USING CONSERVATION TENDERS FOR WATER QUALITY IMPROVEMENTS IN THE BURDEKIN RESEARCH REPORTS

Tender results and feedback from ex-post participant survey

RESEARCH REPORT No 5.

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Using Conservation Tenders for Water Quality Improvements in the Burdekin Research Reports are published by the Centre of Environmental Management, Central Queensland University, Rockhampton, 4702.

These reports represent the provisional findings of a research project titled '*Optimising the efficacy of conservation tenders under varying degrees of heterogeneity: Achieving water quality improvements in the Burdekin Dry Tropics across different management actions in different agricultural production systems and different parts of a river basin'*.

Previous reports in the series are shown in Appendix 1.

The project is being funded by the Australian Government through the National Market Based Instruments Program, with additional support provided by the Burdekin Dry Tropics Natural Resource Management Group. The project is being conducted as a partnership between Central Queensland University, River Consulting, the University of Western Australia and the Burdekin Dry Tropics Natural Resource Management Group.

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Acknowledgements

This work was funded by the Australian Government's Market-Based Instruments Programme.

The Lower Burdekin Water Quality Tender was delivered as a partnership between Central Queensland University, Burdekin Dry Tropics NRM, River Consulting and the University of Western Australia.

Burdekin Dry Tropics NRM provided significant additional on-ground resources.

The Bureau of Sugar Experiments Stations (BSES) and the Queensland Department of Primary Industries and Fisheries (DPI&F) contributed critical staff resources to enable implementation of the Tender.

We specifically wish to thank Dr Scott Crawford, Diana O'Donnell, Paul Duncanson and Duan Biggs (BDTNRM); Adam West, Rob Milla, John Nicholas and Marnie McCulloch (DPI&F); Evan Shannon, Tony Anderson, D Millard, R Matthews, J Dowie, and M Davies (BSES); Dr Jon Brodie (ACTFR) and Dr Peter Thorburn (CSIRO) for supporting the implementation of the Tender in various capacities.

We acknowledge the technical contributions to metric parameterisation provided by Clinton Muller (CQU).

Acronyms

BDTNRM	Burdekin Dry Tropics NRM
EBS	Environmental Benefits Score
Tender	Lower Burdekin Water Quality Improvement Tender

1 Introduction

The Lower Burdekin Dry Tropics Water Quality Improvement Tender was developed as a research project aimed at exploring issues of scope and scale in tender design (Rolfe et al. 2007a). The project involved the conduct of a 'real' auction to deliver water quality benefits for the Great Barrier Reef lagoon, and was aimed at demonstrating how a water quality tender might be performed.

Key theoretical issues of interest were to:

1. determine whether and how increases in scale and scope of a tender may lead to efficiency gains as competition increases; and

2. investigate whether such increases possibly cause increases in transaction costs or changes in participation rates and bidding behaviour.

In theory, levels of competition between landholders submitting bids and subsequent efficiency of the use of public funds will be enhanced if broad scale tenders can be run because they exploit heterogeneity between landholders. The more landholders included in a conservation tender, the more likely that lower cost bids are submitted and selected. However, this efficiency benefit may be offset by the additional transaction costs of designing, implementing and managing more complex schemes in comparison to applying smaller scale tenders that are industry and area-specific and therefore much simpler to apply. In addition, larger scale auctions might reduce participation levels and influence bidding patterns.

The design of a water quality tender involves careful attention to theoretical objectives and practical implementation issues. To achieve maximum efficiency from the implementation of a conservation tender, four factors need to be carefully considered:

1. Scope of the tender in terms of funding available and pool of potential participants;
2. Auction design facilitating submission of feasible and cost-effective proposals;
3. Evaluation of proposals based on 'merit', i.e. environmental outcomes offered in relation to funding sought, through a metric; and
4. Consistency of auction design, metric design and contract design stages to prevent perverse outcomes.

Scale and scope issues were discussed in Research Report 1 (August 2007). Bid assessment process was described and discussed in the mid term report (September 2007). Metric design was described in Research Report 3 (October 2007). The results of an experimental workshop with cane growers were described in Research Report 4 (April 2007).

Other research goals of the project were to determine how factors such as geographic and industry variability may be incorporated into the design and assessment process, and how auction results may be predicted with agent-based modelling techniques.

The scope of the project and details of the case study have been outlined in the earlier research reports (Rolfe et al., 2007a; 2007b; 2007c).

The practical objectives were to generate water quality improvements in a cost-efficient manner, with focus on reduction of end-of-catchment pollutant loads. Reduction of diffuse source pollutant discharge into the Great Barrier Reef lagoon is seen as critical to support the resilience of the Great Barrier Reef and therefore its long-term chances of being in good health.

The principal aim of this report is to describe the results of the conservation tender, which was designed and implemented in the Lower Burdekin during July 2007—March 2008. Discussion and interpretation of the Tender results is augmented with sensitivity testing for key assumptions and decisions made in metric design. A number of sensitivity tests are reported that address the key scale and scope issue of relevance.

The report also presents results from an ex-post survey of landholders who participated in the Tender. This explores broad aspects about decision making in relation to Tender participation and explores the sensitivity of likely participation by landholders in tenders for different scale and scope assumptions.

The report is structured into five sections. Methodological details are revisited in Section 2, and the results of the Tender and sensitivity tests relating to matters of scope and scale are presented in Section 3. Key results of the ex-post survey of participating landholders are documented in Section 4, and conclusions are drawn in the final section.

2 Method

The conceptual and methodological design of the Tender is explained in earlier research reports (Rolfe et al., 2007a, 2007b; 2007c). However, aspects that are particularly relevant for the results section of this report are expanded on here.

2.1 Scale and scope of the Tender

The Water Quality Improvement Tender (the 'Tender') was implemented in the Lower Burdekin area, which forms part of the Burdekin Dry Tropics region, which in turn forms part of the Great Barrier Reef catchment. Farming, mostly of sugar cane, is the dominant land use on the coastal floodplains. Cattle grazing is mainly restricted to upstream rangelands areas, but also occurs around low-lying wetland areas.

The activities of both industries cause non-point source pollution and contribute to water quality problems in the Great Barrier Reef lagoon (Productivity Commission 2003). However, they differ in the type of diffuse source pollutants and impacts. Sediments predominantly originate from soil erosion off grazing land. While a base level of erosion is 'natural', extensive removal of ground cover vegetation by cattle grazing increases the level of erosion. In sugar cane the key water quality issues are nutrient and pesticide pollution.

Determining the geographical scale of the conservation auction was largely driven by funding availability. The project area is shown in Figure 1, and includes the purple and green shaded areas on the map. Available funding for on-ground activities increased substantially during the project period and the geographical scale needed to be correspondingly increased. In the initial stages of project development, only $200,000 in incentive funding was being considered and the intention was to undertake the Tender in the Haughton River and Barratta Creek catchments. This forms the northern half of the green shaded area on the map. Following the availability of a further $400,000 in funding provided by the BDTNRM, the project area was expanded to include virtually all land in the Lower Burdekin, including grazing land in the Stones and Landers Creek catchments and all cane lands east of Barratta creek.

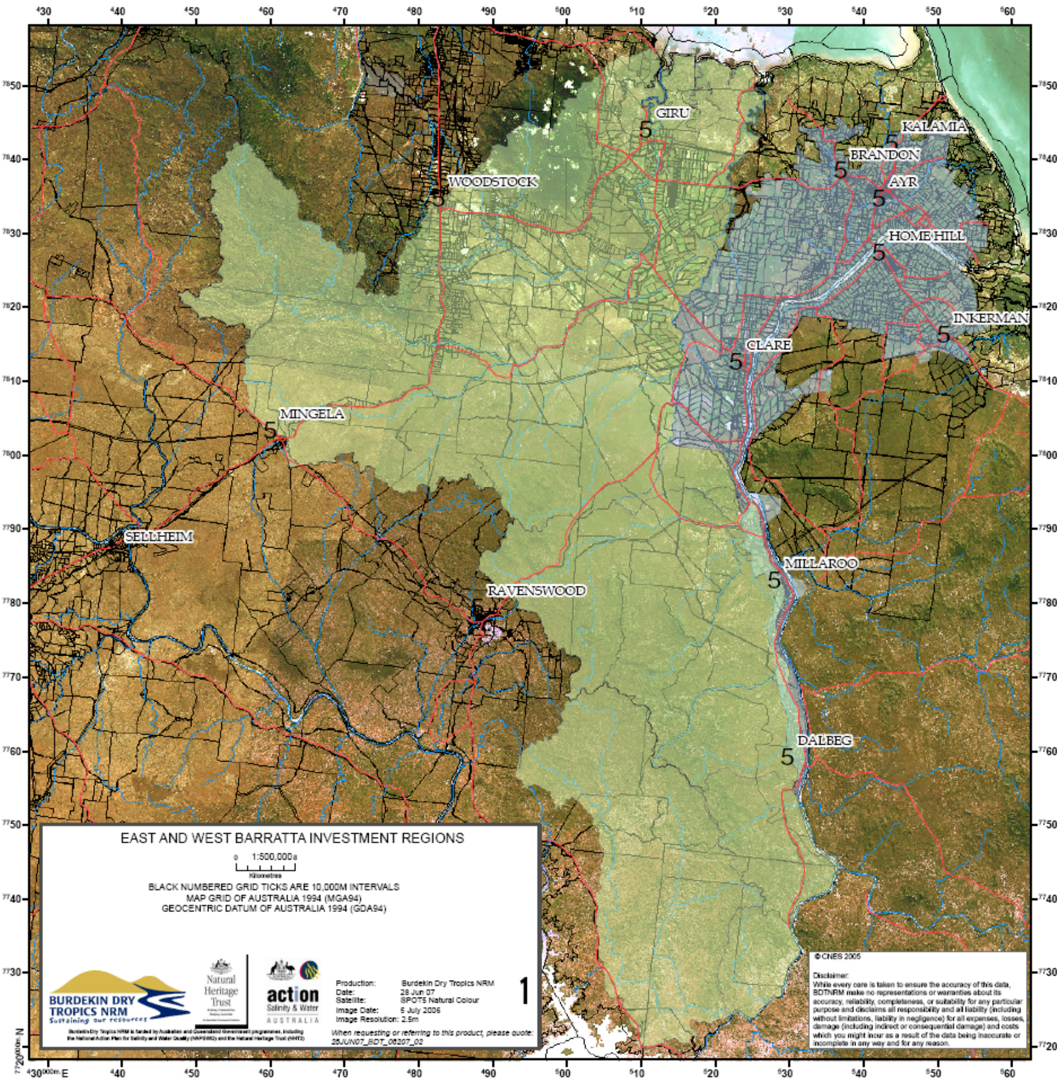
At an early stage of the Tender design, it was intended that the total funding pool be divided evenly between two sections of the Lower Burdekin as a part of the experimental design of the project. One half ($300,000) would be available for both cattle and cane projects in the Haughton River, Barratta Creek, Landers Creek and Stones Creek catchment areas (green area in Figure 1), while the other half ($300,000) would be available for sugarcane growers in the remainder of the Lower Burdekin area (purple area in Figure 1). This separation was abandoned because of the additional complexity in communication it would have required. Instead, all eligible landowners competed for the full pool of funding.

The scope of the auction (the coverage across a range of factors) was set with reference to both scale and institutional factors. Industry eligibility was restricted to sugarcane and cattle grazing. While horticultural production is also an important industry in the region, it was not included in the Tender because the industry was in the process of implementing a separate incentive scheme. Running parallel schemes in the same industry might have caused confusion. The types of actions that could be undertaken under the Tender related to erosion control on grazing land, and measures for reduced diffuse source pollution of pesticides and nutrients on cane land, which could be achieved by reduced application of agrichemicals, their removal out of the environment, or measures to increase efficiency of use.

Figure 1: Geographical stratification of Tender area

Green: cattle and cane in the Haughton River, Barratta Creek, Landers Creek and Stones Creek; Purple: Cane-only east of Barratta Creek

Map kindly supplied by BDTNRM



2.2 The Metric

A critical element of each conservation tender is the development of the metric, which is the rationale for assessing the environmental benefits of submitted proposals and comparing them so that the most cost effective proposals can be chosen. The metric is important because it provides clarity to bidders about the evaluation process and ultimately identifies the successful proposals.

Metric development and design aspects are described in detail in Rolfe et al. (2007c). Here the metric design is summarised together with detail on key assumptions that are of particular relevance to the sensitivity testing of results.

The estimated environmental benefits of proposals was measured as the environmental benefit score (EBS). The EBS was calculated in a 3-step process:

1. Environmental Benefits = Reduced Emissions x Effectiveness Adjustments

2. Relative Environmental Scores = Environmental Benefits / GBRMPA targets

3. Environmental Benefits Score (EBS) = (Σ Relative Environmental Scores) x Farming Systems Score x Future Intentions Score

The cost effectiveness of each proposal was then assessed on the basis of relative bid value.

4. Relative Bid Value = EBS / Bid Price ($)

Proposals were ranked in order of declining relative bid value. In the selection process proposals were chosen for funding in order of rank until the funding limit had been reached.

There were a number of challenges in developing an accurate metric that were generated by the focus on water quality and the complexities of running a broadly scoped tender. The key issues that influenced complexity were:

- The different pollutants that had to be considered,
- The different pathways (ground and surface water) involved,
- The variety of different activities that could be undertaken to reduce pollutant movement,
- The time scale involved for pollutant movement and for remedial actions to take effect,
- Factors which would limit effectiveness of different actions,

- The variety of current and future management practices and intentions of farmers, and

- Potential differences in the likelihood that farmers would complete actions.

The influence of these factors in the metric assessment could be tested with sensitivity analysis. Here, the most important issues are explained in more detail below.

2.2.1 Reduced Emissions: The contribution of groundwater to end-of-catchment emission reductions

The practical objective of the Tender was to purchase end-of-catchment water quality improvements. Most pollutants travel through surface water runoff. However, groundwater has an important role to play also. The extent of that role is somewhat contentious and scientific estimates vary.

The groundwater system is a much slower system than surface water, meaning pollutants that are discharged into groundwater in any given year may take many years to discharge into a river or into the marine environment directly—as opposed to surface water pollution, which will discharge with virtually no delay, at least within a coastal area such as the Lower Burdekin. There is scientific uncertainty as to the speed of groundwater movement.

Scientific evidence as to the speed of groundwater discharge in the Lower Burdekin varies. Table 1 shows that studies estimate the annual rate of discharge to the river system or to sea is somewhere between 3% and 22% per annum. Most water moving into groundwater is pumped back up for subsequent use in irrigation.

Table 1: **Summary of water balance calculations for the Burdekin River Delta**

	Range of Values ML/year			
	SKM (1997)	Hadgraft & Volker (1980)	Volker (1977)	McMahon, Arunakumaren, & Bajracharya (2002)
Recharge from floods	150 000 – 500 000	46 000		<260 000
Recharge from rainfall		179 000	138 394	
River Recharge	23 500 – 71 500	15 800	84 088	6 000 – 67 500
Artificial Recharge	94 000	27 600	31 533	~100 000

Irrigation Accessions to Groundwater	230 000			330 000 – 650 000
Total Aquifer Recharge	**517 500 – 895 500**	**268 400**	**254 015**	**~430 000 – 850 000**
Irrigation Use				480 000 – 980 000
Open Water Pumping				33 000 – 171 000
Groundwater Pumping	426 000	236 000		440 000 – 830 000
Burdekin River Drainage				0 – 16 250
Groundwater Discharge Sea	3 000 – 10 700	68 600	6 657	1 500 – 9 000
Lateral Flow to BRIA				100 – 3 200
Total Aquifer Discharge	**429 000 – 436 700**	**304 600**		**440 000 – 845 000**

In the metric, based on a decision by BDTNRM and field officers, the influence of groundwater was set at 40%, i.e. emission of pollutants to the groundwater (or reduction thereof) was counted at 40% impact compared to surface water.

2.2.2 Effectiveness Adjustments: Accounting for implementation risk

Implementation risk refers to the commitment from the landholder that the funded management action will actually be implemented as specified in their submissions.

To minimise implementation risk, proposals need to be verifiable. Verification can include photographic evidence, invoices and farm/paddock records. To demonstrate improvement it is essential that the prior situation can be demonstrated, e.g. through at least two years of fertilizer purchase invoices. Verification provides confidence to the participating landholder as well as the BDTNRM that contract conditions have been met.

Implementation risk is also minimised if farmers are ‘good’ managers, are intrinsically motivated to undertake environmental management actions and have a track record of compliance with contractual requirements.

While tender contracts can be designed to incorporate specific monitoring and evaluation conditions, they may not adequately deal with all problems of adverse selection. It is important to consider this factor in bid assessments to

- discount submissions with a low probability of achieving the potentially achievable environmental benefits, and
- reward landholders who are proven land and environmental managers, have good skills and record keeping, and have a good track record of completion of projects.

The initial intention was to aggregate four scores relating to landholder characteristics at equal weightings (total score between 4-20), re-scale the total score to equate 20-100%, then use this to adjust the metric-calculated weighted Environmental Benefit Index for each bid. Essentially, the metric-calculated indices would reflect the "potential" environmental benefits, while the adjusted values would reflect the "likely" environmental benefits. This would adjust for potential differences between landholders in terms of the likelihood that they would complete their actions.

Two issues subsequently arose:

1. Field officers were unable to collect sufficient data during field visits to rate (potential) applicants against the top three criteria.
2. Questions were raised as to the degree of adjustment from "potential" to "likely" EBI given the value could be discounted by up to 80%. In comparison, 'soft' variables account for only 5% of total score in the CCI/BSES scoring sheet.

The research team resolved the issues:

- An adjustment factor from "potential" EBI to "likely" EBI was maintained because the rationale for doing so is convincing and has parallels e.g. in international carbon trading schemes.
- The adjustment would be limited to approximately 15% of the EBI score. The BDTNRM as the principal investor made this decision in consultation with field staff.
- The adjustment factor was re-worked to be a composite of two criteria.
    - The 'farming systems' score derived from the BRS scoresheet received a 10% weighting.
    - Intentions for future improvements in farming systems approach were weighted at 5%.

3 Tender results and sensitivity to scale and scope parameters

3.1 Tender participation and submissions

The Burdekin Water Quality tender was run by the Burdekin Dry Tropics Natural Resource Management Group in 2007 and 2008, with $600,000 available for landholder incentives from government programs. Key aspects of the tender design and process are summarised as follows:

- Single bidding round,
- Sealed bids,
- Discriminatory pricing,
- An (unspecified) reserve price,
- Multiple bids allowed from landholders,
- No cap on bids,
- One year contracts for successful bidders,
- Two payment periods for successful bidders: 60% upfront and 40% on completion,
- Simple contracts used to secure agreements, and
- Simple monitoring and reporting processes.

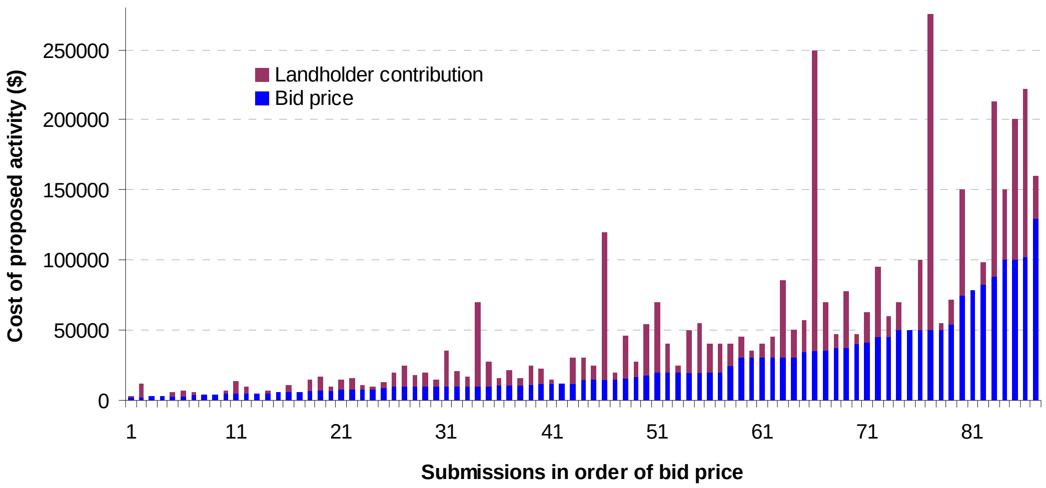
The performance of the tender followed the stages outlined by Latacz-Lohmann and van der Hamsvoort (1998) and Stoneham et al. (2003). First, details of the tender were publicised and promoted[1] (August 2007). Second, landholders could register by completing an Expression of Interest form (September to November 2007). In the third stage, those landholders received a visit from extension and tender design staff to identify suitable projects and explain the process (September to December 2007). In the forth stage, landholders submitted bids (January 2008), which were then evaluated and assessed (February to March 2008). In the final stage, landholders were informed of the outcomes, and contracts drawn up with successful applicants (April 2008).

Landholders submitted 87 applications for funding through the Water Quality Improvement Tender. There were 67 applicants, of which 10 submitted two bids each, three submitted three bids each and one applicant submitted four and another applicant five applications.

Bids ranged from $1500 to $130,000 with a mean of $25,131 and median of $14,800. The proposed cost contribution ranged from 0% to 95% with a mean of 57% and median of 52%. The bids and cost contribution by proponents are shown in Figure 1.

[1] Tender information could be viewed at: *www.burdekindrytropics.org.au/**watertender**/index.html*

Figure 2: Bid values and self-funding components



The majority of submissions (78) were for activities on cane land, and a further nine were for grazing land management. Of proposed activities on cane land, nine related to pesticide reductions, ten were about fertilizer management, 22 were about water management and 41 related to the construction or expansion of a water recycle pit. There were a variety of hardware/earthworks related proposals, including:

- pipes and drains
- tools: bedformers, legume planters, stool splitters
- improved information: GPS, enviroscans, weather station, satellite imagery, laptop computer, EM mapping
- irrigation technology: trickle and drip irrigation, centre pivot, lateral move irrigators
- pesticide applicators: shielded and hooded sprayers
- laser levelling.

There was no clear pattern as to what type of proposed activities generated the lowest or highest bids.

3.2 Tender results: successful bids and environmental benefits

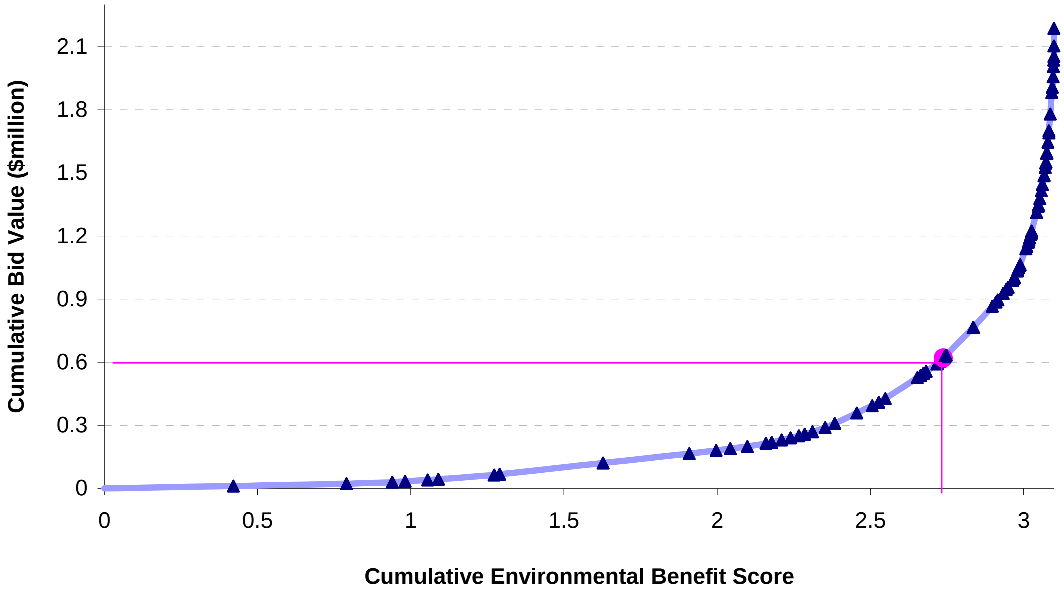
The total ask of the 87 submissions was $2.186 million for a suggested total value of activities of $4.29 million. Available funding was approximately $600,000, equivalent to 28% of total ask, which meant that the tender was highly competitive.

Submissions were assessed using the metric, on the basis of cost effectiveness of the water quality benefits resulting from the proposed activities. Water quality benefits, relative to end-of-catchment target for different pollutants, yielded the environmental benefit score (EBS) of each submission. The ratio of EBS to bid price of a submission determined its rank. Figure 2 shows the cumulative bid curve, with bids sorted by declining EBS/$. The most efficient bid provided a water quality benefit equivalent to

38.3 EBS/$million. The least efficient bid provided a water quality benefit equivalent to 0.002 EBS/$million.

Figure 3: Bid curve showing Tender results

The pink highlights provide marginal bid for funding framework and associated EBS



The top 33 submissions fell within the funding framework, having a combined bid value of $604,979 for a cumulative EBS of 2.728.. The estimated end-of-catchment water quality benefit included:

- Reduction in sediments of 492 tonnes. This is equivalent to 0.04% of the combined sediment reduction targets for the Burdekin and Haughton rivers of 1.28 million tonnes (GBRMPA, 2001).
- Reduction in nitrogen of 69.5 tonnes. This is equivalent to 1.7% of the combined nitrogen reduction targets for the Burdekin and Haughton rivers of 4074 tonnes (GBRMPA, 2001).
- Reduction in pesticides of 25.0 kg. This is equivalent to a reduction of 0.04% of pesticides (effective components) applied in the Lower Burdekin in 1999 (GBRMPA, 2001).

3.3 Sensitivity testing: Variations in funding scale

The cumulative bid curve (Figure 3) demonstrates that a close relationship exists between the funding scale and the cost-efficiency of the tender mechanism. If funding had been set at a higher or a lower level than $600,000, there would have been a significant difference in the marginal environmental benefits per funding dollar for the last bids funded, although a more limited impact on the level of overall benefits. If the funding for the landholders had been doubled (to $1.2 million), the cumulative EBS would have only increased by 11% (from 2.73 to 3.03). Conversely, if only

$300,000 had been allocated (half of the available funding), there would have only been a 14% reduction in the cumulative EBS (to 2.35). The conclusion to be drawn is that if the financial scale is set too high in relation to the scope of the project, substantial inefficiencies may be generated.

There are two key points to note about the cumulative bid curve (Figure 3). First, the shape of the curve demonstrates substantial variation in the opportunity costs of improving water quality. This justifies the use of a competitive framework to select proposals from landholders. To illustrate the variation in costs across landholders, the 10 most highly ranked projects cost $180,574 and were modelled to capture 47,510 kgs of Nitrogen ($1.70/kg), 51.6 kgs of Pesticide ($1,579/kg), and 29.8 tons of Sediment ($117.4/ton). In comparison, the 10 lowest ranked projects would have cost $495,808 and were modelled to capture 870 kgs of Nitrogen ($290.78/kg), no Pesticides and 18 tons of Sediment ($13,480/ton). The level of cost-effectiveness varied by more than 100 times between the 10 most highly-ranked projects and the 10 most lowly-ranked projects. This variation in opportunity costs provides very strong justification for the use of a competitive tender mechanism to select projects as compared to a more uniform allocation of funding.

The second key point to note is that a number of proposals were offered that generated very small environmental benefits and almost no improvement in the cumulative environmental benefits score. This can be shown by the number of bids in the almost vertical section of the cumulative bid curve. The number of bids with very low environmental benefits suggests that the auction process has failed to some extent to attract effective bids from landholders. This may be because landholders had poor information about how to structure environmental proposals or were focused on associated production gains. In this project, the combination of a time constraints with a large scale application meant that there were a number of staff and agencies involved with limited training and only a minimal time for field visits, leading to a sub-optimal outcome.

3.4 Sensitivity Testing: Changes in Geographic Scope.

During the Tender design consideration was given to splitting the available funding between two investment areas, which are shown in Figure 1.

The Barratta Creek boundary between a western (cane plus grazing) and eastern (cane only) investment areas was chosen because it provided a clear geographical delineation and divided the Lower Burdekin into two regions with a comparable number of farms. The larger size of the western area was off-set by the large size of the grazing properties that it included. The supporting arguments for the proposed separation were that this might aid the demarcation of the different funding sources and possibly generate clearer results regarding geographical scale effects on tender results. As explained in Section 6, this separation was not implemented in the actual trial.

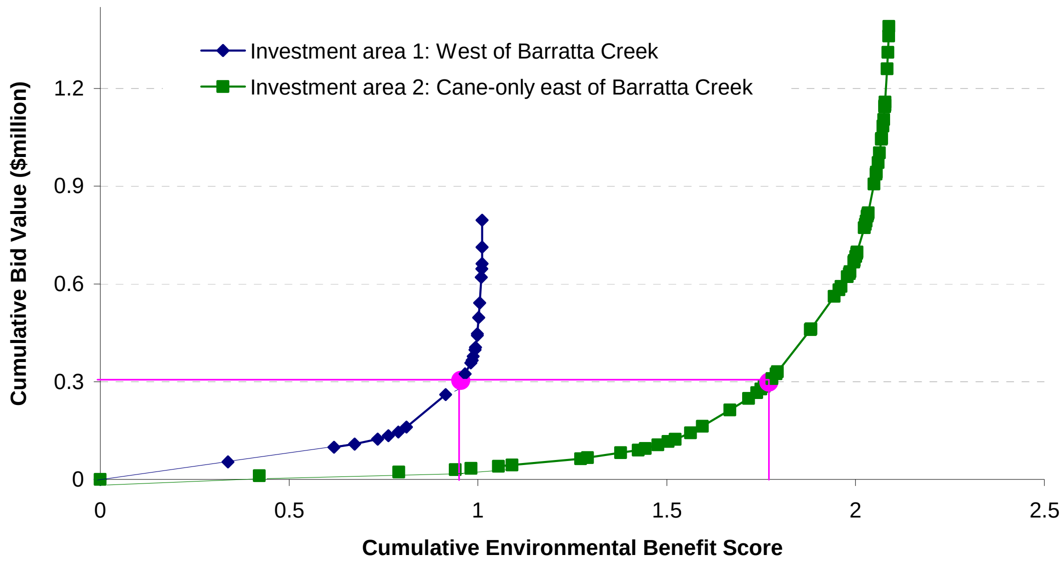
To conduct the ex-post test relating to scale of tender, the submissions were split into two groups according to their location. A total of 25 submissions were located in investment area 1, compared to 62 submissions in investment area 2. Submissions were then ranked within their subregional groups on the basis of cost efficiency. The sub-regional bid curves are shown in Figure 4. The environmental benefit score associated with this investment is EBS_{IA1}=0.95 for investment area 1 for $303,775, which is substantially smaller than EBS_{IA2}=1.78 for investment area 2, at a cost of $298,204. Combined EBS was 2.73 and virtually identical with the Tender results.

In the Tender, the marginal successful submission had an efficiency quotient of 0.77 EBS/$1million. A split into two investment areas would have resulted in a marginal quotient of 0.67 for investment area 1, compared to 0.83 for investment area 2. A comparison of submissions reveals that of those that were successful in the combined tender only one (a recycle pit) missed out from investment area 2, while one additional (slightly less efficient) submission was successful from within investment area 1 (nutrient management activity).

In this case, a sub-regional roll-out of the tender would have impacted the programme efficiency very marginally indeed. Conceivably, however, the effect could have been larger if there had been systematic variation in opportunity costs across the regions. The potential for this is shown in Figure 4, where there is a significant difference in the cumulative EBS score per region

The results from this Tender do not provide empirical proof that an increase in scale—via larger eligible area—necessarily leads to an improvement in Tender efficiency.

Figure 4: Cumulative bid curves for sub-regional tender stratification



3.5 Sensitivity testing: aspects of scope

This section focuses on selected key issues in relation to scope and scale considered in the metric. Some of these issues were specifically built into the research design, others arose during the research process. This section provides insights into the sensitivity of Tender results to relevant assumptions and offers a debate on the these issues in the context of tender efficiency.

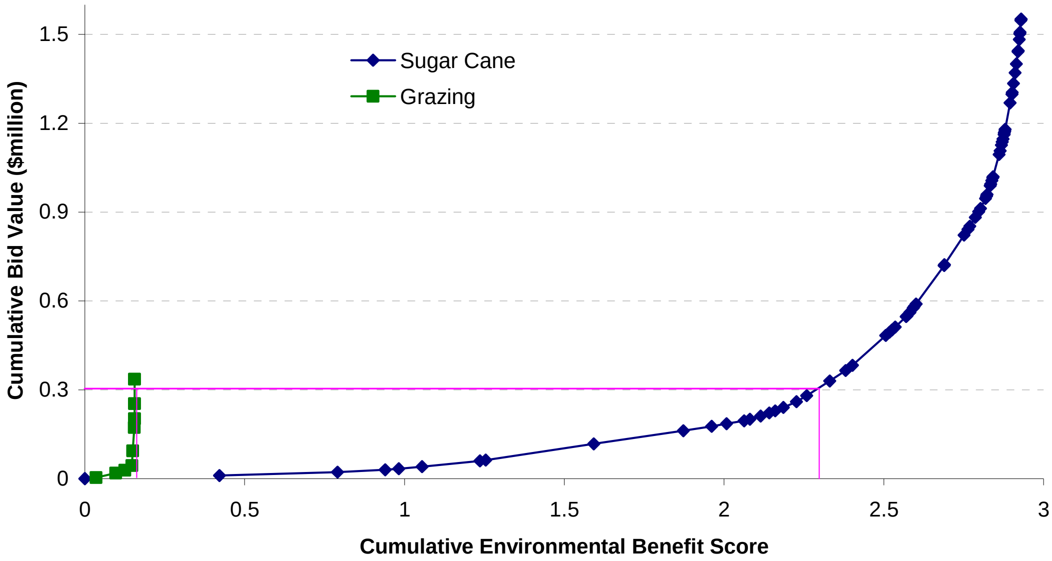
3.5.1 One-industry v's two-industry participation

An important innovation that this conservation tender provided over past trials was the inclusion of two industries. This was principally to test the theory that the inclusion of more industries would improve the efficiency of the tender in comparison to single-industry tenders.

To conduct the ex-post test relating to industry participation, the submissions were split into two groups according to industry. Of the 87 submissions, the majority were from cane growers (78), compared to only nine grazier submissions. Grazier submissions had a total ask of $337,000, compared to $1.85 million for cane submissions. Submissions were ranked within their industry groups on the basis of cost efficiency. The resulting industry bid curves are shown in Figure 5.

Figure 5: Cumulative bid curves by industry

Highlights are for $300,000 funding per industry



If the funding had been allocated equally between the two industries, a $300,000 investment in grazing management would have generated a cumulative EBS of 0.156, while a $300,000 investment in cane industry management would have generated a cumulative EBS of 2.258. When compared to a total EBS of 2.73 in the joint pool, an allocation by industry would have reduced overall efficiency by 17%. A 50/50 distribution of funding on basis of industry would have led to highly ineffective grazing submissions being funded (efficiency of 0.004 EBS/$1million), while moderately efficient bids from the cane industry (below 1.5 EBS/$1million) would have remained unfunded.

It is evident that including two industries in the Tender did generate efficiency gains. In the combined tender four of the nine grazing submissions were successful. The remainder were ranked among the least efficient submissions. Had those four efficient grazing bids not been available, a total of $589,000 would have been assigned to 36 cane submissions. The marginal submission would have had an efficiency quotient of 0.67 EBS/$1million, which is 0.1 below that of the marginal bid for the combined tender.

There are several reasons for the small number of grazing submissions. While grazing land was the majority land-use in the Tender area, grazing properties tended to be much larger than cane properties. This meant that the number of eligible graziers was small compared to eligible cane growers.

3.5.2 Variations in emissions scope

To conduct the ex-post test relating to emissions type, the submissions were divided into the three main categories of Nitrogen, Pesticide and Sediment emissions. The bids were then ranked against a hypothetical allocation of $200,000 for each pollutant type. This generated cumulative EBIs of 0.840 for Nitrogen emissions, 1.025 for Pesticide emissions (only $45,863 in bids available for allocation), and 0.153 for Sediment emissions. The total cumulative EBS that is generated is 2.018, a reduction of 26% in efficiency. The efficiency of the allocation for Nitrogen reductions is more than five times the efficiency of allocations to sediments. The results demonstrate that substantial reductions in efficiency can be generated by focusing tenders within rather than across specific environmental outcomes.

3.5.3 Contribution of groundwater to end-of-catchment discharge of pollutants

Sensitivity testing of tender results was performed to estimate the sensitivity of results to varying the level of influence of groundwater pollution on end-of catchment water quality.

Figure 6 plots the results of the cumulative bid curve for ‘zero influence groundwater’, based on the consideration that reduced groundwater pollution will have no benefit for end-of-catchment water quality during the year of Tender funding.

The principal difference to the results curve (Figure 3) is the reduced level of environmental benefit score—from EBS 2.7 to <2.2 for successful submissions. This ‘loss’ in environmental benefit is the result of the score not counting reduced groundwater pollution from proposed actions.

A more detailed sensitivity analysis is required to illustrate how ranks of individual bids and the competitiveness of different types of proposed actions are affected under different groundwater assumptions.

Figure 6: Bid curve without considering reduced diffuse pollution of groundwater

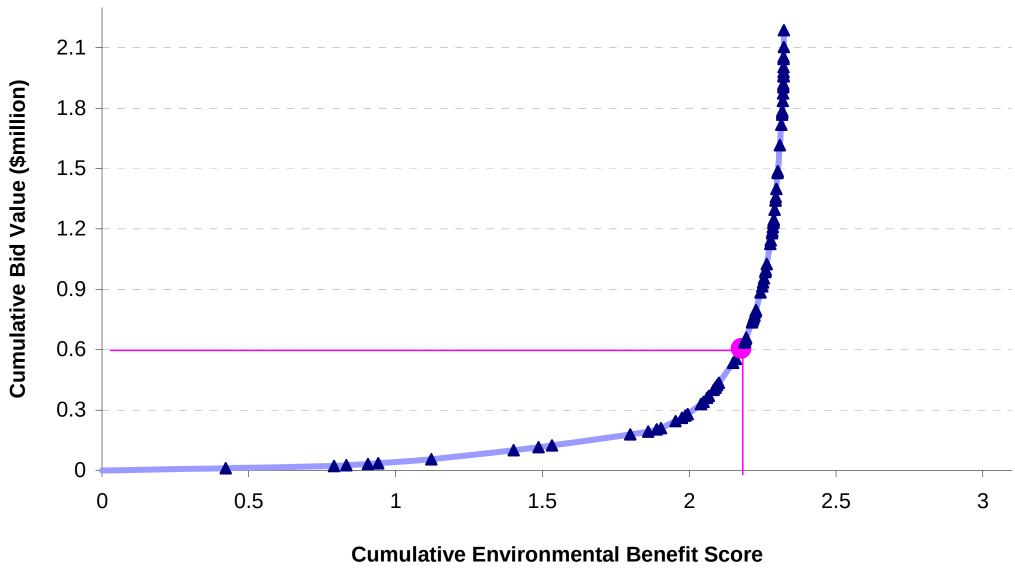


Table 2 illustrates that the results of the Tender show a high level of sensitivity to the assumptions regarding relative impact of groundwater pollution on end-of-catchment. The key findings are:

- Highly competitive submissions, irrespective of the types of activities, are competitive under all scenarios.
- Generally, the relative competitiveness of proposed nutrient management activities and water management activities increases dramatically if their groundwater benefits are weighted more heavily.
  - For example, submission 14, a water management activity with great benefit for nitrogen losses to groundwater is ranked 3rd in the Tender results but would have ranked 35th if the groundwater benefits had not been counted and would not have received funding.
  - The principal reason for this is that most nutrient loss occurs through groundwater leaching while comparatively little is through runoff.
- Comparatively to nutrient management and some water management activities, the relative competitiveness of grazing land management, recycle pits and reduced pesticide applications.

While the losses to groundwater are undisputed, it could be argued that the scenario chosen to determine Tender results might have been biased towards nutrient and water management activities.

Table 2: Ranking of selected submissions under different scenarios of accounting for groundwater pollution

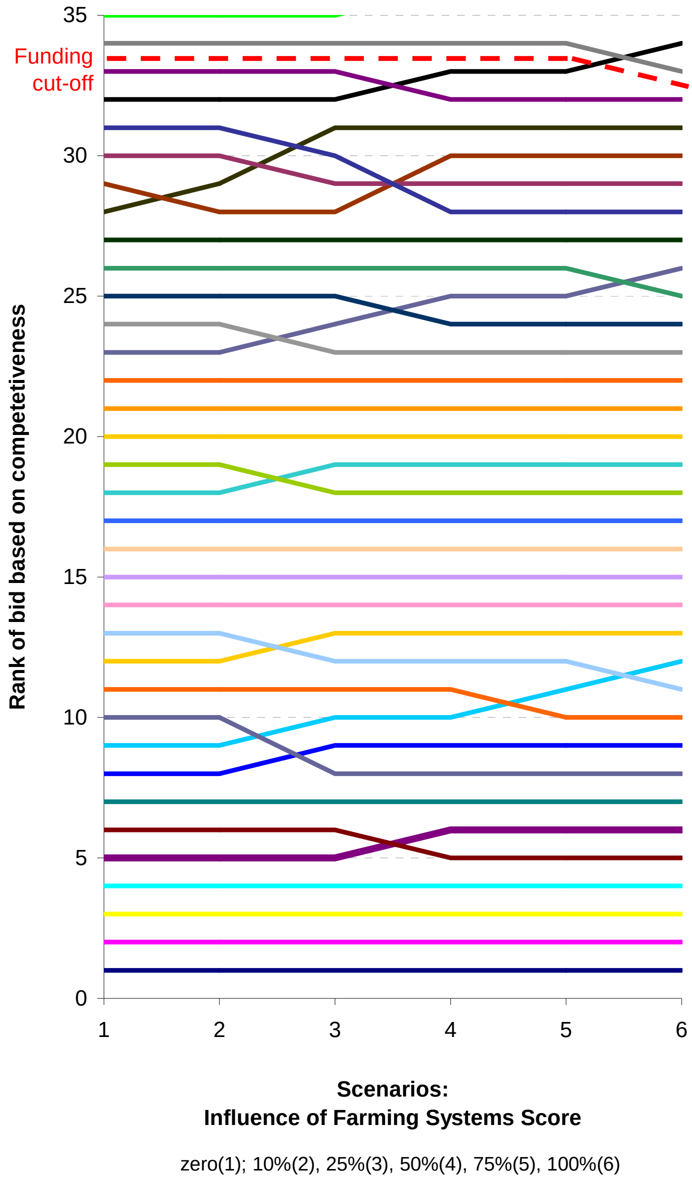
Type of action _submission#; Ranking as per Tender results	Change in Ranking GW:0%	GW:3%	GW:10%	GW:20%	GW:40%	GW:70%	GW:100%
Pesticide_81	0	0	0	0	0	0	-1
Pesticide_25	0	0	0	0	0	-1	-1
Nitrogen-WM_14	-32	-11	-8	-4	0	1	+2
Pesticide_63	+1	+1	+1	+1	0	0	-2
Nitrogen-RP_12	+1	+1	+1	+1	0	-1	-2
Sediment-GLM_35	+2	+2	+2	+1	0	-1	-2
Pesticide_60	+1	+1	+1	0	0	-2	-2
Nitrogen-NM_64	-16	-11	-7	-5	0	+3	+4
Nitrogen-WM_18	-1	-1	-1	-1	0	-1	-2
Nitrogen-RP_37	+3	+3	+3	+2	0	-2	-3
Nitrogen-RP_11	+3	+3	+3	+2	0	-2	-3
Nitrogen-RP_52	+3	+3	+3	+1	0	-2	-4
Nitrogen-WM_23	-59	-19	-5	-2	0	+5	+8
Sediment-GLM_91	+3	+3	+2	+2	0	-3	-5
Nitrogen-WM_79	-25	-15	-4	-2	0	+4	+5
Nitrogen-RP_54	-14	-11	-8	-2	0	+1	+4
Sediment-GLM_90	+5	+5	+4	+3	0	-4	-5
Nitrogen-NM_47	-7	-4	-2	-1	0	+2	+3
Nitrogen-NM_39	+6	+6	+5	+3	0	-1	-2
Nitrogen-RP_2	-6	-3	-5	-2	0	+2	+2
Nitrogen-NM_69	-25	-16	+6	+3	0	+2	+4
Nitrogen-WM_80	-25	-17	-11	-5	0	0	+2
Nitrogen-WM_65	+4	+2	+1	0	0	-1	-4
Nitrogen-RP_51	+10	+9	+8	+4	0	-4	-10
Sediment-GLM_149	+10	+9	+8	+4	0	-4	-10
Nitrogen-NM_56	-27	-21	-10	-3	0	+3	+3
Nitrogen-WM_49	-25	-21	-10	-4	0	+2	+3
Pesticide_84	+11	+11	+6	+3	0	-8	-8
Nitrogen-RP_1	+12	+11	+6	+3	0	-8	-8
Nitrogen-NM_82	-25	-22	-12	-6	0	+4	+5
Nitrogen-WM_50	-23	-19	-8	-3	0	+4	+5
Nitrogen-NM_83	-29	-25	-13	-7	0	+2	+4
Nitrogen-RP_20	+14	+12	+7	+5	0	-5	-7

3.5.4 Accounting for implementation risk

Following discussions among the research partners and following particular consideration of the views held by the industry collaborators, applicants could gain up to a 10% ‘bonus’ through the farming systems score, which was established during farm visits, and a further 5% if they demonstrated future intentions for environmental improvements in the applications.

The impact of the farming systems score on Tender results was sensitivity tested. The test results are shown in Figure 7 and reveal little influence on the selection of successful bidders.

Figure 7: Rank differences from varying influence of farming systems score



- The score, at levels between zero and 100% affected the ranking of few bids at up to three points. This did not affect funding decisions except for one bid at the 100% FSC level. The reasons for this are:
    - The average farming systems score of submissions is .44, with generally little variation between bids.
    - The gaps between submissions, specifically the successful ones, can be large and in some cases 30—50%. This means that small improvements in the EBS based on the FSS can only change bid order where their EBS are close together.

The implementation risk adjustment factor in the metric had been intended to assess the likely effectiveness of the proposed actions in terms of the applicants' management capacity. For example, a single action such as building a tail water dam may be better designed and lead to better environmental outcome if the applicant has good management skills and training, and/or who adopts a farming systems approach. Five criteria had been considered for contribution to a risk adjustment factor in the metric. They are explained and detailed in Table 3.

Table 3: Criteria to assess implementation risk and proposed implementation

Monitoring systems and record keeping, e.g. paddock records, monitoring sites, pasture budgeting records. Consider both existing systems and proposals for new ones. 1 = no records; little recollection 2 = partial records at farm level 3 = good records at farm level 4 = good records at paddock level 5 = GIS-based sub-paddock information
Farming systems management, e.g. extent to which the adjustment is part of a holistic strategy or a one-off attempt, which may not be well coordinate with other farm management practices. 1 = ad hoc approach; small area trials 2 = ad hoc approach but large area involved 3 = adjustment of several factors 4 = integrated farming approach, but some limiting factors remain 5 = holistic management approach supported by technology
Track record, e.g. extent to which the applicant has been involved with conservation organisations and/or extent of participation/compliance in previous schemes. 1 = past participation in programs; but has not complied 3 = no past record; or participated by results unsure 5 = past participation; great results; involvement in research
Physical evidence, e.g. ability to provide physical evidence such as photos, records and invoices to demonstrate outcomes. The challenge is will be with management change, as capital change is easy to verify. 1 = past participation in programs; but has not complied 3 = no past record; or 5 = past participation; great results
Management skills, capacity and accreditation, e.g. extent of industry participation and formal training. 1 = no industry participation, no formal qualifications 3 = some industry participation and technical qualifications 5 = industry leader, high-level conceptual and technical qualifications

For future tender schemes a comprehensive approach might be considered to scoring implementation risk, which requires the development of a supporting heuristic and scoring process and a methodology for collecting the supporting information.

3.6 Transaction costs

There are three broad categories of costs involved in the implementation of conservation auctions:

- Direct design and administration costs,
- Transaction costs for both the landholders and the implementing agencies to find and achieve successful agreements; and
- Indirect impacts on participation and other relevant factors.

As the tender complexity increases, the design and implementation costs of a tender are likely to rise. The challenge in designing a tender typically involves balancing the trade-off between achieving more detailed and efficient outcomes on the one hand, and minimising the different costs involved on the other hand. These trade-offs are often reflected in the metric, where the level of precision involved in assessing proposals is balanced against the costs involved in gaining extra precision.

The efficiency improvements identified in the auction came at the cost of increased transactions costs for tender design and implementation. However, the sources of the cost increases were not as expected.

It had been expected that the principal causes for additional transaction costs were with the engagement of two industries rather than one, and the associated duplication of communication efforts. However, there was very little additional communication effort required to involve the grazing industry. Also, the additional effort of designing a grazing metric component was small. Combined, these added possibly one working week.

Enlarging the size of the eligible cane area—from what had been initially conceived to be the Haughton-Barratta region to include the whole-of-Lower Burdekin cane growing area—generated significant additional transaction costs. While this move increased the funding pool from $200,000 to $600,000, it brought about a level of industry engagement, which otherwise was not required. The implementation of the Tender now relied extensively on input by industry (BSES) and government (DPI&F) field officers, and the associated negotiations and communications took months to conduct and complete.

Metric development proved initially conceptually tricky in the sense that the different industries generate different pollutants. While grazing generates sediment through soil erosion from grazing lands, sediment loss is only a very minor issue on cane land, which is generally flat. Here, the water quality problems are associated with the loss of nitrogen and pesticides into surface and ground water. The problem of comparability of pollutants was solved by relating estimated pollution reduction of each proposal to the end-of-catchment reductions defined by the GBRMPA (2001). If a proposed activity delivered reductions in multiple pollutants, the benefits were treated as additive.

While the grazing land management proposals could be reflected in the matrix easily, the variety of proposals on cane land complicated the cane metric. It needed to integrated infrastructure proposals, mostly recycle pits (which capture tail water runoff from fields and make it available for on-farm re-use), irrigation infrastructure proposals of various kinds, irrigation water management activities, nutrient management infrastructure and activities, and pesticide use and application technology. Finally, there was the issue of linking how to treat groundwater pollution in relation to end-of-catchment water quality benefits. This again meant that the transaction costs of (a) including multiple types of activities within one industry and (b) resolving scientific uncertainties within the metric far outweighed the transaction costs associated with adding one (simple) industry.

The empirical evidence thus suggests that it is important to anticipate increasing levels of transactions costs with increasing scale and scope of a conservation tender. This is not only a question of the area involved, number of industries or number of eligible landholders—rather it is related to the complexity of the issues and possible solutions within each single industry, and the processes necessary to engage industry as well as landholders.

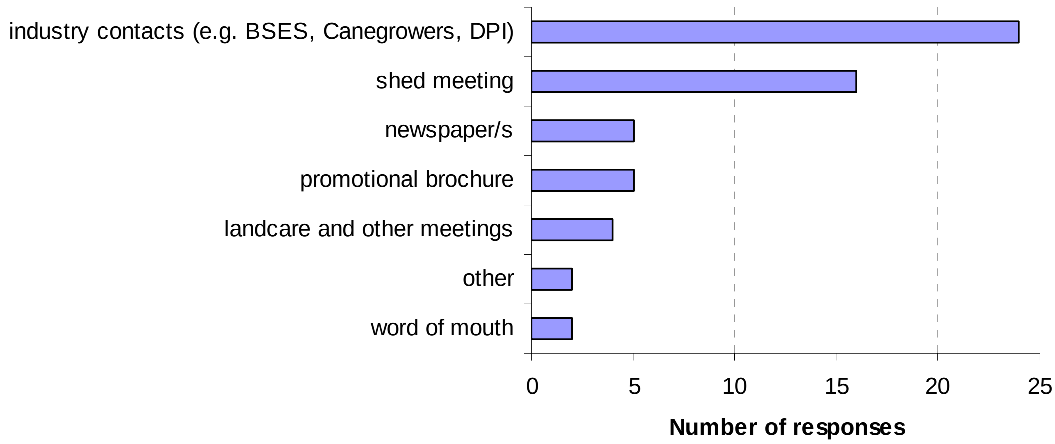
4 Results of the ex-post participant survey

An ex-post survey was conducted of Tender participants. Questionnaires were mailed out approximately one week after the result notifications had been dispatched by BDTNRM. Participants could respond either by mail or wait to be contacted by telephone and complete the survey verbally. The survey was sent to 90 landholders, including all 64 who had submitted at least one Tender application and 26 who had submitted an expression of interest but did not submit an application or did submit but later withdrew their application.

A total of 46 responses were received, of which 36 were returned by mail or facsimile and 10 questionnaires were completed over the telephone. Of responses, 20 (43%) were from participants who had at least one successful submission, 15 (33%) were from landholders whose submission(s) had not been successful and 11 (24%) were from landholders who had initially expressed interest but did not have an application in the Tender.

The majority of respondents learnt about the Tender through industry contacts or in ‘shed meetings’, which were organised by BSES throughout the Lower Burdekin during September and October 2007 (Figure 8).

Figure 8: Sources of knowledge about the Tender



The questionnaire gauged the level of agreement/disagreement of respondents with various statements, which related to values that people hold in relation to water quality. Figure 9 shows a very high level of agreement with most statements. Specifically, 94% of respondents agreed that it was better to avoid emissions that affected water quality than repairing damage caused by pollutants. The same proportion agreed that good water quality was important to them. In excess of 80% of respondents agreed that good water quality was important for the viability of their farms.

Figure 9: Frequency distribution for level of agreements with statements about water quality values

Items sorted by decreasing mean value

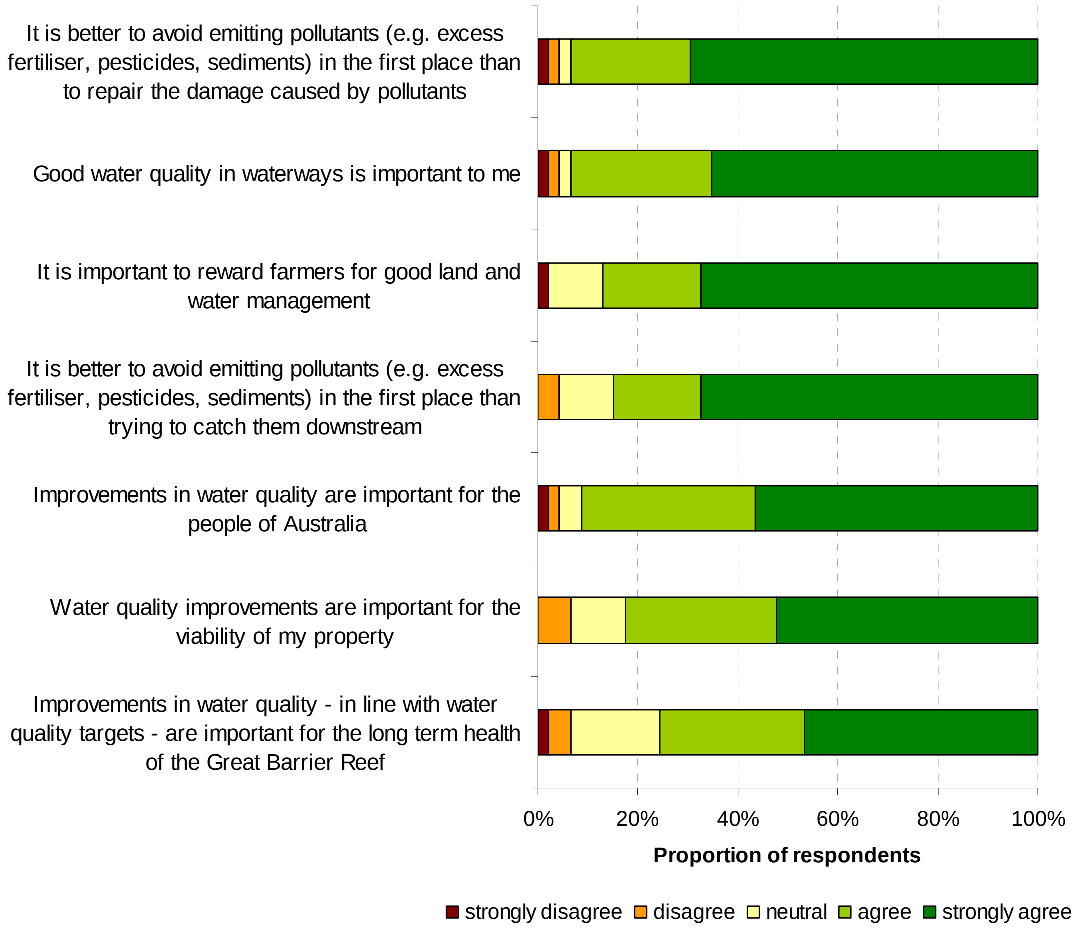


Figure 10 explores the importance of various considerations about participating in the Tender. The thought that the requested payment would allow landholders to bring forward intended actions was important to almost 90% of respondents—it rated as 'very important' to 50% of respondents. This confirms the importance of the Tender as a way of delivering financial incentives. Incentive payments were seen as important by most respondents (65%) in the context of farm viability, but not as important as the thought that the Tender might provide an opportunity to be 'ahead of possible future environmental regulation', which was important to >80% of respondents.

Figure 12 shows how different considerations influenced the decision to actually prepare and submit an application. Again, the financial incentive aspect rated highest among the items and it highlights the importance of financial incentives to accelerate the adoption of conservation practices, which farmers expect they will undertake at some point in the future anyway.

Figure 10: Frequency distribution of importance of considerations for participating in the Tender

Items sorted by decreasing mean value

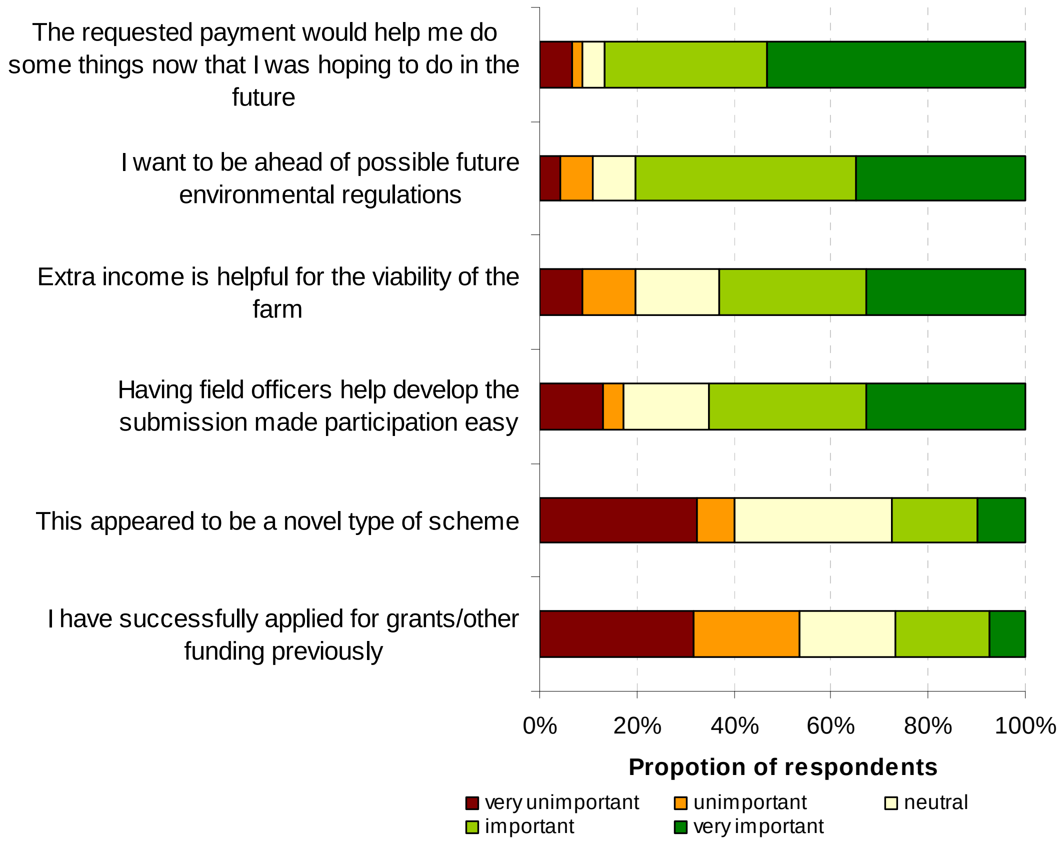
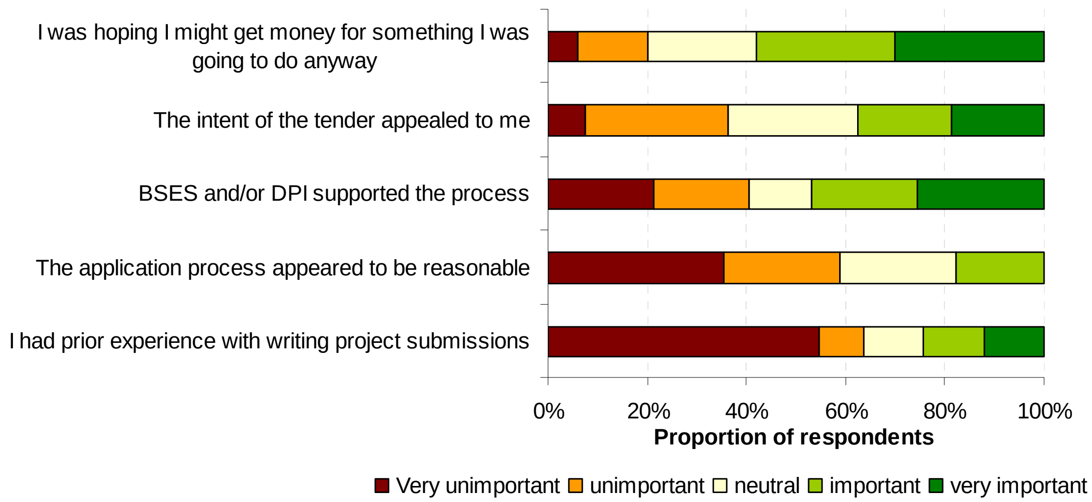


Figure 11: Frequency distribution of importance of considerations for the decision to develop a submission

Items sorted by decreasing mean value

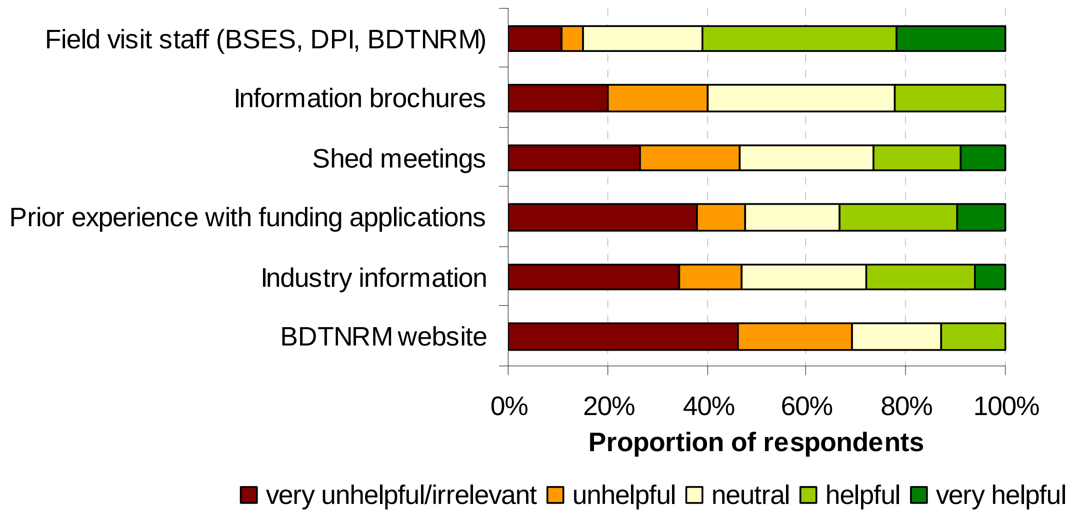


A non-parametric Kruskal-Wallis ANOVA test was undertaken so explore whether there was a statistically significant relationship between the success of participants in the Tender (at least one submission funded) and their rating of the helpfulness of prior experience with writing funding submissions. There was a statistically significant relationship between the two groups ($p = 0.0001$), demonstrating the learning effects of repeated submission writing.

Figure 11 shows the importance of various sources of information in the development of a submission for the Tender. More than 60% of respondents found the field visits helpful, while other information sources were clearly found to have been less helpful in general. Specifically the materials that had been produced to communicate the Tender (brochure and BDTNRM webpage information) received the lowest ratings.

Figure 12: Frequency distribution for relevance of information sources in developing submissions

Items sorted by decreasing mean value



The questionnaire sought to explore how participants derived the bid value that they attached to their submissions. A frequency distribution of responses is shown in Figure 13. A vast majority of respondents (75%) stated that they had not included the value of their time to the implementation of proposed activities in the calculation of total value of their application. A similar proportion of respondents (73%) indicated that they were confident that they knew the total cost of the action(s) they proposed.

In determining how much of the total cost of the project they would seek to recover through the Tender (expressed as bid value), a majority of respondents indicated they applied a cost-sharing formula—but the competitive nature of the Tender was evident in that 64% of respondents agreed that they had kept their bids as low as possible. There was very little evidence of participants inflating their bids to ‘compensate for red tape and other inconveniences’, with only 7% of respondents indicating this consideration played a role in their decision making.

Figure 13: Frequency distribution of level of agreement with various considerations in deriving the bid price for a submission

Items sorted by decreasing mean value

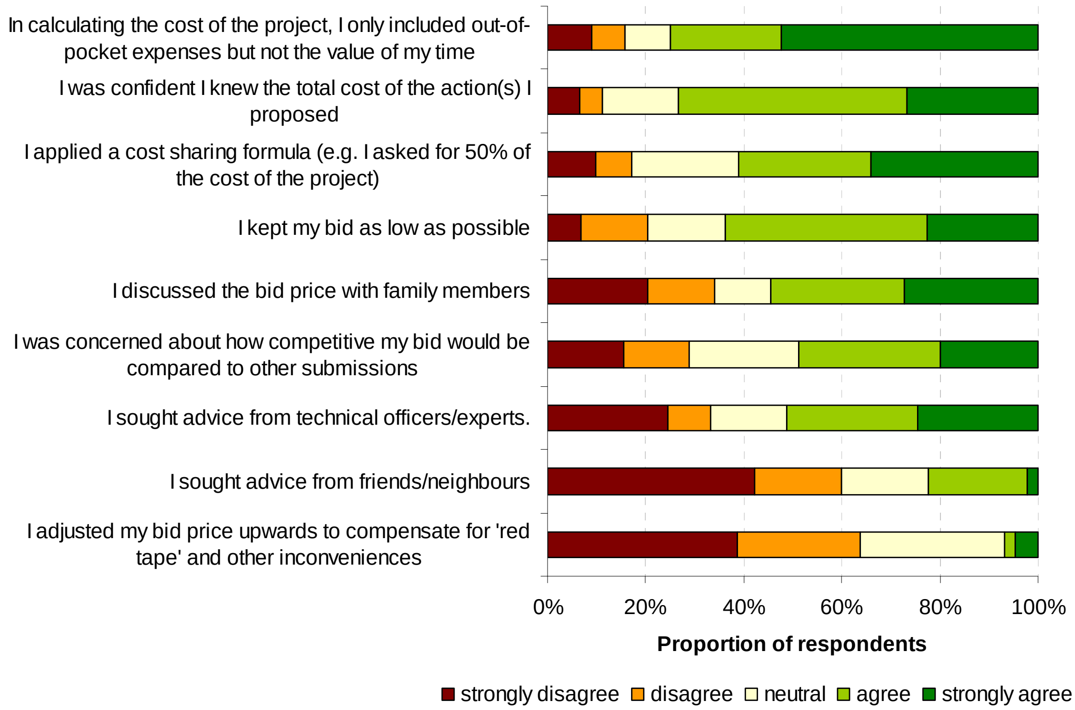


Figure 14: Frequency distribution of attractiveness of various aspects of the Tender

Items sorted by decreasing mean value

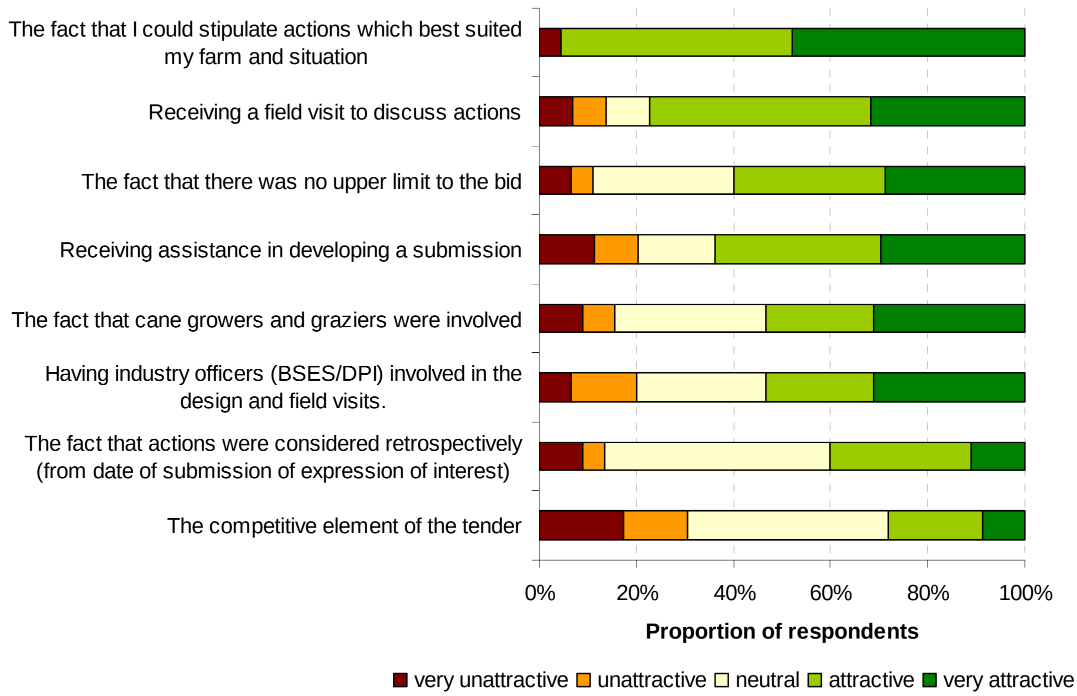


Figure 14 illustrates that what respondents found exceedingly attractive about the Tender was the fact that they could stipulate actions which best suited their farms and individual situations; 96% of respondents rated this aspect as ‘attractive’ or ‘very attractive’. It was also highly appealing to participants to receive a field visit to discuss actions and to receive assistance in developing a submission. Of respondents 60% also found the fact that there was no upper limit to their bids attractive. However, a minority of respondents (28%) found the competitive element of the Tender attractive, a similar proportion (34%) found this aspect unattractive while 38% of respondents were undecided.

Respondents were asked to rate the performance of various aspects of the Tender. As Figure 15 shows, aspects to do with contract design and communication rated highest. If the performance scale was translated into a scores from -2=’very poor’ to +2=’very good’, this aspect would have a mean value of 0.95. The aspect with the lowest performance rating, a mean score or 0, was the time taken between the deadline for submissions and the announcement of results. The results were tested for differences in answers between successful/unsuccessful/EOI-only respondents. No significant differences were found.

Finally, respondents were asked to indicate how likely they were to participate in future tender schemes under a range of conditions. The results are shown in Figure 16. Of respondents, 76% indicated that they were likely to participate in a future scheme that had about the same specifications as the Tender.

Likely participation was sensitive to the combination of scale and scope, and funding pool on offer:

- Likely participation increased to 84% if about twice the funding pool was available, specifically increasing the ‘highly likely’ category from 40% to 62%.

- Likely participation declined to 47% if the eligible area was extended, e.g. to include the Fitzroy basin.

- Likely participation declined to 67% if additional industries were eligible to participate, e.g. if horticulture was included.

Likely participation was somewhat sensitive to the type of organisation administrating the tender.

- Likely participation was identical if it was run by an industry organisation (rather than the NRM group)

- Likely participation declined to 63% and 36% respectively if the tender was run by a research organisation or a government agency.

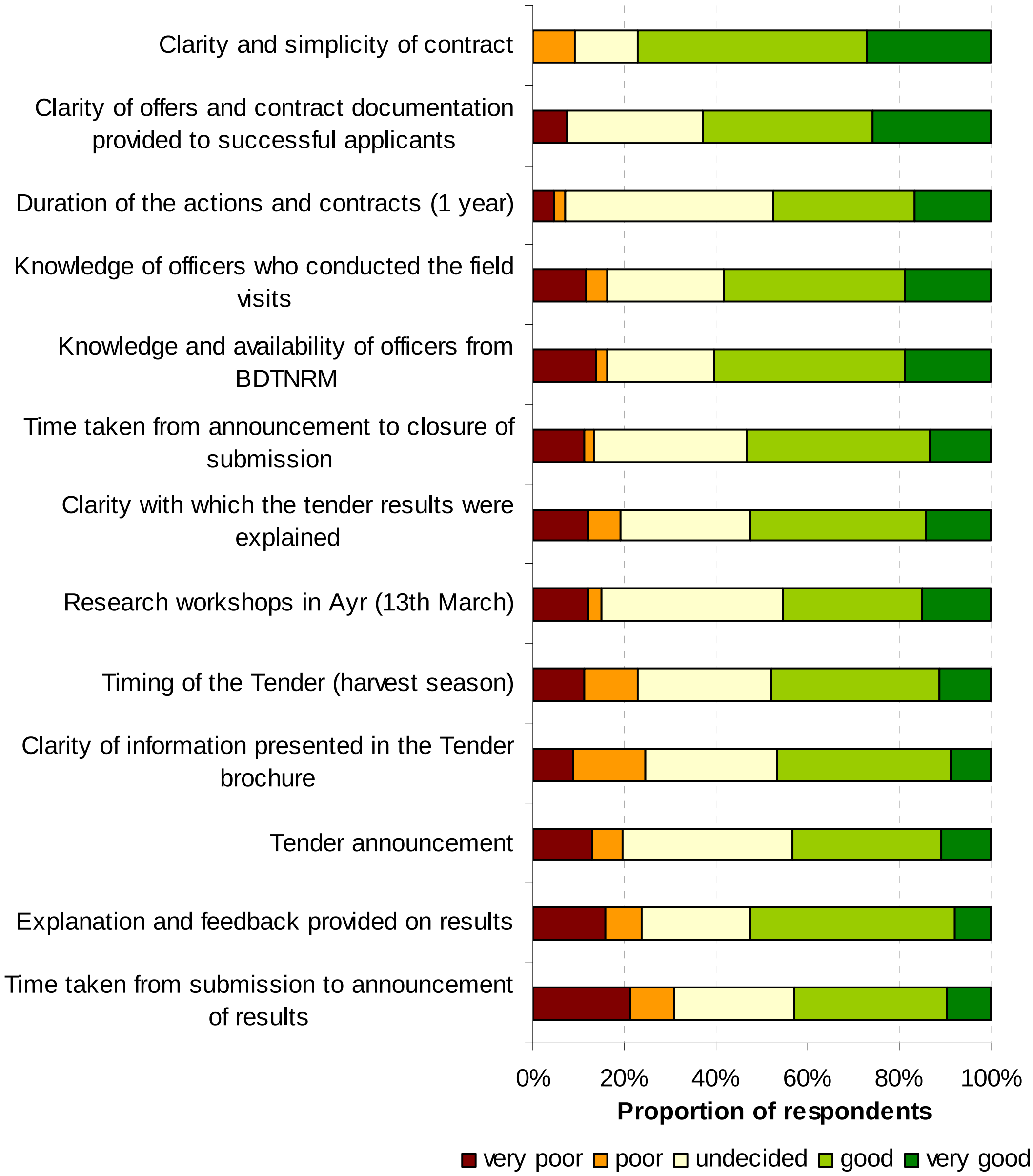
Likely participation was found to be sensitive to success in previous tender schemes.

- Likely participation declined to 71% if the submission in round one was not successful.

- Likely participation declined to 46% and 32% if submissions in two and three consecutive rounds, respectively, was not successful.

Figure 15: Frequency distribution of performance scores of various aspects of the Tender

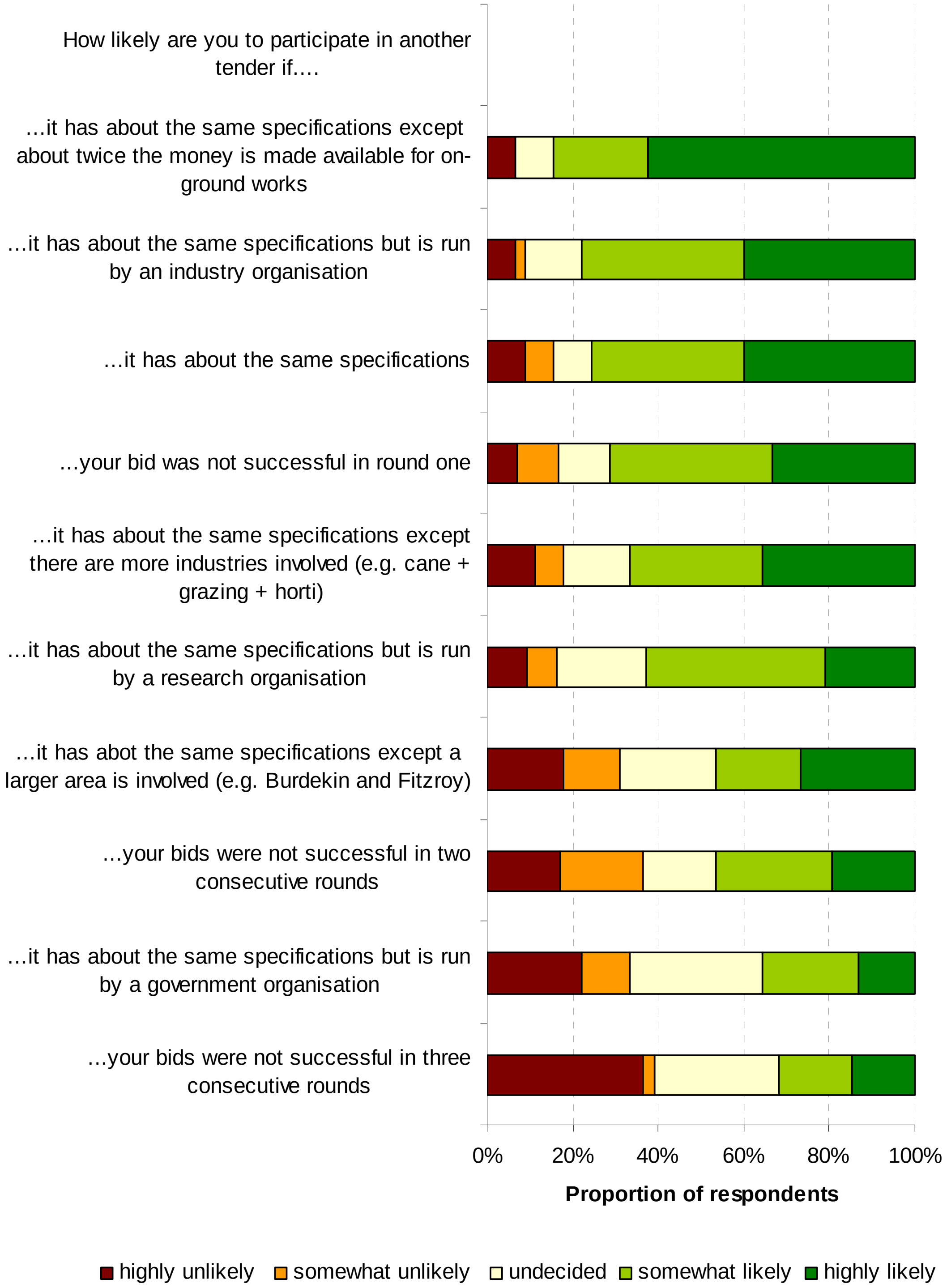
Items sorted by decreasing mean value



Correlation analysis was performed to identify possible differences between successful and non-successful respondents. No significant differences were found.

Figure 16: Frequency distribution of likelihood of participation in a future tender under various conditions

Items sorted by decreasing mean value



5 Conclusions

The Lower Burdekin Water Quality Tender attracted great subscription from eligible landholders, with 67 landholders submitting a total of 87 applications. Total funding sought (aggregate bid amount) was $2.18 million. Funding available was approximately $600,000, which meant that the tender was highly competetive.

Following assessment of the applications through the metric and subsequent ranking on the basis of cost efficiency of water quality improvements offered, the top 33 submission received funding and, with a combined environmental benefit score of EBS=2.728 were estimated to deliver reductions of 492 tonnes of sediment, 69.5 tonnes of nitrogen and 25 kg of effective pesticide components.

Sensitivity testing of results provided a series of insights into aspects of tenders scale and scope. The results:

- did not provide evidence that a large-scale tender is necessarily more efficient than two smaller-scale tenders. In this case, only a very small improvement was evident.
- showed that combining different industries lead to efficiency improvements.
- demonstrated that the assumptions regarding uncertain biophysical relationships can have significant impacts on the tender outcome in terms of relative ranking of different types of submissions.

The research found that increasing transaction costs were associated with increasing complexity of issues to be addressed in a tender, not necessarily the number of industries covered.

Results of the ex-post survey revealed that landholders may not like the competitive nature of an auction scheme, but are attracted by

- the financial incentives, which are not so much viewed in the context of farm viability but rather enable landholders to conduct investments in conservation practices sooner than otherwise possible
- the flexibility of being able to submit actions which suit individual farm circumstances
- technical support being provided in considering participation and preparing a submission.

Results of the ex-post survey demonstrated that likely participation is conservation tenders is reduced if

- the scheme is not run by a NRM group or industry but by government or a research organisation
- the scale of scheme is extended, specifically beyond catchment boundaries
- landholders have (repeated) been unsuccessful in previous rounds.

6 References

Hadgraft R and Volker R, 1980, *A model for predicting aquifer recharge from rainfall and river flow, Groundwater Recharge Conference*, AWRC, Australian Government Publishing Service, Canberra.

McMahon G, Arunakumaren N and Bajrachayra K, 2002, *Estimation of the groundwater budget of the Burdekin River Delta Aquifer, North Queensland"* International Association of Hydrogeologists Conference, 14-17 May, Darwin.

Productivity Commission, 2003, *Industries, Land Use and Water Quality in the Great Barrier Reef Catchment*, Research Report, Canberra.

Rolfe, J., Greiner, R., Windle, J. and Hailu, A. 2007a. Identifying scale and scope issues in establishing conservation tenders, Using Conservation Tenders for Water Quality Improvements in the Burdekin Research Report 1, Central Queensland University, Rockhampton.

Rolfe, J., Muller, C., Greiner, R. and Windle, J. 2007b. *Overview of the Burdekin Case Study*, Using Conservation Tenders for Water Quality Improvements in the Burdekin Research Report 2, Central Queensland University, Rockhampton.

Rolfe, J., Windle, J., Muller, C. and Greiner, R. 2007c. *Designing a metric for conservation tenders at different levels of scope and scale*, Using Conservation Tenders for Water Quality Improvements in the Burdekin Research Report 3, Central Queensland University, Rockhampton.

Sinclair Knight Merz, 1997, *North and South Burdekin Water Boards*, Burdekin River Issues 2, Technical issues Vol. 1 of 3

Volker R, 1977, *Numerical modelling of an aquifer system with intermittent recharge*, AWRC Technical Paper No. 23, Australian Government Publishing Service, Canberra.

Windle, J., Rolfe, J., Greiner, R., and Gregg, D. 2008. Using conservation tenders for water quality improvements in the Burdekin. Results from experimental workshops. Using Conservation Tenders for Water Quality Improvements in the Burdekin Research Report 4, Central Queensland University, Rockhampton.

7 Appendix 1: Previous reports for this project:

Rolfe, J., Greiner, R., Windle, J. and Hailu, A. 2007 *Identifying scale and scope issues in establishing conservation tenders*, Using Conservation Tenders for Water Quality Improvements in the Burdekin Research Report 1, Central Queensland University, Rockhampton.

Rolfe, J., Muller, C., Greiner, R. and Windle, J. 2007 *Overview of the Burdekin Case Study*, Using Conservation Tenders for Water Quality Improvements in the Burdekin Research Report 2, Central Queensland University, Rockhampton.

Rolfe, J., Windle, J., Muller, C. and Greiner, R. 2007 *Designing a metric for conservation tenders at different levels of scope and scale*, Using Conservation Tenders for Water Quality Improvements in the Burdekin Research Report 3, Central Queensland University, Rockhampton.

Windle, J., Rolfe, J., Greiner, R., and Gregg, D. 2008. *Using conservation tenders for water quality improvements in the Burdekin. Results from experimental workshops*. Using Conservation Tenders for Water Quality Improvements in the Burdekin Research Report 4, Central Queensland University, Rockhampton.

Greiner, R., Rolfe, J., Windle, J., and Gregg, D. 2008. *Tender results and feedback from ex-poast participant survey,* Using Conservation Tenders for Water Quality Improvements in the Burdekin Research Report 5, Central Queensland University, Rockhampton.