

Quantifying Climate Variability: Practical Risk and Adaptation Insights for Rural Finance

This research offers valuable risk intelligence for rural bankers, lending managers, and finance and insurance professionals managing dairy sector portfolios operating under increasing climate variability.

Our new, robust method measures location-specific risk exposure — something traditional methods often overlook. It enhances the ability to manage rural lending risks and strengthens financial resilience for farmers.

Key insights

- Farms are being affected by increased climate variability. This variability is expected to continue to increase, further threatening farmers' ability to meet debt obligations.
- The model uses millions of simulations over ten-year timeframes to assess the likelihood and severity of adverse events like consecutive dry seasons, supporting comprehensive stress-testing of financial decisions.
- By integrating climate data, pasture growth and financial models, our approach helps lenders evaluate the financial effects of adaptations such as irrigation storage and stocking rate adjustments.
- Water allocation policies have the potential to mitigate or exacerbate financial risks. Our research can provide critical regional exposure insights.
- Analysis of locations just 20 km apart revealed significant risk differences, underlining the importance of localised assessments.
- The modelling enables the development of early warning signals, actionable triggers, and decision frameworks to prevent over- or under-preparation for climate shocks.
- The method developed through this research offers a new level of foresight to guide informed, strategic decisions in a changing climate.



Who is this research brief for?

- Rural finance professionals
- Insurance professionals
- Large agribusinesses



Research team

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Research info

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How can this research be used?

Climate change is making the world more volatile. Farmers now face multiple compounding variabilities (weather, interest rates, market price, yield) that will interact and make 'normal' years much less likely. This is likely to have a cumulative impact on farmers' capacity to adapt and their financial resilience.

Our five-year research programme developed a modelling framework that can identify significant risks and adaptive capacity limits (see 'Resilience: The three capacities' box) much sooner and more precisely than previously possible.

This approach allows us to quantify the likelihood of consecutive adverse weather events and increased climate variability over the next ten years, and their financial impacts on farms.

Our integrated modelling approach includes all relevant system variables. By applying a range of stress factors such as increased insurance costs, higher interest rates, lower commodity prices and reduced irrigation water availability, our model explores cumulative farm financial risks in a more volatile world.

This provides new insights for rural financing decisions, at a range of scales and in the timeframes needed for effective risk analysis and management.

Banks can use this approach to analyse risk for specific regions, districts, or a portfolio of farms. The results can help finance professionals assess different lending scenarios, understand risk exposure, adjust loan terms, and manage capital more effectively. Early warning signals and decision triggers can be set based on global warming increments and debt levels, so that farming clients can be supported to manage risks and adapt to our changing climate.

Our research results reflect the highly location-specific impacts of climate variability and water supply reliability across New Zealand. For example, our North Canterbury case study revealed that for irrigated dairy farms, water allocation policy (whether adaptive or restrictive) can significantly shift solvency risk. Lenders and insurers can use this insight to factor policy changes into their risk assessments and encourage clients to engage with regional planning processes.

Our location-specific methodology could be applied in any of New Zealand's diverse farming regions. By enabling more accurate assessment of climate risk, the approach can improve farmers' financial resilience to increasing local climate variability and global economic volatility, and reduce institutional exposure to risk.

Resilience: The three capacities



Absorptive Capacity

The ability of a system (such as a farm, business, or community) to **absorb** external shocks or stresses (such as climate variability or financial disruptions) while maintaining its structure and functions. This represents the system's capacity to "buffer" stresses without significant change.



Adaptive Capacity

The capability of a system to **adjust to** climate-related risks and changes, minimising adverse effects or taking advantage of new opportunities without major changes in function. Practices, processes, or structures may be modified to cope with changing conditions or reduce vulnerability.



Transformational Capacity

The potential of a system to **fundamentally change** its structure, function, or operating model in response to severe or persistent risks (such as those from climate change or market shifts). This may include transitioning to new production systems, markets, or institutional arrangements.

Why is this research needed?

Current climate risk assessment and adaptation planning primarily focuses on extreme weather events and changes in average temperature and rainfall, projected over time horizons as distant as 2100.

While New Zealand has support mechanisms for farmers affected by severe weather emergencies, we are unprepared for the ongoing challenge of increasing climate variability and consecutive climate shock events.

Increasing climate variability is affecting farmers now and has much greater consequences than changes in average climate conditions.

On top of this, the probability of consecutive adverse weather and climate sequences is also changing, with severe droughts and wet periods becoming more likely and frequent, meaning there is less time between events to recover and rebuild resilience.

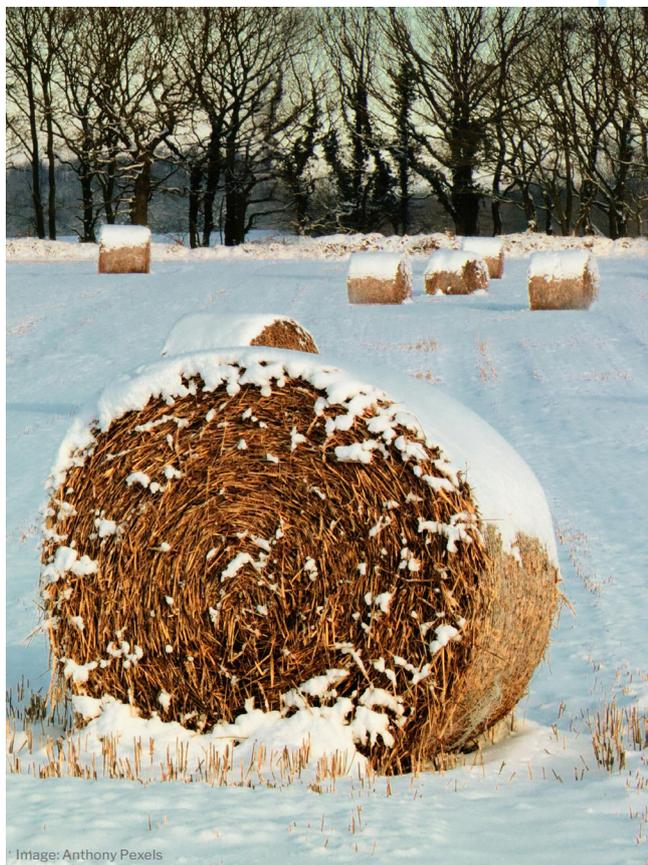
For example, a second drought event in three years will have higher impact than the first. If commodity prices are depressed or if interest rates have increased during the second drought, the cumulative impact will be even greater.

Currently, climate change risk assessments are based on the consequences of a given event, but don't consider the plausibility of that event occurring. This research enables more robust risk assessments that factor in both consequences and probability so that plausible scenarios can be defined.

Our research is the first to quantify the probability and consequences of complex climate event sequences at decision-relevant timeframes and scales.

Climate variability vs average climate

Climate change is often talked about in long-term averages, which gives the impression of a slow increase in temperature over time. However, climate change is actually experienced day-to-day as an increasingly variable climate. An average 22°C summer may once have reflected days ranging from 18–26°C. Today, an average 22°C summer may include days from 14–30°C.



Climate shocks and scares

Climate shock events, like an autumn drought or cold spring, can typically be recovered from in a period of 6–12 months with current farm management. Most farms are resilient to one climate shock, but events in fairly close succession can hurt a farming business.

Scare combinations are defined as three climate shock events in one year, followed by similar the following year. Scare combinations make recovery very difficult.

Our research found that flow-on effects and external pressures mean the third year following a scare combination is likely to trigger farmers to make transformational adaptation decisions, such as increasing on-farm water storage or adding storage for supplementary feed (see 'Resilience: The three capacities' box).

What did we do?

We first identified weather events and climate sequences that impact farms and explored recovery time following an adverse event, with participants from 10 farming businesses.

Working with farming consultants, practitioners and DairyNZ science and economics specialists, we then identified the key variables and connected systems that influence dairy farm vulnerability to climate shocks. We developed models of these connected systems (Figure 1).

For our North Canterbury case study, the connected systems were pasture production, river flow and ecological health, water allocation policy, and feed supplement prices. Key external variables included interest rates and milk payout rates. Debt levels were set as initial conditions derived from national statistics.

The climate scientists in our research team then ran 295 million simulations of 10-year weather and climate data sequences for two irrigated farm sites in Eyrewell in the Waimakariri District, Canterbury. The climate sequences were derived from regional climate models for the current climate (2015–25) but could be generated for future years or climate scenarios.

Next, we applied the climate time series datasets to a simple hydrology model that predicted irrigation supply

availability and the hydrological determinants of stream ecology health, with and without irrigation water takes.

The irrigation reliability and climate time series datasets were then applied to the pasture growth model, and the pasture growth model results then applied to the farm system model (Dumont et al, 2025a). The farm systems model accounts for the decisions and actions farmers take in response to climate variability – the ‘absorptive capacity’ of the farm (see ‘Resilience: The three capacities’ box).

We translated the farm system model results into an economic health score to identify where the absorptive capacity of a farm is exceeded and the degree to which it is exceeded, relating to differing levels of solvency risk.

We assessed the costs and benefits of two adaptation strategies at two interest rates: a high-cost irreversible investment in irrigation storage, and a low-cost reversible change to stocking rates under variable financial conditions (Dumont et al, 2025b).

Building on this work, we finally developed a method to assess climate risks and explore adaptation options within five-to-ten-year timeframes that are relevant to lending decisions (Etheridge et al, 2025).

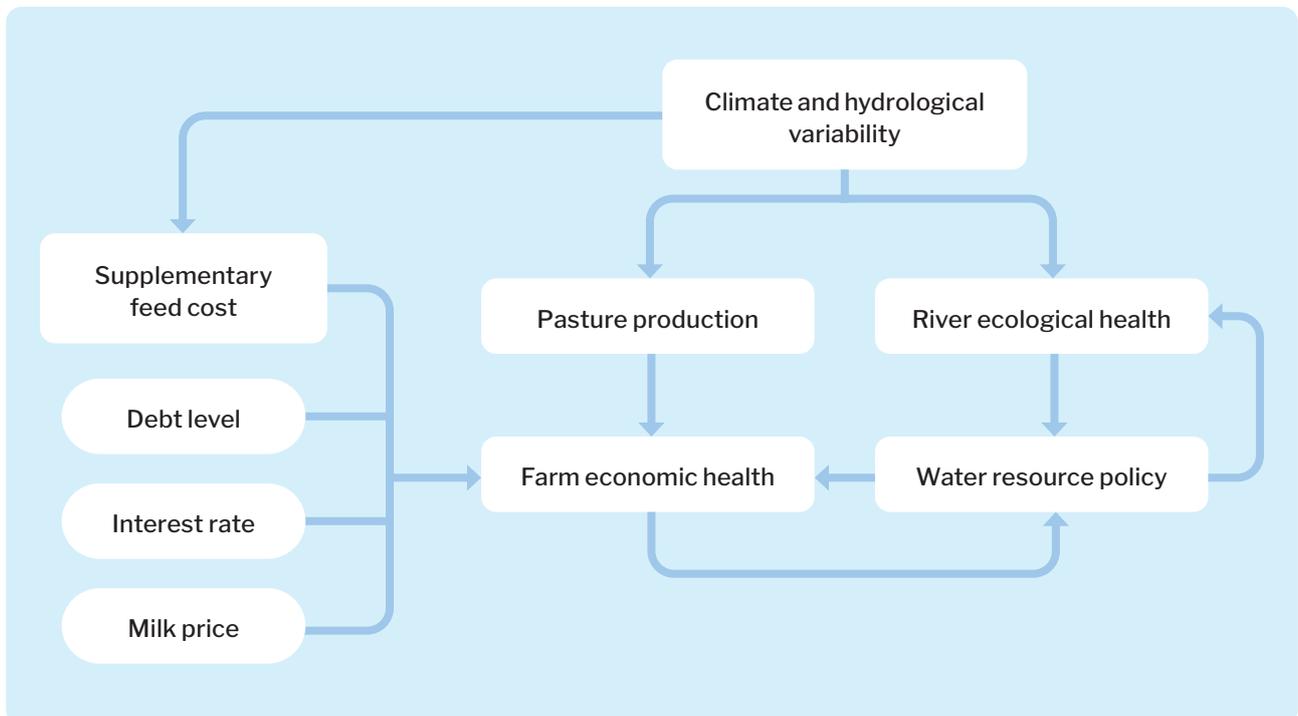


Figure 1: Causal diagram

What did we find?

Climate change is already having an impact on New Zealand dairy farms — but we have not inhabited the current climate for long enough to understand our current exposure to climate variability risk. We need to use models to understand these risks.

The model outputs described below show the distribution of farmland area across financial risk categories under defined interest rate and payout scenarios. The risk category is based on the probability of missing debt servicing payments and running an operating loss over the 10-year simulation.

Location-specific, scenario-based analysis is needed

The effects of climate variability are location specific. We found significantly different risks at our two case study sites, which are just 20 km apart. One-size-fits-all approaches are unlikely to be successful, and therefore bespoke risk assessment and adaptation planning are needed.

Research has shown that climate change is likely to drive increased interest rate and price volatility. This underlines the importance of scenario-based assessment of climate variability exposure under a range of external stresses. Our models were fast enough to explore external system stresses over 295 million climate simulations within practical time and cost constraints.

In the 'status quo' example (*Figure 2*) the adsorptive capacity of farms is generally sufficient to mitigate financial risk at 6.3% interest and \$9.00/kg milk solids payout. Risk exposure to near-term climate variability increases significantly under higher interest rate and lower payout scenarios, as expected.

Note: The study was undertaken using lower farm costs and milk payouts so should not be directly compared to the current (September 2025) milk solids payout.

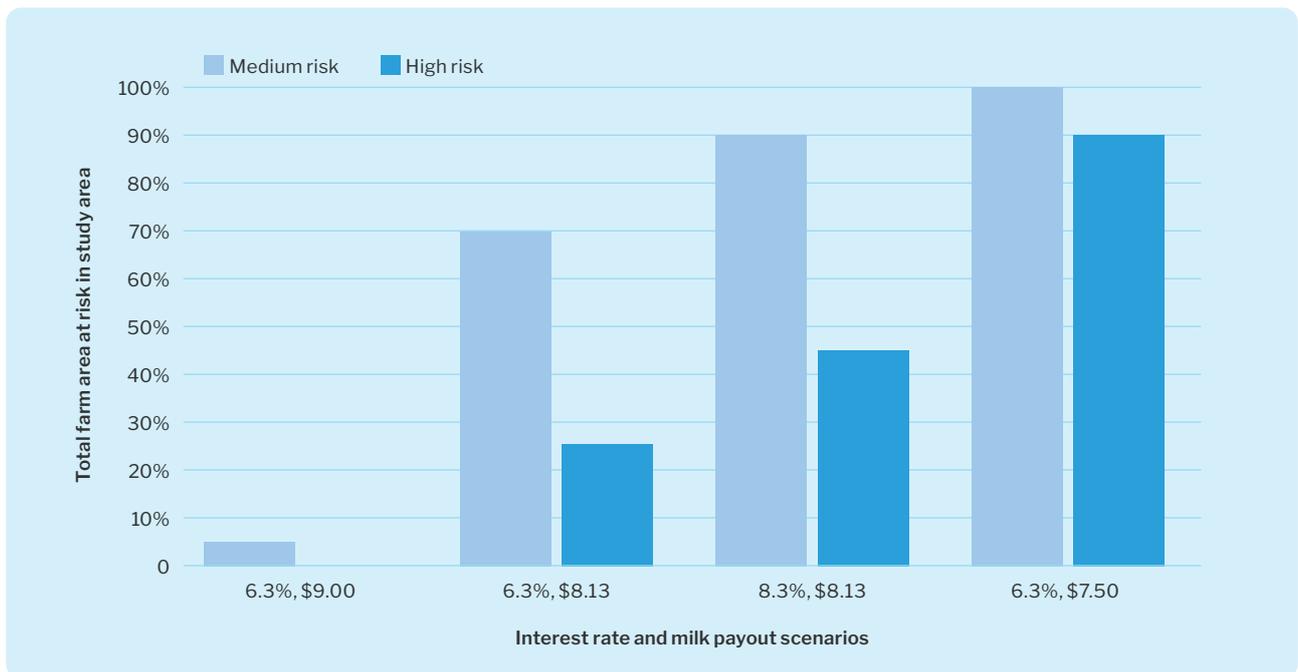


Figure 2: Farm exposure to variability climate risk — status quo



Risk profile changes with on-farm adaptations

The impact of climate change is likely to be greater on farms in regions with less reliable irrigation sources, on dryland systems, and on farms being managed at their physical limits.

We assessed the costs and benefits of two on-farm adaptation strategies at two interest rates and payouts: investment in irrigation water storage and reducing stocking rates. Figure 3 and Figure 4 show how the risk profile changes with these adaptations.

On-farm irrigation storage can reduce climate risk exposure where irrigation supply reliability is constrained (Figure 3), but this depends on stocking rate, feed storage capacity and debt levels. Some scenarios show an increase in risk with on-farm storage investment, due to the increased debt burden. Investment in on-farm storage can therefore be either adaptive or maladaptive, depending on the circumstances.

Reducing stocking rates reduced climate risk exposure significantly for our case study sites (Figure 4), with average profit increasing despite lower profit peaks. We assumed the farms' pasture management system could accommodate this. The low irrigation reliability for our case study sites was a key factor in the scale of the risk reduction. Dryland pasture systems may see a similar pattern because lower stocking rates reduce exposure to pasture production variability.

Our industry workshop revealed that farmers are much more likely to adapt in response to experience rather than predictions. Transformational adaptation, such as farm system change, is likely to be resisted until crisis points are reached. The trigger for farm system change requires a very high probability (30–70%) of a high-impact climate shock event sequence. Outreach programmes to communicate climate risks may be required to promote a proactive approach to risk management.

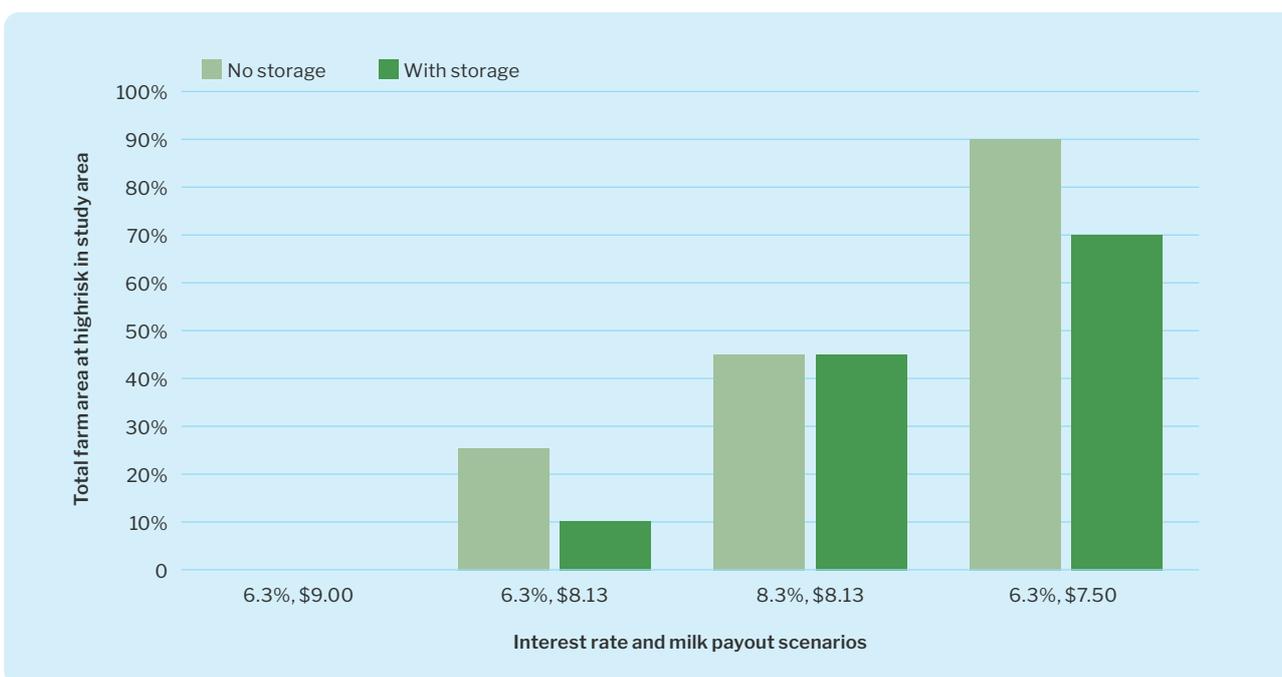


Figure 3: Farm exposure to high climate variability risk – with and without irrigation storage

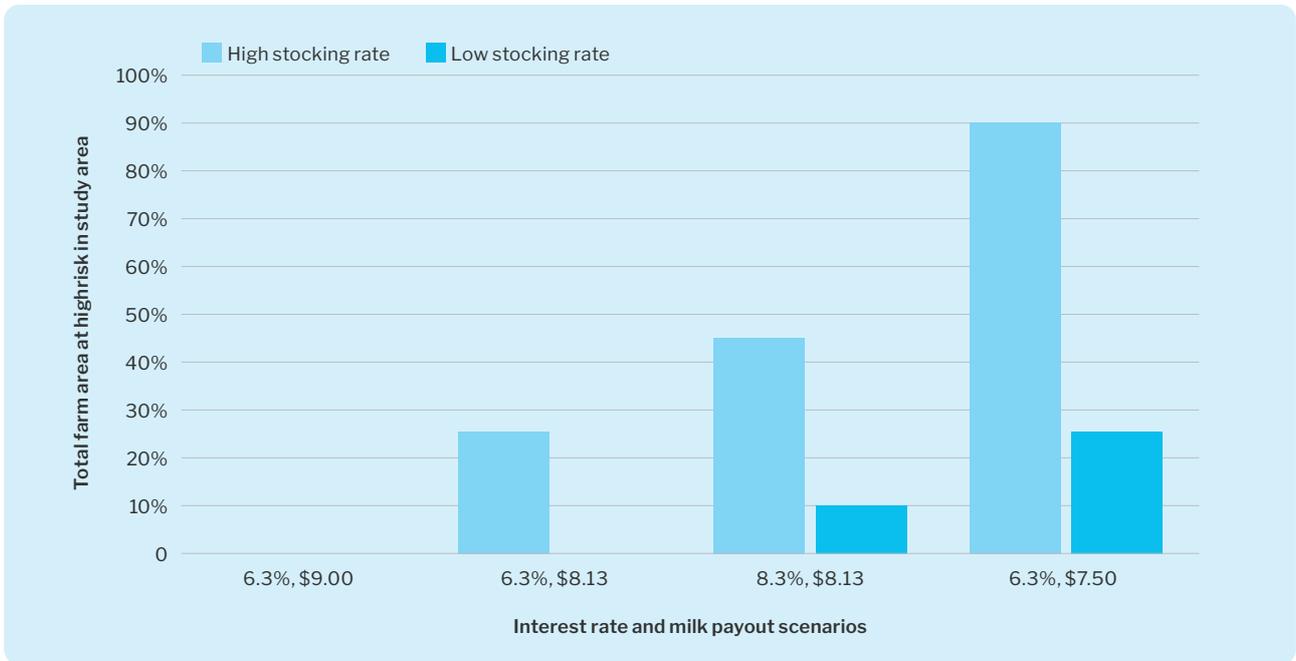


Figure 4: Farm exposure to high climate variability risk – with and without reduced stocking density

Regional water allocation policy is connected to solvency risk

Water allocation regimes could become more adaptive and supportive or restrictive in response to climate change, and can either strengthen farm resilience or amplify financial stress.

Adaptive water allocation policy makes more water available during periods of severe pasture growth stress. This can improve farm resilience but impact stream health. Stream ecosystem health may also

decline due to near-term climate change. Reduced irrigation water availability is a possible response to declining stream health, and could increase farm financial risk significantly.

Figure 5 plots financial risk under a \$8.13/kg milk solids payout and 6.3% interest rate scenario for the status quo water allocation policy; supportive policy with more irrigation water available in years with severe pasture growth deficit; and more restrictive policy to protect stream ecosystems. Risk from near-term climate variability varies significantly.

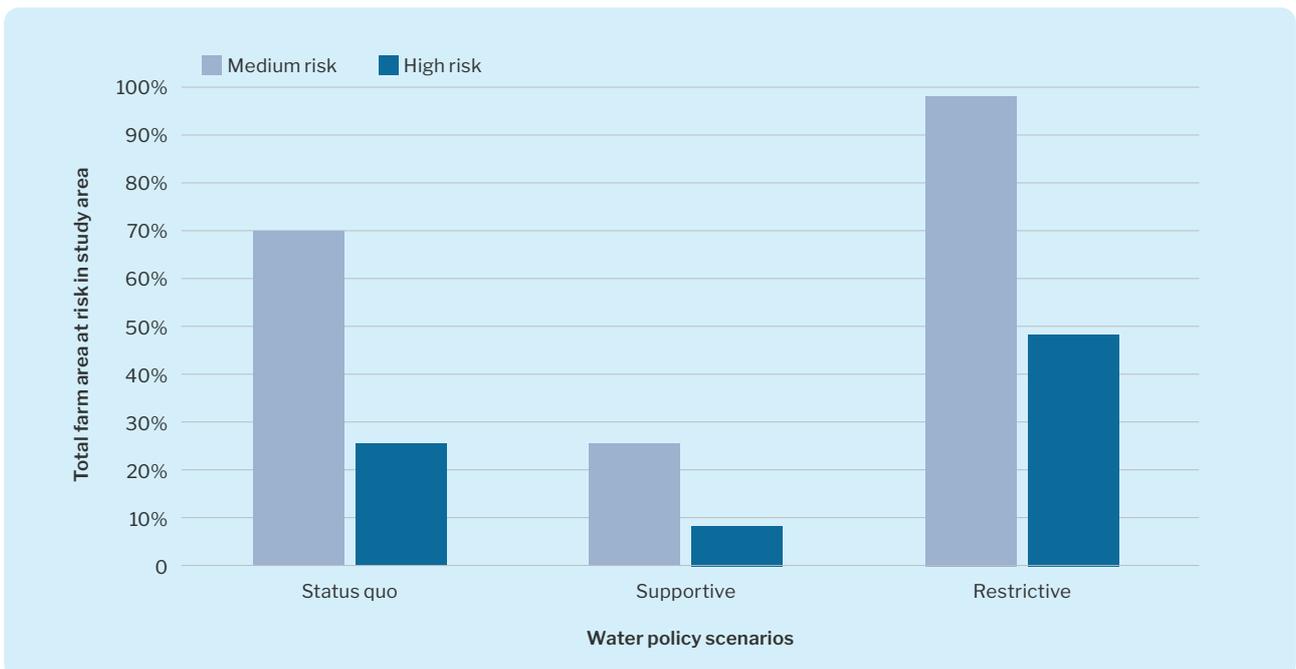


Figure 5: Farm exposure to high climate variability risk – with supportive and restrictive water allocation policy

We turn climate uncertainty into insights

Our cutting-edge climate variability risk assessment methodology delivers precise, location-specific risk intelligence, so you can make smart finance decisions and grow financial resilience for your rural clients. You can use our modelling insights to:

- Enhance risk assessments by quantifying exposure to climate variability impacts
- Identify rural lending finance before they become problems
- Offer unique climate-informed lending arrangements
- Support farmers with location-specific adaptation advice

Our climate risk and adaptation analysis service delivers actionable intelligence at the scale and timeframes that matter, whether you're assessing national exposure, regional or district portfolios, or specific catchment risks.



Contact us now to discuss how we can strengthen your rural lending strategy.

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Key publications

Matt Dumont, Zeb Etheridge, Andrew Curtis, Pierre Beukes, Alex Schuddeboom. (2025a.) Current climate variability of pastoral yield: a case study in Canterbury, New Zealand. *Climatic Change* 178:98. <https://doi.org/10.1007/s10584-025-03946-z>

Matt Dumont, Zeb Etheridge, Andrew Curtis, et al. (2025b). The Current Impacts of Climate Change on Farm Systems and Preventing Maladaptation, A Case Study of the Waimakariri Zone, New Zealand. *In submission, pre-print available on request.*

Zeb Etheridge and Matt Dumont. (2025.) Navigating Climate Variability Risks: an Adaptation Decision Support Method for Land and Water Management. *In progress, abstract, method and results available on request.*

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