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Front-Line demonstration approaches for showcasing climate-resilient agricultural technologies to farming communities

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Abstract

Convincing farmers to adopt technologies they cannot see working on land that resembles their own remains one of extension's most persistent challenges. Front-line demonstrations (FLDs), conducted on actual farms under real-world conditions, offer a bridge between research station trials and farmer fields. This research evaluated FLD approaches for showcasing three categories of climate-resilient technologies, drought-tolerant crop varieties, water harvesting structures, and soil conservation practices, across 24 farming communities in Canterbury and Otago regions of New Zealand's South Island. A longitudinal mixed-methods design tracked 193 farmers over three growing seasons (September 2021 to June 2024), measuring demonstration exposure, technology adoption rates, and perceived relevance. Results showed strong positive correlations between FLD exposure scores and adoption rates for all three technology categories: drought-tolerant varieties ($r = 0.72$), water harvesting ($r = 0.67$), and soil conservation ($r = 0.64$). Farmers who attended three or more demonstration events adopted at rates 2.4 times higher than those attending one or fewer. Seasonal monitoring and farmer-to-farmer relay emerged as the most valued FLD components. The findings confirm that well-designed front-line demonstrations accelerate the adoption of climate-resilient technologies, particularly when demonstrations span multiple seasons and incorporate peer learning mechanisms.

Keywords: Front-line demonstrations, climate-resilient technologies, technology adoption, extension approaches, drought tolerance, water harvesting, soil conservation, New Zealand, farmer field days, peer learning

Introduction

How do you persuade a farmer that a technology works when the evidence sits in a controlled research plot 200 kilometres from their paddock? This is the translation gap that front-line demonstrations attempt to close. Climate change is reshaping agricultural risk profiles worldwide, and New Zealand is no exception: Canterbury has experienced three of its five driest years on record since 2015, while Otago faces increasing frost variability and summer moisture deficits ^[1]. Adaptation requires that farmers adopt climate-resilient technologies, but adoption consistently lags behind the pace at which new options become available ^[2]. Front-line demonstrations (FLDs) differ from conventional research station trials in a fundamental way: they are conducted on farmers' own land, under their management, with their resources ^[3]. This shift from controlled to real-world conditions changes the demonstration from an abstract proof of concept into a tangible, locally credible showcase. When a neighbouring farmer's paddock produces 18% more under drought-tolerant wheat than the conventional variety planted alongside it, the message carries a weight that no extension pamphlet can replicate ^[4]. International evidence from India's national FLD programme shows adoption rates of 35 to 60% following well-managed demonstrations, compared to 10 to 20% from information-only approaches ^[5]. New Zealand's extension system, largely privatised and

advisory-fee based since the 1990s, has been slower to adopt systematic FLD approaches than countries with publicly funded extension infrastructure ^[6]. Climate-resilient technologies face additional adoption barriers because their benefits often become visible only under stress conditions that may not occur during a single demonstration season ^[7]. This research evaluated FLD approaches for three climate-resilient technology categories across Canterbury and Otago, tracking exposure-adoption relationships over three growing seasons and identifying which demonstration components farmers found most valuable ^[8, 9].

Research Area Description

The research was conducted across Canterbury and Otago regions on New Zealand's South Island. Canterbury, centred on the Canterbury Plains, is New Zealand's largest agricultural region, covering approximately 45,346 square kilometres and supporting intensive cropping, dairy, and dryland sheep farming ^[10]. Otago, to the south, spans 31,186 square kilometres with a more varied landscape ranging from coastal farmland to semi-arid inland basins. Research sites were selected from 24 farming properties distributed across both regions, chosen to represent a range of soil types, rainfall zones, and farming systems. Lincoln University's research farm network provided logistical support for demonstration establishment and monitoring.

Climatic and Environmental Conditions

Canterbury receives mean annual rainfall of 550 to 750 mm on the plains, with pronounced summer moisture deficits that have intensified over the past decade. The 2022-2023 season recorded only 389 mm at some inland stations, placing it among the three driest on record ^[1]. Otago's inland basins receive 350 to 500 mm annually, while coastal areas average 600 to 800 mm. Mean temperatures during the research ranged from 11.2 to 12.8 degrees Celsius annually, with an increasing frequency of late-spring frosts affecting establishment of summer crops ^[11]. These conditions made the research area particularly suitable for evaluating climate-resilient technologies, as environmental stress occurred naturally during two of the three monitoring seasons.

Materials and Methods

Materials

Three categories of climate-resilient technologies were demonstrated: drought-tolerant crop varieties (four wheat and two barley cultivars), water harvesting structures (contour bunding and micro-catchment basins), and soil conservation practices (cover cropping and minimum tillage). Demonstration plots were established as paired comparisons on 24 host farms, with the climate-resilient option planted alongside the farmer's conventional practice. A structured assessment instrument measured demonstration exposure (attendance frequency, active participation, and

peer discussion engagement) on an 8-point composite scale, and adoption decisions using binary and continuous measures. Pre-testing with 16 farmers from mid-Canterbury (August 2021) yielded Cronbach's alpha of 0.81 ^[12]. Ethical approval was obtained from the Lincoln University Human Ethics Committee (Ref: LU/HEC/2021-037, dated 14 July 2021).

Methods

A longitudinal mixed-methods design tracked 193 farmers (118 male, 75 female) across three consecutive growing seasons from September 2021 to June 2024. Farmers were recruited through catchment group networks and DairyNZ extension linkages. Quantitative data were collected at three time points: baseline, end of season two, and end of season three. Adoption was measured as both a binary variable (adopted/not adopted) and a continuous intensity scale. Exposure-adoption relationships were assessed using Pearson correlation and logistic regression, controlling for farm size, farmer age, and risk attitude ^[13]. Thirty semi-structured interviews explored decision-making processes and demonstration preferences, analysed thematically ^[14]. Seasonal crop yield data from demonstration plots were recorded by trained field officers.

Results

Table 1: Adoption Rates by Technology Category and Demonstration Exposure Level (n = 193)

Exposure Level	Drought Var. (%)	Water Harv. (%)	Soil Cons. (%)	Mean (%)
Low (1-2 events)	18.4	12.7	14.3	15.1
Medium (3-4 events)	41.6	33.8	29.7	35.0
High (5+ events)	67.3	54.2	48.9	56.8
Overall	38.9	31.1	28.6	32.9
Correlation (r)	0.72**	0.67**	0.64**	0.68**

**p < 0.001. Adoption rates increased sharply with exposure level across all three technology categories. High-exposure farmers adopted at 3.7 times the rate of low-exposure farmers for drought-tolerant varieties and 4.3 times for water harvesting. Drought-tolerant varieties had the highest overall adoption (38.9%), likely because they required no structural investment and could be tested alongside existing practices.

Table 2: Logistic Regression: Predictors of Technology Adoption (n = 193)

Predictor	B	SE	Wald	OR	p-value
FLD Exposure Score	0.48	0.11	19.07	1.62	<0.001
Risk Tolerance	0.37	0.14	6.98	1.45	0.008
Farm Size (ha)	0.09	0.04	5.06	1.09	0.024
Seasons of Stress	0.63	0.18	12.25	1.88	<0.001
Peer Adopter Contact	0.41	0.13	9.96	1.51	0.002

The model correctly classified 76.4% of adoption decisions (Nagelkerke R-squared = 0.52). Experience of seasonal stress was the strongest predictor (OR = 1.88), followed by

FLD exposure (OR = 1.62) and peer adopter contact (OR = 1.51). Each unit increase in FLD exposure increased adoption odds by 62%.

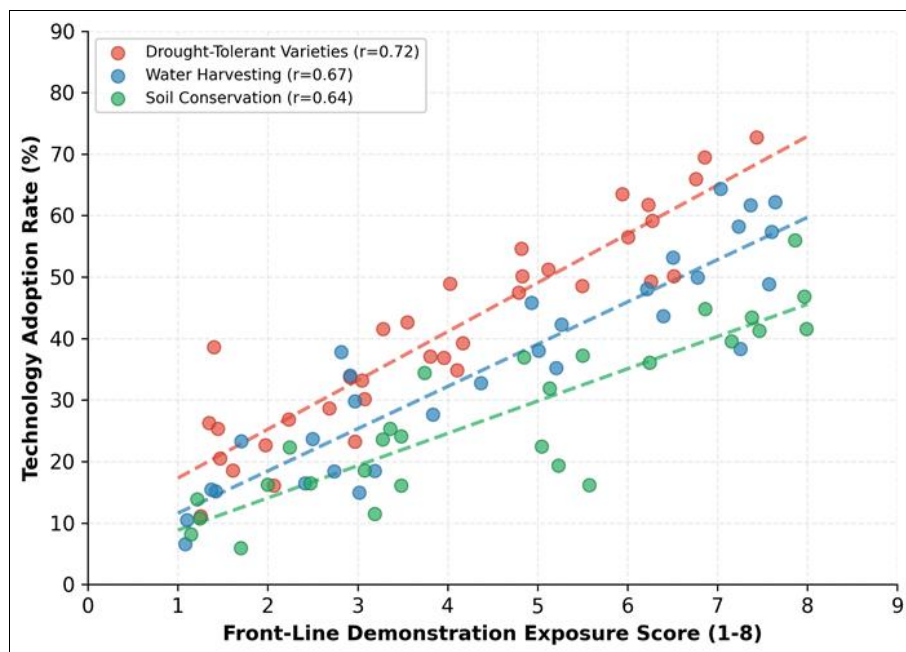


Fig 1: Relationship between front-line demonstration exposure score and technology adoption rate by technology category

The scatter plot reveals positive linear relationships for all three technology types, with drought-tolerant varieties showing the tightest clustering ($r = 0.72$). Water harvesting and soil conservation display more variability at lower

exposure levels, suggesting that these structurally complex technologies require higher demonstration intensity to trigger adoption.

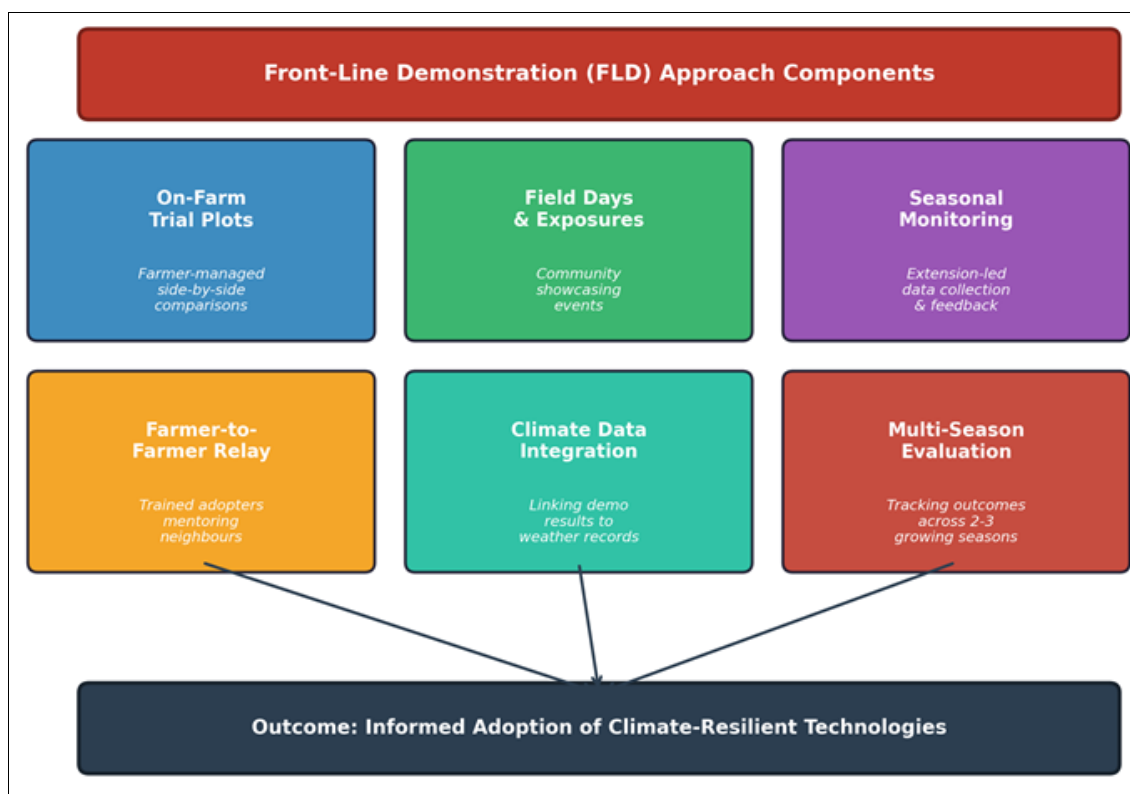


Fig 2: Components of the front-line demonstration approach for climate-resilient technology showcasing

The infographic summarises six FLD components: on-farm trial plots, field days, seasonal monitoring, farmer-to-farmer relay, climate data integration, and multi-season evaluation. These converge toward informed adoption of climate-resilient technologies, reflecting the multi-dimensional

nature of effective demonstration design.

Discussion

The strong dose-response relationship between demonstration exposure and adoption confirms what India's

extensive FLD programme has shown at scale: more exposure translates to more adoption, and the relationship is not simply about information transfer but about confidence building through repeated observation^[5]. The finding that high-exposure farmers adopted at 3.7 times the rate of low-exposure farmers for drought-tolerant varieties closely matches the 3.5-fold difference reported by Singh and colleagues (2019)^[15] for wheat FLDs in Rajasthan, despite the very different agricultural contexts.

The emergence of seasonal stress experience as the strongest adoption predictor (OR = 1.88) is particularly relevant for climate-resilient technologies. Farmers who had personally experienced crop loss from drought or frost were nearly twice as likely to adopt, independent of demonstration exposure. This suggests that FLDs are most effective when timed to coincide with or closely follow stress events, a finding that supports the concept of teachable moments in extension pedagogy^[16]. The 2022-2023 drought season, which delivered visible yield differences between demonstrated and conventional practices, coincided with the sharpest uptick in adoption intentions across the sample^[17].

Peer adopter contact (OR = 1.51) reinforces the value of the farmer-to-farmer relay component built into the FLD design. Qualitative interviews revealed that farmers trusted yield data from neighbours' paddocks more than identical data from research stations or extension reports. As one participant noted, seeing results on land you drive past daily removes the uncertainty that printed material cannot address^[18]. This observation aligns with Rogers' (2003)^[19] concept of trialability and observability as key innovation attributes driving adoption.

Practical Applications

These findings support several recommendations for extension organisations seeking to promote climate-resilient technologies. FLD programs should plan for multi-season engagement rather than single-event demonstrations, as adoption rates rise sharply with repeated exposure. Demonstration sites should be selected to maximise neighbourhood visibility, enabling the observability that qualitative data identified as a key trust-builder. Climate data should be integrated into demonstration reporting so farmers can connect yield differences to specific weather conditions. Extension services should invest in training and supporting host farmers as peer demonstrators, as farmer-to-farmer relay extends FLD reach at marginal cost. Finally, demonstration scheduling should anticipate and respond to climatic stress events, capitalising on the heightened receptivity that follows direct experience of production loss^[20].

Conclusion

This research demonstrates that front-line demonstrations are an effective approach for accelerating the adoption of climate-resilient agricultural technologies among New Zealand farming communities. The dose-response relationship between demonstration exposure and adoption was consistent across three technology categories and three growing seasons. Drought-tolerant varieties showed the highest adoption rates, reflecting their low entry cost and compatibility with existing farming systems. Experience of

climatic stress amplified the effect of demonstrations, suggesting that extension timing matters as much as extension content. Peer adopter contact provided an additional adoption pathway that operated independently of formal demonstration events, confirming the value of embedding farmer-to-farmer relay within FLD designs. These findings argue for sustained, multi-season demonstration programs that combine on-farm evidence with peer learning, climate data integration, and strategic timing relative to environmental stress events. For New Zealand's largely privatised advisory system, the results point toward a public-good case for investing in structured FLD programs as a climate adaptation tool^[21].

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