



## **Factors influencing adoption and sustained use of agricultural technology in grazing systems of Central Queensland**

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**Key words:** AgTech, Adoption, Grazing, Producer, Perceptions

### **Abstract**

Agricultural technology (AgTech) offers significant opportunities for enhancing productivity and sustainability in rangeland grazing systems; however, its adoption to date has been limited. This study examines factors influencing the adoption and sustained use of AgTech among Central Queensland beef producers. Through semi-structured interviews with 15 beef graziers, we explore how producers' motivations, experiences, and perceptions affect their engagement with AgTech. Thematic analysis illustrates that adoption and continued use of AgTech are more likely when it enhances a producer's feelings of competence, is positively regarded by peers, and is considered a viable financial investment. Conversely, challenges in these areas often lead to low implementation or discontinuation. These insights can inform strategies to improve AgTech development and integration, ultimately enhancing the resilience and sustainability of extensive grazing systems.

### **Introduction**

The agricultural sector is undergoing a transformative shift with the integration of advanced technologies, collectively known as agricultural technology (AgTech). These innovations aim to improve productivity, efficiency, and sustainability in farming practices (Rose & Chilvers, 2018). In beef grazing systems, AgTech offers tools for enhanced herd management, pasture monitoring, and resource optimisation. Technologies such as remote sensing, GPS tracking, and automated feeding systems have the potential to revolutionise traditional operations (Bailey et al., 2021). Although these represent advanced applications of AgTech, integration into beef businesses can be through much more conventional forms, such as the addition of weigh scale, or farm management software.

Despite the potential benefits, the adoption and sustained use of AgTech among beef producers varies widely. Some producers successfully integrate these technologies into their long-term operations, while others discontinue use after initial adoption (Fielke et al., 2020). Understanding factors influencing uptake and continued use is crucial for developing strategies to enhance sustained technology use if we are to increase productivity and resilience in the agricultural industry. Previous research has identified barriers such as high initial costs, lack of technical support, and integration difficulties with existing systems (Pierpaoli et al., 2013).

Incorporating agricultural extension methods tailored to diverse adoption pathways is essential for addressing these challenges. Recent research by Nettle et al. (2024) emphasises that effective extension requires addressing social, technical, and institutional barriers. Their findings highlight that a combination of peer learning, co-innovation, and tailored advice is critical for supporting producers through the adoption and continued use of technologies. This aligns with the focus of this study on understanding the roles of competence, community and financial risk perception in AgTech adoption, particularly as they influence producers' decisions to sustain or discontinue the use of these tools.

### **Methods**

A qualitative research design was employed to explore the motivations, experiences, and perceptions of beef graziers regarding AgTech adoption and continued use (approval number: 24-883). A phenomenological approach facilitated an in-depth understanding of the lived experiences of producers and their involvement with AgTech (Creswell & Poth, 2018). Participants were selected using random purposeful sampling, targeting Central Queensland beef graziers. Inclusion criteria required active involvement in beef grazing operations, and willingness to discuss their experiences with Agtech. Recruitment occurred through industry networks and producer associations. A total of 15 beef graziers participated, representing diverse enterprise sizes, and levels of AgTech engagement. Semi-structured interviews were conducted either face-to-face, or via telephone. An interview guide was developed, covering topics such as business background, motivations for AgTech adoption, experiences with implementation, perceptions of usability and usefulness, and factors influencing continued use or discontinuation. With consent, interviews were audio-recorded and transcribed verbatim. Thematic analysis was conducted following the guidelines outlined by Braun and Clarke (2006). NVivo 12 software facilitated the coding and identification of patterns in the data. Initial codes were generated inductively. Themes were iteratively refined to improve accuracy and distinctness.

### **Results**

A total of 15 interviews were conducted with six males, six females and three couples. All participants held an active role in decision making on property either through management roles or ownership. The length of interviews ranged from 15 to 120 minutes, resulting in approximately 24 hours of recorded conversations. Ten participant's businesses were primarily involved in cattle breeding and growing. Three participants had mixed farming operations with beef cattle alongside cropping enterprises. One participant had a sole focus on backgrounding and trading cattle, and one business operated as a stud. The number of cattle in each business ranged from 120 to 6,500 head.

Three primary themes emerged from the analysis that influence adoption and continued or discontinued use of AgTech: Competence, Community, and Perceived financial risk.

#### ***Competence***

The theme of competence explores how the Agtech tool contributes to producer's feeling capable within their business. This emerged as a critical factor influencing both adoption and sustained use of technology.

Usefulness with regard to business priorities: Beef cattle businesses vary in their structure, focus and measures of success. A producer's perspective of a tool being useful varies depending on their priorities. In this study, usefulness was commonly identified through operational benefits such as labour saving, increased confidence in decision making and improved communication. Discontinuation was prevalent where the tool was not seen to add value to a producers existing skillset or where it imposed on a higher

priority value, for example doing things quickly. One producer had AgTech installed (EID's in every animal, an EID scanner and a set of scales) however indicated:

“I just don't use it because it's quicker without it. It stays slow with it. Like lots of places and that – you go through, and you watch them and they're stuffing around. And they're read this one, this one doesn't read so they've got to run it back and pull the tag out. Where I can pump them straight through in an hour.”

Usability and adaptation to local conditions: The usability of AgTech tools and their adaptability to individual contexts significantly impacted producers' sense of competence. Tools that were intuitive, required minimal training and offered practical ways to maintain the system, enhanced confidence and encouraged continued use. Whereas technologies that were perceived as complicated or not suited to the producers' operating environment diminished competence, often resulting in discontinuation.

“It won't actually sync in the paddock without losing data. So then, well then you lose your confidence in the program, right? Then you've got to come back to the office and it's another job you've got to sit down and do. Whereas if you're in the paddock and you're moving them that was one of the prime draw cards to using it.”

Access to training and support: Adequate training and technical support contributed to producers feeling competent and more capable in using the Agtech tools to benefit their business. Initially being connected to a person directly for follow up support was highly regarded. Often, once producers had confidence that they were supported, they were more inclined to troubleshoot on their own and successfully navigate implementation phases. An absence of support from some AgTech providers was linked to frustrations, reduced confidence and discontinuation.

### ***Community***

The theme of community encompasses the social and relational factors influencing AgTech adoption and sustained use. Producers valued acceptance within their community and were cautious about deviating from accepted norms.

Peer influence and social proof: Producers were curious about, and strongly influenced by, the experiences and opinions of their peers. Observing successful use of AgTech by peers increased confidence and motivation to explore using technology. They often sought reassurance from trusted community members before fully committing to AgTech use.

“Your next door neighbour or your cousin's uncle who has been using it for two years, or you know whatever they've all got experience. So, um, to me I would go to someone who I know has used it.”

Collaborative learning and support networks: Community networks provided opportunities for shared learning and support. Often key producers were referred to as they had a reputation for being a trusted source for ground-truthed Agtech experience. Engagement with peers facilitated knowledge exchange, problem-solving, and mutual support. Producers without access to supportive networks were more comfortable with ‘business as usual’ which hindered exploration and sustained use of AgTech.

“Person 1 is trying to make you use that other shit. Yeah, but I don't want to use it. What happens if your phone goes flat or something? ... I don't think many people do use the electric one.”

### ***Perceived financial risk***

Producers highlighted several dimensions of financial risk associated with AgriTech adoption, reflecting concerns about return on investment, reliability, and economic justification.

Uncertainty around lifespan and reliability: AgTech tools were often perceived as high-risk investments due to uncertainties around their lifespan and reliability. Producers expressed frustration when tools failed to operate consistently. Others relayed experiences with discontinued technology and tools that didn't meet the expectations set. Malfunctions disrupted operations, incurred added labour and maintenance expense and eroded confidence in the technology's value.

“It's just that it's got a few hiccups that can be a pain in the butt sometimes, and I'll go down there, and I'll start a new session and it'll just throw me a curveball. And I've got to work it out, and, you know what it's like. You've got people waiting around.”

Challenges in evaluating return on investment and cash flow constraints: Many producers struggled to assess the financial value proposition of AgTech tools. The economic benefits often required long-term use to materialise, while the upfront costs presented immediate challenges.

“The problem is, the case has to be so compelling because if it's not you constantly think, ‘What else could I buy for that?’ And we just get away with doing it.”

Prioritisation of tangible benefits: Technologies with clear and direct economic benefits, such as preventing theft, were prioritised over other AgTech tools. Producers felt more confident investing in tools with demonstrable short-term outcomes, which contrasted with the abstract or delayed benefits of many AgTech solutions.

“Technology's not, it's important but it's not of great importance to us I guess you'd say. You know, our security cameras and stuff like that yeah that's important because we need to be able to monitor that no one's driving in and stealing all of our diesel”

### **Discussion and Conclusion**

This study highlights the complex factors influencing the adoption and sustained use of AgTech among beef producers in Central Queensland, emphasising the importance of tailoring solutions to individual business priorities. Adoption is driven not only by technological capabilities but also by human behaviour, social dynamics, and the specific contexts of each enterprise. Technologies that enhance producers' feelings of competence, align with their priorities, and address their needs for usability and reliability are more likely to be adopted and used long-term.

Competence emerged as a critical theme, with producers favouring tools that are intuitive, adaptable to local conditions, and supported by training. This aligns with findings by Sewell et al. (2017), who highlight that competence-building through training and tailored advice is essential for successful technology adoption. Conversely, technologies perceived as unreliable or difficult to use often led to frustration and discontinuation. Community influence also plays a vital role, as producers rely on peers and trusted individuals to validate their decisions. As suggested by Prager and Creaney (2017), peer-to-peer networks and social learning environments can build confidence in adopting new technologies. Stories and experiences shared by relatable figures can build confidence and foster adoption, while negative perceptions can hinder uptake.

Perceived financial risk remains a significant barrier, with producers expressing difficulty in assessing the return on investment for many AgTech tools. Immediate and tangible benefits, such as those provided by security systems, were prioritised over tools with long-term or less visible payoffs. Clear communication about economic benefits, supported by cost-benefit analyses and evidence of success in local contexts, can help address these concerns.

The adoption of AgTech requires a process of change that often involves vulnerability and habit shifts. Extension strategies should acknowledge this, providing time, support, and accountability mechanisms to facilitate the transition. Timing is also crucial, with producers more likely to adopt new tools when triggered by specific events or compelling evidence of benefit from trusted sources.

Although the sample size of this study is small, the diversity of experiences underscores the need for a tailored approach to AgTech adoption. Strategies should prioritise building competence, leveraging community networks, addressing financial concerns, and supporting producers throughout the adoption process. By focusing on shared lived experiences and aligning with producers' values and goals, AgTech adoption can be enhanced, contributing to more resilient and sustainable grazing systems.

### **Acknowledgements**

The authors thank the participating producers as these insights could not have been gleaned without them. This project received funding from Tropical North Queensland Drought Hub, an Australian Government Future Drought Fund initiative.

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