‘BeeDar’ Pollination Mapping System

BY BEE INNOVATIVE

CQUniversity AUSTRALIA

HINKLER AGTECH INITIATIVE

A CASE STUDY BY CENTRAL QUEENSLAND UNIVERSITY

INTRODUCTION

This trial was undertaken as part of CQUniversity's Hinkler AgTech Initiative.

The Initiative aimed to increase the productivity and profitability of the Bundaberg region's agricultural sector through greater availability and utilisation of agricultural technology (AgTech).

An extensive consultative process undertaken with agribusinesses identified on-farm needs that may be addressed using AgTech. Trials of selected AgTech products and services were then undertaken in partnership with agribusinesses and technology providers to determine the technologies' efficacy in on-farm conditions.

This case study provides an overview of findings from one of the technology trials, including grower feedback and considerations for other growers when deciding whether to utilise the technology in their own enterprise.

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Introduction

Australian agriculture is seeing a rapid emergence of new technologies that are changing traditional farming practices. Agricultural technology (AgTech) promises improved productivity and yield and the ability for growers to make better decisions, but the rate of uptake of AgTech remains impeded by several factors. These factors include a lack of awareness by growers of potential technology solutions, difficulty in evaluating the on-farm efficacy of technology and a gap between grower needs and technology developments. The aim of this case study is to assist growers by providing background information on a commercially available technology, including details of its performance and value proven through on-farm trials.

Bee Innovative's 'BeeDar' system provides growers with an assessment of honeybee pollination activity in their crops. A drone, equipped with the BeeDar technology, is flown over crops to produce pollination heat maps. These maps are analysed by Bee Innovative and provided to the grower with specialist advice on how to improve pollination rates. Bee Innovative is an established Australian company and the BeeDar technology has been successfully deployed in a range of horticultural and broadacre crops throughout Australia and overseas.

FIGURE 1: A Honeybee Laden with Pollen

What Does the Technology Deliver?

The BeeDar system delivers fast, accurate and real time measurement of honeybee pollination rates in a range of horticulture, tree and broad acre crops. BeeDar counts the number of individual honeybees that are actively pollinating and presents the information in the form of heat maps that indicate the variation in pollination activity throughout a crop. Bee Innovative's apiary specialists analyse these maps, along with other information such as farm geography, landmarks and prevailing wind direction to advise the grower on hive configurations that will optimise pollination rates.

Optimal pollination rates can significantly increase crop yields. Studies undertaken in Australia and oversees have consistently demonstrated yield increases between 20-30% for horticultural crops such as blueberries, strawberries and watermelon and tree crops such as apples and avocados. Researchers also found that optimal pollination rates increase the average weight and size of individual fruit.

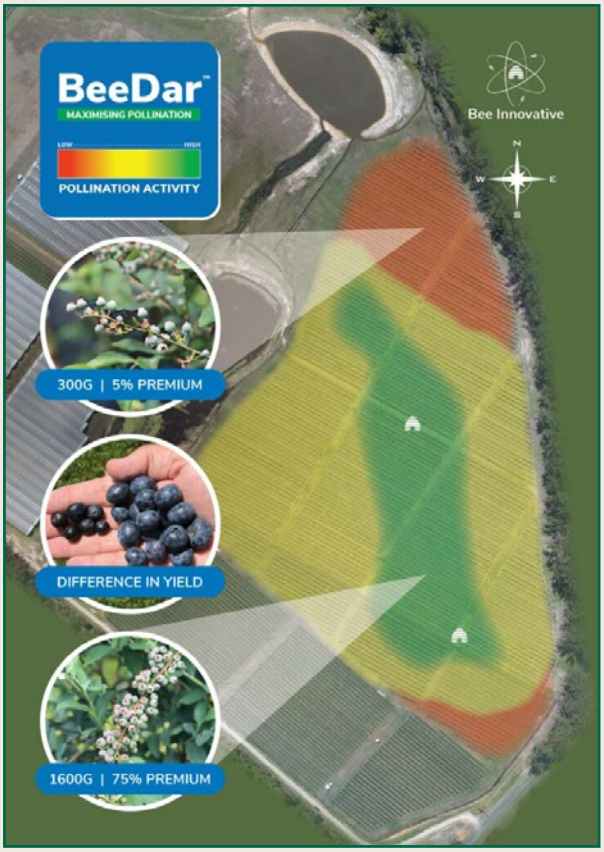

FIGURE 2: Example of a Heat Map Indicating Pollination Activity and Yield Variation in Blueberry Crop

What is Required from the Grower?

Bee Innovative is the sole provider / operator of the BeeDar technology and a grower needs to engage them directly to deploy the technology. The price structure of Bee Innovative's service varies according to the area being mapped, and ranges from $40/ha for areas greater than 400ha to $150/ha for small areas, e.g., 10ha.

The grower needs to provide access to their property during the data collection phase. Three flights are usually undertaken daily during early morning, midday and afternoon, over three consecutive days. Depending on the crop type and farm layout, the grower may wish to contract Bee Innovative on a two to three-year contractual basis to ensure optimal pollination beyond a single crop cycle. To achieve optimal results, the grower will need to work with their beekeeper and Bee Innovative advisors to analyse the pollination data and implement any recommended changes to hive location or farm layout.

Bee Innovative generally works with growers on a multi-year contract basis, mapping pollination activity for a single crop cycle, then making recommendations to optimise pollination for the following year. For tree crops, a two to three-year program delivers benefits for the life of the trees, which may be 20 years or longer, because the physical variables of orchards that affect bee behaviour, do not change over time.

A grower may also want to undertake ground truthing to determine any yield and productivity increases resulting from improved pollination rates. Depending on the crop type, this work may require significant labour resources and may be best outsourced to an agronomic provider or research organisation.

How Does the Technology Work?

The BeeDar system incorporates both hardware and software technology. The hardware consists of a spherical radar 'dish' attached to an aerial drone and deploys short-range radar to detect the presence and movement of individual honeybees. The system has integrated GPS capacity which identifies the location of each bee to within +/- 2cm. As the drone passes over a crop, the radar assesses each bee's activity to determine whether it is flying or pollinating a flower.

This data is transmitted to a laptop containing the Bee Dar software program. The program aggregates the data from all drone flights and presents it in the form of heat maps that illustrate variation in pollination activity (# of pollinating bees/m² /hr) throughout each crop. The heat maps provide a simple, colour-coded representation of pollination activity throughout a crop - green indicates areas of good pollination, yellow indicates areas that could be improved and red signifies a major pollination problem.

Bee Innovative's apiary specialists analyse the heat maps, along with other information such as farm geography, landmarks and prevailing wind direction and provide recommendations to the grower on hive configurations to achieve improved pollination rates. The maps are provided to the grower in digital, easily viewed format and remain their property for future reference.

FIGURE 3: BeeDar in Flight

Technology Provider

Bee Innovative is an Australian company based in the Hunter Valley and has been operating on a commercial basis since 2018. The company's two co-founders combined their extensive respective experience in beekeeping and electronic engineering to develop BeeDar. Bee Innovative has an established client base throughout South-Eastern Australia and is partnering with the University of North Dakota, USA to expand the application of BeeDar technology into broadacre sunflower crops.

BeeInnovative is the sole provider of BeeDar technology, and their fee-for-service cost model includes a specialist drone operator, provision of density mapping, data interpretation and recommendations for improved pollination.

FIGURE 4: Example of Poor Pollination and Good Pollination in a Single Cluster of Blueberries

Applications of Technology (Current and Potential)

BeeDar can be deployed in any crop but is most beneficial to those crops that are dependent on, or benefit from, pollination. The system can be deployed in any environment able to be flown by a small drone, including larger closed protected cropping structures (greenhouses). While growers of tree and berry crops have been the earliest adopters of the BeeDar technology, Bee Innovative is also working closely with the broadacre sector, particularly in seed production.

With the support of CQUniversity's Hinkler AgTech Initiative, Bee Innovative undertook a trial of Bee Dar in four separate watermelon crops in Bundaberg. The results of these trials are shown in Figure 5.

The pollination rates indicated by the maps are:

- Red- 0-20 bees/m2/hr
- Yellow- 21-50 bees/m2/hr
- Green-- 51-99 bees/m2/hr
- Dashed Green- › 100 bees/m2/hr

Analysis of these maps indicated that pollination rates were impacted by a combination of distance from hives, topographical features and prevailing wind conditions. Ground truthing for this trial involved manually weighing watermelons from nine 10m x 10m zones in each of the crops. The results demonstrated a clear correlation between pollination activity and crop yield with an average watermelon sampled from green zones weighing 30% more than fruit sampled from red zones, for all four crops.

FIGURE 5: Pollination Heat Maps for Bundaberg Watermelon Crops

Figure 6 illustrates the variation in pollination of a greenhouse blueberry crop.

The map indicates that bees are entering both ends of the greenhouses and pollinating more actively near those entry points where it is significantly cooler than the middle of the greenhouses. These results reflect a feature of bee behaviour. As a community, bees work to provide three resources to the hive: nectar, pollen and water. They will not travel further or work harder than is necessary to find these resources.

In addition to these trials, the Bee Dar system has been deployed in a variety of pollination dependent crops in Australia and the USA, including tree crops such as avocados and broad acre crops such as sunflowers. Improved pollination, resulting from BeeDar insights, has seen increases in crop yield and quality for all crops.

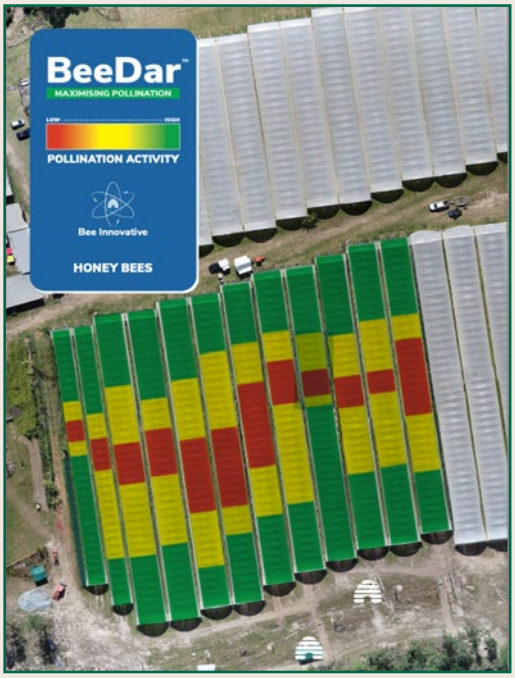

FIGURE 6: Pollination Heat Maps for Greenhouse Blueberry Crop

Value of Technology

One of the greatest benefits of the BeeDar system is the removal of 'guesswork' from the pollination process and a more informed decision-making process for growers. Traditionally, there is rarely any scientific rigor applied to the number and siting of beehives for crop pollination other than the combined experience of the beekeeper and grower. Monitoring the efficacy of pollination usually involves the grower walking around the crop at the end of flowering season and visually assessing if they had a good or bad year of pollination.

On-farm trials in Australia and documented studies from here and oversees consistently demonstrate that optimal pollination rates generally result in a 30% increase in yield for pollination-dependent crops. In some blueberry crops, yield increases resulting from Bee Dar insights have reached 150-200%.

Additional Considerations

When a hive is first sited on a property, bees quickly establish and begin using, local landmarks to navigate back to their hive. It is therefore not advisable to shift hives midway through pollination activity, because the bees will return to the original location of the hive and can die searching for it. If growers require an immediate solution to poor pollination activity, Bee Innovative will work with the beekeeper to map activity as soon as bees arrive on farm. If trouble spots emerge, the beekeeper can place later hives accordingly.

Given that bees often travel beyond farm boundaries to source nectar, Bee Innovative recommend growers take a collaborative approach to deploying the Bee Dar technology and where possible, work together with beekeepers to provide optimal pollination at a 'regional' level. This approach minimises the cost of the Bee Dar service for individual growers but may only be possible where adjoining farms are growing crops with similar pollination requirements.

Both the beekeeper and the grower are responsible for ensuring the success of the beekeeping / pollination service. The beekeeper must ensure the bees are well managed and healthy and can provide an effective pollination service. The grower must ensure the bees are not disturbed or harmed by on-farm activities such as the use of agricultural chemicals. If agricultural chemicals with a residual effect are used, a delay may be needed before hives can be taken back to a crop.

REFERENCES AND INFORMATION SOURCES

For further information on this trial and results, email CQUniversity's agricultural research team:
agriculture@cqu.edu.au

Information regarding Bee Innovative and the Bee Dar system, including contact details, is available at:
beeinnovative.com.au

A copy of 'Pollination of Crops in Australia and New Zealand' is available here:
agrifutures.com.au/wp-content/uploads/publications/12-059.pdf

Summaries of other technology trials undertaken through the Hinkler AgTech Initiative are available at:
bundabergagtechhub.com.au

Australian Government

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