Cyclone Gabrielle Research Symposium

19th – 20th November 2025

Havelock North Function Centre

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Lessons for the management of highly productive land

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Symposium Programme

Wednesday 19th November 2025

10:00am – 5:00pm

10:00am **Welcome and Opening**
Xan Harding

10:10am **Part 1: Observations from previous similar events**
Peter Manson
AgFirst Pastoral
Historical North Island Flood Events: Lessons for understanding flood sediment deposition and management

Part 2: Observations after Cyclone Gabrielle

10:30am Dr Kathleen Kozyniak
Team Leader Air & Land Science, Hawke's Bay Regional Council
An extraordinary storm: the severity of Cyclone Gabrielle's weather in Hawke's Bay

10:50am Dr Murry Cave
Principal Scientist, Gisborne District Council
The Science Response in the Year of Storms; A Gisborne/Tairawhiti perspective

11:10am Dr Chris Massey
Engineering Geologist, ESNZ - GNS
Insights into causes of landslides triggered by Cyclone Gabrielle

11:30am **Short break**

Part 3: Impacts of Cyclone Gabrielle on highly productive land

11:40am Dr Stephen Trolove
Senior Scientist, Cropping Systems & Environment, BSI-PFR
The effects of Cyclone Gabrielle on fruit tree health in Hawke's Bay

12noon Lisa Arnold
*Masey University and WSP. Environmental Consultant, WSP***Impact of Cyclone Gabrielle on stonefruit orchards in Hawke's Bay: a case study**

12:20pm Sarah McArley
AgFirst, Hawke's Bay
Charting the course following Cyclone Gabrielle

12:40pm Dr Dan Bloomer
LandWISE
Baseline sediment sampling in Tairawhiti and Hawke's Bay

1:00pm **Lunch**

1:40pm Dr Dirk Wallace
Senior Researcher, FAR
Impacts on cropping businesses

Part 2: Observations after Cyclone Gabrielle (cont.)

2:10pm Dr Emily Lane
Principal Scientist - Natural Hazards and Hydrodynamics, ESNZ - NIWA
Understanding the flooding caused by Cyclone Gabrielle

2:30pm Ryan Paulik
Hazards Analyst, ESNZ – NIWA
Building Flood Damage from Ex-Tropical Cyclone Gabrielle: Insights on Damage Processes and Implications for Flood Risk Assessments

2:50pm **Afternoon Tea**

Part 4: Food safety lessons

3:20pm	Professor Phil Bremer *Chief Scientist for the New Zealand Food Safety Science Research Centre* **Lessons from the Horticultural Sector Response to Cyclone Gabrielle**
3:50pm	Dr Damien Farrelly *CEO, Fresh Produce Safety Centre* **Food safety and critical incidents: A unified approach for safer produce**
4:10pm	Chris Herries *Regional Manager, Horticentre Hawke's Bay* **Silt nutritional status and contamination concerns**
4:30pm	**Panel discussion – Day 1 insights** *Prof Phil Bremer (NZFSSC)* *Garth Eyles* *Dr Bruce Searle (BSI)*
5:00pm	**Day 1 concludes** *Social Mixer followed by dinner*

Symposium Programme

Thursday 20th November 2025

9:00am – 3:00pm

9:00am **Welcome and reflections from Day1**
Jerf van Beek

Part 5: Landscape impacts

9:10am Dr Warwick Allen
Researcher, Plant Community Ecology, Bioeconomy Science Institute (Manaaki Whenua – Landcare Research Group)
Ecological impacts of Cyclone Gabrielle

9:30am John Ballinger
Senior Land Management Advisor – technical, Northland Regional Council
Cyclone Gabrielle and poplar windthrow in Northland: Field observations, vulnerability factors, and management implications

9:50am Josh van der Werden
BSI-PFR
Seed/plant types and establishment in sediment

10:10am **Morning tea**

10:40am Dr Dirk Wallace
Senior Researcher, FAR
Recovery of annual cropping over 2 years

11:00am Dr Dan Bloomer
LandWISE
Returning to (some) baseline sampling sites to assess cropping soil recovery

Part 6: Policy

11:20am Michelle Sands
General Manager, Strategy and Policy, Horticulture NZ
Cyclone Gabrielle – Informing future planning frameworks

Part 7: Perspectives and reflections from on the ground

11:40am Alan Kale
ELAK Consultants Ltd
Recovery of annual cropping ground – Grower learnings

12 noon **Lunch**

12:45am Danielle Adsett
Manager Market Access, NZ Apples & Pears
Technical and extension learnings from Cyclone Gabrielle

1:15pm **Part 8: Breakout session – reflecting on lessons learned**

2:00pm **Reporting back**

2:30pm **Collation into lessons**

3:00pm **Symposium close**

Symposium Abstracts

Part 1: Observations from previous similar events

Historical North Island Flood Events: Lessons for understanding flood sediment deposition and management

Alex Dickson[1], Dan Bloomer[1], Callum Rees[2], *presented by Peter Manson*[3]

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The East Coast of New Zealand's North Island represents a dynamic landscape repeatedly shaped by extreme flood events. This presentation examines the documented history of significant floods, with particular focus on the Heretaunga Plains - a 300 km^2 alluvial region formed over 250,000 years by three major river systems (Ngaruroro, Tūtaekurī, and Tukituki). Today, 90% of the Heretaunga Plains is classified as highly productive land (LUC classes 1-3), supporting approximately 14,550 hectares of fruit and vegetable production.

Historical records reveal catastrophic flooding across the East Coast dating back to European settlement. **The 1867 flood** when the Ngaruroro River broke its banks near Fernhill, deposited 30-50 cm of sediment across much of the Heretaunga Plains and permanently changing the river's course. This event prompted the first parliamentary response - the problematic 1868 Hawke's Bay and Marlborough Rivers Act, which allowed individual property owners to construct stopbanks, often diverting water onto neighbouring properties.

The 1931 Napier earthquake, while not a flood event, profoundly influenced subsequent flooding patterns. The 7.8 magnitude earthquake caused land uplift of up to 2.7 meters and forced both the Esk and Tūtaekurī Rivers to change course. The earthquake triggered approval of comprehensive river control schemes in 1933, with work beginning in 1934 to embank the Ngaruroro and Tūtaekurī Rivers along their entire course over the Plains.

The ANZAC Day 1938 Esk Valley flood catalysed New Zealand's modern soil conservation movement. Over three days (April 23-25), Puketitiri recorded over 1,000 mm of rainfall, with the Esk River experiencing an estimated peak flow of 1,347 m^3/s. The floodwaters buried approximately 700 hectares of productive farmland under 1-3 meters of sediment, destroyed 12 bridges, and severely damaged 42 others. The immediate response involved distributing 24 tonnes of ryegrass seed and 3.6 tonnes of white clover.

However, recovery was complicated when strong winds in January 1939 turned the valley into a "miniature desert," destroying much of the newly established pasture. This catastrophe directly led to the passing of the Soil Conservation and Rivers Control Act 1941.

The 1948 Gisborne/Poverty Bay flood prompted the first rigorous scientific research on flood sediment revegetation. The storm caused significant damage across the Waipaoa catchment, with agricultural losses of £165,000 (approximately $15 million today). McKee and Graham's (1952) groundbreaking research, conducted after both the 1948 and 1950 floods, established foundational principles about sediment classification, optimal timing for oversowing, and species selection that remained valid for decades. Their insight of a narrow "moisture window", when surface water has drained but sediment remains sticky enough for successful oversowing, was validated repeatedly in later events. Their finding that Italian and short rotation ryegrass outperformed other species in flood sediments became a consistent theme in subsequent research.

Cyclone Bola (March 6-9, 1988) brought three days of torrential rain when the system stalled over the East Coast. With 916 mm at Tolaga Bay and maximum intensities of 85 mm/hour, the cyclone deposited sediment up to 1.5 meters deep across 8,000 hectares, with primary sector losses of $90 million ($210 million in 2023 dollars). Research by Gray and Korte following Bola confirmed McKee and Graham's earlier findings, with Moata Italian ryegrass proving most vigorous even without fertilizer, outperforming perennial ryegrass.

The 2004 Southern North Island Storm left approximately 20,000 hectares underwater, with damages of $300 million. Comprehensive research found sediment deposits typically had high pH, low phosphorus and potassium, and minimal organic matter. Studies demonstrated that while oversowing provided quick initial cover, full cultivation with sediment incorporation produced better long-term outcomes, though it required waiting 30+ days for suitable moisture conditions.

This historical pattern of extreme weather events - with major floods recurring approximately every 10-40 years - provides essential context for understanding Cyclone Gabrielle (2023), which exceeded even these historical benchmarks in rainfall intensity and damage extent.

The presentation traces how European land clearance since the 1800s intensified erosion rates threefold in some catchments by replacing deep-rooted native forest (which reduces erosion by 70-90% during storms) with shallow-rooted pasture. It examines the evolution of flood protection from the problematic 1868 Rivers Act through to modern coordinated stopbank schemes.

Consistent themes emerge across 85+ years of documented events: the critical importance of timing for oversowing success, the need to classify sediment by texture and depth, the superior performance of Italian ryegrass, the connection between upland land use and downstream impacts, and the requirement for long-term commitment to recovery. These lessons, documented in research from 1952, 1990, 2004, and beyond,

offer crucial guidance for building resilience in New Zealand's valuable horticultural regions facing climate change and increasingly frequent extreme weather events.

This research was supported and funded by Page Bloomer Associates as part of master's degree studies. It was completed in parallel with Cyclone Gabrielle research funded by MPI, Vegetables New Zealand and FAR.

Part 2: Observations after Cyclone Gabrielle

An extraordinary storm: the severity of Cyclone Gabrielle's weather in Hawke's Bay

Dr Kathleen Kozyniak

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Cyclone Gabrielle rivalled in severity with one of Hawke's Bay's most infamous storms, Cyclone Bola. Impacts included loss of life, flooding, landslides, property and infrastructure damage, and the deposition of sediment and woody debris. The infrastructure damage included parts of Hawke's Bay Regional Council's (HBRC's) environmental monitoring network and disrupted lines of communication from some telemetered rainfall and climate sites. The data remained logged at the sites and was retrieved when communication was restored. This enabled the magnitude of the weather event in Hawke's Bay to be documented and compared to historical storms.

Cyclone Gabrielle originated near the Solomon Islands, developed into a Category 4 storm in the Coral Sea and tracked to New Zealand. It's moisture holding capacity was boosted as it crossed warmer than average seas enroute to Hawke's Bay. It arrived when the region had experienced 6 months of above normal rainfall, including from Cyclone Hale the month prior, leaving soil moisture levels near or at field capacity. This meant the land was ill-placed to absorb more moisture and reduce runoff to waterways. Additionally, wet soils are susceptible to shallow landsliding and render trees vulnerable to wind-throw.

The storm struck Hawke's Bay overnight on 13-14th February, bringing extraordinary rainfall to a region that was already saturated. Rainfall of 546 mm, half a year's worth, fell at Glengarry in the Esk catchment, with 501 mm falling within 24 hours, 372 mm in 12 hours and 56 mm in one hour. It is possible 700 mm fell higher in the catchment. The one-hour rate at Glengarry nears the 60 mm measured in the Napier floods in 2020, while 63.5 mm fell at Glengarry when the Esk River flooded in 2018. Rainfall during the event contributed to a February total in the Esk catchment that was 600% of the long-term average.

Cyclone Gabrielle brought high rainfall to other parts of Hawke's Bay. The eastern area of Wairoa and high ground in the Tūtaekurī and Ngaruroro catchments received 450-500 mm, some of the highest falls in the region. Residents living at Sherenden and Waiwhare reported to HBRC that 700-750 mm fell there.

The region's February rainfall was more than 450% of the long-term average. Nearly all HBRC's rainfall sites recorded their highest February rainfall and it boosted rainfall for the 2022-23 hydrological year (July to June) to the wettest year in the records of nearly all HBRC's sites.

The short-interval (1-18 hours) intensity of Cyclone Gabrielle's rainfall was greater than Cyclone Bola's. At 24-60 hour intervals, Cyclone Gabrielle's rainfall was higher at most sites that existed at the time of Cyclone Bola, except some in the Wairoa District.

Easterly winds gusted 120-150 km/h around Mahia, eastern Wairoa and Cape Kidnappers. Vegetation that is structurally adapted to the country's prevailing westerly wind are more susceptible to damage from high winds in other directions. Gusts around Napier reached 89 km/h compared to 78 km/h during Cyclone Bola but were not as strong as the 117 km/h reached during Cyclone Bernie in 1982. Cyclone Bernie is known to have downed up to 40 ha of trees in the Urewera National Park.

The broadness of the weather system allowed sufficient fetch to generate large swells and wind waves. Satellite measurements of sea surface winds showed gale to storm force easterly winds blowing over approximately 600 nautical miles east of Hawke's Bay. The estimated significant height of combined wind waves and swell from modelled ERA reanalysis data exceeds 7 m at a location near Mahia Peninsula and is the fifth highest in the more than 80-year record. It is the highest in the record at the same and other locations in Hawke Bay for waves and swell coming from the easterly quadrant.

Cyclone Gabrielle was a severe storm that proved challenging for environmental monitoring and communication infrastructure, compromising real-time data collection from sites. Complementary rainfall estimation methods, such as weather radar and modelling, undercooked totals in key catchments in the absence of rain gauge data to calibrate them. It highlights the benefit of HBRC's efforts to build further resilience in its gauge network.

The storm also demonstrates the difficulty urban and rural landscapes have assimilating rainfall with intensities approaching 60 mm in one hour, 150 mm in three hours and 200 mm or more in six hours, such as observed during Cyclone Gabrielle, the Napier flood and the 2018 flooding in the Esk Catchment. This is especially the case when soil moisture is already high.

Links:
https://www.hbrc.govt.nz/environment/state-of-the-environment/three-yearly-report/

The Science Response in the Year of Storms; A Gisborne/Tairawhiti perspective

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For the Gisborne/Tairawhiti region 2023 was a difficult year with 8 severe storms and several irritating ones while Cyclone Hale (January), Cyclone Gabrielle and Son of Gabrielle (February), June and then November having the most impacts. The storms caused severe flooding, landslides and the mobilisation of large woody debris. The impacts of Gabrielle were profound with 9 breaks to Gisborne's water supply pipeline, multiple bridges lost, roads damaged and houses damaged or destroyed. Compounding the impacts were antecedent conditions with soils fully saturated after Cyclone Hale and with elevated watertables persisting into 2024.

The above-mentioned impacts were the focus of much of the media attention, but the impacts on the productive rural sector outside of forestry did not get the same attention but maize, and vegetable crops were destroyed and citrus, apple and kiwifruit orchards badly damaged.

The Crown via the CRI's and other government agencies such as MPI and MfE all initiated science responses as did Gisborne District Council itself. Three years on it is useful to reflect on that science response, how effective was it, did it deliver and was it well targeted at the real needs of the community and the economy. Equally the science response was just that; it focussed on the short-term immediate response and not on the long-term recovery for the impacted regions.
If we don't consider those things that went well, those that didn't go well or those that petered out without reaching a conclusion, we will not learn from the experience. That implicitly means we will likely repeat the same mistakes the next big event.

Gisborne District Council had its own science actions leading up to the storm events, during the immediate response phase and also during the long tail of recovery. These actions included;

- Identifying the threat and mobilising for response well before the first watch issued by MetService,
- Acquiring key data particularly aerial imagery, flood heights etc as soon as practicable post event,
- Connecting in with key science funders and providers post event in an attempt to steer the science response towards what was needed in the community, not that which was interesting to the researchers,
- Supporting the collection of perishable data such as soil samples for the research providers,

- Telling the story of the storms of 2023 via conferences and workshops in Gisborne, presenting papers in other fora, submitting on the many various reviews and regulatory changes post 2023, including reviews of the science response itself, and in too many cases,
- Picking up the tab or undertaking the work to complete science projects that were not completed.

From our analysis of the science response, it can be concluded that the overall Central Government-funded research supporting the North Island Weather Events was well intentioned. But it lacked focus and did not carefully consider whether or not the research undertaken would provide meaningful benefits to the communities impacted by the storms. Not all response research fell into this category, however, and it is telling that research that were community led (albeit having the Regional Councils as a proxy for the community) or were industry led (but often funded by MPI) were more focussed on community or economic outcomes and were able to deliver the required outputs. Two projects stand out;

- Cyclone Gabrielle Baseline Sampling 2023 which delivered in September 2023 and focussed on soils (MPI supported by Vegetables NZ), and
- Cyclone impacts on fisheries (MPI-Fisheries).

But there remain big gaps and one that particularly comes to mind is an overarching detailed technical analysis of the event that looks at how the storm developed, and the across region impacts. What was the total and daily rainfalls and where those rains fall, what was the maximum flood spread, how many landslides were there and what was the relationship between land use and landslides? How did the soils change as a result of those silt inputs. What land use changes are required to make the regions more resilient? And possibly, the elephant in the room question that no one wants to address is whether or not our people are living in places that can be made safe from future severe weather events like those that occurred in 2023.

Insights into causes of landslides triggered by Cyclone Gabrielle

Dr Kerry Leith[1], Dr Chris Massey[2], T. Robinson[3], B. Lukovic[4], S. McColl[4], T. Carey-Smith[4], B. Rosser[4], L. Wortherspoon[5], H. Smith[6], H. Betts[6], R. Buxton[4], J. Bidmead[4].

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In February 2023, Cyclone Gabrielle brought record rainfall to the North Island, triggering more than 160,000 landslides. Our study looked closely at over 116,000 of these landslides in Hawke's Bay and Tairāwhiti to understand what controlled where they happened.

The key finding is that while heavy rain was the main trigger, the relationship is not simple. Once rainfall passed very high levels (more than 220–330 mm in 24 hours), the amount of rain became less important than other factors such as slope steepness, soil type, and land cover. In some places, rain was so extreme that the soil was already fully saturated, meaning the usual effect of "how wet the ground was before the storm" didn't matter.

This means that during severe storms, the areas most at risk are not always those with the highest rainfall totals. Instead, land characteristics like geology, soil depth, and whether slopes are forested or bare play a bigger role in determining where slips occur.

This research shows that managing land cover and soil health can make a real difference to landslide risk, especially as more frequent extreme storms are expected with climate change. Understanding which parts of the farm are most vulnerable can help with planning, reducing damage to land, stock, and infrastructure in future storms.

This research is published in:
Massey C, Leith K, Robinson TR, Lukovic B, McColl S, Carey-Smith T, Rosser B, Wotherspoon L, Smith H, Betts H, et al. 2025. What controlled the occurrence of more than 116,000 human-mapped landslides triggered by Cyclone Gabrielle, New Zealand? Landslides 1–20. https://doi.org/10.1007/s10346-025-02591-y

This study was funded by New Zealand's Ministry of Business, Innovation and Employment, Award Number: C05X170 and C05X2304.

Part 3: Impacts of Cyclone Gabrielle on highly productive land

The effects of Cyclone Gabrielle on fruit tree health in Hawke's Bay

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Cyclone Gabrielle struck New Zealand in February 2023, causing widespread flooding that affected approximately 2500 of the 7000 ha of pipfruit orchards in the Hastings region. The cyclone came during a season that was already very wet, with high soil moisture readings recorded from spring 2022 until late spring 2023. There is little published information about how to manage pipfruit orchards affected by large amounts of sediment and ponded water, therefore transects were established in selected orchards to monitor soil and tree health post-cyclone to provide information for future growers who may face similar challenges.

Flooded orchards were divided into three categories based on the best knowledge at the time:

1) Sediment >30 cm – tree survival unlikely and sediment removal would be very expensive
2) Sediment 0–30 cm or ponded water for ≥1 week – tree survival uncertain
3) No sediment or ponded water – tree survival highly likely.

Soil, sediment and tree health measurements were taken 2–4 weeks after the cyclone in 29 orchards across the Heretaunga Plains where tree survival was uncertain (Category 2). The health of nine trees was scored at seven sites along a transect. Holes were also augered and the depth of mottles, gleying and waterlogging measured. Further tree health scoring was conducted in May 2023, and in the subsequent growing season at flowering and just before harvest. A grower survey was conducted in May 2023 regarding management practices, and for yield data after the harvests of 2024 and 2025.

Flowering was abundant in the season following the cyclone. Some growers were uncertain how their trees would respond to chemical thinners so used lighter rates, and reported large hand-thinning costs. By harvest 2024, tree deaths averaged 12%, with an average ill-thrift score post cyclone of 0.24 (where 0 was healthy and 4 was dead). Much higher losses were seen in young trees, especially 1-year-old trees, than in mature trees. Good drainage was essential to tree survival, with trees on gleyed soils or a high-water table <45 cm below the surface 2 weeks post cyclone experiencing higher tree losses. Seventy-five percent of orchard managers from the surveyed blocks reported reduced fruit yields in 2024, with 91% of these stating that the yield loss was at least partly

attributable to the cyclone. Possible explanations for the cyclone-related yield loss included root damage, tree loss, poorer bud quality including *Phytophthora* infection in buds, and difficulties in completing necessary management practices due to the cyclone. By harvest 2025 most of the orchards surveyed had recovered from the cyclone, with only 27% of growers reporting a yield decrease that they attributed to the cyclone. The size of the yield loss was typically estimated at 5–25%, apart from one block where losses of 79% were reported. This block was located on a poorly drained loam where water had ponded for >4 weeks after the cyclone, and tree losses from *Phytophthora* had been high.

Most growers removed the sediment within two months of the cyclone in the blocks studied. In one orchard where the sediment had not been removed from around the trunk, 13% of trees had developed trunk fungal lesions when assessed at flowering, whereas the incidence of trunk lesions was <2.5% at other the orchards. Although not included in this survey, growers reported very high tree losses in blocks inundated with ≥50 cm of sediment. In blocks where sediment was left above the graft union, growers noted a marked increase in tree vigour in the second season after the cyclone because of scion rooting.

Management recommendations post flooding included:

- Dig holes to 60 cm to check for gleying or a high-water table
- Have drains checked and working
- Prioritise draining water and removing sediment from young trees over mature trees
- Apply phosphorous acid to reduce *Phytophthora* risk
- Remove sediment to below the graft union (taking care to avoid trunk damage)
- Cultivate the sediment into the underlying soil and sow understorey species
- Conduct soil and leaf tests the following season and fertilise accordingly.

Funding sources:
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For more information regarding this work:

Trolove S, Husband E, Sorensen I, White M, van der Weyden J, Arnold N, Walker J, Horner M, Brookes J. The effects of Cyclone Gabrielle on pome fruit tree health in Hawke's Bay. *Manuscript in preparation for submission to the New Zealand Journal of Crop and Horticultural Science*.

Trolove S, Bews A, Becker M, Adsett D. March 2025. Findings of a grower survey on the impacts of Cyclone Gabrielle on pipfruit orchards. A Plant & Food Research report prepared for: New Zealand Apples & Pears Incorporated. PFR SPTS No. 26898.

Impact of Cyclone Gabrielle on stonefruit orchards in Hawke's Bay: a case study

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This case study investigated five stonefruit orchards that were impacted by Cyclone Gabrielle to varying degrees and located across different parts of Hawke's Bay, including Esk Valley, Bay View, Meeanee and Tomoana. Peach, nectarine, plum and apricot were planted at these orchards.

Qualitative interviews were conducted in January-February 2024 for each orchard, to document and understand which areas were affected by the cyclone, how they were affected (i.e. waterlogging, sediment deposition, wind damage), any management approaches taken, and future plans for the orchards. Follow up interviews were conducted in September 2025 to document how the orchards were faring, including changes to orchard plantings and management approaches, and any notable observations.

The main cause of tree deaths and declining tree health across the five orchards was likely to have been due to hypoxic soil conditions resulting from prolonged waterlogging and/or sediment deposition. Plantings across all orchards were on Golden Queen peach rootstock which is highly intolerant of hypoxic soil conditions. Drainage of flood water appears to have played a key role in the health and survival of trees.

As at September 2025, some adversely affected plantings have been removed, and replanted in stonefruit or apples. Esk Valley blocks were severely impacted and have not returned to production.

This work provides a case study of stonefruit orchards across Hawke's Bay, documenting two different points in time, approximately 1 year and 2 ½ years after Cyclone Gabrielle. The findings from this study provide valuable insights and may support decision-making for growers impacted by future events.

Charting the Course following Cyclone Gabrielle

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Cyclone Gabrielle on 14 February 2025 brought unprecedented conditions to growers in Hawke's Bay, creating continuously evolving challenges requiring immediate, short-term, mid-term, and long-term responses. How to harvest any remaining crop? What recovery is required? How to sustain orchard productivity for future seasons and protect investment? AgFirst worked to triage a range of different support techniques, that changed with the progression of post cyclone needs through the immediate (February 23 – May 23), short term (June 23 – Dec 23), and medium term (Dec 23 – Dec 24) timelines.

Immediate – February 2023 to May 2023

Once the safety of families, friends, and community had been established, growers and industry looked to determine the scale of impact. AgFirst worked alongside the pipfruit industry to collect data, quantify impacted area, determine the volume of affected fruit unable to be harvested, the value of that fruit, the cost of redeveloping, and the financial impact on profitability. Amongst the chaos of unknowns and while everything else was in disarray, numbers felt solid. They gave growers a mechanism to comprehend what had happened, communicate their loss, and therefore their needs going forward.

Following quantification, AgFirst assisted in creating decision matrices, setting out logical step by step tools to help decision making. It was clear growers' capacity for decision making was low and the variability of damage was significant across orchards, therefore the matrices sought to consider the individual orchard needs, but provide quick management decisions, and rank priorities. For example, for those blocks requiring silt removal, prioritisation was ranked by block economic status and the rootstock susceptibility as well as the future potential returns of the variety, and its productive potential.

Grower information transfer was critical, especially in such a widespread, unprecedented event with such a range of impacts. One novel technique was AgFirst's creation of a Whatsapp group for growers and stakeholders. The platform provided an easy and concise way to share ideas, photos, equipment availability, and advice. This Whatsapp group was a great success; It gave growers a no obligations connection, enabled simple, effective and unintimidating communication.

Short Term - June 23 to December 23

Upon completing the 2023 harvest, attention turned to tree and soil health and how this would impact the 2024 crop. Physiological responses of trees post flooding/silt was unknown and growers were concerned about bud quality, bloom density and the fruit set

as a result. Crop loading decisions influence the pruning and thinning strategies for a block, so setting the crop load correctly was a major focus for growers in the 2024 spring.

It became apparent that the drainage systems of a block greatly influenced the health of the trees. For those blocks with good drainage, tree health recovered more quickly, and the impacts on the bloom were lesser than those blocks with poor drainage and flooded root systems.

Silt removal was still ongoing thorough the medium term. Clearing the silt from the bases of the trees was a priority to prevent scion rooting, and the associated issues this causes with vigour, production and fruit quality.

Medium Term – December 2023 to December 2024

As it transpired, the 2024 crop yield and quality outcomes were adversely impacted and the final harvest did not return the yield recovery estimated. AgFirst considers this is a result of ongoing effects of compromised root systems caused not only by Cyclone Gabrielle, but the poor weather conditions the seasons prior, alongside climate conditions that drove smaller fruit size outcomes.

Affected growers also had to make big decisions about the future direction of blocks. For those blocks which sustained significant damage, this was often whether replacing trees within an existing block was a cost-effective solution, or if grafting over to a new variety within the same system spacing was suitable. Growers were weighing up whether blocks should be cleared to greenfields and completely replanted, or even whether blocks would be better suited to an alternative land use. An understanding of the market trends, costs of production, succession planning, and capital availability factor into these decisions, some of which are still ongoing today.

Long Term – 2025 & Beyond

Unprecedented impacts required growers and industry to chart a course through the unknown to return to productivity and profitability. It is clear fruit trees and perennial horticultural crops are more resilient than initially expected, as are growers and the Hawke's Bay industry. Yield outcomes in 2025 have shown further recovery, highlighting that triages of actions taken had clear benefit, as has the widespread unintimidating sharing of information.

Baseline sediment sampling in Tairawhiti and Hawke's Bay

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This presentation covers work completed by LandWISE, AgResearch, Gisborne District Council, Massey University and others. The collaboration came together in the aftermath of Cyclone Gabrielle, aware that very limited data had been collected or published immediately after other events. The core team included Alex Dickson (coordinator) and Dan Bloomer from LandWISE, Alec Mackay of AgResearch, Alan Palmer from FLRC at Massey University, and Bryce McLoughlin and David Suter from Gisborne District Council.

Following Cyclone Gabrielle, one of the key challenges for growers was managing sediment deposited on some of the country's most productive soils. The critical question was how best to return these low fertility, low organic matter soils back to full production.

Historical precedent existed for addressing this challenge. Long-term studies completed after the May 1948 North Island storm in the Gisborne region and the February 2004 Southern North Island storm floods in the Manawatu/Rangitikei regions examined effective management practices for sediment revegetation and developed guidelines for farmers. These studies produced a decision tree based on factors like depth and texture to guide optimal sediment management. After Cyclone Gabrielle, growers who followed these established guidelines achieved good outcomes where conditions were suitable.

In the immediate aftermath of the cyclone, we consulted the science community including Plant & Food (now Bioeconomy Science Institute), AgResearch, Massey University and independent horticultural consultants for guidance. The collected information was compiled to help affected growers plan immediate responses, then uploaded to the LandWISE website and presented at grower meetings.

Stage one baseline sampling was designed to provide growers with current site-specific information for management decisions. Conducted one to three months after the cyclone, this sampling effort collected 151 samples from 111 sites across all major catchments, sediment types, and enterprise types, plus 14 additional samples for contamination testing. Assessment parameters included sediment depth, texture, bulk density, structure, fertility, and earthworm presence along 50m transects. Both planned and actual field actions were recorded. The baseline project engaged 65 farmers and growers across the impacted areas.

The initial sampling filled a major gap in knowledge of the behaviour of soils and sediments in the weeks and months immediately following a storm event. Sediment deposition on the Hawke's Bay and Tairawhiti varied in depth (< 5 cm to > 100 cm), texture (sand to silty clay loam), volumetric moisture content (10 – 80%), bulk density (0.75 – 1.65 g cm^{-3}), nutrient fertility including pH (5.5 – 8.5), Olsen P (2 – 30 µg ml^{-1}), exchangeable potassium (2 – 16 MAF units), sulphate sulphur (2 – > 200 mg/kg) and in its biology (12 – 70 earthworms m^{-2}). The physical condition of the sediment as assessed using the Visual Soil Assessment methodology varied from poor to moderate. Initial concern regarding chemical or biological contaminants in the sediments was not supported by any of 14 samples taken from sites in Hawke's Bay. The initial survey as recorded actions growers took, or were intending to take, where significant amounts of sediment (5 – 20+ cm) were deposited on their highly productive land as there is little or no documented information on best management of sediment impacted sites with high value crops on elite soils. Previous studies have been almost exclusively of re-grassing pastureland.

Our broader goal was establishing a multi-year longitudinal study focused on cropland and orchards, building on the 1948 and 2004 research. The baseline sampling was carried out collaboratively by LandWISE, Massey University, AgResearch, Plant and Food Research, Hawke's Bay Regional Council and Gisborne District Council, with support from Horticulture NZ, and the Ministry for Primary Industries.

However, the earlier studies focused primarily on pastoral remediation and contained limited information directly relevant to highly productive orchard or cropping land. The proposed stage two aimed to follow baseline sampling with continued monitoring to improve knowledge for site remediation responses on very high-value land for future similar events. Ultimately, stage two was only able to visit a small number of sites on and around the Heretaunga Plains.

Report:
Cyclone Gabrielle Baseline Sampling Report
https://www.landwise.org.nz/mp-files/cyclone-gabrielle-baseline-sampling-report-september-2023.pdf/

Impacts on cropping businesses

Dr Dirk Wallace[1], Alan Kale[2], Diana Mathers[3], Elliot Calendar[4], Melanie Briant[4]

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The Foundation for Arable Research (FAR) funded by MPI and Vegetable Research & Innovation, initiated a project in September 2023 to document and capture growers' recovery experiences from Cyclone Gabrielle, offering insights for future adverse events.

What Was Done:
The project established 46 case study sites across 9 clusters in Hawke's Bay and Gisborne/Tolaga Bay, encompassing diverse locations, crop types, and grower approaches. Sites included varying damage scenarios which will be discussed:

What Was Learned:
- Wind, water and sediment

The event produced various impacts across the North Island. The effect of wind, water and sediment deposition will be discussed separately. Where possible, crops that were still able to be harvested where to produce some cashflow. There was little guidance on this, as for many crops that remained the yields were low, machinery wear was high and stress load on those harvesting was significant.

- Debris

Debris deposition was a significant challenge. Removal of debris was step one for many, as this had to be achieved before harvest could be considered.

- Impact assessment

Initial assessment of economic impact was challenging and required regional support. Land owners understood the damage they would have to deal with, but moving this information through to government officials could be simplified in the future.

- Economic cost

At its simplest there were three components to on farm economic cost of this event. 1) Crop loss, this may have been total or partial, 2) Remediation cost, 3) Crop loss from following season, this may be complete, partial or negligible. The economic cost for each grower was a result of these three factors, we will attempt to draw general conclusions.

What It Means:
This project has highlighted that initial impacts were highly variable, contingent on geography, sediment type, and subsequent weather. Regardless of damage, this was a

time of extreme stress for the communities effected and as outsiders we must consider how we can work together to alleve this impact in the future.

Part 2: Observations after Cyclone Gabrielle

Understanding the flooding caused by Cyclone Gabrielle

Dr Emily Lane

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Cyclone Gabrielle caused flooding over much of the east coast of the North Island, especially in Hawkes Bay and Tairāwhiti. Understanding the flooding that occurred helps us better prepare for future events. This presentation reports on work undertaken by NIWA (now Earth Sciences NZ) and collaborators in the aftermath of Cyclone Gabrielle to better quantify the flood hazard in Hawkes Bay and Tairāwhiti.

Building Flood Damage from Ex-Tropical Cyclone Gabrielle: Insights on Damage Processes and Implications for Flood Risk Assessments

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Flooding events provide valuable opportunities to collect empirical data on the processes that drive building damage. In the aftermath of Ex-Tropical Cyclone Gabrielle, post-event flood damage surveys were conducted across the Hawke's Bay and Tairāwhiti regions. In this presentation we will share damage observations and data for over 1,000 buildings, capturing flood hazard intensities, building characteristics, and damage to individual building components. We identify the key factors contributing to building damage during the cyclone and offer insights into how this damage data can inform future flood risk assessments.

Part 4: Food safety lessons

Lessons from the horticultural sector response to Cyclone Gabrielle

Professor Phil Bremmer[1], Graham Fletcher[2], Allan B Wolf[3], Reginald Wibisono[3], Bethan Shaw[3], Nicola King[4], Peter Cressey[5], Milana Blackmore[6]

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Tropical Cyclone Gabrielle devastated horticulturally intense parts of New Zealand just as apple, kiwifruit and many vegetable crops were reaching maturity.

Questions of immediate concern for the horticulture sector included: the risk posed by directly affected produce and produce suspended above flood waters on trees and vines and how to determine the safety of produce in flood-affected blocks.

Challenges included: the wide-spread scale of the destruction; regulators and researchers needing to simultaneously address multiple risks; a lack of preparedness for an event of such magnitude; limited communications; disruption to the workforce; an inability to make generalizations across sites or crops; working amongst piles of silt; limited local or international guidance; limited knowledge of background microbial levels on produce and in soils; disagreement on potential risks and what to test for, and a lack of capacity for timely testing.

Donations of time and resources by regulators, researchers, and industry stakeholders, coupled with emergency funding by the Government, enabled best practice recommendations to be issued within 5-days of the event, plus desk-based and on-the-ground assessments to commence. However, a lack of capability and the challenging conditions meant that it took a month before well-structured food safety testing programs commenced. While all produce directly impacted by flood water was disposed of, subsequent testing indicated that risks from agrichemicals (pesticides, fertilizer) or micro-organisms (from silt, manure, dead animals) had not significantly increased, possibly due to dilution effects and the contaminants being reduced overtime by sunlight and rain. This presentation will expand on the nature of the event, and the challenges it posed as well as outlining the steps required to ensure that horticultural stakeholders, including researchers and government, become better prepared to deal with future adverse events.

Food safety and critical incidents: A unified approach for safer produce

Dr Damien Farrelly

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The potential food safety risks from flooding were significant given the scale of the event, level of contamination in floodwaters, and proximity to harvest for many crops. While guidelines exist on food safety risk management for flooding, they were not readily available, shared or adopted to support growers with readiness or response after the event. Businesses and the community understandably were very focused on the human and economic impacts of the cyclone, thus food safety was not necessarily front of mind for everyone. There was a fragmented approach to addressing food safety risks with individual product groups, regulators, industry and retailers generally tackling the issues separately. This meant that there was a lack of centralised collaboration and communication among key stakeholders in this time of greatest need.

In the immediate aftermath, New Zealand Food Safety developed Guidance for harvesting flood-affected produce for human consumption in collaboration with industry stakeholders like Horticulture New Zealand. There was push back from industry on the scientific justification within the guidelines (e.g. buffers), and the mandatory nature of guidelines given they were developed by the regulator. Product specific guidelines were also developed by industry (e.g. for apples and kiwifruit) based on existing science and new research trials undertaken in the immediate aftermath of the cyclone.

Consumers were warned not to consume produce that had floated off-farm in floodwaters, and concerns were raised that some flood impacted produce had made its way into the supply chain.

Most growers followed food safety guidelines, regulations, and requirements in their GAP programmes which required them not to harvest any produce that had been in contact with flood water or produce within buffer zones around flood waters. This led to significant economic losses for growers who did the right thing for food safety risk management.

Gladly, no food safety outbreak was linked with fresh produce in the aftermath of the cyclone. Though the risk was high, it was generally well managed which is a positive outcome for consumers and the industry.

The main lesson learned was that the industry should establish a collaborative network to respond in a timely manner during critical incidents, mitigate the risks of a large-scale food safety issue linked to fresh produce, and partner to collectively prepare for future crises. The concept of a New Zealand Fresh Produce Safety Network proposes to meet this need by enhancing leadership, strategic alignment, and coordination of activities

across the New Zealand fresh produce food safety system. The network could prioritise food safety research and development of guidelines to support growers to manage food safety risks more effectively in the next major flood, as well as improved guidelines on managing critical incidents. The network could also facilitate efficient and effective communication on food safety. During the Nelson-Tasman floods, the response and communication was notably improved compared to cyclone Gabrielle demonstrating that some lessons have been learned and the food safety system is already moving in the right direction.

The Fresh Produce Safety Centre (FPSC) has recently updated and published the Fundamental Guidelines for Fresh Produce Food Safety which include a chapter on Managing Critical Incidents. To manage such incidents effectively, businesses should develop, maintain and regularly test their Incident Management Plan (IMP) which readily integrates with other business systems. The key elements of an IMP include:

1. establish an incident management team with clearly defined roles and responsibilities
2. identification and risk assessment of incidents
3. monitoring and reporting
4. traceability systems including hold and release management
5. recall and withdrawal management
6. effective stakeholder communication (e.g. regulatory agencies, peak industry bodies, customers, suppliers), certification body, assurance programme (e.g. GLOBALG.A.P., NZGAP) and consumers
7. investigation (e.g. data collection, laboratory analysis and root cause analysis)
8. preparedness and training (e.g. annual system tests, practice implementation via simulation) including using lessons learned to update the IMP.

Resources:

- Guidance for harvesting flood-affected produce for human consumption - NZ Government
  (https://www.mpi.govt.nz/funding-rural-support/adverse-events/food-safety-in-natural-disasters-and-emergencies/guidance-for-harvesting-flood-affected-produce-for-human-consumption)
- Resources on floods and food safety - Fresh Produce Safety Centre
  (https://fpsc-anz.com/2022/03/09/resources-on-floods-and-food-safety-2022/)
- Fundamental Guidelines for Fresh Produce Food Safety – Fresh Produce Safety Centre
  (https://fpsc-anz.com/)
- Important food safety guidance for Nelson/Tasman growers - Horticulture New Zealand
  (https://www.hortnz.co.nz/news-events-and-media/media-releases/important-food-safety-guidance-for-nelsontasman-growers)

Silt nutritional status and contamination concerns

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Straight away once the water disappeared there was concerns being voiced about the possible toxic effects of the silt, including what possible toxins could be contained in the silt, and what the long term affects the silt may have on the soil. Soil tests were taken straight away following the flooding from four of the major flooded area's being Esk Valley, Dartmoor Valley, Twyford and Pakowhai. Analysis included looking at heavy metals and agrichemical contamination. Soil pH and nutrient values were also measured. The impact of the the results onto the parent soil material was assessed.

At the time there was also much discussion about the possible contamination of the silt from the many agrichemical sheds in the district that had been upended and if this was a risk to all of those people undertaking the clean-up.

Part 5: Landscape Impacts

Ecological impacts of Cyclone Gabrielle

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In mid-February 2023 Cyclone Gabrielle struck the North Island of New Zealand causing widespread destruction. As part of the cyclone response, Manaaki Whenua – Landcare Research partnered with NIWA, mana whenua, regional councils, and other stakeholders to assess the impacts of Cyclone Gabrielle on native ecosystems, from forests and wetlands to rivers and coastal dunes. We used a range of approaches to assess the cyclone's ecological impacts, including remote sensing, spatial data intersection, permanent forest plots, long-term monitoring datasets, environmental DNA (eDNA), and interviews with land managers. This talk will summarise our key findings and present some recommendations to help mitigate the impacts of future extreme weather events on ecosystems.

Two reports have been published as part of this work:
Allen *et al*. (2024) Ecological impacts of Cyclone Gabrielle (https://www.landcareresearch.co.nz/assets/researchpubs/Cyclone_Gabrielle_Integrated_ecological_assessment_Full_report.pdf)

McMillan *et al*. (2023) Rapid assessment of land damage – Cyclone Gabrielle. (https://environment.govt.nz/assets/Rapid-assessment-of-land-damage-Cyclone-Gabrielle-Manaaki-Whenua-Landcare-Research-report.pdf)

We wish to thank the Ministry for the Environment (MfE) and Ministry of Business, Innovation and Employment (MBIE) for funding this research under the Extreme Weather Research Platform. We are also grateful to the following organisations for their support: Hawke's Bay Regional Council, Auckland Council, Northland Regional Council, Horizons Regional Council, Gisborne District Council, Department of Conservation, QEII National Trust, Te Aitanga-a-Hauiti, Rongowhakaata Iwi Trust, Whareponga, and ecosanctuaries throughout the North Island.

Cyclone Gabrielle and Poplar Windthrow in Northland: Field Observations, Vulnerability Factors, and Management Implications

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Cyclone Gabrielle (12–16 February 2023) was one of the most damaging wind events to impact Northland in recent decades, combining extreme gusts exceeding 130 km/h with prolonged soil saturation following the wettest start to a year on record for Whangārei. While damage was widespread across the region, anecdotal reports suggested significant windthrow in poplar (*Populus* spp.) plantings. Given the species' importance for erosion control, shelter, and timber, the Northland Regional Council, in collaboration with Te Uru Rākau, undertook a rapid post-event assessment to investigate the extent, patterns, and drivers of poplar windthrow.

Seven sites across Northland were surveyed, representing a range of soil types, topographies, planting regimes, and poplar clones—predominantly Kawa (*P. deltoides* × *yunnanensis*), the region's most widely planted clone since the 1980s. Observations revealed highly variable outcomes: some stands experienced near-total loss (up to 82% toppled), while others remained largely unaffected.

Key vulnerability factors included:

- Soil conditions: Poorly drained or saturated soils, shallow rooting due to high water tables, boulders, or pan layers reduced root anchorage strength.
- Exposure and wind direction: Sites exposed to the most damaging south-westerly gusts suffered greater losses, with turbulence effects sometimes causing mid-stand collapse rather than edge failure.
- Clone differences: Kawa showed higher susceptibility than other clones such as Veronese, potentially due to smaller root plates relative to above-ground biomass.
- Age and form: Older, tall, unthinned stands with high height-to-diameter ratios were more prone to windthrow.
- Proximity to waterways: Trees planted too close to drains or eroding streambanks were undermined, with root systems compromised on the water-facing side.

Notably, some mature Kawa stands on well-drained soils and in sheltered positions showed no windthrow, underscoring the role of site-specific conditions. In contrast, other species—such as adjacent radiata pine shelterbelts—were sometimes unaffected, highlighting interspecies differences in wind resilience.

The investigation identified several management implications to improve cyclone resilience without compromising the primary functions of poplar plantings:

1. Site selection: Avoid planting Kawa in poorly drained soils or immediately adjacent to waterbodies; set back 3–5 m from bank edges.
2. Clone diversification: Incorporate clones with demonstrated windthrow resistance into planting programmes, alongside other desirable traits such as rust resistance, possum resistance, and timber quality.
3. Stand design: Prioritise the primary purpose (e.g., erosion control, shelter) over timber production in high-risk sites; where timber is a goal, manage stocking and thinning to reduce height-to-diameter ratios.
4. Root system considerations: Recognise that soil constraints (e.g., boulders, pans) can limit root depth and spread, increasing vulnerability.

Cyclone Gabrielle's impacts on poplar in Northland illustrate the complex interplay between extreme weather, site conditions, and genetic factors. While Kawa remains a proven performer for erosion control in the region, its relative vulnerability to cyclonic winds warrants a more diversified and site-specific approach to clone selection and planting design. Ongoing field trials by the Northland Regional Council will inform future recommendations, ensuring that resilience to windthrow is integrated into breeding, selection, and land management strategies.

These findings are summarised in the following report:
www.nrc.govt.nz/resource-library-summary/publications/land/poplar-windthrow-following-cyclone-gabrielle/

Seed Size and Establishment Method Determine Crop Recovery Following Cyclone-Induced Silt Deposition

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In February 2023, Cyclone Gabrielle caused catastrophic flooding across New Zealand's North Island, depositing thick layers of alluvial silt across productive farmland in Hawke's Bay and Gisborne. These deposits—ranging from a few centimetres to over 60 cm in depth—abruptly replaced fertile topsoil with biologically immature substrates, creating uncertain soil conditions that limited immediate replanting options. The event destroyed several tonnes of vegetable produce and affected nearly 6,000 hectares of farmland, highlighting the urgent need to understand how crops respond to such large-scale disturbances and identify management strategies that enable rapid recovery.

To determine which crops could successfully establish under post-cyclone conditions, we tested the hypothesis that seed size, root morphology, and establishment method are primary determinants of crop performance following deep alluvial deposition. A field trial was established on commercial vegetable land in Hawke's Bay across three representative silt depths: 0 cm (original topsoil exposed as control), 20 cm, and 40 cm of deposited silt overlying the original soil profile. Four vegetable crops were selected to represent contrasting seed sizes and establishment strategies: small-seeded carrot (*Daucus carota*), medium-seeded pea (*Pisum sativum*), large-seeded maize (*Zea mays* L.), and transplanted broccoli (*Brassica oleracea* var. *italica*). This design allowed us to evaluate how seed energy reserves, root vigour, and transplant establishment interacted with the physical and biological constraints imposed by freshly deposited silt.

The trial was planted in November 2023, approximately ten months after the cyclone, following termination of a temporary ryegrass cover crop used to stabilize the soil. Crops were managed according to commercial best practices, with uniform irrigation and fertilization adjusted to soil test recommendations. We measured emergence, total biomass, yield, and harvest index to assess crop performance. Statistical analysis used ordinary least squares regression models with robust standard errors, with treatment effects expressed as percentage change relative to baseline.

Results showed that yield penalties declined systematically with increasing seed size and transplant establishment. Small-seeded carrot was severely affected, with emergence dropping from 89% at 0 cm to just 29% at 40 cm depth, and root yield declining by 68% at the deepest treatment. This poor performance likely reflected carrot's dependence on close seed–soil contact and oxygen-rich conditions for germination—requirements that the compacted, poorly structured silt could not provide. Medium-seeded pea showed moderate sensitivity, with emergence declining to 69% and

total biomass decreasing by 23% at 40 cm. Although peas germinated reasonably well, plants failed to sustain growth, probably due to oxygen-poor conditions that impeded root respiration and nitrogen fixation.

In contrast, large-seeded maize performed well across all treatments, showing no significant change in emergence (averaging 81%), grain yield (approximately 13 t ha^{-1}), or total biomass with increasing silt depth. Field observations confirmed that maize roots penetrated the full 40 cm of silt to access moisture and nutrients from the buried topsoil. Transplanted broccoli also maintained stable marketable yields across all depths and showed a slight numerical advantage at 40 cm, likely due to moisture retention and weed suppression. Transplanting allowed broccoli to bypass vulnerable germination stages entirely, demonstrating the value of this establishment method for early recovery.

When crop responses were integrated statistically through a unified regression model, the analysis explained 86% of total variation (R^2 = 0.86). Predicted yield losses per 10 cm of silt deposition declined sharply along the seed-class gradient: −24.8% for carrot, −15.6% for pea, −6.3% for maize, and +3.0% for transplanted broccoli. Each increase in seed or establishment class improved yield stability by roughly 10 percentage points, providing a quantitative expression of how seed energy reserves and root vigour buffer crops against the constraints of immature substrates.

These findings demonstrate that seed size, root morphology, and establishment method are reliable predictors of crop viability under deep silt deposition. Small-seeded vegetables are unsuitable for direct replanting in heavily buried soils and should be delayed until silt layers are biologically reintegrated or structurally improved. Large-seeded or transplanted species can sustain yields and enable rapid production recovery, making them priority choices for immediate post-flood cropping. As extreme weather events intensify under climate change, these insights provide evidence-based guidance for floodplain restoration and climate-resilient crop selection in disaster-affected agricultural systems.

This work was funded by Strategic Science Fund Investment HB Response – Promoting crop recovery.

Recovery of annual cropping over 2 years

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The Foundation for Arable Research (FAR) funded by MPI and Vegetable Research & Innovation, initiated a project in September 2023 to document and capture growers' recovery experiences from Cyclone Gabrielle, offering insights for future adverse events.

What Was Done:
The project established 46 case study sites across 9 clusters in Hawke's Bay and Gisborne/Tolaga Bay, encompassing diverse locations, crop types, and grower approaches. Sites included varying damage scenarios: silt removed, retained, or undisturbed, and the use or absence of cover crops. Growers implemented a range of recovery strategies:

What Was Learned:
Regional Weather Impact: Recovery success was influenced by post-cyclone weather. Central Hawke's Bay and Heretaunga Plains benefited from favourable growing conditions, leading to successful cropping and normal-to-above-average yields. Conversely, Wairoa, Gisborne, and Tolaga Bay experienced continual rain, hampering access, causing poor growth, increased leaf disease, and challenging harvests.

Sediment Type Significance: The nature of deposited sediment critically influenced outcomes. Silty clay loams generally enabled successful cropping and a return to normal rotations. However, sandy sediments resulted in poorer crops and increased financial risks due to issues like reduced moisture retention. Deep silt layers often restricted root access and nutrient uptake.

Cultivation and Timing Insights: Silt's moisture-retaining properties necessitated longer drying periods and more cultivation passes. Extra deep ripping was commonly required to address floodwater-induced compaction. Ploughing proved effective for aeration. Timely cultivation after sufficient drying reduced the number of passes needed.

Crop-Specific Challenges: While Hawke's Bay saw no increased pest/disease inputs, Gisborne/Tolaga faced Northern Leaf Blight in maize and new weed issues like sedge grass. Volunteer maize was a significant problem, requiring strategic management like false seedbeds. Late planting often led to reduced yields.

Grower Resilience: Growers' existing knowledge, experience, and strong informal networks were vital for successful recovery. The importance of self-care and seeking external assistance was also highlighted.

What It Means: For many, particularly with silty clay loams and favourable weather, a rapid return to productive cropping with normal yields is achievable through intensive, adaptive management. However, areas with sandy deposits or persistent wetness face greater, longer-term challenges and financial risks.

Returning to (some) baseline sampling sites to assess cropping soil recovery

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When Cyclone Gabrielle struck New Zealand in February 2023, agricultural land in Hawke's Bay, Wairoa and Gisborne was inundated with sediment. A key challenge was understanding how to manage this sediment to return highly productive cropping and orcharding soils back to full production.

Previous studies, including those after the 2004 Southern North Island Storm, provide sediment management guidance but focused primarily on pastoral recovery. Information for high-value cropping and orcharding soils is sparse.

Baseline samples were collected thirty to ninety days after the event from 155 sites across 110 locations, representing different catchments, sediment types, and farm enterprises. Sediment depth, texture, fertility, structure, and earthworm abundance were assessed, growers' actions recorded, and contamination samples collected from ten sites.

Some of the baseline sites were revisited to assess recovery progress. In spring 2023, ten Hawke's Bay sites were resampled to assess winter changes in sediment and soil properties. These sites were paired by location and sediment characteristics but managed differently over winter. These ten sites plus six additional ones were resampled in autumn 2024, collecting both soil and crop-harvest measurements. Over two years, sixteen sites were sampled multiple times to track recovery.

Results demonstrate that land and growers are resilient, with most impacted areas returning to similar productivity within a short timeframe. Establishing annual ryegrass as soon as possible consistently enhanced recovery and accessibility. Light grazing does not damage structureless sediment and may help by incorporating organic matter and breaking up surface capping. Once conditions allow, successful crops can be established and good production achieved.

These findings align with earlier studies from 1938, 1948, 1988 and 2004, supporting expectations of similar recovery following the 2025 flood events impacting Nelson and Tasman growers.

Ideally, all 155 sites would be revisited to collect comprehensive information on soil recovery and grower experiences. Since Cyclone Gabrielle will not be the last such event, understanding optimal management responses is crucial for supporting future impacted communities.

This collaborative work involved LandWISE, Massey University, BSI - AgResearch, BSI - Plant & Food, and Gisborne District Council, with support from Ministry for Primary Industries and the Vegetable Research and Innovation Board.

Report:
Cyclone Gabrielle Cropping-Soil Recovery - Hawke's Bay Repeat Sampling: Final Report
https://www.landwise.org.nz/mp-files/2025-cyclone-gabrielle-hawkes-bay-sampling-final-report.pdf/

Part 6: Policy

Cyclone Gabrielle – Informing future planning frameworks

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Part 7: Perspectives and reflections from on the ground

Recovery of annual cropping ground – Grower learnings

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In February 2023, Cyclone Gabrielle caused catastrophic flooding across Hawke's Bay, Wairoa, and Gisborne, inundating extensive areas of annual cropping land. The Foundation for Arable Research (FAR), in collaboration with MPI's North Island Weather Event Fund, Vegetables Research & Innovation, and the Hawke's Bay Regional Council, initiated a multi-year programme to document recovery processes, quantify soil and crop responses, and capture the lived experiences and lessons of affected growers.

What Was Done

The project followed 34 flood-affected sites across Central Hawke's Bay, the Heretaunga Plains, and Wairoa over two cropping seasons. These sites represented a full range of arable and vegetable production systems including onions, maize, sweetcorn, peas, tomatoes, brassicas, and seed crops.

By 2024–25, Five onion case studies on the Heretaunga Plains tested productivity on previously inundated silt-mixed soils, while a maize trial at Eskdale evaluated compost amendments on a site where half the silt had been removed. In Wairoa where planting was not possible in the 2023-24 season, three farms with deep silt layers and two with mixed deposits demonstrated the challenges of extended remediation under limited access and resources.

In parallel, structured interviews captured farmer perspectives on soil recovery, business adaptation, and mental resilience. These included smaller single-operator enterprises and larger multi-crop businesses. Following on from this a Disaster Response Decisions framework was developed which summarised the two years of learnings and provided staged recommendations for "looking after yourself, your business, and your land."

What Was Learned

Soils and crops recovered faster than expected.

By the second harvest after the cyclone, most silt-affected soils were described as "working better than before." Where silty clays had been incorporated, residual clay lumps were visible but did not hinder productivity. Sites where sand dominated showed greater variability and required higher nutrient inputs, but production had largely normalised. In Wairoa, deeply buried soils (up to 700 mm silt) remained slow to recover and required repeated N, P and K applications plus organic matter rebuilding through grazing or green manure.

Crop yields across all crop types matched or exceeded pre-cyclone levels.
Onions - a high-risk, high-input crop - performed exceptionally well in year two, with yields of 70-86 t/ha considered average to above average. Dryland maize silage and grain crops produced comparable yields to pre-event seasons, and in some cases, higher. No additional pest or disease pressures emerged, confirming the resilience of these soils once physically re-worked and nutritionally balanced.

Silt removal was rarely beneficial.
Evidence from Eskdale showed no yield advantage from removing silt, and compost applications had no measurable effect. Removal created compaction risks and high costs, while working the silt in proved equally or more effective. Farmers concluded: "work with what you've got."

Patience was essential.
Growers repeatedly emphasised the importance of waiting for soils to dry before cultivation. Those who delayed avoided machinery damage, compaction, and wasted effort. This lesson - "there was no disadvantage to taking time" - became a cornerstone of recovery advice.

Resilience was tested but strengthened.
Two years on, most growers reported that soils were "as good as before, or better," but the mental and financial toll remained high. Smaller operators faced disproportionate strain, with some questioning the viability of continuing. Larger, diversified enterprises weathered the recovery more but became more risk-averse - avoiding high-value perennial plantings in flood-prone zones and reassessing asset protection and insurance. Across all businesses, community support and peer networks were cited as the most valuable form of help: "Take all the help that is offered."

Institutional and regulatory pressures compounded stress.
Growers expressed frustration at overlapping demands - recovering land while facing changing water and land-use regulations. Many felt excluded from consultation processes and unsupported in representing their interests. These systemic pressures highlight the need for coordinated post-disaster governance that aligns recovery with long-term resilience planning.

What It Means
The collective findings challenge early pessimism about the agricultural viability of silt-affected land. Physical recovery of cropping soils was quicker and more complete than feared, provided that growers exercised patience, avoided unnecessary disturbance, and maintained organic matter and nutrient balance. The resilience of New Zealand's alluvial cropping systems reflects both inherent soil properties and the practical ingenuity of growers responding to crisis.

However, financial resilience is far more fragile. The cyclone's losses were largely absorbed within farm businesses, with limited external compensation. None of the interviewed growers believed they could withstand another comparable event in the near

future. This underlines the urgency for integrated regional strategies that combine flood-risk mitigation, land-use planning, and mental-health support.

At a practical level, key recommendations emerging from this work include:

1. Treat deposited silt as a resource, not waste - incorporate rather than remove.
2. Delay cultivation until soils are trafficable.
3. Use quick-return crops to restore cash flow and confidence.
4. Build soil organic matter through cover crops and grazing.
5. Strengthen grower-to-grower networks as critical recovery infrastructure.

Technical and extension learnings from Cyclone Gabrielle

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Cyclone Gabrielle was a significant weather event that affected the East Coast of New Zealand, including the apple producing areas of Gisborne and Hawke's Bay, in February 2023. Rainfall and surface flooding had a disastrous effect on the apple sector, with a range of impacts including total tree loss, silt deposits up to a metre deep, and severe packhouse flooding in the most severely affected areas. In Hawke's Bay around 2500 hectares of production land and 40% of the harvest was affected, and a further 30% (155 ha) in Tairāwhiti-Gisborne.

Immediately following the cyclone, New Zealand Apples and Pears Incorporated (NZAPI) staff began response and support activity, made exceptionally difficult in the short-term by loss of power and communications, inability to travel and personal impacts on staff. In the weeks following the cyclone, response activity became more coordinated, with NZAPI acting as a key collector and distributor of information for apple growers and the wider horticultural sector. Advice and recommendations were sought from consultants, retailers, the research community, councils and the New Zealand Ministry for Primary Industries (MPI), and collated and disseminated to growers in a range of formats to support orchard recovery. Technical topics included harvest support and food safety guidelines, silt management and removal, pest and disease control, and tree/crop management. Broader aspects included waste removal, mental health referral, and funding guidance.

This support activity continued throughout 2023 and into 2024. The extent of Cyclone Gabrielle's impact on growers and their orchard operations was compounded by timing, just after the start of 'Royal Gala' harvest, which challenged almost every aspect of the harvesting and export programme in 2023. To maximise learning opportunities from this event and be better prepared for future events, NZAPI commissioned Plant and Food Research to provide a review which broadly summarised and referenced the material that was provided to growers, explored how advice was implemented and how useful it was, and provided a knowledge-bank and insights to inform the industry response to future challenges.

A summary of the lessons learnt include:
Communication lessons learnt:

- Information needs to be shared through various sources (i.e. written, via consultants, website, text), and a clear communication strategy should be implemented
- Start immediately, be trustworthy and consistent, be brief and practical, be relevant and provide local perspectives, and reiterate the basics.

- Growers showed a preference for 'pushed' formats of information, such as email, social media, text and calls, as time and energy to seek information was limited in the chaos following the crisis.

Technical lessons learnt

- Following a crisis where food is potentially contaminated, a thorough risk assessment must be conducted with urgency, to inform the best course of action to ensure food safety. In the case of Cyclone Gabrielle, growers were directed not to harvest any fruit that had potentially touched floodwater, until the presence and nature of possible contamination was established, and appropriate measures could be communicated.
- Various statements made immediately following Cyclone Gabrielle suggested that apple trees could die if exposed to waterlogging for as few as three days and up to 14 days. It transpired that these estimates were unduly pessimistic. Extended waterlogging that followed the cyclone found that apple trees on the Heretaunga Plains were more resilient to waterlogging and silt deposition than expected.
- Effective silt management decisions will require expert analysis and guidance. Key learnings were that there was no immediate urgency to remove silt, and there is a significant economic consideration before works should be completed. Practical assessments such as soil profile assessments to assess for waterlogging, and understanding silt composition will make a difference to the speed at which silt removal needs to take place.

Report:

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