Do improved grazing management practices lead to increased levels of ground cover?

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Abstract. Grazing in Queensland is identified as a key contributor of suspended sediments entering the Great Barrier Reef. The Australian and Queensland Governments developed the Reef Water Quality Protection Plan, which set targets for adoption of best management practices and ground cover targets, to improve water quality. Extension has been a critical element to enabling these adaptive management practices. This paper compares and contrasts ten grazing properties in the Fitzroy Basin to understand the effectiveness of a past extension program and improve our understanding of enduring change. The past extension program, Central Queensland Better Economic and Environmental Futures, was the extension program selected to review. The paper explores the differences between different remotely sensed ground cover and low risk practices across the properties. Further research is required to articulate and explore the relationships between ground cover and management practices. This research contributes to understanding key management practices for ground cover management.

Keywords: Adoption, remote sensing, grazing land management, land condition, sediment, improved run-off.

Introduction

Recent studies have shown that the health and resilience of the Great Barrier Reef (GBR) is declining due to a range of pollutants from agricultural activities, including sediment from grazing lands (Thorburn & Wilkinson 2013; Thorburn, Wilkinson & Silburn 2013). The Reef Water Quality Protection Plan (Reef Plan) was developed by the Australian Federal and Queensland State Governments in response to the decline in water quality and health of the GBR (Queensland Government 2013). Reef Plan aims to halt the decline of water quality entering the GBR by reducing sediments and nutrient through achieving a 90% adoption of best management practices and a minimum of 70% ground cover at the end of the dry season (Queensland Government 2013).

Literature on adoption has identified a number of factors, both financial and non-financial, that are important to explain varying rates of adoption of improved management factors by landholders. Pannell et al. (2006) summarised the reasons for non-adoption of practices as:

1. Landholders do not have the relevant information about the problem or opportunity.
2. Landholders have the relevant information but there is no benefit for them to adopt.
3. There is risk and uncertainty associated with the benefits of adopting.

A range of non-financial factors that may explain why landholders in GBR catchments may be reluctant to adopt improved management practices have also been explored. For example, Greiner et al. (2008) and Greiner and Gregg (2011) report that intrinsic motivations of graziers in the Burdekin catchment and other parts of northern Australia were more dominant than financial or economic considerations in explaining adoption. Landholders more likely to adopt conservation practices were indicated by their attitudes to risk, conservation ethics, and lifestyle motivations; while landholders who were strongly motivated by economic and financial drivers stated that they were unlikely to adopt unless there was direct financial incentives.

Maintaining ground cover is critical to reduce hillslope, gully and streambank erosion. Ground cover in the form of green and dead standing grass plays an important role in both the control and generation of run off and sediment loss (Carroll, Merton & Burger 2000; Bartley et al. 2006; Packett et al. 2009). A cover level of 50% or greater is recommended to reduce excessive erosion and sediment loss (Silburn et al. 2011). More recently, Bartley et al. (2014) noted that sediment loss reduces up to 70% when ground cover levels are maintained at approximately 72%. To understand progress towards the targets, the percentage of graziers adopting management are reported, as are the levels of ground cover. The assumption is that certain management practices lead to increased ground cover. A key limitation to achieving the targets is that adoption rates are relatively low and there is limited understanding of the relationship between improvements in management and increased levels of ground cover. To understand if further extension will support increased adoption is critical. To progress towards these targets, a

small project was developed to further understand the links between management and ground cover.

Project objectives

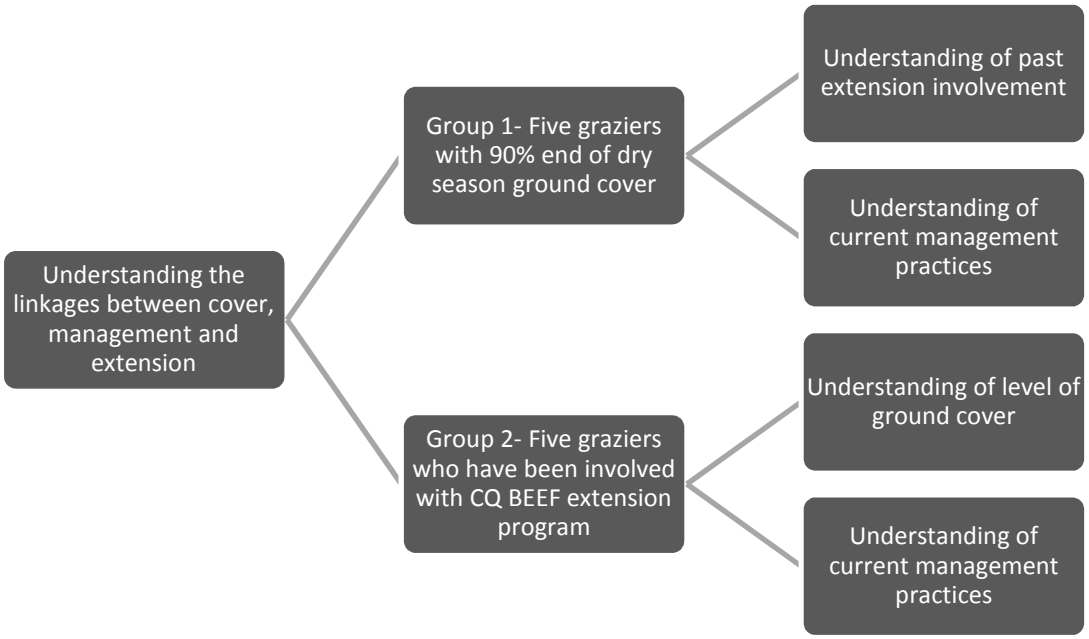
The project had three objectives:

1. To further understand the links between management and ground cover.
2. To review if the past extension program, Central Queensland Better Economic and Environmental Futures (CQ BEEF), has impacted cover levels over time.
3. To further understand the management practice of landholders with 90% ground cover.

The approach

A case study approach of ten graziers was used which linked together two components (Hunt et al. 2012): the past Central Queensland Better Economic and Environmental Futures (CQ BEEF) extension program level of management practice; the level of ground cover and the management practices if there had been involvement with extension in some other form. The project selected two groups of graziers based on either high levels of ground cover, or involvement in CQ BEEF. Each group was then interviewed to understand their involvement in extension and adoption of the management practices (Figure 1).

Figure 1. Project overview



Group 1

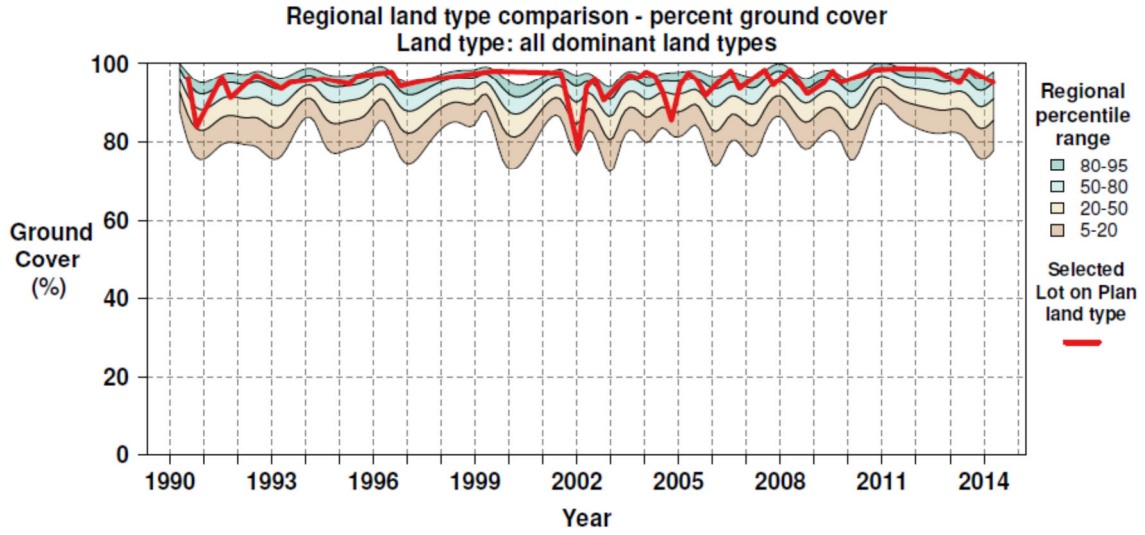
The method used to select graziers in Group 1 was based on graziers who had cover of 90% or greater using remote sensed ground cover imagery. To do this three steps were required to be taken:

1. Estimate the vegetative cover relative to suface ground cover at three different time points.
2. Identify management effects as opposed to climate effects.
3. Compare relative to other properties in the same region.

First, levels of cover were estimated using the Landsat-based seasonal fractional ground cover images (TERN-AusCover 2014b). This provided a quarterly estimate of the amount of vegetative cover on the surface of the ground. It differs from the seasonal fractional cover (TERN-AusCover 2014a) in that the contribution from woody vegetation (trees) has been accounted for. The spatial resolution was 30 metres and at each location an estimate of bare, green and non-green vegetation was provided. The sum of the green and non-green vegetation was used as an indicator of total ground cover for each grazier. Cover levels were averaged for the property over the period 1991-2014, the previous 10 years (2004-2014) and the previous five years (2009-2014). These latter summaries were aimed at providing temporal context to the analysis in order to take some account for recent management history, compared to long-term management history which may include multiple managers.

Second, in order to identify management effects on ground cover levels as opposed to regional effects, a comparative approach was used, in the manner of the FORAGE Regional Ground Cover report (Department of Science Information Technology Innovation and the Arts 2014) (Figure 2). If total ground cover only was used, those properties ranked highest were likely to be selected from the wetter, more productive regions of the catchment, and drier western areas would be under-represented. The comparative approach compares a given property with locations within a 50 km radius of the centre of the property. Comparison locations were also chosen from similar land use and a similar mix of land types (Figure 2). This ensured that grazing properties were not compared with State reserves, stock routes or more intensive land uses, and that differences in cover were not due to differences in soils or land forms. It also assumed that properties within the local region have experienced a similar climate and therefore differences in ground cover between them are due to management rather than rainfall or other climatic effects.

Figure 2. Example of regional land type comparison



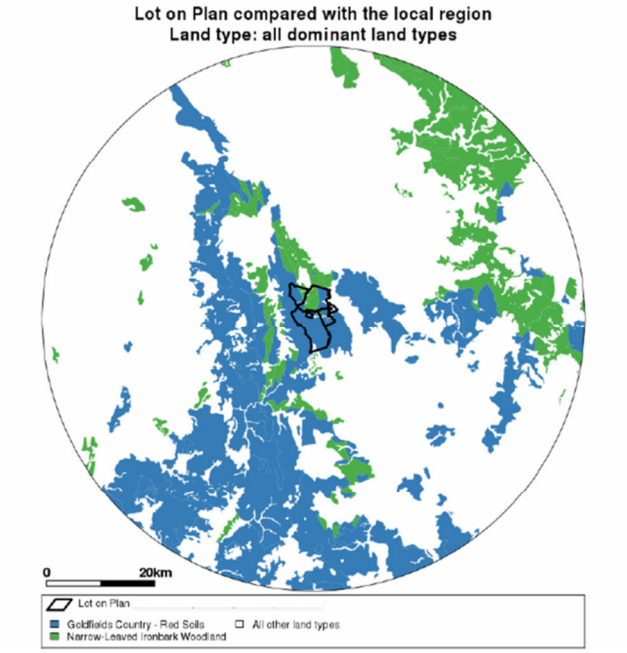
Third, the level of total ground cover of the property in question was compared to locations within a 50 km radius and given a rank at each season (Figure 3). These seasonal rankings were averaged over the last 10 years to provide an average spatial ranking for the property. This time period was chosen to minimise the influence of possible prior management practices, but it was sufficiently long enough to reduce the impact of short-term events. Properties with a high average spatial ranking were considered to have generally higher cover than surrounding similar properties. Five properties were selcted and where possible, properties for Group 1 were chosen from the top ten percent based on average rank. Group 1 participants thus represent those properties in which cover levels were high, relative to the surrounding region.

It was critical to step through with each grazier as to where they were positioned at each of these steps, and for them to understand why they were selected. The five properties in Group 2 also had their ground cover data processed in the same manner.

Group 2

CQ BEEF was a past extension program, which aimed to enable graziers to learn how to improve business skills and grazing land management, as articulated in the Grazing Land Management EDGE program (Chilcott et al. 2005). The program was a mix of group extension and individual extension. The groups were spatially located in particular areas with a group facilitator and were supported by specific expertise when required by the group. The graziers self-directed their extension to topics of interest, such as herd performance or output forages. CQ BEEF was resource intensive and ran for four years from 2005 to 2009.

Figure 3. An example of level of total ground cover of a property and locations within a 50 km radius



The project revolved around the formation of a network of participatory action learning teams throughout the region. Where possible teams were built around existing socio-geographic networks and within neighbourhood catchments (an NRM boundary). These teams were by necessity of function, a partnership between producers and the project staff; where there was a high degree of commitment and participation. It was a producer-driven process supported by the project team. Learning and capacity building was enabled through identifying areas for improvement, and the knowledge, skills and actions necessary to make those improvements. The initial focus within each team was identifying management improvements leading to production and/or profit enhancement in the context of managing a business that is viable in the long term – including consideration of the natural resource base. Identification of these management improvements involved a combination of facilitated discussion, focusing tools, and enterprise analysis.

It must be noted that there there was no overlap between the two groups, in that out of the ten graizers there were none that were in the highest 10th percentile for cover and were a part of CQBEEF.

Management Practices:

The grazing land management practices were assessed for both Group 1 and Group 2. Best practices for grazing land management are focused on pasture utilisation rates (O'Reagain, Bushell & Holmes 2011), wet season spelling (Ash, Corfield & Ksiksi 2002; Bartley et al. 2014) off stream watering points and managing stream banks and gullies through management of stocking rates. Management practices were categorised for Reef Plan, with practices classified as A,B,C,D, based on the soil erosion risk, where (A) represents best management practices considered to be low risk, through to (D) representing high risk or superseded practices. The level of risk associated with a practice is strongly linked to its likelihood of causing erosion, such that low risk practices tend to increase ground cover, while high risk practices, tend to reduce the level of ground cover.

To achieve the sediment reduction targets, 90% adoption of (B) level management practices is required. Currently, adoption in the Fitzroy shows 14% of graziers are managing for hillslope erosion, 16% are managing for streambank erosion and 15% are managing for gully erosion (Table 1.). Given the rates are low, there is increased pressure to improve extension programs and therefore increase the adoption of these practices.

Table 1. Percentage of grazier classification of management practice across the different erosion process in the Fitzroy

Erosion process	Management categories			
	A Low risk	B Moderate to low risk	C Moderate risk	D High risk
Hillslope	4%	14%	59%	23%
Streambank	20%	16%	15%	48%
Gully	6%	15%	55%	24%

Both groups were assessed to understand where they were positioned under the management practice risk framework. The grazing land management section questions were grouped based on the corresponding erosion process; hillslope, streambank and gully erosion. Each property's management practices were benchmarked based on the current Reef Plan Water Quality Risk Framework weightings for Rangeland Grazing (Department of Agriculture Fisheries and Forestry, 2014). For management of hillslopes, 13 questions specific to key management practices that impact on hillslope erosion were asked. Each question gave graziers at least two options and each was weighted to allow calculation of the overall level of management risk. The graziers were also asked one question that was specific to the management of streambanks. This question addressed how graziers manage and control grazing pressures on frontage country through the use of fencing or other infrastructure to exclude stock from riparian areas (Department of Agriculture Fisheries and Forestry 2014). Finally, three questions specific to the management of gullies were asked.

Graziers were asked a set of 59 closed questions in total that were categorised into separate sections in order to provide a general description of the grazing enterprise, business information, current grazing land management practices, as well as invovlement in other extension programs. The questionnaire was developed from four different surveys (Greiner et al. 2008; Department of Agriculture Fisheries and Forestry 2014; Fitzroy Basin Association 2014). Each interview was conducted on property with the primary decision maker/s of the grazing enterprise, either the manager or owner. Interviews ranged from 40 minutes to 90 minutes with an average duration of one hour.

Results

To begin with, the ground cover levels for each property surveyed using three different cover metrics, are reported. Following this, the results of the management practice interviews for each of the different erosion processes are presented.

Ground cover

Ground cover levels between groups were different over the previous five years (Table 2). In the past five years, graziers from Group 2 had lower cover levels compared to graziers from Group 1, with Group 2 ranging from 82-91% average ground cover as opposed to 86-95% for Group 1. All graziers had ground cover levels above the Reef Plan end of dry season ground cover target of 70%. The 23 year period of 1991-2015 is a period where there has been variance in rainfall and seasons with all graziers still maintaining high levels of cover. All graziers had fairly consistent cover levels over the different periods explored; indicating that they were generally consistent in managing for ground cover.

Management practice scores and ratings

The management practice scores and ratings for hillslope, streambank and gully erosion of both groups of graziers are given in Table 3.

Hillslope All graziers in Group 1 with the exception of Grazier 2 were ranked as having a moderate risk (C) practice rating. For Group 2, all graziers scored highly overall with three out of five graziers ranked as having low risk (A) management practices, while Graziers 6 and 9 were ranked as having moderate to low risk (B) practices.

Streambank Results indicate varied streambank management practice ratings. Two graziers from Group 1 ranked as having low risk (A) management practices, while the remaining three properties indicated moderate to low (B), moderate (C) and high risk (D) management. Group 2 results were varied with two properties being ranked as having low risk (A) management practices, one with moderate risk (C) management and two 'N/A'. The properties who scored

'N/A' had 'No significant areas of river and creek frontage or wetlands' and therefore could not be given a score.

Gully All graziers from Group 1 had moderate risk (C) management practices for gully erosion management. Graziers from Group 2 scored varied results for this section with Graziers 7 and 8 indicating low risk (A) management, Grazier 6 moderate to low risk (B) and Graziers 9 and 10 moderate risk (C) management.

Table 2. Average level of total ground cover (%) from 1991-2014 and over the most recent five and 10 years for both groups of graziers

	Ground cover from 1991 - 2015 (%)	Previous 5 years (%)	Previous 10 years (%)
Group 1			
Grazier 1	79	86	79
Grazier 2	93	93	92
Grazier 3	92	95	94
Grazier 4	93	94	94
Grazier 5	88	92	89
Group 1 Average	89	92	89.6
Group 1 Range	79-93	86-95	79-94
Group 2			
Grazier 6	85	91	88
Grazier 7	80	86	82
Grazier 8	83	87	85
Grazier 9	83	84	84
Grazier 10	83	87	83
Group 2 Average	82.8	87	84.4
Group 2 Range	80-85	84-97	82-88

Table 3. Management practice scores and ratings for hillslope, streambank, and gully erosion for both groups of graziers

	Hillslope		Stream bank		Gully	
	Score	**Rating**	**Score**	**Rating**	**Score**	**Rating**
Group 1						
Grazier 1	56.5	C	100	A	35	C
Grazier 2	67	B	33	C	62	C
Grazier 3	42.5	C	66	B	44	C
Grazier 4	47	C	100	A	37	C
Grazier 5	40	C	0	D	45	C
Group 1 Average	50.6	C	59.8	B	44.6	C
Group 1 Range	42.5-56.5	C-B	0-100	D-A	37-62	C
Group 2						
Grazier 6	68	B	33	C	75	B
Grazier 7	81	A	N/A	N/A	85	A
Grazier 8	94	A	100	A	89	A
Grazier 9	71	B	N/A	N/A	52	C
Grazier 10	82	A	100	A	47	C
Group 2 Average	79.2	A	77.7	A	69.6	B
Group 2 Range	68-94	B-A	33-100	C-A	47-89	C-A

Extension and engagement

Although Group 1 were not engaged in the CQBEEF program, Grazier 1, Grazier 3, and Grazier 4 have been involved in other grazing extension programs such as Grazing BMP modules and

engagement with the natural resource management body (FBA). These graziers have also been more involved in a wider scope of extension and have sought to be involved in research such as the Cash Cow Project and B-Smart futures. All graziers in Group2 were part of CQ BEEF however Grazier 6 Grazier 8 and Grazier 9 have been involved in other extension such as Forage Budget support and Grazing BMP modules (Table 4).

Table 4. Involvement in past extension programs

	Forage budgeting on property support	Project Development visit	Grazing BMP modules	CQ BEEF	Other
Group 1					
Grazier 1			1		Cash cow
Grazier 2					
Grazier 3					
Grazier 4		1	1		RCS kit day, MLA beef up forum, bull buying seminar
Grazier 5		1	1		breed plan, Epigenetics, herd masters workshops
Group 2					
Grazier 6	1			1	
Grazier 7				1	
Grazier 8			1	1	
Grazier 9	1			1	
Grazier 10				1	

Discussion

The project set out to understand the linkages between extension, ground cover and management practices. The project higlights that perhaps there is some disparity between the management practices and ground cover. It also highlights that extension through CQ BEEF and other extension programs has provided graziers with knowledge to understand the importance of ground cover. The project also provides an indication of the importance of extension in adoption of management practices and shows that a multi-faceted approach allows improvements across the industry. Lastly, it suggests that achieving the targets of 90% adoption of landholders of best management practices may not be a meaningful target if the desired outcome is increased cover.

The level of management practice and the corresponding level of groundcover indicate that further adjustment is required and perhaps only key practices that have a clear correlation with ground cover should be considered in the Reef Plan targets. Although rainfall was accounted for over time, the Project has not produced a clear understanding of how cover would be impacted in prolonged drier times. This is potentially where further research and extension would be required to ensure management practices are adopted and requires further work.

The level of extension varied between the two groups; however both groups had exposure to different forms of extension to build their level of knowledge and skills. This indicates that a suite of extension activities across different facets of management practices would be required so as to allow for graziers to select appropriate activities based on individual needs across their businesses. To achieve the target of 70% ground cover for Reef Plan, the project highlights that perhaps cover is a more suitable than adoption of best management practices as a metric when considering the variance in the results. However, the caveats of a small sample size and potentially the "warm glow" bias (Pearce & Turner 1990) of those selected for high cover, hinder the conclusions and further work is required to understand the links between ground cover, extension and management practices.

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