

# **Land Managers Decision Making about Water Quality: Views from Extension Officers of the Wet Tropics, Queensland, Australia**

Rachel Hay and Lynne Eagle





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for improved water quality in the GBR: an action research project

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## ACRONYMS

<b>DoEE</b>	.....	Department of the Environment and Energy
<b>GBR</b>	.....	Great Barrier Reef
<b>HCPSL</b>	.....	Herbert Cane Productivity Services Limited
<b>NESP</b>	.....	National Environmental Science Program
<b>NRM</b>	.....	Natural Resources Management
<b>RRRC</b>	.....	Reef and Rainforest Research Centre Limited
<b>SRA</b>	.....	Sugar Research Australia
<b>TCPSL</b>	.....	Tully Cane Productivity Services Limited
<b>TWQ</b>	.....	Tropical Water Quality
<b>WTSIP</b>	.....	Wet Tropics Sugar Industry Partnership



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We also acknowledge the potential for voluntary response bias, where there is overrepresentation of individuals that have strong opinions about extension activity in the Wet Tropics.

We would like to say a very special thanks to the Terrain NRM and Wet Tropics Sugar Industry Partnership (WTSIP) teams for their administrative support.

We wish to extend our sincere appreciation to Extension Officers in the Wet Tropics regions who took the time and effort to complete our survey at such a busy time of year. Without such input the project could not have gone ahead.



## **EXECUTIVE SUMMARY**

The Wet Tropics Sugar Industry Partnership, Terrain NRM and a team from James Cook University worked together over three years to evaluate training programmes, grants and tenders that the government uses when trying to support land managers to control erosion and reduce nitrogen use. Data for the study was first collected in 2016, then again in 2017 and 2018. This report delivers results from the 2017 data collection. It also provides recommendations for key stakeholders regarding possible actions that should be considered in future interactions between extension officers and land managers in the Wet Tropics and other cane growing regions. The final version of the abridged questionnaire is included as Appendix 1.

The extension officers involved in the survey were from six of the nine river catchment areas of the Wet Tropics cane growing region (see Section 3.1.1). The experience of extension officers varied from 1-3 years to 35+ years in the industry. Insights from the analysis follow, along with a brief recommendation, which outlines strategies that can be used to fine-tune existing landholder interactions. Further explanation of the recommendations can be found in Section 8.0.

The data was collected via an abridged version of the 2016 “Land Manager” survey (Farr, Eagle, Hay, & Churchill, 2017) in the Wet Tropics region. At the request of the Natural Resource Management (NRM) agency, the survey was delivered solely to extension officers in the Wet Tropics region of Queensland, Australia (See Section 2.1). Due to the small sample size the analysis is primarily descriptive and compares responses from extension officers in 2017 to responses from land managers in 2016.

The survey questions asked extension officers to comment on seven different themes identified from an extensive literature review (Eagle, Hay, & Farr, 2016), key findings from the analysis follow:

### ***Decision Making Influencers***

When asked about who influences land manager decisions, the data identifies that extension officers may be underestimating the importance of land manager decision influencers e.g. about protecting the Great Barrier Reef, and about family and servicing debt, which may lead to distrust or lack of respect for the extension officer. See Section 6.2. Misunderstanding the importance of decision influencers may change the way information is exchanged, which in turn can significantly affect the way that information about water quality is processed and how the information influences behaviour change.

Recommendation: Use social network analysis to identify information gatekeepers and opinion leaders.

### ***Grants and Funding***

Extension officer's perception of success and/or failure in grant applications may present barriers or enablers for land managers who apply for grants or funding. If the land manager, via the extension officer, perceives a threat of not receiving a grant, then the land manager may not take the time to apply for any grants that are available and if they do apply, their

application may be inhibited by the extension officers perceived rate of success i.e. they may not put as much effort into the grant application if they perceive it will not be successful.

Recommendation:

- Recognise the key role of extension officers and determine what professional development support might be beneficial in continuing to build trust and engagement with land managers.

### ***Workshops, Training Programs and Other Activities***

Extension officers responded that land managers sought information about workshops, training programs and other activities from their industry extension networks, industry bodies and friends and personal networks. At the time of the survey, the workshops, training and activities were important to improving land and soil management practices to raise awareness of water quality issues as well as accreditation and networking. Extension officers thought that land managers found all workshops useful, but in particular Six Easy Steps, soil health workshops and SRA Masterclasses were identified as most valuable. Extension officers indicated that holding workshops, training and other activities outside of the harvest season, targeting skills deficiency and better coordinated systems would make the activities work better for land managers. Extension officers responded that nutrient management, soil chemistry, more involvement with extension officers and strategic coordinated extension programs with assistance from the DEHP would help in future to assist land managers to make farm improvements.

Recommendations:

- Recognise land manager diversity but use typology principles to develop material and communication approaches to support extension officers
- Build on the role of farmers whose views are respected as potential information gatekeepers / disseminators / role models.

### ***Nutrient Management Practices***

There are some disparities between extension officers and land managers thoughts on how land managers make decisions about nutrient management practices. When calculating fertilizer application rates, land managers rated 'tailoring their own fertilizer rates' as more important when making decisions on how to apply fertilizer than 'using industry standards'. Extension officers on the other hand indicated that they thought land managers would use industry standards before using techniques that tailor their own fertilizer rates. Both land managers and extension officers identified that land managers also use their advisors to calculate fertilizer application rates. This finding indicates with some confidence that land managers are calculating fertilizer rates using industry standards. However, extension officer's anecdotal comments indicate that land managers may think they are using the industry standard (Six Easy Steps) but are incorrectly applying the standard and therefore may not be meeting the industry standard. This may be because land managers in addition to using best management practice are also calculating fertilizer rates based on experience, alternative methods, based on soil tests and by seeking advice from local private agronomists.

### **Run-Off Management Practices**

In most cases extension officers indicated that land managers in the wet tropics do not capture run-off from their farms. However, when land managers do capture runoff, extension officers responded that they use grass headlands, drain systems, laser leveling and sediment traps or recycle pits. In 2017, only 15.8% of extension officers selected that land managers use sediment traps. Extension officers support this with anecdotal comments that there is a limited use of sediment traps in the Wet Tropics Region (see Table 25). By contrast in 2016, 42% of land managers selected that they currently have recycle pits/sediment traps to manage run-off, indicating that land managers are responding to calls to manage run-off. Land managers are influenced by other farmers when using the systems that they choose to handle runoff. Extension officers are not sure if land managers in the Wet Tropics can afford to use the practices available for handling runoff, but were confident that they had the technical knowledge to handle run-off. Extension officers and land managers nominated industry extension advisors as people whose advice land managers most frequently follow when handling run-off. The least important advisors for capturing run-off identified by extension officers were regional cane associations and Landcare.

### **Other Innovative Practices**

Extension officers have identified that land managers are using other innovative practices including bed renovators, contour planting, experiments with flocculants (a particle clumping substance), grassed headlands and riparian vegetation, wet land bioreactors (a natural water purification process), sediment traps, minimum tillage, wetlands, spoon drains, subsurface fertilizer application, headland management, correct drainage, trash blanketing and spraying out and covering fallowed fields. One extension officer stated that *“the innovation is about minimising the amount of sediment, DIN and chemicals, which is about placement, timing, farming systems; there are plans to intercept groundwater DIN using filters”* as a solution to reducing runoff.

### **Perceptions of Causes and Pressure on Water Quality**

Extension officers agreed (84.2%) that nutrient losses from cane growing are having an effect on the water quality of local streams, rivers and waterways and land managers (42%) disagreed, responding that cane growing has no effect on the water quality of local streams, rivers and waterways. By Contrast, while 30% of land managers believe that their activities are negatively affecting water quality, none of the extension officers believe that land managers take this view. About 13% of extension officers were unsure and 15% took a neutral stance about nutrient losses affecting water quality and a small percent of extension officers nominated that they didn't know if cane farming has an impact on water quality.

#### **Recommendations:**

- Ensure all communication, by whatever means, sends consistent messages irrespective of source, and channelling communication through trusted sources. Monitor media coverage and respond to inaccurate messages and develop proactive media relationships.
- Review communication strategies, adding social media where appropriate. Need to recognise the overall diversity of information sources and preferences.
- Proactive plans should be developed for combating or at least minimising the effects of competing and conflicting messages including negative media coverage (see Eagle et al., 2016, Section 2.7). We have reviewed media coverage of the Great

Barrier Reef during 2016 (excluding tourism-related coverage). The findings indicate that the media presents a sensationalised and, at times, hostile perspective on reef-related issues (Eagle, Hay, & Low, 2018), although there is evidence that this is improving in the 2017 media analysis that is under way.

A more detailed analysis is contained in the following sections of this report.

## **1.0 INTRODUCTION**

The key role of extension officers in interactions with land managers to alter farming practices has been recognised both in Australia and in other countries facing similar environmental management issues (see, for example, Ampt, Cross, Ross, & Howie, 2015; Swann & Richards, 2016; Vanclay, 2004). Extension officers act as intermediaries between research and farming to provide services to land managers. They operate as facilitators and communicators, helping land managers to apply knowledge and information to obtain the best results in relation to their product (e.g. sugar cane, grazing). Land managers on the other hand, use, develop and care for their land as a resource. Their land may be used for a variety of purposes including agriculture. In the context of this study land managers are cane farmers and graziers, but they may also produce other crops in addition to their primary industry (e.g. rice, bananas and other crops). While the role of extension officers has altered over time, often as the result of major policy and funding changes (Greiner & Gregg, 2011), they have always worked closely with land managers and as such have a unique insight into the way they make decisions.

## 2.0 ADOPTION OF NEW INNOVATIONS (TECHNOLOGY, PROCESSES OR PRACTICES)

Adoption of new innovations (technology, processes or practices) relies on many factors including that the innovation must have a perceived ease of use, and that it must be useful (Davis, 1989; Tey & Brindal, 2012). Producers must also give time, capital, willingness and effort to adopt new innovations (Tey & Brindal, 2012), otherwise the benefit of adoption will not be met and therefore uptake will fail. There are also other influencers of adoption or non-adoption decisions that are driven by both cognitive and normative influences that can be better explained using the diffusion of innovation model.

Rogers' (1962) Diffusion of Innovation Model (Figure 1) shows a fluent movement through the bell curve from innovation to early adoption through to laggards, with the percentage of any population shown for each segment. The bell curve implies that adoption would begin with the early adopters and would peak with the early and late majority and decline with laggards until 100% diffusion of innovation was completed. It was seen as a given that adoption would take place.

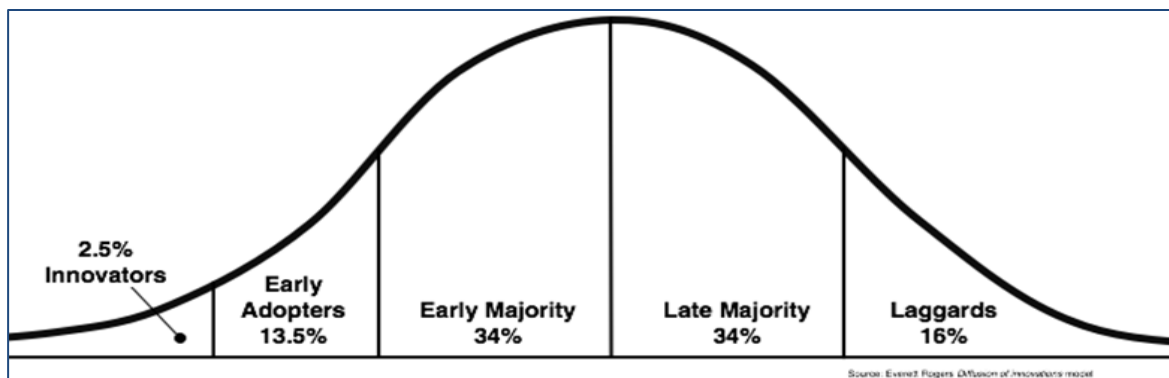


Figure 1: Diffusion of Innovation Model (Rogers, 1962)

While in the original model there is an assumption that innovations will progressively be completely adopted, there is the chance that they can be abandoned. Rogers (1962) cites five characteristics of innovations that must be met for the adoption to occur: 1) where the innovation must give relative advantage, that is, it must supersede or perform better than its predecessor; 2) It must be compatible with existing values, past experiences and the needs of the adopter; 3) The innovation must be relatively easy to understand, if not then adoption will not occur; 4) Adoption will occur more readily if the adopter has an opportunity to trial the innovation; and 5) The results of the innovation must be observable by others, for if they can see the results, they will more readily adopt the innovation (pp. 15-16).

Moore (2002), in a revised Diffusion of Innovation model has positioned abandonment as a chasm between the early adopters and the remaining adopters, identified in Figure 2 as the early market and the mainstream market. The early market is made up of innovators and visionaries, while the mainstream market is made up of pragmatists, conservatives, and sceptics, see Figure 2.



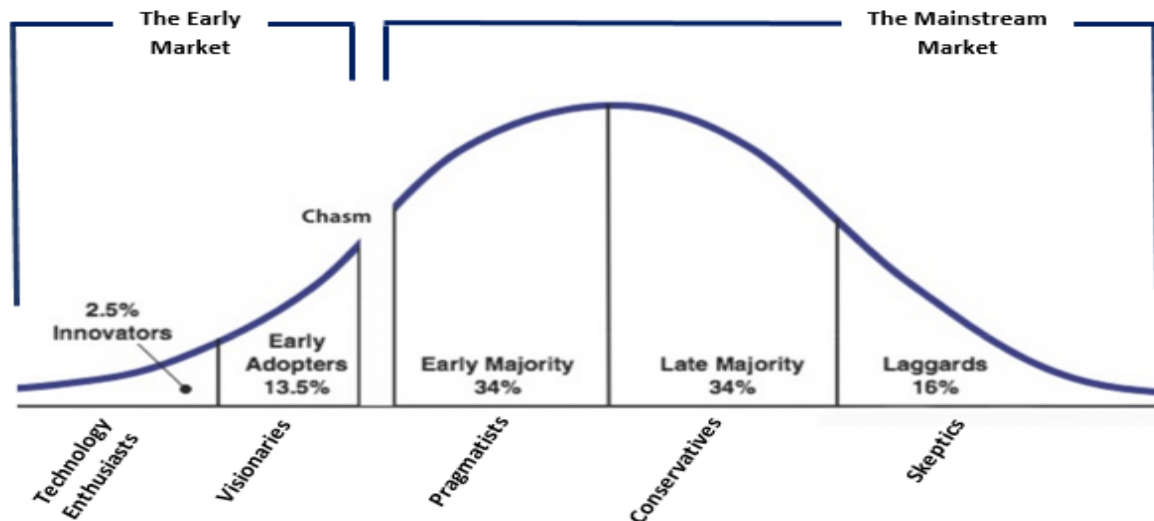


Figure 2: Revised Diffusion of Innovation Model (Moore, 2002)

Producers tend to sit in the mainstream market because they are not normally risk takers (Marshall, Stokes, Webb, Marshall, & Lankester, 2014). Early adopters are usually change agents, the first to implement something new and then tell others about it. In contrast, the early majority want the product they choose to fill a gap, to increase productivity for existing operations, they want to evolve processes and they want the products to work properly – if they don't then they will be part of the late majority and will wait for others to test the product to ensure it works in the way it is promoted (Moore, 2002). However, it is more complicated than the simple chasm.

Producers are driven by both cognitive and normative influences. Cognitive influencers are guided by the producer's reference group (Bearden & Etzel, 1982) and they rely on "*shared perspectives and scripts for understanding the world*" (Miller, Le Breton Miller, & Lester, 2011). These reference groups may not have all the information required to make a decision to adopt (or not adopt) new behaviours. Normative influences that stem from "*shared values and a sense of responsibility to the [proximate] reference group [such as family]*" (Miller et al., 2011, p. 3) also provide a barrier to adoption. Producers' priorities include providing financial security to the family and protecting the family business (Miller et al., 2011). Therefore depending on the strength of the cognitive and normative beliefs and the strength of the influence of their reference group, there is an opportunity for the producer to be influenced to take a conservative strategy to the adoption of new technology, processes or practices to preserve the business entity for future generations and as such they remain in the chasm (Moore, 2002; Sunyoung, Mathiassen, & Gallivan, 2009).

Understanding user acceptance of innovation is critical because it will provide points of potential focus, which can be used to "*create favourable perceptions and thus foster user acceptance and usage*" (Venkatesh, 2000, p. 343).

### 3.0 THE COMMUNICATION PROCESS

As noted by Eagle et al., (2016) “people are unlikely to take action unless they perceive potential positive or negative personal consequences, but are also influenced by social interactions with others in their communities (Gooch & Rigano, 2010)” (p. 67). It is important to identify sources of information used and the level of trust these sources have across different population groups. Findings from previous studies in the climate change context are worthy of consideration in the agri-environmental context. For example, we have already noted concerns about climate change science communication effects (Eagle et al., 2018). There is a need to communicate clearly the science underpinning the drive for behaviour change.

Good communication involves a two-way exchange as well as a good understanding of the audience receiving the communication (Penrose, Rasberry, & Myers, 1993; Sigband & Bell, 1994). Different communication circumstances call for different message tones, framing and language, and a one size fits all approach will not create successful communication with land holders (see Hay, Eagle, & Chan, 2018 for a best practice communication guide).

Shannon and Weaver's (1949) Mathematical Theory of Communication shows that for communication to occur, there must be a sender, a receiver and a channel (print, digital, static or web) for the message to travel through (Figure 3). Messages must be encoded by the source, pass through a channel and then be decoded in the way the message was intended by the receiver.

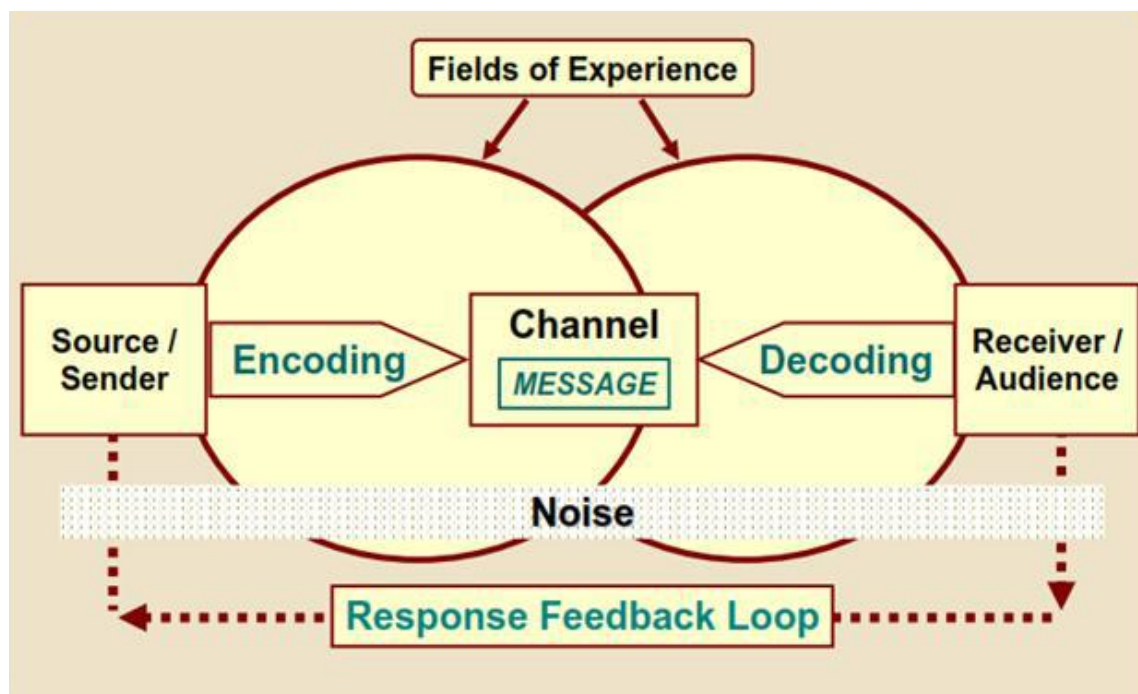


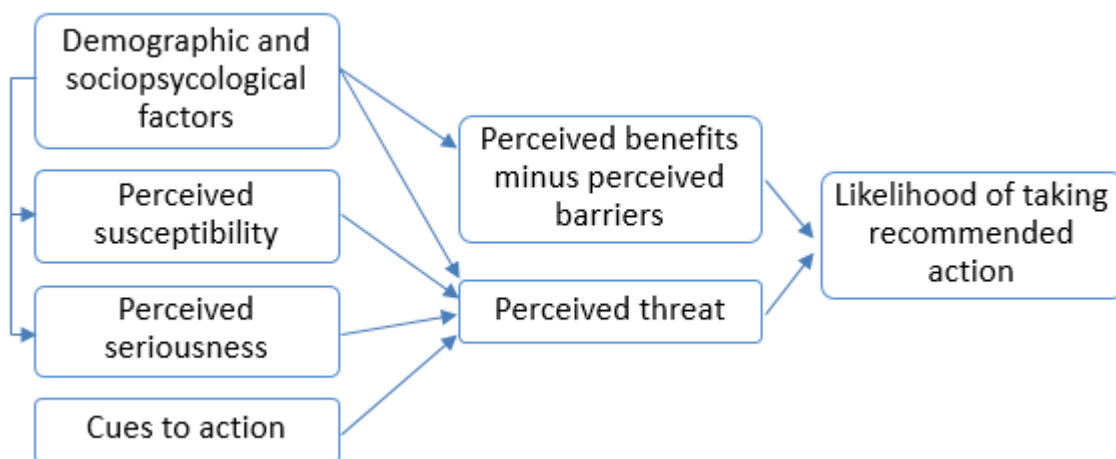
Figure 3: The Communication Model (Shannon and Weaver, 1949) Image Source: Google Images

The message may be interrupted by ‘noise’ surrounding the message, which may include complex noise from the receiver’s field of experience, expert opinion, distrust or lack of respect of the sender, fear, family and other reference groups or less complex noise such as

advertising, media, competing messages, badly expressed messages, information overload and disinterest or a lack of awareness of the relevance of the message (Tymson, Lazar, & Lazar, 2006).

## 4.0 APPLYING THEORY: THE HEALTH BELIEF MODEL

The Health Belief Model (HBM) (Janz & Becker, 1984; Rosenstock, 1974) is a value expectancy theory that explains decisions based on expected outcomes and has similar constructs to several widely used models including the Theory of Planned Behaviour (Eagle et al., 2016, Section 2.6). The theory (typically used in health) is used to weigh up perceived personal risk of negative outcomes from continuing current behaviour versus alternative outcomes through behaviour change. Personal characteristics and knowledge can modify decision outcomes (Eagle et al., 2013). Where a threat is perceived an alternative behaviour is actioned or not actioned, depending on the severity of the conditions surrounding the decision. These conditions may be influenced by demographic, psychological and knowledge factors. While theory alone cannot change behaviour, it can help us to understand behaviour and then use insights from individual experience to take action.



**Figure 4: Health Belief Model**

While this model was developed in the context of health, its principles can be applied to other areas of activity, including environmental sectors.

Extension officers from the Wet Tropics Region of Queensland Australia were invited to participate in a survey about how they thought cane land managers managed nutrient and sediment loss from their property. The survey was delivered online and was started by 31 extension officers, however, only 27 extension officers completed the survey. The following information gives a descriptive overview from the results of the data.

The following analysis of the survey data highlights that land managers' decisions are not always made with the same consideration of actions and consequences that is expected by extension officers, as such there may be negative consequences when land managers make decisions about runoff management practices.

## **5.0 METHODOLOGY**

### **5.1. Survey Development and Sampling Strategy**

The survey was abridged from the NESP TWQ Hub Project 2.1.3 Terrain NRM Cane Growers Survey. The original survey aimed to evaluate the training programs, grants and tenders that the government uses when trying to support land managers to control erosion and reduce nitrogen use.

The original survey was developed using information gathered from an initial literature review related to the science of social marketing (see Eagle et al., 2016) and from literature surrounding agriculturally relevant behaviours that impact water quality (see Churchill et al., 2017). Key determinants of pro-environmental behaviour in the agricultural sector (see Farr et al., 2017a) were also used to guide the development of the survey. For more information on the original survey's development see Farr, Eagle, Hay & Churchill (2017).

The original survey was distributed each year over three years (2016-2018) to land managers in both the Wet and Dry Tropics. In the second year (2017), the Wet Tropics Extension Officers were asked to participate in a modified and shortened form of the survey. The modified survey asked questions about:

- The location of the extension officer and how long they had been working in their job;
- What extension officers thought were decision making influencers for land managers;
- What grants, funding, workshops and training they thought land managers were undertaking; and
- What the extension officers thought the land managers current practices were in nutrient management, drain management and irrigation (not typically used in the Wet Tropics).
- Extension officers were asked what sort of innovative practices the land managers were doing to manage nutrient and sediment loss from their property; and
- What the extension officers thought were the main pressures on the Great Barrier Reef.

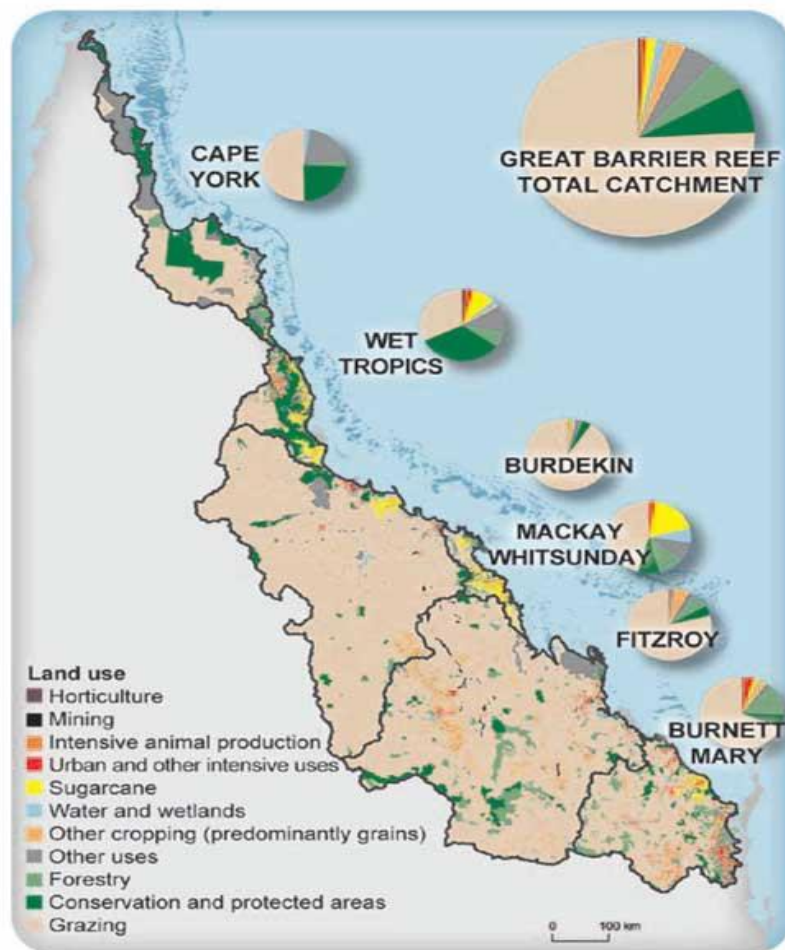
As previously mentioned, the 2017 land manager data incorrectly reports on the irrigation practices, which are not used in the wet tropics, and not on nutrient or drain management practices, therefore responses from the 2016 land manager survey, which include questions on nutrient and drain management were compared to the 2017 extension officer survey responses. The 2018 data will be reported separately in the NESP Project 2.1.3 Final Report: Findings from a longitudinal study of farmer decision influencers for Best Management Practices, Queensland, Australia (Hay, Eagle, & Saleem, 2018).

## 6.0 RESULTS AND DISCUSSION

### 6.1. Background Information Extension Officers

#### 6.1.1. Location of Extension Officers

The survey was open to all extension officers in the Wet Tropics Regions. The Wet Tropics region is located in tropical north eastern Queensland, it is an expansive area of some 2.2 million hectares between Townsville and Cooktown and is recognised as ‘Australia’s biological crown jewels’ (Benn, 2013, p. 10; Turnour et al., 2015). The Wet Tropics World Heritage Area is a part of the Wet Tropics catchments and is adjacent to both the Wet Tropical Rainforests and the Great Barrier Reef World Heritage Area (Emtage & Herbohn, 2012; TERRAIN NRM, 2017).



**Figure 5: Map of Land Use, Great Barrier Reef Catchment**  
(Source: Australian Government, Reef 2050 Water Quality Improvement Plan)

Nine river catchments lie within the Wet Tropics: Mossman and Daintree rivers, Tully and Murray rivers, Barron River, Russell and Mulgrave rivers, the Herbert River and the North and South Johnstone rivers (Ashburner et al., 2012). Table 1 identifies the breakdown of the extension officers per region who responded to the survey. The majority (58.2%) are from the Herbert River, the Mulgrave River and the Tully River regions, Sixteen percent of

respondents were from the Barron River and nearly 13% were from the Mossman region. Nearly 10% were from the Johnston or South Johnstone catchment in the Wet Tropics Region.

**Table 1: Wet Tropics regions where Extension Officers are located**

	<i>Frequency</i>	<i>Percent</i>
Barron	5	16.1
Herbert	6	19.4
Mulgrave	6	19.4
Johnstone/South Johnstone	3	9.7
Mossman	4	12.9
Tully	6	19.4
Total	30	96.8
Missing (area not specified)	1	3.2
<b>Total</b>	<b>31</b>	<b>100</b>

### 6.1.2 Experience of Extension Officers

Of the 31 responses, only 17 extension officers answered the question “How long have you been an extension officer in the sugarcane industry?” The majority of extension officers have been in the industry for between zero and three years (29.1%), by contrast nearly 10% had been in the industry for more than 10 years (35 years, 20 years and 14 years) and 10% had worked as an extension officer for 4-6 years. Nearly 7% had worked as extension officers between seven and ten years. While all of the extension officers are working primarily in sugar cane production, one noted that they have only worked in cane for one year, spending their remaining time as an extension officer in the grain, cotton, pasture and horticulture industries.

**Table 2: Length of time as an extension officer in the sugarcane industry**

	<i>Frequency</i>	<i>Percent</i>
< 1 year	2	6.5
1-3 Years	7	22.6
4-6 years	3	9.7
7-10 years	2	6.5
10 years +	3	9.7
Total	17	54.8
Missing (time in industry not stated)	14	45.2
<b>Total</b>	<b>31</b>	<b>100</b>

## 6.2. Decision Making Factors

The next question asked extension officers how important they thought the listed statements were to land managers when making decisions about what to do on their farm or property. Extension officer responses were collected with the expectation that their responses would be similar to land manager responses about decision making and hence support land managers in behaviour change. However, while extension officers have a good understanding of land manager decision making, the data suggests that the level of importance placed on variables that influence land manager decisions differs from extension officer's views depending on the drivers of decisions. For example, when asked about how important maintaining the physical and mental health of the land manager's family was when making decisions, only 11.1% of extension officers responded that it was extremely important or essential, whereas 71.5% land managers responded that it was extremely important or essential when making decisions. Likewise maintaining family traditions and heritage, spending time with family, keeping in contact with friends and family and maintaining relationships with other land managers are rated as more important by land managers than by extension officers, although the influence on decision making is not as strong (see Table 3).

The 2017 extension officer responses are compared to those gained from land managers in 2016, see Section 5.1 for information on the survey development.

**Table 3: Percent of extension officer and land manager responses about family, friends and other land manager influencers when making decisions (n=27)**

<b>Percent Responses Extension Officers (Land manager responses in brackets)</b>	<b>Extremely unimportant (irrelevant)</b>	<b>Somewhat unimportant</b>	<b>Unimportant</b>	<b>Neutral</b>	<b>Important</b>	<b>Somewhat important</b>	<b>Extremely Important (essential)</b>	<b>I don't know</b>
Maintaining physical and mental health of family	3.7 (0.8)	0.0 (0.4)	3.7 (0.0)	14.8 (1.6)	29.6 (3.7)	18.5 (22.0)	11.1 (71.5)	18.5 (0.0)
Maintaining family traditions and heritage	0.0 (1.2)	0.0 (1.2)	0.0 (1.6)	0.0 (17.1)	22.2 (16.7)	51.9 (30.6)	14.8 (31.4)	11.1 (0.0)
Spending face-to-face time with family and friends	0.0 (0.4)	0.0 (0.8)	0.0 (0.8)	3.7 (4.1)	18.5 (12.2)	48.1 (35.0)	22.2 (46.7)	7.4 (0.0)
Keeping in contact with family and friends in other ways (e.g. via phone, through social media)	0.0 (2.5)	0.0 (0.4)	3.7 (2.1)	22.2 (11.9)	22.2 (12.8)	25.9 (35.0)	7.4 (34.6)	18.5 (0.8)
Maintaining good relations with other farmers/graziers in the local area	0.0 (0.4)	0.0 (0.0)	3.7 (0.4)	3.7 (2.8)	29.6 (15.4)	40.7 (43.1)	14.8 (37.8)	7.4 (0.0)

It is important to understand how family opinion can influence the adoption or non-adoption of new technology, processes or practices. As discussed in the introduction, land managers



are driven by both cognitive and normative influences. Therefore, it is important that extension officers recognise the importance of family relationships in land manager decision making to support land managers and their families with information about best management practices.

By contrast variables surrounding how land managers make financial decisions are better understood by extension officers who rated keeping farm costs low, keeping a stable cash flow and minimising risk as extremely important (land managers also rated these variables as extremely important) (see Table 4). However, extension officers responded that maximising farm profits was somewhat important (44.4%) to land managers' decision making, while land managers rated maximising profits as extremely important (66.9%). Only 3.7% of extension officers rated servicing debt as an extremely important influencer of land manager decisions, whereas land managers rated this as extremely important (55.4%) when making decisions on their farm or property. The data shows that while extension officers understand the financial decision making that land managers face, it is clear that the level of importance attributed to those decision drivers are not equal between land managers and extension officers.

**Table 4: Percent of extension officer and land manager responses about financial influencers when making decisions**

<b>Percent Responses Extension Officers (Land manager responses in brackets)</b>	<b>Extremely unimportant (irrelevant)</b>	<b>Somewhat unimportant</b>	<b>Unimportant</b>	<b>Neutral</b>	<b>Important</b>	<b>Somewhat important</b>	<b>Extremely Important (essential)</b>	<b>I don't know</b>
Keeping farm costs low	0.0 (0.8)	3.7 (0.0)	3.7 (0.4)	0.0 (2.8)	11.1 (9.8)	29.6 (22.4)	48.1 (63.8)	3.7 (0.0)
Keeping a stable (steady) cash-flow	0.0 (0.8)	0.0 (0.0)	0.0 (0.0)	3.7 (0.8)	14.8 (10.2)	33.3 (24.0)	40.7 (64.2)	7.4 (0.0)
Maximising farm profits (income minus costs)	0.0 (0.8)	0.0 (0.0)	3.7 (0.0)	0.0 (1.6)	7.4 (6.5)	44.4 (24.1)	37.0 (66.9)	7.4 (0.0)
Minimising risk (of very high costs or very low income)	3.7 (0.8)	0.0 (0.0)	3.7 (0.8)	0.0 (3.3)	14.8 (14.2)	29.6 (27.6)	40.7 (53.3)	7.4 (0.0)
Servicing debt	0.0 (2.9)	7.4 (0.0)	7.4 (2.1)	22.2 (10.4)	25.9 (5.0)	18.5 (23.3)	3.7 (55.4)	14.8 (0.8)

Land manager's value having time to pursue hobbies as somewhat important (25.6%) or extremely important (21.5%), while extension officers selected having time to pursue hobbies as important (25.9%) or somewhat important (18.5%) (See Table 5). Both extension officers and land managers ranked a land manager being able to make their own decisions as important or extremely important. Extension officers recognised that land managers learning about and testing new ways of doing things on their property was important (66.6%), however, land managers placed a higher value (96.4%) on the importance of learning and testing new ways of doing things. This finding is counterintuitive since best management practices have not been readily adopted. This may be due to land managers internal locus of

control (Ajzen, 2002) in terms of decisions made with family about management practices on their farms.

Sharing new ideas is also rated as important by both land managers and extension officers. Having efforts recognised by the wider community was rated as important by both extension officers and land managers. However, nearly 15% of land managers rated it as extremely important. Rogers (1962, pp. 15-16) fifth characteristic of diffusion of innovation *i.e. the results of the innovation must be observable by others, for if they can see the results, they will more readily adopt the innovation*, which must be met for adoption to occur supports this finding. Having the community recognise their (land managers) efforts may encourage others to adopt the new innovation (technology, process, practice) as well as ratify the land manager's decision to change their behaviour.

**Table 5: Percent of extension officer and land manager responses about hobbies, making their own decisions and learning about and sharing new ideas when making decisions**

<b>Percent Responses Extension Officers (Land manager responses in brackets)</b>	<b>Extremely unimportant (irrelevant)</b>	<b>Somewhat unimportant</b>	<b>Unimportant</b>	<b>Neutral</b>	<b>Important</b>	<b>Somewhat important</b>	<b>Extremely Important (essential)</b>	<b>I don't know</b>
Having time to pursue hobbies	0.0 (2.4)	7.4 (2.8)	7.4 (6.5)	22.2 (16.7)	25.9 (23.6)	18.5 (25.6)	3.7 (21.5)	14.8 (0.8)
Being able to make your own decisions about your farm/property	0.0 (0.8)	0.0 (0.0)	0.0 (0.0)	3.7 (0.8)	0.0 (4.5)	25.9 (24.8)	63.0 (69.1)	7.4 (0.0)
Learning about and testing new ways of doing things on your farm/property	0.0 (0.0)	3.7 (0.4)	11.1 (1.2)	11.1 (2.0)	25.9 (10.2)	40.7 (43.5)	0.0 (42.7)	7.4 (0.0)
Sharing new ideas with others	0.0 (1.2)	3.7 (0.4)	7.4 (1.2)	22.2 (4.9)	44.4 (16.7)	11.1 (40.7)	3.7 (35.0)	7.4 (0.0)
Having efforts recognised by the wider community	0.0 (6.9)	7.4 (7.3)	3.7 (3.7)	22.2 (26.9)	25.9 (20.4)	25.9 (19.2)	7.4 (14.7)	7.4 (0.8)

In terms of farm management land managers rated leaving the farm in better condition than when they first got it (69.4%), maintaining or improving water supplies and storages (65.8%) and minimising sediment runoff (65.8%) as extremely important, whereas extension officers rated these variables as lower importance when making decisions about how land managers manage their properties, see Table 6.

**Table 6: Percent of extension officer and land manager responses about leaving the land in a better condition, maintaining water supplies and minimising sediment when making decisions**

<b>Percent Responses Extension Officers (Land manager responses in brackets)</b>	<b>Extremely unimportant (irrelevant)</b>	<b>Somewhat unimportant</b>	<b>Unimportant</b>	<b>Neutral</b>	<b>Important</b>	<b>Somewhat important</b>	<b>Extremely Important (essential)</b>	<b>I don't know</b>
Leaving the land/farm in better condition than it was when you first started managing it	0.0 (0.4)	0.0 (0.0)	3.7 (0.0)	7.4 (2.0)	18.5 (4.5)	48.1 (23.7)	14.8 (69.4)	7.4 (0.0)
Maintaining/improving water supplies and storages	3.7 (2.4)	0.0 (0.0)	3.7 (0.5)	25.9 (27.7 )	29.6 (5.3)	14.8 (12.6)	3.7 (29.6)	18.5 (21.8 )
Minimising sediment run-off and/or nutrient losses	0.0 (0.4)	0.0 (0.0)	3.7 (0.0)	14.8 (2.5)	44.4 (3.7)	22.2 (27.6)	7.4 (65.8)	7.4 (0.0)

Similarly, when land managers were asked about safeguarding native plants and animals, helping to safeguard local waterways and helping to safeguard the Great Barrier Reef they rated the variables as extremely important. The data shows that extension officers underestimate land managers' perceptions of the importance of safeguarding the environment when making decisions about what to do on their farm or property.

**Table 7: Percent of extension officer and land manager responses about safeguarding the surrounding environment when making decisions**

<b>Percent Responses Extension Officers (Land manager responses in brackets)</b>	<b>Extremely unimportant (irrelevant)</b>	<b>Somewhat unimportant</b>	<b>Unimportant</b>	<b>Neutral</b>	<b>Important</b>	<b>Somewhat important</b>	<b>Extremely Important (essential)</b>	<b>I don't know</b>
Helping to safeguard native plants and animals	3.7 (0.4)	7.4 (0.0)	7.4 (0.0)	29.6 (11.2)	25.9 (14.9)	14.8 (36.0)	3.7 (37.2)	7.4 (0.4)
Helping to safeguard local waterways	0.0 (0.4)	0.0 (0.0)	0.0 (0.0)	25.9 (2.5)	40.7 (7.0)	18.5 (34.2)	7.4 (56.0)	7.4 (0.0)
Helping to safeguard the Great Barrier Reef	0.0 (0.0)	0.0 (0.4)	0.0 (0.4)	18.5 (4.1)	55.6 (8.6)	7.4 (27.2)	11.1 (59.3)	7.4 (0.0)

Extension officers underestimating the importance of land manager decision influencers may lead to distrust or lack of respect for the extension officer. Furthermore, misunderstanding the level of importance of decision influences, may change the tone, language and framing of the message being sent by the extension officer about behaviour change and in turn be misinterpreted by the land manager as being dictatorial (controlling or overbearing) or patronising (superior attitude towards others). This may significantly affect the way that messages are processed (if at all) and whether the messages are ultimately influential in encouraging the behaviours desired (Clark, 2014).

### 6.3. Grants and Funding

Extension officers were asked where they thought land managers sourced the main information about grants and financial assistance, if they believed the land manager applications were successful and what the most important aim was that the land managers hoped to achieve with the grant. The extension officers were also asked if they thought the grant/financial assistance was useful in achieving the land managers identified aim.

Extension officers answered that the main sources of information for grants and/or financial assistance used by land managers comes from extension officers (38.6%), then from local networks, industry meetings, emails and newsletters (20.5%). Land managers surveyed in the first round of data collection (2016) answered that the Canegrowers organisation was the primary source of information (42.8%) followed by extension officers (22.3%) (See Farr et al., 2017, p. 28 for the detailed first round (2016) data analysis). Table 8 shows where extension officers thought that land managers sourced information for grants and funding from. For example respondents identified the Commonwealth website (2.3%), extension officers (2.3%), local networks etc. (11.4%) and WTSIP, Terrain and SRA (4.5%) as sources of information for the Reef Trust Phase IV grants or funding and individual contact or advisors (2.3%) for Project Uplift (MSF) funding.

**Table 8: What are the main sources of information land managers used? (n=44)**

	Grant Name					
	Reef Trust Phase III %	Reef Trust Phase IV %	Reef Rescue %	Project Uplift (MSF) %	Reef Program %	Total
Commonwealth website		2.3				2.3
Extension Officer / NRM Groups / BMP	36.3	2.3				38.6
Individual contact/ Advisors	4.5		2.3	2.3		9.1
Local networks, industry meetings, emails and newsletters	11.4	6.8			2.3	20.5
Productivity Board			4.5			4.5
Soil Health Workshops	2.3					2.3
Sugar Research Australia			2.3			2.3
Web	2.3					2.3
WTSIP / Terrain / SRA	6.8	4.5				11.3
Other			4.5		2.3	6.8
<b>Total</b>	<b>63.6</b>	<b>15.9</b>	<b>13.6</b>	<b>2.3</b>	<b>4.6</b>	<b>100</b>

Sixty one percent of extension officers identified the Reef Trust Phase III and IV funding and the Reef Rescue applications had less than 10% chance of being successful. Just over 13% of extension officers identified a 30% chance of land managers successfully applying for funding for the Reef Trust Phase III and IV. Only 7.8% or extension officers indicated that there would be more than 50% chance of land managers successfully applying for funding. The data indicates a lack of confidence from extension officers about grant money being allocated to the land managers in their areas.

**Table 9: What percent of applications do you believe were successful? (n=38)**

	Grant Name					
	Reef Trust Phase III %	Reef Trust Phase IV %	Reef Rescue %	Project Uplift (MSF) %	Reef Program %	Total
< 10%	36.8	21.5	2.6			61.0
11 - 20%	2.6				2.6	5.3
21 - 30%	7.9	5.3				13.2
31 - 40%			2.6			2.6
41 - 50%		2.6				2.6
100%	2.6			2.6		5.3
Yet to be determined	7.4	2.6				10.5
<b>Total</b>	<b>57.4</b>	<b>32.1</b>	<b>5.3</b>	<b>2.6</b>	<b>2.6</b>	<b>100</b>

Extension officers were asked to rank the usefulness of the grant for the land manager from 1 complete waste of time to 7 extremely useful. The overall mean score shows that extension officers felt that the Reef Rescue and the Project Uplift (MSF) (M=6.00 each) were the most useful funding packages for land managers to achieve their aims.

**Table 10: How useful was the grant in helping land managers achieve that aim? (n=49)**

	Grant Name				
	Reef Trust Phase III %	Reef Trust Phase IV %	Reef Rescue %	Project Uplift (MSF) %	Reef Program %
Complete waste of time	5.7				
Extremely useful	3.8	2.5			
Neutral	11.3	4.8	2.5		2.48
Somewhat a waste of time	5.7				
Somewhat useful	13.3	16.3	8.2		2.48
Useful	9.4	6.1	2.5	2.5	
<b>Mean</b>	<b>5.00</b>	<b>3.67</b>	<b>6.00</b>	<b>6.00</b>	<b>3.50</b>

The survey asked extension officers to write what they thought was the most important aim that land managers hoped to achieve with the grant. The open ended responses were separated (if more than one response) and coded into two themes 1) equipment or tools and 2) practice change. Of the 44 responses, around 20% of extension officers responses indicated that they thought land managers would use the funding to upgrade or purchase new equipment (see Table 11.)

**Table 11: What was the most important aim that land managers hoped to achieve with this grant?  
Anecdotal responses themed to equipment or tools (n=9)**

Equipment/Tools	Reef Trust Phase III	Reef Trust Phase IV	Reef Rescue	Project Uplift (MSF)	Total
Assistance with purchase of new equipment to improve fertiliser application	1				1
Get machinery to improve their farming practices	1				1
GPS for controlled traffic	1				1
Purchase equipment to effectively pursue innovation already underway	1				1
Finance infrastructure and equipment	2	1			3
Update machinery			1		1
Unknown but probably equipment				1	1
Note: Reef Program not selected in this question					9

Seventy-two percent of extension officers, indicated that they thought land managers would use the grant funding to change land management practices. Some examples of uses in practice change include improving soil health, water quality and reducing nitrogen runoff from their farm or property. While other examples include having an opportunity to explore new ideas and implement new practices while sharing the cost (see Table 12).

**Table 12: What was the most important aim that land managers hoped to achieve with this grant?  
Anecdotal responses themed to practice change (n=30)**

Practice Change	Reef Trust Phase III	Reef Trust Phase IV	Total
Chance to explore an idea which they otherwise wouldn't proceed with.	1		1
Farm profitability and production	1	1	2
Financial assistance to make change	1	1	2
Funding/ Obtain funds to improve/implement new practices	2	1	3
Improve their farming system while reducing off-farm impacts	4	2	6
Improved Soil Health	1	1	2
Improved water quality	1		1
Innovative practice change	1		1
Reduce N & Increase Profit	1	1	2
Reduced N leaving farm	1	4	5
Test something new/ Do something different and also reduce N use	1	1	2
Trial some of their ideas sharing the costs	1		1
WQ through soil health but concept was not supported by assessment panel despite majority of applications focused on this topic. Successful - address drainage, improve bed forming and legume fallow, use of technology for better decision making	1		1
Use of mill mud as alternative source of N		1	1
Note: Reef Rescue, Project Uplift (MSF), Reef Program not selected in this question			<b>30</b>

Nearly 7% of extension officer responses indicated that a land manager's main aim for receiving funding was to get something for free, another indicated that there were a diverse range of aims and another was unsure what the land managers main aim for the funding was.

**Table 13: What was the most important aim that land managers hoped to achieve with this grant?  
Anecdotal responses themed to other (n=5)**

Other	Reef Trust Phase III	Reef Rescue
Get something for free	2	1
Diverse range of ideas	1	
Unsure	1	

*Note: Project Uplift (MSF) and Reef Program not selected in this question*

The extension officer's perception of success or failure of grant application rounds may in itself become a barrier to land managers adopting best management practices (see Section 4.0.) If extension officers perceived a threat that the grants are not worth spending time on (i.e. because there is a perception that they will not be successful), then by virtue, the land manager may also perceive that they have a slim chance of receiving funding and as such, may not be able to validate the cost/benefit of applying for the grant and may forego the process.

## 6.4. Workshops, Training Programs and Other Activities

Table 13 is a cross tabulation that identifies the workshops and training programs offered to land managers in the Wet Tropics region and where the information about the workshops or programs was found.

The first part of the question asked extension officers to list workshops or training they have led or in which they knew land managers had participated. Twenty-three workshops, training, meetings or information sessions were identified in the 12 months prior to the survey period (see Table 14).

The second part of the question asked where land managers and extension officers might find information about the workshops and training. Participants were allowed to identify more than one place that they found information. The majority of responses identified the industry extension network (39%), followed by Sugar Research Australia (SRA) (16.2%) then from those who organised it (13.9%). Friends and personal networks account for 11.6% or responses. Other information sources include the Tully Cane Productivity Services Limited (TCPSL), the Herbert Cane Productivity Services Limited (HCPSL), Terrain Natural Resource Management Group, the Wet Tropics Sugar Industry Partnership (WTSIP) team and Canegrowers.

**Table 14: Please tell us about any workshops/training programs focused on land-management issues that you have led or that you know land managers have participated in, over the past 12 months (6 Easy Steps, Smart Cane BMP) in your cane District (n=43)**

Name of Program (2016-2017)	How did you find out about the program									
	Canegrowers	Industry Extension Network	Friend/My network	SRA	TCPSL	Through organising it	WTSIP Team	HCPSL	Terrain	Total
APEN Conference							1			1
ASSCT		1								1
BMP Drainage						1				1
BMP Soil Health			1			1				2
Cane Changer Workshops	1	1	2							4
District shed meetings - Productivity Services and SRA						1				1
Drainage management				1		2				3
Extension Training Workshop	1	2		1						4
Face to face weed management plans		1								1
Face-to-face nutrient management plans		2								2
Farmers teaching farmers bus trip		1								1
Grower Breakfast Meetings					2					2
Harvesting workshop								1		1
Innisfail Canegrowers meeting	1	2	1	1						5
Mulgrave Water Quality Information Day						1				1
Protecting our chemicals workshops										0
Reverse Tender Information Sessions									1	1
SIX EASY STEPS		1		1						2
Smart Cane BMP		1								1
Soil Health Workshop			1							1
SRA open day				1						1
SRA Protect Our Chemicals		3								3
SRA Soils Master Class		2		2						4
<b>Total</b>	<b>3</b>	<b>17</b>	<b>5</b>	<b>7</b>	<b>2</b>	<b>6</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>43</b>

Extension officers were asked to list what they thought was the most important thing land managers hoped to achieve by doing the workshop or training. The majority of the qualitative answers indicated aims relating to improved land management practices around soil management and to raise awareness of water quality issues. Other important achievements include accreditation and networking (see Table 15).



**Table 15: What was the most important thing you hoped to achieve by doing the workshop, training program or activity?**

<b>Accreditation</b>	<b>Better Practices</b>
<ul style="list-style-type: none"> <li>• BMP Accreditation</li> <li>• Comply with industry requirements</li> <li>• Get in the system towards Smartcane BMP Accreditation. Buffer for compliance requests if relevant</li> <li>• Meet regulations</li> </ul>	<ul style="list-style-type: none"> <li>• Better facilitation and extension practices</li> <li>• Better understanding of soil health</li> <li>• Improving farm sustainability including reducing environmental impacts</li> <li>• Improve knowledge/understanding of soil health/biology</li> <li>• Hoped to educate the growers on innovation and change</li> <li>• Enhanced skills</li> <li>• Improving understanding and practices of soil health</li> <li>• Increase the understanding of the importance of soil health</li> <li>• Increase understanding of nutrient management</li> <li>• Information on applying</li> <li>• Information on chemical pollution</li> <li>• Information on farming issues</li> <li>• Learn more about soil health</li> <li>• Learn more on soil health</li> <li>• Practise improvement</li> <li>• Refresh growers and extension providers on the principles of drainage</li> <li>• Targeted Herbicide Applications</li> <li>• Targeted Nutrient Applications</li> </ul>
<b>Networking</b>	
<ul style="list-style-type: none"> <li>• Engagement with growers</li> <li>• Group discussions to better understand how we can get mass change in the cane industry</li> <li>• Peer to peer learning</li> </ul>	
<b>Raise Awareness</b>	
<ul style="list-style-type: none"> <li>• Awareness of how catchment monitoring works and a number of ways growers can reduce losses of inputs to the environment</li> <li>• Awareness of how to reduce risks of chemical loss to waterways</li> <li>• Exposure to many aspects of Extension</li> <li>• Inform growers, get growers thinking</li> <li>• Know more about the issues with harvesting losses in the Herbert</li> <li>• Know more about where growers need help with nutrient management</li> <li>• More in-depth and practical understanding of the impacts of positive soil health farming systems</li> <li>• Up to date relevant information</li> </ul>	

Extension officers were asked which workshops or training programs were the most useful and why. All of the workshops were listed, with some extension officers stating that all of them were useful. Separately listed were six easy steps, soil health workshops, and SRA masterclasses. Each of the listings gave an explanation as to why the extension officers thought that they were most useful, with compliance, keeping up to date and learning about management practices highlighted as the elements that were most useful. Each statement is shown in Table 16.

**Table 16: Which of these workshops or training programs do you think would be the most useful to land managers and why?**

<ul style="list-style-type: none"> <li>• All of them</li> <li>• All workshops nominated are useful, for different purposes and messages, resources are too few to waste on unworthy extension pursuits</li> <li>• Drainage management</li> <li>• Extension training</li> <li>• Nutrient Management Planning, It can help in multiple areas, targeted nutrient application, help keep records for BMP and help meet regulatory requirements</li> <li>• Protecting our chemicals - dual goal of understanding water quality science, building trust and providing various solutions</li> </ul>
<ul style="list-style-type: none"> <li>• SIX EASY STEPS. Need to know for compliance.</li> <li>• SIX EASY STEPS. soil health, drainage, BMP- all useful</li> <li>• SIX EASY STEPS. Even though it has been offered for quite some time with approximately 90% of the Wet Tropics growers attending at least one course, there is still a great need for learning within nutrient management.</li> <li>• SIX EASY STEPS. Smartcane, new round of 6ES</li> </ul>
<ul style="list-style-type: none"> <li>• Soil Health - it puts a different spin on things</li> <li>• Soil Health Masterclass</li> <li>• Soil Masterclass: It is informative on aspects of agriculture that it is good to know and hence land managers can be alert to and react to them when the opportunity arises</li> </ul>
<ul style="list-style-type: none"> <li>• SRA Protecting our chemicals - used rainfall simulator to show loss pathways that were not visible, so growers could accept the advice provided about when and how to apply chemicals</li> <li>• SRA Soil Masterclass as it opens grower's eyes up to the biological component of healthy soils and changes they can make to improve their soils and therefore productivity.</li> <li>• SRA, Digging deeper, bio fertiliser trialling. There is growing interest in this space despite the large level of scepticism. Industry needs to explore this aspect of farming</li> </ul>

Extension officers were asked what could be done to make grants, programs, workshops, training activities or extension activities work better for land managers. Responses shown in Table 16 indicated that land managers should be consulted as to what suits them, the workshops should be practical, relevant and appealing with good trainers and one on one time with experts and farmers. Training/workshops should be held outside of the harvest season, they should target skills deficiency, be better coordinated and have a simplified process. The grant process is difficult to navigate and successful grants are viewed as rewarding growers who are doing the wrong thing and ignoring land managers who are doing the right thing (see Table 17 for anecdotal comments from extension officers).

**Table 17: What do you think could be done to make grants/programs/workshops/training activities and/or extension activities work better for land managers (i.e. to help them meet their personal goals)?**

<ul style="list-style-type: none"> <li>• Ask growers what they want, at a District scale, and then structure a generic training program to suit all cane Districts in the Wet Tropics region.</li> <li>• Avoid being overly prescriptive in the adherence to particular farming system practices, very difficult to work with 'one size fits all'</li> <li>• Less regulation and more education about soil health and management techniques to improve soil health and enhance crop productivity potential</li> </ul>
<ul style="list-style-type: none"> <li>• Workshops - practical and interactive information on the impacts both financial and environmental of farming systems. Best achieved through on ground demonstrations followed up with small group on farm discussion around new information that has become available through science and practical application of this science.</li> <li>• Make them relevant, appealing and designed by and for the growers</li> <li>• One on one time with experts</li> <li>• one to one work with farmers</li> <li>• Good trainers</li> </ul>
<ul style="list-style-type: none"> <li>• Organise funding / Training opportunities during the Slack to allow for maximum engagement from growers</li> <li>• Target learning/skill deficiency areas</li> <li>• Keep simplifying the process. We have to get Collector App out of the face of growers. It is far too complicated and clunky</li> <li>• Convenient timing and location</li> <li>• Better coordination. There seems to be competing and clashing efforts due to timing of funding, and in some cases, double ups of the same or similar programs.</li> </ul>
<ul style="list-style-type: none"> <li>• With current grants they are rewarding growers who are doing the wrong thing (ones that are over applying N) to get them to do the right thing (using 6ES). Whereas with the grower who have already changed to doing the right thing are always missing out. Grants can be improved by assisting growers who have already made the change to using the correct farming practices.</li> <li>• Talking to growers many find the grant process difficult to navigate, it looks like the same grower get the grants and that leads to cynicism</li> <li>• Grants need to be simple to apply for</li> <li>• I think have programs they have to apply/sign up to and be committed to learning and engaging. Through the program provide hands on learning and also undertake a situation analysis and action planning activity. With the identified needs and barriers to moving forward the program should then focus "funds/grants" to address the barriers and enable the action to commence. Grants do not work as the grower comes in expecting to 'buy' get what they want. E.g. - I would like a fertiliser box. They get disappointed when they do not get what they expect.</li> </ul>

Extension officers were then asked the question “What support or training was required in the future to help land managers make farm improvements?” Most of the responses highlighted support for nutrient management, better understanding of soil chemistry and how the greater system works to build a better understanding of water quality programs and on ground solutions. Extension officers also highlighted more involvement between extension officers and land managers to identify what land managers might need to pursue practice change, strategic and coordinated extension programs and different organisations working together collaboratively to maximise benefits for growers, communities, organisations and the environment.

**Table 18: What extension support or training do you think is needed in the future to help land managers make farm improvements?**

<ul style="list-style-type: none"> <li>• Support for Nutrient Management plans and training/funding to help growers move to GPS and min till/controlled traffic</li> <li>• Better understanding of basic soil chemistry as related to 6ES - needs to be practical with landholders informed as to procedures when taking a soil test (don't take it from the worst part of the block) and the influence of different nutrients/chemical reactions on their crop as related to soil. How to interpret a soil test and calculate nutrient rates. Reseller workshop with a focus on herbicide legislation, risks, application methods, timing and mobility</li> <li>• Better understanding of the basics and how the greater system works which sometimes means pulling it a part first. Provide concepts, situational analysis hands on learning, action planning and then execution.</li> <li>• Build better understanding of overarching water quality programs, build better understanding of on ground solutions to WQ issues, build better understanding of how to do community monitoring - growers also need this training</li> </ul>
<ul style="list-style-type: none"> <li>• Longer term association with extension staff and programs to build credibility for the extension process, also more involvement by growers on what they identify they might pursue as practice change objective</li> <li>• More scope for one-on-one extension support with a dedicated extension officer</li> <li>• Extension on the ground with more people to implement more one on one discussions and assistance.</li> <li>• People they relate to running extension</li> <li>• Strategic and coordinated extension programs. Training alone won't work.</li> <li>• Well-coordinated delivery of extension services with different organisations working together collaboratively to maximise benefits for growers, communities, organisations and the environment.</li> </ul>

Extension officers also highlighted the need for the Department of Environment and Heritage Protection (DEHP), now the Department of Environment and Science (DES) to have a presence in the industry to motivate change, that farmer led workshops are important and that incentive based training, where growers can clearly see how the outcomes improve productivity, farm and lifestyle were necessary. Lastly, extension officers thought focussing on trials and demonstrations may help land managers to make farm improvements.

**Table 18 continued... What extension support or training do you think is needed in the future to help land managers make farm improvements?**

<ul style="list-style-type: none"> <li>• DEHP needs to be a presence to give the industry motivation to change.</li> <li>• Whatever is relevant to them to improve their sustainability</li> <li>• Training in computer technology</li> <li>• I think farmer led workshops are an important part of training.</li> <li>• Incentive based training where growers clearly see how the outcome improves their productivity, farm and lifestyle</li> </ul>
<ul style="list-style-type: none"> <li>• Focus on P regulations - trial results around them. Focus on high C% paddocks that, under regulations, are only allowed reduce amounts of N - on those high C% blocks are we reducing the N by too much? Trials etc. around this.</li> <li>• Demonstration on nitrogen loss pathways on individual growers farm (visual monitoring rather than conceptual modelling)</li> </ul>

In the 2016 survey, land managers were supportive of current systems in terms of grants, but less supportive of how training programs were delivered. Land managers cited that governments were not listening, that nitrogen goals were unrealistic and that land managers already doing the right thing were not being recognised. Similar arguments were given in terms of making application processes easier, having practical small group meetings, one on one training and extension officers specific to each property (see Farr et al., 2017, p. 39 for 2016 land manager responses).

## **6.5. Current Practices**

The next set of questions asked extension officers the reasons why land managers are doing specific agricultural practices or not doing them and what extension officers think motivates land managers in these decisions.

### **6.5.1. Nutrient Management Practices**

Extension officers were asked how they thought land managers calculated fertiliser application rates. They were asked to select more than one response that applied from a list of given responses or select other and list what they did. Table 19 compares 2016 land manager responses with 2017 extension officer responses.

A multiple response analysis showed that nearly 26% of extension officers (2017) indicated that land managers use the industry standard to calculate fertiliser use on all parts of their farm for district yield potential. However, 29.4% of land managers in a 2016 survey indicated that they tailored their fertiliser rates to different parts of the property. The second most selected way that land managers calculate fertiliser is by having their advisor do it for them (2016, 25.2%; 2017, 22.2%). Nearly 20% of land managers and 18.5% of extension officers indicated that land managers do something else (see Table 20 for anecdotal comments from extension officers).

**Table 19: How do you think land managers calculate fertiliser application rates?**

<b>2016 Land Manager Responses (N=248)</b>			<b>2017 Extension Officer Responses (N=31)</b>		
I tailor my fertiliser rates to different parts of the property	133	29.4%	7	25.9%	They use industry standard rates (Six Easy Steps) for district yield potential, and use that amount on all parts of their farm
My advisor does this for me	114	25.2%	6	22.2%	Their advisor does this for them
I use industry standard rates for district yield potential, and use that amount on all parts of my farm	96	21.2%	5	18.5%	They tailor their fertiliser rates to different parts of their property
Other. Please tell us what you do. See comments below	87	19.2%	5	18.5%	Other. Please tell us what they do
I estimate amounts from my farm yield and use that amount on all parts of my farm	13	2.9%	2	7.4%	They estimate amounts from their farm yield and use that amount on all parts of their farm
I use more fertiliser on under-performing (low yield) blocks than on other blocks	7	1.5%	1	3.7%	They use more fertiliser on high – performing (high yielding) blocks
I use more fertiliser on high – performing (high yielding) blocks	3	0.7%	1	3.7%	They use more fertiliser on under-performing (low yield) blocks than on other blocks
<b>Total</b>	<b>453</b>	<b>100%</b>	<b>27</b>	<b>100%</b>	

The anecdotal comments from when extension officers selected ‘Other, please tell us what they do’ indicate that extension officers (2017) think that land managers may think they are using the industry standard (Six Easy Steps) but are incorrectly applying the standard and therefore not applying the industry standard correctly (see Table 20 for anecdotal comments from extension officers).

**Table 20: How do you think land managers calculate fertiliser application rates? Other, please tell us what they do? Extension officer responses to ‘other’**

- 
- Generally they use 6ES protocols but tailor them to suit their farm
  - Some use advisors and some don't. The majority use 6ES and district yield potential. Some use less, some use more
  - Tend to use historical application rates
  - There are progressive farmers and less progressive farmers. As a result all options provided are possible
  - They are all different! some as per one, others guess at either increasing or reducing on zones within block, others think they are doing 6ES but are basing it off one soil test for a whole farm and then just basing on what the reseller tells them. Then there are some that do their own farm plans and try and do 6ES across farm and others working with an advisor to do a whole of farm NMP - I would guess the latter are fewer. Most growers think they are doing 6ES.
- 

Land managers in 2016, ‘Other’ responses about how they calculate fertiliser application rates include following best management practices, calculations based on experience, alternative methods, calculations based on soil test and that they would seek advice. Land managers were allowed to give more than one response. The responses were organised into themes and are provided in Table 21.

**Table 21: How do you calculate fertiliser application rates? Other, please tell us what you do – Land Managers responses to ‘other’**

<b>Best Management Practice</b> <ul style="list-style-type: none"> <li>• 6 Easy Steps</li> <li>• BMP recommendation</li> <li>• Smartcane BMP</li> <li>• Regulator recommendations</li> </ul>	47
<b>Based on experience</b> <ul style="list-style-type: none"> <li>• Historical fertiliser amounts</li> <li>• For planting the compactor puts on the same rate across the property; I trail the ratoon rate</li> <li>• I chase the results myself and vary according to cane variety</li> <li>• I have arrived at nutrient programme over a period of time by analysis of data (testing) and cropping results. Productivity results ground truth this approach</li> </ul>	12
<b>Alternative Methods</b> <ul style="list-style-type: none"> <li>• 4.9 cut per Ac with 1% zinc</li> <li>• Alternate methods for last 12-13 years - using liquid fertiliser</li> <li>• Experimental low rates using biology</li> <li>• Last yield - use mill mud</li> <li>• Liquid fertiliser computer controlled</li> <li>• Using mill product each year</li> <li>• Apply less than recommended</li> <li>• Based on previous history of paddock to past paddock size</li> </ul>	8
<b>Based on soil tests</b> <ul style="list-style-type: none"> <li>• Estimate amounts from farm yield and soil tests - follow GES</li> <li>• Variable rate technology now available</li> <li>• To a degree as soil types are the same and my budget plays an important role as well</li> <li>• MAS</li> <li>• NMP - based on GES</li> </ul>	26
<b>I seek advice</b> <ul style="list-style-type: none"> <li>• Local agronomists</li> <li>• Private agronomist advice</li> </ul>	5

The next question asked extension officers to think about the main tools that land managers used to calculate fertiliser rates and agree or disagree with a series of statements (see Table 22 for statements).

The majority of extension officers identified that land managers use their main tools for calculating fertiliser rates because ‘the farmers they respect most do this’ (47.4%). Nearly 53% of extension officers disagreed with the statement that land managers in the region would not have the technical skills to use the main tools to calculate fertiliser rates, highlighting the regions land managers as having the technical knowledge to calculate fertiliser rates.

Just over one third (36.8%) of extension officers disagreed that land managers would not be able to afford to use their main system for calculating fertiliser rates. More than half (58%) of extension officers responded neutrally or that they did not know if land managers would not be able to afford to use their main system for calculating fertiliser rates and only 5.3% agreed

that land managers would not be able to afford their main system. Nearly 85% of extension officers agreed that land managers use their main tool to calculate fertilizer rates because of people or organisations whose advice they follow think that land managers should use those tools.

Forty two percent of extension officers somewhat agreed or agreed that land managers only calculate fertilizer rates because they are forced to by cost, legislation or regulation or by government or government departments.

**Table 22: Think about the main tools used to calculate fertilizer rates. Please tell us how much you agree or disagree with each of the statements (N=19)**

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly Agree	Don't know/ Not Sure
<b>The farmers I respect most do this</b>			5.3	10.5	15.8	47.4	10.5	5.3
<b>Most farmers in this region would not have the technical knowledge to do this</b>	5.3	31.6	15.8	10.5	26.3			10.5
<b>Most farmers in this region would not be able to afford to use this system for calculating fertilizer rates</b>		10.5	26.3	10.5	5.3			47.4
<b>The people/organisations whose advice I follow most think I should do this</b>				5.3	21.1	57.9	5.3	10.5
<b>I only do this because I am forced</b>	15.8	21.1			21.1	21.1		21.1
<b>Who forces you?</b> Six Easy Step Legislation, DEHP, Fertiliser Costs / Regulations, Government, Legislation, Reef Regulations, REGS, Regulations.								

Extension officers were asked to rank from 1= most important to 12=least important whose advice they think land managers follow most when calculating fertilizer application rates. A means analysis compared responses from land managers in 2016 to extension officers in 2017 (see Table 23).

Other extension Officers, Researchers, Canegrowers, Landcare, Regional Cane Associations, people from Government, and NRM's were ranked as less important compared to industry extension, others, family who are also cane growers, private agronomists and other cane growers, by both land managers and extension officers when considering whose advice land managers follow about calculating fertilizer application rates (see Table 23 for overall responses from land managers (2016) and extension officers (2017)).



**Table 23: Please tell us whose advice you think land managers follow most when it comes to calculating fertiliser application rates.**

Land Manager Nominated Advisor	2016	2017	Extension Officer Nominated Advisor
Industry extension advisors (e.g. from SRA [BSES], Production	1.52	2.06	Industry extension advisors (e.g. from SRA [BSES], Production
Other. Who?	1.73	2.31	Family who are also cane farmers
Private Agronomists	2.04	2.64	Other cane farmers
Family who are also cane farmers	2.46	3.43	Other. Who?
Researchers	2.69	3.50	Private Agronomists
Other cane farmers	2.98	4.89	Other extension officers. From where?
Other extension officers. From where?	3.17	5.14	Researchers
Cane Growers (the organisation)	3.42	6.25	Cane Growers (the organisation)
Landcare	5.50	6.86	Regional cane association (e.g. from Kalamia, Invicta, Inkerma
People from government departments. Which departments?	5.54	7.75	People from government departments. Which departments?
People from NQ Dry Tropics/TERRAIN	5.67	9.00	People from NQ Dry Tropics/TERRAIN
Regional cane association (e.g. from Kalamia, Invicta, Inkerma	5.75	10.00	Landcare

Land managers in 2016 and extension officers in 2017 ranked industry extension advisors (2016, M=1.52; 2017, M=2.06) as the people whose advice they follow most and regional cane associations (2016, M=5.75) and Land Care (2017, M=10.00) as the people whose advice they follow least when calculating fertiliser rates.

‘Other’ (M=1.73) was rated second most important in 2016. ‘Other’ rated by land managers (2016) included Agribusiness agronomist, suppliers, and fertiliser representatives, financial and environmental constraints, myself (qualified soil analyst), re-sellers, Smartcane BMP and Six Easy Steps. Extension officers (2017) rated ‘Family who are also cane farmers’ (M=2.31) as the second most important advisor to land managers when calculating fertiliser rates.

Land managers (2016) rated “Private agronomists’ (M=2.04) as the third most important advisor, where extension officers (2017) ranked ‘Other cane farmers’ (M=2.64) as the third most important advisers to land managers.

Both land managers (2016) and extension officers (2017) identified ‘other extension officers’ as people whose advice that land managers followed when calculating fertiliser rates, ranking them seventh (M=3.17) and sixth (M=4.89) respectively. ‘Other extension officers’ nominated by land managers (2016) include extension officers from DAF, Canegrowers, and Productivity Boards, fertiliser representative, HCPSCS, SRA, MSF Sugar Mill, SLA, TSL, TCPSL, Smartcane BMP and supplier’s agronomist. ‘Other extension officers’ nominated by extension officers as people whose advice land managers follow to calculate fertiliser rates include agricultural sales personnel, QDAF, resellers and WTSIP.

The 2016 data indicates that land managers follow advice about nutrient management practices primarily from industry extension officers, others, family who are also cane growers, private agronomists and other cane growers. Others include agribusiness agronomist, suppliers, and fertiliser representatives, financial and environmental constraints, myself (qualified soil analyst), re-sellers, Smartcane BMP and Six Easy Steps. While the 2017 data

indicates that extension officers identify commercial resellers and fertiliser suppliers as people who land managers seek advice from about nutrient management practices.

### 6.5.2. Run-off Management Practices

The next question asked extension officers “How do you think most land managers handle run-off from rainfall or irrigation? Extension officers could select more than one response that applied.

Nearly 16% of extension officers selected that land manager’s handle run-off from rainfall or irrigation by using recycle pits or sediment traps. This supported in the anecdotal comments that “there is limited use of recycle pits and sediment traps”. The remaining 84% of extension responses identify that land managers either do not capture run-off or they do something else (see Table 24).

**Table 24: How do you think most land managers handle run-off from rainfall or irrigation?**

	Frequency	Percent
<b>They do not capture runoff</b>	8	42.1
<b>Other. Please tell us what you think they do</b>	8	42.1
<b>Recycle pits/sediment traps</b>	3	15.8
<b>Total</b>	19	100.0

The 2016 land manager data indicates that nearly 43% of land managers have recycle pits or sediment traps, 14% use grassed headland and/or trash blankets and 2% use grassed drains or underground drainage to handle run-off. Just over 32% of land managers indicated that they do not capture run-off (see Farr et al., 2017, p. 57). This is in contrast to the 2017 survey, where only 15.8% of extension officers selected that land managers use recycle pits/sediment traps.

Other comments from extension officers (2017) include that land managers use drains, grassed headlands and sediment traps. However, extension officers commented that while some land managers are trying to do the right thing, there is still room for improvement.

**Table 25: How do you think most land managers handle run-off from rainfall or irrigation? Other, please tell us what you think they do?**

- 
- Combination. Some who try to do the right thing might still have room for improvement
  - Drains
  - Grassed headlands leading into drainage lines. Laser levelling is gaining popularity but can be cost prohibitive.
  - Have grassed headlands. Many consider sediment traps
  - In Tully the emphasis is to shed water quickly - there is a mature system of drains, supplemented by new subsurface drains, plus laser-levelling and sediment traps
  - No irrigation and many growers have sediment traps in strategic locations
  - Some pits and sediment traps
  - There is limited usage of recycle pits and sediment traps
-

Extension officers were asked to think about the main system used to handle run-off and what they thought drives the majority of land manager's decisions about handling run-off (from rainfall and irrigation) and to agree or disagree with each of the statements in Table 26.

Nearly 70% of extension officers selected that land managers decisions about handling run-off is due to most farmers they respect also using the same practice. Nearly 37% of extension officers disagreed that most land managers in the region would not have the technical knowledge to use the practice. Forty-two percent of extension officers did not know or were not sure if land managers would not be able to afford to use the practice for handling run-off.

Nearly 50% of extension officers selected that land managers use the tools they do for handling run-off because the people or organisations that they follow most think they should follow their selected practice to handle run-off.

Extension officers disagreed that land managers were being forced to use their selected practice for handling run-off, but nominated environmental risk management and government as something that would be forcing land managers to handle run-off (see Table 26).

**Table 26: Thinking about the main tools used to handle run-off. Please tell us how much you agree or disagree with each of the statements (N=19)**

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly Agree	Don't know/ Not Sure
	%	%	%	%	%	%	%	%
<b>The farmers I respect most do this</b>		10.5		10.5	21.1	31.6	15.8	10.5
<b>Most farmers in this region would not have the technical knowledge to do this</b>	10.5	26.3		26.3	15.8	5.3		15.8
<b>Most farmers in this region would not be able to afford to use this system for calculating fertiliser rates</b>	10.5	5.3	15.8	21.1	5.3			42.1
<b>The people/organisations whose advice I follow most think I should do this</b>	5.3			21.1	10.5	21.1	15.8	26.3
<b>Land managers only do this because they are forced to</b>	15.8	21.1	10.5	15.8				36.8
<b>Who/what is forcing land managers?</b> Environmental risk management planning, government								

Extension officers were asked to rank from 1= most important to 12=least important whose advice they think land managers follow most when handling run-off. A means (M) analysis compared responses from land managers in 2016 to extension officers in 2017 (see Table 27). Both land managers (2016, M=1.54) and extension officers (2017, M=1.81) nominated industry extension advisors as advisors that land managers follow when making decisions about handling run-off.

Land managers in 2016 nominated 'others' as the second most important advisor (M=1.58) that is followed when making decisions about handling run-off. Others include private advice, drainage board, family who are not cane farmers, Terrain NRM, operators who have experience in land conservation, myself/ourselves, literature from DPI, self-education, drainage system designed by P. Jackson FCB, personal passion, family, environmental engineer, son is a civic engineer, farm tour, canegrowers, contractors, grader driver, Murray Riversdale Water Board, Cairns Regional Council, Natural floodplain – no options, drainage training course also use our experience, and Jeff Benjamin - water hydrologist/engineer (see Farr et al., 2017, p. 60). Extension officers in 2017 nominated 'others' (M=4.71) as the sixth most important advisor for land managers when handling run-off. 'Others' includes fertiliser suppliers, land managers own experience, private consultants and resellers.

Family who are also cane farmers (M=2.20) was ranked third most important advisor by land managers (2016) and second most important adviser (M=2.33) by extension officers (2017). Regional Cane Associations (M=6.40) and Landcare (M=12.00) were ranked as the least important advisors when it comes to handling run-off by land managers and extension officers respectively.

**Table 27: Please tell us whose advice you think land managers follow most when it comes to handling run-off.**

Land manager nominated advisor	2016	2017	Extension officer nominated advisor
Industry extension advisors (e.g. from SRA [BSES], Production Boards, Productivity Services Group)	1.54	1.81	Industry extension advisors (e.g. from SRA [BSES], Production Boards, Productivity Services Group)
Other. Who?	1.58	2.33	Family who are also cane farmers
Family who are also cane farmers	2.20	3.09	Other cane farmers
Cane Growers (the organisation)	2.70	3.50	Private Agronomists
People from NQ Dry Tropics/TERRAIN	2.75	3.80	Other extension officers. From where?
Other cane farmers	2.94	4.71	Other. Who?
Researchers	2.95	5.00	Researchers
Landcare	3.16	5.50	Cane Growers (the organisation)
Private Agronomists	3.35	6.00	Regional cane association (e.g. from Kalamia, Invicta, Inkerman, Tully Sugar)
Other extension officers. From where?	3.57	6.33	People from government departments. Which departments?
People from government departments. Which departments?	4.43	8.25	People from NQ Dry Tropics/TERRAIN
Regional cane association (e.g. from Kalamia, Invicta, Inkerman, Tully Sugar)	6.40	12.00	Landcare
<i>Note: 1= most important to 12=least important</i>			

For the most part extension officers have identified that run-off is not captured in the Wet Tropics Region. When it is, land managers use grass headlands (commonly thought of as sediment traps) drain systems, laser levelling and sediment trap or recycle pits. Extension officers are confident that land managers have the knowledge to manage run-off, but are not sure if land managers can afford run-off management systems. According to extension officers land managers place most trust in industry extension officers when it comes to following advice about handling run-off and they trust Land care the least.

### 6.5.3. Other Innovative Practices

The next question asked extension officers to list any other innovative practices that they thought land managers were using to reduce run-off. Thirteen extension officers answered the question, responses are shown in Table 28 and include bed renovators, contouring, wetlands bioreactors, minimum tillage, spoon drains and minimising sediment, DIN and chemicals.

**Table 28: What other innovative practices are land managers using to reduce run-off?**

- 
- Bed renovators
  - Contour planting has been around for a long time with not much uptake.
  - Experimenting with flocculants
  - Grassed headlands and riparian vegetation
  - In Tully there will always be runoff; the innovation is about minimising the amount of sediment, DIN and chemicals, which is about placement, timing, farming systems; there are plans to intercept groundwater DIN using filters
  - Installing wet lands and bioreactors. This is only a handful of growers.
  - Looking into directing run-off through designated sediment traps or bio-reactors
  - Minimum tillage controlled traffic fallow crops
  - Occasional wetland on a proactive farmer's farm. These farmers do this because they care as individuals.
  - Spoon drains
  - Strategically located wetlands
  - Subsurface fertiliser application, headland management, correct drainage
  - Trash blanketing and reduced tillage, spray-out fallow, cover crops during fallow
- 

While 41% of extension offices identified that land managers are using innovative practices to reduce run-off in the Wet Tropics Region, 63% of land managers in 2016 identified that they were using other innovative practices to reduce run-off. Some of the practices include using mill mud, timing of application of nitrogen, using legume crops in fallow, using trash to make earth walls in washouts, zero tillage, slow release fertiliser and laser levelling (a full list of practices can be found in Farr et al., 2017, p. 61).

## 7.0 PERCEPTIONS OF CAUSES AND PRESSURES ON WATER QUALITY

Extension officers were asked to agree or disagree with the statement “nutrient loss from cane growing properties has no impact on water quality in local streams, rivers and waterways?” Extension officers primarily disagreed (84.2%) with the statement indicating that they agree nutrient loss from cane growing properties does have an impact on the water quality of local streams, rivers and waterways. Just over 15% didn’t know or were neutral with regard to whether cane farming has an impact on water quality.

**Table 29: Level of agreement with the statement - Nutrient loss from cane growing properties has no impact on water quality in local streams, rivers & waterways (n=19)**

	Frequency	Percent
Strongly disagree	7	36.8
Disagree	5	26.3
Somewhat disagree	4	21.1
Neutral	2	10.5
Somewhat Agree, Agree, Strongly Agree	0	0.0
Don't know/Not Sure	1	5.3
<b>Total</b>	<b>19</b>	<b>100</b>

In 2016, 42% of land managers agreed that nutrient losses from their properties had no impact on the water quality of local streams, rivers and waterways. By contrast 30% of land managers believe that their activities are negatively affecting the water quality of streams, rivers and waterways. Thirteen percent were unsure and 15% took a neutral stance.

The next question asked extension offices to list what they thought were the top two causes of poor water quality in their districts local streams, rivers & waterways. Statements were coded into four themes, agriculture, anthropogenic, natural and other (see Table 30 to Table 33).

Agriculture was mentioned the most times and the first top causes were listed as fertiliser run-off, late season harvesting, over clearing of riparian zones, no vegetation on drains, farming in inappropriate areas. The second top causes in agriculture were herbicide/pesticide run off, improperly timed crops, lack of understanding and over application of nutrients (see Table 30).

**Table 30: What are the top causes of poor water quality in your districts local streams, rivers & waterways? - Agriculture**

First Top Cause	Second Top Cause
<b>Agriculture</b>	
<ul style="list-style-type: none"> <li>• Agricultural runoff</li> <li>• Fertiliser and chemical application rates</li> <li>• Fertiliser run off</li> <li>• Late season harvest leading to more farming operations leading into the wet season.</li> <li>• Fertiliser runoff</li> <li>• Over clearing of riparian zones</li> <li>• Poorly managed agricultural enterprises</li> <li>• Zero veg buffers on drains, poor timing to rainfall, not accounting for mill mud, legumes etc., farming in inappropriate areas/poor cane crops</li> </ul>	<ul style="list-style-type: none"> <li>• Herbicide / Pesticide run off</li> <li>• Instances where crop inputs are improperly timed, or excessive amounts applied</li> <li>• Lack of understanding on nutrient and chemical movement from farms to waterways - hard to quantify something you can't see. Leaching hasn't been explored enough to understand loss pathways</li> <li>• Routine over-application, would guess in the vicinity of 20 - 30 kgs over. Related to insisting to only think and talk in bags/acre which makes it difficult to understand soil tests and crop nutrition advice.</li> </ul>

The second most listed causes were anthropogenic (e.g., pollution, population growth, deforestation etc.). The first top anthropogenic causes were listed as the human population including sewage, roads, air pollution, boats, tourists and roadworks and urban run-off. The second top anthropogenic causes were listed as disturbed landscape, accelerated drainage systems, free campers, poorly managed industry, feral pigs, tourism, urban run-off and waste and pollution (see Table 31).

**Table 31: What are the top causes of poor water quality in your districts local streams, rivers & waterways? - Anthropogenic**

First Top Cause	Second Top Cause
<b>Anthropogenic</b>	
<ul style="list-style-type: none"> <li>• Cane contributes but so does everyone. Sewage, roads, air pollution, boats, tourists and boating all contribute and play a part. They are all top causes and it requires everyone to get involved.</li> <li>• Human population</li> <li>• Road works</li> <li>• Urban runoff - Phosphorous loads coming from townships</li> </ul>	<ul style="list-style-type: none"> <li>• Disturbed landscape for commercial production</li> <li>• Accelerated drainage systems reducing retention times in catchments</li> <li>• free campers, poorly managed industry and housing developments</li> <li>• Pigs in the national parks and on other public and private land disturbing watercourses and drainage lines during the dry season</li> <li>• Tourism</li> <li>• Town, Urban runoff</li> <li>• Urban spread and associated problems with waste and pollution</li> </ul>

Natural causes were mentioned the third most times and the first top causes were listed as erosion, heavy rainfall, adverse weather events, natural sediment run-off, nutrients from rainforests and torrential wet season rainfall. The second top natural causes were listed as sediment flushes from nature (and incorrect farming) and sediment/soil runoff and erosion (see Table 32).

**Table 32: What are the top causes of poor water quality in your districts local streams, rivers & waterways? - Natural**

First Top Cause	Second Top Cause
<b>Natural</b>	
<ul style="list-style-type: none"> <li>• Erosion</li> <li>• Heavy rainfall with unpredictable delivery times</li> <li>• High flow in adverse weather events causing stream bank erosion</li> <li>• Natural sediment run off from the undisturbed Daintree forest and hills around Cairns, ineffective sewerage treatment</li> <li>• Nutrients from the rainforest</li> <li>• Torrential wet season rainfall</li> </ul>	<ul style="list-style-type: none"> <li>• Sediment flushed into waterways from first big rains - this will come from a mix of both incorrect farming practices and nature causes</li> <li>• Sediment runoff and erosion from flooding events</li> <li>• Soil runoff</li> </ul>

There were two comments from extension officers that indicated that they either weren't sure of what the causes were or that the assumption that water quality is poor is incorrect in some areas of the Wet Tropics Region (see Table 33).

**Table 33: What are the top causes of poor water quality in your districts local streams, rivers & waterways? - Other**

<b>Other</b>
<ul style="list-style-type: none"> <li>• I am not sure to be honest. Many are choked out with weeds, which can't be too good</li> <li>• There is an inherent assumption that the water quality is poor. In large parts of the Tully district the streams flow with clear water</li> </ul>

Land managers in 2016, offered the top three causes of poor water quality in their districts local streams, rivers and waterways to be feral pigs, soil run-off/erosion and flood/rain events/cyclones. The second top cause was listed as run-off from urban and commercial areas, poor farming practices and feral pigs in national parks (see Farr et al., 2017, p. 63 for an extensive list of causes as nominated by land managers in 2016). Anecdotal comments from land managers also challenge that there is poor water quality in their districts for example *"I do not believe the waterways are of poor quality"*, and *"I would like to see proof of the water quality in our local area"* and *"Local streams are pretty good"*.

Next, extension officers were asked to agree or disagree with the statement "Cane growing plays almost no role in the declining health of the Great Barrier Reef". Extension officers primarily disagreed (78.9%) with the statement indicating that they agree that cane growing plays some role in the decline of the health of the Great Barrier Reef. Just over 10% agreed with the statement indicating that they do not think cane farming plays a role in the health of the Great Barrier Reef and just over 5% didn't know if cane farming has an impact on the health of the Great Barrier Reef or not.



**Table 34: Extension officer's responses to the question "Cane growers play almost no role in the decline of the Great Barrier Reef" (n=19)**

	<b>Frequency</b>	<b>Percent</b>
Strongly disagree	1	5.3
Disagree	7	36.8
Somewhat disagree	7	36.8
Neutral	1	5.3
Somewhat agree	1	5.3
Agree	1	5.3
Strongly agree	0	0.0
Don't know/Not Sure	1	5.3
<b>Total</b>	<b>19</b>	<b>100</b>

<b>Mean</b>	<b>N</b>	<b>Sd</b>
3.11	19	1.663

Forty-nine percent of land managers in the 2016 survey agreed that the cane industry plays no role in the declining health of the Great Barrier Reef. By contrast 25% of land managers disagreed with the statement indicating that they thought cane growing does play a role in the declining health of the Great Barrier Reef. Twenty percent of land managers selected neutral as their response (see Farr et al., 2017, p. 64).

The final question asked extension officers to list the top two pressures on the health of the Great Barrier Reef. Statements were coded into three themes, climate change/natural/weather related, anthropogenic and agriculture.

Climate change, natural or weather related statements were mentioned the most times and the first top pressures on the health of the Great Barrier Reef were listed as climate change, coral bleaching, natural sediment run-off, warming waters, cyclones and other weather events, global warming and poor government policy. The second top pressures in the climate change, natural or weather related theme were listed as climate change including natural sediment run-off, cyclones, rising water temperatures and the Crown of Thorns (see Table 35).

**Table 35: What are the top pressures on the health of the Great Barrier Reef? - Climate change/Natural/Weather related**

First Top Cause	Second Top Cause
Climate change/Natural/Weather Related	
<ul style="list-style-type: none"> <li>• Climate change</li> <li>• Climate change - coral bleaching</li> <li>• Climate change, natural sediment run off from undisturbed forest</li> <li>• Only know what is being said in the press, so climate change and runoff from coastal agriculture and other land use</li> <li>• Climate change, warming waters, cyclones.</li> <li>• Climate change. Poor government policy, unhealthy relationship between government and coal lobby.</li> <li>• Coral bleaching</li> <li>• Cyclones</li> <li>• Global Warming</li> <li>• Major weather events (cyclones &amp; floods)</li> <li>• Nature cycle/ climate change</li> <li>• Climate change, tourism</li> <li>• Heavy rainfall with unpredictable delivery times</li> <li>• Temperature</li> </ul>	<ul style="list-style-type: none"> <li>• Climate change, natural sediment run off from undisturbed forest</li> <li>• Climate change</li> <li>• Cyclones</li> <li>• Large scale events (cyclones etc) that are every few years as opposed to constant (like top pressures)</li> <li>• Rising water temperatures and resultant increasing acidity.</li> <li>• Crown of thorns</li> </ul>

The second most listed pressures were mostly anthropogenic (e.g., pollution, population growth, deforestation etc.). The first top pressures were listed as the population, rising ocean temperatures and urine from tourists. The second top pressures were listed as development in both urban and agriculture, lack of reef resilience, tourism trampling and urban run-off (see Table 36).

**Table 36: What is the top pressures on the health of the Great Barrier Reef? - Anthropogenic**

First Top Cause	Second Top Cause
Anthropogenic	
<ul style="list-style-type: none"> <li>• Population</li> <li>• Rising ocean temp followed closely by more localised anthropogenic factors</li> <li>• Tourism urine</li> </ul>	<ul style="list-style-type: none"> <li>• Development</li> <li>• Developments both urban and agricultural along the adjoining landscapes probably although movement of waters from the Coral Sea has an impact</li> <li>• Lack of reef resilience due to negative herbicide, sediment and nutrient impacts from land use - agricultural and urban</li> <li>• Tourism trampling</li> <li>• Urban runoff from townships and cities</li> </ul>

Agriculture was mentioned the third most times and the first top pressures were listed as nitrate concentration. The second top natural pressures were listed as agricultural run-off, agricultural systems, declining water quality and herbicide residue (see Table 37).

**Table 37: What is the top pressures on the health of the Great Barrier Reef? - Agriculture**

First Top Cause	Second Top Cause
<b>Agriculture</b>	
<ul style="list-style-type: none"> <li>Nitrate concentrations</li> </ul>	<ul style="list-style-type: none"> <li>Agricultural runoff, COTS</li> <li>Agricultural systems</li> <li>Declining water quality</li> <li>Herbicide residue concentrations</li> <li>Water quality due to agricultural run-off</li> </ul>

The top pressures cited by land managers in 2016 were climate change and global warming (29%); urban run-off (18.8%); extreme weather events (e.g. cyclones) (14.8%); tourism industry (7.2%); and nutrient and sediment run-off (5.4%). They also cited rising sea temperature, poor land management practices, coral bleaching, shipping and oil spill, natural growth and decline, fishing activities, feral pigs, Crown-of-thorns starfish, government regulations and politics. There is also a tendency of blame shifting related to the health of the reef. Just over 1% of cane growers believe that cattle farmers and poor grazing practices are the top pressures on the health of the GBR (see Farr et al., 2017, p. 64 for a full list of pressures on the health of the Great Barrier Reef).

## 8.0 RECOMMENDATIONS AND CONCLUSION

The key role of extension officers in interactions with Australian land managers has long been recognized (see, for example, Ampt, Cross, Ross, & Howie, 2015; Vanclay, 2004). The challenge now is to support extension officers at a regional level in their interactions, particularly in difficult relationships with land managers who hold entrenched views regarding the best practice for managing their own land. The following recommendations are made to assist extension officers in their interactions with land managers.

### 8.1. Decision Making Factors

- Use social network analysis to identify information gatekeepers and opinion leaders.

The data indicates that extension officers may be underestimating the importance of decision influencers (e.g. protecting the Great Barrier Reef, family and servicing debt, see Section 6.2), which can affect the way messages are communicated and hence influence behaviour change (Section 3.0).

Given the evidence that decisions are not generally made by one single individual and that the views of ‘farmers I respect’ are important, we believe that there is value in considering the use of Social Network Analysis (SNA). It is important to identify who is involved directly or indirectly in decision making and the strength of their influence as it may influence future communication strategies (see Eagle et al., 2016, Section 4.0). It is recommended that extension officers are trained in social network analysis and that the analysis be applied to cane farmers and graziers in the cane growing and grazing regions where there is the potential for identifiable individuals to play a key role, positive or negative, in information dissemination.

SNA is a set of techniques used to analyse the social and informational contacts between individuals with graphical representation (‘sociograms’) that use dots or circles to represent individuals and lines to represent connections between them (Dempwolf & Lyles, 2012). The following SNA is an example of a cane farming family located in the North Queensland Region.

The value of SNA in the agri-environment context will lie in analysing the flow of information and discussions, and in particular in identifying the extent of influence of key information gatekeepers and opinion leaders who may have either power or influence over the adoption of innovations. It overcomes the limitations of analysis based only on geographic proximity by analysing social relationships that may be based on kinship or other factors. Advanced analysis can identify the strength of ties or connections between individuals (Prell, Hubacek, & Reed, 2009), see further outline of SNA in Farr et al., (2017, p. 89).

The sociogram, which contains data provided by a cane grower of their own network, shows that all of the individuals are connected in this network. The cane farmer (1) is connected to eleven people in Group 1, but also to the second cousin (13) who is connected to six people in Group 3. The cane farmer (1) is also connected to Group 2 via another second cousin (20), who is connected to eleven people. There is an indirect (weak) connection between second cousin (13) in Group 3 and the second cousin (20) in Group 2 via the uncle (18).

While the second cousins (13 & 20) might know each other they do not influence each other, but rather they both play a role in influencing the uncle (20). The cane farmer (1), second cousin (13), second cousin (20) and the uncle (18) may be identified in this farming family as the influencers. Therefore, it is important to identify the key influencers in any social network, both as potential disseminators of information or potential 'blockers' of practice change.

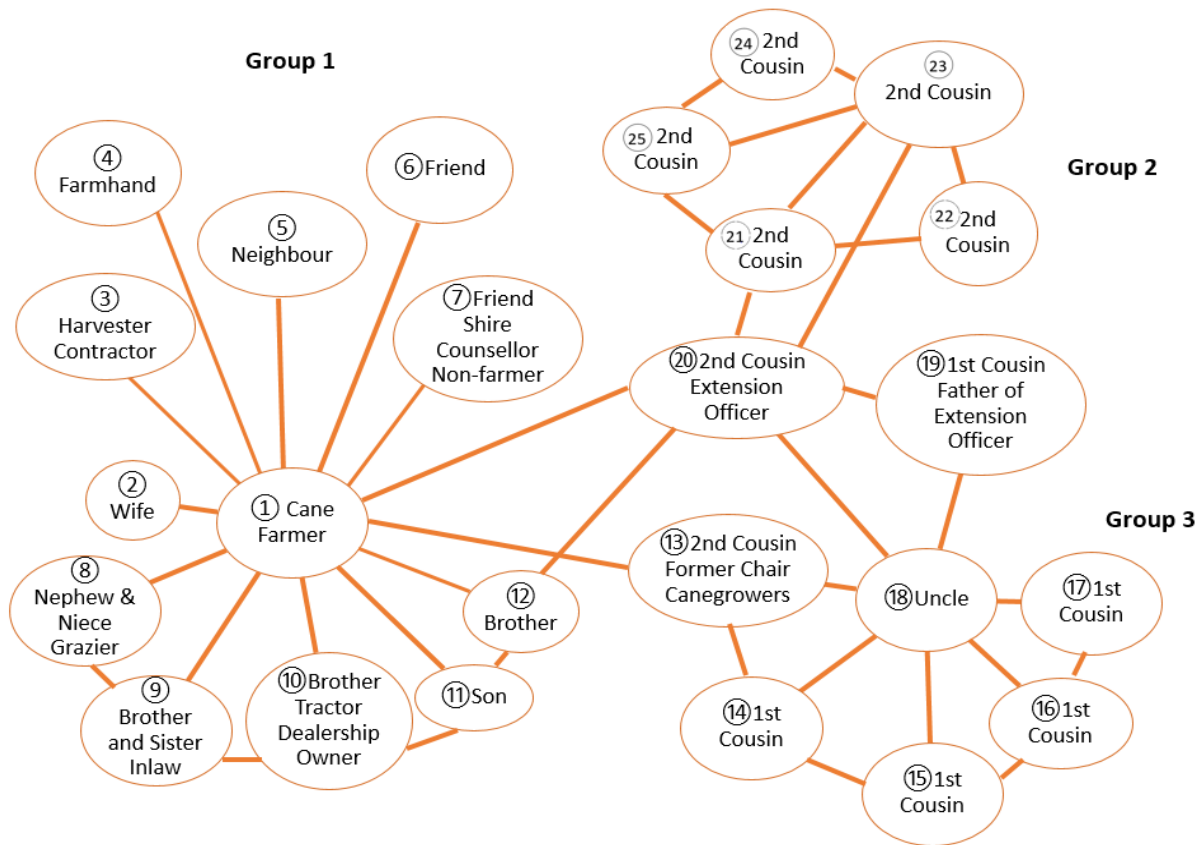


Figure 6: Social Network of a North Queensland Cane Farmer

## 8.2. Grants and Funding

The findings identify that an extension officer's perception of the success or failure of an application to a grant or funding may become a barrier for land managers to apply for funding, see Section 6.3. Early adopters (Hay, 2018, pp. 109-112) have larger numbers of social contacts, which influence the rate of adoption because of their role in those networks (Dowd et al., 2014). However, ideas will only be taken up if there is a favourable attitude towards them, which occurs when "others [extension officers] who he or she [land managers] have cause to trust are considering it or have already adopted it" (Scott, 2012, p. 69). Thus, key influencers (including extension officers) may act as a significant barrier to uptake of innovations (see the discussion of diffusion of innovation in Eagle et al., 2016, p. 15). It may also be useful for extension officers to map networks for the land managers with whom they interact and to consider their own roles within these networks.

- Recognise the potential key role of extension officers and determine what professional development support might be beneficial in continuing to build trust and engagement with land managers.

There is a contrast in the findings where extension officers believe they are cognisant of land managers beliefs and land managers believe that their expertise and opinions are not valued and their 'farmer voices' are not being heard (Section 6.2). This contrast between extension officer and land managers understanding may lead to scepticism regarding the need to change practice. Misunderstanding the level of importance of decision influencers, may change how messages are delivered and in turn be misinterpreted by the land manager. The misinterpretation may affect the relationship between extension officer and land manager. Practice change requires building a level of trust that is needed for positive long-term relationships (Eagle et al., 2016, Section 1.3). Therefore it is recommended that business coaching be used to help extension officers to determine and receive professional development tools that might be beneficial to increase their engagement with land managers (Blackman, Franklin, Rossetto, & Gray, 2015).

### **8.3. Workshops, Training and Other Activities**

- Recognise land manager diversity but use typology principles to develop material and communication approaches to support extension officers.
- Build on the role of farmers whose views are respected as potential information gatekeepers / disseminators / role models.

Extension officers and land managers both identified that workshops and training were appropriate and useful. However, extension officers highlighted that best management practice workshops need to be held outside of the harvest season, that they should target skills deficiencies and be better coordinated with simpler processes (see Section 3.4). Land managers highlighted that the instructors need to be more knowledgeable, that programs are currently poorly targeted, and that people at the coal-face need to be more involved with the development of training practices. Land managers also called for more tailored delivery of programmes (see Farr et al., 2017, pp. 49-59).

While the diversity of farmers and farming practice is acknowledged, it is useful to consider the role of typologies in developing resources to aid extension officers in their interactions with land managers through the identification of the range decision-making drivers and the types of land managers who are motivated by similar drivers (Graymore, Schwarz, & Brownell, 2015). Shrapnel and Davie's (2001) five dominant personality styles may be used to direct learning (Figure 7).

For example, the "vigilant personality" values autonomy, therefore may prefer a one on one approach to information gathering. Whereas the "solitary personality" feels comfortable alone, and prefers not to deal with people at all, therefore may suit an online learning environment or learning from trade magazines or television. The "serious personality" is not outgoing and does not like to be told things and would value information sharing in educated groups. By contrast, the "sensitive personality" is cautious when in groups and is stressed by

unfamiliar surrounds; therefore, they would learn better in small groups of familiar people, such as extension staff (see Hay, 2018; Hay, Eagle, & Low, 2017).

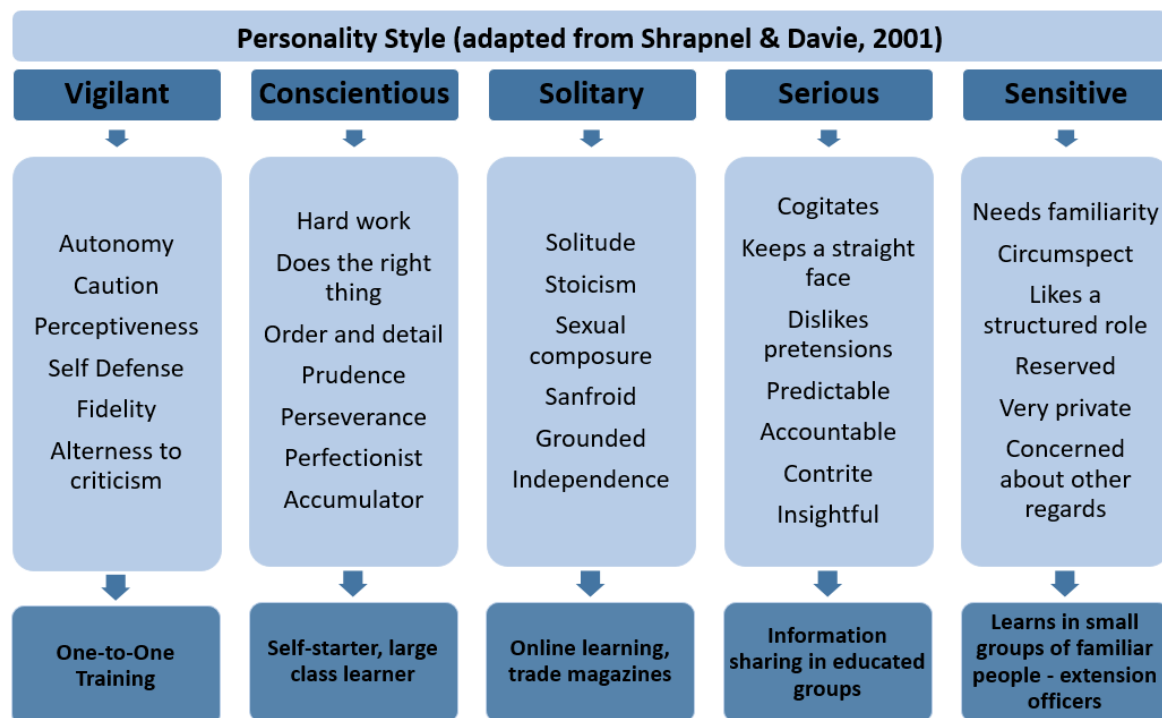


Figure 7: Farmer Typologies and Learning Preferences

We recommend that training programs be coordinated with land manager representatives of cane growing and grazing in the regions. We further recommend that training programs are themed towards the currently identified skills deficiency and that programs are developed towards best management practice and conducted outside of the harvest season. The final recommendation is to use the farmer typology and learning preferences to deliver training programs.

#### 8.4. Perceptions of Causes and Pressure on Water Quality

- Ensure all communication, by whatever means, sends consistent messages irrespective of source, and channelling communication through trusted sources. Monitor media coverage and respond to inaccurate messages and develop proactive media relationships.
- Review communication strategies, adding social media where appropriate. Need to recognise the overall diversity of information sources and preferences.
- Proactive plans should be developed for combating or at least minimising the effects of competing and conflicting messages including negative media coverage (see Eagle et al., 2016, Section 2.7). We have reviewed media coverage of the Great Barrier Reef during 2016 (excluding tourism-related coverage). The findings indicate that the media presents a sensationalised and, at times, hostile perspective on reef-related issues (Eagle et al., 2018), although there is evidence that this is improving in the 2017 media analysis that is under way.

There are a range of competing and conflicting messages received by land managers, including largely negative media coverage of issues relating to the health of the Great Barrier Reef, and messages from mills and farm supply merchants. We note that information overload appears to be an irritating factor for some land managers and recommend that a system be set up to monitor information from all sources, including news media and social media, and to combat messages that run counter to the desired core messages regarding BMP that are disseminated through governmental agencies and other stakeholders.

We recommend that consistent messages to be sent, irrespective of the source with key informants being involved in message design and delivery where possible. Ideally this would be as part of an integrated communications strategy (Dahl, Eagle, & Low, 2015), using a combination of both traditional and digital media (Batra & Keller, 2016; Keller, 2016) that encompasses federal, state and local-originated material and encompassed all forms of communication, whether print, electronic or face-to-face advice as part of this integration.

We note, however, that there is widespread distrust of government-originated information, therefore the source of information must be considered, along with the readability issues identified in our earlier report (Hay & Eagle, 2016) and also the communication channels preferred by land managers.



## **9.0 LIMITATIONS**

While the sample size represents 100% of extension officers invited to complete the survey (N=31), the sample was restricted to one single cane growing region (the Wet Tropics) in North Queensland. Therefore, the results may not be representative across all cane growing regions.

We also acknowledge the potential for voluntary response bias, where there is overrepresentation of individuals that have strong opinions about extension activities. However, it should be noted that such bias is normatively defensive because the study has occurred within the explicitly extension officer group and that the research has been conducted without concealment or fabrication (MacCoun, 1998).

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