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Engaging farmers with climate projections: integrating long-term climate risk into farm business resilience planning

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ABSTRACT

Supporting climate adaptation efforts in agriculture is an urgent issue requiring practical pathways to integrate climate risk into plans for action. Although prior research extensively covers various aspects of climate adaptation, two key gaps remain: (1) the limited use of multi-decadal climate projections to support long-term climate adaptation and resilience, and (2) the under-examined role of intermediaries in integrating climate projections into farm business planning. We address these gaps by identifying how engaging farmers with long-term climate risks through farm business planning processes can improve outcomes for on-farm climate adaptation and climate resilience. In a case study based in Queensland, Australia, we engage with intermediaries delivering business planning to farmers for climate resilience. Using a co-development methodology, two workshops were organised, with the help of the Queensland Department of Primary Industries and local partners to demonstrate how farm business plans can support improved adaptation to future climate risks. We set out an engagement framework that, with appropriate contextual adaptation, has potential applicability beyond agricultural settings to other sectors engaged in resilience planning. A key finding from this case study is that the institutionalisation of long-term climate risk planning programs within existing governance structures can enable broader adoption and scalability. Furthermore, planning for long-term climate risk needs to become part of the regular cadence of business planning, regularly revisited and adapted to ensure plans to address climate risks are monitored and updated.

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1. Introduction

Climate risks are already impacting numerous aspects of farm businesses in Australia and are projected to increase (Brown et al., 2019; Godde et al., 2021; Hughes et al., 2019). Climate risks in agriculture impact productivity, profitability, land management, labour, water availability, animal and plant health and biodiversity. Therefore, building climate-resilient farm business has never been more critical. Improving resilience requires proactive planning to safeguard farm businesses against future risks from climate variability, involving the use of adaptation, new knowledge and practices (Eeswaran et al., 2021; Kheir et al., 2025; Tunio et al., 2024).

Although it is well-established that agricultural systems need to adapt to climate change, there is a tension between planning and implementing short and long-term adaptation measures. Developing strategic, whole-of-farm plans that consider medium to long-term business objectives and future climate trends remains relatively uncommon (Antwi-Agyei et al., 2021; Vaughan et al., 2018). Although primary producers are familiar with financial business planning for bank loans and investments, business planning for climatic change and adaptation is a new approach. Longer-term plans are increasingly recognised as a proactive mechanism to help farmers anticipate future climate-related hazards and reduce their impact through timely planned action (Aryal et al., 2021; Jagannathan et al., 2023a). This is not to suggest that farmers are not adapting to climate change; they are indeed adjusting their farming practices to minimise climate change impacts, but typically on shorter-time scales (Alexanderson et al., 2023; Rodriguez et al., 2014). However, in most cases, these adjustments are guided by reactive, autonomous adaptation rather than proactive plans (Tuihedur Rahman et al., 2021; Williams et al., 2019).

Holistic, whole-of farm business plans have multiple benefits, which clearly maps the interdependencies across the enterprise, clarifying relationships and trade-offs between management areas. It also assists with anticipating second-order impacts rather than optimising each farm business component in isolation. Holistic farming is particularly helpful considering climate risks (such as increased temperatures, changed rainfall patterns, floods, fires, droughts and heatwaves, pests and diseases) can impact different components of the farm in ways that can interact and compound. Written plans can be shared for input from multiple parties (e.g., banks, advisors, family), linked with multiple operations of the businesses (e.g., budgets, insurance, succession), and be revisited over time, revised and adjusted. Most farmers typically plan only for the upcoming season and rarely for a full year (Robertson and Murray-Prior, 2016). As a result, formalised business plans, even for short-term climate adaptation, are uncommon in practice, while plans that consider long-term, climate-risks and resilience are even less prevalent.

While studies find that multi-decadal climate services can help farmers identify and manage future risks (Malakar et al., 2025; Malakar et al., 2024), their use in informing longer-term business development remains limited (Jagannathan et al., 2023b; Vaughan et al., 2018). Climate services include information on weather and seasonal forecasts (<3 months), as well as climate projections on decadal timescales (Nkiaka et al., 2019). A core aim of these services is to help farmers make informed farm decisions based on weather and climate data (Vaughan and Dessai, 2014). Globally, the use of weather and seasonal forecasts for short-term, tactical decisions is well-documented (Anshul et al., 2022; Austin et al., 2020; Chiputwa et al., 2020). However, pathways for integrating long-term projections into strategic, climate resilient business planning remain unclear and underdeveloped.

Investment through the Australian Government's Department of Agriculture, Fisheries, and Forestry (DAFF) and its flagship initiative, the Future Drought Fund, intends to increase drought and climate change resilience in the agriculture sector. Two of its programs are directly relevant to addressing the abovementioned challenges: Farm Business Resilience Program (FBRP) and Climate Services for Agriculture (CSA). FBRP, co-funded and delivered in partnership with Australian states and territories, aims to build long-term resilience in farm businesses through strategic planning, risk management, and capacity development (DAFF, 2024). The CSA program is jointly implemented by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology. Its signature digital product, My Climate View, offers historical climate data, seasonal outlooks, and future projections at a fine resolution (5km^2) across Australia with the aim to improve agricultural decision-making (Power et al., 2023). This paper examines the use of My Climate View by extension officers delivering the FBRP as a case study of how climate data can be integrated into planning processes to support better informed decision-making and climate adaptation for primary producers.

In this study, we collaborate with actors who actively bridge gaps between research, innovation and practice. We refer to these actors as intermediaries, given their essential role in systems where decision-making depends on collecting, processing, and providing information from multiple sources (Conway, 2025; Cornish et al., 2025). In agriculture, a key intermediary and source of information is extension officers, who may be funded by the government or private sector and whose role is to help disseminate information to farmers and "facilitate people engaged in agricultural production to solve problems and to obtain information, skills, and technologies to improve their livelihoods and wellbeing" (Birner et al., 2009, p.342).

As well as extension officers, farmers may also engage with a broader network of intermediaries (such as consultants, advisors and peers, in paid or unpaid roles) to support operational and strategic decisions (Nettle et al., 2018). Importantly, these intermediaries do not simply provide information; they shape how information is interpreted, prioritised, and acted upon with farm decision-making contexts. For example, crop advisors play a critical intermediary role in facilitating the adoption of conservation practices by translating technical knowledge into actionable farm-level decisions (Eanes et al., 2019). Similarly, advisors influence financial and strategic planning by helping farmers evaluate risks, weigh trade-offs, and align decisions with business goals (Hayden et al., 2023). In animal health management, sustained interactions between farmers and intermediaries have been shown to influence practice change, highlighting how ongoing engagement can reinforce behavioural shifts overtime (Clark et al., 2024). Moreover, Jakku et al. (2024) demonstrate that intermediaries play a critical role in translating climate services and supporting longer-term, strategic climate adaptation.

These insights highlight that intermediaries are not passive conduits of information but active agents shaping how knowledge is interpreted and translated into farm-level decisions. In contexts of uncertainty such as climate adaptation, farmers' decisions are mediated through trusted advisory relationships, where intermediaries influence how risks are framed and acted upon. This makes intermediaries a critical leverage point in behavioural change processes, justifying their central role as the analytical focus of this study. Accordingly, this study is designed to work closely with a group of intermediaries who are primarily tasked with facilitating the development of farm business resilience plans in the Australian state of Queensland, under the FBRP managed by the Queensland Department of Primary Industries (DPI). Tailored industry engagement and the delivery of program outputs are led by peak industry stakeholder groups, farm business planning agencies and DPI's commodity-focussed extension groups.

This paper has three contributions. First, it empirically draws on co-development workshops with Queensland intermediaries delivering the FBRP to identify challenges and strategies for integrating climate projections into farm business planning. Second, it conceptually combines social-psychological persuasion theory with climate services and intermediation literature to explain how source, message, and recipient characteristics interact in strategic planning contexts. Third, unlike prior studies on short-term seasonal forecasting, this study operationalises multi-decadal projections through a co-developed, intermediary-led engagement framework into a single actionable structure.

2. Methodology

2.1. Study design

Our study is methodologically underpinned by the principles of co-development, a participatory approach for collaborative research and engagement, particularly in sectors that involve diverse stakeholder groups and institutions (Eastwood et al., 2012; Norström et al., 2020). Co-development is defined as "the process of working alongside clients, stakeholders and collaborators to produce new knowledge, product, services, or activities aimed at solving a particular problem" (Fleming et al., 2023a, p.3). In climate science, similar approaches have been applied, for example, in scenario planning for climate adaptation (Butler et al., 2020) and community-led climate initiatives aimed at local conservation (Kelly et al., 2020).

Such participatory approaches have been increasingly valued within climate services. These processes are expected to build collective consensus and strengthen the legitimacy of climate services by grounding it in stakeholder needs and shared understanding (Fleming et al., 2025; Neset et al., 2021). Vincent et al. (2018) further argue that collaborative processes can enhance both the generation and utilisation of climate information, thereby improving its uptake for climate adaptation. Therefore, we employ co-development as a key method to identify challenges and opportunities for using multi-decadal climate services to inform longer-term business planning for on-farm climate adaptation and climate resilience.

The aim here is to bring multiple institutions together to co-develop pathways for effectively engaging farmers with multi-decadal climate projections and supporting their integration into farm business planning. Both the development of formal farm business plans and the use of multi-decadal climate projections are relatively new practices in this context. Therefore, our focus is on producing actionable engagement approaches that help intermediaries to facilitate the introduction and uptake of these innovations with farmers.

Drawing on social psychology literature, three attributes are considered essential for active engagement that leads to behavioural, and, ultimately, practice change (Petty et al., 1981; Petty et al., 2018): source characteristics (the information source); message characteristics (the content and framing of information); and recipient characteristics (the motivation and ability to process information) (Blackstock et al., 2010). Fig. 1 presents three scenarios to explain the interplay between these three attributes in relation to behavioural change.

Scenario A illustrates a situation where the source is not trusted (shown by a dotted line). Even though the message appears useful and the recipient is motivated, the lack of trust in the source prevents the information from leading to behavioural change.

Scenario B shows the opposite dynamic: the source is trusted, but the message lacks useful information. As a result, the information still fails to translate into behavioural change.

Scenario C represents the ideal conditions for influencing behavioural change. Here, the source is trusted, the message is useful, and the recipient is open and motivated, enabling the information to turn into action. Importantly, this process is not a one-off event. Rather, it depends on an ongoing relationship between the source and the recipient. Two-way communication is essential to (1) identify what each party brings to the table, (2) learn from each other's experiences, and (3) establish a credible environment that

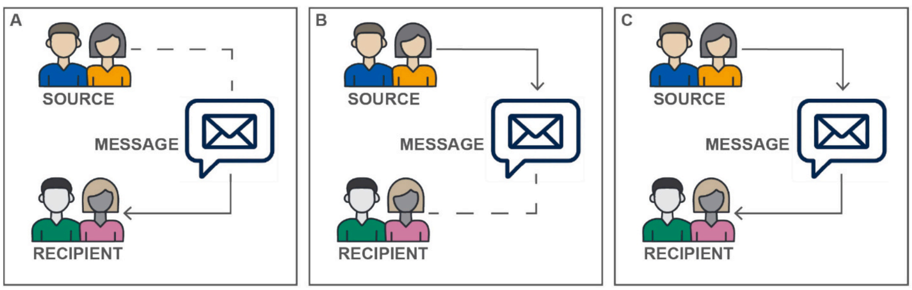

Fig. 1. The interplay between the source, message, and the recipient in influencing behavioural change, where source = intermediary, message = climate information, and recipient = farmer.

supports behavioural change in farm management.

In the context of this study, the source refers to intermediaries who facilitate farm business planning with farmers. The recipients are farmers who engage with these intermediaries to develop, review and update their business planning as an ongoing process of reflection and adaptation. Behavioural change is defined as the proposed actions, identified in business plans, that are informed by climate projections.

Here, we make two critical assumptions. First, recipients (farmers) see value in, and are motivated to engage with, farm business planning. In Queensland, the Department of Primary Industries, through Queensland Rural and Industry Development Authority (QRIDA), provide financial incentives for the preparation of farm business plans and the implementation of drought-resilient activities (QRIDA, 2025). Second, the source (intermediary) is trusted by the recipient and is willing to engage meaningfully in the planning process. There are agencies contracted by the Queensland Government and funded by the FBRP to provide this service. Our primary focus in this study is to work with the source (intermediaries) to co-develop practical pathways for crafting messages aimed at improving recipient (farmer) engagement and supporting behavioural change for better climate adaptation and future resilience.

2.2. Data collection

We employed two co-development workshops for data collection, grounded in participatory principles, such as, trust, respect, inclusivity, and equity, and intended to enable open conversation to address a shared problem (Fleming et al., 2023b; Neset et al., 2021; Vincent et al., 2018). Most importantly, it prioritises local knowledge and allows the collaborative development of knowledge through collective consensus. This process generally begins with discovering and defining the problem, followed by co-developing ideas and testing them.

A key inclusion criterion for participant selection was to involve intermediaries responsible for the delivery of FBRP in Queensland. To identify potential participants, we partnered with QLD DPI, Tropical North Queensland Drought Resilience Adoption and Innovation Hub (TNQ Drought Hub) and their partners (Table 1).

Twenty-seven participants were involved in the two co-development workshops (Fig. 2). The first workshop was conducted in person in September 2024 with intermediaries working primarily in the horticulture sector. It was conducted over a half day. The second workshop was held online in June 2025 with professionals contributing to any agricultural commodity; it ran for 2.5 h. In the first workshop, three guiding questions were explored: (1) What are the challenges in discussing climate projections with farmers? (2) How would climate projections benefit farm business resilience planning? (3) How can discussions about future climate projections be facilitated with farmers? Since the second workshop was planned for only 2.5 h (considering time availability of the participants), we primarily focused on questions (2) and (3). Conducting two workshops enabled us to strengthen the findings by incorporating perspectives from a broader range of sectoral professionals involved in the delivery of FBRP. It also allowed for an iterative research design, where insights from the first workshop informed a more targeted second workshop focused on the co-development of engagement approaches.

In each workshop, participants were randomly divided into smaller groups for breakout discussions, three groups in workshop 1 (Groups 1–3) and two in workshop 2 (Group 4 and 5), followed by report-back sessions. A facilitator was appointed to guide and streamline the discussion, with each group also supported by a dedicated notetaker and a presenter. All sessions were audio-recorded and later professionally transcribed for analysis. Consent was obtained from all participants for recording the discussions. Ethics clearance for this process was granted by CSIRO's Human Research Ethics Committee.

2.3. Data analysis

We employed an inductive method for data analysis. This method allows researchers to generate patterns and themes directly from the data without relying on a pre-existing coding framework (Castleberry and Nolen, 2018; Elo and Kyngäs, 2008). Inductive data analysis is widely used in agriculture studies, including identifying farmers' knowledge sources (Toffolini et al., 2017), generating knowledge for socio-ecological systems (Malherbe et al., 2024), identifying the role of agriculture advisors (Stanley-Clarke, 2019), and co-producing knowledge with smallholder farmers (Restrepo et al., 2018). Given the limited research on the use of climate projections

Table 1
FBRP partners that were involved in participant selection for this study.

FBRP partners	Organisation description
Queensland Fruit & Vegetable Growers (QFVG)	The Queensland-based industry body that represents the state's commercial fruit, vegetable, and nut growers.[1]
Central Western Queensland Remote Area Planning & Development Board (RAPAD)	A regional council alliance that supports and advances the region's community, environmental, and economic development.[2] Its Farm Business Planning Officers support producers under the entity *Farm Business Planning North Queensland.*
Rural Solutions Queensland (RSQ)	A not-for-profit organisation that works with primary producers across Southern Queensland to provide independent and confidential business support.[3] Through initiatives such as the FBRP, RSQ supports producers in strengthening farm planning and managing climate- and business-related risks.

[1] https://www.qfvg.com.au/about
[2] https://rapad.com.au/about-us/
[3] https://rsq.org.au/

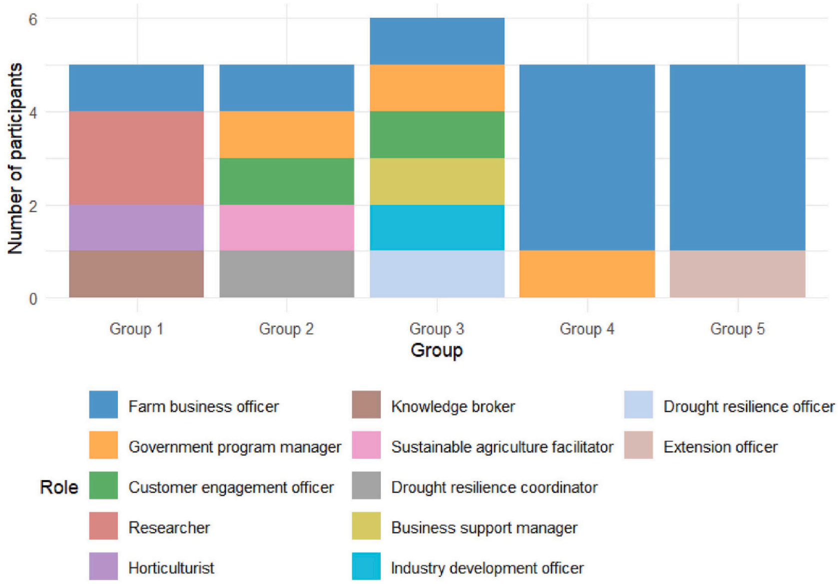

Fig. 2. Professional background of the participants involved in the co-development workshops.

for business planning, an inductive approach enabled us to generate insights without depending on a prescriptive analytical framework.

The transcripts of the audio-recorded breakout sessions were uploaded in NVivo 14 for analysis. Each group's transcript was analysed separately to identify common themes. Although each group was provided with a set of questions to guide discussion, the exact structure was not always followed to maintain the flow of the conversation. Accordingly, the analysis focused on identifying topics that aligned closely with the guiding questions and summarising the corresponding findings. The thematic analysis primarily examined farmers' receptivity to using climate projections and the co-development of engagement pathways. The thematic coding was led by one researcher and subsequently reviewed by a second researcher to ensure consistency and validity. The resulting themes were then shared with participants for feedback and validation.

3. Results

Farm business planning in Queensland is a multi-stage, multi-agency process. Fig. 3 shows a generalised process for developing farm business plans; however, individual planning process may differ. It typically begins with the introduction of the program to farmers by either program partners or QRIDA. In addition, non-program partners may share information about FBRP with their clients. Farm business planning officers (FBPOs or planning officers) play a central role in this process. Once farmers express interest in undertaking farm business planning, they may engage with planning officers, who work closely with them to develop their business plans; however, farmers may also choose to develop their plans independently without planning officer involvement. During this process,

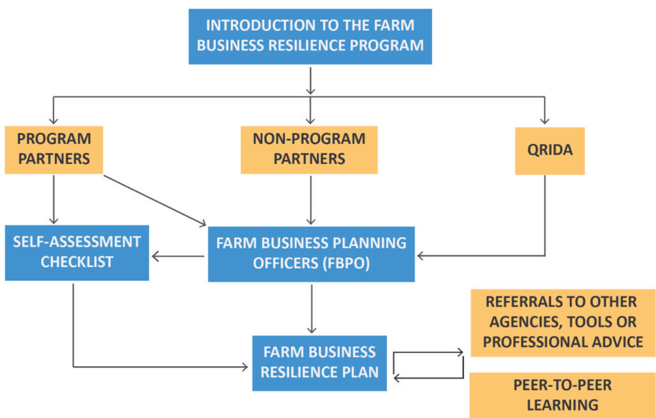

Fig. 3. A flow chart depicting a process for farm business planning, developed based on the second workshop. This planning process shows a multi-agency support assisting producers to make goal-driven decisions and improve their economic, environmental, and social resilience.

farmers may seek professional advice from technical experts or draw on peer knowledge. The duration of the process, from the introduction to finalisation of the initial plans, can range from several weeks to several months (although the plans may cover multi-year timeframes), depending on the level of farmers' engagement and their business context.

In the subsequent sub-headings, the results are grouped into two categories. The first set examines themes that influence farmers' receptivity to using climate projections. The second set focuses on the co-development of pathways that potentially increase farmers' engagement with, and uptake of, climate projections in their farm business planning.

3.1. Farmers' receptivity to using climate projections

All the participants had experience in working with farmers in farm business planning. They all found that climate projections could be useful for farmers. A participant in Group 1 noted that, by being provided with access to climate projections, farmers may recognise the vulnerabilities within their production systems and become better positioned to develop plans to address them. As they explained:

"…if you've got the 2030 projections, or the 2050 projections, you could say, well, I need to upgrade this [irrigation] system by this [time] period. Or purchase a whole different system … it's going to help you figure out what your future payback periods or cost benefit periods are going to be on certain pieces of infrastructure."

The group also discussed challenges that might inhibit farmers' receptivity. We identified four different but interconnected themes, climate and computer literacy, market obligations, risk tolerance, and short planning cycles (Fig. 4). Two of these factors relate to individual capacities (climate literacy and risk tolerance), while the other two are related to farm business characteristics (short planning horizons and market obligations).

Participants in Group 3 discussed climate and computer literacy. The lack of these skills creates challenges for farmers in interpreting data to inform farm decisions. One participant explained:

"Another one in my mind is lack of understanding about how to interpret probabilistic information … I think we all struggle…dealing with uncertainty, but because it is uncertain information based on probabilities a lot of the time, that makes it more difficult."

Group 2 differentiated two broad categories of farmers depending on how open they were to innovation. According to the group, innovative farmers were more open to new ideas, tools, and farming practices. One member of the group elaborated:

"When we engage with farmers, we're generally engaging with the ones that are more innovative and they say, well, you've got some information about climate projections. Great. Let me see how it works for my operation."

Farmers who are less open to innovation, on the other hand, tend to rely on established habits, basing their decisions on past experiences rather than data. The group expressed that farmers are often strongly influenced by memories of past events and the lessons drawn from them. As a result, engaging with this group requires a different approach. As they noted:

"I think sometimes people have a positivity bias, so they think back to the positive times as a reference point as opposed to looking at the actual data … More based on memories and emotions associated with events… I'd say there'd be a significant proportion that don't see the impetus to understand the data around climate … You almost need a different approach with those guys…".

Farmers' reliance on memories and past events, rather than on data, reflects not only limited climate literacy but also differences in risk tolerance, which may be influential by financial circumstances as well as personality traits, e.g. willingness to fail. Past events represent lived experiences that farmers have personally endured, whereas climate projections are perceived as untested data. As a result, farmers may be hesitant to use these projections to inform actionable decisions. Additionally, farmers who have successfully managed past climatic events may feel confident in their existing skills and capacities, believing these will be sufficient to handle future challenges. However, participants noted that this confidence may generate a false sense of security, leaving farmers ill-prepared for future changes as climate risks extend beyond the range of previous experience.

Due to market obligations, farmers may be locked into actions despite weather and climate challenges. Farmers can develop long-term relationships with market players and may be obliged to honour these commitments. As a result, they sometimes ignore weather risks and proceed to plant crops, leading to high investment and low profit. One participant in Group 3 recalled their engagement with a large farm that invested in a crop solely because of market commitments:

"…my experience when I was working on the farm, we had some pretty tough commitments to certain markets we were supplying to … The [weather] conditions across all the growing regions weren't right to actually supply the produce … that crop was probably the most expensive crop that was planted … Plant without acknowledging the climate risk, because they have to for market reasons."

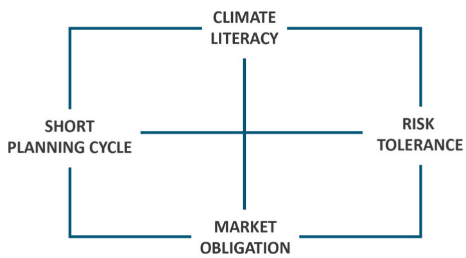

Fig. 4. Individual characteristics (climate literacy and risk tolerance) and farm-level characteristics (short planning cycle and market obligation) that affect farmers' receptivity to using climate projections in farm business planning.

Participants further highlighted that such practices are not uncommon. Farmers often plant without acknowledging the climate risk because they have to for market reasons. The participant further emphasised:

"They're not looking at the weather risk; they're looking at the supply chain risk that they have moving forward."

Short planning cycle is another interconnected theme that makes farmers less receptive to the uptake of climate projections. For farmers, "longer-term" often means up to a year, while most planning within intensive farming industries happens on much shorter timeframes, usually a week or two or within a crop cycle. Weather forecasts beyond three days are generally seen as highly uncertain, so farmers are often hesitant to base their decisions on them. One participant in Group 1 shared how a farmer would approach long-term forecasts as:

"For the longer-term climate discussions, they are constantly thinking about what will happen or what next year will be like? … We can look at the [weather] forecast, but the only forecast that's useful is the next three days. We can look at the seasonal outlooks or the monthly outlooks, but there's that…I don't know how it's going to affect me. So, you could plan for a lot of different things and pay for a lot of infrastructure, but that certain scenario that you plan for might not come to fruition."

Farmers often focus on immediate issues, as running a farm involves dealing with numerous day-to-day challenges. Consequently, they tend to prioritise urgent matters, with long-term thinking typically extending no further than 12 months. According to participants, helping farmers think beyond a single season is important, but this short planning horizon limits the use of climate projections. As one Group 3 participant noted:

"I think they [farmers] are time poor … Particularly around an issue which they might not have front of mind, initially … they might be more focussed on their agronomy or crop management…or dealing with their labour force."

3.2. Co-developing engagement pathways

Participants reported engaging with farmers in two main ways when supporting farm business planning: through group activities and one-on-one interactions. Correspondingly, two key themes were identified: shared learning and personalised guidance, reflecting how participants could work with farmers to increase their receptivity to using climate projections in their planning (Fig. 5).

Shared learning was identified as a foundation to foster collective exchange of knowledge in group settings. All groups explained that a critical first step in supporting farmers to adopt any new practice, such as the use of climate projections to inform their farm businesses, is building their awareness of it. Raising awareness of the tool and demonstrating how to use it are fundamental to encourage its adoption. Participants from Group 1 shared:

"All we [as intermediaries] can do is make them aware of the tool and help them use it. If we can effectively show them how to use it in an easy, structured, simple format, they're not wasting a lot of time, and they will absorb a lot more of it."

Group 2 participants emphasised that practical demonstrations are a must for actively engaging farmers in risk assessment exercises. One participant clarified:

"Demonstrating the practical application of [My Climate View] already, given that it actually creates results, as in people making different business decisions."

The awareness-raising events can be both formal (e.g., workshops) or informal (e.g., one-on-one conversations with experts). However, the introduction of these tools must be deliberate to support farmers in thinking long-term. Group 2 participants noted:

"For some of them, it might just be general awareness that these additional tools are out there … It's just that general education…around

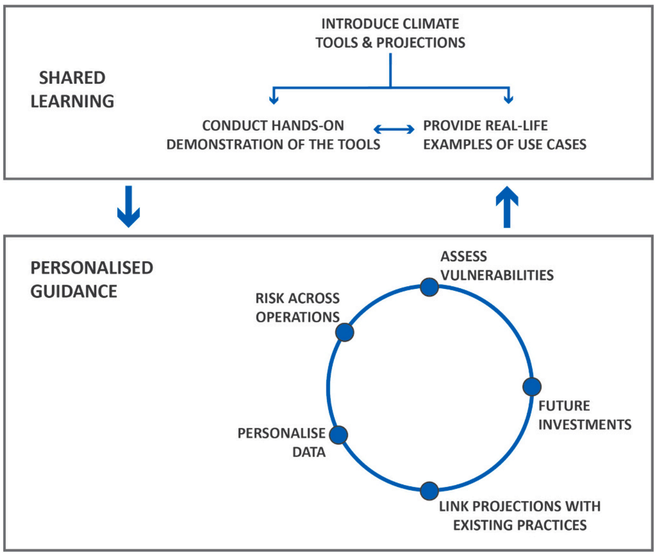

Fig. 5. Schematic depiction of potential engagement pathways to increase farmers' receptivity to using climate projections in their farm business planning: shared learning through group-based awareness-raising and personalised guidance through one-to-one interactions.

some of these tools. Whether it's more initial workshops, or support for growers. Whether it's the agronomist support on the ground … they're [farmers] going to want to actually access this information [climate projections] too and make that bit of a change."

Groups also noted that farmers respond well to real-life examples, which can motivate them to try changes in their practices, as Group 1 shared:

"…and giving the examples of how they might use it [My Climate View] … I think it's more about giving them realistic examples of how you can use it … a real-world example of how that kind of tool can be used … most people are going to be able to understand that kind of thing."

The personalised guidance theme highlights the importance of identifying capacities and vulnerabilities specific to individual businesses and structuring discussions around them. Participants described walking farmers through climate projections to assess risks, linking existing practices to projected changes, personalising climate information, and identifying operational risks as part of guiding them through farm business planning.

According to Group 3, adding climate-related questions systematically could prompt farmers to discuss future climate risks and vulnerabilities and ultimately access climate projections. A process that starts by asking for their existing short-term risks and then builds a connection with future risks may help farmers become more aware of long-term thinking in their business plans.

"[Deidentified] did [a program], and they did what you're talking about, and had the short-term, 'What do you do in a heatwave?'… Then the long-term, 'How can you change farm infrastructure?'… They had two, almost mini plans, in one, and it was almost crisis management, and then the actual long-term resilience."

Structured discussions, including strategic questions, about future climate may also encourage farmers to reflect on their intended goals. For example, farmers who manage multiple properties may be interested in comparing these properties to identify which crops or breeds are likely to remain viable under future conditions. Planning for future investments can also help shift the conversation towards forward-looking decisions, including significant change, such as selling and moving to somewhere with better projections for future conditions. Participants in Group 2 noted this:

"…so future enterprise mix, future investment decisions, whether you're actually going to continue or not…".

Participants indicated that farmers with long-term experience are often locked into their traditional practices. Because farming involves a complex set of interconnected activities, these farmers may fear that changing one practice could disrupt the entire system. Participants emphasised that any new tool or practice should therefore be linked to farmers' existing routines. Such changes should be introduced gradually, taking a phased approach that allows farmers and practitioners to explore the benefits together. Linking climate risks with existing risks helps farmers understand that they are interrelated, and that ignoring one can exacerbate the other. One participant in Group 4 explained:

"I tend to say things along the lines of, 'Can you describe the last drought and what you would do differently?' Then, if they don't bring up things like My Climate View…, then that's the point in time where I go, 'Have you thought about these tools?'"

Groups also identified the importance of having conversations about farming legacy and succession planning, particularly for older farmers, to identify future challenges and the actions needed to maintain their legacy. They additionally highlighted the value of drawing on historical data, which can help farmers explore future climate trends. Historical data can provide observed changes over time, which can pique farmers' interest when comparing past patterns with future projections. Group 5 noted:

"I always get them [farmers] to look at the frequency of drought and dry periods. 'Will that increase? What's the historical stats on that?' … Then that can be brought in there about, 'What are the projections? Let's look at the projections now.'"

Farmers believe in historical data but not necessarily in projections, so by comparing the two, they are more likely to trust the projections. If their experience aligns with the data, it further builds trust. This is important because neighbours can have very different experiences with weather, so the projections may not always align with their own memories or records.

In a group workshop setting, engaging growers in conversation about the recollection of extreme climate events builds ownership in the process and interest in planning. However, in some cases, climate-related discussions are best suited to the one-on-one conversations between planning officers and farmers during the planning process. Making climate information personally relevant to farmers can be key in this regard, especially if conversations include difficult decisions. When asked about what questions are relevant during these one-on-one conservations, one participant explained:

"It can be about when you're discussing grass types in pasture or varieties of crops they grow in each season. It can be tied to the production side easily that way. So, you're looking at…crops, then, you ask what the variety is and then you can ask what impact…more days of heat over 35 or 38 degrees is going to do to that variety…".

Instigating climate-related questions can be helpful. That is, asking specific questions related to climate risks and encouraging them to access climate projections is identified as an important step during the planning process. Group 4 participants described:

"…once you are in the plan, you're bringing it [My Climate View] up all the way through ... So, when production goals for grazing, you know you're talking about – if your temperatures are increasing or you're getting an extra 20 heat stress days a year, how does that affect what breed selection? Or how does that affect what shed you're wanting or what water resource you're wanting?"

Participants in Group 5 described using a phased approach when engaging individually with farmers to build momentum around the importance of longer-term thinking informed by climate projections. This approach emphasised respect, listening closely to farmers' views and maintaining a natural conversational flow during individual interactions. Participants noted that frequent interruptions or showing disinterest in farmers' experiences and opinions can derail discussions and eventually erode trust. As one participant explained, introducing any new topic must wait until trust between the intermediary and the farmer is established, stating:

"When you're talking with a client, you have to roll with where they're going to a certain degree before you can start punching in where you want to go. So, you have to be respectful and let them roll the way they go … Trying to put these conversations [climate risks] in a process, I think, is a bit problematic, because it becomes disrespectful then to the producer [farmer]. You do have to listen."

Participants noted the value of linking climate projections to the entire farm operation, emphasising that climate is an integral component of every operational unit. They explained that identifying risks across every aspect of the business can reveal simple, practical solutions, and help demonstrate how climate projections can support overall business efficiency. Achieving this, however, requires planning officers to work with farmers, unpacking their farming system and discussing climate information relevant to each component of their operations. This process should account for the inter-relationships between different farm components. For example, while discussing current crop or livestock management practices, an intermediary can pose questions about how additional days above critical temperature thresholds might affect those specific crops or animal breeds. By doing so, farmers start to recognise the implications of the projections on factors like feed requirements, water needs, and breed suitability across their operation.

4. Discussion

A proactive business plan informed by future climate information is believed to help farmers strengthen the climate-resilience of their enterprises, by providing a structured way to assess potential future climate risks and integrate adaptive strategies into their farming systems. Therefore, this study aimed to co-develop engagement pathways by and for intermediaries to support farmers in introducing and actively using climate projections within farm business planning.

The co-development workshops identified key challenges and potential actions. We found that farmers' receptivity to climate projections is shaped by past experiences and short-term goals. Participants explained that decisions are often based on experience and memories rather than data, a pattern well-documented in farm decision-making literature (Guido et al., 2020; Hasibuan et al., 2020; Zimba et al., 2025). Risk perceptions also influenced decisions under uncertainty (Brick and Visser, 2015; Jin et al., 2020; Mase et al., 2017). Farmers perceive multi-decadal climate projections as highly uncertain, particularly when considering transformational change activities. Together, reliance on experiential knowledge and risk aversion can constrain farmers' use of climate projections in longer-term farm planning.

Participants at the workshops highlighted that the emphasis on maintaining or increasing productivity can act as a barrier for longer-term thinking. Farmers' short-term goals tend to focus on the here and now, with immediate needs prioritised, while other considerations are perceived as occurring at a mentally constructed distance, referred to as psychological distance (Chu and Yang, 2020; Wang et al., 2021). Farmers who perceive climate change as occurring in a psychologically distant future are therefore less likely to act on climate projections (Keller et al., 2022; Spence et al., 2012). Consequently, overcoming this barrier by introducing climate projections into intermediary-supported business planning, producers can also include long-term goals that explicitly evaluate, monitor, or manage climate risks.

We co-developed pathways to engage with farmers for increasing their receptivity towards climate projections and inform their business planning (Fig. 6). The pathways consist of exposure, internalisation, and trust and credibility components.

The exposure component reflects the shared learning approach (e.g., workshops, group meetings), which is particularly useful in creating a collective environment for social influencing and problem-solving (Borek and Abraham, 2018). It also allows intermediaries to foster interactions among several individuals at once (Borek et al., 2019). Within the context of this research, priorities for shared learning were centred on raising general awareness, especially regarding available climate tools, climate literacy, and practical use cases.

Limited climate literacy and unfamiliarity with climate services, including among intermediaries, were identified as key barriers to engaging farmers with climate projections. A group setting can therefore provide a good starting point for familiarising farmers with new climate tools and raising awareness about climate change more broadly. However, the introduction of new tools must involve hands-on demonstrations and practical exercises to build confidence and tackle usability issues. Such exercises also allow intermediaries to learn from participants, fostering a two-way exchange of knowledge and reducing the risk of these events being perceived as top-down or solely expert-driven (Calo, 2018; Giraldo et al., 2025).

Farmers respond well to real-life examples (Rizzo et al., 2024; Toffolini and Jeuffroy, 2022); hence, practical use cases of climate projections were identified as a key enabler during the co-design workshops. These examples can be both output- and process-oriented, such as sharing experiences of using My Climate View or applying projections to long-term investment planning. In group settings, this

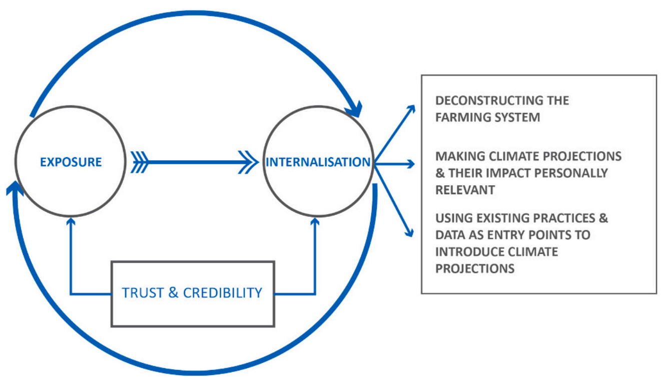

Fig. 6. Co-developed engagement pathways between intermediaries and farmers for the use of climate projections in farm business planning.

fosters discussion around both opportunities and challenges, while generating new ideas and motivating behavioural change (Guerin, 2025). This peer-to-peer learning approach is strongly aligned with FBRP's emphasis on group workshops and farmer-to-farmer learning.

The personalised guidance approach enables internalisation among farmers to adopt behavioural change by integrating climate projections into farm business planning. This approach shows the importance of one-on-one interactions between intermediaries and farmers. Priorities for personalised guidance include deconstructing the farming system, making climate projections and their impacts personally relevant, using existing practices and data as entry points to introduce new tools and practices, and reinforcing awareness.

A farming system is composed of multiple interconnected components, each with its own vulnerabilities. In many cases, these vulnerabilities are closely linked to weather and climate. Because farmers often take weather and climate as given, their planning may focus primarily on achieving production goals and fulfilling market commitments. In these cases, it is helpful to introduce climate-related questions into business planning discussions and unpack how future climate risks may interact and affect different components of the farming system.

This introduction of climate risk assessment can occur through both structured and unstructured approaches. A structured approach involves posing specific, targeted questions during discussion of particular topics, for example, asking how an increase in heat-stress days might affect production goals for grazing. An unstructured approach allows facilitators to listen closely and interject climate-related prompts where relevant, adapting to the flow of conversation. Regardless of the approach, constructively challenging farmers to consider future climate risks as they develop business plans can be highly beneficial, helping them build greater climate resilience into their farming operations.

Using existing practices and data as entry points for introducing new climate tools was identified as a key strategy. Farmers often rely on historical climate data to inform their business goals and may find climate projections more engaging when they can compare past patterns with future changes. This comparison provides a useful starting point for exploring future risk. Similarly, grounding discussions in existing practices and associated challenges can create openings for practice change, which climate projections can then inform and justify. Linking projections to succession planning and framing legacy was also highlighted as a valuable approach. Discussing future visions for the farm, and how conditions may change, can help integrate climate projections into long-term planning.

The trust and credibility component is the foundation of the entire engagement pathway; without this, no engagement is fruitful (Rust et al., 2022; Xhoxhi et al., 2018). Because discussing farm business requires sharing personal information, such as finances, investments, goals, and areas of weakness, maintaining confidentiality is therefore a must. Trust and credibility are key drivers that strengthen the intermediary's influence (source characteristics) and increase the likelihood that advice will translate into action (Dockès et al., 2018; Gribben et al., 2025).

Furthermore, any effort to influence practice change should be iterative, as multiple exposures and repeated messaging are often identified as important triggers for behavioural change (Henriksson et al., 2021; Surendran et al., 2023). While awareness-raising was highlighted as critical within the shared learning approach, participants emphasised that it must be reinforced throughout the personalised guidance engagement. In practice, the journey from initial introduction to effective utilisation of climate tools should follow a phased approach rather than a one-off event. It would be unethical for intermediaries to force farmers into changing practices; instead, any change must stem from the farmers' own self-realisation and their assessment of risks and opportunities.

This study has some limitations. We base our findings on a collaboration with a limited number of intermediaries responsible for the delivery of FBRP in Queensland. Therefore, the findings may reflect context-specific features of both the state and the program. However, as FBRP is a nationwide initiative, the insights, particularly the engagement approaches for integrating climate projections into farm business planning, are likely to be transferrable, with appropriate contextual adaptation (e.g., socio-cultural contexts, institutional support), to other settings.

This study was designed to focus on the intermediary perspective as a distinct and underexamined area in climate services delivery. The complementary farmer perspective, including longitudinal evidence of behavioural outcomes, represents an important and natural direction for follow-on research.

5. Conclusion

Prior research extensively examined climate adaptation in the agriculture sector; however, two key gaps remain: the limited use of multi-decadal climate projections for long-term resilience and the under-examined role of intermediaries in integrating these projections into farm business planning. The study addresses these gaps by using a co-development methodology with intermediaries in Queensland to identify challenges in using climate projections in business planning and to develop intermediary-farmer engagement pathways. Our study suggests three key elements of pathways for integrating climate projections into farm business planning are: exposure, internalisation, trust and credibility.

While this study focuses on farm-level engagement, effective implementation of intermediary-farmer engagement for long-term climate resilience requires systemic change at institutional and policy levels. Although intermediaries can influence planning, the implementation of actions, including monitoring and iterative learning, may lie beyond their role. Institutional support is therefore critical to track progress and strengthen future planning.

Viewing business planning as a one-off activity can undermine efforts to build climate-resilient agriculture. Shifting towards long-term planning requires regularly revisiting decisions informed by climate projections, supported by sustained funding and institutional embedding of programs such as FBRP and CSA. Furthermore, effective planning must consider the broader framing context. Engaging iteratively with diverse perspectives (advisors, industry programs and leaders, family) can help develop more resilient plans by clarifying assumptions, dependencies, and risks.

CRediT authorship contribution statement

Yuwan Malakar: Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Aysha Fleming:** Writing – review & editing, Validation, Supervision, Conceptualization. **Jonathan McComb:** Writing – review & editing, Methodology, Investigation. **Natalie Hughes:** Writing – review & editing, Investigation, Formal analysis. **Geoffrey Bahnisch:** Writing – review & editing, Supervision, Investigation, Conceptualization. **Stephanie Dickson:** Writing – review & editing, Methodology, Investigation, Conceptualization. **Thomas Golland:** Project administration, Methodology, Investigation, Conceptualization. **Karen George:** Supervision, Methodology, Investigation, Conceptualization. **Neil Cliffe:** Writing – review & editing, Supervision, Methodology, Investigation, Conceptualization. **Mahesh Prakash:** Supervision, Resources, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

The authors do not have permission to share data.

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