Journal of Rural Studies 55 (2017) 193–202

Contents lists available at ScienceDirect

Journal of Rural Studies

journal homepage: www.elsevier.com/locate/jrurstud

Ordering adoption: Materiality, knowledge and farmer engagement with precision agriculture technologies

Vaughan Higgins [a, *], Melanie Bryant [b], Andrea Howell [c], Jane Battersby [d]

[a] School of Humanities and Social Sciences, Charles Sturt University, Albury, New South Wales 2640, Australia
[b] Tasmanian School of Business and Economics, University of Tasmania, Hobart, Tasmania 7001, Australia
[c] Deakin University, Burwood, Victoria 3125, Australia
[d] Charles Sturt University, Albury, New South Wales 2640, Australia

ARTICLE INFO

Article history:
Received 11 April 2017
Received in revised form
29 June 2017
Accepted 18 August 2017

Keywords:
Adoption
Ordering
Materiality
Technology
Farming knowledge
Precision agriculture

ABSTRACT

In their efforts to understand why and how farmers adopt new technologies, techniques and programmes, rural sociologists and geographers have typically focused on the social and cultural relations in which farming knowledge and practices are embedded. However, limited scholarly attention has been given to the important ways in which materials and materiality are a constitutive element in how farmers come to know and engage with technology. This paper addresses this issue through the application of theoretical work on ordering, which focuses on the materially heterogeneous processes and implicit strategies that hold together and perform particular social and organisational arrangements. Drawing upon qualitative data from a research project on adoption of precision agriculture (PA) in the Australian rice industry, we identify two principal modes of ordering: (1) *commercial-technological,* in which lack of compatibility between technologies produced by different machinery manufacturers creates challenges for farmers in integrating and adapting PA to existing farming practices and systems; and (2) *biophysical*, where drought and low water allocations create uncertainty and a reluctance by farmers to make large capital outlays for PA technology. While these modes of ordering constrain rice growers' capacities to adopt PA technology, we argue that growers also engage in their own alternative ordering practices to negotiate, work with, and work around these constraints. We refer to this work as *tinkering* and argue that it is a powerful, yet little recognised, form of ordering enabling growers to take advantage of the material benefits of PA in a way that is flexible, adaptable, and fits their immediate farming circumstances. In concluding, we contend that an ordering approach provides a fruitful way forward in recognising the more-than-cultural dimensions through which farmers engage with technology, and particularly the complex ways in which materiality intertwines with, shapes, and is shaped by, farming knowledge and practices.

1. Introduction

Rural sociologists and geographers have long argued that farmers' knowledge, and the broader social and cultural relations in which such knowledge is embedded, is crucial to understanding farmer engagement with and adoption of new programmes, techniques and technologies (e.g., Clark and Murdoch, 1997; Morris, 2006; Oliver et al., 2012; Riley, 2008; Warren et al., 2016). This 'socio-cultural' approach to knowledge has generated significant insights into making sense of why farmers might partially adopt or not adopt at all. It has also drawn attention to farming knowledge as a relational achievement; that is how farmers' tacit, experiential knowledge relates to and is integrated with other forms of knowledge (such as 'scientific' knowledge), and the consequences of these relations for programmes or initiatives seeking to change farming practices. However, in focusing primarily on the social and cultural relations that underpin farming knowledge, limited attention is given to 'knowledge in action' (Bruckmeier and Tovey, 2008, p. 321), that is, the ways in which knowledge, and the practices associated with the application of that knowledge, are a co-production of social and material products (Jasanoff, 2004). This

* Corresponding author.
E-mail addresses: vhiggins@csu.edu.au (V. Higgins), melanie.bryant@utas.edu.au (M. Bryant), andrea.howell@deakin.edu.au (A. Howell), jbattersby@csu.edu.au (J. Battersby).

http://dx.doi.org/10.1016/j.jrurstud.2017.08.011
0743-0167/

paper addresses this issue by investigating the significance of materiality in how farmers understand and engage with technology.

Materials – which include human craftwork, texts, machines, markets, plant matter and animals – are a constitutive element of how farmers come to 'know' and engage with new technologies and techniques (Higgins, 2006; Legun, 2015; Singleton, 2010). However, their significance in the context of research on farmer adoption is yet to be explored systematically. According to Law (1992, p. 381), studying how these materials are organised and 'come to be patterned to generate effects like organizations, inequality, and power' is an important task for social scientists. Such a task involves identifying and examining the relations between different 'modes of ordering' – the combination of socio-materially heterogeneous processes and implicit strategies that give rise to particular social and organizational arrangements (Law, 1994; Mol and Law, 2002). An analytical emphasis on socio-material ordering, which we apply in this paper, builds on growing engagement with a relational approach in agi-food studies, which is characterised by attention to 'how materialities, practices and discourses matter in terms of their effects and affectivities' (Carolan, 2017, p. 136).

Drawing from a qualitative study of technology adoption in the Australian rice industry, this article investigates the modes of ordering that influence how growers come to know and engage with precision agriculture (PA). Broadly, PA refers to a range of techniques – such as yield monitoring and mapping, remote sensing, and variable rate technology – that utilise technologies including Global Positioning Systems and Geographic Information Systems. As a suite of technologies, PA is argued to contribute 'to the long-term sustainability of production agriculture' through more targeted and strategic use of inputs that 'reduce losses from excess applications and from reduction of losses' due to nutrient imbalances, weed escapes and insect damage (Bongiovanni and Lowenberg-DeBoer, 2004, p. 383). An ordering approach draws attention to the heterogeneous sets of relations and implicit strategies through which PA is enacted, without assuming that these relations are necessarily 'social' or 'cultural'. It also provides broader insights into the variously enabling and constraining effects engendered by these sets of relations. Based on our analysis, we identify two principal modes of ordering PA: *commercial-technological* and *biophysical*. We argue that while these forms of ordering have a generally constraining effect on rice growers' understanding of how PA can work for them, and their capacities to implement PA on-farm, growers also engage in their own alternative ordering practices – which we refer to as *tinkering* – to negotiate, work with, and work around these constraints. Tinkering is partly a consequence of the material constraints imposed by commercial-technological and biophysical modes of ordering. However, it is also a practical strategy for growers in caring for their farm as an economic and social unit (Krzywoszynska, 2016), which enables them to take advantage of the material benefits of PA in a way that is flexible and fits their immediate farming circumstances.

2. Mapping a socio-cultural approach: from values and motivations to 'knowledge-cultures'

While social science research on farm-level adoption is diverse, it is broadly united in taking a 'socio-cultural' approach – the recognition that social and cultural relations are fundamental to understanding farmer responses to new programmes, techniques or technologies. This literature can be divided into two related areas of focus: farmers' values and motivations, and the relationship between farmers' tacit knowledge and scientific knowledge. These are outlined briefly below.

Rural social researchers have been studying the role of values, goals and motivations in influencing farmers' adoption decisions since the 1950s (e.g., Gasson, 1973; Ilbery, 1983; Moon and Cocklin, 2011; Morris and Potter, 1995; Rogers, 2003). Early research by Rogers (2003) found that farmers with high levels of motivation are more likely to make the changes necessary to adopt an innovation, while Gasson (1973) found that farmers' intrinsic orientation to their work, underpinned by the high importance of instrumental goals, are central in understanding their adoption decisions. Scholars have since built on this research by seeking to identify farming values and goals across a range of geographic contexts and farming systems, and the implications for the design of programmes seeking to change specific aspects of farm practices and/or farmers' adoption behaviour. For example, Greiner and Gregg (2011, p. 264) found that farmers are 'motivated by actively pursuing personal and family well-being and make decisions within a care-based ethic rather than simply reacting to financial opportunities, imperatives and constraints'. Similarly, Bohnet et al. (2011, p. 635) argue that 'graziers are motivated by pursuing personal values', and policies and extension programmes are unlikely to be effective if they 'do not take graziers' values and motivations into consideration'. An important insight from this literature is that individual values and goals underpinning farm practices are located within broader farming cultures, providing farmers with a sense of meaning and identity (Burton, 2004; Burton et al., 2008; Sutherland and Burton, 2011). For example, Burton (2004, p. 210) contends that agricultural landscapes are 'highly symbolic environments where the social value of production must be considered on a par with economic value'. Particular farming practices generate 'symbolic capital and socio-cultural rewards' and are strongly associated with being recognised as a 'good farmer' (Warren et al., 2016, p. 179). Whether or not a new innovation or practice is consistent with notions of good farming therefore has a strong influence on farmer adoption decisions.

Recognising that farmers' goals and values are an important feature of broader farming cultures, social researchers have also examined the role of farming knowledge in the implementation of new practices, innovations, or government programmes. This literature broadly emphasises the need to understand and take into account farmers' tacit and experiential knowledge. Failure to do so contributes to farmers' loss of trust in scientific and government institutions and difficulties for authorities in achieving farmer engagement or adoption (Clark and Murdoch, 1997; Wynne, 1996). Farming knowledge is in some respects distinctive from 'scientific' knowledge (Murdoch and Clark, 1994; Winter, 1997). Yet, at the same time, the two forms of knowledge are related. As Riley (2008) argues, farmers are 'experts in their own fields' (p. 1288); their experience-led understandings and practices provide important insights into farm management, but these 'are often beyond the reach of techniques and records of elite science' (p. 1291). This relational approach to knowledge has increasingly informed social science research on farmer understandings of, and engagement with, programmes aimed at improving on-farm productivity or agri-environmental management (Bruckmeier and Tovey, 2008; Ingram, 2008a; Morris, 2006; Oliver et al., 2012; Riley, 2008). It is this approach to knowledge that we seek to build upon in this paper.

Applied specifically to PA, a relational approach to knowledge is best exemplified in the work of Tsouvalis et al. (2000) who use the heuristic of 'knowledge-cultures' to examine the merging and inter-mingling of different knowledge forms in the context of yield mapping (a technique of PA). The notion of knowledge-cultures recognises that knowledge is a relational achievement. It acknowledges 'the fluid and interactive nature of different ways of sense-making', the 'formative contexts within which meaningful, symbolic actions and knowledges are shaped', and 'the processes