Tropical Water Quality Hub

National Environmental Science Programme

Interim Report

Questionnaire Design, Sampling Strategy and Preliminary Findings: A Comparison of the Burdekin and Wet Tropics regions

Marina Farr, Lynne Eagle and Rachel Hay

JAMES COOK UNIVERSITY
AUSTRALIA

Questionnaire Design, Sampling Strategy and Preliminary Findings

A Comparison of the Burdekin and Wet Tropics regions

Marina Farr[1,2], Lynne Eagle[1,2], Rachel Hay[1,2]
[1] College of Business, Law and Governance, James Cook University
[2] TROPWater, JCU

Supported by the Australian Government's
National Environmental Science Program
Project 2.1.3 Harnessing the science of social marketing and behaviour change for improved water quality in the GBR: an action research project

This report should be cited as:
Farr, M., Eagle, L., and Hay, R. (2017) *Questionnaire Design, Sampling Strategy and Preliminary Findings: A Comparison of the Burdekin and Wet Tropics regions.* NESP Project 2.1.3 Interim report. Report to the National Environmental Science Program. Reef and Rainforest Research Centre Limited, Cairns (70pp.).

Published by the Reef and Rainforest Research Centre on behalf of the Australian Government's National Environmental Science Program (NESP) Tropical Water Quality (TWQ) Hub.

The Tropical Water Quality Hub is part of the Australian Government's National Environmental Science Program and is administered by the Reef and Rainforest Research Centre Limited (RRRC). The NESP TWQ Hub addresses water quality and coastal management in the World Heritage listed Great Barrier Reef, its catchments and other tropical waters, through the generation and transfer of world-class research and shared knowledge.

Cover photographs: Lynne Eagle

This report is available for download from the NESP Tropical Water Quality Hub website:
http://www.nesptropical.edu.au

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

APEN..... Australasia-Pacific Extension Network
BMP..... Best Management Practice
BSES ..... Bureau of Sugar Experiment Station
BIRRR..... Better Internet for Rural, Regional and Remote Australia
CEO ..... Chief Executive Officer
CRM..... Customer Relationship Management
GBR..... Great Barrier Reef
GCTB..... Green cane trash blanket
GES ..... Genetic evaluation system
MAS..... Mossman Agricultural Services
NESP ..... National Environmental Science Program
NMP..... Nutrient management plan
NRM..... Natural Resource Management
NQ ..... North Queensland
NQDT..... NQ Dry Tropics
QLD ..... Queensland
QOL..... Quality of life
SEM ..... Structural equation model
SNA ..... Social Network Analysis
SRA ..... Sugar Research Australia
UNESCO..... The United Nations Educational, Scientific and Cultural Organization
WT ..... Wet Tropics

Abbreviations

ac..... acre
ha..... hectare
ML..... megalitre
m..... metre
mm..... millimetre

ACKNOWLEDGEMENTS

This project is supported through funding from the Australian Government's National Environmental Science Program (NESP). We would like to acknowledge the invaluable contribution of all those who offered their time to this project – responding to emails, reading through and commenting on questionnaires, participating in workshops, and sharing their knowledge and expertise with us. We would like to say a special thanks to Peter Chase, Scott Crawford, Carole Sweatman, Angela Cameron, Emma De Smet, Jeanette Durante, Jean Erbacher, Peter Gibson, Margaret Gooch, Billie Gordon, Nyssa Henry, Colleen James, David Low, Fiona McCartney, Kevin McCosker, Brigid Nelson, Adam Northey, Scott Robinson, Carlie Rocco, and Natalie Stoeckl.

We would like to say a very special thanks to our interviewers for their effort and professionalism during the data collection process and also to the NQ Dry Tropics, Terrain NRM and WTSIP teams for their administrative support.

We wish to extend our sincere appreciation to graziers and cane growers in the Burdekin and 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

This report provides a preliminary analysis and comparison of the initial data collected from land managers in the Burdekin and Wet Tropics (WT) regions, mainly in the form of descriptive statistics. It also provides provisional recommendations for key stakeholders regarding possible actions that should be considered in future interactions with land managers. Individual area-specific reports have already been provided to each of the two NRM organisations in whose regions the data was collected. This report combines the findings from the two individual reports to provide a single document comparing findings across the two regions. There were a number of open-ended questions – the responses to these have been collated and are contained in the individual NRM reports.

Two questionnaires were developed – one for cane growers and one for graziers. When developing questionnaires, we sought to keep questions similar in each questionnaire wherever possible, to enable comparisons between both groups (e.g. socio-demographics, attitudes and motivations) and between the case study areas (e.g. cane growers in Wet Tropics and cane growers in Burdekin). The final versions of the questionnaire are included as Appendices in Farr et al. (2017a, b).

The sample population in the preliminary analysis was obtained from a membership database of cane growers in the Wet Tropics and cane and cattle producers supplied by NQ Dry Tropics (NQDT). Each respondent was allocated a unique identifier that enable the researchers to de-identify the data. The identifier will allow the researchers to track changes in future responses across the three years and to analyse those changes.

Insights from the preliminary analysis of data collected in round one show that the respondents:

- Have a mature profile - the median age of cane growers is 57 years in the WT and 52 in the Burdekin region. The median age of Burdekin graziers is also 52 years, which is significantly greater than the median age of the Australian population (37 years).
- Own or own and manage their property (65 per cent of cane growers in the WT, and 80 per cent of cane growers and 84 per cent of graziers in the Burdekin).
- Have lengthy land management experience - (average of 29.2 years in the WT, 18.9 years for graziers and 20.9 years for cane growers in the Burdekin), often following earlier generations on properties: maintaining traditions and heritage is important (63 per cent of cane growers in the WT, and over 50 per cent of cane growers and graziers in the Burdekin indicated this to be of the highest importance).
- Do not make decisions in isolation (43 per cent of cane growers in the Wet Tropics, 41 per cent of cane growers and 66 per cent of graziers in the Burdekin) – family / extended family are commonly involved.
- Are positive about overall quality of life (91 per cent of cane growers in the Wet Tropics, >90 per cent of cane growers and graziers in the Burdekin).
- Have no significant plans to change future practices (>95 per cent of cane growers in the Wet Tropics, 95 per cent of cane growers and 93 per cent of graziers in the Burdekin).
- Do not believe their farming practice adversely impacts water quality in local streams, rivers, and waterways (42 per cent of cane growers in the Wet Tropics, 61 per cent of cane growers and 30 per cent of graziers in the Burdekin).

- Do not believe that the cane/grazing industry plays a significant role in the declining health of the Great Barrier Reef (GBR) (49 per cent of cane growers in the WT, 66 per cent of cane growers and 39 per cent of graziers in the Burdekin).
- Have some tendency to shift the blame related to water quality and the health of the Great Barrier Reef to other industries, organisations and individuals.

1.0 INTRODUCTION

This report is associated with NESP Tropical Water Quality Hub Project 2.1.3 Harnessing the science of social marketing and behaviour change for improved water quality in the GBR: an action research project. It provides a preliminary overview and comparison of the initial data collected from land managers in the Burdekin and Wet Tropics regions, mainly in the form of descriptive statistics (Section 3). Section 4 presents a series of provisional recommendations and conclusions based on the data analysis. A more sophisticated data analysis incorporating structural equation modelling will be undertaken and reported on separately in the next reporting period.

2.0 THE SURVEY AND STUDY AREAS

Two questionnaires were developed – one for cane growers and one for graziers (see Farr et al., 2017a, b). The aim was to create the questionnaire in such a way that the responses could be used to create variables for Structural equation modelling (SEM) or other similar analytical techniques (see Farr et al., 2017c).

Six behaviours/practices were identified as the most relevant to water quality in cane growing and grazing in the Wet Tropics and Burdekin regions – three of which were associated with cane growers and three associated with grazing activities.

Three final 'behaviours' under consideration for cane growers were:

- What irrigation scheduling tools do you use?
- How do you calculate fertiliser application rates?
- How do you handle run-off from rainfall or irrigation?

Three final 'behaviours' under consideration for graziers were:

- Did you spell paddocks during the most recent wet season?
- In the previous 12 months, have you adjusted stock numbers to paddock conditions?
- How do you manage stock around waterways?

The specific sections of the land manager surveys included:

- Socio-demographic background of participants (e.g. age, gender, cultural heritage, income, etc.).
- Background information of farm characteristics (farm ownership, number of years owned/managed the property, land-use etc.).
- Main goals, motivators and priorities associated with farming (e.g. how health, family tradition, spending time with family and friends, financial situation, local community and environment are important when making decisions about what to do on a farm).
- Satisfaction with overall quality of life and the reason for that satisfaction.
- Attitudes towards grants, financial assistance, workshops and training designed to encourage adoption of practices and how useful they are to achieve personal goals.
- Current 'practices' (self- reported behaviours), with specific focus on:
    - Irrigation, run-off from rainfall and irrigation, and calculation of fertiliser application rates for cane farmers;
    - Managing stock around waterways, wet-season paddock spelling, and adjusting stock numbers to pasture conditions for graziers
- Attitudes toward each practice/behaviour under consideration because in order to find a highly significant correlation between attitude and behaviour, attitude needs to be measured towards that particular behaviour (Ajzen & Fishbein, 1980).
- Plans to participate in a specific behaviour (e.g. calculating fertiliser application) next year, which will enable us to measure the expression of land manager's behavioural intentions (Flick, 2013).
- The reasons and motivations for involvement in current practice/behaviour, and whose advice is most important when making the decision to participate in current practice/behaviour.

- Non-motivational factors such as lack of funds and financial assistance, lack of skills and environmental factors (e.g. drought) which will allow us to measure if a participant has actual control to perform specific behaviour (Flick, 2013).
- Perceptions of the contribution to water quality in local streams, rivers, and waterways compared to other concerns.
- Optional specific questions about net income earned from the property.

Most of the questions about motivations and general attitudes have been assessed on a 7-point Likert scale (=1 if extremely unimportant (irrelevant); =4 if neutral; =7 if extremely important (essential)). Attitudes, norms and beliefs towards a specific behaviour have been assessed on a 7-point Likert scale (=1 if strongly disagree; =4 if neutral; =7 if strongly agree). Satisfaction with overall quality of life was measured on scale from 0 (very unsatisfied) to 100 (very satisfied) (see Farr et al., 2017a, Appendix 4 and 5, which contain copies of cane growers and graziers questionnaires respectively).

Two catchments were chosen as the case study areas:

- The Burdekin region because of its recognition as the ‘‘catchment hot spot’ for nitrogen, sediment and pesticide run-off (Lankester et al., 2009); and
- The Wet Tropics region, which is recognised as having high or very high nitrogen run-off

‘Sugarcane production has been the predominant agricultural industry for coastal Queensland since the middle of the 19th century’ and over 85% of cane production in Queensland (QLD) occurs in the Burdekin, Mackay-Whitsunday, and Wet Tropics regions (Smith et al., 2014, p. 1). The Burdekin region produces both cattle and sugarcane, whereas the Wet Tropics mainly produces sugar cane. While grazing covers around 96% of the regions inland area, sugar cane is often located near the coastal areas and is grown with substantial use of nitrogen fertiliser (Thorburn et al., 2013a). Run-off from grazing activities in the catchments adjacent to the GBR are mainly blamed for pollutants (e.g. sediments and nutrients loads) running to the GBR lagoon (Brodie & Mitchell, 2005; Haynes et al., 2007). Nitrogen losses from sugar cane activities can be discharged through ‘deep drainage below the root zone, or as surface run-off’ (van Grieken et al., 2012, p. 2). Surface run-off has little opportunity to be filtered through streams implying that pollutants flow quickly to the GBR lagoon.

Terrain NRM and NQ Dry Tropics were contracted to help with data collection activities in the Wet Tropics and Burdekin regions respectively. Each respondent has been allocated with a unique identifying number, which will allow us to track changes in responses across the three-year period, while also enabling us to analyse those changes. Having a unique identifier allows Terrain and NQ Dry Tropics to protect the confidentiality of participants. A detailed record of people who refused to be involved was kept during the data collection process to ensure that they would not be contacted twice. Farr et al. (2017 a, b) provides more information on data collection activities in the Wet Tropics and Burdekin study areas.

3.0 PRELIMINARY RESULTS

This section of the report provides insights from the preliminary analysis and comparison of initial data collected in round one (as at 20 April 2017 for the Wet Tropics and as at 10 January 2017 for the Burdekin region). SPSS software (Field, 2009) is used to create cross tabulation tables and Pearson's Chi-square Test (for categorical variables) (see Appendix 1) and Independent Sample T-test (to compare the means between two unrelated groups on the same continuous variable) (Appendix 2) to investigate if there are any statistically significant differences between:

- the case study areas (e.g. cane growers in the Wet Tropics and cane growers in the Burdekin); and
- the two groups of land managers (e.g. cane growers and graziers in the Burdekin region)

3.1 Background information

3.1.1 Making decisions relating to land-management and farming on the main property

We asked the land managers about making decisions relating to land-management and farming on their main property.

Using the Pearson's Chi-square Test, we tested if there are statistically significant differences between the decision making responses depending on case study areas (cane growers in the Wet Tropics vs. cane growers in the Burdekin). There were no statistically significant differences between the decision making responses and whether cane growers were from the Wet Tropics or from the Burdekin region $\chi^2(2) = 1.914$, $p=0.38$. The responses of growers in the Wet Tropics were not statistically different to the responses of growers in the Burdekin region (p-value of 0.38 > 0.10) implying that the region doesn't have any significant impact on how the land managers are making decisions (e.g. individual or shared) relating to land-management on their main property.

A Chi-square Test was performed to see if there were statistically significant differences between the two regions in the responses of who is involved in join/shared decision on main property. However, one of the assumptions for Chi-square Test has not been met (51 cells (85.0 per cent) had expected count less than 5 and the minimum expected count was 0.18) (see assumption 6, Appendix 1). Thus, the test was inconclusive.

Using the Pearson's Chi-square Test, we tested if there were statistically significant differences between the decision making responses and type of land manager (cane grower vs. grazier). However, one of the assumptions for Chi-square Test has not been met (6 cells (60 per cent) had expected count less than 5 and the minimum expected count was 0.4) (see assumption 6, Appendix 1). Thus, the test was inconclusive.

We then used a Chi-Square Test to see if there were statistically significant differences between the two groups of land managers for the responses of who is involved in join/shared decision on main property. However, one of the assumptions for Chi-square Test has not

been met (18 cells (90.0 per cent) had expected count less than 5 and the minimum expected count was 0.4) (see assumption 6, Appendix 1). Thus, the test was inconclusive.

To summarise, the region does not have any statistically significant impact on whether or not the decision relating to land-management and farming on the main property is entirely individual, partly individual or joint/shared decision. The results on decision making for two groups of land managers (cane growers and graziers in the Burdekin) were inconclusive. Pearson's Chi-square Tests for who is involved in join/shared decision on the main property were both inconclusive for study regions and for two groups of land managers in the Burdekin. As such, we can only discuss differences between the regions and the groups based on the descriptive statistics presented in Table 1 and Table 2 below.

Nearly 43 per cent and 41 per cent of cane growers in the Wet Tropics and Burdekin respectively indicated that they share their decisions while over 66 per cent of graziers also shared decisions. Just over 44 per cent of cane growers in the Wet Tropics and nearly 39 per cent in the Burdekin said that they make decisions entirely on their own. By contrast only 14 per cent of graziers said that their decisions are entirely individual (Table 1).

Table 1: Respondent's decisions making parties

		Per cent of respondents (%)		
		Wet Tropics	*Burdekin*	
		Cane growers (N=247)	*Cane Growers (N=49)*	*Graziers (N=71)*
Making decisions about land-management & farming on main property	Joint/Shared decision	42.91%	40.82%	66.20%
	Entirely my decision (i.e. individual)	44.13%	38.78%	14.08%
	Majority of decision is mine	12.96%	20.41%	19.72%

Growers in the Wet Tropics prefer to share the decisions primarily with their brothers and sisters (26 per cent) or consult with their spouses (28.4 per cent) while cane growers in the Burdekin consult primarily with their brothers (22 per cent)[1], children (22 per cent) or their parents (22 per cent) (Table 2). Nearly one third of graziers prefer to share the decision solely with their spouses, while 25 per cent consult with both their spouse and their children.

We note the extremely small sample size for cane growers and graziers in the Burdekin region. Steps will be taken to increase numbers in the second round of data collection.

[1] It should be noted that there was no option to select sister in the Burdekin survey. This was an oversight from the testing phase. For future surveys this has been changed to brother or sister.

Table 2: Who is involved in join/shared decision on main property

	Per cent of respondents (%)		
	Wet Tropics	*Burdekin*	
	Cane growers (N=127)	*Cane growers (N=18)*	*Graziers (N=47)*
Brother/Sister	25.98%	22.22%	2.13%
Children	11.81%	22.22%	2.13%
Parents	18.11%	22.22%	4.26%
Spouse	28.35%	11.11%	31.91%
Spouse/Children	7.09%	5.56%	25.53%
Spouse/Parents			10.64%
Brother/Other		5.56%	
Management team		5.56%	
Spouse/Children/In-laws		5.56%	4.26%
Parents/Brother			2.13%
Spouse/Parents/Children			2.13%
Spouse/In-laws			2.13%
Spouse/Children/Employees/Consultants			2.13%
Spouse, Land owner			2.13%
Spouse/Parents/NPRSR Department/Forestry Department/Government red tape			2.13%
Townsville City Council			2.13%
Other extended family*	2.36%		
Other**	6.30%		
Other (not specified)			4.26%

*include grandfather and in-law
**include supervisor, advisors, assistant farm manager, partner, share farm agreement, farm leadership team, owner

3.1.2 Other properties

We asked the land managers about owning or managing other properties.

Using the Pearson's Chi-square Test, we tested if owning/managing other properties depended on the case study areas (cane growers in the Wet Tropics vs. cane growers in the Burdekin). There was a significant association (at 10 per cent level of significance) between owning or managing other properties and whether cane growers were from the Wet Tropics or from the Burdekin region $\chi^2(1) = 2.905$, p=0.08. This significant result reflects the fact that 32 per cent of cane growers in the Wet Tropics own/manage other properties and 68 per cent do not, whereas 45 per cent of cane growers in the Burdekin region own other properties and 55 per cent do not own/manage any other farms (Table 3).

Consequently, the region where cane growers live and operate significantly influences the decision to own and/or manage other properties. Cane growers in the Burdekin are more likely to own and/or manage other properties than growers in the Wet Tropics region.

Table 3: Proportion of cane growers who owns or manage other properties

		Other properties		
		Yes	*No*	*Total*
Wet Tropics	Count	77	165	242
	Expected Count	82.1	159.9	242
	% within Burdekin or Wet Tropics	31.8%	68.2%	100%
Burdekin	Count	21	26	47
	Expected Count	15.9	31.1	47
	% within Burdekin or Wet Tropics	44.7%	55.3%	100%

Using the Pearson's Chi-square Test, we tested if owning/managing other properties depended on whether the land manager in the Burdekin region is a cane grower or a grazier χ^2 (1) = 0.320, *p*=0.57. The responses for cane growers were not statistically different to the responses for graziers (p-value of 0.57 > 0.10). As such, being cane grower or being grazier does not significantly influence the decision to own or manage other properties.

To summarise, the region in which a cane grower lives and works does have a statistically significant impact on willingness to own or manage other properties but being grazier in the Burdekin does not. Cane growers in the Burdekin are more likely to own/manage other properties than cane growers in the Wet Tropics region.

3.1.3 Main land-use on other property

Using the Pearson's Chi-square Test, we tested if the land use on other properties depends on case study areas (cane growers in the Wet Tropics vs. cane growers in the Burdekin). However, one of the assumptions for Chi-square Test has not been met (12 cells (75.0 per cent) had expected count less than 5 and the minimum expected count was 0.18) (see assumption 6, Appendix 1). Thus, the test was inconclusive.

Using the Pearson's Chi-square Test, we tested if the land-use on other properties depend on whether the land manager in the Burdekin region is a cane grower or a grazier but one of the assumptions for Chi-square Test has not been met (2 cells (25.0 per cent) had expected count less than 5 and the minimum expected count was 0.4) (see assumption 6, Appendix 1). Thus, the test was inconclusive.

To summarise, the results of Chi-square Test on land-use on other properties were inconclusive between the regions and between the two groups of land managers. As such, we can only discuss differences between the regions and the groups of land managers in the Burdekin and the Wet Tropics based on descriptive statistics presented in Table 4 below.

The majority of cane growers (91 per cent) in the Burdekin region and nearly half of growers in the Wet Tropics region (49 per cent), who selected that they own, manage, and/or lease

other properties, use their land for growing sugarcane. However, nearly half of other growers in the Wet Tropics (47 per cent) have not specified the main land use on other farms/properties. The majority of graziers (88 per cent) in the Burdekin, who stated that they own, manage, and/or lease other properties, use their land for grazing activities.

Table 4: Other property land use

Land use	*Per cent of properties (%)*		
	Wet Tropics	*Burdekin*	
	Cane growers (N=150)	*Cane growers (N=49)*	*Graziers (N=57)*
Sugarcane	49.33%	*91.8%*	8.77%
Grazing	1.33%	6.12%	87.71%
Lease block	1.33%		
Bananas	0.67%		
Grain		2.04%	
Mango/Grazing			1.76%
Sugarcane/Grazing			1.76%
Not specified	47.33%		
	100%	100%	100%

3.1.4 Off-farm 'job'

Using the Pearson's Chi-square Test, we tested if a participant's off-farm employment depends on case study areas (cane growers in the Wet Tropics vs. cane growers in the Burdekin). However, one of the assumptions for Chi-square Test has not been met (1 cell (16.7 per cent) had expected count less than 5 and the minimum expected count was 4.50) (see assumption 6, Appendix 1). Thus, the test was inconclusive.

We also used the Chi-square Test to investigate if a participant's spouse off-farm employment depends on case study areas. There were no statistically significant differences between a participant's spouse off-farm employment responses and whether participants were from the Wet Tropics or from the Burdekin region χ^2 (2) = 2.512, p=0.28. The responses of growers in the Wet Tropics were not statistically different to the responses of growers in the Burdekin region (p-value of 0.28 > 0.10) implying that the region doesn't have any significant impact on their spouses' off-farm employment hours.

Using the Pearson's Chi-square Test, we tested if a participant's off-farm employment depends on whether the land manager in the Burdekin region is a cane grower or a grazier. However, one of the assumptions for Chi-square Test has not been met (2 cells (33.3 per cent) had expected count less than 5 and the minimum expected count was 3.10) (see assumption 6, Appendix 1). Thus, the test was inconclusive.

We then used the Chi-square Test to investigate if a participant's spouse off-fam employment depended on whether the land manager in the Burdekin region is a cane grower or a grazier. However, one of the assumptions for Chi-square Test has not been met (1 cell (16.7 per cent)

had expected count less than 5 and the minimum expected count was 4.66) (see assumption 6, Appendix 1). Thus, the test was inconclusive.

To summarise, the results of participant's off-farm employment were both inconclusive for the study regions and for two groups of managers in the Burdekin. However, the Chi-square Test confirmed that the region doesn't have any significant impact on their spouses' off-farm employment hours. Similar test for two groups of land managers were inconclusive. As such, we can only discuss differences or similarities between the regions and the groups of land managers in the Burdekin based on descriptive statistics presented in Table 5 below.

Table 5: Respondent and his/her spouse off-farm work employment

	Per cent of respondents (%)		
	Wet Tropics	*Burdekin*	
	Cane Growers (N=235)	*Cane growers (N=45)*	*Graziers (N=71)*
No – do not work off-farm	62.13%	77.78%	77.46%
Yes, less than 20 hours per week off-farm	11.06%	4.44%	8.45%
Yes, more than 20 hours per week off-farm	26.81%	17.78%	14.08%
	Spouse (cane grower) (N=188)	*Spouse (cane grower) (N=45)*	*Spouse (grazier) (N=71)*
No – do not work off-farm	50.00%	60.0%	76.06%
Yes, less than 20 hours per week off-farm	18.09%	20.0%	4.23%
Yes, more than 20 hours per week off-farm	31.91%	20.0%	19.72%

The majority of cane growers in the Wet Tropics (62 per cent) and in the Burdekin (78 per cent) and their spouses (50 per cent and 60 per cent respectively) are not working off-farm (Table 5). Notably, a higher percentage of growers and their spouses in the Burdekin region do not have off-fam employment compare to growers from the Wet Tropics region. The percentage of people who are not working off-farm is even greater for graziers in the Burdekin. Just over seventy-seven per cent of graziers and 76 per cent of their spouses are not employed outside the farm. A greater percentage of growers and their spouses in the WT are working more than 20 hours per week off-farm compare to farmers and their spouses that work off-farm hours in the Burdekin.

3.1.5 Number of people living on the main farm/property

The respondents were asked how many people live on their main farm/property.

The mean number of people living on the main cane growing property in the Wet Tropics was estimated as being 3.32 while the mean number of people living on the main property in the Burdekin was 4.19. Using the Independent Samples *t* - test, we investigated if the means of number of people who live on the main cane farm /property in the Wet Tropics and in the Burdekin are significantly different. The results show that there was significant difference (at 5 per cent level of significance) in the mean of number of people live on the main property

between the Wet Tropics and the Burdekin regions (t_{277}= 2.120, *p=0.035*). The average number of people living on the main property in the Burdekin was 0.9 greater than the average number of people living on the main property in the Wet Tropics.

The mean number of people living on the main cane growing property was estimated as being 4.19 while the mean number of people living on the main grazing property was 4.59. Using the Independent Samples *t* - test, we investigated if the means of number of people living on the main farm /property in the Burdekin is statistically different between the two groups of land managers (cane growers and graziers). The results show that there was no significant difference in the mean of number of people live on the main property between those two groups of land managers (t_{112}= 0.654, *p=0.514*).

3.1.6 Main property characteristics and land uses

The respondents were asked questions about the main property that they manage and/or own.

Using the Pearson's Chi-square Test, we tested if owning, leasing or sharing the main property depends on the region where growers live and operate (cane growers in the Wet Tropics vs. cane growers in the Burdekin). However, one of the assumptions for Chi-square Test has not been met (16 cells (61.5 per cent) had expected count less than 5 and the minimum expected count was 0.18) (see assumption 6, Appendix 1). Thus, the test was inconclusive.

Using the Pearson's Chi-square Test, we tested if owning, leasing, or sharing the main property depend on whether the land manager in the Burdekin region is a cane grower or a grazier. However, one of the assumptions for Chi-square Test has not been met (6 cells (60.0 per cent) had expected count less than 5 and the minimum expected count was 0.40) (see assumption 6, Appendix 1). Thus, the test was inconclusive.

The results of the Chi-square Tests were inconclusive, thus we can only discuss differences or similarities between the regions and the groups of land managers in the Burdekin based on the descriptive statistics presented in Table 6 below.

Table 6: Percentage of respondents who own, lease, or share the main property

	Per cent of respondents (%)		
	Wet Tropics	*Burdekin*	
	Cane growers (N=245)	*Cane growers (N=45)*	*Graziers (N=71)*
Own	64.90%	80.00%	53.52%
Manage	2.86%	15.56%	14.08%
Lease	3.27%	4.44%	1.41%
Share	4.08%		
Own/Manage	4.49%		21.13%
Own/Lease	12.65%		2.82%
Own/Share	0.82%		1.41%

	Per cent of respondents (%)		
	Wet Tropics	*Burdekin*	
	Cane growers (N=245)	*Cane growers (N=45)*	*Graziers (N=71)*
Own/Manage/Lease	1.63%		1.41%
Own/Manage/Share	0.82%		2.82%
Manage/Lease	2.86%		1.41%
Manage/Share	0.41%		

Table 6 indicates that nearly 65 per cent of cane growers in the Wet Tropics and 80 per cent in the Burdekin said that they owned their own farm. The majority of graziers own (53 per cent) or own and manage (21 per cent) their properties. (Note: some of the data for cane growers in the Burdekin is missing due to the skip logic error).

3.1.7 Number of years owned/managed the main property

The mean number of years cane growers owned/managed their main property in the WT region was estimated as being 29.2 years while the mean number of years in the Burdekin was 20.9 years. Using the Independent Samples *t* - test, we investigated if those means are significantly different. The results show that there was significant difference (at 1 per cent level of significance) in the mean of number of years between the Wet Tropics and the Burdekin regions ($t_{75.9}$= -3.794, $p<0.001$). The average number of years growers own/manage their main property in the Wet Tropics were 8.3 years greater than the average number of years in the Burdekin.

The mean number of years cane growers owned/managed their main property in the Burdekin was estimated as being 20.9 years while the mean number of years graziers own/manage their main property was 18.9 years. Using the Independent Samples *t* - test, we investigated if the means are statistically different between the two groups of land managers (cane growers and graziers). The results show that there was no significant difference in the means of number of years owning/managing the main property between those two groups of land managers (t_{111}= -0.661, $p=0.510$).

3.1.8 Main land use on the main property and size of the land

We asked the respondents about land-use on their main property and size of the land for the main use.

Using the Pearson's Chi-square Test, we tested if land-use on the main property depends on the region where growers live and operate (cane growers in the Wet Tropics vs. cane growers in the Burdekin). However, one of the assumptions for Chi-square Test has not been met (90 cells (93.8 per cent) had expected count less than 5 and the minimum expected count was 0.18) (see assumption 6, Appendix 1). Thus, the test was inconclusive.

The result of the Chi-square Test were inconclusive, thus we can only discuss differences or similarities between the regions and the groups of land managers in the Burdekin based on the descriptive statistics presented in Table 7 below.

As was expected 94 per cent of cane growers in the Wet Tropics and 85 per cent in the Burdekin indicated that sugarcane activities are the main land-uses on their main property. More than 96 per cent of graziers also said that grazing activities are the main land-uses on their main property. Growing tropical fruits, vegetables, nuts and tobacco were also mentioned by land managers in the Wet Tropics as land uses on their main property while growers in the Burdekin mentioned grazing, beef cattle production and breeding, and growing crops as their main land-uses.

Table 7: Main land-use on main property (1st choice)

Land-use	*Per cent of respondents (%)*		
	Wet Tropics	*Burdekin*	
	Cane growers (N=246)	*Cane growers (N=44)*	*Graziers (N=64)*
Sugarcane	94.31%	85.0%	3.57%
Grazing/ Beef cattle/Production/Breeding	2.03%	5.0%	96.42%
Mix- Peanuts/Vegetables/Dairy	2.03%		
Grain		5.0%	
Tropical fruits (e.g. Paw Paw, Bananas)	1.22%		
Tobacco	0.41%		
	100%	100%	100%

The mean of the main land-use in hectares (ha) in the Wet Tropics region was estimated as being 162.44ha while the mean of the main land-use in hectares in the Burdekin was 488.77ha. Using the Independent Samples *t* - test, we investigated if those means are significantly different between the regions. The results show that there was significant difference (at 10 per cent level of significance) in the mean of the main land-use in *ha* between the Wet Tropics and the Burdekin regions ($t_{39.01}$= -1.928, $p = 0.061$). The average main land-use in hectares in the Burdekin was 326.33ha greater than the average main land-use in the Wet Tropics.

The mean of the main land-use in hectares (cane growers) was estimated as 488.77ha while the mean of the main land-use for graziers was 23381.2ha. Using the Independent Samples *t* - test, we investigated if the means are statistically different for two groups of land managers. The results show that there was statistically significant difference in the means of the main land-use between cane growers and graziers ($t_{55.11}$= 4.277, $p<0.001$). The average main land-use in hectares in gazing properties in the Burdekin was 22 892.5ha greater than the average main land use in cane growing properties.

To summarise, the results indicate that the main land-use in the Burdekin is significantly greater than in the Wet Tropics. Our results also indicate that the main use of land for grazing in hectares are significantly greater than the main use of land for sugar cane. These findings

are more likely to relate to the total sizes of the properties in the Wet Tropics and Burdekin. Sugar cane properties in the Wet Tropics might be relatively smaller than in the Burdekin and grazing properties in the Burdekin is relatively larger compare to sugar cane properties. Moreover, land used for cattle grazing is marginal, thus, requires a large area for grazing than for growing sugar activities.

3.1.9 Land-uses that is most important to the financial viability of the main property and importance of enjoyment

The respondents were asked which of the land-uses are most important to the financial viability of the main property and which ones they are enjoying most.

Using the Pearson's Chi-square Test, we tested if land-uses which are most important to the financial viability are different between the Wet Tropics and the Burdekin region. However, one of the assumptions for Chi-square Test has not been met (61 cells (89.7 per cent) had expected count less than 5 and the minimum expected count was 0.18) (see assumption 6, Appendix 1). Thus, the test was inconclusive.

We then tested if the land-uses for enjoyment are different between the case study areas. One of the assumptions for Chi-square Test has not been met (92 cells (93.9 per cent) had expected count less than 5 and the minimum expected count was 0.18) (see assumption 6, Appendix 1). Thus, the test was also inconclusive.

Using the Pearson's Chi-square Test, we tested if land-uses which are most important to the financial viability are different for cane growers and graziers in the Burdekin. However, one of the assumptions for Chi-square Test has not been met (16 cells (72.7 per cent) had expected count less than 5 and the minimum expected count was 0.40) (see assumption 6, Appendix 1). Thus, the test was inconclusive.

We then tested if the land-uses for enjoyment are different between the two groups of land managers. One of the assumptions for Chi-square Test has not been met (20 cells (76.9 per cent) had expected count less than 5 and the minimum expected count was 0.40) (see assumption 6, Appendix 1). Thus, the test was also inconclusive.

To summarise, the results of the tests for importance of land-uses to the financial viability of the main property and importance of enjoyment were inconclusive for the study regions and for two groups of managers in the Burdekin. As such, we can only discuss differences or similarities between the regions and the groups of land managers in the Burdekin based on descriptive statistics presented in Table 8.

Just over 72 per cent of cane growers in both regions said that cane growing activities are the most important use of land to the financial viability of their property while 65.5 per cent in the Wet Tropics and 54.5 per cent in the Burdekin said that they enjoy it most. Grazing, breeding, growing, and selling cattle in both regions, was not an important land-use for cane growers either financially or for enjoyment. Off-farm work was more important to financial viability in the Wet Tropics (12.4 per cent) but for enjoyment it was slightly more important in the Burdekin region (6.8 per cent). Cane farmers in the Wet Tropics indicated that there were other land uses such as growing bananas, fruits (e.g. Paw Paw, Lime, Pineapples) and vegetables (e.g. Pumpkins, Spuds) that were important to the financial viability of the farm

and that they were enjoying (Table 8). Cane growers in the Burdekin said that there were other land uses that they enjoy such as planting other crops such as beans and rice.

Just over 69 per cent of graziers in the Burdekin said that grazing activities are the most important use of land to the financial viability of their property and 69 per cent of graziers also said that they are enjoying grazing. Eleven per cent of graziers indicated that they are breeding and selling cattle and it was, unsurprisingly, more important for graziers (18 per cent) than for cane growers (2 per cent) to grow cattle. To be expected, cane growing was not financially important or enjoyable for graziers at all. Likewise, grazing for cane growers in the Burdekin was not important land-use either financially or for enjoyment (Table 8).

Table 8: Land-uses which are most important to the financial viability and enjoyment on main property

Activities	Per cent of respondents (%)					
	Financial importance			Enjoyment importance		
	Wet Tropics	*Burdekin*		*Wet Tropics*	*Burdekin*	
	Cane growers (N=234)	*Cane growers (N=44)*	*Graziers (N=66)*	*Cane growers (N=226)*	*Cane growers (N=44)*	*Graziers (N=66)*
Sugarcane	72.22%#	72.73%	1.52%	65.5%###	54.54%	1.52%
Sugar cane & off-farm	0.85%			2.21%	4.55%	
Grazing		2.27%	69.70%		2.27%	69.71%
Breeding, growing & selling cattle		2.27%	10.62%	2.66%	2.27%	18.20%
Grazing & Mangoes			1.52%			
Grazing, Hay, Silage			1.52%			1.52%
Grazing & off-farm work			3.04%			
Aquaculture & Grazing	0.43%	2.27%				
On Farm	2.99%	9.09%	4.56%	11.95%	9.09%	4.55%
Off-farm work	12.39%	6.82%	6.06%	5.31%	6.82%	1.52%
On farm/Off-farm	0.85%			2.21%	2.27%	
Bean crops					6.82%	
Bananas	4.27%			1.77%		
Fruits	2.14%			2.65%		
Vegetables	1.28%			0.88%		
Grain		2.27%			2.27%	
Rice					2.27%	
Other, see comments below	2.14%##	2.27%*		3.54%####	2.27%**	1.52%***
N/A					2.27%	1.52%
None/Don't enjoy any	1.33%		1.52%		2.27%	

*include 'my health'
**include 'on farm uses' and 'making the farm more environmentally friendly'
***include land care, maintaining weeds and erosion control, and land management
#Respondents also mentioned bananas, cattle, on farm work, papaya, paw paw, and pepper were also mentioned by respondents as the most important activities to the financial viability
##Category 'Other' include small crops, Quarry, and 'variable' as the most important activities to the financial viability
###Respondents also mentioned cattle, exotic fruits, and fish farming were also mentioned by cane growers as the most important activities for enjoyment
####Category 'Other' include quarry, camping, coffee, small crops, natural bush, nursery, natural forest, diversified fallow - rice/peanuts as the most important activities for enjoyment

3.1.10 Average revenue

The respondents were asked if on average their revenue from the last year is better, worse or the same as in previous years.

Using the Pearson's Chi-square Test, we tested if the average revenue from the last year responses are different between the regions. However, one of the assumptions for Chi-square Test has not been met (2 cells (25 per cent) had expected count less than 5 and the minimum expected count was 0.15) (see assumption 6, Appendix 1). Thus, the test was inconclusive.

Using the Pearson's Chi-square Test, we tested if an average revenue from the last year responses are different for cane growers and graziers in the Burdekin. However, one of the assumptions for Chi-square Test has not been met (2 cells (33.3 per cent) had expected count less than 5 and the minimum expected count was 2.37) (see assumption 6, Appendix 1). Thus, the test was inconclusive.

To summarise, the results of the Chi-square Tests for an average revenue were inconclusive for the study regions and for the two groups of land managers in the Burdekin. As such, we can only discuss differences or similarities between the regions and the groups of the land managers in the Burdekin based on the descriptive statistics presented in Table 9 below.
Fifty-nine per cent of cane growers in the Wet Tropics and 61 per cent in the Burdekin said that this year revenue is better than previous years. More than half of graziers in the Burdekin (54.5 per cent) also said that this year revenue is better (Table 9).

Table 9: Average revenue from the last year

		Per cent of respondents (%)		
		Wet Tropics	*Burdekin*	
		Cane growers (N=243)	*Cane growers (N=44)*	*Graziers (N=66)*
This year's revenue	Is better than previous years	58.85%	61.36%	54.55%
	Is about the same as previous years	27.98%	27.27%	36.36%
	Is worse than previous years	13.17%	11.36%	9.09%

3.2 Personal goals and aspirations

Land managers were asked about two personal goals and aspirations for their farm/property that are most important when they aim to achieve something on their farm.

Using the Pearson's Chi-square Test, we tested if land managers' personal goals and aspirations responses are different between the regions. However, one of the assumptions for Chi-square Test has not been met (106 cells (88.3 per cent) had expected count less than 5 and the minimum expected count was 0.18) (see assumption 6, Appendix 1). Thus, the test was inconclusive.

Using the Pearson's Chi-square Test we tested if land managers' personal goals and aspirations responses are different for cane growers and graziers in the Burdekin region but SPSS could not perform the test.

To summarise, the results of the Chi-square Tests for land managers' personal goals and aspirations was inconclusive for the study regions and could not be performed for two groups of land managers in the Burdekin. As such, we can only discuss differences or similarities between the regions and the groups of land managers in the Burdekin based on descriptive statistics presented in Table 10 below.

An increase in profitability (18 per cent) and productivity (17.6 per cent), financial security (16 per cent) and sustainability (6.97 per cent) were the main goals for growers in the Wet Tropics region. The main goals for cane growers in the Burdekin were productivity (23 per cent), sustainability (18.6 per cent), financial security (11.6 per cent) and soil health improvement (11.6 per cent). Viability for future generations, lifestyle, happiness and work balance, and good sustainable crop were also among their main goals (Table 10). Long – term sustainability was the most important second goal for cane growers in both regions.

Similar to cane growers, nearly twenty-one per cent of graziers in the Burdekin said that sustainability was the main goal for their farm and 13 per cent stated that their main goal is profitability. Improving ground cover/pasture (10 per cent), and financial security (8 per cent) were also amongst their main goals. Long term sustainability (19 per cent) and passing on healthy property to future generation and its viability (12 per cent) were amongst the most important second goals indicated by graziers (Table 10).

Table 10: Personal goals to achieve on farm/property

	Per cent of respondents (%)					
	Personal goal 1			*Personal goal 2*		
	Wet Tropics	*Burdekin*		*Wet Tropics*	*Burdekin*	
	Cane growers (N=244)	Cane growers (N=43)	Graziers (N=62)	Cane growers (N=215)	Cane growers (N=38)	Graziers (N=58)
Productivity[#]	17.62%	23.26%	4.84%	8.84%	7.89%	6.90%
Sustainability	6.97%	18.62%	20.96%	22.33%	18.42%	18.97%
Profitability/Income[##]	18.44%	9.30%	12.90%	9.3%	13.16%	8.62%
Financial security[###]	15.98%	11.63%	8.07%	3.72%	7.89%	5.17%
Viability for future generation	5.33%	4.65%	6.45%	9.77%	7.89%	12.07%
To improve soil health	2.87%	11.63%	3.23%	0.93%	2.63%	
Lifestyle/Happiness/ Work balance	4.51%	2.33%	3.23%	7.44%	10.53%	3.45%
Debt reduction	3.28%		4.84%		1.93%	3.45%
Expand the farm/Farm diversification	4.1%			6.51%		
Pride/Family tradition	2.87%			4.65%		
Keep farming the property	3.69%			3.72%		
Sell farm/property	3.69%			0.93%		
Retirement/Transition to retirement	2.05%			2.79%		
Improved groundcover/pastures			9.67%		2.63%	8.62%
Maximize development/ Sustainability			1.61%		2.63%	6.90%
Better property management			4.84%		2.63%	3.45%
Improving farm/property	1.23%			4.19%	7.89%	5.17%
Viability		4.65%	4.84%			
Improving overall herd fertility			3.23%			1.72%
Drought sustainable			1.61%			3.45%
Improve carrying capacity			1.61%			3.45%
Good sustainable crop	2.05%	9.31%			0.47%	
Efficiency				1.86%	5.27%	

	Per cent of respondents (%)					
	Personal goal 1			*Personal goal 2*		
	Wet Tropics	*Burdekin*		*Wet Tropics*	*Burdekin*	
	Cane growers (N=244)	Cane growers (N=43)	Graziers (N=62)	Cane growers (N=215)	Cane growers (N=38)	Graziers (N=58)
Trying new technologies/Learning more	0.41%			2.33%		
Recognition of effort/outcomes	0.41%			2.33%		
Low costs	0.41%			1.4%	5.27%	
Higher sugar (CCS)	0.41%			1.4%		
Buy my own farm/property	0.82%					
Less regulations				0.93		
Other, see below	2.87%*	4.65%*	8.06%*	3.26%**	5.27%**	8.62%**
		100%	100%		100%	100%

#Efficiency, environmental sustainability, profitability, and reduce inputs and costs were also mentioned by growers
##Sustainable income, productivity, satisfaction, and low costs were also mentioned by growers
###Financial viability, stability, financial independence, financial success, and family transfer were also mentioned by growers
*Category 'Other' (Goal 1 – Cane growers) include 'build tractor transporters that suit our 1.524m rows', 'keep farming the property', 'fix up farm - buildings, tractor etc.', 'have farm 100% irrigable', 'I have achieve been 1st , 2nd , 3rd and 6th and over', 'survive the down turns/low sugar prices'
* Category 'Other' (Goal 1 – Graziers) include 'educating children', 'improve genetics', 'improvement', 'just getting to the next year. Sane. Between drought and politics lucky to be still alive'
**Category 'Other' (Goal 2 – Cane growers) include 'safety' and 'the best use of water', 'achieve a fair price for sugarcane by products', 'better infrastructure', 'pest management', 'presentation', 'rid property of feral pigs', 'saving money to achieve a common goal', 'work ethics'
**Category 'Other' (Goal 2 – Graziers) include 'better infrastructure', 'bulldozing all the trees and planting buffer grass', 'cattle prices & rain are good', 'climate insulation', 'improving weight for age through bull selection and pasture improvement'

3.3 Importance of different factors when making decisions about what to do on the farm / property

Land managers were asked to indicate how important a range of different factors were when making decisions about what to do on the farm / property (using a seven – point Likert scale from extremely unimportant through to extremely important). The estimated means of the importance of different factors and mean differences are shown in Table 11 and Table 12.

Maintaining physical and mental health of family, being able to make their own decisions about farm/property, and leaving the land/farm in better condition than it was when they first started managing it were the three most important factors for cane growers in the Wet Tropics. Leaving the land/farm in better condition than it was when you first started managing it, being able to make their own decisions about farm/property, keeping farm costs low and maximising farm profits (income minus costs) were the most important factors for growers in the Burdekin (Table 11). Leaving the land/farm in better condition than it was when you first started managing it, maintaining/improving water supplies and storages, and maintaining physical and mental health of family were the most three important factors for graziers (Table 12).

Using the Independent Samples *t* - test, we investigated if the means were significantly different between the regions. The results show that there was significant difference (at 1 per cent, 5 per cent and 10 per cent level of significance) in the means between the Wet Tropics and the Burdekin regions (Table 11) for:

- Maintaining good relations with other farmers/graziers in the local area ($t_{47.26}$= -3.070, $p = 0.004$)
- Maintaining/improving water supplies and storages ($t_{102.18}$= 5.196, $p < 0.001$)
- Maintaining family traditions and heritage($t_{47.92}$= -2.129, $p = 0.038$)
- Maintaining physical and mental health of family ($t_{46.20}$= -1.859, $p = 0.069$)
- Spending face-to-face time with family and friends ($t_{47.31}$= -1.833, $p = 0.073$)
- Keeping in contact with family and friends in other ways (e.g. via phone, through social media) ($t_{53.65}$= -1.691, $p = 0.097$)

There was no significant difference between other means. The average importance score for maintaining/ improving water supplies and storages in the Burdekin was one point greater than the average importance score in the Wet Tropics. Similarly the average importance score for maintaining good relations with other farmers/graziers in the local area in the Wet Tropics was 0.7 points greater than the average importance score for maintaining good relationships with other farmers/graziers in the Burdekin. Maintaining family traditions and heritage was also more important for growers in the Wet Tropics region. The average importance score in the Wet Tropics was 0.6 greater than the average importance score in the Burdekin. Other family related factors such as maintaining physical and mental health of family, spending face-to-face time with family and friends, and keeping in contact with family and friends in other ways (e.g. via phone, through social media) were also more important to cane growers in the Wet Tropics than to growers in the Burdekin.

Table 11: Importance of various factors when making decisions on farm/property (Cane growers in the Wet Tropics and Burdekin regions)

	Region	*N*	*Mean*	*Mean difference*
Maintaining physical and mental health of family	Burdekin	42	6.17	
	Wet Tropics	246	6.59	-0.423*
Maintaining family traditions and heritage	Burdekin	42	5.00	
	Wet Tropics	245	5.64	-0.645**
Spending face-to-face time with family and friends	Burdekin	42	5.74	
	Wet Tropics	246	6.19	-0.449*
Keeping in contact with family and friends in other ways (e.g. via phone, through social media)	Burdekin	43	5.35	
	Wet Tropics	241	5.78	-0.427*
Maintaining good relations with other farmers/graziers in the local area	Burdekin	43	5.42	
	Wet Tropics	246	6.13	-0.716***
Keeping farm costs low	Burdekin	43	6.44	
	Wet Tropics	246	6.43	0.011
Keeping a stable (steady) cash-flow	Burdekin	43	6.30	
	Wet Tropics	246	6.48	0.181
Maximising farm profits (income minus costs)	Burdekin	43	6.44	
	Wet Tropics	245	6.53	-0.089
Minimising risk (of very high costs or very low income)	Burdekin	43	6.42	
	Wet Tropics	246	6.26	0.158
Servicing debt	Burdekin	43	6.16	
	Wet Tropics	238	6.09	0.075
Having time to pursue hobbies	Burdekin	43	5.30	
	Wet Tropics	244	5.21	0.093
Being able to make your own decisions about your farm/property	Burdekin	43	6.47	
	Wet Tropics	246	6.59	-0.124
Learning about and testing new ways of doing things on your farm/property	Burdekin	43	6.14	
	Wet Tropics	246	6.23	-0.092
Sharing new ideas with others	Burdekin	43	5.60	
	Wet Tropics	246	5.97	-0.367
Having efforts recognised by the wider community	Burdekin	43	4.49	
	Wet Tropics	243	4.64	-0.154
Leaving the land/farm in better condition than it was when you first started managing it	Burdekin	43	6.56	
	Wet Tropics	245	6.59	-0.030

Maintaining/improving water supplies and storages	Burdekin	42	6.43	
	Wet Tropics	161	5.43	1.000***
Minimising sediment run-off and/or nutrient losses	Burdekin	43	6.37	
	Wet Tropics	243	6.55	-0.179
Helping to safeguard native plants and animals	Burdekin	42	5.90	
	Wet Tropics	241	5.98	-0.074
Helping to safeguard local waterways	Burdekin	43	6.35	
	Wet Tropics	243	6.42	-0.071
Helping to safeguard the Great Barrier Reef	Burdekin	41	6.32	
	Wet Tropics	243	6.40	-0.078

*significant at 10% level, **significant at 5% level, ***significant at 1% level
Note: Mean difference $_{Regions}$ = Mean $_{Burdekin}$ – Mean $_{Wet\ Tropics}$

Using the Independent Samples t - test, we investigated if means of the importance of different factors are significantly different between the two groups of land managers in the Burdekin region. The estimated means of the importance of different factors and the mean differences are shown in Table 12.

The results show that there was significant difference (at 1 per cent, 5 per cent and 10 per cent level of significance) in the mean of

- Having time to pursue hobbies ($t_{100.93}$= -3.115, $p = 0.002$)
- Helping to safeguard the Great Barrier Reef ($t_{99.53}$= -3.239, $p = 0.002$)
- Keeping farm costs low (t_{103}= -2.427, $p = 0.017$)
- Having efforts recognised by the wider community (t_{102}= -2.427, $p = 0.025$)
- Helping to safeguard local waterways (t_{103}= -1.854, $p = 0.067$)

There was no significant difference between other means. The average importance score for having time to pursue hobbies was 1.04 point greater for cane growers than for graziers. Similarly the average importance score for helping to safeguard the Great Barrier Reef was 0.9 greater for growers than for graziers. Having efforts recognised by the wider community, keeping farm costs low, and helping to safeguard local waterways were more important for growers and less important for graziers.

Table 12: Importance of various factors when making decisions on farm/property (Cane growers and graziers in the Burdekin)

	Group	*N*	*Mean*	*Mean difference*
Maintaining physical and mental health of family	Grazier	62	6.50	
	Cane grower	42	6.17	0.333
Maintaining family traditions and heritage	Grazier	62	4.66	
	Cane grower	42	5.00	-0.339
Spending face-to-face time with family and friends	Grazier	62	5.95	
	Cane grower	42	5.74	0.214
Keeping in contact with family and friends in other ways (e.g. via phone, through social media)	Grazier	62	5.61	
	Cane grower	43	5.35	0.264
Maintaining good relations with other farmers/graziers in the local area	Grazier	62	5.71	
	Cane grower	43	5.42	0.291
Keeping farm costs low	Grazier	62	5.92	
	Cane grower	43	6.44	-0.523**
Keeping a stable (steady) cash-flow	Grazier	62	6.18	
	Cane grower	43	6.30	-0.125
Maximising farm profits (income minus costs)	Grazier	62	6.29	
	Cane grower	43	6.44	-0.152
Minimising risk (of very high costs or very low income)	Grazier	62	6.32	
	Cane grower	43	6.42	-0.096
Servicing debt	Grazier	62	5.95	
	Cane grower	43	6.16	-0.211
Having time to pursue hobbies	Grazier	62	4.26	
	Cane grower	43	5.30	-1.044***
Being able to make your own decisions about your farm/property	Grazier	62	6.44	
	Cane grower	43	6.47	-0.030
Learning about and testing new ways of doing things on your farm/property	Grazier	62	5.89	
	Cane grower	43	6.14	-0.252
Sharing new ideas with others	Grazier	62	5.35	
	Cane grower	43	5.60	-0.250
Having efforts recognised by the wider community	Grazier	61	3.66	
	Cane grower	43	4.49	-0.833**
Leaving the land/farm in better condition than it was when you first started managing it	Grazier	62	6.66	
	Cane grower	43	6.56	0.103
Maintaining/improving water supplies and storages	Grazier	62	6.58	
	Cane grower	42	6.43	0.152
Minimising sediment run-off and/or nutrient losses	Grazier	62	6.34	
	Cane grower	43	6.37	-0.033
Helping to safeguard native plants and animals	Grazier	62	5.63	
	Cane grower	42	5.90	-0.276
Helping to safeguard local waterways	Grazier	62	5.92	
	Cane grower	43	6.35	-0.429*
Helping to safeguard the Great Barrier Reef	Grazier	61	5.39	
	Cane grower	41	6.32	-0.924***

*significant at 10% level, **significant at 5% level, ***significant at 1% level
Note: Mean difference $_{Groups}$ = Mean $_{Grazier}$ – Mean $_{Cane\ grower}$

3.4 Life satisfaction

Land managers were asked to respond on a 100 point scale (0=very unsatisfied; 100=very satisfied) about their quality of life (QOL) to better understand factors that might influence decision making (Table 13).

Fifty-nine per cent of cane growers in the Wet Tropics were very satisfied and 20 per cent were satisfied with their overall quality of life. Just over 4 per cent were neutral and 3.8 unsatisfied or very unsatisfied with their QOL. The mean satisfaction with the QOL was estimated as being 78.6 indicating that the majority of land managers are satisfied or more than satisfied with their overall quality of life. More than 62 per cent of cane growers in the Burdekin were very satisfied and more than 22 per cent were satisfied with their overall quality of life. Just over 3 per cent were neutral and over 7 per cent unsatisfied or very unsatisfied with their QOL. The mean satisfaction with the QOL was estimated as being 77.4. The results indicate that the majority of land managers are satisfied or more than satisfied with their overall quality of life.

More than 62 per cent of graziers in the Burdekin were very satisfied and more than 22 per cent were satisfied with their overall quality of life. Just over 3 per cent were neutral and over 7 per cent unsatisfied or very unsatisfied with their QOL. The mean satisfaction with the QOL was estimated as being 76.8 indicating that the majority of graziers are satisfied or more than satisfied with their overall quality of life.

Our mean estimates of overall QOL are consistent with the mean estimates of life satisfaction in Australia from various surveys conducted since 1950s. The estimates of QOL for Australian adults are ranging from 6.5 to 7.5 on a 10-point scale (ABS, 2009). Our mean estimates are also consistent with the Australian Personal Wellbeing Index, 'which measures people's satisfaction with their own lives (or with seven aspects or domains of their personal lives)' and which is consistently showing average satisfaction levels at around 75 per cent (ABS, 2009). As such, there is no significant difference compared to the overall population.

Using the Independent Samples *t* - test, we investigated if the means of life satisfaction in the Wet Tropics and in the Burdekin are significantly different. The results show that there was no significant difference between the means (t_{284}= -0.439, *p=0.661*).

Using the Independent Samples *t* - test, we investigated if the means of life satisfaction in the Burdekin are statistically different for two groups (cane growers and graziers). The results show that there was no significant difference between the means (t_{102}= -0.139, *p=0.890*).

Table 13: Overall satisfaction with quality of life

Life satisfaction score	*Per cent of respondents (%)*		
	Wet Tropics	*Burdekin*	
	Cane growers (N=244)	*Cane growers (N=42)*	*Graziers (N=62)*
0 (Very unsatisfied)	0.4%	2.38%	
10	0.4%		
19			1.61%
25 (Unsatisfied)	1.2%		1.61%
30	0.4%		1.61%
40	0.8%	4.76%	
45	0.8%		1.61%
50 (Neutral)	4.5%	4.76%	3.23%
52.5	0.4%		
55	0.8%		
57			1.61%
59			1.61%
60	4.9%	7.14%	6.45%
61			1.61%
63			1.61%
65	2.9%		1.61%
70	2.5%	11.90%	6.45%
71		4.76%	
72			1.61%
74		2.38%	
75 (Satisfied)	20.5%	2.38%	3.23%
77	0.4%		
79		2.38%	
80	13.1%	4.76%	9.68%
81			4.84%
82			4.84%
82.5	1.2%		
83			1.61%
85	14.3%	7.14%	6.45%
86		2.38%	3.23%
87		2.38%	1.61%
88		2.38%	3.23%
90	12.7%	16.67%	11.29%
91		2.38%	3.23%

Life satisfaction score	Per cent of respondents (%)		
	Wet Tropics	Burdekin	
	Cane growers (N=244)	Cane growers (N=42)	Graziers (N=62)
92		2.38%	3.23%
92.5	0.8%		
95	6.6%	9.52%	8.06%
97	2.9%		
99	0.4%		
100 (Very satisfied)	7.00%	7.14%	3.23%
	100.00%	100.00%	100.00%

3.5 Grants, funding, workshops and training programs

Grants and financial assistance

Land managers were asked to tell us about the grants and financial assistance that they applied for to do things on their property but there were insufficient responses in the Burdekin region to provide analysis on this question due to an error in the 'skip logic' within Qualtrics. This has been rectified for the second round of data collection.

Land managers were asked to identify the grants and financial assistance programs that they have applied for in the past 5 years. They were also asked to select on a seven point scale (1= complete waste of time to 7= completely useful) the usefulness of the grant.

There were 341 applications (cane growers) in the Wet Tropics region in total. Some respondents applied for 2, 3 or more grants/financial assistance programs. The majority of grants and funding applications were successful (88.5 per cent). Reef Rescue was the most popular (88 per cent of total applications) and it was useful for the applicants (M=6.35) in the Wet Tropics region. The main sources of information about those grants and programs were Canegrowers organisation (42.8 per cent) and extension officers (22.3 per cent). There were 44 applications (cane growers) in the Burdekin region in total. The majority of grants and funding applications in the Burdekin were successful (>93 per cent). Reef Rescue was the most popular grant (84.1 per cent) and it was the most useful for the applicants (M=6.76), followed by the drought funding, which was also very useful (M=6.50). The main sources of information about the grants in the Burdekin were NQ Dry Tropics (23.4 per cent), BSES/Canegrowers (14.9 per cent), and extension officers (12.8 per cent).

There were 55 applications in total for grants and financial assistance programs that graziers in the Burdekin applied for. Some respondents applied for 2 or 3 grants/financial assistance programs. The majority of grants and funding applications were successful (>93 per cent). Drought grants and financial assistance programs were the most popular (20 per cent of applications) and extremely useful for the applicants (mean usefulness is 7, implying that graziers found the grants completely useful).

Workshops and training programs

Land managers were asked about participation in workshops, training programs and extension activities in the last 5 years. Due to the 'skip logic' error in Qualtrics, we were not able to conduct the formal Chi-square Test. As such, we can only discuss differences or similarities between the regions and the groups of land managers based on descriptive statistics presented in Table 14 below.

A majority of cane growers in the Wet Tropics stated that they had participated in workshops, training programs and extension activities (Table 14). Eighty-two per cent of growers participated in 5 or less and nearly 9 per cent of respondents in the Wet Tropics participated in more than 5 workshops and training programs while just over 59 per cent of growers in the Burdekin indicated participation. Even lower percentage of graziers in the Burdekin (48 per cent) said that they participated in workshops, training programs and extension activities (Table 14).

Table 14: The proportion of respondents that participated in workshops, training programs or field days

	Per cent of respondents (%)		
	Wet Tropics	*Burdekin*	
	Cane growers (N=246)	*Cane growers (N=41)*	*Graziers (N=58)*
No, I have not participated in any	8.5%	41.46%	51.72%
Yes		58.54%	48.28%
Yes, I participated in 5 or less	82.5%		
Yes, I participated in more than 5	8.9%		

Land managers were also asked to identify the workshops, training programs or other support activities such as field days and on-farm demonstrations that they have participated over the past 5 years. They were also asked to select on a seven point scale (1= complete waste of time to 7= completely useful) the usefulness of the workshop, training program or field day.

There were 685 participations (cane growers) in the Wet Tropics in total. Some growers participated in 2, 3 or more workshops and/or training programs. Nutrient management (WTSIP) (30 per cent of total participations) was the most popular and quite useful program (the mean usefulness score for this program was 6). Smartcane BMP (17 per cent), AusChem (15 per cent), Integrated Weed Management (WTSIP) (12 per cent), and Drainage and Sediment Control (WTSIP/BMP) (4.5 per cent) were also popular amongst cane growers in the WT. There were 59 participations of cane growers in the Burdekin in total. SIX EASY STEPS and Smartcane BMP were the most popular workshops/programs and both programs were useful to the land managers (the mean usefulness score for those programs were 4.45 for Smartcane BMP and 5 for SIX EASY STEPS, indicating that the SIX EASY STEPS were more useful than the Smartcane BMP).

The main sources of information about these workshops and training programs in the Wet Tropics were Canegrowers organisation (44.7 per cent) and extension officers (15.6 per cent) while the main sources of information in the Burdekin were extension officers (29 per cent), friends/peers (16 per cent), and NQ Dry Tropics (12 per cent).

There were 59 participations of graziers in the Burdekin in total. Some graziers participated in 2 or 3 workshops and/or training programs. Holistic Management (14 per cent) and BMP (10 per cent) were the most popular programs and graziers find them to be useful (the mean usefulness for those programs was 5.6 for Holistic Management and 4.8 for BMP). The main sources of information about these workshops and training programs were emails (30.5 per cent), NQ Dry Tropics (18.6 per cent), and friends (10.2 per cent).

3.6 Current practices (self-reported behaviour)

Cane growers were asked if they were involved in any irrigation practices. One hundred and nine respondents[2] in the Wet Tropics answered this question. Eighty-three and a half per cent of respondents said that they were not involved in any irrigation practices (89 responses) and 16.5 per cent said that they were irrigating their crops (20 responses). As such, the following analysis of data related to irrigation practices in the Wet Tropics is based on 20 observations. Not all 20 cane growers responded to all further questions relevant to irrigation practices, thus, the number (N) of respondents reported in the preliminary analysis may vary.

This initial analysis in the Burdekin region is based on a very small sample size for the Burdekin region (N=38) which is related to specific issues (for example due to issues with skip logic in the survey software, cane growers did not answer every question). Therefore, the number of participants reported may also vary.

Irrigation practices

While 83 per cent of cane growers in the Wet Tropics said that they were not involved in any irrigation practices, 92 per cent of cane growers in the Burdekin said that they are irrigating their crops.

Using the Pearson's Chi-square Test, we tested if an involvement in irrigation practices depends on the case study areas (cane growers in the Wet Tropics vs. cane growers in the Burdekin). There was a significant association (at 1 per cent level of significance) between involvement in irrigation practices and whether cane growers were from the Wet Tropics or from the Burdekin region χ^2 (1) = 69.834, p<0.001. This significant result reflects the fact that 16.5 per cent of cane growers in the Wet Tropics are involved in irrigation and 83.5 per cent do not irrigate their crops, whereas 92 per cent of cane growers in the Burdekin are involved in irrigation practices and 8 per cent do not (Table 15). As such, the region where cane growers live and operate significantly influence the decision to be involved in irrigation practices.

[2]Those who left this question blank or who crossed it are not counted as those who answered the question

Table 15: Proportion of cane growers who are using/not using irrigation practices

		Use of irrigation practices		
		Yes	*No*	*Total*
Wet Tropics	Count	18	91	109
	Expected Count	39.3	69.7	109.0
	% within Burdekin or Wet Tropics	16.5%	83.5%	100%
Burdekin	Count	35	3	38
	Expected Count	13.7	24.3	38.0
	% within Burdekin or Wet Tropics	92.1%	7.9%	100%

Growers who irrigate their crops were asked how much irrigated water they use per hectare (acre) for their crops each year (see

Table 16), how much irrigation water runs off their blocks and which irrigation scheduling tools they are using. Ninety-five per cent of participants in the Wet Tropics and 94 per cent in the Burdekin were planning to use the same irrigation scheduling tools next year (Table 17).

Most of the 19 cane growers in the Wet Tropics (68 per cent) said that they use between 0ML and 5ML of irrigated water per hectare per annum, nearly 16 per cent of respondents use 5-10ML, 5 per cent up to 15ML and the rest of cane growers in the Wet Tropics said that it was not applicable or they do not know how much irrigated water they use. Of the 29 respondents in the Burdekin, the majority of respondents (92 per cent) said that they are using irrigation practices. Only 7 per cent of Burdekin cane growers use between 5ML and 15ML of irrigated water per hectare per annum, 21 per cent of respondents use 5-10ML, 45 per cent use between 10-15ML and the rest of cane growers are using 25ML and more (

Table 16).

Table 16: The amount of irrigated water that cane grower uses per hectare

ML per ha	*Per cent of respondents (%)*	
	Wet Tropics	*Burdekin*
	Cane growers (N=19)	*Cane growers (N=29)*
0-5ML	68.42%	6.90%
5-10ML	15.79%	20.69%
10-15ML	5.26%	44.83%
15-20ML		13.80%
20-25ML		
25-30ML		3.45%
30-35ML		
35-40ML		3.45%
40-45ML		3.45%
>45ML		3.45%
N/A	5.26%	
Don't know	5.26%	

The mean of MLs of irrigated water per hectare per annum in the Wet Tropics region was estimated as being 0.55ML/ha while the mean of MLs of irrigated water per hectare per annum in the Burdekin was 13.28ML/ha. Using the Independent Samples *t* - test, we investigated if those means are significantly different. The results show that there was significant difference (at 1 per cent level) in the mean of MLs per hectare per year between the Wet Tropics and the Burdekin regions ($t_{24.25}$= 4.328, $p < 0.001$). The average use of irrigated water in the Burdekin was 12.73ML/ha per annum greater than the average use of irrigated water per hectare per annum in the Wet Tropics.

The majority of cane growers (100 per cent in the Wet Tropics and 91 per cent in the Burdekin) estimated their run-off from irrigation as being between zero and 25 per cent of all irrigated water used on the block. The other 9 per cent of growers in the Burdekin said that their run-off was between twenty-five and 50 per cent.

Using the Pearson's Chi-square Test, we tested if irrigation scheduling tools used by land managers' are different between the regions. However, one of the assumptions for Chi-square Test has not been met (82 cells (97.6 per cent) had expected count less than 5 and the minimum expected count was 0.18) (see assumption 6, Appendix 1). Thus, the test was inconclusive. As such, we can only discuss differences or similarities between the regions based on descriptive statistics presented in Table 17 below.

Fifteen per cent of cane growers in the Wet Tropics and 57 per cent in the Burdekin region are using multiple irrigation scheduling tools. Forty per cent of growers in the Wet Tropics and nearly 30 per cent in the Burdekin are not using any irrigation scheduling tools (see Table 17). The other 15 per cent of growers in the WT and 15 per cent in the Burdekin use a single

irrigation scheduling tool (soil moisture probes such as tensiometers & capacitance probes and mini pans respectively). Ninety-five per cent of participants in the WT and 94 per cent in the Burdekin were planning to use the same irrigation scheduling tools next year.

Table 17: Irrigation scheduling tools used by cane growers

Irrigation scheduling tools	*Per cent of respondents (%)*	
	Wet Tropics Cane growers (N=20)	*Burdekin Cane growers (N=35)*
Mini pans[#]		14.71%
Soil moisture probes such as tensiometers & capacitance probes*	30%	11.76%
Calculation of daily crop water use, using crop factors, class A pan, or crop model (e. g. WaterSense)		2.94%
Mini pans/Soil moisture probes such as tensiometers & capacitance probes**	10%	14.7%
Mini pans/Calculation of daily crop water use, using crop factors, class A pan, or crop model (e. g. WaterSense)		8.82%
Mini pans/Soil moisture probes such as tensiometers & capacitance probes/ Calculation of daily crop water use, using crop factors, class A pan, or crop model (e. g. WaterSense)[##]	5%	5.88%
Soil moisture probes such as tensiometers & capacitance probes/Calculation of daily crop water use, using crop factors, class A pan, or crop model (e. g. WaterSense)[###]		11.76%
Other***	15%	20.59%
None	40%	8.82%

*'Visually', 'pumping rates per rainfall equipment', 'go by plant, Enviroscan, and Trickle irrigation were also mentioned by growers as irrigation tools

** Test from Productivity Services and recommendations, Irriweb, G-dots were also mentioned by growers as irrigation tools

***Category 'Other' (the Wet Tropics region) include calculator built into system, advisor does calculations, Enviroscan/Shovel/Hands & watch the drain. Category 'Other' (the Burdekin region) include 'amount of supply restraints', 'gut feeling and look at moisture levels', leaf stress, 'run all pumps and cover as much ground as possible and repeat', 'my own practical experience', 'shovel and expert eye', and 'years of observation'

G-dots, 'my own experience', knowledge, rule of thumb, and recycle pits were also mentioned by growers as irrigation tools

Trickle systems, experience, and Enviropans were also mentioned by cane growers as irrigation tools

also mentioned 'visually' and plant growth rate

Cane growers were asked how much they agree or disagree with statements related to their current tools for scheduling irrigation (a seven point Likert scale from strongly disagree = 1 through to strongly agree = 7 was used to assess each statement).

Using the Independent Samples *t* - test, we investigated if the means of attitudes and motivations are significantly different between the regions. The results show that there was significant difference (at 5% level of significance) in the mean of statement 'I only do this because I am forced to' (t_{12}= 2.413, $p = 0.033$). The average score for feeling forced to schedule irrigation in the Burdekin region is 2.5 points greater than the average score in the Wet Tropics implying that cane growers in the Wet Tropics feel freer to schedule or not to schedule their irrigation. There was no significant difference between the other means (Table 18).

The majority of cane growers in both regions indicated that their current system for scheduling irrigation is the best way to maintain good cash-flow, the best way to reduce business risk and to meet their personal goals, and it is the most effective way of controlling nutrient loss from their property.

Due to an error in the survey software responses to this question in the Burdekin region are low (N=6). As previously noted, the low response rate precludes any generalisation to the wide population but gives us an indication of attitudes and motivations associated with scheduling irrigation.

Table 18: Attitudes and motivations associated with scheduling irrigation[3]

	Region	*N*	*Mean*	*Mean difference*
The farmers I respect most do this	Burdekin	6	5.83	
	Wet Tropics	13	5.46	0.372
Most farmers in this region would not have the technical knowledge to do this	Burdekin	6	4.00	
	Wet Tropics	11	5.18	-1.182
Most farmers in this region would not be able to afford to use this system for scheduling irrigation	Burdekin	6	4.83	
	Wet Tropics	11	3.55	1.288
I only do this because I am forced to. Who/what is forcing you?	Burdekin	6	3.83	
	Wet Tropics	8	1.38	2.458**
The people/organisations whose advice I follow most think I should do this	Burdekin	6	5.17	
	Wet Tropics	11	5.36	-0.197
The best way to meet my own personal goals (question 17)	Burdekin	6	6.00	
	Wet Tropics	14	6.29	-0.286
The best way to maintain good cash-flow	Burdekin	6	6.17	
	Wet Tropics	12	6.50	-0.333
The best way to reduce business risk	Burdekin	6	6.17	
	Wet Tropics	12	6.33	-0.167
The least time-consuming (or labour intensive)	Burdekin	6	5.17	
	Wet Tropics	12	5.17	0.000
The most effective way of controlling nutrient loss from my property	Burdekin	6	6.17	
	Wet Tropics	12	6.08	0.083

*significant at 10% level
**significant at 5% level
***significant at 1% level
Note: Mean difference $_{Regions}$ = Mean $_{Burdekin}$ – Mean $_{Wet\ Tropics}$

Cane growers were asked to indicate whose advice they follow most when scheduling irrigation. Industry extension advisors such as SRA [BSES], Production Boards, and Productivity Services group were highly ranked of whose advice cane growers in the Wet Tropics follow most. Family who are also cane farmers, other cane farmers, private

[3] Only 20 cane growers in the Wet Tropics indicated that they were involved in any irrigation practices but only 12 people responded to the questions related to attitudes and motivations

agronomist, researchers and industry extension advisors were highly ranked of whose advice cane growers in the Burdekin follow most.

Calculating fertiliser application rates

Cane growers were asked how they calculate fertiliser application rates, they were allowed to give more than one answer.

Using the Pearson's Chi-square Test, we tested if the ways of calculating fertiliser application rates used by land managers' are different between the two regions. However, one of the assumptions for Chi-square Test has not been met (140 cells (92.1 per cent) had expected count less than 5 and the minimum expected count was 0.18) (see assumption 6, Appendix 1). Thus, the test was inconclusive. As such, we can only discuss differences or similarities between the regions based on descriptive statistics presented in Table 19 below.

More than 55 per cent of the participants in the Wet Tropics and 45 per cent in the Burdekin said that they are using multiple ways to calculate application rates. Just over 16 per cent of cane growers in the Wet Tropics and nearly 16 per cent in the Burdekin indicated that their advisors do it for them and 12 per cent and 18 per cent respectively said that they tailor their fertiliser rates to different parts of the property (Table 19).

Table 19: Different ways to calculate fertiliser application rates

	Per cent of respondents (%)	
	Wet Tropics Cane growers (N=245)	*Burdekin Cane growers (N=38)*
My advisor does this for me*	16.33%	15.79%
I tailor my fertiliser rates to different parts of the property**	12.65%	18.42%
I use industry standard rates for district yield potential, and use that amount on all parts of my farm***	11.02%	2.63%
I use industry standard rates for district yield potential, and use that amount on all parts of my farm/My advisor does this for me/I tailor my fertiliser rates to different parts of the property	11.02%	5.26%
My advisor does this for me/I tailor my fertiliser rates to different parts of the property	10.20%	7.89%
I tailor my fertiliser rates to different parts of the property/SIX EASY STEPS	10.20%	
Soil tests/types		10.52%
I use industry standard rates for district yield potential, and use that amount on all parts of my farm/My advisor does this for me	9.39%	
I use industry standard rates for district yield potential, and use that amount on all parts of my farm/I tailor my fertiliser rates to different parts of the property	6.94%	7.89%
I estimate amounts from my farm yield and use that amount on all parts of my farm	5.31%	7.89%
I use more fertiliser on under-performing (low yield) blocks than on other blocks/I tailor my fertiliser rates to different parts of the property	1.63%	2.63%

	Per cent of respondents (%)	
	Wet Tropics Cane growers (N=245)	*Burdekin Cane growers (N=38)*
I use industry standard rates for district yield potential, & use that amount on all parts of my farm/I use more fertiliser on high-performing (high yielding) blocks/I tailor my fertiliser rates to different parts of the property		2.63%
My advisor does this for me/I use more fertiliser on under-performing (low yield) blocks than on other blocks/I tailor my fertiliser rates to different parts of the property		2.63%
SIX EASY STEPS		2.63%
I estimate amounts from my farm yield & use that amount on all parts of my farm/I use more fertiliser on under-performing (low yield) blocks than on other blocks/I tailor my fertiliser rates to different parts of the property		2.63%
I use more fertiliser on high-performing (high yielding) blocks		2.63%
I use industry standard rates for district yield potential, & use that amount on all parts of my farm/I use more fertiliser on high performing (high yielding) blocks		2.63%
Other****	5.31%	5.26%

*Also mentioned SIX EASY STEPS, local agronomist, MAS, soil tests, a second option from Productivity Services extension officer, experience, farm climate, advisor, more fertiliser on under-performing (low yield) blocks, and tailoring fertiliser rates to different parts of the property

** Also mentioned NMP, pressure for plant, soil tests, and GES

***Also mentioned mill product, SIX EASY STEPS, regulator recommendations, and GES

****Category 'Other' include BMP recommendation, historical fertiliser amounts, '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', liquid fertiliser, soil test, soil type, 'use my historically min rates', sulphate of ammonium, GES ,soil tests/Incitic recommended rotations, estimate amounts from farm yield and soil tests - follow GES, experience, and private agronomist advice

Cane growers were asked how much they agree or disagree with statements related to their current system for calculating fertiliser application rates (a seven point Likert scale from strongly disagree = 1 through to strongly agree = 7 was used to assess each statement).

Using the Independent Samples *t* - test, we investigated if the means of attitudes and motivations related to fertiliser application rate are significantly different between the regions. Although cane growers indicated that their current practice for calculating fertiliser rates is the most effective way of controlling nutrient loss from the property and that it is the best way to meet their own personal goals and those two statement have the highest mean score in both regions, there was no significant difference between the means of controlling nutrient loss but there was significant difference at 5 per cent level of significance between the means of personal goals between the regions (Table 20). There were statistically significant differences (at 1 per cent, 5 per cent and 10 per cent level of significance) in the means including statements such as:

- I only do this because I am forced to (t_{248}= 3.551, $p < 0.001$)
- Most farmers in this region would not be able to afford to use this system for calculating fertiliser rates (t_{250}= 2.923, $p = 0.004$)

- The least time-consuming (or labour intensive) ($t_{45.48}$= -3.604, *p < 0.001)*
- The farmers I respect most do this (t_{257}= -1.971, *p = 0.050)*
- The people/organisations whose advice I follow most think I should do this (t_{254}= -2.356, *p = 0.019)*
- The best way to meet my own personal goals (t_{253}= -2.383, *p = 0.018)*
- The best way to reduce business risk (t_{254}= -1.915, *p = 0.057)*

The average score for feeling forced to calculate fertiliser application rate in the Burdekin region is 1.22 point greater than the average score in the Wet Tropics suggesting that cane growers in the Wet Tropics feel more flexible when making decision about calculating (or not) their fertiliser application rate. Similarly, the average score for believing that most farmers in the region would not be able to afford the current system of calculating fertiliser application rates in the Burdekin region is 1.15 greater than the average score in the Wet Tropics (Table 21). Thus, cane growers in the Wet Tropics have relatively stronger beliefs that most farmers in their region can afford the current system of calculating fertiliser rates.

The average score associated with statements 'The farmers I respect most do this' and 'The people/organisations whose advice I follow most think I should do this' in the Wet Tropics region are 0.62 and 0.7 greater than the average scores for the same statements in the Burdekin indicating that cane growers in the Wet Tropics are aligned more with these statements. Furthermore, the average score for usefulness of current fertiliser application practices for meeting personal goals is 0.44 greater in the Wet Tropics than in the Burdekin indicating that current fertiliser application practices in the Wet Tropics are more in line with growers' personal goals compare to growers in the Burdekin region.

Table 20: Attitudes and motivations associated with calculating fertiliser rates

	Region	*N*	*Mean*	*Mean difference*
The farmers I respect most do this	Burdekin	38	5.16	
	Wet Tropics	221	5.77	-0.616**
Most farmers in this region would not have the technical knowledge to do this	Burdekin	38	3.74	
	Wet Tropics	213	3.64	0.094
Most farmers in this region would not be able to afford to use this system for calculating fertiliser rates	Burdekin	38	3.82	
	Wet Tropics	214	2.66	1.152***
I only do this because I am forced to. Who/what is forcing you?	Burdekin	38	3.26	
	Wet Tropics	212	2.05	1.216***
The people/organisations whose advice I follow most think I should do this	Burdekin	38	5.11	
	Wet Tropics	218	5.80	-0.697**
The best way to meet my own personal goals (question 17)	Burdekin	38	5.82	
	Wet Tropics	217	6.26	-0.447**
The best way to maintain good cash-flow	Burdekin	38	6.05	
	Wet Tropics	219	6.17	-0.116
The best way to reduce business risk	Burdekin	38	5.79	
	Wet Tropics	218	6.16	-0.191*
The least time-consuming (or labour intensive)	Burdekin	38	4.29	
	Wet Tropics	218	5.50	-1.206***
The most effective way of controlling nutrient loss from my property	Burdekin	38	6.05	
	Wet Tropics	218	6.24	-0.186

*significant at 10% level
**significant at 5% level
***significant at 1% level
Note: Mean difference $_{Regions}$ = Mean $_{Burdekin}$ – Mean $_{Wet\ Tropics}$

Cane growers were asked to tell us whose advice they follow most when calculating fertiliser application rates. Industry extension advisors and private agronomist were highly ranked of whose advice cane growers in the Wet Tropics follow most while in the Burdekin, private agronomist and extension advisors were highly ranked by respondents.

Handling run-off practices

Similar to irrigation and fertiliser rate application, more than half of the cane grower participants (>60 per cent) in the Wet Tropics and 47 per cent in the Burdekin are using multiple ways to handle run-off. Nearly 43 per cent growers in the Wet Tropics and 24 per cent in the Burdekin had recycle pits and sediment traps to recycle the water and nearly half (47.4 per cent) of cane growers in the Burdekin had both recycle pits and adequate pumping capacity to recycle the water. Thirty-six per cent in the Wet Tropics and 8 per cent in the Burdekin indicated that they do not capture run-off (Table 21). Nearly every respondent was planning to use their current approaches next year.

Table 21: Practices for handling run-off from rainfall and irrigation

	Per cent of respondents (%)	
	Wet Tropics Cane growers (N=243)	*Burdekin Cane growers (N=38)*
I have recycle pits/sediment traps*	42.39%	23.68%
I have recycle pits/sediment traps and have adequate pumping capacity to recycle the water**	0.41%	47.37%
Grassed headlands/Trash blanket***	7.41%	
Grassed headlands****	6.58%	
Grassed drains/Underground drainage	2.06%	
I capture what i can but whole farm is not able to recycle		2.63%
All water from irrigation stays on farm		2.63%
Paddocks are laser levelled so there is min run-off		2.63%
I have recycle pits/Alluvial Soils		2.63%
I do not capture run-off	36.21%	7.89%
Other*****	4.94%	10.53%

*Also mentioned buffer zones, grassed headlands and drains, riparian buffer, trash blanket, natural lagoon or site that filter run-off, silt traps on drains, contouring, grass waterways, good farm layout, early fertilising, minimal tillage, spoon drains, riparian vegetation, clean drains, good fallow cover, graded headlands, contour banks, some contoured rows, grassed creeks, grassed slopes, levee banks, paddock layout, laser levelling, bank stabilisation through tree planting, no tillage in ratoons, zonal tillage, flood gates, rock pitching, rock walls, planting rows across the flow, green harvest, rush planting in wetlands, planted trees, retaining walls, silt, Integrated surface drainage, legume fallow, wetland, 'natural lagoons enhanced replenishment activities to remove barriers within lagoon systems naturally within the property'

**Participants also mentioned practices such as 'end banks to stop paddock run-off but want to install more recycle pits', 'recycle other farmers irrigation run off as well', 'shape of drill furrow, makes it easier, less water and power'; 'excess capacity - water is 100% used and then re-used'; 'keep grassy headland', 'up to 100mm of rain'

***Also mentioned bank stabilisation with rock, mowed drains, grassed drains and waterways, riparian vegetation, minimum tillage, green harvest, vegetated creeks, spoon drains, and trees

****Also mentioned clean drains, re-use the cleared sediment, grassed drains and waterways, rocks, spoon drains, GCTB, riparian vegetation, contours, and minimum tillage

*****Category 'Other' include engineered wetlands, rock walls, planted trees, natural gully, natural sediment trap, constructed drainage network, grass mapped paddocks, 10m wide grassed headland, 40m of vegetation to watercourse, and water detained by small pipes, end banks, good ground cover

Cane growers were asked how much they agree or disagree with statements related to their current system for handling run-off (a seven – point Likert scale from strongly disagree =1 through to strongly agree = 7 was used to assess each statement).

Table 22: Attitudes and motivations associated with handling run-off

	Region	*N*	*Mean*	*Mean difference*
The farmers I respect most do this	Burdekin	38	5.05	
	Wet Tropics	192	5.89	-0.833**
Most farmers in this region would not have the technical knowledge to do this	Burdekin	38	3.08	
	Wet Tropics	192	3.10	-0.025
Most farmers in this region would not be able to afford to use this system for handling run-off	Burdekin	38	4.18	
	Wet Tropics	192	3.31	0.872**
I only do this because I am forced to. Who/what is forcing you?	Burdekin	38	2.97	
	Wet Tropics	184	1.98	0.990***
The people/organisations whose advice I follow most think I should do this	Burdekin	38	4.84	
	Wet Tropics	189	5.74	-0.893***
The best way to meet my own personal goals (question 17)	Burdekin	38	6.08	
	Wet Tropics	190	6.33	-0.247
The best way to maintain good cash-flow	Burdekin	38	5.95	
	Wet Tropics	190	6.08	-0.137
The best way to reduce business risk	Burdekin	38	5.79	
	Wet Tropics	191	6.04	-0.252
The least time-consuming (or labour intensive)	Burdekin	38	4.95	
	Wet Tropics	191	5.67	-0.723**
The most effective way of controlling nutrient loss from my property	Burdekin	38	6.32	
	Wet Tropics	188	6.33	-0.014

*significant at 10% level
**significant at 5% level
***significant at 1% level
Note: Mean difference $_{Regions}$ = Mean $_{Burdekin}$ – Mean $_{Wet\ Tropics}$

Cane growers in both regions indicated that their current practices for handling run-off is the most effective way of controlling nutrient loss from the property and that it is the best way to meet their own personal goals. While those two statements have the highest mean score in both regions, there was no significant difference between the means (Table 22) but there was a significant difference (at 1 per cent, 5 per cent and 10 per cent level of significance) in the means including statements such as:

- I only do this because I am forced to (t_{220}= 2.688, $p < 0.008$)

- The people/organisations whose advice I follow most think I should do this (t_{225}= -2.713, *p = 0.007)*
- The farmers I respect most do this ($t_{47.01}$= -2,467, *p = 0.017)*
- Most farmers in this region would not be able to afford to use this system for calculating fertiliser rates (t_{228}= 2.127, *p = 0.035)*
- The least time-consuming (or labour intensive) (t_{227}= -2.383, *p < 0.018)*

The average score for feeling forced to handle run-off from rainfall and irrigation in the Burdekin region is 0.99 points greater than the average score in the Wet Tropics suggesting that cane growers in the Wet Tropics feel more flexible when making decisions about handling run-off. Similarly, the average score for believing that most farmers in the region would not be able to afford to use the current system of handling run-off in the Burdekin region is 0.87 greater than the average score in the Wet Tropics. Thus, cane growers in the Wet Tropics have relatively stronger beliefs that most farmers in their region can afford current system of handling run-off.

The average score associated with statements 'The farmers I respect most do this' and 'The people/organisations whose advice I follow most think I should do this' in the Wet Tropics region are 0.83 and 0.89 greater than the average scores for the same statements in the Burdekin indicating that cane growers in the Wet Tropics are aligned more with these statements.

Cane growers were asked to tell us whose advice they follow most when it comes to handling run-off from rainfall and irrigation. Industry extension advisors and family who are also cane farmers were highly ranked for whose advice cane growers in the Wet Tropics region follow most while growers in the Burdekin ranked private agronomist and extension advisors.

3.7 Other innovative practices to reduce nitrogen and/or run-off

Land managers were asked if they use any other innovative practices to reduce nitrogen and/or run-off.

Sixty-three per cent of cane growers in the Wet Tropics and nearly 58 per cent in the Burdekin region indicated that they do use other innovative practices (Table 23). Using the Pearson's Chi-square Test, we tested if land managers' responses are different between the two regions. There were no statistically significant differences between an involvement in other innovative practices and whether cane growers were from the Wet Tropics or from the Burdekin region χ^2 (1) = 0.461, *p*=0.59. The responses of growers in the Wet Tropics were not statistically different to the responses of growers in the Burdekin region (p-value of 0.59 > 0.10) implying that the region doesn't have any significant impact on whether or not cane growers are involved in other innovative practices to reduce nitrogen and/or run-off from rainfall and/or irrigation.

Sixty-eight per cent of graziers and 58 per cent of cane growers in the Burdekin region indicated that they do use other innovative practices (Table 23). Using the Pearson's Chi-square Test, we tested if land managers' responses are different between two groups of land managers. There were no statistically significant differences between an involvement in other

innovative practices and whether participants were cane growers or graziers χ^2 (1) =1.094, *p*=0.38. The responses of cane growers were not statistically different to the responses of graziers in the Burdekin region (p-value of 0.38 > 0.10) implying that farming activities such as growing cane and grazing do not have any significant impact on whether or not land managers are involved in other innovative practices to reduce nitrogen and/or run-off from rainfall and/or irrigation.

Table 23: Other innovative practices to reduce nitrogen and/or run-off

	Per cent of respondents (%)		
	Wet Tropics	*Burdekin*	
	Cane growers (N=231)	*Cane growers (N=38)*	*Graziers (N=54)*
Yes	63.6%	57.9%	68.5%
No	36.4%	42.1%	31.5%

3.8 Land managers' perceptions of top causes and pressures on water quality

Land managers were asked about their perceptions of sediment/nutrient loss from their property and what they think about water quality in local streams, rivers and waterways (Table 24). A standard 7-point Likert scale was used as shown in Table 24.

Thirty per cent of growers in the WT and 25 per cent in the Burdekin somewhat to strongly disagree that nutrient losses from their properties are having no impact on water quality in local streams, rivers and waterways indicating that at least one third of cane growers in the WT and one quarter in the Burdekin believe that their activities are somehow negatively affecting the water quality in local streams, rivers and waterways (Table 24). By contrast 42 per cent of cane growers in the Wet Tropics and 61 per cent in the Burdekin said that they are somewhat agree, agree or strongly agree with the statement, indicating that they do not believe that the losses from their properties are impacting water quality locally.

Table 24: Land managers' perceptions of water quality in local streams, rivers, and waterways

Sediment/Nutrient loss has no impact on WQ locally	*Per cent of respondents (%)*		
	Wet Tropics	*Burdekin*	
	Cane growers (N=246)	*Cane growers (N=36)*	*Graziers (N=53)*
Strongly agree	18.7%	16.67%	11.32%
Agree	15.0%	19.44%	13.21%
Somewhat agree	8.1%	25.00%	5.66%
Neutral	15.0%	11.11%	13.21%
Somewhat disagree	12.6	8.33%	15.09%
Disagree	8.9%	5.56%	24.53%
Strongly disagree	8.5%	11.11%	15.09%
Do not know/Not sure	13.0%	2.78%	1.89%

The mean perception of nutrient loss from the property and its impact on water quality in local streams, rivers and waterways was estimated as being 4.44 for cane growers in the Wet Tropics and 4.73 for growers in the Burdekin. Using the Independent Samples *t* - test, we investigated if the means of the responses to *Nutrient loss from my property has no impact on water quality in local streams, rivers, and waterways* statement are statistically different between the regions. The results show that there was no significant difference between the means (t_{249}= 0.822, *p=0.412*). The responses of growers in the Wet Tropics were not statistically different to the responses of growers in the Burdekin region implying that the respondents feel that the region the live and work in doesn't have any significant impact on land managers' perceptions of nutrient losses from their properties and its impact on local waterways.

The mean perception of nutrient/sediment loss from the property and its impact on water quality in local streams, rivers and waterways in the Burdekin was estimated as being 4.73 for cane growers and 3.56 for graziers. Using the Independent Samples *t* - test, we investigated if the means of the responses to *Nutrient loss from my property has no impact on water quality in local streams, rivers, and waterways* statement are statistically different between two groups of farmers. The results show that there was a significant difference between the means (t_{87}= -2.764, *p=0.007*) at 1 per cent level of significance.

The average score for nutrient/sediment loss from the property and its impact on water quality in local streams, rivers and waterways for cane growers is 1.17 point greater than the average score for graziers in the same region. The results suggest that cane growers, compared to graziers, are more reluctant to admit that their farming activities are adversely impact water quality in the Burdekin region.

The top causes of poor water quality locally cited by growers in the Wet Tropics were feral pigs in national parks and rainforest, soil run-off and erosion, extreme weather events such

as floods and cyclones, and sediment and nutrient run-off. The top causes of poor water quality cited by cane growers in the Burdekin were run-off from farms and bush areas, excessive chemical usage, nutrient and sediment run-off, and poor farming practices and other farmers. Graziers in the Burdekin were mainly blaming poor grazing practices and cattle country, drought, dry weather and lack of rain, and poor weed control management.

The results suggested that there may be a tendency of blame shifting related to water quality. Four per cent of cane grower responses in the Wet Tropics and 6 per cent in the Burdekin indicate that overgrazing, livestock farming, and run-off from grazing are the main reasons for poor water quality in local streams, rivers, and waterways whereas 3 per cent of graziers in the Burdekin blame the cane industry and poor cane farming practices for water quality in waterways.

Land managers were asked about their perceptions of the cane growing/grazing industry and its role in the declining health of the GBR (Table 25). Twenty-five per cent of growers in the WT and 13.9 per cent in the Burdekin somewhat to strongly disagree that the cane industry plays almost no role in the declining health of the GBR. By contrast 49 per cent of cane growers in the Wet Tropics and 66 per cent in the Burdekin said that they are somewhat agree, agree or strongly agree with the statement.

Table 25: Land managers' perceptions of cane growing/grazing industry and its role in the declining health of the GBR

Cane/grazing industry plays almost no role in the declining health of the GBR	*Per cent of respondents (%)*		
	Wet Tropics	*Burdekin*	
	Cane growers (N=243)	*Cane growers (N=36)*	*Graziers (N=53)*
Strongly agree	21.4%	19.44%	13.21%
Agree	14.8%	19.44%	13.21%
Somewhat agree	12.8%	27.78%	13.21%
Neutral	20.2%	16.67%	20.75%
Somewhat disagree	12.8%	8.33%	15.09%
Disagree	9.1%	2.78%	11.32%
Strongly disagree	3.3%	2.78%	11.32%
Do not know/Not sure	5.8%	2.78%	1.89%

The mean perception score of cane growing industry and its role in the declining health of the GBR was 4.7 for cane growers in the Wet Tropics and 4.97 for growers in the Burdekin. Using the Independent Samples *t* - test, we investigated if the means of the responses to the *Cane industry plays almost no role in the declining health of the GBR* statement are statistically different between the regions. The results show that there was no significant difference between the means ($t_{53.35}$= 0.994, $p=0.325$). The responses of growers in the Wet Tropics were not statistically different to the responses of growers in the Burdekin region implying that the region doesn't have a significant impact on land managers' perceptions of cane growing industry and its role in the declining health of the GBR.

The mean perception score of the cane growing/grazing industry and its role in the declining health of the GBR was estimated as being 4.73 for cane growers and 4.08 for graziers in the Burdekin region. Using the Independent Samples *t* - test, we investigated if the means of the responses to *Cane industry plays almost no role in the declining health of the GBR* statement are statistically different between two groups of farmers. The results show that there was a significant difference between the means (t_{87}= -2.380, *p=0.020*) at 5 per cent level of significance. The average score of the cane growing/grazing industry and its role in the declining health of the GBR for cane growers is 0.9 point greater than the average score for graziers in the same region. The results suggest that cane growers in the Burdekin, compared to graziers, are more reluctant to believe that the cane growing industry plays some role in the declining health of the GBR.

The top pressures on the health of the GBR cited by growers in the Wet Tropics were climate change and global warming (30 per cent), urban run-off (19 per cent), extreme weather events (e.g. cyclones) (16.4 per cent), tourism industry (7.3 per cent), and poor land management practices and farming systems (6.4 per cent). The top pressures cited by growers in the Burdekin were climate change and global warming (21.6 per cent), nutrient and sediment run-off (13.5 per cent), urban run-off (5.4 per cent), extreme weather events (e.g. cyclones, an increase in sea temperature) (5.4 per cent), tourism industry (5.4 per cent), and shipping accidents, anchor damage and oil spills (5.4 per cent). Graziers mainly blamed run-off from urban areas and coastal development (26 per cent), and climate change and global warming (19.7 per cent) for the declining health of the GBR.

There is also a tendency of blame shifting related to the health of the reef. Just over 1 per cent of cane growers in the Wet Tropics and over 15 per cent in the Burdekin believe that cattle farmers, graziers' land, use of hormones on cattle production, and poor grazing practices are the top pressures on the health of the GBR whereas 2 per cent of graziers blame cane growers and farmers near the coast for declining health of the reef.

3.9 Demographic background

Gender

As expected the sample was dominated by males. Ninety - seven per cent of cane growers in the Wet Tropics and 100 per cent in the Burdekin region identified as male while 62 per cent of graziers identified as male and 37 per cent identified as female (see Table 26).

Table 26: Demographic characteristics of cane growers/graziers

		Percentage of respondents (%)		
		Wet Tropics	*Burdekin*	
		Cane Growers (N = 244-246)	*Cane growers (n=38)*	*Graziers (n=53)*
Gender	Male	97.13%	100%	62.26%
	Female	2.87%		37.74%
Born in Australia	Yes	94.72%	100%	94.34%
	No	5.28%		5.66%
Cultural Heritage	Australian (non-indigenous)	36.69%	63.16%	92.45%
	Italian	36.69%	23.68%	5.66%
	Australian/Italian	8.87%		
	Maltese	2.82%		
	English	2.42%		
	Indian	1.61%		
	Other (e.g. Spanish, Canadian, Irish, Yugoslav, Albanian, Chinese, German)	10.89%	13.16%	
	Other (not specified)			1.89%
Marital status	Married or De-factor	87.8%	94.74%	94.34%
	Divorced	2.03%	2.63%	3.77%
	Widowed	2.44%		
	Single	7.72%	2.63%	1.89%

Using the Pearson's Chi-square Test, we tested if the distribution of gender is different between the two regions. There were no statistically significant differences between being a male/ female and whether cane growers were from the Wet Tropics or from the Burdekin region χ^2 (1) = 1.118, p=0.599.

Using the Pearson's Chi-square Test, we tested if the distribution of gender is different between the two groups of land managers. There was a significant association (at 1 per cent level of significance) between gender and whether participants were cane growers or graziers χ^2 (1) = 18.379, p<0.001. This significant result reflects the fact that farming activities (growing cane and grazing) significantly influence involvement by gender (Table 27). Cane growers in the Burdekin are 100 per cent males while females can be also involved in grazing activities.

Table 27: Gender distribution (cane growers/graziers) in the Burdekin region

		Male	*Female*	*Total*
Cane grower	Count	38	0	38
	Expected Count	29.6	8.4	38.0
	% within cane grower or grazier	100%	0%	100%
Grazier	Count	33	20	53
	Expected Count	41.4	11.6	53.0
	% within cane grower or grazier	62.3%	37.7%	100%

Born in Australia

The majority of respondents in both regions were born in Australia (Table 26).

Using the Pearson's Chi-square Test, we tested if the distribution of *born in Australia* is different between the regions and between the two groups of land managers in the Burdekin. However, one of the assumptions for Chi-square Test has not been met (1 cell (25.0 per cent) had expected count less than 5 and the minimum expected count was 1.74 for Chi-square Test between the regions) and (2 cells (50.0 per cent) had expected count less than 5 and the minimum expected count was 1.25 for Chi-square Test between the groups) (see assumption 6, Appendix 1). Thus, the tests were inconclusive.

Cultural Heritage

Thirty-six per cent of cane growers in the Wet Tropics were non-Indigenous Australian and another 36 per cent of growers had Italian cultural heritage. Nearly 9 per cent of growers in the Wet Tropics were of Australian/Italian heritage, 3 per cent were Maltese, 2.5 per cent were English, 1.6 per cent were Indian and remaining 11 per cent were of other cultural heritage including Albanian, Yugoslav, Chinese, Finnish, Irish or mix of them. Sixty-three per cent of cane growers in the Burdekin were non-Indigenous Australian while 24 per cent had Italian cultural heritage. The remaining 13 per cent were of other cultural heritage including Spanish, Canadian or Irish (Table 26).

Using the Pearson's Chi-square Test, we tested if cultural heritage of participants is different between the two regions. However, one of the assumptions for Chi-square Test has not been met (9 cells (50.0 per cent) had expected count less than 5 and the minimum expected count was 0.18) (see assumption 6, Appendix 1). Thus, the test was inconclusive.

Using the Pearson's Chi-square Test, we tested if cultural heritage is different between two groups of land managers. However, one of the assumptions for Chi-square Test has not been met (3 cells (50.0 per cent) had expected count less than 5 and the minimum expected count was 3.34) (see assumption 6, Appendix 1). Thus, the test was inconclusive.

Marital status

The majority of respondents were either married or in de facto relationships (Table 26). Using the Pearson's Chi-square Test we tested if marital status of the respondents is different between the regions and between the two groups of land managers in the Burdekin. However, one of the assumptions for Chi-square Test has not been met (3 cells (37.5 per cent) had expected count less than 5 and the minimum expected count was 0.80 for Chi-square Test between the regions) and (4 cells (66.7 per cent) had expected count less than

5 and the minimum expected count was 0.84 for Chi-square Test between the groups) (see assumption 6, Appendix 1). Thus, the tests were inconclusive.

Age

The majority of cane growers who answered the survey in the Wet Tropics (61 per cent) were aged between 50 and 69 years of age whereas the majority of growers who answered the survey in the Burdekin (63 per cent) were aged between 45 and 64 years of age (Table 28). There was 13 per cent of cane growers in the Wet Tropics and 8 per cent in the Burdekin aged 70+. Medium age of cane growers in the Wet Tropics was 57 years and 52 years in the Burdekin which is significantly greater than the median age of the Australian population (37 years).

The majority of graziers (66 per cent) who answered the survey were aged between 40 and 64 years of age (Table 28). There was 1.9 per cent of graziers aged 70+. Medium age of graziers in the Burdekin was 52 years which is significantly greater than the median age of the Australian population (37 years).

Table 28: Age of respondent

Age group	*Per cent of respondents (%)*		
	Wet Tropics	*Burdekin*	
	Cane growers (N=247)	*Cane growers (N=38)*	*Graziers (N=53)*
20-24 years	0.40%		1.89%
25-29 years	0.40%		3.77%
30-34 years	2.43%	5.26%	11.32%
35-39 years	5.26%	7.89%	7.55%
40-44 years	8.50%	7.89%	11.32%
45-49 years	8.50%	13.16%	13.21%
50-54 years	14.57%	18.42%	11.32%
55-59 years	18.62%	18.42%	16.98%
60-64 years	15.79%	13.16%	13.21%
65-69 years	12.15%	7.89%	7.55%
70-74 years	5.67%	2.63%	1.89%
75-79 years	5.26%	2.63%	
80-84 years	1.62%	2.63%	
85 years and older	0.81%		
Total	100%	100.0%	100.0%

Using the Pearson's Chi-square Test, we tested if the distribution of age of participants is different between the two regions and between the two groups of land managers in the Burdekin. However, one of the assumptions for Chi-square Test has not been met (15 cells (53.6 per cent) had expected count less than 5 and the minimum expected count was 0.13 for Chi-square Test between the regions) and (17 cells (65.4 per cent) had expected count

less than 5 and the minimum expected count was 0.42 for Chi-square Test between the groups of managers) (see assumption 6, Appendix 1). Thus, the tests were inconclusive.

Average age (mid points) of cane growers was estimated as 56.8 years in the Wet Tropics and 53.7 years in the Burdekin. Average age (mid points) of graziers in the Burdekin region was 48.9 years.

Using the Independent Samples *t* - test, we investigated if the age means are statistically different between the regions. The results show that there was no significant difference between the means (t_{283}= -1.463, *p=0.145*) implying that there is not significant difference in the age of cane growers in both regions.

Using the Independent Samples *t* - test, we investigated if the age means are statistically different between the two groups of land managers. The results show that there was a significant difference between the means (t_{89}= -1.839, *p=0.069*) at 10 per cent level of significance. The average age of a cane grower in the Burdekin is 4.73 years greater than the average age of a grazier in the same region.

Formal Education

Twenty-seven per cent of growers in the Wet Tropics and 34 per cent in the Burdekin indicated that they completed formal education to year 10. Another 27 per cent of cane growers in the WT and 13 per cent in the Burdekin achieved a trade or apprenticeship. Only 7 per cent of respondents in the Wet Tropics answered that they have completed a university degree (Table 29). There were more cane growers with a university degree in the Burdekin region (21 per cent). By contrast, nearly 36 per cent of graziers in the Burdekin have completed a university degree and 21 per cent completed to year 10. The other respondents (graziers) either completed to year 12, achieved a trade or apprenticeship or went to agricultural college (Table 29).

Table 29: Highest level of education completed by respondent

Education	*Per cent of respondents (%)*		
	Wet Tropics	*Burdekin*	
	Cane growers (N=248)	*Cane growers (N=38)*	*Graziers (N=53)*
Primary school (year 7)	5.67%		
High school (year 10)	27.53%	34.21%	20.75%
High school (year 12)	12.55%	10.53%	7.55%
Trade / apprenticeship	27.53%	13.16%	13.21%
Agricultural college	9.31%	13.16%	9.43%
TAFE	1.62%	2.63%	7.55%
Diploma of Agriculture/Certificate	3.24%		
University	6.88%	21.05%	35.85%
Other	5.66%*	5.26%**	5.66%***

* Category 'Other' include Scholarship and University (not completed)

**category 'Other' include grade 8 and Diploma animal husbandry

***include grade 8 and 9, certificate IV

Using the Pearson's Chi-square Test, we tested if the distribution of the responses about education was different between the two regions and between the two groups of land managers in the Burdekin. However, one of the assumptions for Chi-square Test has not been met (36 cells (75.0 per cent) had expected count less than 5 and the minimum expected count was 0.18 for Chi-square Test between the regions) and (14 cells (63.6 per cent) had expected count less than 5 and the minimum expected count was 0.40 for Chi-square Test between the groups of managers) (see assumption 6, Appendix 1). Thus, the tests were inconclusive.

3.10 Additional property characteristics

Cane yield per hectare (per acre) achieved on the main property

Cane growers were asked to average out over good and bad years their cane yield per hectare (per acre) that they achieved on their property (Table 30). The majority of cane growers in the Wet Tropics (68 per cent) said that on average they achieved cane yield between 80 tonnes per ha (32.4 tonnes per ac) and 100 tonnes per ha (40.5 tonnes per ac). The majority of cane growers in the Burdekin (78 per cent) said that on average they achieved cane yield between 100 tonnes per ha (40.5 tonnes per ac) and 160 tonnes per ha (72.8 tonnes per ac).

Table 30: Average cane yield per hectare (per acre)

Tonnes per Ha/Ac	*Per cent of respondents (%)*	
	Wet Tropics Cane growers (N=224)	*Burdekin Cane growers (N=37)*
0-20 tonnes per ha (0-8.1 tonnes per ac)		2.70%
20-40 tonnes per ha (8.1 -16.2 tonnes per ac)	0.4%	
40-60 tonnes per ha (16.2-24.3 tonnes per ac)	0.4%	2.70%
60-80 tonnes per ha (24.3-32.4 tonnes per ac)	21.0%	5.41%
80-100 tonnes per ha (32.4-40.5 tonnes per ac)	67.9%	8.11%
100-120 tonnes per ha (40.5- 48.6 tonnes per ac)	6.3%	21.62%
120-140 tonnes per ha (48.6-56.6 tonnes per ac)	3.6%	43.24%
140-160 tonnes per ha (56.6-64.7 tonnes per ac)	0.4%	13.51%
160-180 tonnes per ha (64.7-72.8 tonnes per ac)		2.70%

Using the Pearson's Chi-square Test, we tested if the distribution of average cane yield per hectare (per acre) that farmers achieved on their property different between the two regions. However, one of the assumptions for Chi-square Test has not been met (11 cells (61.16 per cent) had expected count less than 5 and the minimum expected count was 0.15 (see assumption 6, Appendix 1). Thus, the test was inconclusive.

The average cane yield tonnes/per hectare (mid points) that farmers achieved on their property was estimated as 88.30 tonnes/ha in the Wet Tropics and 117.37 tonnes/ha in the Burdekin. Using the Independent Samples *t* - test, we investigated if the means of cane yield are statistically different between the regions. The results show that there was a statistically

significant difference between the means ($t_{39.83}$= 5.808, *p<0.001*). The average cane yield in the Burdekin is 29.06 tonnes/ha greater than the average yield in the Wet Tropics region.

4.0 RECOMMENDATIONS AND CONCLUSION

Note: The recommendations have already been provided in draft form to the CEO of NQ Dry Tropics and Terrain for comment. Further discussions will be needed to decide on how best to implement the recommended strategies. This preliminary analysis of the first round of data within the Wet Tropics and NQ Dry Tropics area revealed no 'unexpected findings' that run contrary to previous studies as outlined in our 2016 literature review (Eagle, Hay, & Farr, 2016) and we have therefore cross referenced to specific sections of that report if additional information is required, adding in additional references where relevant. The responses from both cane growers and graziers indicate that there is a reluctance to accept that their actions impact negatively on the water quality of the Great Barrier Reef. Survey results show that cane growers were reluctant to accept that nutrient loss from their property also has an impact on water quality in local streams, rivers and waterways. Graziers, however, were more critical about their activities and the role that sediment plays in reducing water quality. The results indicate that both groups, for each sector, have some tendency to shift blame to the other sectors (e.g. tourism, industry, government, other farmers, shipping and fishing), and to see issues of water quality as due feral pigs in national parks and rainforest, soil run-off, river bank erosion, and erosion from bare fallow and roads, residential or industrial activity as well as due to weather patterns and climate change.

Drawing on the climate change adaptation literature, there is growing recognition of the need to reconsider the strategies for encouraging wider uptake of BMP and recognition of a need for more than incremental (small to moderate) changes to existing practice and a refocusing on more significant changes to practices (Dowd et al., 2014). We note that similar challenges exist in other parts of the world such as the EU (McGonigle et al., 2012). The recommendations that follow outline strategies that can be used to fine-tune existing landholder interactions.

Land Manager Profiles - Key Factors

- 27 per cent of cane growers in the Wet Tropics and 34 per cent in the Burdekin have completed year 10 high school while 21 per cent of graziers in the Burdekin region also completed year 10 high school. 27 per cent of cane growers in the Wet Tropics and 13 per cent in the Burdekin completed trade/apprenticeship program. 7 per cent of growers in the Wet Tropics and 21 per cent in the Burdekin have completed a university degree whereas 36 per cent of graziers in the Burdekin also completed a university degree.
- The majority of respondents are either married or in de-factor relationships (>88 per cent).
- 37 per cent of cane growers in the Wet Tropics and 23 per cent in the Burdekin have Italian cultural heritage. Majority of graziers (92 per cent) were non-Indigenous Australian.
- 65 per cent of cane growers in the Wet Tropics and 80 per cent in the Burdekin own their properties. 84 per cent of graziers in the Burdekin selected that they own or own & manage the property.
- 72 per cent of growers in the Wet Tropics and 72 per cent in the Burdekin indicate that growing sugarcane is the most important use of land to the financial viability of their farm and 66 per cent and 54 per cent of growers respectively were enjoying growing cane.
- 69 per cent of graziers say that grazing activities are the most important use of land to the financial viability of their property and they are enjoying grazing

Mature profile – older than overall population

The majority of cane growers who answered the survey in the Wet Tropics were aged between 50 and 69 years of age (61 per cent) whereas the majority of growers in the Burdekin were aged between 45 and 64 years of age (63 per cent). Majority of graziers who answered the survey were aged between 40 and 64 years of age (66 per cent).

The median age of cane growers in the Wet Tropics is 57 years and 52 years in the Burdekin. The median age of graziers is also 52 years which is significantly greater than the median age of the Australian population (37 years) (Australian Bureau of Statistics, 2016). The average age of cane growers was estimated as 56.8 years in the Wet Tropics and 53.7 years in the Burdekin. The average age of graziers in the Burdekin region was 48.9 years. There were no significant differences between the means in two regions but the average age of growers in the Burdekin was statistically different from the average age of graziers. The results suggest that cane growers in this region are 4.7 years older than graziers.

Lengthy land management experience

The majority of cane growers in the Wet Tropics (65 per cent) and in the Burdekin (80 per cent) own their properties. Eighty- four per cent of graziers in the Burdekin selected that they own or own & manage the property.

Respondents have considerable land management experience (average of 29.2 years for growers in the WT, 20.9 years for growers in the Burdekin, and 18.9 years for graziers), often following earlier generations onto properties: *maintaining traditions and heritage* are important (over 63 per cent of cane growers in the WT, and over 50 per cent of cane growers and graziers in the Burdekin indicated this to be of the highest importance). Our results show that there was significant difference (at 1 per cent level of significance) in the mean of number of years between the Wet Tropics and the Burdekin regions. The average number of years growers own/manage their main property in the Wet Tropics were 8.3 years greater than the average number of years in the Burdekin. There was no significant difference between the means of number of years owning/managing the main property between two groups of land managers in the Burdekin.

Decisions are not made in isolation – influence of family / extended family

Forty per cent of cane growers in the Wet Tropics, 41 per cent of growers and 66 per cent of graziers in the Burdekin share their decisions with family or extended family. Cane growers in the Wet Tropics consult solely with spouses (28 per cent) or with their brothers and sisters (26 per cent), and parents (18 per cent). Cane growers in the Burdekin prefer to share the decision with their brothers (22 per cent), parents (22 per cent) or children (22 per cent) while graziers consult solely with spouses (32 per cent) or with both their spouse and their children (25 per cent).

Positive about overall quality of life

Approximately 79 per cent of respondents in the Wet Tropics, 84 per cent of cane growers and 67 per cent of graziers in the Burdekin were either very satisfied or satisfied with their overall quality of life. The majority of cane growers and graziers (over 90 per cent) had no significant plans to change future practices.

Acceptance and Blame

Forty - two per cent of cane growers in the Wet Tropics and 61 per cent in the Burdekin do not believe their farming practice adversely impacts water quality in local streams, rivers, and waterways. Forty-nine per cent of cane growers in the WT and 66 per cent in the Burdekin do not believe that cane industry plays a significant role in the declining health of the GBR. Four per cent of cane growers in the WT and 6 per cent in the Burdekin believe that overgrazing, livestock farming, and run-off from grazing are the main reasons for poor water quality in local streams, rivers, and waterways. Similarly, just over 1 per cent of cane growers in the WT (2 responses) and 15 per cent in the Burdekin believe that producing cattle and poor grazing practices are the top pressures on the health of the GBR.

Thirty per cent of graziers in the Burdekin also do not believe their farming practice adversely impacts water quality in local streams, rivers, and waterways. However, 55 per cent of graziers in our sample do believe that their practices is negatively impacting water quality locally. Thirty-nine per cent of graziers do not believe that cane/grazing industry plays a significant role in the declining health of the GBR. Three per cent of graziers blame the cane industry and poor cane farming practices for water quality in waterways. Similarly, 2 per cent of graziers blame cane growers and farmers near the coast for declining health of the reef.

Selling the Science

As 42 per cent of cane growers in the WT and 61 per cent in the Burdekin and do not accept that their farming practices negatively impact water quality, there is a clear need to engage them in discussions on this issue and to 'prove' cause and effect in ways that will lead to engagement. This will require liaison with environmental science specialists to help 'sell the science' AND to offer practical and affordable behavioural practice advice, both in face-to-face and via meetings and workshops.

Extension Officers

Note: On the basis of discussions with stakeholders re the material below, the research team was asked to submit a paper for the 2017 International Conference of the Australasia-Pacific Extension Network (APEN) conference. This paper has been accepted and discussion will take place at the conference regarding appropriate strategies and tactics. A more extensive set of recommendations in the form of a full academic paper for submission to an appropriate journal will then be developed. The key role of extension officers in interactions with Australian and mangers has been recognised (see, for example, Ampt, Cross, Ross, & Howie, 2015; Vanclay, 2004). The challenge now is to support 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, which also may be more difficult when there is a considerable difference between the land manager and extension officer ages. Land managers believe their expertise and opinions are not valued and their 'farmer voices' are not being heard, leading to scepticism regarding the need to change practice. Practice change requires building a level of trust that is needed for positive long-term relationships (see Eagle et al., 2016 Section 1.3).

We note that the role of agricultural extension officers has altered over time, often as the result of major policy and funding changes and note that there are calls for major professional development strategies to help these key individuals facilitate innovation and significant practice change (Ampt, Cross, Ross, & Howie, 2015), with possible implications for on-going

professional training. We now outline possible ways in which their role can be supported and strengthened. Recommendations for an increased focus on the role of extension officers are not new, and are consistent across countries, including Australia (see, for example, Di Bella, O'Brien, Nash, & Wegscheidl, 2015; Hunt, Birch, Vanclay, & Coutts, 2014; Wegscheidl, Trendell, & Coutts, 2015), The USA (Warner, 2014; Warner, Stubbs, Murphrey, & Huynh, 2016) and Greece (Koutsouris, 2014). An American approach is noteworthy because of the recommendations that extension officers be given professional development training in social marketing techniques, particularly in the use of message framing and message tailoring techniques. The outcomes of this strategy are claimed to increase positive behaviour change but also the job satisfaction of extension officers together with their confidence in their ability to continue to influence behaviour change (Warner, 2014; Warner, Stubbs, Murphrey, & Huynh, 2016). It is noted that communications training improves active engagement particularly where there is added complexity caused by controversial topics such as the impact of climate change (Diehl et al., 2015).

Support for Innovators / Positive Deviants

Support for those land managers who have changed practice but who are seen by their peers as 'going against the norm' (described in the literature as 'positive deviants' (Pant & Hambly Odame, 2009) needs to be considered given the strength of comments from both cane growers and graziers. Survey comments indicate that '*farmers I respect*' (i.e. strong social norms as part of farmer identity) is a stronger influence than wider community factors, and that sharing new ideas is important (see the discussion of diffusion of innovation in Section 2.1 of Eagle et al., 2016, particularly the issues of compatibility, trialability and observability). 'Positive deviants' experiencing success are meeting their personal goals and expected outcomes of a particular practice. Meeting personal goals and expected outcomes are beliefs that are highlighted as important in the survey responses. Perceived control was also highlighted as important. Therefore, efforts to promote best management practice clearly and convincingly should demonstrate the ecological benefits, such as improving environment and enhancing land managers ability to participate in ecological conservation activities to meet the perceived control behaviour. This suggests opportunities for extension officers to facilitate group 'social learning' with land managers, to share ideas and to learn from and support each other (Hermans, Klerkx, & Roep, 2015) as part of strategies for '*persuasion by discussion*' (Scott, 2012, p. 64) and collective action (Blackstock, Ingram, Burton, Brown, & Slee, 2010).

Integrated marketing communication

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 and to combat messages that run counter to the desired core messages re BMP. There is a need for 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 encompasses 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.

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 are summarised in Table 31 and indicate that the media presents a sensationalised and, at times, hostile perspective on reef-related issues.

Table 31: Great Barrier Reef 2016 Media coverage examples

Category	*Example*
Climate change / Global Warming / Ocean Acidification (23 articles)	*Ritter, D. (2016). Great Barrier Reef: why are government and business perpetuating the big lie? The Guardian, November 1.*
Coral bleaChing (42 articles)	*Brissenden, M. (2016). Two-thirds of the northern Great Barrier Reef wiped out. ABC Radio, 29 November.*
Reef is Dead / Dying (21 articles)	*Marshall, P. & Smith, A. (2016). Outside magazine Great Barrier Reef wiped out. ing the big lie The Australian, 4 November.*
"Peter Ridd controversy" (10 articles)	*Micheal, P. (2016). Great Barrier Reef threat overstated, says Queensland professor. Courier Mail, May 19.*
UNESCO potential 'at risk' listing (16 articles)	*Day, J., Grech, A. & Brodie, J. (2016). Great Barrier Reef needs far more help than Australia claims in its latest report to UNESCO. The Conversation, 6 December.*
Water quality improvement (4 articles)	*Smail, S. (2016).Great Barrier Reef water quality improved by wetlands restoration, scientist says. ABC News, 14 June.*
Funding increase calls (17 articles)	*Michael, P., Viellaris, R. (2016). Great Barrier Reef Marine Park authority 'starved of funds'. Courier Mail, 7 November.*
Cane monitoring compliance measures (4 articles)	*Anon. (2016). Queensland to enforce Great Barrier Reef protection methods with cane farmers. Envirotech-online.com, April 1.*
Farmer protests at negative portrayal (4 articles)	*McKillop, C. (2016). Great Barrier Reef debate leaves farmers frustrated over their negative portrayal on water quality improvements. ABC Rural, 29 June.*
Government actions re reducing run-off (5 articles)	*Gregory, K. (2016). Great Barrier Reef: Qld Government's cattle station purchase 'makes agriculture sector scapegoat'. ABC News, 23 June*
Reef Report Card (5 articles)	*Smail, S. (2016). Barrier Reef Reef: Report card reveals pollution levels too high. ABC News, 20 October.*
Plastic bags (14 articles)	*Aust Assoc Press (2016). Qld government seeks plastic bag ban reactions. November 25.*
Coal mines (22 articles)	*Knaus, C. (2016). Minister defends coal industry after call to ban new mines to save reef. The Guardian, 25 November.*
Shipping	*Whigham, N. (2016). Research shows the devastation of a potential coal spill on Great Barrier Reef. News.com, May 17.*

Social media strategies

There are some who propose the "cyber extension" model, where the bulk of communications are electronic. This is a concept that has evolved from developing countries (Burman et al., 2013) but we recommend that this be viewed with some caution and that digital media communication be considered as part of a wider integrated communication strategy rather than replacing existing strategies. A strategy for the inclusion of strategic uses of social media may have several benefits. It may help to reach individuals who are hard to reach via conventional media (Quinton, 2013) or who resist face to face contact. It can be a low cost and fast way of distributing information (White, Meyers, Doerfert, & Irlbeck, 2014). However, we note that while there are claims that people '*are swarming to social media'* (Heller Baird & Parasnis, 2011, p. 31), internet use varies widely, including across the agricultural sector, with both insufficient / inadequate Internet connections and information overload being significant barriers (Jespersen et al., 2014).

There is a need to separate email (the most commonly used digital medium) from other electronic platforms AND to ensure that the platforms used are those that land managers can access and prefer to use, for example smart phone technology, tablets and laptops (Hay & Pearce, 2014, p. 322). In a recent study, land managers surveyed about the technology they use, identified that 87 per cent were using smart/mobile phones, 86 per cent were using laptops, 72 per cent were using a tablet and another 72 per cent were using a home PC (Hay, 2017). While having access to technology does allow communication with land managers via social media, we must keep in mind that 20 per cent of the population of developing countries have literacy problems and a further 20 per cent have limited literacy (see Hay & Eagle, 2016, p. 2). Therefore, we must ensure that the platform used is appropriate and that the content is written at a level suitable to the audience. In addition, not all land managers have access to social communication platforms. Seventy-three per cent of respondents (N = 716) to a Regional Access Survey stated that they did not have reliable mobile coverage, 74 per cent of mobile broadband users had download speeds of less than 5Mbps and that they had limited data (88 per cent stated that current data did not meet their needs) (BIRRR Regional Internet Access Survey, 2016). Those connected to the Sky Muster™ NBN™ in some cases are experiencing even less connectivity (BIRRR Skymuster Survey Results, 2017).

Overall message fatigue needs to be recognised as an additional barrier as it leads to both message avoidance and resistance irrespective of the media channel used (So, Kim, & Cohen, 2016). Where social media strategies are included, communication will be interactive, with participants generating content and no one individual or organisation being able to control the exchange of information (Dijkmans, Kerkhof, & Beukeboom, 2015). Further, organisations such as NRMs need to resource social media activity due to its proactive direct relationship between participants rather than the passive nature of one-way information distribution via more traditional media channels (Aula, 2010).

An additional factor to consider is the use of visual imagery. While visual imagery may at first gain attention and interest, it can also help those who struggle to understand the text-based information or other concepts (Dowse, 2004). It can also make specific elements of the communication stand out (Altinay, 2015). Where the topic has a high involvement for the farmer, the image becomes a central route to persuasion and may influence decisions. Likewise when there is low involvement with the topic, imagery allows for low or non-

conscious information processing, which may change an attitude toward the message or a non-conscious belief, leading to behavioural and/or attitude change (Petty & Cacioppo, 1984). Therefore it is important that visual imagery is relevant and reflects the topic being presented. In addition, local imagery is more effective when gaining acceptance or when there is a need for local action. Further investigation of current imagery will be completed in the upcoming NESP Project 3.1.3.

Customer relationship management plans

The application of Customer Relationship Management (CRM) principles in agriculture is relatively new but it is acknowledged that "a farmer's commitment to their advisor will remain strong if they have frequent meaningful interaction over a long period of time, high perceptions of equity and value, trust and confidence" (Kuehne, Nettle, & Llellyn, 2015, p. 1). Therefore, CRM may be of use, in conjunction with the use of social network analysis, typologies and other strategies outlined in this document. Additionally, the principles of business-to-business marketing may be useful in recognizing long decision making cycles, complex decision making units and the importance of reference groups (Brennan, Canning, & McDowell, 2014)

Social network analysis

Given the evidence that decisions are generally not 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). 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), as the following example of the connections between a group of 24 individuals illustrates.

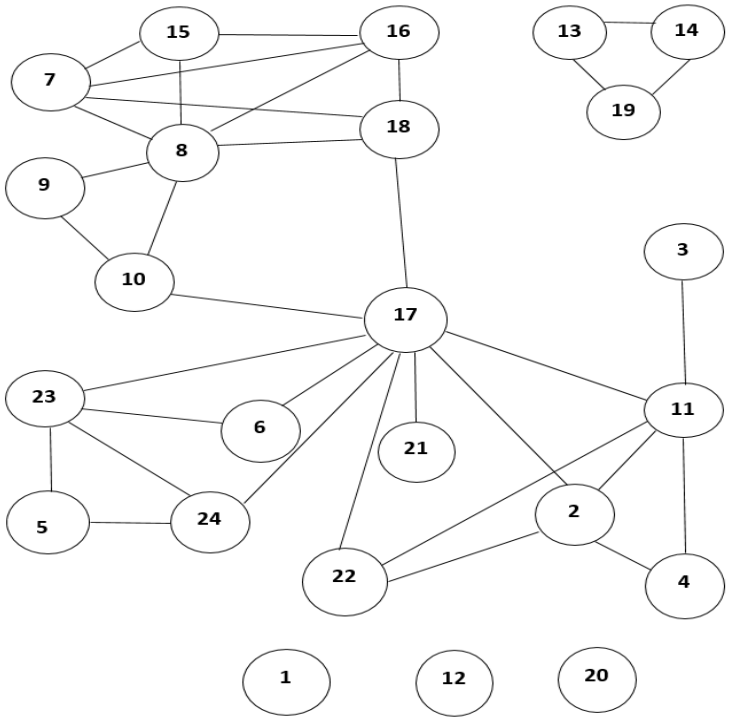

Figure 1: Social network Analysis Example: 'Sociogram' of 24 people (Scott, 2012, p. 29 reproduced from Moreno, 1934, p. 145)

The sociogram in Figure 1 shows that there are three individuals who are not connected to any others (individuals 1, 12 and 20), three that are connected only to two other people (individuals 13, 14 and 19), while all other individuals are connected to a wider group. Within this 'connected' group, individual 17 is an example of someone with multiple connections and who should be examined to determine their actual or potential role as an information gatekeepers or opinion leaders and also what role they may play in decision making among those other individuals with whom they are connected. These people may be valuable in helping to 'sell the science', particularly through information sharing and facilitating actual demonstrations of practice change.

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), as the impact of these two types of ties are different as shown in Table 32 below, with both positive and negative implications.

Table 32: Network concepts relevant for natural resource management (adapted from Prell, Hubacek, & Reed, 2009, p. 505) + indicates positive effect, - indicates negative effect

Network concept	*Effect on resource management*
Strong ties	
+	Good for communicating about and working with complex information
+	Hold and maintain trust between actors
+	Actors more likely to influence one another's thoughts, views, and behaviours
+	Encourage creation and maintenance of norms of trust and reciprocity
-	Encourage the likelihood that actors sharing strong tie hold redundant information
-	Actors less likely to be exposed to new ideas and thus may be less innovative
-	Can constrain actors
Weak ties	
+	Tend to bridge across diverse actors and groups
+	Connect otherwise disconnected segments of the network together
+	Good for communicating about and working with simple tasks
+	New information tends to flow through these ties
-	Not ideal for complex tasks=information
-	Actors sharing weak ties are less likely to trust one another
-	Can break more easily

It may therefore be useful to attempt to map out social networks for land managers where there is the potential for identifiable individuals to play a key role, positive or negative, in information dissemination. It may also be useful for extension officers to map networks for the land managers with whom they interact and to also consider their own roles within these networks.

The ability of an individual (also called 'actors' in recent academic literature) or an organization to disseminate or manipulate knowledge depends on how many other

individuals look to them as a credible source of information and knowledge (Muñoz-Erickson & Cutts, 2016).

Early adopters have larger numbers of social contacts and 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 who he or she have cause to trust are considering it or have already adopted it" (Scott, 2012, p. 69). Thus these key people may act as a significant barrier to uptake of innovations (see the discussion of diffusion of innovation in Eagle et al., 2016, Section 2.1).

It is related to other concepts such as social capital (see Eagle et al., 2016, Section 4.1.3) and to the concepts of networks or communities of practice which evolved from the education sector. Communities of practice are defined as "groups of people who share a common pursuit, activity or concern. Members do not necessarily work together, but form a common identity and understanding through their common interests and interactions" (Oreszczyn, Lane, & Carr, 2010, p. 405). These authors suggest that networks of practice have weaker ties between members and may be linked by shared practice.

Typologies

The diversity of farmers and farming practice is acknowledged, but 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 (2001) used semi structure interviews to discover the dominant personality styles of cattle and crop producers in Queensland. Five dominant personality styles emerged which may be used to direct learning (Table 33). 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, and by contrast, the "sensitive personality" is cautious when in groups, and is stressed by unfamiliar surrounds, therefore would learn better in small groups of familiar people for example extension staff. Recognising cattle producers as having unique personality traits is a large step towards shared understanding(Shrapnel & Davie, 2001). There is no current comparable data on personality traits for cane growers. However, we would assume that personality also plays a role in the cane grower decision making.

Table 33: Characteristics of the dominant personality Styles (reproduced from Shrapnel and Davie, 2001)

Personality Style				
Vigilant	*Conscientious*	*Solitary*	*Serious*	*Sensitive*
Autonomy	Hard Work	Solitude	Cogitates	Needs Familiarity
Caution	Does the right thing	Stoicism	Keeps a straight face	Circumspect
Perceptiveness	Order and detail	Sexual composure	Dislikes pretensions	Likes a structured role
Self defence	Prudence	Sangfroid	Predictable	Reserved
Fidelity	Perseverance	Grounded	Accountable	Very private
Alertness to criticism	Perfectionist Accumulator	Independence	Contrite Insightful	Concerned about other regards

A summary of our key recommendations are given below:

- There is a need to 'sell the science' to gain acceptance of the cause-effect relationship between farming practice and water quality. NRM groups should work with environmental science specialists to change views on the impact of farming practice on water quality.
- There is a potential to extend the key role of extension officers in potentially influencing increased uptake of BMP practices. There is a need to 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.
- It is crucial to support innovation by celebrating success and sharing ideas. Land managers should see their expertise is valued and their voices heard.
- Facilitating sharing of ideas and practices.
- Building on the role of farms whose views are respected as information gatekeepers / disseminators / role models.
- A need to ensure all communication, by whatever means, sends consistent messages irrespective of source, and channelling communication through trusted sources. Developing strategies for minimising the impact of competing and conflicting messages.
- Ensuring that all persuasive communications are integrated in terms of key messages.
- Monitor media coverage and respond to inaccurate messages and develop proactive media relationships.
- Incorporating social media strategies as part of an integrated communication strategy that centres on the information channels and platforms used and preferred by land managers. Review communication strategies, adding social media where appropriate, recognising that this is likely to be most popular with younger land managers. Need to recognise the overall diversity of information sources and preferences.
- Incorporate long-term relationship management strategies based on customer relationship management and business to business marketing concepts.
- Utilise Social Network Analysis to identify:

- key information gatekeepers / opinion leaders who may help or hinder information dissemination and innovation uptake, and recognise social relationships based on cultural / kinship factors.
- where individual extension officers may fit into various networks

- Recognise land manager diversity but use typology principles to develop material and communication approaches to support extension officers in their interactions with specific subsets of land managers.

The analysis of data presented in this report is primarily descriptive. The results of full structural equation based analysis will be provided in the next reporting period, with findings linked back to the literature and the implications for future water quality improvement practices will be discussed.

REFERENCES

Ajzen, I., & Fishbein, M. (1980). *Understanding Attitudes and Predicting Social Behavior*. Engelwood Cliffs, NJ: Prentice Hall

Altinay, Z. M. (2015). Communicating Sustainability with Visuals: Issue Perception and Issue Engagement. (PhD), Louisiana State University.

Ampt, P., Cross, R., Ross, H., & Howie, B. (2015). The case for retaining, redefining and reinvigorating extension in agricultural innovation systems. *Rural Extension and Innovation Systems Journal, 11*(1), 157.

Aula, P. (2010). Social media, reputation risk and ambient publicity management. *Strategy & Leadership, 38*(6), 43-49.

Australian Bureau of Statistics. (2016). 3101.0 Australian Demographic Statistics. Canberra, ACT.

ABS (2009). 1383.0.55.001 - Measures of Australia's Progress: Summary Indicators, 2009- Life Satisfaction and Measures of Progress. Retrieved from http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/1383.0.55.001Main+Features282009

Batra, R., & Keller, K. L. (2016). Integrating Marketing Communications: New Findings, New Lessons, and New Ideas. *Journal of Marketing, 80*(6), 122-145.

Bewick, V., Cheek, L., & Ball, J. (2003). Statistics review 8: Qualitative data–tests of association. *Critical care*, *8*(1), 46.

BIRRR. (2016). Better Internet for Rural, Regional and Remote Australia: Regional Internet Access Survey Results, 2016. Retrieved from https://birrraus.files.wordpress.com/2017/04/birrr-report-2016-survey-results-final.pdf:

BIRRR Skymuster Survey Results. (2017). Better Internet for Rural, Regional and Remote Australia: Skymuster Survey Results 2017. Retrieved from https://birrraus.files.wordpress.com/2017/04/birrr-report-2016-survey-results-final.pdf:

Blackstock, K. L., Ingram, J., Burton, R., Brown, K. M., & Slee, B. (2010). Understanding and influencing behaviour change by farmers to improve water quality. Science of The Total Environment, 408(23), 5631-5638. doi:10.1016/j.scitotenv.2009.04.029

Brennan, R., Canning, L., & McDowell, R. (2014). Business-to-Business Marketing (3rd ed.). London: SAGE Publishing.

Brodie, J. E., & Mitchell, A. W. (2005). Nutrients in Australian tropical rivers: changes with agricultural development and implications for receiving environments. *Marine and Freshwater Research, 56*(3), 279-302.

Burman, R. R., Dubey, S., Sharma, J., Vijayaragavan, K., Sangeetha, V., & Singh, I. (2013). Information Dynamics for Designing Cyber Extension Model for Agricultural Development. *Journal of Community Mobilization and Sustainable Development, 8*(2), 182-185.

Dempwolf, C. S., & Lyles, L. W. (2012). The uses of social network analysis in planning: A review of the literature. *CPL bibliography, 27(*1), 3-21.

Di Bella, L., O'Brien, D., Nash, M., & Wegscheidl, C. (2015). Targeted extension strategies to improve water quality outcomes in the Australian sugar industry*. Rural Extension and Innovation Systems Journal, 11*(1), 184.

Diehl, D. C., Galindo-Gonzalez, S., Dourte, D. R., Fraisse, C. W., Sloan, N. L., Bartels, W.-L., & Furman, C. (2015). Toward engagement in climate training: Findings from interviews with agricultural extension professionals. *Journal of Rural Social Sciences, 30*(1), 25.

Dijkmans, C., Kerkhof, P., & Beukeboom, C. J. (2015). A stage to engage: Social media use and corporate reputation.

Dowd, A.-M., Marshall, N., Fleming, A., Jakku, E., Gaillard, E., & Howden, M. (2014). The role of networks in transforming Australian agriculture. *Nature Climate Change, 4*(7), 558-563.

Dowse, R. (2004). Using visuals to communicate medicine information to patients with low literacy. *Adult learning, 15*(1-2), 22.

Eagle, L., Hay, R., Farr, M. (2016). Background Review of Literature on the Science of Social Marketing for NESP Project 2.1.3 Harnessing the Science of social marketing and behaviour change for improved water quality in the GBR. Report to the National Environmental Science Programme. Reef and Rainforest Research Centre Limited, Cairns.

Farr, M., Eagle, L. Hay, R., and Churchill, M. (2017a) *Questionnaire Design, Sampling Strategy and Preliminary Findings: The Burdekin region*. NESP Project 2.1.3 Interim report. Report to the National Environmental Science Program. Reef and Rainforest Research Centre Limited, Cairns (124pp.).

Farr, M., Eagle, L. Hay, R., and Churchill, M. (2017b) *Questionnaire Design, Sampling Strategy and Preliminary Findings: The Wet Tropics region*. NESP Project 2.1.3 Interim report. Report to the National Environmental Science Program. Reef and Rainforest Research Centre Limited, Cairns (100pp.).

Farr, M., Eagle, L., and Hay, R. (2017c). *Key Determinants of pro-environmental behaviour of land managers in the agricultural sector: Literature Review.* NESP Project 2.1.3 Supplementary review. Report to the National Environmental Science Program. Reef and Rainforest Research Centre Limited, Cairns (97pp.).

Flick, B. (2013). Landowners' management of riparian forest in far north Queensland, Australia: A social psychological prospective. PhD Thesis, James Cook University.

Field, A. (2009). Discovering statistics using SPSS (3rd edition). SAGE Publication, London.

Graymore, M., Schwarz, I., & Brownell, B. (2015). Development of quick tool for farmer segmentation: Practical uses for extension work. *Rural Extension and Innovation Systems Journal, 11*(1), 33.

Hay, R. (2017). PhD Thesis - Initial Analysis of Survey Data: Technology Adoption by Women in Agriculture Survey 2016. Technology Adoption by Women in Agriculture. College of Business Law and Governance. James Cook University.

Hay, R., & Eagle, L. (2016). Harnessing the science of social marketing and behaviour change for improved water quality in the GBR: Documentary Analysis (readability, message framing and message tone). Retrieved from http://nesptropical.edu.au/wp-content/uploads/2017/01/NESP-TWQ-2.1.3-INTERIM-REPORT-2.pdf:

Hay, R., & Pearce, P. (2014). Technology adoption by rural women in Queensland, Australia: Women driving technology from the homestead for the paddock. *Journal of Rural Studies, 36*, 318-327.

Haynes, D., Brodie, J., Waterhouse, J., Bainbridge, Z., Bass, D., & Hart, B. (2007). Assessment of the Water Quality and Ecosystem Health of the Great Barrier Reef (Australia): Conceptual Models. *Environmental Management, 40*(6), 993-1003. doi: 10.1007/s00267-007-9009-y

Heller B.C., & Parasnis, G. (2011). From social media to social customer relationship management. *Strategy & Leadership, 39*(5), 30-37.

Hermans, F., Klerkx, L., & Roep, D. (2015). Structural conditions for collaboration and learning in innovation networks: using an innovation system performance lens to

analyse agricultural knowledge systems. *The Journal of Agricultural Education and Extension, 21*(1), 35-54.

Hunt, W., Birch, C., Vanclay, F., & Coutts, J. (2014). Recommendations arising from an analysis of changes to the Australian agricultural research, development and extension system. *Food Policy, 44*, 129-141.

Jespersen, L. M., Hansen, J. P., Brunori, G., Jensen, A. L., Holst, K., Mathiesen, C., & Rasmussen, I. (2014). ICT and social media as drivers of multi-actor innovation in agriculture–barriers, recommendations and potentials. European Commission, Directorate-General for Research.

Keller, K. L. (2016). Unlocking the Power of Integrated Marketing Communications: How Integrated Is Your IMC Program? *Journal of Advertising, 45*(3), 286-301.

Kent State University Libraries (2017). SPSS Tutorials: Independent Samples t- test. Available from http://libguides.library.kent.edu/SPSS/IndependentTTest (accessed 17 May 2017).

Koutsouris, A. (2014). Exploring the emerging intermediation roles (facilitation and brokerage) in agricultural extension education. *International Journal of Agricultural Extension*, 21-37.

Kuehne, G., Nettle, R., & Llellyn, R. (2015). The Key Social Processes Sustaining the Farmer/Adviser Relationship.

Lankester, A., Valentine, P., & Cottrell, A. (2009). 'The sweeter country': social dimensions to riparian management in the Burdekin rangelands, Queensland. *Australasian Journal of Environmental Management, 16*(2), 94-102.

McGonigle, D., Harris, R., McCamphill, C., Kirk, S., Dils, R., Macdonald, J., & Bailey, S. (2012). Towards a more strategic approach to research to support catchment-based policy approaches to mitigate agricultural water pollution: A UK case-study. *Environmental Science & Policy, 24*, 4-14.

McHugh, M. L. (2013). The Chi-square Test of independence. *Biochemia medica*, *23*(2), 143-149.

Muñoz-Erickson, T. A., & Cutts, B. B. (2016). Structural dimensions of knowledge-action networks for sustainability. *Current Opinion in Environmental Sustainability, 18*, 56-64.

Oreszczyn, S., Lane, A., & Carr, S. (2010). The role of networks of practice and webs of influencers on farmers' engagement with and learning about agricultural innovations. *Journal of Rural Studies, 26*(4), 404-417.

Pant, L. P., & Hambly Odame, H. (2009). The promise of positive deviants: bridging divides between scientific research and local practices in smallholder agriculture. *Knowledge management for development journal, 5*(2), 160-172.

Petty, R. E., & Cacioppo, J. T. (1984). Source Factors and the Elaboration Liklihood Model of Persuasion. *Advances in Consumer Research, 11*(1), 668-672.

Prell, C., Hubacek, K., & Reed, M. (2009). Stakeholder analysis and social network analysis in natural resource management. *Society and Natural Resources, 22*(6), 501-518.

Quinton, S. (2013). The digital era requires new knowledge to develop relevant CRM strategy: A cry for adopting social media research methods to elicit this new knowledge. *Journal of Strategic Marketing, 21*(5), 402-412.

Scott, J. (2012). What is Social Network Analysis. London: Bloomsbury Academic.

Shrapnel, M., & Davie, J. (2001). The influence of personality in determining farmer responsiveness to risk. *The Journal of agricultural education and extension, 7*(3), 167-178.

Smith, M., Poggio, M. J., Thompson, M. & Collier, A. (2014). *The Economics of Pesticide Management Practices on Sugarcane Farms: Final Synthesis Report.* Department of Agriculture, Fisheries and Forestry (DAFF), Queensland.

So, J., Kim, S., & Cohen, H. (2016). Message fatigue: Conceptual definition, operationalization, and correlates. *Communication Monographs*, 1-25.

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

van Grieken, M., Roebeling, P., Bohnet, I., Whitten, S., & Webster, A. (2012). Economic incentive-based instruments for the adoption of management options for water quality improvement in heterogeneous sugarcane farming communities. Paper presented at the International Environmental Modelling and Software Society (iEMSs). 2012 International Congress on Environmental Modelling and Software, Managing Resources of a Limited Planet, Sixth Biennial Meeting, Leipzig, Germany.

Vanclay, F. (2004). Social principles for agricultural extension to assist in the promotion of natural resource management. *Animal Production Science, 44*(3), 213-222.

Warner, L. A. (2014). Enhancing the capacity to create behavior change: Extension key leaders' opinions about social marketing and evaluation. *Journal of Agricultural Education, 55*(4), 176-190.

Warner, L. A., Stubbs, E., Murphrey, T. P., & Huynh, P. (2016). Identification of the Competencies Needed to Apply Social Marketing to Extension Programming: Results of a Delphi Study. *Journal of Agricultural Education, 57*(2), 14-32.

Wegscheidl, C., Trendell, P., & Coutts, J. (2015). Evaluating the role of extension in helping to improve water quality in the Great Barrier Reef. *Rural Extension and Innovation Systems Journal, 11*(1), 1.

White, D., Meyers, C., Doerfert, D., & Irlbeck, E. (2014). Exploring agriculturalists' use of social media for agricultural marketing. *Journal of Applied Communications, 98*(4), 72-86.

APPENDIX 1: THE PEARSON CHI-SQUARE TEST

The Pearson Chi-square Test is the Chi-square Test of independence and it is the most common test for nominal variables. Chi-square Test provides information on any significant differences between two variables and also provides information on categories that account for those differences (Field, 2009; McHugh, 2013).

The Pearson Chi-square Test is non-parametric test and should be used when

- the variables are nominal or ordinal (McHugh, 2013)
- the sample sizes of the study groups are not equal (McHugh, 2013)
- the data are measured at ratio or an interval level (McHugh, 2013)

The Pearson Chi-square Test has a number of assumptions:

(1) the cells data should be counts or frequencies but not percentages (McHugh, 2013)
(2) the categories should be mutually exclusive (McHugh, 2013)
(3) each subject should contribute to only one cell in the Chi-square (McHugh, 2013)
(4) the study groups should be independent (McHugh, 2013)
(5) two variables should be measured as categories (nominal or ordinal) (McHugh, 2013)
(6) at least 80% of the cells should have expected frequencies greater than 5 and no cell should have expected frequency of less than 1 (Bewick, Cheek, & Ball, 2003)

APPENDIX 2: THE INDEPENDENT SAMPLES T-TEST FOR EQUALITY OF MEANS

The Independent samples t-test is a parametric test that compares the means of two independent samples (groups). The test has a number of assumptions:

(1) continuous dependent variable
(2) categorical independent variable
(3) independent samples/groups – violation of this assumption will result in inaccurate p-value
(4) normally distributed dependent variable – violation of this assumption will reduce the power of the test (especially heavily skewed or thick tailed distributions) but the large samples can yield accurate p-values
(5) Homogenous variances (variances should be equal across samples/groups) – violation of this assumption can result in inaccurate p-value

If one or more assumptions are violated, one may want to run the nonparametric Mann-Whitney *U* Test instead (Kent State University Libraries, 2017).

The null hypothesis (H_0) and alternative hypothesis (H_1) of the independent samples t- test can be expressed as

H_0: $\mu_1 - \mu_2 = 0$ (the population means are equal)

H_1: $\mu_1 - \mu_2 \neq 0$ (the population means are not equal)

Where μ_1 and μ_2 are the population means for sample/group 1 and sample/group 2 (Kent State University Libraries, 2017).

SPSS produces two forms of t - test statistic, depending on equality of variance assumption (i.e. whether or not equal variances are assumed) as well as a test for the homogeneity of variance which is called Levene's test.

The hypotheses testing for the Levene's Test for Equality of Variances are

H_0: $\sigma_1^2 - \sigma_2^2 = 0$ (the population variances of sample/group 1 and 2 are equal)

H_1: $\sigma_1^2 - \sigma_2^2 \neq 0$ (the population variances of sample/group 1 and 2 are not equal)

Where σ_1^2 and σ_2^2 are the population variances of sample/group 1 and 2 respectively. The homogeneity of variance assumption is violated if we reject the null hypothesis. If Levene's F- statistic is insignificant (p-value is large), we cannot reject the null, thus the population variances of sample 1 and 2 are equal. As such we should use t-test statistic where equal variances are assumed. If Levene's F-statistic is significant (p-value is small), we reject the null, thus the population variances of sample 1 and 2 are not equal and we should use t-test statistics where equal variances are not assumed (Kent State University Libraries, 2017).

Reef & Rainforest
RESEARCH CENTRE

www.nesptropical.edu.au