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Increasing uptake of improved land management practice to benefit environment and landholders: insights through a transaction cost lens

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Transaction costs, related to either investigating improved land management practices (ILMP), engaging in adoption support programs for these practices and/or implementing changes on-ground, create barriers to ILMP adoption. Perceived and actual transaction costs have long been hypothesised as a potential barrier to grazier adoption of ILMPs in catchments to the Great Barrier Reef. Applying a framework derived from transaction cost theory, we assess this hypothesis. Through semi-structured interviews of a sample of participants in two ILMP programs, we find that ILMP adoption support program characteristics have a large influence on perceived and actual transaction costs of landholders seeking to engage in ILMP programs or adopt ILMPs. The importance of establishing and nurturing relationships between landholders and extension officers was also highlighted as critical to reducing landholder transaction costs. The degree to which relationships reduce transaction costs demonstrates the importance of fostering landholder leadership in ILMP program design as well as targeted extension in supporting adoption.

Keywords: land management; practice adoption; transaction costs; water quality; Great Barrier Reef

1. Introduction

Increasing awareness of adverse environmental impacts generated by agricultural practices has seen a global trend of governments and environmental groups encouraging and facilitating landholder adoption of improved land management practices (ILMP). However, in many cases, policies have failed to meet environmental targets (such as improvements to water quality) (Alons 2017; Ribaudo and Shortle 2019). This has resulted in an emerging literature focused on understanding landholder motivations to adopt ILMPs as well as what creates a barrier to uptake (Coggan *et al*. 2021; Pannell and Claassen 2020; Prokopy *et al*. 2019; Reimer *et al*. 2014; Weersink and Fulton 2020; Yoder *et al*. 2019). Within this literature, there is an increasing understanding of the

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importance of perceived and actual transaction costs — the indirect costs associated with the transfer of a good from one agent to another (Niehans 1971)— in adoption decision making by landholders. For example, in relation to perceived transaction costs, Rolfe *et al*. (2018) and Rolfe and Star (2019) highlight that the largest perceived risk that graziers have when entering a grant or tender scheme designed to improve water quality into the Great Barrier Reef (GBR), Australia, was related to the perception of paperwork, and therefore transaction costs, associated with contractual arrangements. Similarly, Palm-Forster *et al*. (2016) found that landholders in Ohio (USA) perceived there to be high transaction costs related to bid preparation in a competitive process for payments to change land management for phosphorous reduction in local waterways, resulting in low participation. More recently, and drawing on Moynihan, Herd, and Harvey (2015), Mack *et al*. (2019) assessed actual and perceived transaction costs and their influencing factors associated with administrative workloads of Swiss farmers participating in an agri-environmental grassland milk and meat program whilst El Benni *et al*. (2022) assessed farmer administrative burden due to cross compliance requirements. Also drawing on Moynihan, Herd, and Harvey (2015), Ritzel *et al*. (2020) assess how drivers to transaction costs influence each other, assessing the relationship between compliance costs, psychological cost and administrative burden.

There is also a growing body of literature that reports ex-post measures of transaction costs of environmental policy (Falconer, Dupraz, and Whitby 2008; Falconer and Saunders 2002; Kuperan *et al*. 2008; Mettepenningen, Verspecht, and Van Huylenbroeck 2009; Rorstad, Vatn, and Kvakkestad 2007; Vatn, Kvakkestad, and Rorstad 2002; Coggan *et al*. 2014). These highlight that transaction costs are not small. For example, Mettepenningen, Verspecht, and Van Huylenbroeck (2009) report that the average private landholder transaction cost for adopting practice changes under various European Agri-Environmental schemes (AES) was 15 per cent of the total private adoption cost. Rorstad, Vatn, and Kvakkestad (2007) found that private transaction costs ranged from seven to 37 per cent of the total payment received, depending on the type of AES. Coggan *et al*. (2014) found that for sugarcane growers engaging in Reef Rescue, a program designed to financially assist farmers to upgrade machinery to adopt ILMPs that would reduce nitrogen runoff onto the GBR, the average total transaction costs per farm, as a percentage of the average funding provided, was 38 per cent.

Knowing how landholders perceive or experience transaction costs may help in the design of policies and programs such that participation transaction costs are minimised (Shahab, Clinch, and O'Neill 2018). Exploring drivers of private transaction costs through a theoretically derived framework, the aim of this paper is to contribute to addressing this gap. We do this by exploring two different programs implemented to support ILMP adoption in catchments to the GBR. Drawing on results from semi-structured interviews with landholders involved in the case study ILMP programs, we highlight where and how landholders either perceived there to be transaction costs and/or experienced transaction costs and what this means for engagement in programs and adoption of ILMPs. We take these findings and make suggestions on policy design which could reduce private transaction costs for engaging with ILMP programs and conducting on-ground change in the future.

2. Conceptual framework

Transaction costs can be best described as the indirect costs associated with the transfer of a good from one agent to another (Niehans 1971). These costs typically occur as the costs of transactors' time and/or expenditure on goods and services to support the transaction. Costs may be incurred through information collection activities to initiate the transaction, in efforts to find transactors and in implementing monitoring and enforcement initiatives (contracting) to secure the transaction. When thinking about ILMPs for grazing, the transaction itself may be twofold. First, the transaction may be the engagement of the landholder with the ILMP support program. This may involve finding out about the practices and the support programs to assist in the adoption of the improved practices, but may not actually result in adoption of the ILMPs themselves. Second, the transaction may flow through to result in engagement with the support program and the adoption of the ILMP(s) by the landholder. In both cases, the transactors are the landholders (referred to as private transactors) and the ILMP support providers (regional bodies, government agency extension staff etc which are often referred to as public transactors). Further, transaction costs relate to the costs incurred in enabling engagement and adoption of the ILMP which can be clearly differentiated from abatement costs, being those costs incurred from using the ILMP within the landholder's operation, such as loss of production value, increased labour costs from hiring more staff etc. Because we are interested in how transaction costs influence landholder adoption, the discussion is concentrated solely on drivers of private transaction costs.

The literature surrounding transaction costs suggests that the existence, extent and distribution of transaction costs are influenced by the characteristics of the transaction, the characteristics of the transactors and the institutional environment in which the transactions take place (Challen 2000; Coggan *et al*. 2014; Mack *et al*. 2019; McCann 2013; McCann and Claassen 2016; Mettepenningen, Verspecht, and Van Huylenbroeck 2009; Shahab, Clinch, and O'Neill 2018). Whilst we note the importance of the institutional environment to transaction efficiency, we exclude the institutional framework from the discussion about drivers of landholder transaction costs in this paper. Key drivers of private transaction costs, as derived from transaction cost theory and its original application to understand the organisation of the firm (Williamson 1996, 1998, 1999, 2000), are discussed in the remainder of this section and summarised in Figure 1.

2.1. Characteristics of the transaction

The specificity of the "good" being transacted, the timing and/or frequency of the transaction, as well as uncertainty about the transaction, are all characteristics of the transaction that influence transaction costs (Williamson 1996, 1998, 1999, 2000).

2.1.1. Asset specificity

Asset specificity is a notoriously confusing term (de Vita, Tekaya, and Wang 2011), but generally refers to transactions that require "specialised investment that cannot be redeployed to alternative uses or by alternative users without a loss in productive value" (Williamson 1996, 377). Asset specificity can be best thought of in terms of "did engaging in the transaction require an investment in an asset, knowledge or technology, site or timeframe specific to the transaction, that loses value outside of the transaction?" If the answer is "yes" then the transaction is asset specific. In the "organisation of the firm" context of transaction cost theory, asset specificity generates transaction costs due to the time and effort invested to create and enforce well-formed

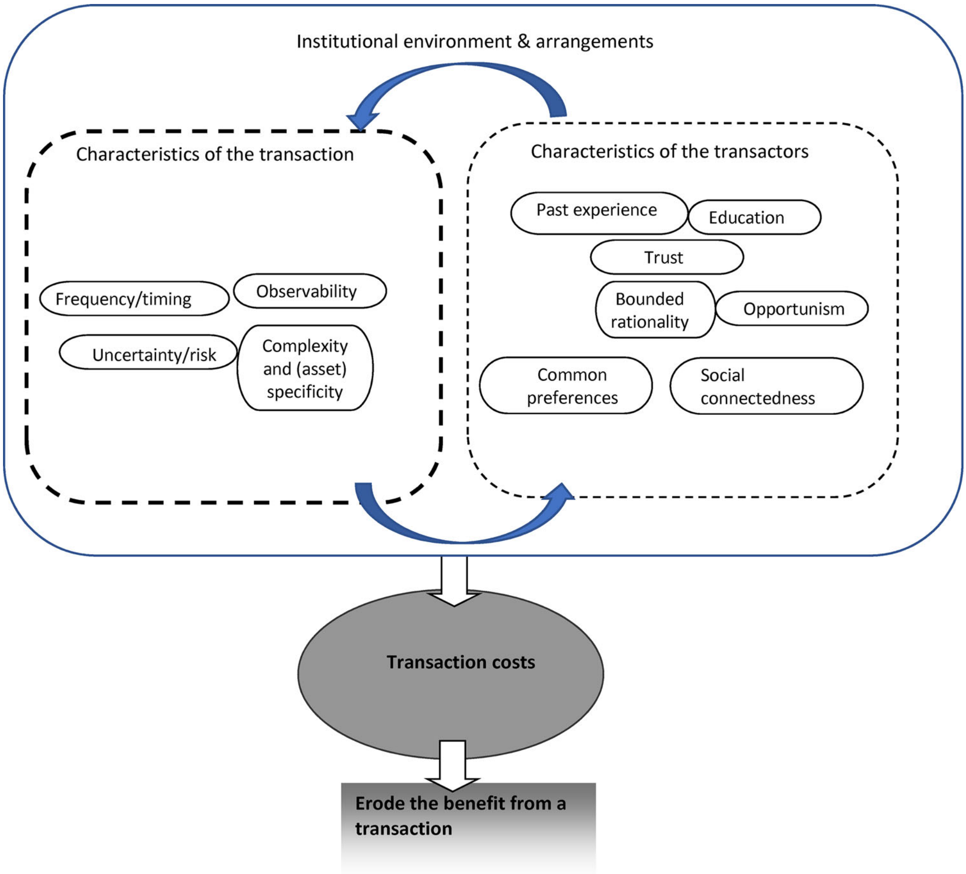

Figure 1. Influences of transaction costs and impact on gains from trade.

contracts to avoid being left with an asset that is not reusable if a transaction fails. This is especially relevant when transactors are opportunistic (Williamson 1981, 1998, 2000). In the context of agri-environmental transactions, specificity is related to the need to invest in physical assets and/or knowledge specific to the transaction (Coggan *et al*. 2017), the importance of the site to the transaction, otherwise known as site specificity, or the importance of the time of transaction to the outcome (Malone, Yates, and Benjamin 1987; Masten, Meehan, and Snyder 1991). In reviewing transaction cost drivers for landholders engaged in agri-environmental transactions, opportunism is not such a problem (opportunism would be something to consider when assessing drivers on the government side of the transaction). Therefore, asset specificity generates transaction costs through time and effort to collect information about specific investments for the transaction, more so than developing complete contracts.

2.1.2. Transaction timing/frequency

Many and frequent transactions of the same good enable transactors to capitalise on economies of scale related to information collection and spread the transaction cost load. However, frequent transactions of goods that have information asset specificity will drive up transaction costs. This is because the knowledge is not transferable between transactions; each transaction requires investment in new knowledge (Williamson 1981, 1985, 1996, 1998, 2000).

2.1.3. Uncertainty

Uncertainty is a big driver of transaction costs for the exchange of environmental goods or outcomes. Uncertainty contributes to the generation of transaction costs for environmental outcomes due to the need to collect information about what the contracted parties are required to do (inputs/actions); and the outcome to be achieved. The greater the uncertainty about actions/inputs or outcomes, the more information transactors need to collect to support the transaction. The extent of transaction costs associated with uncertainty is influenced by the observability (McCann *et al*. 2015) and trialability (Pannell and Zilberman 2020) of the contracted outcome and/or the ease of linking behaviour of the contracted parties to the transacted outcome. Transaction costs can be further exacerbated due to the need to manage additional risks, such as biosecurity, that arise due to the initial information collection exercise. In some cases, transaction costs associated with low observability of outcomes can be managed through measuring inputs rather than outcomes. For example, observing the revegetation of riparian zones may be a lower cost way of reducing uncertainty about a water quality related transaction compared to measuring pollution levels in a water body. The use of surrogate indicators can also reduce the transaction costs of uncertainty. Transaction costs due to uncertainty can be further lowered through the involvement of information specialists, such as brokers, in the market place (Coggan *et al*. 2013; Stavins 1995) or through participation in activities such as peer to peer learning (Patchett, Bewsell, and Grigg 2020), which have become more cost effective to use due to technologies introduced to maintain connection during the COVID 19 global pandemic.

2.2. Characteristics of the transactors

Transactor characteristics that are identified to influence the extent and distribution of transaction costs are: 1) bounded rationality; 2) opportunism; 3) trust; 4) common preferences; and 5) social connectedness (Williamson 1981, 1985, 1996, 1998, 2000).

2.2.1. Bounded rationality

Bounded rationality refers to the fact that humans are cognitively limited (Simon 1957), meaning that humans are bounded, not by the extent of information available and/or accrued, but by the "mental bandwidth" or ability to use this information in decision making (Mayfield *et al.* in review). Bounded rationality affects transaction costs through actions conducted to reduce the impact of this on decision makers. That is, as transactors are boundedly rational, well-defined and well specified contracts can reduce the cognitive load on transactors and assist in decision making. Constructing these contracts is costly in terms of time and effort. The development of well-designed contracts is particularly beneficial when transactors can be opportunistic in their transactions.

Exploring the impact of bounded rationality on transaction costs of farmers engaging in agri-environmental programs in Europe, Ducos, Dupraz, and Bonnieux (2009) suggest that the impact of bounded rationality on transaction costs was lower when the starting education level of the transactor was higher (both generally and in relation to the transaction). This is because education enhances an individual's ability to deal with cognitive challenges, thereby reducing the transaction cost or burden. Related to education, Ducos, Dupraz, and Bonnieux (2009) also note that past experience with the transaction also reduces the impact of bounded rationality on transaction costs (this is also found by Black and Lynch (2005), Hatfield-Dodds and Pearson (2005)). It is important to note that it is the level of education at the time of the transaction, and not the ability to gain more information, that affects the impact of bounded rationality on transaction costs.

2.2.2. Opportunism

Opportunism is defined as when decisions are made with self-interest and guile (Williamson 1981). When contracted actions are not easily observable and there is high uncertainty about actions and outcomes, along with bounded rationality, there is potential for opportunism by transactors. Opportunism may also arise when transactions are site specific. For example, an environmental outcome may only be achieved through investment in ILMPs at very specific points in the landscape. When this is the case, owners of these lands have the potential to engage in rent-seeking opportunistic behaviour. The potential for opportunism generates transaction costs through additional negotiation efforts, complete contracts between transactors or enhanced monitoring and reporting. Transaction costs generated by opportunism tend to burden the public party in the ILMP transaction. Due to the fact that we are concentrating on private transaction costs, the public transaction costs introduced were not considered relevant to our case studies and not discussed further in this paper.

2.2.3. Trust

Mettepenningen *et al*. (2009) note that a trusting relationship between the public and private parties to an environmental policy "transaction" reduces transaction costs in the processes that lead up to the establishment of a contract, as well as in ongoing policy administration. The impact of trust on adoption of practice change is also highlighted in the literature in relation to agricultural technology uptake (Jakku *et al*. 2018; van der Burg, Bogaardt, and Wolfert 2019), agricultural practice change in GBR catchments (Taylor and Eberhard 2020) and innovation projects more broadly (King *et al*. 2019).

2.2.4. Common preferences

Mettepenningen *et al*. (2009) suggest that having common preferences across parties reduces the transaction costs of interaction. This may be due to trust (less need to conduct independent information collection) and less opportunism (as the landholder is motivated to conduct the ILMP too, so less likely to rent seek or shirk commitments). Common preferences may, in fact, just reduce the perception of transaction costs rather than the actual costs. It is hypothesised by the authors that if landholders are motivated to conduct an activity due to intrinsic motivation, they may be more willing to bear transaction costs. This is consistent with the literature on intrinsic motivation of landholders to supply public goods (Greiner 2013, 2015, Greiner and Gregg 2011; Herr, Greiner, and Stoeckl 2004).

2.2.5. Social connectedness

Social connectedness refers to the connection of a party with other individuals and groups. Social connectedness can reduce the information collection costs of the private parties as they seek to learn about, adopt and adapt to a new policy (Morrison 2009). Social connectedness is also touched on by Bromley (1991), Falconer, Dupraz, and Whitby (2008), Libecap (1989), Milgrom and Roberts (1992), Oates (1986), Williamson (1985, 1998). These authors discuss social connectedness as being affected by the number of participants in an environmental policy (cumulative and new entries each year), and the geographical characteristics of the transactors. Whilst these authors assess this with reference to the public transaction costs, landholders located close together and with similar property characteristics are more likely to generate social connectedness that could reduce the transaction costs of adopting a ILMP (trialability, knowledge transfer etc) (Coggan *et al*. 2021). Of course, this will depend on how specific the knowledge is and its transferability (asset specificity).

3. Focus of analysis – ILMPS for grazing in catchments to the Great Barrier Reef

The World Heritage-listed Great Barrier Reef (GBR), located off the coast of Queensland, Australia and covering an area of 344,400 square kilometres, is the world's largest coral reef ecosystem (Figure 2). However, one of many ongoing threats to the health of the GBR is poor water quality, with agricultural practices continuing to have a significant impact through nitrogen, fine sediment and pesticide discharge. This is despite the implementation of numerous programs using a mix of policy instruments seeking to generate ILMPs by agriculturalists by the Australian and Queensland governments since 2003 (Eberhard *et al*. 2017, 2021; see Figure 3).

With 40% of sediment load flowing to the GBR contributed by grazing in the Burdekin catchment (area 2 in Figure 2) and 15% contributed by grazing in the Fitzroy (area 4 in Figure 2) (Waterhouse *et al*. 2017), government effort has refocused to support landholders to adopt ILMPs specified in the Reef Water Quality Protection Plan (Australian and Queensland Government 2013) and listed in Table 1. The two Queensland Government Reef Water Quality Program-funded programs of focus in this study are the Grazing Resilience and Sustainable Solutions (GRASS) program and the Landholders Driving Change (LDC) - Exploring New Incentives (ENI) program.

3.1. Case study 1. Graziers in the Fitzroy engaged in GRASS

Funded through the Queensland Government Reef Water Quality Program, the Grazing Resilience and Sustainable Solutions (GRASS) program supports graziers, through resources such as customised mapping and one-to-one support, to improve land in poor and degraded condition and to maintain and monitor land in good or fair condition. The program also offers financial support for on-ground works such as fencing, water points and erosion work. The program is focused solely on achieving improved land management. This is a point of difference with the ENI program which is seeking to engage with landholders who have not engaged in ILMP programs before. GRASS is delivered by the Department of Agriculture and Fisheries (DAF), Burnett Mary Regional Group, North Queensland Dry Tropics and Fitzroy Basin Association; and is

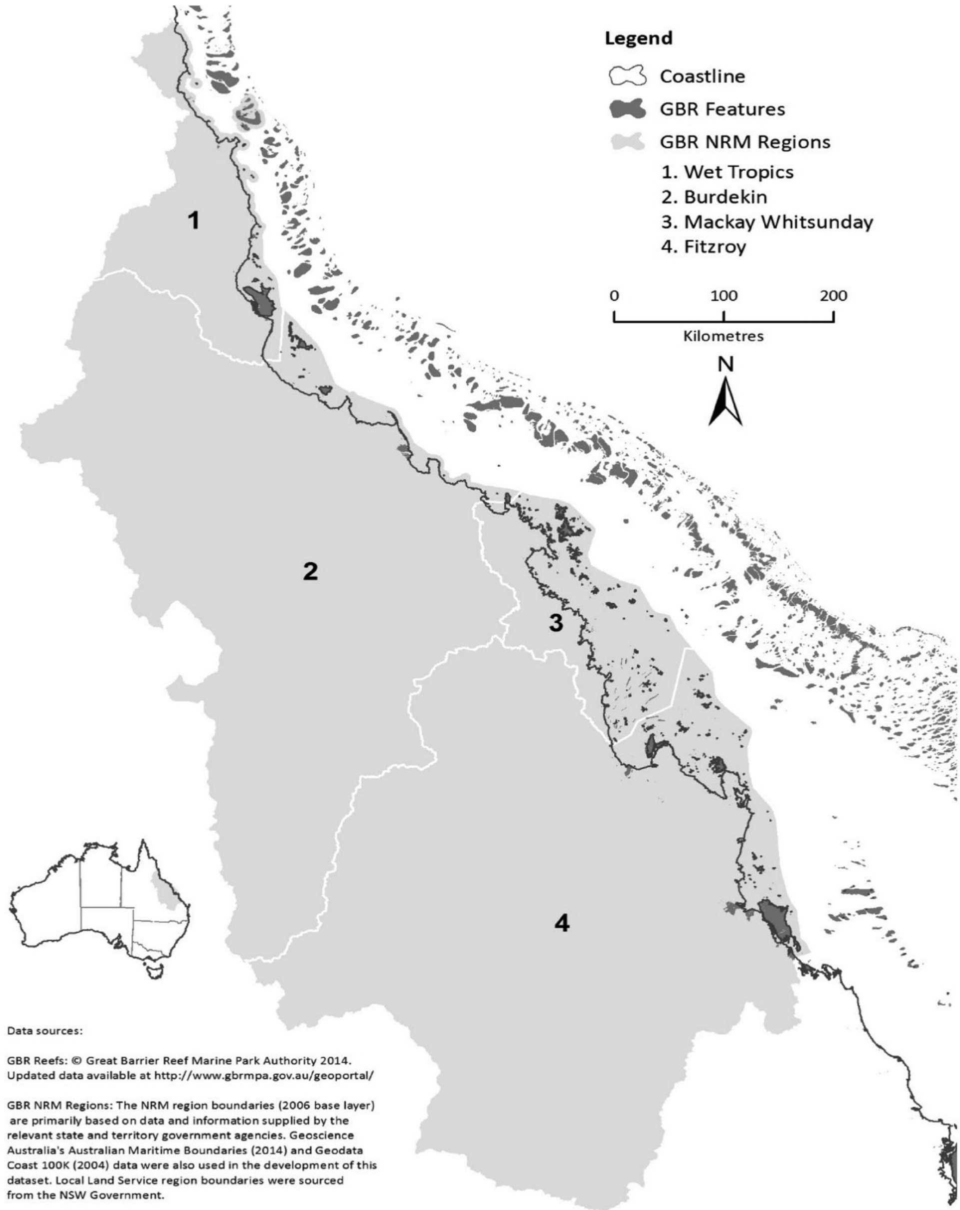

Figure 2. The Great Barrier Reef location and catchments.

operating in the Burdekin, Fitzroy and Burnett Mary catchments. We focused on experiences of graziers in the Fitzroy catchment (area 4 in Figure 2).

3.2. Case study 2. Graziers in the Burdekin engaging in ENI

Throughout 2018–2021, the Department of Environment and Science (DES), through its Queensland Reef Water Quality Program, contracted the NQ Dry Tropics (NQDT) regional body to work with landholders in the Bowen, Broken, Bogie (BBB) sub-

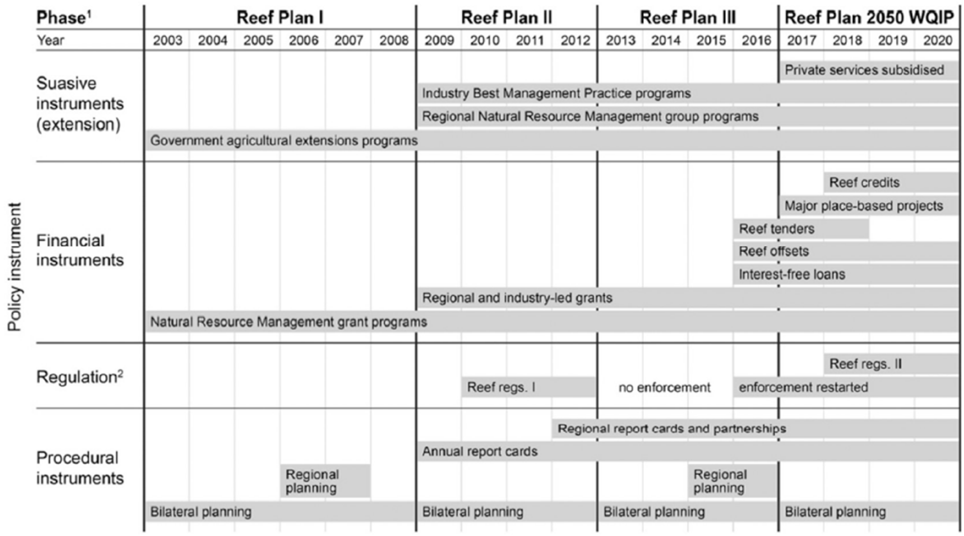

Figure 3. A timeline of major policy instruments for water quality improvement in the GBR.
Source: Eberhard *et al*. (2021).
1. Phase is defined by the bilateral water quality plans (State of Queensland and Commonwealth of Australia 2003, 2009, 2013, 2018).
2. Reef regulations under the Environmental Protection Act 1994 (Qld) were passed in 2009 (Great Barrier Reef Protection Amendment Act 2009) and enhanced in 2019 (Environmental Protection (Great Barrier Reef Protection Measures) and other legislation Amendment Bill 2019).
Note: Suasive and financial instruments were/are voluntary.

catchment of the Burdekin (area 2 in Figure 2) to reduce erosion and improve land management, productivity and reef water quality. The broader program for this is referred to as Landholders Driving Change (LDC) with a specific sub-initiative being “Exploring New Incentives” (ENI). The ENI component of the LDC program was designed to:

1. Engage with landholders who had not engaged in ILMP programs in the past
2. Give these newly engaged landholders a positive experience with the grant process, with the objective of engaging these landholders in activities with direct water quality outcomes now and into the future
3. Enable landholders to trial new technologies and practices at low landholder risk/cost.

Whilst water quality improvements were not the driver of the ENI program, there was the potential for the activities (listed in Table 2) to generate improvements in land condition which have flow-on benefits to water quality.

4. Empirical approach

Our focus was on how and why landholders perceive and/or experience transaction costs when engaging with the programs that support ILMP adoption and in the adoption of the ILMPs. We considered the transaction to be initial engagement and/or adoption of practices specified in the reef water quality protection framework (Queensland Government 2018) and known to improve ground cover (Table 1) as well as adoption of technologies or techniques yet to be proven to reduce sediment, such as

Table 1. Description of improved land management practices for grazing in the GBR.

Desirable land management practice	Which means:
The average stocking rate each paddock will likely carry over a number of years is matched to the carrying capacity of that paddock (long-term carrying capacity or LTCC).	Stocking rate matched to carrying capacity.
Balance between stocking rate and pasture quantity in each paddock, and implications for groundcover, are objectively evaluated.	Forage budgets are used for each paddock, cattle numbers adjusted accordingly.
Management is tailored to encourage recovery of land in declining or poor (C) condition and very poor condition (D).	C: Reassessing and adjusting stocking rates in relation to long-term carrying capacity, sub-dividing areas for improved management, and a planned program of wet season spelling. D: Review grazing management of whole paddock; fence to control grazing; establish diversion banks upslope; break surface of scalded areas and sow grass seed; allow litter and other organic material to accumulate.
Where there has been, or is, strongly selective grazing of land types within a paddock, management actions are in place to maintain/recover land condition of those land types.	Selectively grazed land types fenced from other country where practical and cost-effective; Elsewhere, use regular wet season spelling, with or without fire, to help preferred areas recover.
Grazing pressure on river frontage country and wetlands can be effectively managed.	Fencing; off-stream water points throughout. Wet season spelling, appropriate fire management.
Where possible, remedial actions are taken to facilitate recovery of gullied areas.	Professional advice informs appropriate mix of actions. Roads, tracks and fences managed to minimise soil disturbance.

Source: Australian and Queensland Government (2013).

those listed in Table 2. In both cases, the transactors are the graziers and the government. We only focused on the landholder side of the transaction in this paper.

The case study research method was considered most appropriate for our purpose (Nueman 2003; Flyvberg 2006; Miles and Huberman 1994; Yin 2009). Due to the focus on explaining drivers of transaction costs, qualitative data collected through the interviews with GRASS and ENI participants was analysed through a process which Yin (2009) describes as explanation building. This is a process where the finding of a case or case studies is compared to an initial theoretical statement or proposition(s). (Eisenhardt 1989; Miles and Huberman 1994; Yin 2009). Eisenhardt (1989), Miles and Huberman (1994), Yin (2009) all suggest that the internal validity of this approach is bolstered through the assessment of interview findings examined through several divergent approaches. Step one of this involved the writing up of discussion points from workshop sessions, farm visits and interviews. Step two involved a workshop between researchers to identify recurrent theses and areas of importance, comparing findings from data collection exercises to search for patterns. From this comparison, several themes and patterns of explanations emerged that were used in the explanatory analysis. Findings from ENI landholders were further augmented in a third step which

Table 2. ENI funded activities.

ENI funded activity[1]	Function	Potential flow on land condition improvement.
Pregnancy scan technology	Earlier detection of pregnant cows. De-stock empty cows. Better manage calving period. Calves all of similar age can be circulated around paddocks more easily.	Can better match stocking rate to carrying capacity.
Water telemetry	Sensors on troughs and tanks – know trough and tank levels and flow. Facilitates better management of water – can fix a tank, trough or valve as soon as there is a problem.	Potential to move stock by turning water points on and off. Adequate water supply at troughs removes cattle from creeks and riverbeds which has a positive impact on waterway erosion.
Weed wiper	Efficient and effective application of weed poison – wipes on so less collateral kill (benefit of this depends on the make-up of pasture). Can apply even when windy. Works well in a cell grazing regime – cows eat everything, smash down weeds, we apply to residual weeds then rest the pasture.	Less weeds means less exposed soil under weeds and better pasture. Better pasture and matching stocking rate to carrying capacity means less exposed soil and less sediment runoff. Weed wiper means less chemical (cost and environmental benefit).
Overall grazing land management and weed wiper	Weed wiper, lime spreader, fertiliser spreader – management of giant rats tail (GRT) (weed).	Less weeds and management of soil acidity results in better pasture which leads to better rotation and improvement in end of dry season ground cover.
Weed mister	Spray out lantana.	Less lantana, more pasture, less exposed surfaces, less runoff.
Fire management planning	Facilitate better vegetation management though fire – cool and hot depending on what works best for vegetation.	Sustainable vegetation cover. Less exposed soil after wildfire.
Fauna and flora survey	Inform land use and management based on existing flora and fauna and needs of natural as well as grazing. Production of publicly available material on flora and fauna.	Better management of pasture with understanding of needs of natural and grazing species.

involved using qualitative and quantitative data collected from the same ENI landholders as part of a broader assessment of the whole LDC program, which surveyed representatives of 54 grazing enterprises in 2020. The LDC study facilitated responses to questions about levels of agreement using a ten-point Likert scale, where 1 indicated total disagreement and 10 total agreement. Responses to open-ended questions in the LDC survey have been assessed using NVivo.

4.1. Data collection for case study 1

In November 2020, the researchers teamed up with the DAF extension staff as they conducted a GRASS workshop and site visits to potential GRASS landholders in the Fitzroy. Qualitative data was collected through a two-pronged approach:

1. The researchers ran a session with the 20 landholders who attended a DAF GRASS workshop. In this session, landholders were broken into groups to discuss:
   a. The types of groundcover and streambank land management practices they were currently applying.
   b. What they expected and what they experienced when adopting land management practices.
   c. What helped them to adopt these practices and what made it hard.
   d. What they would like to do in the future and what they needed to support them making changes in the future.
2. One researcher then travelled with the DAF extension officers as they conducted GRASS farm visits for those same landholders who attended the GRASS workshop. Whilst the DAF staff assessed land condition, the researcher re-examined the workshop questions with individual landholders. The researcher spoke to representatives of 6 farm businesses in this detailed component of the information collection.

4.2. Data collection for case study 2

In this study, we concentrated on landholders who had taken up ENI grants in the last 2 years. With the help of NQDT, we invited all landholders who had participated in the latest round of ENI grants to be a part of the study. All 10 ENI landholders agreed to be interviewed by researchers. Seven landholders opted for a telephone interview and three opted for a face-to-face visit; all held in February 2021. One landholder chose to withdraw their comments after interview. Each landholder interview took between 30 and 45 min and followed the line of questioning detailed in Table 3.

5. Results

In this section we provide an overview of how the landholders responded to the questions posed to them about their current groundcover and streambank management practices. Questions asked and responses of participants in the GRASS program are summarised in Table 4. Questions asked and responses of graziers engaged in the ENI program are summarised in Table 3. An assessment of these responses through a transaction cost lens is provided in the discussion section of this paper.

6. Discussion – interpretating landholder responses through a transaction cost lens

6.1. Characteristics of the ILMP transaction and transaction costs

6.1.1. Asset specificity

Recall that, in the context of private transaction costs and ILMPs, asset specificity can be best thought of in terms of “did engaging in the transaction require an investment in an

Table 3. Questions to and responses of GRASS landholders.

Question asked of GRASS landholders in workshop and one to one farm visit	Landholder responses
What types of groundcover and streambank land management practices are you currently applying?	• Riparian fencing • Fencing to support rotational grazing • Fencing off 'sweet spots' to even out grazing pressure within paddocks • Systematic waterpoints to reduce cattle travel and ground pressure • Feed budgeting and grazing charts • Spelling to grow more grass • Matching stocking rate to carrying capacity • Mechanical intervention to support soil water retention, support seed establishment.
What did you expect (or were concerned about)?	• ability to achieve the outcome • how changed management would impact on time management • impact of ILMP on manual tasks
What did you experience when adopting land management practices?	• Variable rate of groundcover recovery related to weather, seasons, and land types • Positivity about the groundcover response from matching stocking rate to carrying capacity
What helped adopt these practices?	• Targeted training (provided privately) was the turning point to understanding the link between land management and business management • Past experiences with programs focussed on regenerative land management assisted in ease of adoption
What made it hard to adopt new practices (or was a barrier to working with programs)?	• Variable seasons make reliable cash flow a problem (hard to plan) • Funding in general • Lack of time • Ability to access specific knowledge tailored to paddocks, soil types etc • Government jargon • Past negative experience with Government (then suspicion that interaction with government will result in more regulation in the future) • Concerns about ownership and control of data once handed over
What would landholders like to do in the future and what do they need to support them making changes in the future?	• Introduce works to aid in further water retention such as mechanical works, contour banks • Improve and maintain grass cover and limit parthenium and weed growth. • More people on the ground with specialised skills and knowledge • More financial assistance • Financial recognition of good works already performed • More support to trial new methods without the risk

Table 4. Questions to and responses of ENI landholders.

Question asked of ENI landholders in one-to-one farm visit	Landholder responses
What did the ENI program support you to do on your property?	See Table 2
Is this your first experience with a funded program with NQDT/LDC	Yes in relation to funding. However, many landholders had past interactions with NQDT regional body through NQDT stakeholder engagement activities, etc.
What were your expectations of conducting funded actions	All landholders reported a feeling of positivity about dealing with NQDT through the ENI and had positive expectations about conducting the contracted activities. All landholders interviewed reported a feeling of excitement about being able to trial the funded activity, for many, this was an activity that they had been wanting to trial for a while but until engagement with ENI, did not have the capital and/or the risk appetite. There were some reports about concern about the potential success of the practice, but no concerns about the potential engagement with NQDT.
What makes it easy or hard for you to engage with the NQDT/ LDC? What do you think could be improved in the future?	What made it easy: • A straightforward process to apply for financial support with detail only around what the landholder wanted to do, how they wanted to do it and what the potential business and water quality impacts could be. • Financial support to cover capital expenditure. This enabled landholders to trial the practice/equipment on their property without the personal risk of losing money if the practice/equipment was not suitable to their property or business model in the long run. • Having an established and ongoing relationship with the same extension officer helped landholders find out about the ENI program, apply for funding and feel supported as they trialled the new practice/equipment. • No landholders reported challenges when engaging with NQDT for the ENI program.
Do you have any plans to continue/expand the funded action on your property in the future? (if yes when and in what ways and what is helping you do this/ if no what barriers or constraints are there?)	All landholders interviewed had plans to either continue or expand investment across their properties. Being able to do this was influenced by the season, time/labour availability and money. Additional funding for trialling with flexible deliverables on contract milestones was noted as facilitating expansion of land management activities.
Do you have any plans to make additional or new changes on your property? (if so what, when and in what ways, what enables and/or makes this a challenge?)	Most landholders expressed a desire to improve stock management across their paddocks through additional and strategic water points (and water telemetry); splitting and fencing for smaller paddocks; better weed management for better pasture. There was also interest in further improving land management through better understanding of flora and fauna on the property and in the region and management to support these (such as use of fire). See above for enablers.
Other	The landholders interviewed were very proud of what they had achieved and were keen to share their experiences with other landholders. Peer-to-peer learning was suggested as a way to capitalise on the investments made by the NQDT and broaden out the learning.

asset, knowledge or technology, specific to the transaction, that loses value outside of the transaction?" If the answer is "yes" then the transaction has characteristics of asset specificity. For agri-environmental transactions, the need to invest in specific assets for a transaction generates transaction costs through information collection activities.

6.1.1.1. Physical asset specificity. Engagement with the providers of the GRASS and the ENI programs did not require investment in physical assets and, therefore, did not generate transaction costs due to physical asset specificity. Adoption of the ILMPs themselves (in both the GRASS and the ENI program) did, however, require investment in specific assets. For example, adoption of GRASS ILMPs often results in a change in grazing regime from grazing that does not shift with seasonal load and grazing pressure to one that does (rotational grazing). This results in landholders investing in property layout reconfigurations requiring significant fencing and water point related capital. Whilst the investment in fences etc. is capital expenditure, landholders reported time and effort expended to collect information about adjusted grazing regimes prior to this capital expenditure. Landholders reported wanting more information about the process and potential business disruption associated with shifting to a new grazing regime. The GRASS program itself is designed to provide information to landholders about how to shift and the implications of ILMP adoption on the broader farm business and support them in applying for grants to fund the capital investment required to make the changes. Similarly, the ENI program was established to reduce the costs of information collection about new technology for land management by supporting the capital costs to trial new technology. Engaging in the ENI program generally resulted in technology that could be used across the whole property, even after the ENI contract had expired. Technology investments were not asset specific.

6.1.1.2. Knowledge specificity. Landholders from both case studies noted that no investment in specific knowledge was required when seeking to engage initially with the programs supporting the adoption of the ILMPs, but that investment in specific knowledge was often required if they adopted the ILMPs. Similar to the asset specificity and transaction costs discussion, however, the GRASS and ENI programs can be seen as initiatives designed to reduce the degree to which knowledge specificity drives transaction costs and generates a barrier to the adoption of ILMPS.

For most of the GRASS ILMPs, additional knowledge was required to implement the ILMP. Whilst knowledge collection incurred time and information transaction costs, once acquired, this knowledge could be applied across the property and outside of the ILMP transaction. An example of this is forage budgeting. Therefore, for most of GRASS ILMPs, knowledge invested in for the ILMP adoption was not specific to that one ILMP. There were some GRASS ILMPs that were knowledge-specific, however. This particularly related to the creation of structures such as contours and diversion banks designed to slow or divert water on a property. Several landholders noted that whilst they understood the benefits and the need for contouring banking, the information required to invest in these structures was specific to the area in which the activity was to be conducted. For example, one landholder said "whilst we understand the importance of the physical works and the benefits [the contour bank] will generate, we don't have the specific knowledge required to know exactly where we should put the contour .... we don't know how it will work on different soil types, what gradient to use .... we don't want to make the problem worse by doing a bad job." The landholder presented a solution to assist in overcoming the knowledge specificity. One landholder commented "There used to be soil conservation officers who would come out and map contour banks on your property and help you get the work done. There are very few government extension people with specialised knowledge left in the region. There are private suppliers, but they are hard to find, and you now have to pay for it." Provision of this information through a public provider could provide a simple solution to overcoming an ILMP adoption barrier with the potential for large public benefits in the form of reduced sediment running into the GBR.

For the ENI case study, the capital cost of investing in technology (and the transaction cost of researching the implications of technology investment) had been a barrier to adoption of technology in the past. However, the technology itself was not specific to the transaction. For example, one landholder was using the knowledge gained in the ENI investment to expand into other areas of digital technology investment such as soil moisture probes and electronic herd management. Interestingly, in the broader LDC survey, ENI landholders recorded the greatest personal growth (improving positive land management behaviours) from knowledge and skills gained due to engagement in LDC and ENI. On a scale of one to ten, related to personal growth, ENI landholders had an average knowledge and skills of 3 "five years ago" (compared with 4.8 for the broader LDC population), which has increased to 6 now and was projected to increase to 8.5 (compared with 8.2 for the LDC population) in five years' time.

6.1.1.3. Time and site specificity and transaction costs. Transactions that are time-dependent generate transaction costs due to the additional information required to get the timing right (from the supplier) and additional contracting and contract variations and monitoring effort required from the buyer (not looked at in this study). The environmental benefits from several ENI technology and GRASS activities were heavily dependent on the time and location of the investment, which many landholders reported to generate barriers to engagement or adoption of ILMPs. This barrier was not necessarily transaction cost related, however. For example, landholders noted "Sometimes we just can't do the actions in the time allowed because the weather does not allow us" (ENI). Landholders also noted "there is often not enough time or labour available"; "The time that a landholder has available will impact on if they apply for funding or not." "A landholder will not lodge an application for a grant if they don't think they can get it done." Information collection transaction costs related to program changes were highlighted by landholders to create a barrier to engagement and ILMP adoption.

Site specificity was noted as a barrier to engagement for GRASS, ENI and broader LDC landholders. Many LDC landholders noted that their ability to conduct the ILMPs in the specific place to generate the contracted outcomes was constrained by the nature of the land (steep gradients, rough country making access difficult). The site-specific nature of the land management change requirement was influencing transaction costs by increasing the time taken to conduct activities and/or increase costs due to the need to make modifications to equipment or pay more to contractors due to time and difficulty of required actions. One LDC survey respondent suggested that this could be handled by making additional funding available for landholders who had to manage land on steep terrain.

6.1.2. Frequency of transactions

Most of the ENI supported investments were one-off, but the application of the investment to the ILMP tended to be seasonally repeated. Therefore, transaction costs generated through information collection when learning about the equipment and how it integrates into property management occurs once and is then spread across a number of repeated transactions which do not each need new information collection investment. GRASS ILMP transactions are more long-term, but the specificity of the investment (property planning, etc.) is lower, resulting in a lower impact on transaction costs.

6.1.3. Uncertainty

ILMPs with greater perceived uncertainty will face greater transaction costs compared to the alternative. Uncertainty generates transaction costs through the time and effort invested in information collection to reduce uncertainty. Some GRASS landholders indicated that they were concerned about how the ILMP would occur on the ground and/or influence their daily operations. For example, landholders commented that they were concerned "that the practice change would not generate the expected outcome" and that "changed land management would impact on the manual task burden and time management of the business."

Both the GRASS and ENI programs were designed to assist landholders to overcome uncertainty. GRASS did this by supplying information to support land management change decision making, and in some cases, also providing some funding support for capital costs incurred in the adoption of the ILMP. ENI reduced uncertainty of technology adoption by covering the initial costs of trialling and training for perhaps an unproven technological investment (ENI). Landholders also reflected on other programs that had enabled them to reduce their uncertainty related to ILMPs. One of these is the broader program under which ENI belongs (Landholders Driving Change – LDC). In a recent survey of LDC participants, 75% of respondents agreed or strongly agreed that the LDC program had enabled them to trial something new on their property.

The authors note that if the government is providing financial assistance for trialling technology and practices, supported sharing of lessons should be actively encouraged to broaden the impact on reducing uncertainty. This could be through peer-to-peer learning like that occurring in New Zealand (Patchett, Bewsell, and Grigg 2020), reporting or landholder demonstration days. The information sharing method, however, should be tightly matched to the landholders sharing the information and the audience and designed to be as low in transaction costs to all parties as possible.

6.2. Characteristics of the transactors and transaction costs

6.2.1. Bounded rationality

Recall that bounded rationality refers to the fact that humans are bounded, not by the extent of information available and/or accrued, but by the ability to use this information in decision making. Education and past experience have been shown to reduce the cognitive load in decision making and reduce the transaction costs related to bounded rationality. We did not assess education level so can only reflect on the degree to which bounded rationality impacted on transaction costs and the degree to which past experience reduced these costs.

Many of the GRASS landholders reported previous experience of implementing ILMPs through the now non-existent industry-led Grazing Best Management Practice (BMP) program. GRASS landholders reported a positive experience with the Grazing BMP, reflecting on the impact of this experience in improving their knowledge of regenerative and sustainable farming practices which they were now implementing more broadly through GRASS. On the other hand, many ENI landholders had also had past experience with broader ILMPs through the Grazing Best Management Practice (BMP) program. However, this experience was negative. For example:

> "I felt disappointed and frustrated with the BMP process. I felt that those who had done all the work were not recognised and that nothing came of it. Those who had not complied were not held to account."

For many ENI landholders, past experience reduced the transaction costs associated with understanding the ILMPs but, because this experience had been negative, it increased the transaction costs of engaging with NQDT as trust had to be re-established.

ENI landholders also reported experience in other areas of government or land management that impacted on their ENI experience. For example, more than one landholder had previous experience working in local or regional government. More than one landholder had previous experience working on the technical elements upon which the ENI or broader ILMP was focused, such as ecology or agronomy. Information collection costs associated with the technology and its application on the property were also reduced due to existing knowledge in this area. ENI landholders reported that past experience with the process of grants meant that they were familiar with filling out forms, how to word their application and the process of applying for grants. Past experience meant that the time and effort conducting administration activities related to the ENI grant were reduced.

None of the landholders interviewed had past experience applying the ILMP on their property. A lack of experience can drive up transaction costs due to the time and effort required to learn about the practice or technology, as it applies specifically to a property and in the time to integrate the practice or technology into the day-to-day operations of the property. By funding training, the ENI began to overcome some of these transaction costs. Transaction costs associated with this learning can be further reduced by observation of other properties. This is discussed in relation to uncertainty and trust.

6.2.3. Trust, social connectedness (relationships) and common preferences

Having a prior, ongoing and trusted relationship and a common goal with the supporting organisation (usually through the extension officer) had a big influence on the transaction costs experienced by the landholders in the ENI program (and subsequent adoption of ILMPs). For example, landholders stated: "Without these past relationships [with NQDT] I don't think I would have been brave enough to come forward and ask about the possibility of trialling new ideas and the ability to gain funding." High staff turnover has had a negative impact on relationships and increases engagement transaction costs. For example, one landholder said "Ongoing relationships with the extension staff are really important. When the extension officers are on short term contracts, tied to short term funding cycles, the relationships are always changing, you always end up talking to a different person and the funding feels very stop start," another landholder stated "We have only been in the focus of NQDT for the last few years. In the early days, they had lots of staff turnover. You never knew who you would end up talking to next. We never bothered applying for grants because with the staff turnover it was all too hard."

Some landholders are yet to develop this trusting relationship (these tended to be those with less experience with support programs for ILMPs). For example, some landholders were mistrustful of the use of information that would be collected on their farming operations a result of engagement in supported ILMPs: “If we sign up to a register to say we have done the GRASS program, aren’t we just putting our hands up to say that we generate sediment on the reef?.” Trusting relationships were noted to be sometimes challenging to develop when they have been damaged in the past “The relationship between farmers and the government was significantly damaged by the whole [industry-led] BMP process. The LDC project has come some way in repairing this relationship.” However, the formation and fostering of a good working relationship could lead to great uptake of ILMPs in the future. For example, one landholder noted: “I am probably more open to ideas and future grants for water and wire due to the ENI experience.”

Connection between landholders was also noted to assist in the adoption of ILMPs. One landholder noted that: “Landholders don’t like being told what to do, they need the information put in front of them, they need face-to-face knowledge sharing. This is critical” 66% of LDC survey participants agreed or strongly agreed that the LDC program had supported them to work with other graziers to test new ideas and 76% of LDC survey participants agreed or strongly agreed that participation in the LDC program had enabled peer to peer knowledge sharing.

Others in the GRASS program suggested that producer groups, facilitated conversations between farmers about a topic and face-to-face access to experts all reduced the (transaction) costs of testing out ideas and growing their knowledge.

7. Conclusion

Through an application of transaction cost theory, the objective of this study was to understand whether and how perceived and actual transaction costs created a barrier to grazier engagement and adoption of ILMP programs. We looked specifically at two ILMP programs in two catchments critical to healthy water quality for the GBR. Drawing on transaction cost theory to create a framework for analysis, we explored whether and how the characteristics of the transaction and the transactors were generating transaction costs. We also explored whether and how programs designed and implemented to encourage adoption of ILMPs were reducing transaction costs.

Overall, we found that initial engagement in both case study ILMP programs did not require investment in assets or knowledge specific for engagement. Transaction costs of initial engagement were also reduced through the nurturing of relationships between landholders and extension staff managing ILMP programs. This is encouraging, as initial engagement is the first step to adoption of ILMPs. Transaction costs were borne in the adoption of ILMPs primarily through the collection of information about how these investments in assets and changed grazing practices would influence the whole farm business. Both the case study ILMP programs were proving successful at reducing the transaction costs associated with this information collection, as well as reducing the capital investment through assistance with applications for grants. Many landholders noted that some ILMPs require very specific knowledge, the cost of acquiring and specific nature of which was creating a barrier to adoption. We suggest that a cost-effective solution to this is government supplied information for ILMPs with highly specific knowledge requirements. Exploring adoption through a transaction cost lens also highlighted the importance of trusting relationships between landholders and, more so, between landholders and extension staff, in reducing transaction costs and supporting ILMP adoption. Extension itself generates public transaction costs. Analysis is needed to understand the balance between the public cost of extension and the public benefit of environmental change.

More broadly, we reflect on the application of transaction cost theory to understand an organisation problem outside of its original application. We note that transaction cost theory emerged from organisational economics seeking to explain the organisation of the firm. Whilst agri-environmental transactions are different to those of the firm, we show that applying the transaction cost theoretical framework is helpful for understanding where costs are occurring, how they influence decision making and what, if anything, can be done to help reduce these.

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Note

1. In some cases, there was more than one property taking up this activity.

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