

## Assessing New Technologies in the Management of Feral Pigs (*Sus scrofa*) in the Queensland Wet Tropics.

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### Executive Summary

The Herbert sugarcane growing district, centred on Ingham in the Wet Tropics of North Queensland, produces an average of 4.16 million tonnes of sugarcane annually across approximately 65,000 hectares of the Herbert River floodplain. Annual rainfall is highly seasonal, averaging 2,070 mm, with the majority falling between December and April, creating distinct wet and dry periods that limit access to large parts of the Shire.

Feral pigs (*Sus scrofa*) and two species of native rats—the canefield rat (*Rattus sordidus*) and the climbing rat (*Melomys burtoni*)—are the primary vertebrate pests affecting sugarcane production. While rats mainly damage crops directly, feral pigs cause extensive crop losses, environmental degradation, predation of native fauna and livestock, and infrastructure damage. Sugar Research Australia estimates annual losses of around 20,000 tonnes, though grower-reported visual assessments likely underestimate actual impacts. Historical data from the Herbert district indicate losses averaging 10,800 tonnes annually from 2021 to 2024.

In response, the Herbert Community Feral Pig Management Program (HCFPMP) was established in 2009, resulting in reduced crop losses until a peak in 2020. Challenges to effective feral pig management include limited seasonal access due to wet conditions, hazardous terrain, and the pigs' extensive and unpredictable movements.

In 2022, Herbert Cane Productivity Services Ltd. (HCPSSL), in partnership with HCFPMP, received funding to trial innovative management approaches using drones, focusing on: 1) conducting population surveys before and after aerial shooting events, and 2) exploring the deployment of baits via drone, specifically fruit-based pre-feed and poisoned baits under Biosecurity Queensland and APVMA permits.

### Key operational insights from Project Squealer include:

- **Monitoring:** Trail cameras with mobile data plans and analytical software are required to monitor pre-feed baits for target and non-target species. Each camera setup costs approximately \$1,060 with ongoing annual costs of \$240.
- **Drone deployment:** Fruit baits must be placed in small, targeted locations. Trials used hessian bags suspended beneath a DJI T50 drone to deliver and release 20–30 kg of fruit per flight. Flights were successful even when the target was obscured from the pilot's view.

- **Regulatory constraints:** BVLOS (Beyond Visual Line of Sight) certification for operators and CASA site approvals are required for larger drones capable of carrying sufficient bait. This adds substantial cost (~\$3,000) and administrative effort.
- **Costs:** A single drone-based baiting activity with four operations (three pre-feed, one target verification) and required monitoring costs approximately \$2,000. Even if operator costs were halved and BVLOS authorisation not required, costs remain high, challenging economic viability when operations are outsourced.

**Project findings and implications:**

- Drones can deliver baits accurately to targeted locations; however, the high operational and monitoring costs currently limit economic feasibility.
- Seasonal wet conditions, logistical constraints, and the limited number of suitably licensed drone operators reduce flexibility for timely bait deployment.
- Effective feral pig management in the Herbert district continues to rely on farmer reporting and local government intervention.
- Project Squealer provides foundational data and operational insights for future research, with potential improvements in cost-efficiency, monitoring technologies, and drone deployment strategies.

This report highlights the operational and economic challenges of drone-based baiting for feral pigs while documenting a viable proof-of-concept. Future developments in drone technology, monitoring systems, and regulatory frameworks may improve the practicality and cost-effectiveness of this approach in feral pig management programs.

Key Words: feral pigs, baiting, drones, crop damage, crop losses, sugarcane, monitoring, trail cameras

## Introduction

The Herbert sugarcane growing district with its main town of Ingham is located in the Wet Tropics of North Queensland, approximately 1200 km north of Brisbane and nearly 1000 kilometres south of the tip of Cape York. The Herbert district grows an average of 4,161,000 tonnes of sugarcane per year<sup>1</sup>, on approximately 65,000 hectares of the Herbert River floodplain. The Herbert River flood plain receives between 1,050mm (2015) and 3484mm (2010) of rain annually with an average of an average of 2,070mm. Most of this rain falls between December and April resulting in distinct annual wet and dry seasons.

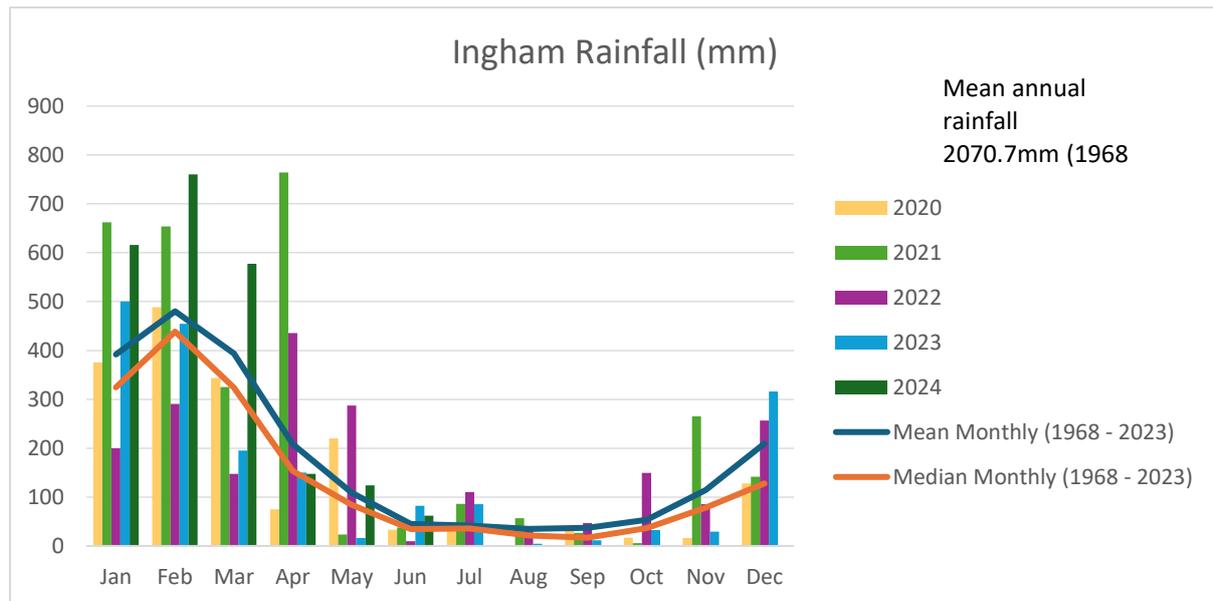


Figure 1 Monthly rainfall between January 2020 and June 2025, showing monthly mean and median<sup>2</sup>. This chart demonstrates the distinction between the wet and dry seasons.

Feral Pigs (*Sus scrofa*) and two species of native rat, the canefield rat (*Rattus sordis*) and the climbing rat (*Melomys burtoni*) are the main vertebrate pest species responsible for losses in the sugarcane crop. Damage from the rat species is primarily to the sugarcane crop itself. The damage caused by feral pigs, on the other hand, extends from just the sugarcane crop to extensive environmental degradation and to predation of many small native animals and young livestock, and damage to farming infrastructure.

The average annual cost of feral pigs to Australian agriculture is estimated at approximately \$156 million (five years to 2020–21), including both production losses and private management costs<sup>3</sup>.

<sup>1</sup> From 'Tonnes Harvested' data between 2007 and 2024, found in the Herbert Sugar Industry Report 2024.

<sup>2</sup> Australian Bureau of Meteorology (2024). Ingham annual rainfall data. Station Number: 032078 - Ingham Composite QLD. Available at: [http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p\\_nccObsCode=136&p\\_display\\_type=dailyDataFile&p\\_startYear=&p\\_c=&p\\_stn\\_num=032078](http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=136&p_display_type=dailyDataFile&p_startYear=&p_c=&p_stn_num=032078). Accessed: 7th May 2024.

<sup>3</sup> Hafi, A., Arthur, T., Medina, M., Warnakula, C., Addai, D. & Stenekes, N. (2023). Cost of established pest animals and weeds to Australian agricultural producers. Australian Bureau of Agricultural and Resource

Within the sugar industry, Sugar Research Australia (SRA) estimates annual crop losses of around 20,000 tonnes of sugarcane (SRA, unpublished)<sup>4</sup>. This is likely an underestimate, as reported losses in the Herbert region alone have averaged 10,800 tonnes annually over the past four years (2021 to 2024). Estimates of sugarcane loss are typically based on visual assessments made by growers of damaged areas. A 2002 study by Mitchell and Dorney found that sugarcane and banana growers in Far North Queensland underestimated crop damage by an average of 37 percent<sup>5</sup>. This suggests that the true economic impact of feral pigs on sugarcane production is considerably higher than current estimates (see Figure 2).

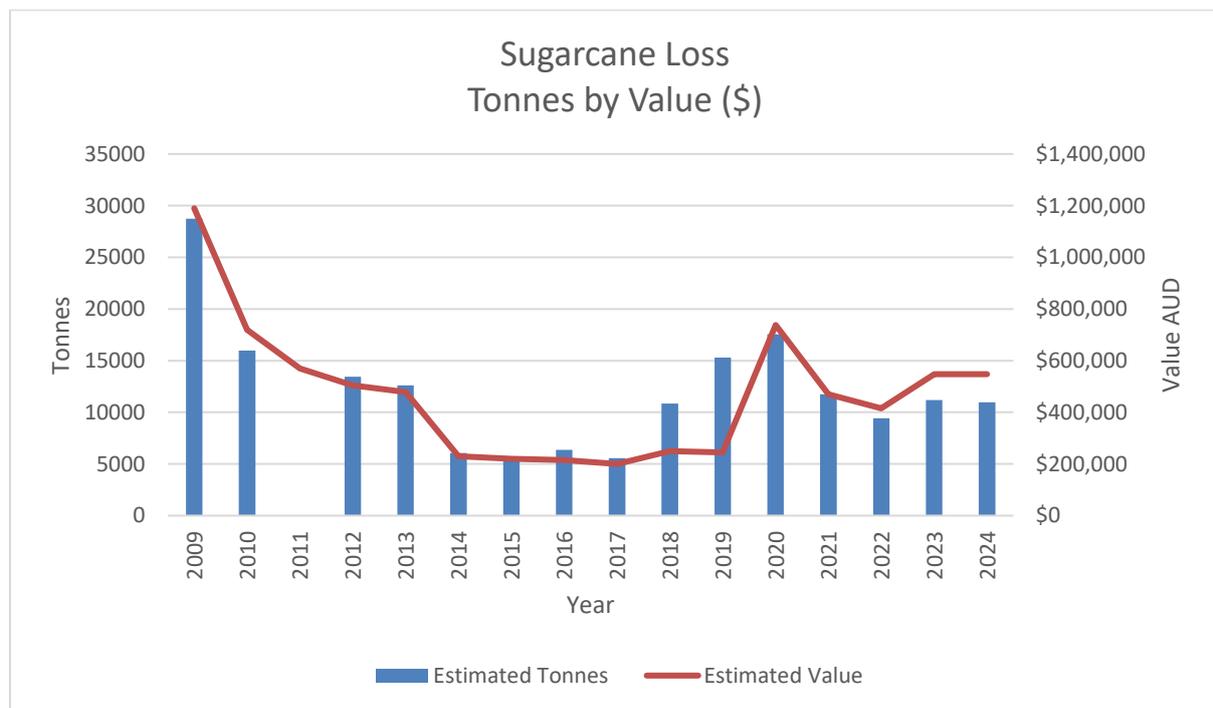


Figure 2 showing the estimated tonnes and value of sugarcane lost to feral pigs between 2009 and 2024. This data is collected annually by the Herbert Cane Productivity Services Ltd. through their “Greensheet” questionnaire on agricultural practices.

In 2009, data collected by the Herbert Cane Productivity Services Ltd. estimated sugarcane losses to feral pigs at \$1.2 million. In response, the Herbert Community Feral Pig Management Program (HCFMP) was established to address the increasing environmental, economic, and social impacts of feral pigs. Following the program’s establishment, losses declined steadily until 2018, when damage

<sup>(3)</sup>Economics and Sciences, Canberra. Available from: <https://www.agriculture.gov.au/abares/research-topics/biosecurity/biosecurity-economics/cost-of-established-pest-animals-and-weeds-to-australian-agricultural-producers>

<sup>4</sup> Sugar Research Australia. (n.d.). Pigs and rats in sugarcane. Retrieved [date accessed: e.g., 5 November 2025], from <https://sugarresearch.com.au/pests/pigs-and-rats/>

<sup>5</sup> Mitchell, JL & Dorney, W 2002, Monitoring systems for feral pigs: monitoring the economic damage to agricultural industries and the population dynamics of feral pigs in the Wet Tropics of Queensland, Final report, Queensland Department of Natural Resources & Mines and the Bureau of Rural Sciences, Queensland.

began to increase again. Losses peaked in 2020 at an estimated 17,560 tonnes before stabilising at around 10,800 tonnes annually from 2021 onwards, nearly double the average annual 5,900 tonnes recorded between 2014 and 2017.

The severity and the extent of the northern wet season places significant limitation on the ability of land managers to access many parts of the Hinchinbrook Shire. This provides feral pigs with the equivalent of an entire breeding cycle with little to no management intervention, with the exception of one of the two aerial shooting events being conducted just prior to the wet season, usually late November or December, and any impact that the local saltwater crocodile population is able to contribute. Estuarine crocodiles and slight variations in local topography also make access to many of the more remote wetlands and local patches of high ground hazardous even by boat.

In 2022, Herbert Cane Productivity Services Ltd (HCPSL) in partnership with the HCFPMP received \$200,000 to assess and trial innovative new approaches to feral pig management including the application of drone technologies. The trial of drone technology had two main objectives: 1) to attempt a population survey before and after an aerial shooting event, and 2) to assess the possibility and plausibility of the deployment of baits by drone. The focus of this paper is the possible deployment of baits by drone.

### **Delivery of Baits Using Drones**

Amazon, in 2013, was the first major retailer to express their desire to make drone-based delivery systems a reality. At the time, however, the development of commercial drones capable of these delivery services was still in its beginnings<sup>6</sup>.

The idea of delivering baits, both poisoned and pre-feed, by drone is nothing new. On the 9<sup>th</sup> of March 2014, the Brisbane times ran a story proposing the delivery of poisoned baits using drones<sup>7</sup>. The subsequent years since though, produce little evidence that poisoned bait delivery has been attempted, for anything, with two exceptions. In August 2018, the Drive, a U.S. online publication published an article stating that the Native American Choctaw Nation in Oklahoma State had received FAA approval to use drones to bait traps for feral pigs<sup>8</sup>. Also, a 2022 article on the Beef Central website showcased a drone-based poisoned bait delivery system to feral dogs<sup>9</sup>. As a result of standover cane after the 2022 harvest, rat numbers exploded across the Herbert District, Travearth

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<sup>6</sup> McNabb M (2022). Amazon Drone Delivery: A Brief History of the Patents, Problems and Progress from the DRONELIFE Archives. Available at: <https://dronelife.com/2022/06/20/amazon-drone-delivery-a-brief-history-of-the-patents-problems-and-progress-from-the-dronelife-archives/> . Accessed 17th July 2024.

<sup>7</sup> Cairns G (2014). Drones carrying poison baits may be used to cull feral pigs. Brisbane Times. March 9, 2014. Available at: URL: <https://www.brisbanetimes.com.au/national/queensland/drones-carrying-poison-baits-may-be-used-to-cull-feral-pigs-20140309-34fem.html>. Accessed: 22nd May 2024. In the years since this article

<sup>8</sup> Margaritoff M (2018). The Choctaw Nation in Oklahoma is using drones to trap feral pigs. The Drive. August 16, 2018.

<sup>9</sup> Beef Central (2024). Drone mounted bait delivery system managing wild dogs in remote terrain. Available at: URL: <https://www.beefcentral.com/news/drone-mounted-bait-delivery-system-managing-wild-dogs-in-remote-terrain/>. Accessed: 13th June 2024.

Drone Services developed a drone-mounted rat-bait dispenser able to dispense Ratoff Sachets into standing sugarcane fields<sup>10</sup>.

The reality of lifting, carrying and deploying baits by drone is not as simple as it sounds. Feral pigs in the Hinchinbrook Shire along with other northern local government areas (LGAs), won't eat grain baits, preferring fruit baits, specifically mangos and bananas. In Queensland, meat baits are only allowed in western and northern grazing areas (Pestsmart 2014) and are therefore not available in the agricultural districts along the coast<sup>11</sup>. Working under a permit held by Biosecurity Queensland, the Hinchinbrook Shire is authorised to use, bananas and mangos as both prefeed and poison baits. An APVMA (Australian Pesticides and Veterinary Medicines Authority) permit acquired by Biosecurity Queensland allows the use of fruit baits in the Burdekin, Cairns, Cassowary Coast, Cook, Douglas, Hinchinbrook, Mareeba and Tablelands local government areas, only.

### **Monitoring**

Pursuant to the APVMA permit, poisoned baiting must be preceded by at least three days of monitoring non-poisoned baits of the same type to assess any visitation by non-target species. Most often this is achieved using on-site trail cameras with sim cards and data plans to capture images and/or video of any animals visiting the pre-feed baits, and any interaction with those baits. Monitoring also provides information on the target species' visitation of the pre-feed baits. Target animals that fail to return to a pre-feeding site equals a baiting activity that doesn't need to happen.

Images and video can be transferred via email or SMS to a computer or a mobile device in real time, or at periodic intervals for review. An alternative now it is possible to transfer the images to a third-party server such as eVorta, which has analytical software to identify any (or at least most) of the species in the image. eVorta was used during Project Squealer to assess its utility and cost. This aspect of the project cost \$20 per month for a Telstra sim and \$30 per month for eVorta, for each of two cameras.

To breakdown the costs per camera for a stand-alone remote camera setup with a mobile data plan and a subscription for an analytical platform such as eVorta includes: a camera, an SD card (memory), a solar panel for ongoing power, twelve rechargeable batteries (required for the functioning of the camera – these run the cameras at night and assist on cloudy days, of which there are a lot during the wet season), an external high power antenna (required for better reception to mobile phone towers, particularly for more remote cameras), mobile data subscription and eVorta (or analytical server). Table 1 (below) shows the cost for a system which will serve as an in-situ, remote, baiting site monitoring camera. The analytics server is an option, but the rest will cost \$1060.80 (2023

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<sup>10</sup> The development of this delivery system was undertaken at the suggestion of HCPSL. While the system has been used in the Herbert, the Author is not aware of any publication documenting its use. The Author however was on-site during its actual use to dispense Ratoff baits in sugarcane.

<sup>11</sup> Pestsmart (2014). Poison baiting for feral pig control in Australia. Pestsmart. Available at: <https://cwba.org.au/wp-content/uploads/2024/05/Poison-baiting-for-feral-pig-control-in-Australia.pdf>. Accessed: 15th July 2024.

pricing) with ongoing costs of \$240 per year. Note that cameras permanently onsite may only last for two or three years before needing to be replaced.

Item	Cost	+ Data Plan	+ eVorta
Swift Enduro G4 camera	\$470.00		
32GB SD Card	\$ 14.00		
Solar panel Swift	\$102.00		
AA Jujitsu rechargeable batteries (12 per camera)	\$ 58.80		
3G/4G Antenna 6.2dBi	\$175.00		
Sim card (12 month)		\$20/month	
eVorta subscription (12 month)			\$30/month
Total (initial setup)	\$819.80	\$1,059.80	\$1,419.80
Ongoing		\$240/year	\$360/year

Table 1. Showing the setup and ongoing costs for one remote trail camera setup with ongoing annual costs.



Image 1 showing a remote trail camera setup with high power antenna and solar panel.

An extra board was used to lift the height of the antenna to the top of the foliage for better connectivity with the mobile network.

The solar panel was placed facing north for the best exposure to the sun.

The camera was placed about one metre from the ground for image acquisition. With hindsight, the camera would have been better placed higher up the pole, both for better ground coverage, and for flood protection. This camera was submerged during the extensive flooding during February 2025. The water levels and ongoing rain was such that the equipment wasn't recoverable until August 2025. The

recovery still required the use of the Hinchinbrook Shire Council's amphibious Argo, at a time when, in previous years, access would have been possible with a four-wheel drive vehicle.

Monitoring of the site, the baits, and all species that interact with the baits, whether pre-feed or poisoned, is a requirement of the baiting permit.

### **The Delivery Mechanism – The Drone**

Baiting for feral pigs with tropical fruit baits requires between 20kg and 50kg of fruit to be placed in a location small enough to be monitored by a remote camera system. That is, the baits have to be placed on the ground, in a small, specific area, rather than dropped from the air in an area-wide dispersal method as for feral dogs. The inconsistent size and shape of mangos and bananas makes transport challenging. Rather than a drop system that dispensed a single meat bait for dogs or a rat bait, the fruit has to be carried in a single container and then placed on the ground for monitoring.



*Image 2. A hessian sandbag with a carrying handle sewn at the opening.*

During trials Project Squealer used hessian sandbags as a transport container. These were strong enough to carry 20kg to 30 kg of fruit at a time, the weave was coarse enough to be ripped apart by a feral pig, while providing a bait cover to prevent non-target species from accessing the baits. A handle made of 25-millimetre hessian strap was sewn onto the sandbag which was then slung beneath a DJI T50 drone using a length of rope, sufficiently long to maintain visual contact with the drone during deployment operations, and a gravity release hook. While the hook held the weight of the bag of fruit, it remained closed, but when the bag was placed on the ground, the hook opened up and the bag of fruit was left on the ground.

The hessian bags can be torn apart or dragged around by the pigs allowing access to the fruits inside. Remains of the bags can then be collected when the site is revisited to collect any unconsumed baits, as per the APVMA permit. Hessian fabrics, often referred to as burlap, can be made out of untreated,

natural fibres such as sisal, or jute<sup>12</sup>. The hessian bag option was seen as reasonable as uneaten poison baits need to be removed from the site after 24 hours. Any remains of the bags or straps can be collected at that time. Later versions of the bag system will allow the bag to be emptied at the baiting site and the bag re-used.

### Flight Trials

The initial trial was undertaken on the 25<sup>th</sup> of January 2023 to assess the potential that fruit a hessian bag, or bananas woven into a hessian strap could be picked up, carried and placed on the ground, onto a target which could not be seen by the drone operator due to an obstruction between the drone operator and the target. A local agricultural drone contractor with a DJI T40 drone was engaged for the trial. Approximately 20Kg of mangos and about 10kg of bananas were used with a hessian sandbag and an 25mm hessian strap for transport containers. These were carried beneath the drone on 10m of rope and a spring-loaded release hook. The length of rope is determined by the height of the trees around the baiting sight, so the drone remains visible to the operator and/or an observer while the baits are being lowered to the ground. At the test site, ten metres of rope was sufficient. As the weight of the payload came to rest on the ground, the hook released from the bag or the strap, leaving the baits on the ground.



The trial area included a low berm of soil covered by guinea grass, making a 4m high obstacle between the drone operator and a 1.8m by 2.4m tarp on the ground as a target, approximately 90m from the drone's launch point. Using an observer to watch the drone, the pilot was able to successfully guide the payload onto the target using the drone's downward-facing camera.

*Image 3 shows the ground target behind the earthen berm and the baits being placed on the target.*

The fruits in the trial were later used as pre-feed baits at an actual baiting site to test whether the pigs could successfully assess the fruit inside the bag. This test proved successful.

### BVLOS – Beyond Visual Line of Sight

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<sup>12</sup> EU Fabrics (2024). Origin of Hessian fabrics and its uses. Available at: URL: <https://www.eufabrics.com/content/23-origin-of-hessian-fabrics-and-its-uses#:~:text=Hessian%20fabrics%20are%20coarse%2C%20woven,tight%20to%20very%20visibly%20open.> Accessed: 07/05/2024.

During the longer-than-usual 2024 wet season, many of the proposed take-off and landing sites became submerged and were unable to be used. Further, access to the sites remained limited until the ground dried out sufficiently to allow access by vehicles, particularly those being used by the drone contractors, which at times were substantial trucks. The proposed field test site was short enough to not require the pilot to have BVLOS certification (IREX or OCTA<sup>13</sup>). Therefore, the field test was postponed several times until conditions improved.

One unforeseen issue was that as ground conditions improved, the project was then competing with farmers for the attention of agricultural drone pilots because they were still unable to drive tractors into their fields to spray weeds. Understandably the farmers and the primary local agricultural crop, sugarcane, became the main focus for the drone pilots for a time.

Our inability to access our preferred take-off and landing sites at the most opportune time brought the project's focus onto heavy lift drone pilots with beyond visual line of sight (BVLOS) certification. At the time of the project, there is a limited number of pilots licensed to fly fly drones in the medium (more than 25Kg but not more than 150Kg) or large (more than 150Kg) categories(CASA)<sup>14</sup>, who also hold qualifications for BVLOS flight. A medium category drone or larger is required to carry the weight of fruit required for prefeed or poisoned, i.e. 20Kg to 30Kg of bait.

BVLOS not only requires the pilot to be certified, but also the area also needs to be assessed by CASA (the Civil Aviation Safety Authority) for risk, and approval granted. New applications may take up to several months for approval, but they may also be rejected. An initial assessment will take approximately 18 hours of assessment time, depending on the complexity of the application, costing a minimum of \$2,880, paid in advance (pers comm, CASA), whether the application is approved or rejected.

The lifespan of an approval is to the end of the applying company's ReOC (Remote Operator's Certificate). When the ReOC needs to be renewed, the BVLOS instrument also will need to be renewed. A ReOC initially is renewed after the first year, then every three years after that.

## **Discussion**

Between 2014 and 2026, very little information has been found regarding the use and any successes of the use of drones to deliver baits of any description for animal control. This study has highlighted several limiting points and potential solutions not available until towards the end of this project. Drone licensing and extended use authorisations have been evolving extensively, particularly since the entry of DJI into the drone market. The availability of affordable and reliable drones for specific purposes has seen new regulations around the use of these aircraft to ensure public safety, whether those involved in the operation, or others within the vicinity of the operation.

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<sup>13</sup> IREX – Instrument rating exam. OCTA – Outside of Controlled Airspace.

<sup>14</sup> CASA (2024). Weight categories for remotely piloted aircraft. Available at: URL:

<https://www.casa.gov.au/drones/get-your-operator-credentials/drone-weight-categories-and-requirements#MicroRPA>. Accessed: 13th June 2024.

While the growth of licensed drone operators with the certification to fly medium and large drones is increasing, the cost of hiring suitable qualified operators is still substantial. Many agricultural operators charge by the hectare and others in such field as filming and survey often quote by the project, so accurately gauging the cost of a single drone baiting activity is difficult. Using estimates obtained through ChatGPT, and looking at minimum estimated costs, a single baiting activity, with the required monitoring, which needs to be in place from the beginning, becomes expensive, possibly bordering on unviable.

One camera to monitor the baiting site will cost approximately \$1,060 and is a requirement of the baiting permit when using fruit-based baits. This cost includes mobile data transfer to a smartphone or tablet for remote review of images.

A single baiting activity will require at least four drone operations: three flights to deploy pre-feed baits and monitor for off-target species, and one return operation to confirm activity by the target species. Using an estimated operational cost of \$250 per hour, and allowing two hours per day for travel and bait deployment, the total cost for the four-day activity is approximately \$2,000.

Multiple flights per day may be required to transport the total quantity of baits, depending on the capacity of the bait-carrying system. Alternative bait-carrying options have been discussed since the trial flights conducted for this project.

Beyond Visual Line of Sight (BVLOS) authorisation is expected to add approximately \$3,000 to the overall cost of the activity.

Component	Times	Cost
Monitoring (trail camera)	Once (initially)	\$1,060
Drone and Operator	4 times x 2 hours	\$2,000
BVLOS	Once	\$2,880

*Table 2 listing the main costs involved with delivering fruit baits for feral pigs by drone.*

Even if the cost of the operator and drone were halved, and Beyond Visual Line of Sight (BVLOS) authorisation were not required, the cost of a single drone-based baiting activity would remain high. At a minimum cost of \$2,000 or more for an initial activity, it is doubtful whether drone baiting is economically viable when a substantial proportion of the work is outsourced. If an organisation were to have its own suitably licensed operators and equipment, the economic outcome may differ. Reducing costs to the initial outlay for monitoring cameras and the wages of an operator may improve viability.

A key consideration is the most effective use of limited resources. GPS tracking of feral pigs in the Hinchinbrook Shire showed no change in movement patterns between the wet and dry seasons. Monitoring wetlands using trail cameras with mobile data plans provides information over a limited geographic area, and while feral pigs may pass through these sites, they do not necessarily return. During Project Squealer, feral pigs were observed to return to monitored wetlands on consecutive days only occasionally. Consequently, being prepared to deploy baits at short notice at a wetland location is difficult to achieve.

Feral pig management activities in the Hinchinbrook Shire have demonstrated more consistent outcomes when farmers report pig activity and request assistance from local government pest control personnel.

While Project Squealer demonstrated that baits can be delivered by drone to highly specific locations, the economic viability of this approach remains questionable at this time. This study has documented the primary operational and economic constraints associated with drone-based bait delivery, with the aim of informing future improvements. Conducting this project with limited prior information presented significant challenges; however, it is hoped that this report will provide a foundation for future work in this area.