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Heterogeneity in practice adoption to reduce water quality impacts from sugarcane production in Queensland

John Rolfe [a,*], Sally Harvey [b]

[a] CQUniversity, Rockhampton, Qld 4702, Australia
[b] Queensland Department of Agriculture and Fisheries, Australia

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ABSTRACT

A key strategy in reducing water quality impacts into the Great Barrier Reef is to change farm management practices to limit the creation of pollutants or their transmission off farm. However, designing programs to improve adoption in agriculture of Better Management Practices (BMPs) can be challenging because of heterogeneity among landholders and between farms and farming systems. This is relevant to broader issues in the adoption literature where a focus on identifying factors influencing and heterogeneity in adoption have rarely transferred through to analysis and prediction models suitable for policy purposes. In this case study these issues have been tested with sugarcane farmers in Queensland, where the current policy settings are targeting increases in adoption of better management practices from 34% in 2011 to 90% by 2018. The main goals of the study were to identify how rates of adoption for different practices might be explained by (a) the motivations of farmers (b) potential barriers to adoption (c) farm characteristics and (d) financial drivers. The results confirm that measures to improve BMP adoption are complicated by heterogeneity in adoption drivers between practices and across groups of landholders, creating challenges to find effective strategies to encourage adoption.

1. Introduction

There is substantial interest in Australia in reducing environmental impacts from agriculture by improving management practices (Pannell et al., 2006; Whitten et al., 2013). A key challenge is to understand the factors driving adoption of new practices, including the social dimensions of practice change (e.g. Cary et al., 2002; Pannell et al., 2006; Cary and Roberts, 2011). While most reviews of adoption practice highlight the importance of net private returns as a core driver (e.g. Pannell et al., 2006), the relevant literature is notable in the extent of different different influencing factors that have been identified. For example, Australian studies have noted that factors such as farm characteristics, practice types, trialability, management values, attitudes and norms, and socio-economic characteristics can be just as important as expected profitability in explaining adoption (Pannell et al., 2006; Morrison et al., 2012; Price and Leviston, 2014; Greiner, 2016).

The focus of much of the agricultural adoption literature to date has been on the identification problem, where the challenge has been to determine which factors influence farmer decisions to improve productivity (e.g. Prokopy et al., 2008; Baumgart-Getz et al., 2012) or adopt conservation practices (e.g. Pannell et al., 2006), as well as to identify the heterogeneity in landholder choices and drivers (Cary et al., 2002; Morrison et al., 2012). The more difficult task is to move from identification to analysis and prediction, as it is the relative importance of factors influencing adoption that is the more critical information for designing policy interventions. While there has been some developments of conceptual frameworks to underpin analysis (e.g. Price and Leviston, 2014), practical applications remain limited.

The case study of interest for this paper are agricultural land uses in Queensland, Australia that contribute pollutants to the Great Barrier Reef (GBR), with sugarcane production the dominant source of nutrients and pesticides (Brodie et al., 2013; GBRWST, 2016). A key strategy in reducing water quality impacts from agricultural production is to change farm management practices to limit the creation of pollutants or their transmission off farm (GBRWST, 2016). There are a number of different mechanisms available to help farmers adopt Best or Better Management Practices (BMPs), including mechanisms that change attitudes (e.g. education programs), mechanisms that improve information (e.g. extension programs), mechanisms that improve technology (e.g.

* Corresponding author.
E-mail addresses: j.rolfe@cqu.edu.au (J. Rolfe), Sally.Harvey@daf.qld.gov.au (S. Harvey).

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research programs), mechanisms that provide incentives to change behaviour, and regulatory programs (GBRWST, 2016).

The sugarcane industry within catchments to the GBR involves around 3777 growers farming 400,000 ha of land (State of Queensland, 2015). Given the importance of voluntary adoption and participation to achieving pollution reduction, the Australian and Queensland Governments now explicitly target rates of adoption of BMPs by landholders as key program outputs (State of Queensland, 2014; GBRWST, 2016). The approach taken is to classify by farmers (or farms) by broad level of adoption of BMPs in an A,B,C,D framework that groups practices from Aspirational Best Practice/Lowest Risk (A) to Traditional Practices/High Risk (D) (State of Queensland, 2014). Under this approach the area of land under different levels of management practice are assessed and tracked over time to measure adoption change.

Heterogeneity in drivers means that farmers may be at a certain practice level for very different reasons; i.e. farmers might use traditional practices because of habit and customs, a lack of capital to change, or poor information about alternatives. In this example, very different policy mechanisms would be needed to change behavior (e.g. education, access to capital, extension). Policy solutions may be even more complex for heterogeneity within farming systems where each farmer has varying mixes of poor to excellent practices. In this case programs might need to be more atomistic and tailored to different elements of each farming system rather than being standardized across a farming district.

These issues are explored in this paper with an application to the adoption of BMPs in the sugar industry in Queensland. Substantial public funds have been allocated through the Reef Rescue program to improving landholder adoption of BMPs in efforts to reduce pollutants to the GBR. The sugarcane industry is a key focus of attention because high transmissions of nutrients (from fertilizer applications) and agricultural chemicals are impacting on water quality, exacerbated by the close proximity of farming along the coast to the inshore reef (Brodie et al., 2013; GBRWST, 2016). The targets for adoption change are ambitious, with the expectation that 90% of sugarcane will be using BMPs by 2018, up from 34% in 2011.

Currently the literature on quantifying adoption drivers for improved land management practices in GBR catchments is very limited. Greiner and Gregg (2011) provide some empirical evidence about how farmer motivations are linked to practice adoption and potential policy instruments, while Emtage and Herbohn use a market segmentation approach to categorise farmers in the Wet Tropics region. Greiner (2016) reports the use of a choice experiment to understand how cattle producers in northern Australia might be involved in biodiversity conservation contracts, while Rolfe and Gregg (2015) used factor analysis on survey responses from graziers in GBR catchments to classify them into different adoption groups.

The research reported in this paper explored the relative importance of different drivers of BMP adoption across landholders and practices to identify the extent of hetegeneity in drivers and implications for policy mechanisms. The contribution to the literature is the assessment of heterogeneity in adoption drivers between and within farms, as distinct from the more standard approach of identifying factors that limit or enhance adoption in particular systems. The paper is structured as follows. Relevant BMPs and literature relating to BMP adoption are outlined in the next two sections, followed by the case study and results in section four, and conclusions in section five.

2. Better management practices in the Great Barrier Reef catchments

There have been a number of investments in Reef Programs and Reef Initiatives funded by the Australian and Queensland Governments since 2003, with nearly $1billion committed between 2009 and 2018 (GBRWST, 2016). Most have been specifically designed to reduce agricultural pollutants damaging the GBR from a number of catchments and industries (Fig. 1), as well as to increase landholder adoption of BMPs.

Examples of BMPs relevant to the sugarcane industry in GBR catchments include controlled traffic permanent beds, zero till rations, legume fallow, soil testing each cycle, nutrient rates block specific, sub-surface nutrient application, and herbicide application based on pressure and timed for stage of growth and rainfall. Dated practices include cultivation of block prior to planting and for weed control in plant cane, applying nutrients at the same rate across all blocks in a single surface application and having one pesticide strategy for whole farm based on historic rates. The categorisation of practices is dynamic and has been adjusted over time to take into account innovation and changes in industry standards and legislation.

There have been several reports and studies over the years that have focused on the adoption of BMPs in the GBR catchments (e.g. Lockie and Rockloff, 2005; Greiner et al., 2007). From 2009 the assessment of adoption rates has been incorporated into Report Cards for the GBR prepared by the Queensland and Australian governments. The first Report Card (State of Queensland, 2011) set the 2009 baseline, and identified that BMPs involving cutting edge (A class) or best management (B Class) were used by 36% of sugarcane growers for nutrient practices, 7% for pesticides and 19% for soil management. This had risen to 40%, 23% and 15% respectively by 2010 (State of Queensland, 2013a), and to 45%, 28% and 20% respectively by 2011 (State of Queensland, 2013b).

From 2009 the focus of reporting changed from the number of farmers adopting BMPS to the area of sugarcane land that was managed under BMP conditions. In the 2014 Report Card (State of Queensland, 2014) it was estimated that 13%, 30% and 23% of sugarcane lands involved BMPs for nutrients, pesticides and soil respectively, increasing to 15%, 32% and 23% in the 2015 Report Card (State of Queensland, 2015). Overall 23% of sugarcane lands were under BMPs in 2015, compared to the target of 90% by 2018. GBRWST (2016) noted that on current trends transformational change in adoption rates will be needed to meet various targets for water quality improvements.

3. Identifying factors that are relevant to adoption

Triggering widespread adoption of BMPs is often challenging, and substantial research effort has been applied to understand what factors underpin farmers' choices to adopt BMPs or participate in agri-environmental schemes that promote BMPs (Cary et al., 2002; Pannell et al., 2006; Knowler and Bradshaw, 2007; Prokopy et al., 2008; Baumgart-Getz et al., 2012). Pannell et al. (2006) classified the drivers into two broad groups: those relating to social, cultural and personal factors, and those relating to the practices themselves. Much of this work has its roots in an older literature on farmer adoption of practices to improve production, given the commonality of factors and motivations.

There have been a number of studies that have examined adoption of BMPs in the GBR catchments. These include studies that identify factors by region (Greiner et al., 2009; Greiner and Gregg, 2011), landholder characteristics, goals and attitudes (Productivity Commission, 2003; Lockie and Rockloff, 2005; Marshall et al., 2011; Emtage and Herbohn, 2012; Rolfe and Gregg, 2015) and financial drivers and premiums required (Roebeling et al., 2009; Rolfe and Gregg, 2015). Factors that have been identified to explain slow adoption in GBR catchments include: