Received 22 August 2018
Revised 1 November 2018
15 November 2018
19 March 2019
Accepted 21 March 2019

Social marketing's role in improving water quality on the Great Barrier Reef

Rachel Hay and Lynne Eagle
College of Business, Law and Governance, James Cook University, Townsville, Australia, and
Muhammad Abid Saleem
Department of Languages, National University of Modern Languages, Islamabad, Pakistan and College of Business, Law and Governance, James Cook University, Townsville, Australia

Abstract

Purpose – The purpose of this paper is to focus on the implications of claimed detrimental impacts for the agricultural activity of the Great Barrier Reef (GBR) ecosystem health in Queensland, Australia. The authors discuss the complex interaction of factors that have contributed to the decline in reef ecosystems and the challenges presented by multiple industries operating within the GBR catchment area. The authors then discuss measures employed to address agricultural run-off, claimed to be a significant factor in declining reef water quality.
Design/methodology/approach – Surveys of land managers were undertaken in partnership with two of the six natural resource management (NRM) organizations operating in areas adjacent to the GBR identified as having very high risk of natural and anthropogenic runoff. The sample population was obtained from a membership database within the two regions. Participants include land managers from the both regions who engaged in sugar cane production (Region 1 and Region 2, included in this paper) and cattle production (Region 2, to be reported later). Quantitative and qualitative data were analyzed including open-ended responses.
Findings – A large-scale study of land managers reveals several reasons for the lack of success at reducing agricultural run-off. The authors discuss the rationale for a move to a theory-grounded social marketing approach to encouraging land manager behavior change, highlighting barriers, and potential enablers of sustained behavior change.
Originality/value – This study is first of its kind that discusses the behavior of land managers in the GBR catchment area and highlights facilitators and impediments of land managers' behavior change toward GBR protection actions.

Keywords Social marketing, Theory of planned behaviour, Environmental degradation, Great Barrier Reef, Agricultural land management

Paper type Research paper

1. Introduction

The Great Barrier Reef (GBR) is both a Marine Park and a World Heritage site (Foxwell-Norton and Lester, 2017; Great Barrier Reef Marine Park Authority, 2017). It is the world's largest coral reef system, extending for more than 2,300 km along the Queensland (north-eastern) coast of Australia (Teakle *et al.*, 2015). It supports between 64,000 and 69,000 direct and indirect full-time equivalent jobs (Deloitte Access Economics, 2017; Butler *et al.*, 2013; Kroon *et al.*, 2016; Piggott-McKellar and McNamara, 2016). An estimated $AU56bn asset (economic, social, traditional owners and brand) value for the GBR was calculated in 2017. The direct economic contribution was estimated at $AU6.4bn, of which tourism contributed $AU2.4bn within the GBR region alone and $AU3.4bnto the overall Queensland economy (Deloitte Access Economics, 2017). The Deloitte estimates do not include the

This project is supported with funding from the Australian Government's National Environmental Science Program.

Asia Pacific Journal of Marketing and Logistics
Vol. 31 No. 5, 2019
pp. 1308-1343

1355-5855
DOI 10.1108/APJML-08-2018-0318

significant contribution to the Queensland economy by agricultural industries within the GBR water catchment areas. Sugar production is estimated to be worth $1.3–$1.5bn per annum (Queensland Cane Growers Association, 2010; Department of Agriculture and Fisheries, 2012), with meat (predominantly beef, which is classed as an export priority (Department of Agriculture Fisheries and Forestry, 2014) production contributing a further $US3.4bn per annum (Queensland Government, 2016). Space constraints prevent a detailed discussion of the impact of other significant industries such as mining on the GBR, for a discussion of this sector's impact see Grech *et al.* (2016).

2. Background and Literature

2.1 Impact of agricultural runoff on GBR water quality

The agricultural sector is cited as a major cause of water quality problems. This is due first to sediment loss from erosion of land, especially land used for grazing livestock (Thorburn *et al.*, 2013) and, second, leaching of fertilizer and pesticide residues from sugar cane production and other intensive agriculture sectors (Butler *et al.*, 2013). Outbreaks of the coral-destroying crown-of-thorns starfish have in the past been linked to increased levels of nutrients such as fertilizer in water (De'ath *et al.*, 2012; Fabricius *et al.*, 2010), although this is now disputed (Guo *et al.*, 2017).

Land managers claim to have been unfairly blamed for declining water quality (Galligan, 2016; Eagle *et al.*, 2016), although this is claimed more in news and trade media than in academic literature. Examples of media headlines are "Farmers unfairly blamed for water quality" (Carruthers, 2016) and "Great Barrier Reef debate leaves farmers frustrated over their negative portrayal on water quality improvements" (McKillop, 2016). Despite numerous initiatives, water quality improvement targets have not been met (Kroon *et al.*, 2016), leading to UNESCO reviewing the World Heritage status of the GBR, but delaying a final decision until 2020 (Coghlan *et al.*, 2017).

While a series of agriculture sector-specific "best management practices" (BMP) have been developed, uptake by land mangers has been lower than expected (Emtage and Herbohn, 2012a; Great Barrier Reef Marine Park Authority, 2014b) and there is little evidence of long-term impact (Greiner and Gregg, 2011). A significant percentage of farmers do not accept that their farming practices adversely affect water quality (Farr *et al.*, 2017b). One challenge is that agricultural runoff is a form of diffuse pollution, which creates difficulties in determining exactly what runoff comes from individual properties and thus what remedial action should occur to minimize it (Kroon *et al.*, 2014; Patterson *et al.*, 2015). Therefore, farmers will be "reluctant to participate if they feel that they will not benefit from engagement" (Blackstock *et al.*, 2010).

It is also claimed that the most significant source of sediment runoff is from steep terrain within National Parks, especially within the northern wet tropics area rather than from coastal plains on which the majority of cane farming occurs (Benn, 2013). Further, the effectiveness of recommended practices has been questioned, with claims that even if all farmers within the GBR catchment area were to adopt BMP, sediment and nitrogen runoff volumes will not reduce sufficiently to meet government-mandated targets although pesticide volume reductions may do so (Kroon *et al.*, 2016).

2.2 Concerns regarding the health of the Great Barrier Reef

Biodiversity on the GBR has reduced over recent decades. For example, coral cover is estimated to have halved in the last 40 years (Kroon *et al.*, 2016). The declining health of the GBR has received substantial media coverage over time (Piggott-McKellar and McNamara, 2016), with recent sensationalized claims suggesting it is in imminent danger of dying, as a result of climate change. For example, "The Great Barrier Reef is dying, and global warming set the scene" (*The Washington Post*, 2016).

This was one of 9 papers internationally to make this claim in 2016, with a further 13 articles discussing the likely impact of climate change on reef ecosystems and 22 articles specifically focussing on coral bleaching. In 2017, after two consecutive bleaching events, international news coverage about the reef increased from 67 articles in 2016 to 449 in 2017. Of these, 25 articles claimed imminent danger of the reef dying, 87 articles reported on coral bleaching and a further 104 articles discussed the likely impact of climate change on reef ecosystems.

GBR ecosystems are also impacted by cyclones (hurricanes), most recently Cyclone Debbie in March 2017 for which the extent of damage is still being determined. Cyclone Yasi in February 2011 is estimated to have damaged some 15 percent of corals (Beeden *et al.*, 2015). As well as direct wave action damage, heavy cyclonic rainfall increases the amount of fresh water flowing onto the GBR resulting in changes to salinity levels potentially killing corals (Hoegh-Guldberg, 2011). Sediment from runoff may also harm seagrass meadows on which numerous species of marine life depend (Great Barrier Reef Marine Park Authority, 2014a; Perry *et al.*, 2014; Wooldridge, 2017; Coles *et al.*, 2015).

2.3 Information deficit assumptions and trust in information sources

There appears to be an (incorrect) assumption that policy intentions automatically translate into on-farm practices (Fraser *et al.*, 2017). Among BMP and other recommended land management practices, reasons for low uptake are focussed on information provision and a failure to recognize that levels of trust in information from government sources is low (Haynes *et al.*, 2008; Emtage and Herbohn, 2012b). Behavior change is rarely achieved through information provision alone due to the complexity of decision making in areas such as this (Simis *et al.*, 2016). The credibility of information sources is also an essential precondition for information to be considered. Prior studies of land managers in the GBR catchment areas indicates that there is both a lack of trust and confidence in government-originated information (Emtage and Herbohn, 2012b).

Understanding a farmer's dominant personality as well as how that personality type learns is essential. Producer profiling, personality types and typology have been successfully used in conservation and natural resource management (NRM) practices, to guide communication strategies, identify target segments, manage risk and tailor land management policy and programs in beef cattle farming (Daloğlu *et al.*, 2014; Shrapnel and Davie, 2001). Bohnet *et al.* (2011) found that "understanding grazier's values and motivations can work with specific groups to achieve results." Recognizing producers' unique personality traits is a significant step toward shared understanding.

Having a clear understanding of the behavior requiring change (improved water quality), and insight into the farmer's behavior (i.e. drivers of decision making, trust, motivation, orientation (e.g. how they learn) and barriers to change) surrounding water quality decisions can assist researchers and other stakeholders to use theory to inform interventions that may create behavior change.

3. Research methodology

Surveys of land managers ($n = 302$) were undertaken in partnership with two (reported as Region 1 ($n = 248$) and Region 2 ($n = 54$)) of the six NRM organizations operating in areas adjacent to the GBR identified as having a very high risk of natural and anthropogenic runoff (Brodie, 2013). NRM organizations, of which there are 56 in Australia, acting under delegated authority from the federal government to coordinate environmental management within their regions. The study, funded by the Australian Government's National Environmental Science Program had two primary objectives: identify behavioral influences on land managers and assess land managers' perceptions of current

communication strategies together with, barriers to behavior change. The sample population was obtained from a membership database within the two regions. Participants include land managers from both regions who engaged in sugar cane production (Region 1 and Region 2, included in this paper) and cattle production (Region 2, to be reported later). Quantitative and qualitative data were analyzed including open-ended responses.

The survey was developed using information gathered from an initial literature review related to environmentally focussed social marketing (see Eagle *et al.*, 2016 for more details) and from literature surrounding agriculturally appropriate behaviors that impact water quality (Churchill *et al.*, 2017). The need to alter approaches to behavior change has been accepted by government agencies including the need to determine "what works, for whom, in what circumstances and for how long" (Marteau *et al.*, 2011). As with other complex areas, BMP-focussed behavior change activity lends itself to a social marketing approach via an understanding of the influence of intrapersonal, interpersonal, organizational, community and societal influences on behavioral decisions across different segments of land managers. This approach is compatible with advocated conservation marketing strategies (Wright *et al.*, 2015; Veríssimo, 2013; Bennett *et al.*, 2017).

3.1 Measurement instrument

The questionnaire development included several rounds of feedback from stakeholders including government and industry specialists, which resulted in an operational definition of the theory of planned behavior (ToPB) constructs. ToPB is the most frequently examined and reported explanation of several social behaviors in the literature (Fishbein and Ajzen, 2010). Use of a structured measurement instrument in this study is reasonable as it is a widely used approach to data collection when the purpose is for testing the relationship of established theories (such as the ToPB in this current study) (Field, 2017). Using a structured measurement instrument and survey methods provides control over the data collection process, it is relatively easy to administer, cost-effective and ultimately provides flexibility in subsequent data analysis (Bickman and Rog, 2009). As an application of the ToPB requires analysis of direct and indirect relationships of its constructs, the choice of analysis technique requires approaches that provide analysis of both direct and indirect effects. Of the methods for analyzing indirect (mediation) effects in behavioral theories, the approach of Baron and Kenny (1986) is the most frequently used (MacKinnon *et al.*, 2007). As outcome variables consisted of binary measurements, this study drew on the approach used by Desislava and Matilda (2011) for the analysis of mediation effects with binary outcomes. The PROCESS macro for SPSS v 24.0 (Preacher and Hayes, 2004a, b) was used in SPSS to analyze direct and indirect effects, which is very convenient and specifically appropriate when explanatory latent constructs are based on a single item (Preacher and Hayes, 2004a). The model estimation was performed by using Model No. 4 of Hayes' templates (Preacher *et al.*, 2007) that provides estimates of indirect effects on the basis of upper and lower limit of confidence intervals, thus accommodating the traditional limitation of the power problem in Baron and Kenny's (1986) approach. To assess the statistical significance of the estimated paths, 5,000 bootstrap re-sample and bias-corrected 95% confidence intervals (CI) were utilized (Preacher and Hayes, 2004b).

Fertilizer application behavior. Farmers were engaged in six different types of fertilizer application behaviors (see Appendix 1 a summary of measurement items). Feedback from stakeholders indicated that the industry standard "six easy steps" was the desired fertilizer application behavior (Reef Water Quality, 2016). Therefore, a binary approach was followed to operationalize fertilizer application behavior. The industry standard "six easy steps" was coded as "1" (desired probable behavior) while all other practices were coded "0."

Run-off practices. Handling run-off practices were also conceptualized in the context of ToPB, where farmers adopted four different types of run-off practices. Insights from stakeholders indicated that using "recycle pits or sediment traps" was the desired practice for handling run-off. "Recycle pits/sediment traps" practices were coded as "1" (desired probable behavior) while all other practices were coded as "0."

Farmers were advised to reflect on their attitude toward fertilizer application behavior and handling run-off practices where subjective norms, perceived behavioral control and motivations toward behavior were all conceptualized and measured in the same way, as follows.

3.2 Attitudes, perceived norms and perceived behavioral control

Attitudes toward fertilizer application behavior were measured using a four-items scale. A single item measured subjective norms while the perceived behavioral control construct was measured by using a three-items scale.

Motivations toward behavior. Four different set of motivations guiding fertilizer application behavior: lifestyle, financial or economic goals, social goals, and environmental goals were conceptualized (Farr *et al.*, 2017b). Lifestyle, financial or economic goals and social goals each were measured by using a five-item scale, while a six-item scale measured environmental goals.

Responses on all items were recorded on a seven-point Likert scale (1 "extremely unimportant" to 7 "extremely important").

3.3 Intervention and evaluation

Interventions in the research region are overseen by the Australian Government's National Environmental Science Programme's (NESP, 2015-2021) primary objective to reduce sediment, fertilizer and pesticide run-off in the GBR Basin. Confounding factors include multi-organization involvement in research in the GBR catchment area. Therefore, the measurement of the effects of any specific intervention comes with some limitations.

We applied the eight National Social Marketing Center's (NSMC) benchmark criteria (National Social Marketing Center, 2016) to results from a study of cane growers in two regions adjacent to the GBR. The NSMC benchmark criteria are internationally recognized procedural guideline to identify, design and implement an intervention for behavior change. The NSMC criteria include:

(1) Behavior – it aims to change peoples' actual behavior.

(2) Customer orientation – it focusses on the audience, fully understands their lives, behavior and the issue using a mix of data sources and research methods.

(3) Theory – it uses behavioral theories to understand behavior and inform the intervention.

(4) Insight – it research identifies "actionable insights," pieces of understanding that may lead to intervention development.

(5) Exchange – it considers the benefits and costs of adopting and maintaining new behavior, maximizes the benefits and minimizes the costs to create and attractive offer.

(6) Competition – it seeks to understand what competes for the audience's time, attention and inclination to behave in a particular way.

(7) Segmentation – it avoids "one size fits all" approach and identifies segments that have common interest and characteristics and then tailors interventions appropriately.

(8) Methods mix – it uses a mix of methods to bring about change in behavior.

Social marketing is a discipline that calls on a variety of theoretical models in a multidisciplinary framework for developing innovative solutions using a substantial research base to initiate behavior change in communities, organization and society. Social marketing came into focus in the UK,due to a major change in behavior change policy with the initial focus being on public health. This was due to the release of the White Paper Choosing Health (Department of Health, 2004). The white paper specifically advocated the adoption of the principles underpinning social marketing in order to attempt to influence a range of public health issues. A feature of the white paper was the acknowledgment that existing educationally focussed communication-based strategies were not effective. A major NSMC report, built on the White Paper, presented evidence of social marketing's potential contribution in the area and its superiority compared to information-based strategies in achieving sustained behavior change. While primarily focussed on health-related issues initially, social marketing has expanded to include a wide range of issues and behaviors in (among others) agri-environmental and NRM (Eagle *et al.*, 2016). We now discuss both key findings and recommended strategies for the improvement of interaction with land managers in the future.

4. Findings

4.1 NSMC Benchmark 1– Behavior

Focus on influencing specific behaviors, not just knowledge, attitudes and beliefs. Specific focus was placed on separating attitudes and actual behaviors relating to specific activities such as runoff control and fertilizer use. Each of the eight interventions targeted best management practice to improve water quality practices using communication design to address the specific behaviors.

4.2 NSMC Benchmark 2 – Customer Orientation

Focus on the audience. Personal goals and aspirations were measured, with the three main drivers of behaviors being productivity, sustainability and financial security. The literature states that when increased productivity aligns with farmers' personal goals, it acts as a conduit to pro-environmental behavior (Lambert *et al.*, 2006). Financial security, for example, greater wealth/capital and therefore more potential to invest, also increases the feasibility of the adoption of pro-environmental behavior (Farr *et al.*, 2017a). The data show that the surveyed farmers' attitude and subjective norms align with sustainable farming practices as two-thirds of cane farmers and one-third of graziers identified sustainability as a personal goal.

4.3 NSMC Benchmark 3 – Behavioral Theories

Use of individual theories or combinations to understand behavior and inform the intervention, including testing of theoretical assumptions. The targeted behaviors were explained through the ToPB. A summary of the results is provided in the succeeding section.

We found that the farmer's choice of fertilizer application according to industry standard was positively influenced by elements of lifestyle and social goals through attitude toward behavior. Similarly, there was a positive influence of environmental goals on fertilizer application behavior (following the industry standard) through subjective norms ("Farmers I respect most do this"). An interesting aspect in these findings is that some of the factors influencing farmers to follow industry standards in fertilizer application failed to cast any impact directly, for example, "Being able to make my own decisions," "Sharing new ideas with others" and "Having efforts recognized by the larger community." However, when mediated by a positive attitude toward behavior, the influence became significant

(see Appendix 2). This supports our conceptualization that pro-social/environmental behaviors can be better understood in a theoretical schema rather than in isolation.

For practices related to handling run-off, the sample from Region 1 ($n = 248$) was used because the sample from Region 2 ($n = 54$) was too small to estimate the model the combined sample was not methodologically feasible to use. Differences in handling runoff practices exist among the farmers of Regions 1 and 2 (thus causing heterogeneity in sample characteristics).

We found that farmers' practice of using recycle pits or sediment traps for handling run-off was influenced by several motivational factors through attitude toward behavior ("Least time consuming" and "Best way to reduce business risk").

Results show that attitude (i.e. "least time consuming") negatively mediated the relationships of lifestyle activities with handling run-off practices, including maintaining family traditions, spending face-to-face time, keeping in contact with family and friends and maintaining good relations with other farmers. Interestingly, two relationships "Spending face to face time with family" and "Maintaining good relations with other farmers/graziers," reflected full mediation (see Appendix 3 and 4).

Financial motivations including low farm cost, maximization of profits, minimizing risk and debt servicing were found to have negatively mediating effects on run-off handling practices through attitude (i.e. least time consuming). Results also highlighted that social motivation including time to pursue hobbies, being able to make own decisions, learning about testing new ways of doing things, sharing new ideas and having efforts recognized by the wider community also have negatively mediated relationships through attitude. All show full mediation except for "Having time to pursue hobbies" (see Appendix 3).

One of the environmental goals (maintaining water supplies and storages) also had an impact on handling runoff practices mediated negatively by attitudes. In addition to the "Least time consuming" attitude, the results showed that "Reduce business risk" attitude also mediated several hypothesized relationships. Lifestyle, economic goals and environmental goals had an impact on run-off handling practices negatively mediated through attitude "reduce business risk" (see Appendices 3 and 4).

4.4 NSMC Benchmark 4 – Insight

Insight into what influences decisions to change or not change behaviors, including the influence of others on decisions. While there is an assumption that a (male) land manager is the sole decision maker (Bock, 2006), the descriptive results showed that the majority of decisions are not taken in isolation, rather involve others, particularly spouses/partners and extended family. Extant literature has shown that women have become more involved in decision making, and their role in farming being recognized as valuable (Farmar-Bowers, 2010; Pannell and Vanclay, 2011; Umrani and Ghadially, 2003). Financial pressure is also evident as a driver toward women's return to work. Results show that the percentage of respondents and their spouses/partners who work off-farm was principally driven by the motive of financial independence manifested in the element "farm is not as profitable as it could be." Therefore, the women who worked off farm are motivated to contribute to the family income and to form social bonds with the working community.

It was noted that the lack of trust existed among farmers and the government agencies reflected in respondent's views. The farmers seemed to depend more on family and peer than governmental agencies for information necessary to improve the farm efficiency. Information overload appears to be an irritating factor for some land managers leading to a lack of trust.

It was further observed that there were instances of non-acceptance of links between current agricultural practices and GBR water quality problems is Perhaps this is why over 90 percent of respondents indicated that they have no plans to change their practice significantly.

Moreover, there is a significant lack of acceptance of agricultural impacts on GBR water quality and therefore the need to alter and enhance knowledge in this regard. For example, existing evidence shows that the majority of respondents in both Regions 1 and Region 2 agreed that "sediment/nutrient loss does not affect water quality locally" (Farr *et al.*, 2016).

4.5 NSMC Benchmark 5 – Exchange

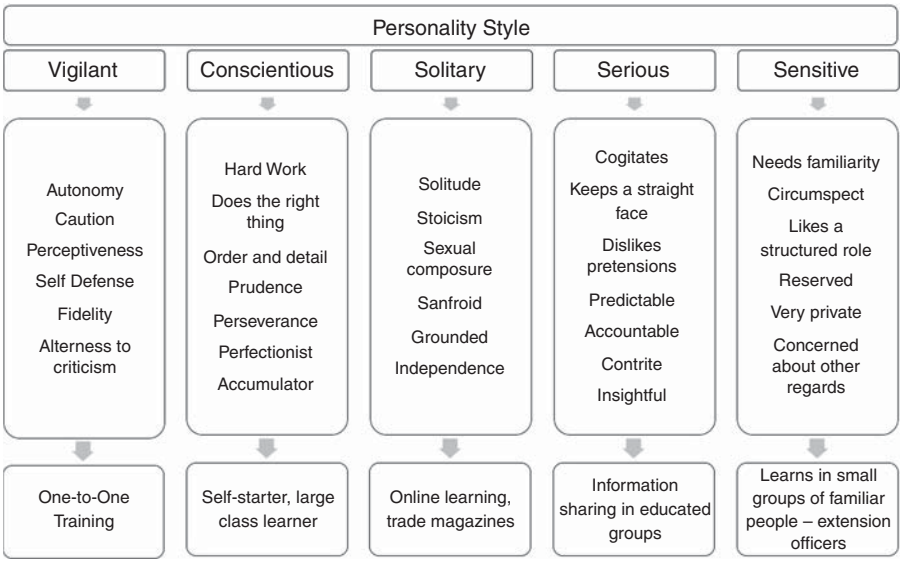
Maximize benefits and minimizing costs of adopting and maintaining desired behaviors. The value of this study has both intangible and tangible dimensions from the exchange. Results underpin that intangible effects come from social goals, while tangible effects in the form of financial support (from government tenders and other funding) gained by more than 88 percent of funding applicants.

4.6 NSMC Benchmark 6 – Competition

Understanding of what competes for time, attention, and inclination to behave in a particular way. Survey respondents reported that the funding process was tedious, difficult, unfair, and untimely, competing against other farming priorities making it less attractive and a waste of time.

4.7 NSMC Benchmark 7 – Segmentation

Avoids one size fits all approach. The diversity of farmers and farming practice is acknowledged, and it is useful to consider the role of typologies (Daloğlu *et al.*, 2014; Van Herzele *et al.*, 2013; McGuire *et al.*, 2015) through the identification of the range of decision-making drivers and the types of land managers who are motivated by similar drivers (Graymore and Wallis, 2010). Using typology in conjunction with an intimate level of knowledge about the landholder, as often held by extension officers, is one solution to successful engagement and in turn behavior change. For example, dominant personality styles (Shrapnel and Davie, 2001) may be used to direct learning as indicated in Figure 1.



Source: Adapted from Sharpnel and Davie (2001)

Figure 1. Characteristics of the dominant personality styles in learning environments

4.8 NSMC Benchmark 8 – Methods Mix

Uses a mix of methods to bring about behavior change, does not rely solely on raising awareness. The materials used to raise awareness of runoff were analyzed for readability in this project (Hay and Eagle, 2016). The analysis found the material supplied to be written in language too complex for the majority of the intended target to be able to readily comprehend it. The message tone used in some of the material may be also have been a barrier, and the visual imagery used may have had unintended effects on communication (Hay *et al*., 2018). The tone of a message can affect the way messages are process and how influential they are or not (Hay *et al*., 2018), while visual imagery can strengthen (or weaken) language fluency by building a connection between verbal and visual representations (Hay *et al*., 2018) There is a need to ensure all communication, by whatever means, sends consistent messages irrespective of source and channeling communication through trusted sources. There is also a need to incorporate social media strategies as part of an integrated communication strategy that centers on the information channels and platforms used and preferred by land managers.

5. Discussion

There is an implicit assumption that a general attitude about an issue such as GBR water quality will lead to behavior change among those who may be able to take individual or collective action, which is incorrect (Ham, 2009). Behavior change will not occur "unless a specific behavior is explicitly targeted and communication is designed to address attitudes relevant to that behavior" (Stern and Powell, 2013). A gap between reported attitudes toward environmental issues and actual behaviors is well documented in the literature (Ockwell *et al*., 2009).

The ToPB was chosen as the most suitable theoretical approach to explore land management practices/"behaviors" as it has been identified as having reasonable power to explain people's behavior in different contexts (Eagle *et al*., 2016). Theory-based behavior change strategies, used in both developed and developing countries (Wheeler *et al*., 2013; Werner *et al*., 2017), have been proven to be more effective than those developed without theoretical foundation (Glanz and Bishop, 2010; Davis *et al*., 2015). ToPB (Ajzen, 1991) has also been used to analyze other pro-environmental behaviors such as water conservation (Pino *et al*., 2017; Yazdanpanah *et al*., 2014; Pradhananga *et al*., 2017) and it is reported to have strong explanatory power for several behaviors in social, societal, environmental and enviropreneurial marketing research (Khoi *et al*., 2018; Kumar *et al*., 2017).

The use of theory to understand drivers of behavior will lessen the knowledge gap between informants and the informed and reduce the lack of acceptance of agricultural impacts on GBR water quality, and inform strategy toward behavior change. In considering strategies, not only must the lack of trust in government-originated sources be considered, but also the ability of the scientific community to "sell the science." The lack of communication skills to enable scientists to transfer new knowledge to farmers has been noted, leading to increased recognition of the potential for advisory personnel/extension officers to become the " 'engine for innovation' and (to) 'build capacity' " (Sewell *et al*., 2017) alongside peer learning and support.

The concept of exchange has been shown to be an important factor in interventions as diverse as injury prevention and land use (Newton *et al*., 2013; Wilhelm-Rechmann *et al*., 2014). While exchange theory offers incentives in return for behavior change (Eagle *et al*., 2013) individuals must "volunteer to change behavior" to receive positive "exchange of value" (Smith, 2006).

The non-acceptance of links between current agricultural practices and GBR water quality problems is evident. There is a significant lack of acceptance of agricultural impacts

on GBR water quality and therefore the need to alter and enhance knowledge in this regard. It has been noted that the "knowledge production processes must involve the stakeholders the most concerned by the problem" (Girard, 2015). Learning from peers is acknowledged as effective in gaining acceptance of new knowledge (Hoffman *et al.*, 2015). Three-quarters of respondents indicated that good relationships with other farmers/graziers in the local area were important to them as was the sharing of new ideas (Farr *et al.*, 2016).

Farmers gather information from a wide range of sources and integrate it themselves. Therefore, it is important to understand those sources and their relative influence on land management practices (Baird *et al.*, 2016). Information overload appears to be an irritating factor for some land managers, and it is recommended that a system is set up to monitor information from all sources (especially extension officers) and to combat messages that run counter to the desired core messages re BMP.

While extension officers (people who work directly with farmers and companies to provide advice related to agriculture, particularly with the view to increase productivity) are highly regarded by land managers in these two NRM Regions, they are not encouraged to have contact with disengaged land managers but rather to concentrate on those already engaged. This is consistent with findings from other countries, for example, the USA, where reluctance to try to build new relationships was evident, as it could negatively impact on existing relationships (Diem *et al.*, 2011). One extension officer noted that they had been told not to visit farms run by members with a specific surname because they were disengaged. However, when the research team investigated further, it appeared that there are several unrelated families in the same region with the same surname, only one of which is disengaged. This means that the three other farms had not been visited by extension officers. Also, extension officers are not encouraged to be innovative; new ideas are not encouraged by either management or longer-serving fellow extension officers.

An additional confounding factor is the disregard for the efforts of "positive deviants" – land managers who have changed practice but who are seen by their peers as "going against the norm" (Pant and Hambly, 2009) – "Positive deviants" experiencing success are meeting their personal goals and expected outcomes of a particular practice. Survey responses (Farr *et al.*, 2016) highlight beliefs, meeting personal goals and expected outcomes and perceived control as important to land managers. Therefore, efforts to promote best management practice, to meet the perceived control behavior, should demonstrate ecological benefits, such as improving the environment and enhancing participation in ecological conservation activities.

There is a range of competing and conflicting messages received by land managers, including mostly negative media coverage of issues relating to the health of the GBR (Eagle *et al.*, 2018), and messages from mills and farm supply merchants. Improved communication within marketing material for water quality programs will help to achieve consistency in approach and message clarity, amongst the gamut of communication materials produced for projects that support Reef communication materials. Improving the way projects communicate and get buy-in from land managers can help to ensure greater project uptake, associated positive results and lasting behavior change.

6. Limitations and future research

There were many competing and sometimes conflicting activities in both regions including eight other research projects, potentially resulting in respondent research fatigue and increased media activity regarding the health of the GBR in 2017 (Eagle *et al.*, 2018). These confounding factors make it impossible to identify the impact of individual projects. Future research needs to be based around an integrated evaluation program of existing and future research.

The ToPB was adapted to explain the factors influencing farmers' cane growing practices. While recognizing that there are differences between Region 1 (wet tropics) and Region 2

(dry tropics) (different irrigation practices between wet and dry tropics), it is assumed that each region shares a common goal to meet the industry standard for fertilizer application. Therefore, a combined sample for estimation of fertilizer application behavior was used. However, this assumption of sample homogeneity should be tested in future studies.

7. Conclusion

The GBR plays an important role in protecting the coastline from wave action and tropical storms, it provides habitats and shelter for marine animals and it assists in carbon fixing (the process of converting inorganic carbon (carbon dioxide) to organic compounds used by living organisms). The GBR also provides community benefits, for example, well-being through the value of its natural beauty, cultural connections to sea country and employment opportunities. Therefore, it is important that strategies be developed to protect the GBR (Great Barrier Reef Marine Park Authority, 2018; Bauer, 2009).

Although the GBR is claimed to be one of the world's best-managed marine parks (Fraser *et al*., 2017), there is at least a partial disconnect between policy intent and on-ground management practices. Critics suggest that policy is fragmented and unsynchronised across different government sectors and levels of government and that this, coupled with limits of jurisdiction and management responsibilities across different sectors of government and resource management, prevents effective environmental management strategies (Dale *et al*., 2016).

A focus on specific behaviors related to GBR water quality will help bridge the gap between those who do not believe their farming practices affect water quality and amongst those who may be able to take individual or collective action. The complexity of factors that affect land management practices means that no single policy instrument is likely to be universally valid (Greiner, 2014; Rolfe and Gregg, 2015). Understanding the target's lives, behaviors and sources of information and influence, for example, how and whom makes decisions and both on and off-farm behavior may act as a conduit for pro-environmental behavior change.

Encouraging best practice land management uptake amongst land managers who have not done so previously requires the encouragement of participation in projects based on an understanding of the multiple pressures and influences on farmer behavior (Blackstock *et al*., 2010; Feola and Binder, 2010) and the specific factors that will lead to potential engagement (Rolfe and Gregg, 2015).

While there is a growing body of literature relating to social marketing in the agricultural context, it focuses either on broad principles (Green *et al*., 2013; Kennedy, 2010; McElhinney, 2016; Takahashi, 2009), workplace health and safety issues (Yoder and Murphy, 2012), electricity and water consumption efficiency or climate change adaptation (Fleming and Vanclay, 2011; Maibach *et al*., 2008). Two graduate student theses address agri-environment issues from a social marketing perspective, with a specific focus on community-based social marketing, but neither provides a detailed analysis of issues nor tests interventions, relying instead on proposals for future activity (Greenland-Smith, 2011; Ramsdell, 2014). This paper contributes to the literature on the application of the social marketing benchmark criteria to the agri-environment and specifically to literature, which applies the social marketing benchmark criteria for behavior change in land management practices.

References

Ajzen, I. (1991), "The theory of planned behavior", *Organizational Behavior and Human Decision Processes*, Vol. 50 No. 2, pp. 179-211.

Baird, J., Jollineau, M., Plummer, R. and Valenti, J. (2016), "Exploring agricultural advice networks, beneficial management practices and water quality on the landscape: a geospatial social-ecological systems analysis", *Land Use Policy*, Vol. 51, pp. 236-243, doi: https://doi.org/10.1016/j.landusepol.2015.11.017.

Baron, R.M. and Kenny, D.A. (1986), "The moderator–mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations", *Journal of Personality and Social Psychology*, Vol. 51 No. 6, pp. 1173-1182.

Bauer, A. (2009), "Human impact of the reef", in Queensland Museum (Ed.), *Importance of Coral Reefs*, Queensland Government, available at: www.qm.qld.gov.au/microsites/biodiscovery/05human-impact/importance-of-coral-reefs.html

Beeden, R., Maynard, J., Puotinen, M., Marshall, P., Dryden, J., Goldberg, J. and Williams, G. (2015), "Impacts and recovery from severe tropical Cyclone Yasi on the Great Barrier Reef", *PloS One*, Vol. 10 No. 4, pp. 1-17.

Benn, K.E. (2013), *The Barriers to Adoption of Recommended Fertiliser Use Practices by Sugarcane Growers in the Wet Tropics*, James Cook University, available at: https://researchonline.jcu.edu.au/29590/1/29590_Benn_2013_thesis.pdf

Bennett, N.J., Roth, R., Klain, S.C., Chan, K., Clark, D.A., Cullman, G., Epstein, G., Nelson, M.P., Stedman, R., Teel, T.L., Thomas, R., Verissimo, D. and Wyborn, C. (2017), "Mainstreaming the social sciences in conservation", *Conservation Biology*, Vol. 31 No. 1, pp. 56-66.

Bickman, L. and Rog, D.J. (2009), *The SAGE Handbook of Applied Social Research Methods*, SAGE Publications, Thousand Oaks, CA.

Blackstock, K.L., Ingram, J., Burton, R., Brown, K.M. and Slee, B. (2010), "Understanding and influencing behaviour change by farmers to improve water quality", *Science of The Total Environment*, Vol. 408 No. 23, pp. 5631-5638.

Bock, B.S.S. (2006), *Rural Gender Relations: Issues and Case Studies*, GBR, CABI Publishing, Wallingford, Oxon.

Bohnet, I.C., Roberts, B., Harding, E. and Haug, K.J. (2011), "A typology of graziers to inform a more targeted approach for developing natural resource management policies and agricultural extension programs", *Land Use Policy*, Vol. 28 No. 3, pp. 629-637.

Brodie, J., Waterhouse, J. and Maynard, J. (2013), "Assessment of the relative risk of water quality to ecosystems of the Great Barrier Reef: A report to the Department of the Environment and Heritage Protection", Centre for Tropical Water and Aquatic Ecosystem Research, James Cook University, Townsville, available at: www.researchgate.net/publication/285590901_Assessment_of_the_relative_risk_of_water_quality_to_ecosystems_of_the_Great_Barrier_Reef_A_report_to_the_Department_of_the_Environment_and_Heritage_Protection_Queensland_Government_Brisbane_-_Report_1

Butler, J.R., Wong, G.Y., Metcalfe, D.J., Honzák, M., Pert, P.L., Rao, N., van Grieken, M.E., Lawson, T., Bruce, C. and Kroon, F.J. (2013), "An analysis of trade-offs between multiple ecosystem services and stakeholders linked to land use and water quality management in the Great Barrier Reef, Australia", *Agriculture, Ecosystems & Environment*, Vol. 180, pp. 176-191, doi: https://doi.org/10.1016/j.agee.2011.08.017.

Carruthers, P. (2016), "Farmers unfairly blamed for water quality", *The Guardian,* News Corp Australia, available at: www.whitsundaycoastguardian.com.au/news/reef-to-get-90m/3080831/

Churchill, M., Farr, M., Eagle, L. and Hay, R. (2017), "Getting the 'best bang for your buck': which land management practices achieve the best water quality outcomes, and the greatest uptake? Unpublished report to the National Environmental Science Programme, Reef and Rainforest Research Centre Limited, Cairns", available at: www.nesptropical.edu.au

Coghlan, A., McLennan, C.-L. and Moyle, B. (2017), "Contested images, place meaning and potential tourists' responses to an iconic nature-based attraction 'at risk': the case of the Great Barrier Reef", *Tourism Recreation Research*, Vol. 42 No. 3, pp. 299-315, doi: 10.1080/02508281.2016.1268744.

Coles, R.G., Rasheed, M.A., McKenzie, L.J., Grech, A., York, P.H., Sheaves, M., McKenna, S. and Bryant, C. (2015), "The Great Barrier Reef World Heritage Area seagrasses: managing this iconic Australian ecosystem resource for the future", *Estuarine, Coastal and Shelf Science*, Vol. 153, pp. A1-A12, doi: https://doi.org/10.1016/j.ecss.2014.07.020.

Dale, A.P., Vella, K., Pressey, R.L., Brodie, J., Gooch, M., Potts, R. and Eberhard, R. (2016), "Risk analysis of the governance system affecting outcomes in the Great Barrier Reef", *Journal of Environmental Management*, Vol. 183 No. 3, pp. 712-721.

Daloğlu, I., Nassauer, J.I., Riolo, R.L. and Scavia, D. (2014), "Development of a farmer typology of agricultural conservation behavior in the American Corn Belt", *Agricultural Systems*, Vol. 129, pp. 93-102.

Davis, R., Campbell, R., Hildon, Z., Hobbs, L. and Michie, S. (2015), "Theories of behaviour and behaviour change across the social and behavioural sciences: a scoping review", *Health Psychology Review*, Vol. 9 No. 3, pp. 323-344.

De'ath, G., Fabricius, K.E., Sweatman, H. and Puotinen, M. (2012), "The 27–year decline of coral cover on the Great Barrier Reef and its causes", *Proceedings of the National Academy of Sciences*, Vol. 109 No. 44, pp. 17995-17999.

Deloitte Access Economics (2017), *At What Price? The Economic, Social and Icon Value of the Great Barrier Reef*, Deloitte Access Economics, Brisbane.

Department of Agriculture and Fisheries (2012), *Field Crops and Pastures: Sugar*, Queensland Government, Brisbane.

Department of Agriculture Fisheries and Forestry (2014), "Draft beef industry action plan 2014–2016", available at: www.southburnett.biz/pdfs/draft-beef-industry-action-plan.pdf

Department of Health (2004), "Choosing health: making healthy choices easier", Printed in the UK for The Stationery Office Limited on behalf of the Controller of Her Majesty's Stationery Office, London, available at: www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4094550

Desislava, I.Y. and Matilda, I.A.B. (2011), "Gender effects on risk-taking of entrepreneurs: evidence from Bulgaria", *International Journal of Entrepreneurial Behavior & Research*, Vol. 17 No. 3, pp. 272-295, doi: 10.1108/13552551111130718.

Diem, K.G., Hino, J., Martin, D. and Meisenbach, T. (2011), "Is Extension ready to adopt technology for delivering programs and reaching new audiences", *Journal of Extension*, Vol. 49 No. 6, pp. 1-7.

Eagle, L., Hay, R. and Farr, M. (2016), "Harnessing the science of social marketing and behaviour change for improved water quality in the GBR: Background review of literature", report to the National Environmental Science Programme, Reef and Rainforest Research Centre, Cairns, p. 98, available at: www.nesptropical.edu.au

Eagle, L., Hay, R. and Low, D.R. (2018), "Competing and conflicting messages via online news media: potential impacts of claims that the Great Barrier Reef is dying", *Ocean & Coastal Management*, Vol. 158, pp. 154-163.

Eagle, L., Dahl, S., Hill, S., Bird, S., Spotswood, F. and Tapp, A. (2013), *Social Marketing*, Pearson, Harlow.

Emtage, N. and Herbohn, J. (2012a), "Assessing rural landholders diversity in the Wet Tropics region of Queensland, Australia in relation to natural resource management programs: a market segmentation approach", *Agricultural Systems*, Vol. 110, pp. 107-118.

Emtage, N. and Herbohn, J. (2012b), "Implications of landholders' management goals, use of information and trust of others for the adoption of recommended practices in the Wet Tropics region of Australia", *Landscape and Urban Planning*, Vol. 107 No. 4, pp. 351-360.

Fabricius, K., Okaji, K. and De'Ath, G. (2010), "Three lines of evidence to link outbreaks of the crown-of-thorns seastar Acanthaster planci to the release of larval food limitation", *Coral Reefs*, Vol. 29 No. 3, pp. 593-605.

Farmar-Bowers, Q. (2010), "Understanding the strategic decisions women make in farming families", *Journal of Rural Studies*, Vol. 26 No. 2, pp. 141-151.

Farr, M., Eagle, L. and Hay, R. (2016), "Questionnaire Design, Sampling Strategy and Preliminary Findings: a Comparison of the Burdekin and Wet Tropics regions. NESP Project 2.1.3 Interim report", report to the National Environmental Science Program, Reef and Rainforest Research Centre Limited, Cairns, p. 79, available at: www.nesptropical.edu.au

Farr, M., Eagle, L. and Hay, R. (2017a), "Key determinants of pro-environmental behaviour of land managers in the agricultural sector: supplementary literature review", NESP Project 2.1.3 Supplementary Literature Review, Report to the National Environmental Science Programme, Reef and Rainforest Research Centre Limited, Cairns, p. 97.

Farr, M., Eagle, L., Hay, R. and Churchill, M. (2017b), "Questionnaire Design, Sampling Strategy and Preliminary Findings: The Wet Tropics Region, Interim report to the National Environmental Science Programme, Reef and Rainforest Research Centre Limited, Cairns (112pp)", available at: www.nesptropical.edu.au

Feola, G. and Binder, C.R. (2010), "Towards in improved understanding of farmers' behaviur: the integrative agent-centred (IAC) approach", *Ecological Economics*, Vol. 69 No. 12, pp. 2323-2333.

Field, A. (2017), *Discovering Statistics Using IBM SPSS Statistics: North American Edition*, Vol. 2017, 5th ed., Ringgold Inc., Beaverton.

Fishbein, M. and Ajzen, I. (2010), *Predicting and Changing Behaviour*, Taylor and Francis, New York, NY.

Fleming, A. and Vanclay, F. (2011), "Farmer responses to climate change and sustainable agriculture", in Lichtfouse, E., Hamelin, M., Navarrete, M. and Debaeke, P. (Eds), *Sustainable Agriculture*, Vol. 2, Springer, pp. 283-293.

Foxwell-Norton, K. and Lester, L. (2017), "Saving the great barrier reef from disaster, media then and now", *Media, Culture & Society*, Vol. 39 No. 4, pp. 568-581.

Fraser, K.A., Adams, V.M., Pressey, R.L. and Pandolfi, J.M. (2017), "Purpose, policy, and practice: intent and reality for on-ground management and outcomes of the Great Barrier Reef Marine Park", *Marine Policy*, Vol. 81, pp. 301-311.

Galligan, D. (2016), "Standing in the spotlight", (0157-3039), available at: https://search.informit.com.au/documentSummary;dn=142242546810696;res=IELHSS

Girard, N. (2015), "Knowledge at the boundary between science and society: a review of the use of farmers' knowledge in agricultural development", *Journal of Knowledge Management*, Vol. 19 No. 5, pp. 949-967.

Glanz, K. and Bishop, D.B. (2010), "The role of behavioral science theory in development and implementation of public health interventions", *Annual Review of Public Health*, Vol. 31 No. 1, pp. 399-418, doi: 10.1146/annurev.publhealth.012809.103604.

Graymore, M.L.M. and Wallis, A.M. (2010), "Water savings or water efficiency? Water-use attitudes and behaviour in rural and regional areas", *International Journal of Sustainable Development & World Ecology*, Vol. 17 No. 1, pp. 84-93, doi: 10.1080/13504500903497249.

Great Barrier Reef Marine Park Authority (2014a), "Great barrier reef outlook report 2014", Townsville, Great Barrier Reef Marine Park Authority.

Great Barrier Reef Marine Park Authority (2014b), "Great barrier reef outlook report 2014".

Great Barrier Reef Marine Park Authority (2017), *Differences between the Marine Park and the World Heritage Area*, Great Barrier Reef Marine Park Authority, available at: www.gbrmpa.gov.au

Great Barrier Reef Marine Park Authority (2018), "GBRMPA – community benefits", The Reef 2050 Integrated Monitoring and Reporting Program, Australian Government, available at: www.gbrmpa.gov.au/our-work/reef-strategies/reef-integrated-monitoring-and-reporting-program/community-benefits (accessed October 30, 2018).

Grech, A., Pressey, R. and Day, J. (2016), "Coal, cumulative impacts, and the great barrier reef", *Conservation Letters*, Vol. 9 No. 3, pp. 200-207.

Green, K.M., DeWan, A., Arias, A.B. and Hayden, D. (2013), "Driving adoption of payments for ecosystem services through social marketing, Veracruz, Mexico", *Conservation Evidence*, Vol. 10, pp. 48-52.

Greenland-Smith, S. (2011), *Barriers and Benefits to Wetland Conservation in Agricultural Nova Scotia*, Dalhousie University, Nova Scotia, available at: https://cdn.dal.ca/content/dam/dalhousie/pdf/science/environmental-science-program/Honours%20Theses/SimonGreenlandSmith.pdf

Greiner, R. and Gregg, D. (2011), "Farmers' intrinsic motivations, barriers to the adoption of conservation practices and effectiveness of policy instruments: empirical evidence from northern Australia", *Land Use Policy*, Vol. 28 No. 1, pp. 257-265.

Greiner, R. (2014), "Environmental duty of care: from ethical principle towards a code of practice for the grazing industry in Queensland (Australia)", *Journal of Agricultural and Environmental Ethics*, Vol. 27 No. 4, pp. 527-547.

Guo, J., Yu, K., Wang, Y., Xu, D., Huang, X., Zhao, M., Yang, H. and Zhang, R. (2017), "Nutrient Distribution in Coral Reef Degraded Areas within Sanya Bay, South China Sea", *Journal of Coastal Research*, Vol. 33 No. 5, pp. 1148-1160.

Ham, S.H. (2009), "From interpretation to protection: is there a theoretical basis?", *Journal of Interpretation Research*, Vol. 14 No. 2, pp. 49-57.

Hay, R. and Eagle, L. (2016), "Harnessing the science of social marketing and behaviour change for improved water quality in the GBR: a documentary analysis of Reef Trust Tender (Burdekin) and Reef Programme", available at: www.nesptropical.edu.au report to the National Environmental Science Programme, Reef and Rainforest Research Centre, Cairns.

Hay, R., Eagle, L. and Chan, J. (2018), "Harnessing the science of social marketing and behaviour change for improved water quality in the Great Barrier Reef: final report best practice guide for development and modification of program communication material", report to the National Environmental Science Programme, Reef and Rainforest Research Centre Limited, Cairns, p. 69, available at: www.nesptropical.edu.au

Haynes, R.B., Ackloo, E., Sahota, N., McDonalnd, H.P. and Yao, X. (2008), *Interventions for Enhancing Medication Adherence*, John Wiley & Sons, available at: https://doi.org//10.1002/14651858.CD000011.pub3

Hoegh-Guldberg, O. (2011), "Coral reef ecosystems and anthropogenic climate change", *Regional Environmental Change*, Vol. 11 No. 1, pp. 215-227.

Hoffman, M., Lubell, M. and Hillis, V. (2015), "Network-smart extension could catalyze social learning", *California Agriculture*, Vol. 69 No. 2, pp. 113-122.

Kennedy, A.L. (2010), "Using community-based social marketing techniques to enhance environmental regulation", *Sustainability*, Vol. 2 No. 4, pp. 1138-1160.

Khoi, N.H., Tuu, H.H. and Olsen, S.O. (2018), "The role of perceived values in explaining Vietnamese consumers' attitude and intention to adopt mobile commerce", *Asia Pacific Journal of Marketing and Logistics*, Vol. 30 No. 4, pp. 1112-1134, doi: 10.1108/APJML-11-2017-0301.

Kroon, F.J., Schaffelke, B. and Bartley, R. (2014), "Informing policy to protect coastal coral reefs: Insight from a global review of reducing agricultural pollution to coastal ecosystems", *Marine Pollution Bulletin*, Vol. 85 No. 1, pp. 33-41.

Kroon, F.J., Thorburn, P., Schaffelke, B. and Whitten, S. (2016), "Towards protecting the Great Barrier Reef from land-based pollution", *Global Change Biology*, Vol. 22, pp. 1985-2002.

Kumar, B., Manrai, A.K. and Manrai, L.A. (2017), "Purchasing behaviour for environmentally sustainable products: a conceptual framework and empirical study", *Journal of Retailing and Consumer Services*, Vol. 1 No. 9, p. 34.

Lambert, D., Sullivan, P., Claassen, R. and Foreman, L. (2006), *Conservation-compatible Practices and Programs: Who Participates?*, available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.459.2160&rep=rep1&type=pdf

McElhinney, J. (2016), "Influencing the agricultural sector to embrace adaptation to climate change, for the sake of global food security", *Environmental Science and Pollution Research*, Vol. 23 No. 9, pp. 9245-9246.

McGuire, J.M., Morton, L.W., Arbuckle, J.G. and Cast, A.D. (2015), "Farmer identities and responses to the social–biophysical environment", *Journal of Rural Studies*, Vol. 39, pp. 145-155.

McKillop, C. (2016), "Great Barrier Reef debate leaves farmers frustrated over their negative portrayal on water quality improvements", ABC: Rural – ABC News, available at: www.abc.net.au/news/rural/2016-06-29/great-barrier-reef-debate-leaves-farmers-frustrated/7549652 (accessed May 11, 2018).

MacKinnon, D.P., Fairchild, A.J. and Fritz, M.S. (2007), "Mediation analysis", *Annual review of psychology*, Vol. 58, pp. 593-614.

Maibach, E.W., Roser-Renouf, C. and Leiserowitz, A. (2008), "Communication and marketing as climate change–intervention assets: a public health perspective", *American Journal of Preventive Medicine*, Vol. 35 No. 5, pp. 488-500.

Marteau, T.M., Ogilvie, D., Roland, M., Suhrcke, M. and Kelly, M.P. (2011), "Judging nudging: can nudging improve population health?", *BMJ*, Vol. 342 No. 7791, pp. 263-265.

National Environmental Science Program (2015-2021), "Tropical water quality hub", National Environmental Science Program, available at: www.environment.gov.au/science/nesp/hub-tropical-water-quality (accessed May 14, 2018).

National Social Marketing Cenre (2016), "Social marketing benchmark criteria", *Planning Guide and Toolkit*, National Social Marketing Centre, available at: www.thensmc.com/toolkit

Newton, J.D., Ewing, M.T. and Finch, C.F. (2013), "Social marketing: why injury prevention needs to adopt this behaviour change approach", *British Journal of Sports Medicine*, Vol. 47 No. 11, pp. 665-667.

Ockwell, D., Whitmarsh, L. and O'Neill, S. (2009), "Reorienting climate change communication for effective mitigation", *Science Communication*, Vol. 30 No. 3, pp. 305-327.

Pannell, D. and Vanclay, F. (Eds) (2011), *Changing Land Management: Adoption of New Practices by Rural Landholders*, CSIRO Publishing, Collingwood, VIC.

Pant, L.P. and Hambly, O.H. (2009), "The promise of positive deviants: bridging divides between scientific research and local practices in smallholder agriculture", *Knowledge Management for Development Journal*, Vol. 5 No. 2, pp. 160-172.

Patterson, J.J., Smith, C. and Bellamy, J. (2015), "Enabling and enacting 'practical action'in catchments: responding to the 'Wicked Problem'of nonpoint source pollution in coastal subtropical Australia", *Environmental Management*, Vol. 55 No. 2, pp. 479-495.

Perry, C.T., Smithers, S.G., Kench, P.S. and Pears, B. (2014), "Impacts of Cyclone Yasi on nearshore, terrigenous sediment-dominated reefs of the central Great Barrier Reef, Australia", *Geomorphology*, Vol. 222, pp. 92-105.

Piggott-McKellar, A.E. and McNamara, K.E. (2016), "Last chance tourism and the Great Barrier Reef", *Journal of Sustainable Tourism*, Vol. 25 No. 3, pp. 397-413.

Pino, G., Toma, P., Rizzo, C., Miglietta, P.P., Peluso, A.M. and Guido, G. (2017), "Determinants of Farmers' intention to adopt water saving measures: evidence from Italy", *Sustainability*, Vol. 9 No. 1, pp. 2-14, doi: http://dx.doi.org/10.3390/su9010077.

Pradhananga, A.K., Davenport, M.A., Fulton, D.C., Maruyama, G.M. and Current, D. (2017), "An integrated moral obligation model for landowner conservation norms", *Society & Natural Resources*, Vol. 30 No. 2, pp. 212-227.

Preacher, K. and Hayes, A. (2004a), "SPSS and SAS procedures for estimating indirect effects in simple mediation models", *Behavior Research Methods, Instruments, & Computers*, Vol. 36 No. 4, pp. 717-731.

Preacher, K.J. and Hayes, A.F. (2004b), "SPSS and SAS procedures for estimating indirect effects in simple mediation models", *Behavior Research Methods, Instruments, & Computers*, Vol. 36 No. 4, pp. 717-731.

Preacher, K.J., Rucker, D.D. and Hayes, A.F. (2007), "Addressing moderated mediation hypotheses: theory, methods, and prescriptions", *Multivariate Behaviour Research*, Vol. 42 No. 1, pp. 185-227, doi: 10.1080/00273170701341316.

Queensland Cane Growers Association (2010), *About the Industry*, Queensland Cane Growers Association, Brisbane.

Queensland Government (2016), *The Queensland Agricultural Sector*, Queensland Government Statistician's Office, Brisbane.

Ramsdell, C.P. (2014), *Paying for Nature: Incentives and the Future of Private Land Stewardship*, Virginia Polytechnic Institute and State University, Blacksburg, VA, p. 98.

Reef Water Quality (2016), "Farming in reef catchments", Department of Environment and Heritage Protection, Australia Government, p. 16, available at: www.qld.gov.au/environment/assets/documents/agriculture/sustainable-farming/rwq-np-method.pdf (accessed May 2, 2018).

Rolfe, J. and Gregg, D. (2015), "Factors affecting adoption of improved management practices in the pastoral industry in Great Barrier Reef catchments", *Journal of Environmental Management*, Vol. 157, pp. 182-193.

Sewell, A.M., Hartnett, M.K., Gray, D.I., Blair, H.T., Kemp, P.D., Kenyon, P.R. and Wood, B.A. (2017), "Using educational theory and research to refine agricultural extension: affordances and barriers for farmers' learning and practice change", *The Journal of Agricultural Education and Extension*, Vol. 23 No. 4, pp. 313-333, doi: 10.1080/1389224X.2017.1314861.

Shrapnel, M. and Davie, J. (2001), "The influence of personality in determining farmer responsiveness to risk", *The Journal of Agricultural Education and Extension*, Vol. 7 No. 3, pp. 167-178.

Simis, M.J., Madden, H., Cacciatore, M.A. and Yeo, S.K. (2016), "The lure of rationality: Why does the deficit model persist in science communication?", *Public Understanding of Science*, Vol. 25 No. 4, pp. 400-414.

Smith, W.A. (2006), "Social marketing: an overview of approach and effects", *Injury Prevention*, Vol. 12 No. Suppl 1, pp. i38-i43.

Stern, M.J. and Powell, R.B. (2013), "What leads to better visitor outcomes in live interpretation?", *Journal of Interpretation Research*, Vol. 13 No. 2, pp. 9-44.

Takahashi, B. (2009), "Social marketing for the environment: an assessment of theory and practice", *Applied Environmental Education and Communication*, Vol. 8 No. 2, pp. 135-145.

Teakle, I., Barnes, M., Grant, B., Guard, P. and Fisk, G. (2015), "Assessing the Impacts of Dredging in the Great Barrier Reef World Heritage Area", *Australasian Coasts & Ports Conference 2015: 22nd Australasian Coastal and Ocean Engineering Conference and the 15th Australasian Port and Harbour Conference*, p. 894.

The Washington Post (2016), "The great barrier reef is dying, and global warming set the scene", *The Washington Post*, available at: www.washingtonpost.com/opinions/the-great-barrier-reef-is-dying-and-global-warming-set-the-scene/2016/12/26/6d669910-bc0b-11e6-94ac-3d324840106c_story.html?utm_term=.966565b95c3a (accessed December 28, 2018).

Thorburn, P., Wilkinson, S. and Silburn, D. (2013), "Water quality in agricultural lands draining to the Great Barrier Reef: a review of causes, management and priorities", *Agriculture, Ecosystems & Environment*, Vol. 180, pp. 4-20.

Umrani, F. and Ghadially, R. (2003), "Empowering women through ICT education: Facilitating Computer Adoption", *Gender, Technology and Development*, Vol. 7 No. 3, pp. 359-377, doi: 10.1177/097185240300700303.

Van Herzele, A., Gobin, A., Van Gossum, P., Acosta, L., Waas, T., Dendoncker, N. and Henry de Frahan, B. (2013), "Effort for money? Farmers' rationale for participation in agri-environment measures with different implementation complexity", *Journal of Environmental Management*, Vol. 131, pp. 110-120.

Veríssimo, D. (2013), "Influencing human behaviour: an underutilised tool for biodiversity management", *Conservation Evidence*, Vol. 10, pp. 29-31.

Werner, M., Wauters, E., Bijttebier, J., Steinmann, H.-H., Ruysschaert, G. and Knierim, A. (2017), "Farm level implementation of soil conservation measures: farmers' beliefs and intentions", *Renewable Agriculture and Food Systems*, Vol. 32 No. 6, pp. 1-14.

Wheeler, S., Zuo, A. and Bjornlund, H. (2013), "Farmers' climate change beliefs and adaptation strategies for a water scarce future in Australia", *Global Environmental Change*, Vol. 23 No. 2, pp. 537-547.

Wilhelm-Rechmann, A., Cowling, R.M. and Difford, M. (2014), "Using social marketing concepts to promote the integration of systematic conservation plans in land-use planning in South Africa", *Oryx*, Vol. 48 No. 1, pp. 71-79.

Wooldridge, S.A. (2017), "Preventable fine sediment export from the Burdekin River catchment reduces coastal seagrass abundance and increases dugong mortality within the Townsville region of the Great Barrier Reef, Australia", *Marine Pollution Bulletin*, Vol. 114 No. 2, pp. 671-678, doi: https://doi.org/10.1016/j.marpolbul.2016.10.053.

Wright, A.J., Veríssimo, D., Pilfold, K., Parsons, E., Ventre, K., Cousins, J., Jefferson, R., Koldewey, H., Llewellyn, F. and McKinley, E. (2015), "Competitive outreach in the 21st century: why we need conservation marketing", *Ocean & Coastal Management*, Vol. 115, pp. 41-48, doi: https://doi.org/10.1016/j.ocecoaman.2015.06.029.

Yazdanpanah, M., Hayati, D., Hochrainer-Stigler, S. and Zamani, G.H. (2014), "Understanding farmers' intention and behavior regarding water conservation in the Middle-East and North Africa: a case study in Iran", *Journal of Environmental Management*, Vol. 135, pp. 63-72, doi: https://doi.org/10.1016/j.jenvman.2014.01.016.

Yoder, A.M. and Murphy, D.J. (2012), "Using social marketing to address barriers and motivators to agricultural safety and health best practices", *Journal of Agromedicine*, Vol. 17 No. 2, pp. 240-246.

Appendix 1

Table AI. Summary of measurement items

Construct	Items	Measurement coding
Fertilizer application behavior	I use industry standard rates for district yield potential, and use that amount on all parts of my farm I use more fertiliser on high – performing (high yielding) blocks I estimate amounts from my farm yield and use that amount on all parts of my farm My advisor does this for me I use more fertiliser on under-performing (low yield) blocks than on other blocks I tailor my fertiliser rates to different parts of the property Other, please tell us what you do	Binary coding Six Easy Steps (industry standard) = 1 All other approaches = 0
Run-off handling behavior	I have recycled pits I do not capture run-off I have recycled pits and have adequate pumping capacity to recycle the water Other, please tell us what you do	Binary coding Recycle pits = 1 All other practices = 0
Attitudes toward behavior	The best way to meet my own personal goals The best way to maintain good cash-flow The best way to reduce business risk The least time-consuming (or labor intensive)	Likert based measurement Strongly disagree = 1 Disagree = 2
Perceived norms	The farmers I respect most do this	Somehow disagree = 3
Perceived behavioral control	The most effective way of controlling nutrient loss from my property I only do this because I am forced to. The people/organizations whose advice I follow most think I should do this	Neutral = 4 Somehow agree = 5 Agree = 6 Strongly agree = 7
Lifestyle	Maintaining physical and mental health of family Maintaining family traditions and heritage Spending face-to-face time with family and friends Keeping in contact with family and friends in other ways (e.g. via phone, through social media) Maintaining good relations with other farmers/graziers in the local area	
Financial/ economical control	Keeping farm costs low Keeping a stable (steady) cash-flow Maximizing farm profits (income minus costs) Minimizing risk (of very high costs or very low income) Servicing debt	
Social goals	Having time to pursue hobbies Being able to make your own decisions about your farm/property Learning about and testing new ways of doing things on your farm/property Sharing new ideas with others Having efforts recognized by the wider community	
Environmental goals	Leaving the land/farm in better condition than it was when you first started managing it Maintaining/improving water supplies and storages Minimizing sediment run-off and/or nutrient losses Helping to safeguard native plants and animals Helping to safeguard local waterways Helping to safeguard the Great Barrier Reef	

Appendix 2

	Consequent										
	Fertilizer application behavior (Y)			Attitude toward behavior "Least time Consuming" (M)	Indirect effect		Confidence intervals		Model Fit		Status
Predictors (X)	Coefficient	SE	*p*	Coefficient	SE	*p*	Coefficient	LL95% CI	UL95% CI	Negalkarke R^2	Level of mediation
Lifestyle											
Maintaining physical and mental health of family	0.153	0.077	0.048	0.302	0.113	0.007	0.046	0.002	0.128	0.0283	Partial mediation
Maintaining family traditions and heritage	0.151	0.077	0.05	0.209	0.073	0.004	0.031	0.0007	0.0904	0.0421	Partial mediation
Maintaining good relations with other farmers	0.131	0.137	0.923	0.289	0.110	0.009	0.047	0.0016	0.1353	0.0242	Full mediation
Social goals											
Being able to make own decisions	0.035	0.167	0.831	0.325	0.135	0.017	0.052	0.003	0.138	0.024	Full mediation
Sharing new ideas with others	0.129	0.117	0.268	0.271	0.092	0.003	0.040	0.002	0.113	0.031	Full mediation
Having efforts recognized by the larger community	0.026	0.075	0.723	0.154	0.077	0.047	0.019	0.0002	0.0634	0.023	Full mediation

Table AII. Indirect effects of fertilizer application behavior through "Least time consuming"

Table AIII.
Indirect effects of handling run-off practices through "Least time consuming"

	Consequent										
	Run-off handling practices (Y)			Attitude toward behavior "Least time consuming" (M)			Indirect effect	Confidence intervals		Model Fit	Status
Predictors (X)	Coefficient	SE	*p*	Coefficient	SE	*p*	Coefficient	LL95% CI	UL95% CI	Negalkarke R^2	Level of mediation
Lifestyle											
Maintaining physical and mental health of family	0.022	0.186	0.906	252	0.241	0.299	−0.069	−0.245	0.024	0.064	NS
Maintaining family traditions and heritage	0.261	0.132	0.049	0.417	0.114	0.000	−0.145	−0.299	−0.048	0.092	Partial mediation
Spending face to face time with family	0.107	0.167	0.521	0.414	0.160	0.010	−0.119	−0.293	−0.023	0.067	Full mediation
Keeping in contact with family and friends	0.311	0.129	0.015	0.314	0.123	0.011	−0.109	−0.257	−0.019	0.106	Partial mediation
Maintaining good relations with other farmers/ graziers	0.204	0.199	0.306	0.482	0.169	0.005	−0.143	−0.338	−0.035	0.071	Full mediation
Financial/economical goals											
Keeping farm cost low	0.0167	0.169	0.921	0.370	0.160	0.021	−0.102	−0.266	−0.018	0.064	Full mediation
Keeping a stable cash flow	0.094	0.187	0.614	0.264	0.220	0.231	−0.0743	−0.235	0.019	0.657	NS
Maximizing farm profits	−0.015	0.200	0.938	0.425	0.189	0.026	−0.116	−0.299	−0.019	0.064	Full mediation
Minimizing risk of very high cost or very low income	−0.045	0.162	0.783	0.389	0.159	0.015	−0.105	−0.275	−0.019	0.064	Full mediation
Servicing debt	0.008	0.117	0.941	0.208	0.121	0.086	−0.060	−0.185	−0.003	0.071	Full mediation
Social goals											
Having time to pursue hobbies	−0.244	0.114	0.034	0.266	0.087	0.002	−0.0627	−0.1571	−0.011	0.097	Partial mediation
Being able to make your own decisions	−0.345	0.262	0.188	0.777	0.142	0.000	−0.182	−0.411	−0.032	0.077	Full mediation
Learning about testing new ways	0.086	0.183	0.638	0.294	0.189	0.121	−0.082	−0.256	−0.0006	0.065	Full mediation
Sharing new ideas with others	−0.117	0.162	0.472	0.431	0.146	0.003	−0.111	−0.287	−0.026	0.067	Full mediation
Having efforts being recognized by the wider community	−0.0281	0.914	0.758	0.184	0.078	0.019	−0.047	−0.133	−0.008	0.058	Full mediation
Environmental goals											
Maintaining water supplies and storages	0.038	0.097	0.694	0.173	0.078	0.027	−0.043	−0.119	−0.005	0.053	Full mediation

Appendix 4

Predictors (X)	Consequent: Run-off handling practices (Y) Coefficient	SE	p	Consequent: Attitude toward behavior "Reduce business risk" (M) Coefficient	SE	p	Indirect effect Coefficient	Confidence intervals LL95% CI	Confidence intervals UL95% CI	Model Fit Negalkarke R^2	Status Level of mediation
Lifestyle											
Keeping in contact with family and friends	0.2968	0.129	0.022	0.245	0.111	0.029	−0.1091	−0.274	−0.020	0.098	Partial mediation
Financial/economic goals											
Servicing debt	0.025	0.118	0.833	0.188	0.095	0.049	−0.070	−0.196	−0.012	0.063	Full mediation
Environmental goals											
Leaving the farm in better condition	0.335	0.250	0.180	0.340	0.213	0.112	−0.129	−0.396	−0.002	0.066	Full mediation

Table AIV. Indirect effects of handling run-off practices through "Reduce business risk"

Appendix 5. Questionnaire

JAMES COOK UNIVERSITY

Project 2.1.3: Harnessing the science of social marketing and behaviour change for improved water quality in the GBR: an action research project

Wet Tropics Sugar Industry Partnership (WTSIP) & Terrain NRM

Cane Growers Survey 2016

The Wet Tropics Sugar Industry Partnership (WTSIP), Terrain NRM and a team from James Cook University are working together to evaluate the training programmes, grants and tenders that the government uses when trying to support land managers to control erosion and reduce nitrogen use. We hope you will agree to be part of this study. We would be very grateful for your input and the opportunity to learn from your experiences.

JAMES COOK UNIVERSITY

Project 2.1.3: Harnessing the science of social marketing and behaviour change for improved water quality in the GBR: an action research project

The Wet Tropics Sugar Industry Partnership, Terrain NRM and a team from James Cook University are working together to evaluate the training programmes, grants and tenders that the government uses when trying to support land managers to control erosion and reduce nitrogen use. We hope you will agree to be part of this study. We would be very grateful for your input and the opportunity to learn from your experiences.

We know that your time is valuable. In recognition of this, by completing this survey you can go into the draw to win a Drone worth $1500 or equivalent value in cash or a travel voucher.

Completing the survey will take approximately 30 to 40 minutes.

We will contact you again in 2017 and 2018 with a much shorter survey.

Participation is entirely voluntary and you can stop taking part in the study at any time without explanation. We very much appreciate the time you are taking to complete the survey.

Would you like to begin the survey now?

If you have any questions about the study or if you are interested in the results, please contact:

Professor Lynne Eagle
College of Business, Law and Governance
James Cook University
Phone: (07) 4781 5717
Email: lynne.eagle@jcu.edu.au

Dr Marina Farr
College of Business, Law and Governance
James Cook University
Phone: (07) 4781 5014
Email: marina.farr@jcu.edu.au

Mrs Rachel Hay
College of Business, Law and Governance
James Cook University
Phone: (07) 4781 3131
Email: rachel.hay@jcu.edu.au

If you have any concerns regarding the ethical conduct of the study, please contact: Human Ethics, Research Office, James Cook University, Townsville, Qld 4811 Phone: (07) 4781 5011 (ethics@jcu.edu.au)

First, some background information about you and your property (you may be asked to answer questions in Hectares or Acres, please only answer using one measurement).

Land Holder ID: _____

Wet Tropics Sugar District: _____

1. Who makes decisions relating to land-management and farming on your property, or if you own more than one, who makes decisions on your main property?

❒ Entirely my decision (i.e. individual) ❒ Majority of decision is mine ❒ Joint/Shared decision

If joint/shared decision, could you please tell us who is involved? (Please tick all that apply)
❒ Spouse
❒ Parents
❒ Children
❒ Brother/Sister
❒ In-laws
❒ Other (please specify)

_____

2. Do you own or manage other properties? (Please tick) ❒ Yes (fill in details below) ❒ No (go to Q3)

If yes, please tell us where the properties are, and what the land is (mostly) used for:

Location (e.g. nearest town)	Approximate Area		Main land-use (e.g. cane, grazing, sugar, horticulture)	
	Hectares	Acres	Hectares	Acres

3. Do you (or your spouse, if relevant) have an off-farm 'job'? (Please tick)

You	Your spouse
❒ No (Go to Q4)	❒ No (Go to Q4)
❒ Yes, I work less than 20 hours per week off-farm	❒ Yes, she/he works less than 20 hours per week off-farm
❒ Yes, I work more than 20 hours per week off-farm	❒ Yes, she/he works more than 20 hours per week off-farm

4. How many people live on your main farm/property? _____

5. Do you manage or own/lease/share main farm/property or both? (Please tick all that apply)

❒ Manage (skip to Q6)
❒ Own (please answer below)
❒ Lease (please answer below)
❒ Share (please answer below)

If own/leased/shared, approximately what percent of the property is:
Owned ____ % Leased ____% Shared _____%

6. How many years have you owned/managed your main property? _____

7. Please provide us with some background information about land-use on your main property

Land use (e.g. grazing, sugar, bananas, rice)	Approximate area used for this (e.g. 10ha for sugar)	
	Ha	Ac

Which of those land-uses is most important to the FINANCIAL VIABILITY of your property? (if off-farm income is most important, please write 'off farm')_____

Which of those land-uses do you ENJOY doing the most (if off-farm activities are the most enjoyable, write 'off farm')
_____

8. Are there any other properties on which you would like to comment?
❒ Yes (please comment below) ❒ No (Go to Q9)

_____
_____

9. On average, is the revenue from the last year better, worse or the same as previous years? (Please select one)

❒ This year's revenue is better than previous years
❒ This year's revenue is worse than previous years
❒ This year's revenue is about the same as previous years

Next, we ask for some background information on what 'drives' you and about your overall sense of well-being.

We would like to better understand the factors that influence your decisions and choices related to your personal goals for your farm/property. Life satisfaction or happiness depends on many things and we would like to know which things make you the most and the least happy.

10. Please think about your own personal goals and aspirations for your farm/property. What are the two most important things you hope to achieve (your goals) for your farm/property?

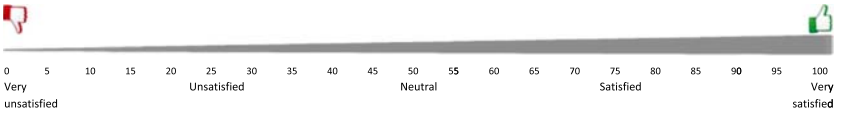
1) _____
2) _____

11. How important are each of the following to you, when making decisions about what to do on your farm/property

	Extremely unimportant (irrelevant)			Neutral			Extremely important (essential)	Do not know
Maintaining physical and mental health of family	☐	☐	☐	☐	☐	☐	☐	☐
Maintaining family traditions and heritage	☐	☐	☐	☐	☐	☐	☐	☐
Spending face-to-face time with family and friends	☐	☐	☐	☐	☐	☐	☐	☐
Keeping in contact with family and friends in other ways (e.g. via phone, through social media)	☐	☐	☐	☐	☐	☐	☐	☐
Maintaining good relations with other farmers/graziers in the local area	☐	☐	☐	☐	☐	☐	☐	☐
Keeping farm costs low	☐	☐	☐	☐	☐	☐	☐	☐
Keeping a stable (steady) cash-flow	☐	☐	☐	☐	☐	☐	☐	☐
Maximising farm profits (income minus costs)	☐	☐	☐	☐	☐	☐	☐	☐
Minimising risk (of very high costs or very low income)	☐	☐	☐	☐	☐	☐	☐	☐
Servicing debt	☐	☐	☐	☐	☐	☐	☐	☐
Having time to pursue hobbies	☐	☐	☐	☐	☐	☐	☐	☐
Being able to make your own decisions about your farm/property	☐	☐	☐	☐	☐	☐	☐	☐
Learning about and testing new ways of doing things on your farm/property	☐	☐	☐	☐	☐	☐	☐	☐
Sharing new ideas with others	☐	☐	☐	☐	☐	☐	☐	☐
Having efforts recognised by the wider community	☐	☐	☐	☐	☐	☐	☐	☐
Leaving the land/farm in better condition than it was when you first started managing it	☐	☐	☐	☐	☐	☐	☐	☐

Maintaining/improving water supplies and storages	☐	☐	☐	☐	☐	☐	☐	☐
Minimising sediment run-off and/or nutrient losses	☐	☐	☐	☐	☐	☐	☐	☐
Helping to safeguard native plants and animals	☐	☐	☐	☐	☐	☐	☐	☐
Helping to safeguard local waterways	☐	☐	☐	☐	☐	☐	☐	☐
Helping to safeguard the Great Barrier Reef	☐	☐	☐	☐	☐	☐	☐	☐

12. Please think about your own life and personal circumstances (yes, this is a 'big' question☺). How satisfied are you with your quality of life as a whole? (Please circle a number)



13. Why do you feel this way?

_____

Next, we would like to know about attitudes towards programs that are designed to help you manage your land

We would like to know your opinion about the usefulness of the programs; and where you look for information about grants, workshops and training associated with land management

14. There are many different ways/places you can apply for grants and/or financial assistance to do things on your property (e.g. Reef Rescue, Reef Program, Reef Trust, Drought assistance, cheap electricity). Please tell us about the grants you have applied for by answering the following questions (if you have applied for more than three (3), just tell us about the most recent applications).

Please tick if you have applied for more than three (3) grants in the last 5 years ☐ yes

Name of grant/financial assistance program that you applied for…	Year you applied	How did you find out about it? (e.g. friend, google, extension officer)	Was your application successful? (tick if yes)	What was the most important thing you hoped to achieve with this grant?	How useful was the grant in helping you achieve that aim? Complete waste of time … Neutral … Extremely useful
			☐		☐ ☐ ☐ ☐ ☐ ☐ ☐
			☐		☐ ☐ ☐ ☐ ☐ ☐ ☐
			☐		☐ ☐ ☐ ☐ ☐ ☐ ☐

15. WORKSHOPS, TRAINING PROGRAMS (including on-line and face-to face) or other support and activities (such as field days, and on-farm demonstrations).

Please tell us about various workshops/training programs or other support and activities you have participated in (or led) which have been focused on land-management issues over the last 5 years (6 Easy Steps, Smart Cane BMP or other such as produce boards e.g. Herbert Cane Productivity Services/Burdekin Productivity Services). If more than five (5), just tell us about the most recent ones.

Please tick if you have participated in more than five (5) during the last 5 years ☐ yes

Name of workshop/training program /activity	Year	How did you find out about it? (e.g. friend, google, extension officer)	What was the most important thing you hoped to achieve by doing this?	How useful was the training in helping you achieve that aim? Complete waste of time ☐ ☐ ☐ ☐ ☐ ☐ ☐ Extremely useful

Which of these workshops or training programs was the most useful and why?

16. What could be done to make grants, training programs, workshops and/or extension activities work better for you (i.e. to help you meet your own personal goals)

_____

16a. What extension support or training would you like in the future to help you make farm improvements?

_____

The following sections will ask about motivations, satisfaction and reasons why you do things. The same statements will be given for three different practices. It may seem repetitive but we will really appreciate if you answer all of them.

Irrigation Practices SKIP QUESTION IF NO IRRIGATED CROPS

We would like to know the reasons why you are doing specific agricultural practices or not doing them, what motivates you in these decisions and whose advice is most important to you (you will be asked to answer questions in Hectares or Acres, please only answer using one measurement)

17. Roughly, how much irrigated water do you use per hectare (acre) for your crops (e.g. ML per acre) each year?

_____ ML per hectare per year
_____ ML per acre per year
_____ I do not know

18. How much irrigation water do you estimate runs off the block? (Please tick)
SKIP QUESTION IF NO IRRIGATED CROPS

❒ 0–25%
❒ 25–50%
❒ 50–75%
❒ 75–100%

19. What irrigation scheduling tools do you use? (Please tick all that apply)

❒ None
❒ Soil moisture probes such as tensiometers and capacitance probes
❒ Mini pans
❒ Calculation of daily crop water use, using crop factors, class A pan, or crop model (e. g. WaterSense)
❒ Other (please tell us which ones)
_____

How long have you used those tools to schedule irrigation? _____years
Do you plan to do this next year? (Please tick) ❒ No ❒ Yes (please tell us what you will do below)

If you plan to do something different, what is it? _____-
_____

20. Think about your current tools for scheduling irrigation and tell us how much you agree or disagree with each of the statements. SKIP IF NO IRRIGATED CROPS

	Strongly disagree			Neutral			Strongly agree	Do not know/ Not sure
The farmers I respect most do this	□	□	□	□	□	□	□	□
Most farmers in this region would not have the technical knowledge to do this	□	□	□	□	□	□	□	□
Most farmers in this region would not be able to afford to use this system for scheduling irrigation	□	□	□	□	□	□	□	□
Compared to other ways of scheduling irrigation, this is:								
The best way to meet my own personal goals (question Error! Reference source not found.)	□	□	□	□	□	□	□	□
The best way to maintain good cash-flow	□	□	□	□	□	□	□	□
The best way to reduce business risk	□	□	□	□	□	□	□	□
The least time-consuming (or labour intensive)	□	□	□	□	□	□	□	□
The most effective way of controlling nutrient loss from my property	□	□	□	□	□	□	□	□
I only do this because I am forced to Who/what is forcing you? _____	□	□	□	□	□	□	□	□
The people/organisations whose advice I follow most think I should do this	□	□	□	□	□	□	□	□

21. Please tell us whose advice you follow most when scheduling irrigation (please rank the most relevant options. 1 = most important)

____ Family who are also cane farmers
____ Landcare
____ Other cane farmers
____ Researchers
____ Canegrowers (the organisation)
____ Industry extension advisors (e.g. from SRA [BSES], Productivity Services group)
____ Regional cane association (e.g. from Kalamia, Invicta, Inkerman, Tully)

____ People from NQ Dry Tropics/Terrain NRM
____ Other extension officers. From where?
_____
____ Private Agronomists
____ People from government departments. Which departments?
_____
____ Other. Who?
_____

Calculating Fertiliser Application Rates

22. How many soil tests per 40 hectares of fallow or re-plant cane did you do last year?

_____ (insert number of soil tests)

Comments:
_____
_____

23. How do you calculate fertiliser application rates? (Please tick all that apply)

❒ I use industry standard rates for district yield potential, and use that amount on all parts of my farm
❒ I use more fertiliser on high – performing (high yielding) blocks
❒ I estimate amounts from my farm yield and use that amount on all parts of my farm
❒ My advisor does this for me
❒ I use more fertiliser on under-performing (low yield) blocks than on other blocks
❒ I tailor my fertiliser rates to different parts of the property
❒ Other. Please tell us what you do
_____

How long have you used this system to calculate fertiliser application rates?

❒ I have always done this
If you have not always done this, please tell us for how many years you have used this system _____(years)

Do you plan to do this next year? *(Please tick)* ❒ No ❒ Yes (please tell us what you plan to do)

If you plan to do something different, what is it?
_____

24. Think about your current system for calculating fertiliser rates and tell us how much you agree or disagree with each of the statements.

	Strongly disagree			Neutral			Strongly agree	Do not know/ Not sure
The farmers I respect most do this	☐	☐	☐	☐	☐	☐	☐	☐
Most farmers in this region would not have the technical knowledge to calculate fertiliser rates in this way	☐	☐	☐	☐	☐	☐	☐	☐
Most farmers in this region would not be able to afford use this system for calculating fertiliser rates	☐	☐	☐	☐	☐	☐	☐	☐

Compared to other ways of calculating fertiliser rates, this is								
The best way to meet my own personal goals (question Error! Reference source not found.)	☐	☐	☐	☐	☐	☐	☐	☐
The best way to maintain good cash-flow	☐	☐	☐	☐	☐	☐	☐	☐
The best way to reduce business risk	☐	☐	☐	☐	☐	☐	☐	☐
The least time-consuming (or labour intensive)	☐	☐	☐	☐	☐	☐	☐	☐
The most effective way of controlling nutrient loss from my property	☐	☐	☐	☐	☐	☐	☐	☐
I only do this because I am forced to Who/what is forcing you? _____	☐	☐	☐	☐	☐	☐	☐	☐
The people/organisations whose advice I follow most think I should do this	☐	☐	☐	☐	☐	☐	☐	☐

25. Please tell us whose advice you follow most when it comes to calculating fertiliser application rates (please rank the most relevant options. 1 = most important)
    - ____ Family who are also cane farmers
    - ____ Landcare
    - ____ Other cane farmers
    - ____ Researchers
    - ____ Canegrowers (the organisation)
    - ____ Industry extension advisors (e.g. from SRA [BSES], Productivity Services group)
    - ____ Regional cane association (e.g. from Kalamia, Invicta, Inkerman, Tully)
    - ____ People from NQ Dry Tropics/Terrain NRM
    - ____ Other extension officers. From where?
      _____
    - ____ Private Agronomists
    - ____ People from government departments. Which departments?
      _____
    - ____ Other. Who?
      _____

Practices for handling run-off (you will be asked to answer questions in Hectares or Acres, please only answer using one measurement)

26. How do you handle run-off from rainfall or irrigation? (Please tick all that apply)
    - ❒ I have recycle pits/sediment traps
    - ❒ I do not capture run-off
    - ❒ I have recycle pits or sediment traps and have adequate pumping capacity to recycle the water
    - ❒ Other. Please tell us what you do
      _____

    How long have you used this system to handle run-off? _____years

Do you plan to do this next year? (Please tick) ❒ No ❒ Yes (please tell us what you plan to do)

If you plan to do something different, what is it?

_____

27. Think about your current system for handling run-off (from rainfall and irrigation) and tell us how much you agree or disagree with each of the statements.

	Strongly disagree			Neutral			Strongly agree	Do not know/ Not sure
The farmers I respect most do this	□	□	□	□	□	□	□	□
Most farmers in this region would not have the technical knowledge to do this	□	□	□	□	□	□	□	□
Most farmers in this region would not be able to afford to use this system for handling runoff	□	□	□	□	□	□	□	□
Compared to other ways of handling run-off, this system is:								
The best way to meet my own personal goals (question Error! Reference source not found.)	□	□	□	□	□	□	□	□
The best way to maintain good cash-flow	□	□	□	□	□	□	□	□
The best way to reduce business risk	□	□	□	□	□	□	□	□
The least time-consuming (or labour intensive)	□	□	□	□	□	□	□	□
The most effective way of controlling nutrient loss from my property	□	□	□	□	□	□	□	□
I only do this because I am forced to Who/what is forcing you? _____	□	□	□	□	□	□	□	□
The people/organisations whose advice I follow most think I should do this	□	□	□	□	□	□	□	□

28. Please tell us whose advice you follow most when it comes to handling run-off (from rainfall and irrigation) (please rank the most relevant options. 1 = most important)

____ Family who are also cane farmers
____ Landcare
____ Other cane farmers
____ Researchers
____ Canegrowers (the organisation)
____ Industry extension advisors (e.g. from SRA [BSES], Productivity Services group)
____ Regional cane association (e.g. from Kalamia, Invicta, Inkerman, Tully)
____ People from NQ Dry Tropics/Terrain NRM
____ Other extension officers. From where? _____
____ Private Agronomists
____ People from government departments. Which departments? _____
____ Other. Who?
_____

29. Do you use any other innovative practices to reduce nitrogen and/or runoff? (Please tick)

❒ Yes (please tell us which practices you use below)
❒ No (skip to Q30)
If yes, which practices _____
_____?

30. Please indicate if you agree or disagree with each statement below

	Strongly disagree			Neutral			Strongly agree	Do not know/ Not sure
Nutrient loss from my property has no impact on water quality in local streams, rivers & waterways	☐	☐	☐	☐	☐	☐	☐	☐

What are the top causes of poor water quality in <u>your</u> local streams, rivers & waterways?
1) _____
2) _____

Cane-growing plays almost no role in the declining health of the Great Barrier Reef	☐	☐	☐	☐	☐	☐	☐	☐

What are the top two pressures on the health of the Great Barrier Reef?
1) _____
2) _____

31. Roughly how many ML per hectare (acre) of water do you think <u>most other cane growers</u> in your region (not you personally) apply to their crops each year? SKIP QUESTION IF NO IRRIGATED CROPS IN YOUR AREA

_____ ML per hectare per year OR
_____ ML per acre per year

32. How many soil tests per 40 hectares of fallow or re-plant cane do you think that <u>most other cane growers</u> in your district (not you personally) did last year?

_____ (insert number of soil tests)

Comments:
_____
_____

33. Would you like to enter into the prize draw? We will need your email address to notify you of the winner (this information will not be shared)

Email address: _____

Just a little more background information about you. Background information about you and your farm will help us to identify and understand your priorities and farming style, which is essential for improvement of natural resource management.

34. What is your age group?

☐ 15–19 years	☐ 35–39 years	☐ 55–59 years	☐ 75–79 years
☐ 20–24 years	☐ 40–44 years	☐ 60–64 years	☐ 80–84 years
☐ 25–29 years	☐ 45–49 years	☐ 65–69 years	☐ 85 years and older
☐ 30–34 years	☐ 50–54 years	☐ 70–74 years	

35. What is your gender? (Please tick) ❒ Male ❒ Female

36. What is your cultural heritage? (Please tick)

❒ Australian (Non-Indigenous)
❒ Aboriginal and/or Torres Strait Islander
❒ Italian
❒ Greek
❒ English
❒ Indian
❒ Other (Please specify)

_____

37. Were you born in Australia? (Please tick) ❒ Yes ❒ No

38. What formal education do you have? (Please tick one)

❒ High school (year 10)
❒ Trade/apprenticeship
❒ TAFE
❒ University
❒ High school (year 12)
❒ Agricultural college
❒ Other (please specify) _____

39. What is your marital status? (Please tick one)

❒ Single
❒ Married or De-facto relationship
❒ Divorced
❒ Widowed

OPTIONAL QUESTIONS

Combined with demographic factors and characteristics of the farm this type of information will really help us to understand your situation better. It will really help us to deeper understand your reasons for adopting or not adopting practices associated with water quality improvement.

Remember this information is kept private.

40. Averaged out over good and bad years, roughly what cane yield per hectare (per acre) do you achieve on your property?

☐ 0–20 t/ha (0–8.1 ton/ac)	☐ 20–40 ton/ha (8.1–16.2 ton/ac)	☐ 40–60 ton/ha (16.2–24.3 ton/ac)
☐ 60–80 ton/ha (24.3–32.4 ton/ac)	☐ 80–100 ton/ha (32.4–40.5 ton/ac)	☐ 100–120 ton/ha (40.5–48.6ton/ac)

- ☐ 120–140 ton/ha (48.6–56.6 ton/ac)
- ☐ 140–160 ton/ha (56.6–64.7 ton/ac)
- ☐ 160–180 ton/ha (64.7–72.8 ton/ac)
- ☐ 180–200 ton/ha (72.8–80.9 ton/ac)
- ☐ 200–220 ton/ha (80.9–89 ton/ac)
- ☐ More than 220 ton/ha (more than 89 ton/ac)

41. Roughly, what was the NET income earned from this property last year (after all costs and taxes were taken out)? _____

Is this before or after you have paid yourself (and other family members who help on the property) wages/salary?

- ❒ Before paying myself and family
- ❒ After paying myself and family

THANK YOU

We know that your time is valuable. In recognition of this, by completing this survey you can go into the draw to win a Drone worth $1500 or equivalent value in cash or a travel voucher.

DID YOU PROVIDE YOUR EMAIL ADDRESS?

Corresponding author
Muhammad Abid Saleem can be contacted at: muhammadabid.saleem@my.jcu.edu.au