information in small groups (Figure 8), and the use of this method contributed to the success of the events. Most growers (>90%) attending the Masterclasses contributed to the discussions and many commented that this was due to the small size of the groups and the informal environment it created.

The complementary use of educational and participatory approaches at the Masterclasses were effective in delivering information to growers and allowing them to make their own decisions on adoption of farm biosecurity practices to suit their specific farms and businesses. This is reflected in the diversity of practices that growers adopted (Figure 6). All growers attending the Masterclasses used the remote response cards to provide feedback during the information presentations. This proved particularly important because it allowed growers to answer questions anonymously, and generated grower-to-grower discussions on the practicalities of individual farm biosecurity practices. In fact, growers resolved many of the barriers to adoption of farm biosecurity practices between themselves. For example, growers considered increased labour costs as a barrier to adopting the practice of removing old strawberry debris by hand. Some growers in the audience recommended that mechanical devices, including potato and carrot harvesters, could be used to remove old strawberry debris to reduce labour costs.

Prior to the Masterclasses, our survey results showed that 68% of strawberry growers seek information on management of soil-borne diseases from agronomists and chemical resellers. The participation of agronomists, chemical resellers and extension officers at the Masterclasses was important in maintaining momentum of the key messages on farm biosecurity after the events. For example, R&R Fumigation Services, a well-known chemical reseller across the industry, invited Dr McFarlane to speak on biosecurity at one of their industry communication events.

The practice that most growers adopted following the Masterclasses (approximately half of all attendees) was educating their staff about farm biosecurity. Growers reported that they did this by drawing on the information they received at the Masterclasses. However, growers also commented that they require better resources to help them educate their staff, such as a farm biosecurity manual for strawberry. Therefore, we recommend that the APBSF fund the development and delivery of a biosecurity manual for growers. The biosecurity manual would incorporate the information developed (i.e. biosecurity practices and related imagery) and gained (i.e. strawberry growers' feedback) from the current project. The development of a structured biosecurity manual would be useful to growers, as a means of further educating themselves, visitors, and staff.

The greatest barrier to the adoption of farm biosecurity by strawberry growers (raised by growers at every Masterclass) is their reluctance to adopt practices that are not respected by utility and labour providers. Growers were alarmed that these providers do not follow hygiene practices when operating on strawberry properties, despite the presence of farm biosecurity signs. For example, growers commented that several utility providers do not wash their vehicles prior to entering the property and think that they can access all parts of the farm, including production zones, without supervision from the owners. One grower said, 'what is the point of adopting any of these practices when [specific water company] thinks they have the authority to drive their dirty trucks from my neighbours' farm straight onto my property?'. Moreover, other fruit and vegetable growers have expressed similar complaints, regarding the ignorance of utility and labour providers to farm biosecurity (Callum Wilson, AUSVEG, personal communication). Therefore, there is a strong opportunity for the APBSF to lead and fund a program to educate utility and labour providers about the seriousness of farm biosecurity and the impact it has on rural businesses. A collaborative approach with input from AUSVEG, Berries Australia, Wine Australia, Horticulture Innovation Australia, and the APBSF would allow the program to assist multiple rural industries in specific regional areas. Evidence from the Masterclasses suggests that the adoption of farm biosecurity practices by these groups would also encourage growers to maintain strict biosecurity practices on their farms.

The Australian strawberry industry has benefited from the current project. Evidence showed that growers have commenced adoption of specific farm biosecurity practices as a result of the Masterclasses. Furthermore, the Victorian strawberry industry has commissioned new work to assess the adoption of farm biosecurity by the industry. The current project has also complemented the National research program to develop better fumigant and cultural controls for charcoal rot disease of strawberry (Horticulture Innovation Australia Project BS15005). We anticipate that the continued adoption of farm biosecurity practices integrated with improved controls by Australian strawberry growers will result in a more resilient and profitable industry.

7. Recommendations

Recommendations to Strawberry Growers

Soil-borne diseases have increased in importance in the strawberry fruit industry since the phase-out of the soil fumigant methyl bromide. This fumigant was extraordinarily effective, and growers can no

longer rely on a single product to control soil-borne diseases in strawberry crops on their farms. **Strawberry growers should consider the farm biosecurity practices discussed at recently held Masterclasses and in this report, and how to practically apply them on their farms.** No single farm biosecurity practice will control soil-borne diseases but, used together in practical ways, they can decrease the risk of spreading infested soil between and within properties. **The integrated use of farm biosecurity practices with soil disinfestation (e.g. registered soil fumigants, biofumigants) and cultural controls (e.g. resistant cultivars, removal of diseased plants from production zones) is currently the best way of minimising the impact of soil-borne diseases in strawberry crops.**

Recommendations to Research and Extension Specialists

Strawberry growers expressed a strong preference for receiving extension information at small group events held in regional locations. The use of this method proved successful in the current project in attracting high attendance rates (approximately one third of the industry) of strawberry growers to extension events. Incorporating educational and participatory approaches at workshops also proved a successful communication strategy because it engaged growers in discussions and empowered them to make decisions about adoption of technologies in a way that was relevant to their specific farms and businesses. This approach contributed to adoption of farm biosecurity practices by strawberry growers in this project. Involving agronomists, chemical resellers and Industry Development Officers in extension events was also important in maintaining momentum and continuity of message after the completion of this project. This is because strawberry growers reported receiving information on farm practices from these groups. **Researchers and extension workers should consider the use of small group workshops incorporating educational and participatory approaches as a method for driving adoption of new technologies in the strawberry industry.**

Recommendations to the Australian Plant Biosecurity Science Foundation

This project identified three important areas/gaps that warrant further work to improve the use and effectiveness of farm biosecurity practices in the strawberry industry:

- 1) **Production of a Farm Biosecurity Manual for Strawberry.** Results showed that the key change strawberry growers adopted following the Masterclasses was to educate their staff about farm biosecurity. However, growers wanted further resources and material specific to strawberry to assist them with this task. There is a strong opportunity for APBSF to further engage with the industry and develop a farm biosecurity manual for strawberry. There is evidence of industry demand for this product, and its use would further drive the adoption of farm biosecurity by strawberry growers. **We recommend that APBSF funds the development, production and delivery of a farm biosecurity manual for strawberry production using information and data gathered from the current project.**
- 2) **Education and Training on Farm Biosecurity for Utility and Labour Providers.** This project identified that a key barrier to the adoption of farm biosecurity by strawberry growers was

the non-compliance of utility and labour providers in following hygiene instructions and procedures. Growers perceived that their efforts to adopt farm biosecurity would be wasted due to the poor practices of these providers. Growers from other horticultural and agricultural industries have expressed similar concerns. Utility and labour providers need greater awareness on the importance of farm biosecurity and its impact on rural businesses. Education and training programs to influence practice change and compliance by these providers have great potential to impact the effectiveness of farm biosecurity across a diverse group of rural industries around Australia. There is a strong opportunity for APBSF to take the lead and champion this issue with government, industry, and other funding providers. **We recommend that APBSF initiate a reference group to develop strategies to improve the awareness and compliance of utility and labour providers on farm biosecurity.**

- 3) **Evaluation of the Impact of Farm Biosecurity on Soil-Borne Diseases of Strawberry.** The Victorian Strawberry Industry Development Committee (VSIDC) has funded a project in 2020 to survey the strawberry fruit industry on the incidence of soil-borne diseases and the adoption of farm biosecurity and control practices for their management. The results from this survey will be compared with data from a similar survey conducted in 2017 (prior to the commencement of the current project). The information from the VSIDC project would allow the APBSF to further evaluate the impact of the current project and estimate its return-on-investment. **We recommend that APBSF writes to VSIDC requesting access to the final report from the survey, and commissions an evaluation of the impact of the current project in the industry based on the results from the VSIDC project.**

8. Tables, Figures, References and Publications

Tables and Figures

Table 1. Qualitative data collected from Australian strawberry growers regarding their barriers to adoption of farm biosecurity practices.

| Biosecurity practices | Barriers to Adoption |
|--|---|
| Limiting property access | <ul style="list-style-type: none"> • Sales and utilities representatives do not comply • Tourists enter without permission • Lack of fencing on strawberry farms (many are rented) • “Pick your own strawberries” relies on ease of access by visitors • Multiple properties make the task difficult • Hard for people to comply • Laws may be required to enforce these rules |
| Erecting biosecurity signage | <ul style="list-style-type: none"> • Utilities providers do not always respect the signs or comply • May require a lot of signs to cover all entry points • Language barriers |
| Providing designated visitor/ employee carparks | <ul style="list-style-type: none"> • Difficult to implement in remote areas • Some properties are leased/rented, and changes would require landlord investment and/or approval |
| Property zoning/ manage visitor movements | <ul style="list-style-type: none"> • Utility and labour providers do not always comply • Visitors are not always respectful • “Pick your own strawberries” allow lots of visitor access and is difficult to manage |
| Paddock zoning/ work from low to high disease | <ul style="list-style-type: none"> • Requires practice to be consistent • Exceedingly difficult to do, due to inconsistent weather patterns • Requires knowledge of disease levels in different |

paddocks, and may require improvements to current diagnostic techniques

Employee and visitor hygiene

- Annoying
- Difficult to manage with irregular casual staff

Removal of strawberry plants and weeds

- Both are costly and time consuming
- Difficult task, due to manual labour requirements
- Practical issues for removing old crowns

Certified strawberry runners

- n/a (universally adopted)

Clean equipment and vehicles

- Very annoying and tedious
- A lot of time and money required
- Water availability issues
- Water run-off issues

Staff and visitor inductions

- Lack of resources specific to strawberry production
 - Language barriers
-



Figure 1. Plant death of strawberry plants caused by *Fusarium* wilt on a farm at Wanneroo, WA.



Figure 2. Dr. Dylan McFarlane demonstrating the benefits of totally impermeable film to Australian strawberry growers at a Farm Biosecurity Masterclass at (a) Wanneroo, WA and (b) Stanthorpe, QLD.

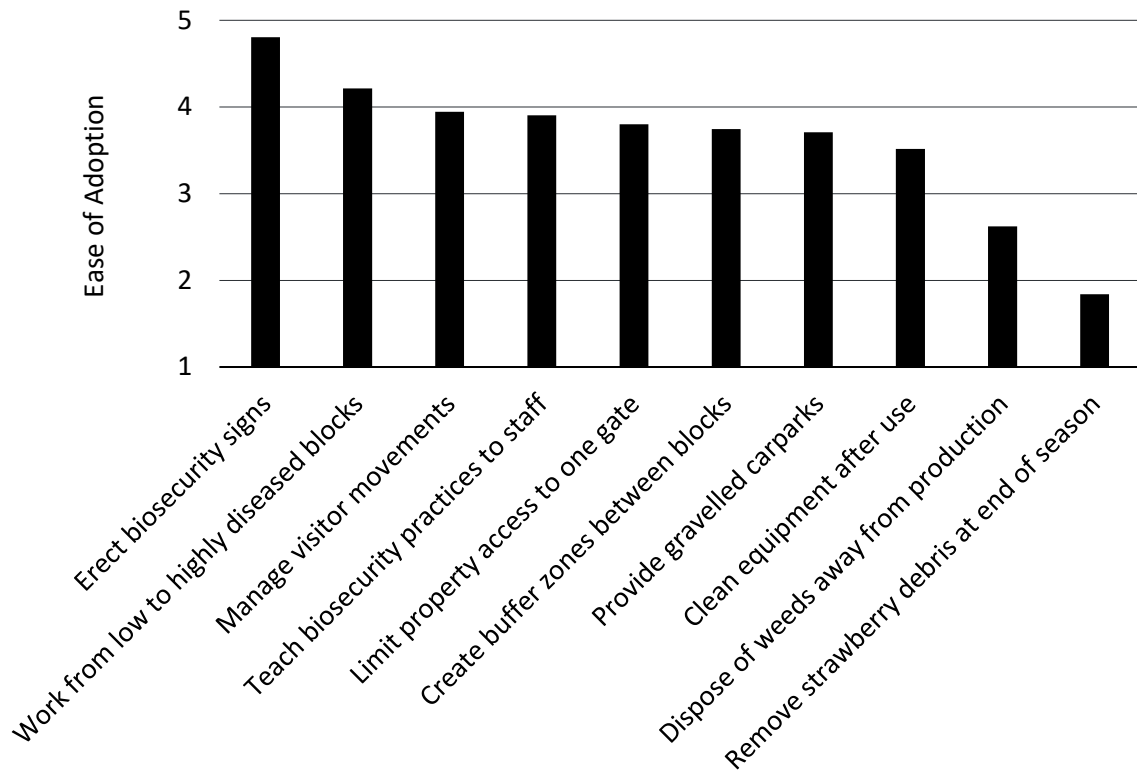


Figure 3. The perceived ease of adoption of 10 biosecurity practices by Australian strawberry growers. The ease of adoption scale is rated from 1 (very difficult) to 5 (very easy).

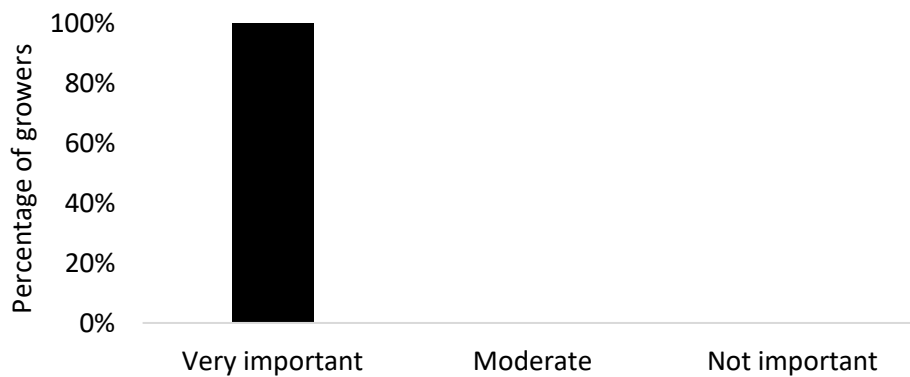


Figure 4. The perceived importance of using certified/accredited runner material by Australian strawberry growers.

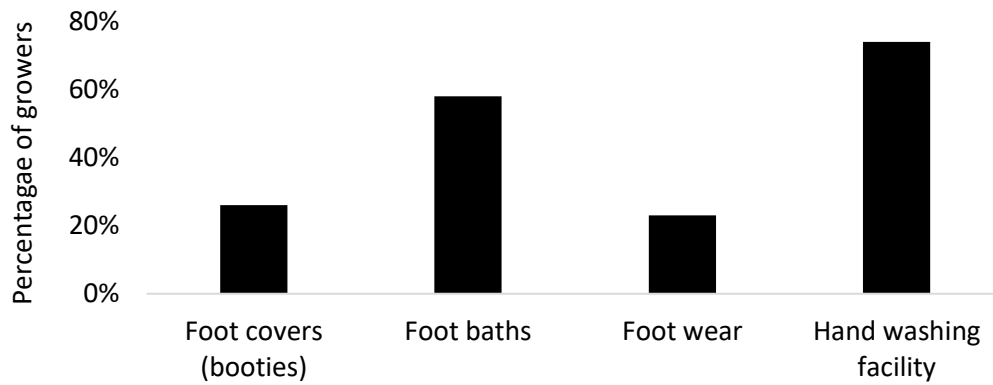


Figure 5. The percentage of Australian strawberry growers that would supply foot covers, foot baths, foot wear and/or hand washing facilities to their staff.

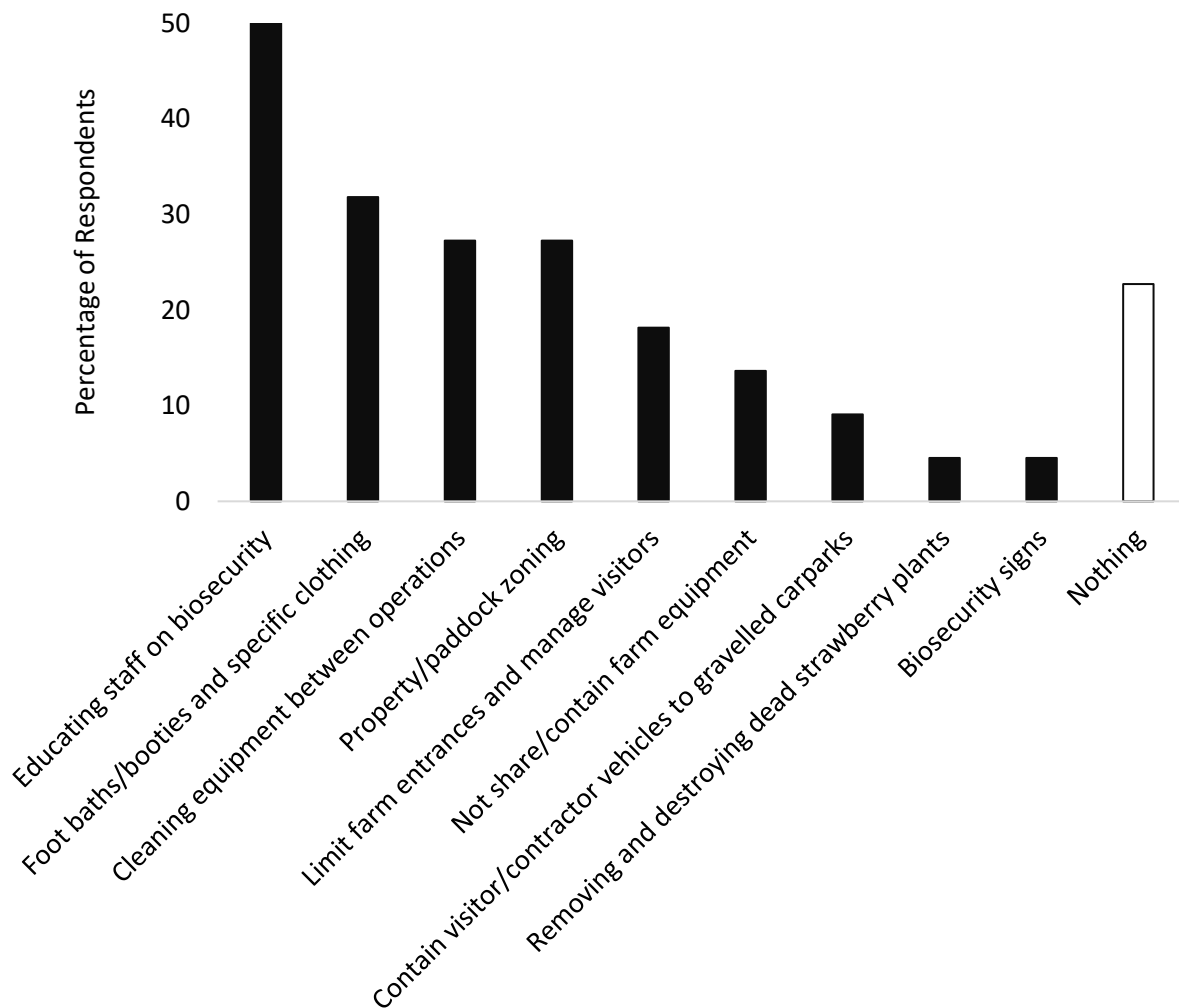


Figure 6. Adoption of specific biosecurity practices by strawberry growers in Australia, one month after the Masterclasses.



Figure 7. Dr. Dylan McFarlane presenting information on the management of soil-borne diseases in Australia at the MBAO conference in San Diego, USA.

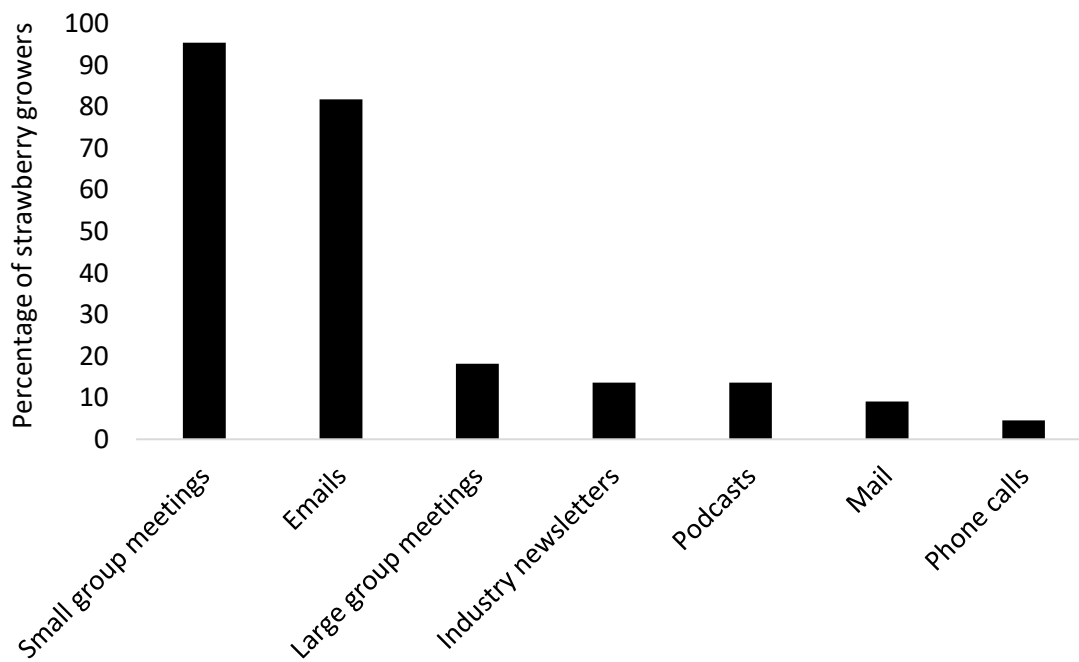


Figure 8. The percentage of Victorian strawberry growers who prefer to receive industry related information via different delivery systems. *This survey was conducted prior to the current project, in 2018.

Publications

McFarlane, D. & Mattner, S. (2019a). Masterclasses to improve biosecurity for soil-borne disease, *The Punnet February 2019*, Strawberry Innovation.

McFarlane D., Zon C. & Mattner S. (2019b). National Masterclasses to improve biosecurity for better management of soil-borne diseases of strawberry: Western Australia report, *Simply Red*, 53, 3-5.

McFarlane D., Zon C. & Mattner S. (2019c). Masterclasses facilitate the adoption of farm biosecurity for soil-borne pathogens of strawberry. *MBAO Fumigation and Alternatives for Production, Storage and Trade Conference*, 14.



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