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## **RURAL DATA DIVIDES: CRITICAL FACTORS OF DIGITAL AGTECH ADOPTION ON AUSTRALIAN FARMS**

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As global agricultural production methods and supply chains have become more digitised, farmers around the world are adopting digital agricultural technologies (AgTech) such as drones, IoT, remote sensors, blockchain and satellite imagery to inform their on-farm decision making. Yet, many Australian farmers are not taking up digital AgTech and are thus being left behind in the digital economy (Marshall et. al., 2020). Although researchers have sought to understand barriers to adoption in Australia, agricultural industries do not have a complete understanding of why some farmers take up AgTech and others do not. Related studies tend to focus on individual-level barriers, yielding well-documented issues such as access to digital connectivity, availability of AgTech suppliers, non-use of ICTs, and cost-benefit for farmers (Zhang et al., 2017). Contrastingly, we took a novel ‘ecosystems’ or ‘communicative ecology’ (Hearn & Foth) approach to investigate digital inclusion and human factors of digital AgTech adoption on farms in Queensland, Australia’s most agricultural state by landmass.

We undertook a case study of a digital farming project – involving concurrent implementations of remote sensors, automation, satellite crop imagery, WiFi/4G

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connectivity, and a customised 'smart farming' data dashboard – on a cotton farm in the Darling Downs. Spanning over 77,000 square kilometers, the Darling Downs is a longstanding farming region in south-east Queensland growing a variety of crops, fruit and vegetables, and livestock. Digital connectivity is inconsistent in the Downs, characterised by patchy 3G and 4G mobile/cell networks and a combination of fixed wireless and satellite broadband services.

Interviews and participant observation were conducted across the farm's supply chain (ecosystem) to understand how the experiences, perceptions, and activities of different stakeholders constituted a community-level orientation to digital agriculture, which enabled and constrained on-farm adoption. Participants included the cotton farmers, technology providers, data analysts, agronomists, suppliers (e.g., tractors, seed, fuel), and representatives of local business development groups and the state government agricultural department.

Thematic analysis of the data revealed two key themes pertaining to digital AgTech adoption struggles revolving around a central concern with data: how data is produced, where data is stored and how it is accessed, and how data can be used to inform on-farm decision making to improve outcomes. This made sense in the context of the digital farming project, which aimed to capture and converge data from several devices (sensors, satellite, etc.) on a single dashboard to directly inform the farmers' decision making. Each theme is outlined below.

Firstly, the **value of data and digital AgTech** was questioned by some people within the ecosystem. While digital technology was recognised as necessary for many aspects of farming, there was limited appetite for 'technology for technology's sake' in systems and processes that already operate well. More specifically, the value of automated data collection and decision making was seen by some to undermine farmers' and agronomists' tacit knowledge and holistic understanding of factors that inform decision-making in specific farming contexts. Relatedly, in a study of remote farming communities in Chile, Pavez et al. (2017) found that rural business owners saw technology as a 'necessary evil' that would progress their business but degrade their local community connections. Underlying adoption issues highlighted in the Chilean study, such as fear of digital technologies disrupting localised networks, were echoed by some participants in the Darling Downs study.

A second theme emerged around **data ownership, privacy, agency and autonomy**. There was ambiguity surrounding who owns data collected by farm machinery and IoT, and a reluctance among farmers to share their data even if it could offer community or sector benefits. Similar issues such as data "portability, privacy, trust and liability" (Wiseman et al., 2019) and data sovereignty (Carolan, 2018) have been observed in international studies. A further issue on the cotton farm was that the technology providers installed a variety of data-generating technologies with different interfaces lacking interoperability. Critically, the farmers lacked the necessary digital and data literacy skills to access, manage and use this data effectively. Although a dashboard was devised to converge data, it was evident that specialist expertise for data translation was required. Equally, support and resourcing for the farmers to acquire data

capabilities was limited, which Asmar et al. (2020) suggests can result in complete disengagement from technology.

Overall, we observed a 'data divide' (Powell, 2017) between the generation and application of farm data. That is, there was a data capability gap between provision of the devices and software by technology companies and the ability of farmers to implement, use and maintain them effectively and independently. In the cotton farm case study, the success of the digital farming project largely rested with the farmers' determination to learn new, advanced digital and data literacy skills to manage and interpret data, as well as significant commitment of time and resources to the project. Many other farmers simply would not have the wherewithal to see such a project through.

Our research thus raises questions about the level of expertise farmers should be expected to attain in the transition to digital farming, who in the ecosystem is best placed to fill this 'data divide', and what interventions are necessary to address the significant barriers to adoption and effective use that remain in rural communities. It also highlights a tension between farmers' *independence* as decision-makers on their own properties and their *dependence* on digital technologies – and the localized ecosystems that support uptake of digital AgTech – to inform on-farm decisions.

While early adopters and technology advocates globally are spruiking and realising the benefits of digital AgTech, many stakeholders are reluctant or unable to participate fully in the digital economy. By holistically considering how macro- and micro-level factors may be combined with community-level influences, this paper contributes to scholarship and practice by providing a more complete and holistic account of the contextualised factors that drive or undermine digital AgTech adoption on farms in rural communities. Our study provides insights and evidence to inform strategies for rural ecosystems to transition farms to meet the requirements and opportunities of Agriculture 4.0 in Australia and abroad.

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