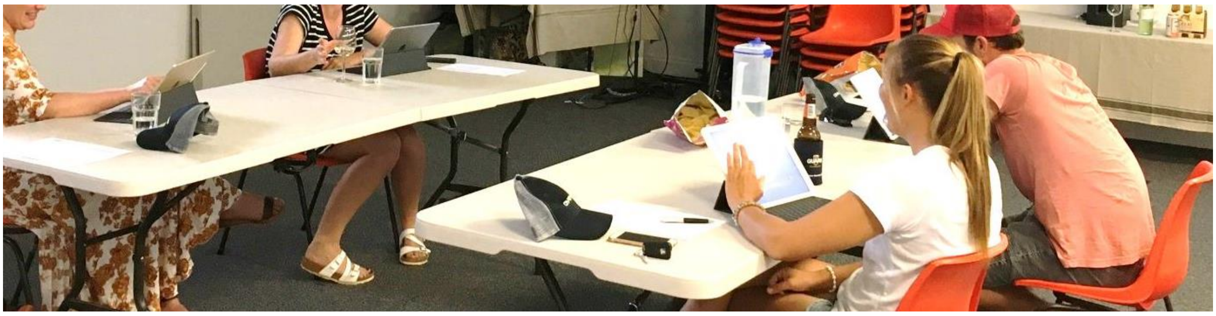
Summary of final report for Biosecurity R&D Fund[1] research project:

Using economic experiments to demonstrate the principles of successful biosecurity cooperation to producers

Proponent: The University of Western Australia

Compiled by Jenny Crisp (DPIRD Biosecurity R&D Fund manager) in May 2018[2]



Project information

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R&D Fund contribution	$71,528
Other contributions	$175,072
Total investment into project	$407,281
Start date	1st June 2016
Finish date	31st March 2018 (extension to May 31st 2018 approved)

Introduction and justification

Decisions by producers to protect their businesses from a range of exotic and endemic pest and diseases provides a private benefit to the farm and a public benefit to the region by preventing or slowing the spread of pests and diseases. Direct biosecurity threats to cereal production include phosphine resistant stored grain insects, Russian wheat aphid and Karnal bunt; all of which could be managed by collective action on the part of producers. Other threats include wild pigs and rabbits that require coordinated action for any control attempts to be successful.

The aim of this project was to gather data on the response of individuals to a hypothetical biosecurity management experiment where participants contribute money to protect their own income and increase group protection. The intent was to explore mechanisms that could reduce a tendency towards free-riding in biosecurity management systems.

Approach and key findings

Approach

There were three stages to the research approach. The first step in the research approach was to consult with the Mingenew-Irwin Group (MIG) to confirm their participation and identify their biosecurity priorities. The initial driver for MIG involvement in the research was the Chief

[1] The Biosecurity R&D Fund is part of the Boosting Biosecurity Defences project, supported by Department of Primary Industries and Regional Development (DPIRD)

[2] This summary draws on information from: R&D Fund Final report for the Economic experiments project as well as two reports about the student experiments and producer experiments submitted with earlier milestone reports.

Executive Officer (CEO) for MIG at the time. `She however, resigned from the CEO position early on in the research project timeframe and the research team had to re-engage and re-negotiate MIG involvement with the new CEO. Confirmation of MIG participation and preliminary identification of biosecurity priorities and how the experiments might be best received was achieved, although this did take some time and did impact on the research schedule. (Further clarification and insight about biosecurity issues and priorities from the producer perspective was gained through group discussion with producers at the end of each producer experiment.)

The next step was to design the experiments with computer science students in the UWA Behavioural Economics Laboratory. The original plan was to use 'z-Tree' experimental economics software for developing and conducting economic experiments, however soon after the project start, the students identified newly available 'o-Tree' software as an opportunity to improve the research. 'o-Tree' is more flexible and will allow experiments to be run remotely (e.g. with producer groups) anywhere with access to the internet. This greatly increased the future potential to run experiments/games with regional biosecurity groups on a larger scale, for educational or research purposes. Installing and working with new software though, did further (slightly) delay the project schedule

The third step was to run the experiments/games with both students and producers. The advantage of using student participants is that rigorous testing and replication of the experiments can be completed quickly and at a relatively low cost compared to producer participants. The biosecurity experiments/games are run with 4 participants and each game has 15 rounds. To date experiments have been conducted with 20 producers (5 groups of 4 from MIG) and 116 students (29 groups of 4). Participants were only able to participate in one group and one treatment, as it was expected that experience from one experiment would impact on choices made in subsequent experiments (if allowed). MIG staff tested a version of the game prior to the producer experiments to ensure instructions were clear. Four different experimental treatments were applied.

Treatment 1: Basic biosecurity

Four participants play 15 rounds of the game; individually and independently selecting a monetary contribution to a level of collective biosecurity protection for each round. The only information they receive before making a decision in the next round is how much money they accumulated and whether an incursion has occurred or not. They do not see the contribution to of their co-players, and they are not allowed to communicate with each other during the game. Overall protection is given by the joint probability that the group will not suffer a pest incursion, and if an incursion occurs it affects the whole group equally.

This treatment was completed 17 times with 12 student groups and 5 producer groups; each group with four participants. Producer participants were from the Mingenew-Irwin Group in the Mid-West Region of Western Australia. Producer sessions concluded with a 'debriefing' discussion about biosecurity in the region and on participant's farms.

Treatment 2: Monitoring

Monitoring is as for treatment 1 except that at the end of each round, participants are told what contribution (effort) other players made in that round. They are not allowed to discuss this information, or anything else, with each other during the game. This treatment was completed 6 times in 2017 (6 student groups; each group with four participants).

Treatment 3: Pledging

Pledging is as for treatment 2 except that every three rounds, each participant proposes a group target and pledges an individual effort that is seen by the group. Players then make their decision on effort. They are still not allowed to discuss anything during the game. This treatment was completed 5 times in 2018 (5 student groups; each group with four participants).

Treatment 4: Pledging modified

Modified pledging is as for treatment 3 except that players are given examples of the link between individual effort and the joint probability of protection. There is still no discussion allowed during the game. This treatment was completed 6 times in 2018 (6 student groups; each group with four participants).

Results

The optimal solution to these experiments/games is for everyone to contribute close to the maximum level of biosecurity protection. Results for treatment 1 (Basic biosecurity) indicated that on average, level of biosecurity effort (protection) contributed by both student and producer participants was sub-optimal, and that biosecurity effort tended to decline over the 15 rounds. Producers were not overall significantly more cooperative than students. When an incursion occurred, students (on average) significantly further reduced their level of effort (perhaps interpreting an incursion as evidence of other participants not contributing). In contrast, producers tended to maintain their level of biosecurity effort after an incursion.

Treatment 1 was the only experiment conducted with producers as well as students. It had been hoped to run more than the 5 experiments with producers, but the delays outlined in approach section above, as well as short windows of seasonal availability for producers within the research timeframe, allowed only the 5 replicates.

Treatment 2 (Monitoring), where participants were made aware of the level of effort other players were making after each round, did not result in any significant difference to the group's level of biosecurity cooperation compared to not being aware (treatment 1).

Unexpectedly, both pledging treatments (where participants proposed a group target and pledged their individual effort every 3 rounds, or where an explanation of the link between individual effort and joint probability of protection was also provided), resulted in reduced cooperation relative to the other treatments.

Discussion of results

The research findings so far suggest that within a biosecurity management system that requires contribution by all individuals for group benefit, there is a tendency towards 'free-riding' and that this tends to get worse over time. This was the case for both students and producers.

The monitoring and pledging treatments were designed to reduce 'free-riding' and increase biosecurity effort. Providing information about the level of protection other participants were contributing (monitoring) did not improve biosecurity contributions/cooperation. It is possible that knowing that fellow participants were shirking on effort was not much different to suspecting this was the case based on frequency of pest incursions. Incorporating a pledge/promise relating to future individual contributions, with or without an explanation of the value of cooperation, also reduced biosecurity effort. Possibly some players used the pledge as a way of getting others to take the burden of biosecurity protection.

It is likely, based on related experiments, that any of the treatments trialled here would be more effective at reducing 'free-riding' behaviour if open discussion between players about their choices and options is allowed. Penalties for non-compliance with individual or group pledges could also be effective as a means of sustaining group protection.

Some insights into producer behaviour (as well as feedback to improve the experiments themselves) was gleaned during post-experiment discussions with producer groups.

- *During the game, what did you conclude when there was an incursion?*
- *Did you change your strategy towards increasing or reducing your protection contribution?*
- *How useful do you think this game is as an educational tool?*
- *What are the top three biosecurity threats on your farm?*

- *Do you think your neighbours have the same priorities?*
- *Is the effort that you put into biosecurity dependent on what your neighbours are doing?*
- *What strategies have you used to encourage your neighbours to help with a local biosecurity threat?*
- *In the face of a serious biosecurity incident how should producers encourage an effective, long term, collective response?*

Producers identified the importance of impartial information about biosecurity risks and management from an external organisation such as DPIRD and MIG, and the need to share information amongst producers. Leadership and coordination roles were also identified as important. Collaborating with neighbours in an informal way was viewed as essential for issues like wild pigs. Producers also viewed the small group of farmers who did nothing to manage biosecurity risk as an intractable problem.

Unexpected benefits

This project was one of the first in Australia to make use of the new open-source experimental software 'o-Tree' (developed at the University of Zurich by Chen et al, 2016). As previously mentioned, 'o-Tree' is more flexible than the previously nominated 'z-tree' and allows experiments to be run remotely; greatly increasing its potential range and application. To the researcher's knowledge, this was also the first time a web-based economic experiment was implemented in the WA wheatbelt.

Changes to initial plan

The original plan included a treatment to test the impact of communication/discussion between participants, and also planned to test all treatments on producers as well as students. These elements were not able to be delivered in the shorter timeframe; the delay due mainly the need to re-establish MIG involvement after resignation of the CEO and subsequent even more limited opportunities to access producers in seasonal 'quiet times'. Taking the opportunity to use the new and more flexible software 'o-Tree' also contributed to schedule delays.

It was also planned to develop a set of strategies/recommendations for producer groups about how to foster collective biosecurity management, based on experimental results. As none of experimental treatments trialed were effective at modifying player's behavior towards optimal cooperation, there was no new information upon which to base any strategies.

Next steps

From a research perspective, the next steps are to run more experiments to help understand the adverse outcome from the pledging treatments, and to find mechanisms that will reliably increase group protection. Sufficient replicates for all the treatments need to also be run with producers, and biosecurity management decisions within the games further explored. More experiments are planned to be run in 2018 by UWA (post-project) to progress this research.

As well as being useful from a research perspective, the experiments/games have potential as an educational tool to help producer/community/biosecurity groups understand the impacts of individual decisions on collective biosecurity management. It also has potential as an educational tool to teach agriculture students about the principles of biosecurity risk management.