# Parametric solutions for hail damage in agriculture: a pilot

June 2024

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# Hail risk and its impact

Hail can inflict severe damage on agricultural crops in Australia, particularly during the storm-prone spring and summer months. When hailstones strike, they can bruise, puncture, and even obliterate various crops, including grains, fruits, and vegetables. The intensity of the damage largely depends on the size of the hailstones and the stage of crop development at the time of the storm, this coupled with the fact that southeastern Queensland is particularly prone to extreme storms and weather events. QFF and its research partners Celsius Pro, WTW and UniSQ through close collaborations with members Queensland Fruit and Vegetable Growers (QFVG) identified that adverse weather can severely impact the viability of high value horticultural crops, particularly slow growing commodities like pineapples, and tree crops such as, fruit trees and avocados.

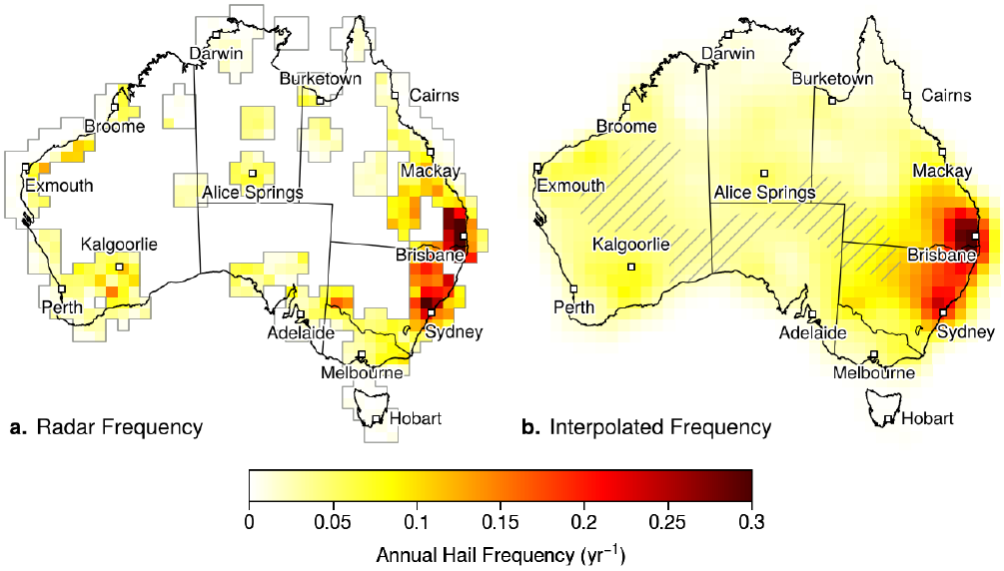


Figure 1: National radar-based hail climatology of Australia (Brook et al, 2023).

The feedback the project received from pineapple growers was that pineapple plants are particularly vulnerable; even small hailstones can cause significant injury, potentially leading to stunted growth and blemishes that grow as the size of the fruit increases. Hail can cause bruising that reduces marketability, affecting the quality and price of the produce. For fruit crops like grapes or stone fruits, hail can create scars or blemishes, rendering the fruit unsellable. Hail can also disrupt the overall growth of tree crops, damage may lead to increased susceptibility to diseases and pests as plants become weakened. The economic impact on farmers can be profound, with losses stemming from both reduced yields and increased costs for implementing damage control measures.

When speaking to horticultural producers originally about whether low rainfall parametric insurance would suit the needs of their commodities, producers identified hail damage as a greater risk to farm income, than drought, for their businesses. Rather than develop a product for a natural hazard identified as lower risk to their business the project team took the view that by increasing resilience to the most pressing climatic risks would in turn build a business

overall tolerance to all risks including drought. Smoothing income volatility during shock periods increases a business's ability to withstand cumulative pressures such as concurrent natural hazard (i.e severe storm) and drought cycles.


Figure 2: Media indicating impact of hail damage on farm.

# Adaptation options

Traditional indemnity hail cover products do exist for agricultural crops however as a result of increasing climate variability, premiums are increasing or products are becoming unavailable. Additionally, traditional insurance products can delay recovery efforts, as traditional indemnity insurance often involves lengthy assessments and paperwork.

The project pilot identified that where a crop is considered lower value or seasonal (i.e. in ground vegetable crops) horticultural producers are generally of a view that self-insurance through cashflow management and replanting of crops is a preferable adaptation strategy. This level of risk-comfort may change with increases to climate variability and hazards become more frequent.

In some instances, producers may choose to install hail netting as an option to offset their hail damage risk. However, there are a couple of reasons that hail netting may not be an effective adaptation option.

1. Initial Investment and Maintenance Expenses

The upfront costs of purchasing and installing hail netting can be significant. For small or financially constrained farms, this expense may be prohibitive. This is supported by the complete exhaustion of the funds in Queensland, allocated to the Horticultural Netting Program which aimed to help primary producers of commercial horticulture crops offset the cost of purchasing and installing horticultural netting to increase crop productivity and reduce the adverse impacts of hail and animal predation on commercial horticulture crops. Ongoing maintenance and potential repairs add to the overall cost of using hail netting.

2. Weather Limitations

In some areas, strong winds can damage netting or make it difficult to secure properly, leading to concerns about its effectiveness. Additionally, the netting can be stretched and damaged by the weight of caught hail, while this is the desired outcome during a hailstorm, there is significant cost associated with the repair of infrastructure. While it was not included within the scope of this pilot, it is possible that a parametric insurance product could be structured in a way that protects against the costs associated with the repairs to the netting infrastructure rather than the damage to the crop.

3. Impact on Crop Growth

Hail netting can create shade that may negatively affect certain crops, reducing photosynthesis and potentially impacting growth and yield. It can also impede airflow, increasing humidity and the risk of fungal diseases. As a result, is it not a suitable adaptation strategy for all crops.

4. Practical Considerations

The use of hail netting may not be suitable for production system of some horticultural crops. Either the scale of the production is too large to net effectively, or the production activities are incompatible with netting infrastructure.

Generally, protected cropping is not a significant production type, only 29% of horticulture farms farm under protected cropping, predominantly in the southern temperate regions (PCA, Hort Innovation 2017)

## Government support

The Disaster Recovery Funding Arrangements (DRFA) in Australia often do not include activations for severe storms primarily due to the classification and criteria used to define eligible disasters. Severe storms can sometimes be viewed as part of regular weather patterns rather than catastrophic events like floods or bushfires, which are often more devastating and less predictable. Additionally, the funding framework generally prioritises disasters with widespread impacts and longer-term recovery needs. This can lead to gaps in support for specific events like hailstorms or localised severe weather, despite the significant damage they can cause to agricultural and community infrastructure. As a result, affected areas might struggle to secure adequate recovery funding. Where this is the case, it is imperative that farm businesses have access to suitable and affordable mitigation options such as parametric hail insurance.

## Index-based insurance

Farmers in regions where hail plate trials were implemented welcomed the opportunity to access index-based hail insurance coverage as traditional indemnity insurance products are often becoming prohibitively expensive or simply unavailable. There is the potential for farm businesses to embrace parametric hail insurance if premiums are provided at a “reasonable” cost.

Parametric index insurance can effectively manage the risk of hail for farming by providing timely and predictable financial support based on specific weather parameters rather than actual losses. This type of insurance triggers payouts when predefined thresholds—such as hail size, intensity, or storm occurrence—are met, ensuring quick access to funds. Farmers benefit

from reduced administrative burdens and faster claims processing compared to traditional insurance, which often involves lengthy assessments of damage. With upfront knowledge of potential payouts, farmers can better plan for recovery, invest in mitigation strategies, or cover immediate costs following a hail event. Overall, parametric insurance enhances resilience against hail-related risks in agriculture.

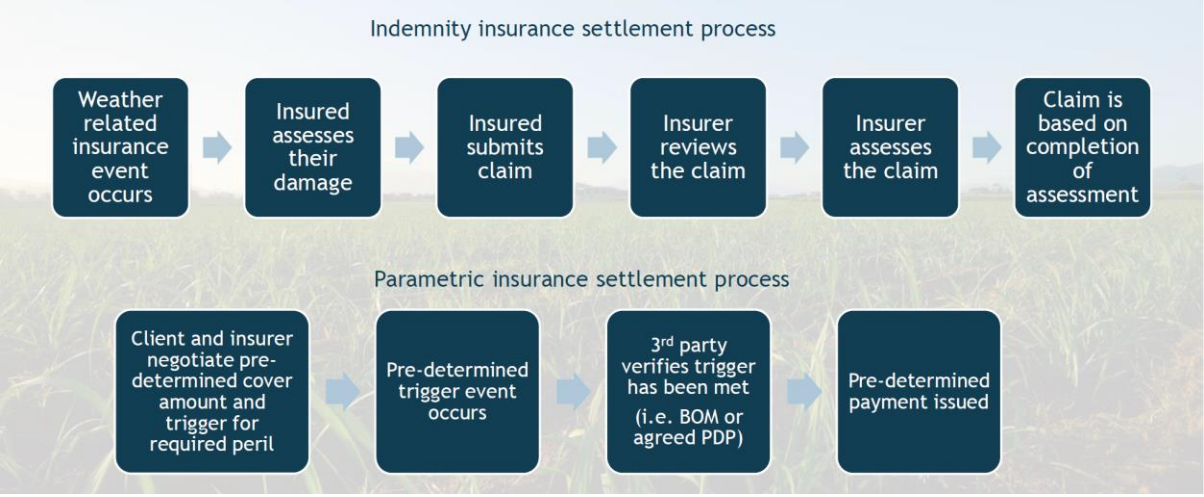


Figure 3: Parametric and Indemnity Insurance comparison

By addressing some of the inefficiencies of traditional insurance, it empowers farmers to respond swiftly to adverse weather events and enhances their overall resilience against the unpredictable nature of climate impacts. As awareness grows and data accuracy improves, parametric insurance has the potential to become a critical component of agricultural risk management in hail-prone regions.

## Hailios hail plate Trial

Hailios hail plate technology is designed to mitigate the impact of hail on agricultural crops. The system consists of lightweight, durable hail plates that are strategically deployed in close proximity to the highest value crops. Their ability to be moved around the farm also allows the producer to move the plate as the harvest location changes.

These plates act as the on ground ‘eye witness’ for the data collection and trigger required for structuring a hail parametric product where BOM data is not granular enough. Part of the reason for the lack of parametric products for hail is because of the lack of available micro (location) level data for hailstorm impacts. Hailstorms can often impact very discrete areas much smaller than the 2km grid data provided by the Bureau of Meteorology, with the aid of Hailios and their hail measurement plate the project hopes to gather hail impact data at the paddock level that will help inform new parametric hail insurance products.

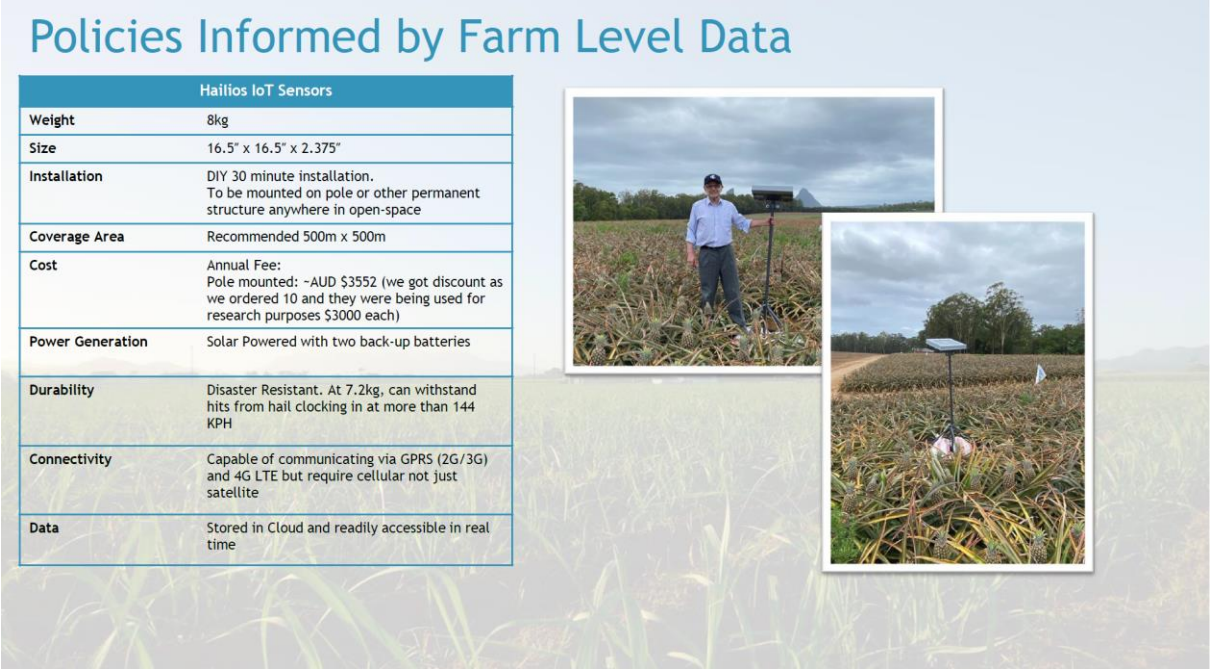


Figure 4: Hailios Hail Plate Summary

Creating effective parametric insurance products requires sophisticated modelling and a deep understanding of the agricultural landscape and weather patterns. This complexity can pose challenges for insurers, particularly smaller companies that may lack the resources to develop and market these products.

Accurately pricing parametric insurance involves complex modelling and statistical analysis. Insurers must balance competitive pricing with adequate coverage, which can be challenging, especially in volatile weather conditions.

Insurers often use statistical models to predict the likelihood of hail events and their potential impact. However, the accuracy of these models can vary significantly based on the quality of data and the assumptions made during the modelling process. Before the Hailios technology was developed there was very limited, viable or accurate sources of hail data to underwrite parametric policies, which enable much faster payouts and more inclusive protection.

## Crops, locations and trial details

The aim of the pilot was to develop new insurance products that integrate insurance technologies to manage income stability and deliver innovative insurance options to help offset the financial effects of natural hazard events and establish the market need for parametric hail insurance products in a way that is data backed and site specific.

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The businesses participating in the trial received a two year subscription and installation of one Hailios hail plate, they also received access to any data gathered during the trial period.

In return, the business agreed to work with project partners to develop parametric hail insurance quote and draft policy from CelsiusPro and/or WTW that was tailored to the needs of their production type. While these products were available to be purchased after quoting it should be noted that none of the participating businesses chose to purchase the cover. The insurance premiums. The average premium for hail products developed as part of the trial was 5% which is considered on the lower end of premiums, all growers indicated that they thought the premium was reasonable, however other production costs meant that variable discretionary costs like insurance were less likely to be incurred by the business.

### Table 1: Crops, Risk & Locations

| Crop | Risk | Locations | Number of Hail Plates |
|---|---|---|---|
| **Avocados** | Damage to mature fruit causing downgrades.<br><br>Damage to mature trees resulting in lower production. | Hampton, Qld | 1 |
| **Custard Apples** | Damage to mature fruit causing downgrades.<br><br>Damage to mature trees resulting in lower production. | Beerwah, Qld | 1 |
| **Vegetable mixed cropping (leafy greens, root vegetables and rhizome crops such as turmeric & ginger)** | Damage to mature crops leading to stunted growth and lower yields. | Nobby, Qld<br><br>Forest Hill, Qld | 2 |
| **Bulk grain storage** | Splitting of protective tarp covering harvest grain leading to moisture damage and spoiling of stored grain resulting in downgrades | Moree, NSW | 1 |
| **Pineapples** | Hail can cause cash flow issues lasting from between 6 - 12 months depending on the severity of the storm. Rotations on farm are typically 16 months long so there are approx. 5-6 harvests a year. A rotation involves, 1- 8 months planting tops and establishment, then between months 9 -16 | Beerwah, Qld x 2<br><br>Glasshouse, Qld<br><br>Abington, Qld<br><br>Yepoon, Qld | 5 |

| | | | |
|---|---|---|---|
| | flowering, maturing fruit and harvest. | | |
| **Cotton** | Cotton bolls, the fruit of the cotton plant, are particularly vulnerable to hail. Hail can cause physical damage to the bolls, resulting in premature opening or the loss of developing fibres. This affects both the quantity and quality of the cotton harvested. As a significant cash crop for farm businesses, downgrades as a result of hail can have a severe impact on the income stream of a fam business and increase income volatility. | Forest Hill, Qld | 1 (also vegetable farm above) |

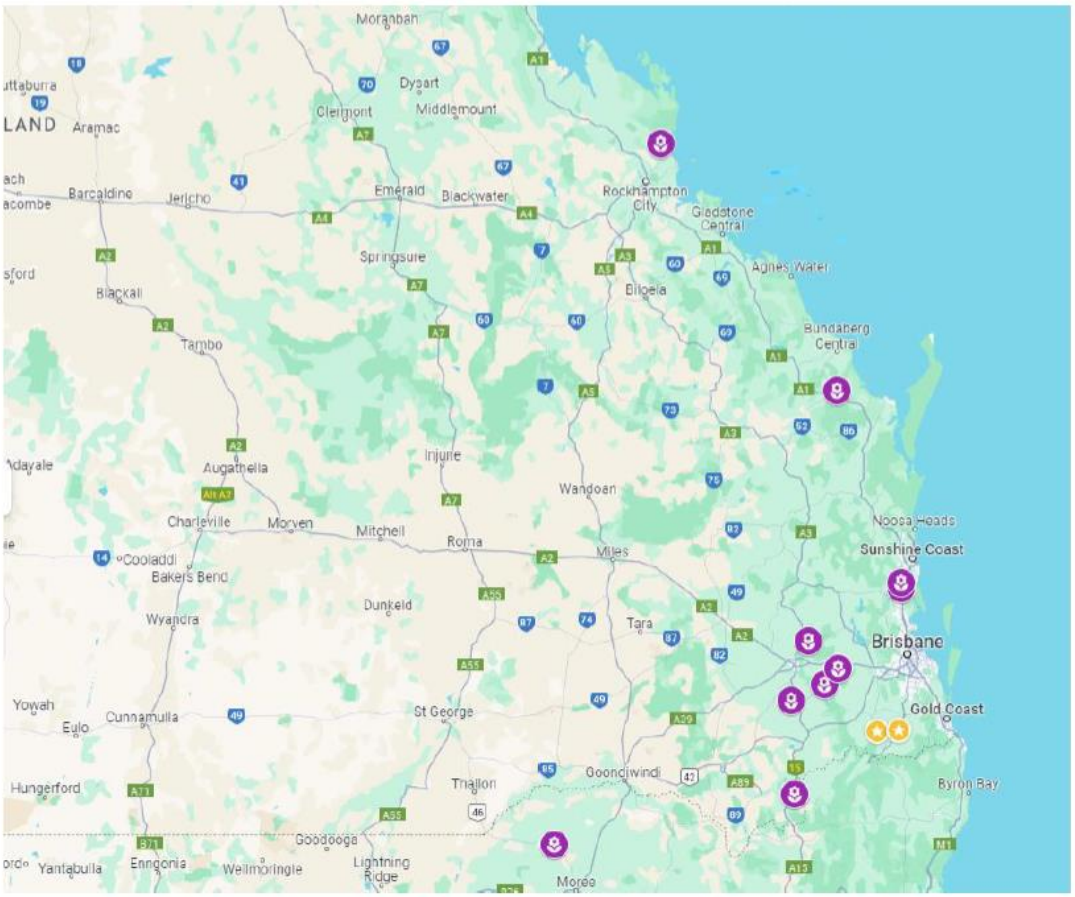



Figure 5: Map showing Hailios plate locations

Over the duration of the trial there were seven storm events that tiggered readings across the 10 plates. A summary of those hail events is included in the table below.

| ID | Date/time | Duration | Site ID | Max. hail class | Amount of imp... ↑ | Total kinetic energy | Temperature [C] |
|---|---|---|---|---|---|---|---|
| 770 | 03/12/2023 6:17 AM | 0 | 218 | 6 | 1 | 15.550 | 24.8 |
| 772 | 09/28/2023 6:23 AM | 0 | 212 | 2 | 1 | 0.356 | 18.9 |
| 778 | 03/24/2023 7:13 AM | 0 | 213 | 4 | 2 | 3.610 | 24.5 |
| 758 | 08/29/2023 4:44 AM | 3 | 209 | 2 | 9 | 0.620 | 19.3 |
| 780 | 11/10/2023 6:05 AM | 1 | 243 | 2 | 23 | 3.432 | 21.4 |
| 771 | 09/28/2023 5:44 AM | 3 | 218 | 2 | 36 | 4.874 | 22.6 |
| 779 | 11/10/2023 6:31 AM | 15 | 213 | 5 | 426 | 337.582 | 22 |

| Hail Class | H1 | H2 | H3 | H4 | H5 | H6 | H7 | H8 | H9 | H10 | H11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Diameter [inch] | ... - 0.50 | 0.50 - 0.75 | 0.75 - 1.00 | 1.00 - 1.25 | 1.25 - 1.50 | 1.50 - 1.75 | 1.75 - 2.00 | 2.00 - 2.25 | 2.25 - 2.50 | 2.50 - 2.75 | 2.75 - ... |
| Diameter [cm] | ... - 1.27 | 1.27 - 1.90 | 1.90 - 2.54 | 2.54 - 3.17 | 3.17 - 3.81 | 3.81 - 4.44 | 4.44 - 5.08 | 5.08 - 5.71 | 5.71 - 6.35 | 6.35 - 6.98 | 6.98 - ... |
| # Impacts | 20 | 187 | 193 | 25 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

## Challenges

The trial encountered the following challenges:

- Connectivity the Hailios hail plates require GPRS (2G/3G) and 4G LTE but require cellular not just satellite. In areas with poor mobile connectivity the hail plates may not be able to operate. Hailios have indicated that they're addressing this issue in future software updates.
- Initiation of the plates during transit. The plates use solar with a back-up battery of approx. three days running life as their power source. There is no external charging option for the plates. The trial encountered issues with the plates powering on due to being knocked during transit and the battery being drained. Two plates had to be replaced with additional plates from the warehouse in the USA.
- No local provider, Hailios is US based, which means troubleshooting can be complicated particularly with the time difference. This becomes particularly challenging when travelling reasonable distances and setting up times with farms, only to find that the product does not work when you arrive.
- Cost -AUD $3,200 annual subscription on top of an insurance premium can be prohibitive in some scenarios.
- Education of growers about parametric products – parametric products are new to many growers, overcoming perception barriers often caused by poor experiences with traditional indemnity insurance products has been a challenge.

## Opportunities: Covering additional risks

Given the simplicity of index-based insurance products, they can be further customised to manage multiple risks during the growing season, creating multi-risk index-based insurance. For example, during a season, a pineapple grower may wish to protect from hail, drought, and excessive heat, as all of them significantly impact pineapple production. Therefore, to address the multiple risk appetite and risk preferences of the producers, the project has also developed multi-risk index-based insurance solutions.

Multi-risk index-based insurance policies are based on a weight risk rating, which considers the producers' risk appetite and preferences. According to this approach, the total risk rating is established at 100% (see Table 2). For example, a pineapple grower who encounters various risks during the growing season recognises cyclones, hail, and droughts as the primary concerns and assigns higher risk ratings to these specific risks (see Table 2). This allows the grower to tailor a policy that suits their risk management and financial needs.

Based on the risk rating and trigger points designed for specific risks (e.g., decile one for drought), the weighted approach calculates the overall premium (see example below).

### Table 2: Weighted risk rating approach developed for multi-risk index-based insurance

| Risk | Risk rating | Risk rating (pineapple example) |
|---|---|---|
| **Cyclone** | 25% | 0 |
| **Drought** | 25% | 25% |
| **Hail** | 25% | 50% |
| **Heat** | 25% | 25% |
| **Total** | 100% | 100 |

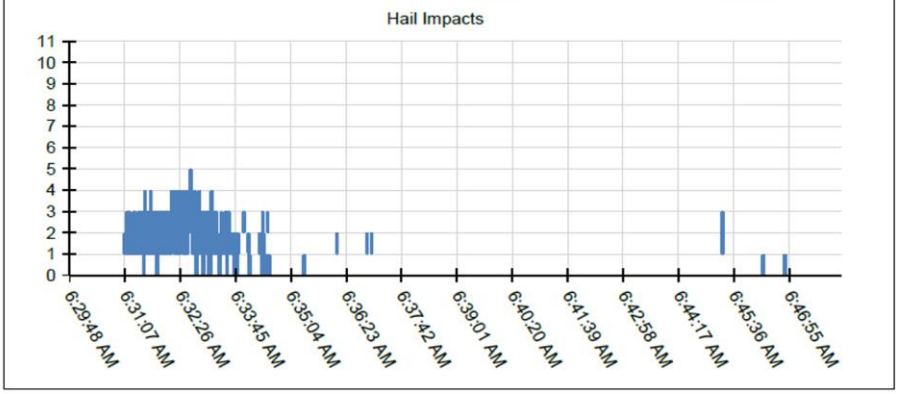
# Case Study – Hail Event November 2023

On 10 November 2023, the farm in Forrest Hill was impacted by a severe hailstorm. The Hailios hail plate located on the property was impacted and 426 impacts and the beetroot crop was significantly impacted

The hail plate recorded the size and intensity of each other 426 impacts and timestamped each one.


| | |
|---|---|
| **Sensor ID:** | **1** |
| GPS: | -27.6088496563171 152.343756763754 |
| # Impacts: | 426 |
| Max. hail class: | 5 |
| Total kin.energy [J]: | 337.582 |

| Hail Class | H1 | H2 | H3 | H4 | H5 | H6 | H7 | H8 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Diameter [inch] | ... - 0.50 | 0.50 - 0.75 | 0.75 - 1.00 | 1.00 - 1.25 | 1.25 - 1.50 | 1.50 - 1.75 | 1.75 - 2.00 | 2.00 - 2.25 | 2.25 - 2.50 | 2.50 - 2.75 | 2.75 - ... |
| Diameter [cm] | ... - 1.27 | 1.27 - 1.90 | 1.90 - 2.54 | 2.54 - 3.17 | 3.17 - 3.81 | 3.81 - 4.44 | 4.44 - 5.08 | 5.08 - 5.71 | 5.71 - 6.35 | 6.35 - 6.98 | 6.98 - ... |
| # Impacts | 20 | 187 | 193 | 25 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |




Note: timezone recorded is US Central time

During the trial the business obtained two quotes that would have paid out in this scenario. The first quote included both hail size and intensity and would have paid the business $180,000 in this scenario for a $54,000 premium (Note: These products are scaled the full sum insured in the quote was $600,000). The second quote was structured to only include hail size and would have paid $150,000 on a premium of $30,000.

Quote A – Hail Size & Intensity

Premium: $54,000 Premium: $30,000*does not include Hailios subscription covered by the project.

| Hailsizes (stone max. diameter in centimeter) | Low Intensity (1 <=N<10) | Moderate Intensity (10 <=N<80) | High Intensity (80<=N<400) | Extreme Intensity (N<= 400) | |
|---|---|---|---|---|---|
| d>=5.0 | 10% | 20% | 50% | 100% | |
| 4.00 <= d < 5.00 | 5% | 15% | 40% | 85% | |
| 3.00 <= d < 4.00 | 3% | 10% | 30% | 70% | $180,000 |
| 1.50 <= d < 3.00 | 1% | 5% | 15% | 30% | |

Quote A – Hail Size Only

Premium: $30,000*does not include Hailios subscription covered by the project.

| Hailsizes | Payout | |
|---|---|---|
| 5.00 <= d | 100.00% | |
| 4.00 <= d < 5.00 | 75.00% | |
| 3.00 <= d < 4.00 | 25.00% | $150,000 |
| 2.00 <= d < 3.00 | 10.00% | |

In this case study, the application of the Hailios hail plates has proved that a triggered event, verifiable by the Bureau of Meteorology and direct plate impressions can provide the evidence needed by insurance companies to trigger a payout.

In this instance, hail was evidenced, but the farmer chose not to take up the insurance product and therefore did not receive a payout.

The grower was very impressed by the structure and example of the technology in use. They indicated that while they were comfortable with their decision to wear the damage to their seasonal beetroot crop in this instance and “self-insure” that they would certainly consider cover for a higher value crop such as cotton.