



Economic analysis of grazing systems for water quality improvement in the Burnett Mary catchment

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Executive Summary

This analysis provides estimates of the level of incentive payments required for grazing farmers to adopt beneficial management practices (BMPs) at a scale large enough to impact on water-quality outcomes at the catchment scale. It includes consideration of both profitability and non-profit barriers. It will be used as the basis for bio-economic modelling and analysis using the Investment Framework for Environmental Resources (INFFER™) to underpin the Burnett Mary Water Quality Improvement Plan.

Compared with other regions in the Great Barrier Reef, there has been limited financial-economic analysis undertaken for the grazing industry in the Burnett Mary region. As such, the work is preliminary and results can be considered as 'ball-park'. Nevertheless, the results build on local knowledge and previous economics work conducted, includes a broader range of considerations than previous work, and can be considered 'best available' at the present time.

Required levels of annual incentive payments were calculated based on considerations of farm size (small 288ha, medium 880 ha, large 4134 ha) and land productivity class (high, medium and low). Required incentives consisted of three components: changes in the annual profitability of land use following adoption, the up-front costs required for adoption, and non-profit barriers to adoption. Local experts provided information that assisted with estimation of each of these components.

Estimated incentive payments for adoption of BMPs ranged from \$10 to \$160 per hectare per year, across different practices in different circumstances. Required payments per hectare were highest for small farms relative to medium and large farms. They were also higher for low-productivity farms. In general, the highest incentive payments were required for practices that involve high up-front costs (practice 3, shift from D to B; practice 4, shift from C to B) and those with very high non-profit barriers (practice 1, shift from D to C; practice 2, shift from C to B).

Of the 90 scenarios examined (for different practice shifts on different farm sizes and three productivity levels), the required incentive payment was at least \$20 per ha per year for 80 of them, at least \$38 per ha per year for 42 of them and at least \$50 per ha per year for 36 of them.

As well as supporting previous work which suggests that small farm size and low productivity land classes pose large challenges for adoption of practices, and that adoption circumstances are complex, our work indicates that non-profit related barriers can be substantial. Our results suggest that incentive payments would be required to ensure adoption of all land productivity classes, farm sizes and practice shifts, including moving from C-B practice.

Because of this, and because of the large areas involved, if enhanced adoption of BMPs was required over the entire 3 million ha of grazing land in the Burnett Mary region, the total costs would be substantial. For example, conservatively assuming an average incentive payment of \$25 per ha per year, total costs would be \$75million/year.

These results support much of the previous work and also suggest further challenges. Previous work has suggested that the most cost-effective sediment reductions might be achieved on low productivity land types. Our results suggest that accounting for non-profit barriers and the lesser financial capacity of small farms adopting practices which involve high upfront costs suggest that, for some practices, incentive payments need to be higher on low productivity land types.

Consideration of farm heterogeneity (individual farmer capacity, farm viability as well as biophysical considerations) suggests that very strong targeting and market mechanisms for land stewardship need more discussion and action if environmental values are to be protected.

Introduction

The Burnett Mary Regional Group is developing a region-wide Water Quality Improvement Plan (WQIP), with major emphasis on the sugarcane and grazing industries. As part of developing a transparent and integrated approach to assessing the net benefits associated with farmer adoption of management practices to improve water quality, a bioeconomic model is being developed (Roberts et al. 2013). Results from the bioeconomic model will be used as an input to the Investment Framework for Environmental Resources (INFFER™), to assess the benefits, costs and cost-effectiveness associated with achieving differing levels of nutrient and sediment load reduction.

For both bioeconomic modelling and INFFER™, estimates of the net benefits associated with management practice changes are required. A companion report detailing benefits and costs associated with sugarcane has been written (van Grieken et al. 2014).

There has been limited financial-economic analysis undertaken for grazing industries in the Burnett Mary region. We have developed an approach which builds on work from other regions, and supplements it with local expertise and knowledge. We have also incorporated (for the first time, and albeit in preliminary and simple fashion) the costs of non-financial barriers to adoption because we believe such factors are very important in some cases.

Review of economic analysis from other regions

We reviewed the readily available economic work from other regions. Major findings included:

- Star et al. (2012a), for the Fitzroy Basin and using a single property size (5,000ha), showed that the most cost-effective sediment reductions (dollar cost per tonne of sediment reduced) were likely to be achieved on low productivity land types because the opportunity cost of reduced pasture utilisation on such land types is relatively low compared with higher land productivity types. They also estimated that the costs of achieving sediment reductions could vary by more than 100 times. Opportunity costs were very sensitive to the existing land condition and the marginal costs of sediment reduction increased sharply as higher and higher levels of reduction are sought.
- Star et al. (2012b) for the Fitzroy, Herbert and Burdekin catchments and using property sizes of 5,000 and 10,000 ha, estimated the cost of sediment reduction across land productivity types, starting management practice (A, B or C) and at different levels of pasture utilisation (% total standing dry matter). Results show that costs to abate sediment are cheapest on low productivity land classes and at C class starting practices. The range of values for the costs of sediment reduction costs has positive and negative values for most land types. The positive costs of sediment reductions present the opportunity cost for landholders to reduce grazing pressure and forgo income. These are values where the landholder has not reached the economically optimal grazing pressure and therefore involves opportunity cost in reducing pasture utilisation. The values which are negative present opportunities where over the long term the landholder is making a loss, by operating past the economically optimal point. The economically optimal point represents that for the management assumptions used in the model this is the optimal utilisation rate.

- Whish (2012), using the GRASP model, showed that high land productivity types were more resilient (can carry more stock, and can be grazed to lower levels of total standing dry matter, or conversely can have higher pasture utilisation rates) than low land productivity types.
- Silburn et al. (2013) in the Paddock to Reef grazing synthesis report concluded that regenerating high productivity land types can be profitable to farmers and therefore that offering incentives to farmers would present an expensive option for government on such land types. In contrast the report re-iterates the results regarding low productivity land types, saying that they are more prone to highest sediment loads and that regeneration of D class land on such would be unviable for producers, thus requiring incentives if sediment reductions were to have achieved.
- Edwards and Star (2013) reported that improving land from C to B condition over high and medium productivity land types in the Burdekin and Herbert catchments is likely to be profitable.
- McCosker et al. (2009) reports that one of the major issues facing the northern Australian beef industry is that there is inadequate scale of enterprises in more closely settled areas.
- Rolfe and Gregg (2013) report that adoption drivers vary markedly between farmers and between practice types, as do attitudes to risk, and thus simple classification of landholders into adoption categories is likely to be too simplistic. Overall they concluded that broadscale and generic engagement and adoption mechanisms are unlikely to be effective and that a range of mechanisms that can be tailored to meet the diverse needs of landholders will be required.

Previous economic analysis for grazing enterprises show that levels of management, land productivity types and different farm sizes are all important in assessing whether there are benefits or costs associated with adopting management practices which improve water quality. C practices offer more potential for improved profitability than B or A practices. However results are highly heterogeneous, and even more so when attitudes to risk and additional adoption drivers and barriers are considered. Work to date has not attempted to quantitatively consider non-financial barriers to practice adoption. Given the often conservative nature overall of beef producers, consideration of such will be important in assessing realistic ‘ball-park’ costs to achieving water quality improvement.

Methods used for the Burnett-Mary economic analysis

Principles

The following principles were used to develop the economic analysis outlined in this report:

1. Build on the existing knowledge base
2. Recognise that we cannot fully represent the heterogeneity of conditions in the grazing industry – the figures should be considered as ‘ballpark’ and a starting basis for discussion
3. Supplement with local knowledge and technical expertise through consultation and participation of willing local expertise
4. Make assumptions and results available for review and discussion
5. Acknowledge the limitations and uncertainties

6. The analysis can be used in a 'stand-alone' fashion to generate discussion, as well as being used as an input for bioeconomic modelling

Land condition - ABCD framework

Land condition in northern Australia has been defined by the Grazing Land Management framework (Chilcott et al., 2005) as the capacity of land to respond to rain and produce useful forage. The ABCD land condition framework has been widely used in the Queensland grazing industry as a measure of how well the grazing ecosystem is functioning. Because land condition (as assessed by groundcover measures such as % total standing dry matter) is a critical factor in assessing sediment loss, the ABCD framework has been used and adapted as the basis for assessing the ability of land management practices to impact on water quality in the Great Barrier Reef programs.

The financial-economic analysis is based on the 'ABCD' water quality risk framework developed through the Paddock to Reef Monitoring and Modelling Program. Management classified as 'A' is likely to have the highest potential to generate environmental benefits (although the commercial viability of these practices is not yet proven), followed by 'B' class management, 'C' class management and 'D' class management. We used the high-level action practices from the ReefPlan3 water quality risk framework (Anon. 2013) to as the basis of assessing A, B, C and D level management actions. Supporting actions listed as part of the Reef Plan3 water quality risk framework were not considered because they do not directly impact on water quality. The practices are summarised below:

- Practice 1. Average stocking rates imposed on paddocks are consistent with district long-term carrying capacity benchmarks for comparable land types, current land condition and level of property development
- Practice 2. Retention of adequate pasture and groundcover at the end of the dry season (pasture assessment and stock management) informed by (a) knowledge of groundcover needs and (b) deliberate assessment of pasture availability in relation to stocking rate in each paddock during the latter half of the growing season or early dry season
- Practice 3. Strategies implemented to recover any land in poor or very poor condition (C or D class)
- Practice 4. The condition of selectively grazed land types is effectively managed
- Practice 5 - Timing and intensity of grazing is managed in frontages of rivers and major streams (including associated riparian areas)
- Practice 6. Gully remediation – strategies implemented, where practical and affordable, to remediate gullied areas.

Results from management practices 1-4 form the basis of this report. We collected information on practices 5 and 6 from a workshop of local people (outlined in the next section) and the information has been used in bioeconomic modelling. However, because the SourceCatchments model considers farm land as a separate component of overall sediment/nutrient reduction to that of gullies and streambanks we did not consider the latter as 'land' management. Additionally, for this farm-level report, it was not appropriate to estimate the average gully or stream length per farm. GIS information per subcatchment unit was used to estimate gully/streambank lengths in different areas of the catchment for the bioeconomic model, to which the remediation costs collected at the local workshop were applied on a \$/km basis.

Workshop of local people

Because the ABCD framework was developed for use Reef wide, it was important to confirm that each of the management practices were relevant to the Burnett Mary region (our work in sugarcane economic analysis having found some practices did not apply to this region). A grazing industry workshop of local stakeholders was conducted, facilitated by Geoff Park and Anna Roberts and involving Katie Muller, Tracey Rockemer, Peter Crawford, Marie Vitelli (by phone), Michael Moller and Fred Bennett. Participants from the Mary River Catchment Council were also invited; whilst they did not attend, information collected was sent to them and a follow up information meeting was held to provide opportunity for input.

At the workshop it was confirmed that all ABCD high-level action practices were relevant to the region. We also discussed the importance of simply capturing the variability in farm size and land productivity class. Workshop participants had insufficient information to make suggestions about these matters and thus farm size and land productivity class categories were decided upon later (details in later sections).

At the workshop, and for each agreed practice, the following information was collected (note that factors were assumed to apply to a medium-sized farm):

- Which of the following practice shifts were feasible and should be considered in practice – D-C, D-B, D-A, C-B, C-A, B-A
- Rating of the profitability of moving between individual practice shifts – rated as Highly profitable (H), Moderate (M), Low but positive profit (L), Zero (0), Slightly unprofitable (UL), Moderately unprofitable (UM), Highly unprofitable (UH).
- Estimated increase in adoption (%) in the next 5 years if no financial incentives were offered
- Number of years it would take to shift practice once the decision to shift had been made
- Description and indicative costs (upfront, maintenance and how often upfront costs are required). Note that upfront costs were usually provided on a ‘per farm’ basis, which enabled economic analysis to discriminate between large and small farms later on, upfront costs being lower per ha on larger than smaller farms.
- Qualitative estimate of the non-profit related barriers associated with shifting practice (an ‘all things considered’ ranking of factors such as increased management complexity, incompatibility with management objectives, risk and other non-financial barriers) – ranked as Very High (VH), High (H), Medium-High (M-H), Medium (M), Low (L) or zero.

Land productivity types

We used three aggregated land productivity type (high, medium, low) categories which had been developed to cover grazing lands on a Reef wide basis (See Figure 1).

Farm sizes

After the workshop of local people, we worked in close collaboration with Marie Vitelli from Agforce. She and Noel Brinsmead used Agforce data to estimate the median size of small, medium and large farms in the Burnett Mary region. Their estimates were 288 ha for small farms, 880 ha for medium and 4143 ha for large-sized properties. These farm sizes formed the basis of the economic analysis.

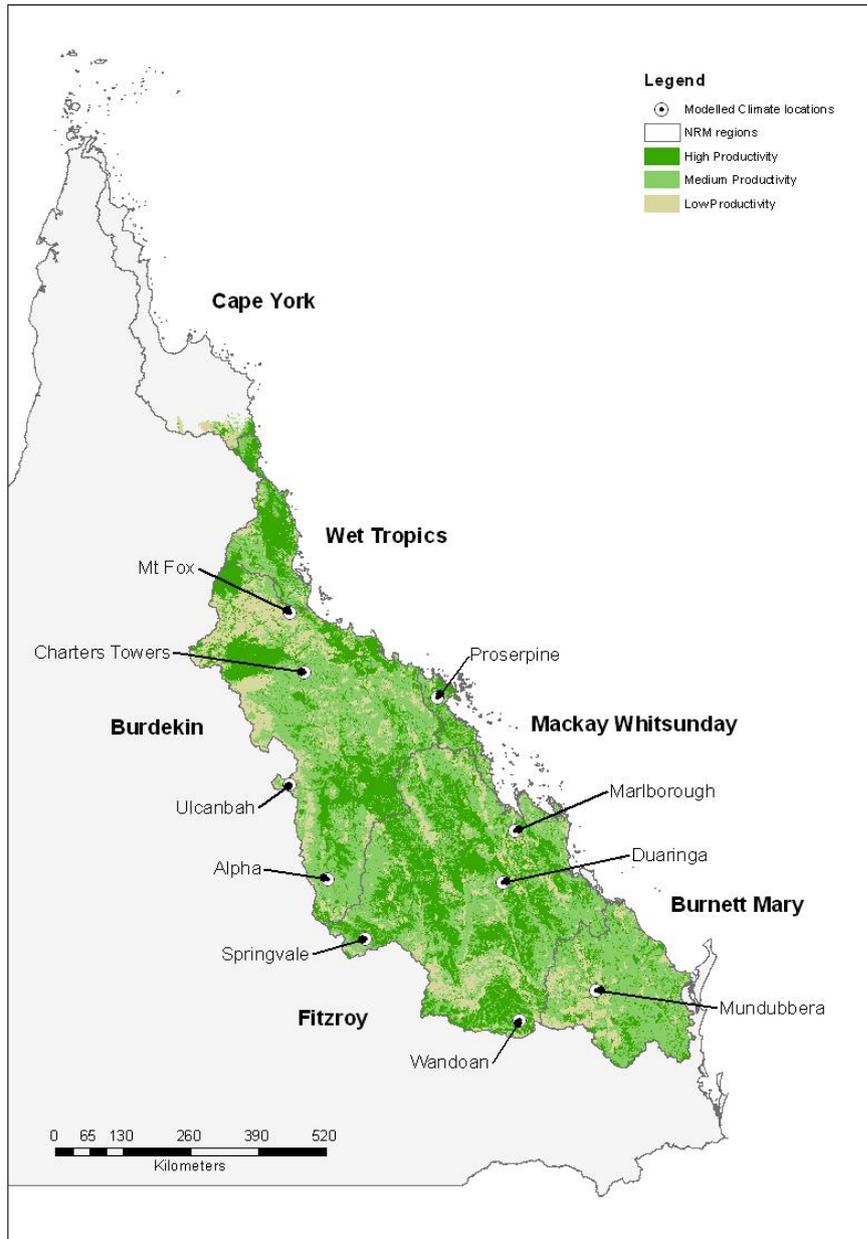


Figure 1: High, medium and low grazing land productivity types (reproduced from Whish 2012)

Benefits and costs of practice changes were calculated for the 3 farm sizes and three land productivity classes. Whilst in reality it is likely that low productivity land classes are more likely to correspond to large farm sizes, we had no basis in the time available to disaggregate the size by land productivity classes beyond this level.

Agforce was able to estimate the percentage area of small, medium and large farms across the Burnett Mary catchment (12% area in small farms, 32% medium and 56% large over all catchments. For the bioeconomic modelling (not outlined as part of this report), we we assumed that the inland and mid Burnett regions had 66% area large farms, 27% medium and 7% small farms (i.e. 10% more large farms and 5% less of each medium and small than the above Agforce numbers), with the

reverse in the Baffle, Burrum and Kolan and Mary catchments (46% area large farms, 37% medium, 17% small farms) where Agforce mapping indicated a lower proportion of large farms than in mid and inland Burnett region.

Initial land condition

We needed to estimate the starting land condition of farms, land condition having a major impact on the costs of sediment and nutrient reduction. The only information source we had came from Kevin McCosker (unpublished excel spreadsheet) of Burnett Mary region-wide estimates of the percentage of grazing land in A (15.7%), B (51.6%), C (24.8%) and D (7.9%). For each farm size we assumed these proportions of land in each starting condition.

Profitability (gross margins) beef production

In the absence of detailed economic analysis for the Burnett Mary region we had extensive follow up by phone and email with Damien O’Sullivan (extension officer) and Fred Chudleigh (DAFF economist Toowoomba). They provided information about the overall profitability of farm production, but not about the profitability of each of the practice shifts. We used the information about overall profitability together with information from the workshop with local experts about the profitability of practice shifts and evidence from the literature about farm practice change (e.g. Pannell et al. 2006) to estimate required incentive payments to prompt practice change.

This provided parameters for medium-productivity farms. We then needed to make adjustments for low and high-productivity farms. We noted the results of Star et al. (2012a, 2012b) that the opportunity cost of agricultural production is lower on low-productivity land. However, this is not the only consideration when estimating incentive payments. We noted that stakeholders generally expected the new BMPs to be more profitable than traditional agriculture. Therefore the land productivity would also affect the profitability of the new practices (just as it affects the opportunity costs). As a result, for the D to C practice shifts, we assumed that the net profit from changing to new BMPs is positively related to land productivity. For other practice shifts, we generally assumed no effect of land productivity on required incentives.

Incorporation of non-financial adoption aspects

Experience with economic modelling of environmentally beneficial management practices around the world indicates that actual farmer adoption of the practices often falls a long way short of what would be expected based on the estimated profit impacts (or on managers’ expectations about the profit impacts). There are various possible reasons for this. One set of reasons relates to inaccuracies in the expectations about profit:

- Estimates may be based on overly optimistic assumptions about increases in productivity or they may overlook additional costs or opportunity costs that would have to be borne by farmers.
- There may be complex farming-systems impacts that are overlooked by environmental managers, but which would be important to farmers. These can particularly be expected for grazing systems.

Another set of possible reasons relates to non-financial barriers to adoption. It is well recognised in the literature on adoption of farm innovations (e.g. Pannell et al. 2006) that there are various non-profit barriers that can affect adoption decisions.

- Perceived riskiness of the new practices
- Uncertainty about the performance of the new practices
- Complexity of the new practices
- Perceived incompatibility of new practices with the existing farming system
- The costs of learning about the new practices.

Thirdly, there are likely to be transaction costs that must be borne by farmers in order to participate in programs that aim to encourage adoption of BMPs. This includes costs of time involved in learning about the program, negotiating contracts, reporting and monitoring results. There is evidence that these transaction costs can be substantial and can constitute a significant disincentive to participation (e.g. Coggan et al. 2010).

At the workshop of local experts, each practice shift was assigned one of four ratings for non-profit barriers to adoption: low, medium, high and very high. It was assumed that there is an interaction between non-profit barriers and the profitability of the practice switch, with non-profit barriers being less significant the more profitable the practice. Equivalent dollar values for non-profit barriers were estimated subjectively for each rating, and for each level of practice profitability. These dollar values were anchored by values of \$75 per ha per year for very high non-profit barriers under low profitability, and zero for low non-profit barriers under high profitability. The \$75 value was chosen to be similar to a typical level of annual profit in this farming system (Fred Chudleigh, pers. comm.), on the basis of our judgement that non-profit barriers, in extreme cases, are of similar magnitude to per ha profit.

Putting it all together - Level of annual incentive payments required under different levels of land productivity, initial land condition and farm size

Incentive payments were calculated on a \$/ha per year basis using a 6% discount rate and annualising up-front costs over a time period of 20 years. Incentive payments were estimated based on farm size (upfront costs apportioned over the three farm size), initial land condition and land productivity class.

Results

A summary of the results collected at the workshop is presented in Table 1 – further details are available upon request from both workshop notes and an excel spreadsheet.

With the exception of restoring land which is in highly degraded (practice 3), all other practices were deemed to be moderately or highly profitable when moving from D-C condition. Moving from C to B or B to A condition was also assessed as generally being profitable, albeit only slightly.

Overall the level of non-profit barriers appear to be significant barriers to widespread practice adoption. For practices 1 and 2, moving from D-C condition was assessed as having very high non-profit related barriers. For C-B practice shifts, non-profit barriers ranged from low (practice 4) to very high (practice 2). Moving from B-A practices had either medium or low non-profit related barriers.

Table 1: Profitability, indicative up-front costs and non-profit related barriers associated with grazing enterprises in the Burnett Mary region.

Practice shift	Profitability ^A	Description of what is needed to achieve	Up-front cost (\$/farm)	Non-profit barriers
Practice 1. Average stocking rates consistent with district long-term carrying capacity benchmarks				
D-C	M	Reduce stocking rate over the medium to long term	200	VH
C-B	L	Reduce average stocking rate, + increased record keeping and pasture monitoring	2000	H
B-A	L	As above + property mapping	5000	M
Practice 2. Retention of adequate pasture and groundcover at the end of the dry season				
D-C ^E	H	Assess pasture/groundcover – shift from watching cattle to assessing pasture	200	VH ^E
C-B	L	Quantitative record keeping rather than eyeballing	200	VH
B-A	L	Forage budget, grazing day charts etc, active management of cattle numbers	5000	M
Practice 3. Strategies implemented to recover any land in poor or very poor condition ^C				
D-B	UH	Recovery actions –e.g. fence and mechanical action where required	27,650 ^D	H
Practice 4. The condition of selectively grazed land types is effectively managed				
D-C	M	Spelling	0	M
C-B	L	Fencing to land types where practical – the low hanging fruit, additional watering points	82,960 ^D	L
B-A	L	As above plus all fencing to land class	82,960 ^D	L

^A Profitability of making the practice switch assuming no incentives used to encourage adoption – Very High (VH), High (H), Moderate (M), Low (L), Zero (0), Slightly unprofitable (UL), Moderately unprofitable (UM), Highly unprofitable (UH)

^BIncluding aspects such increased management complexity, incompatibility with management objectives, other non-financial barriers

^C Assumed to be 5% of farm area

^D Calculations done post workshop, medium farm size assumed

^E Only 5% farmers at this level, generational issue

Required incentive payments (excluding up-front costs) by practice profitability and non-profit barriers

The level of required incentive payment (\$/ha per year based on profitability and non-profit barriers - up-front costs not considered) are shown in Table 2. As noted above, the incentive payment of \$75/ha for high non-profit barriers under low profit was selected to be close to the mid-point estimated gross margins suggested by Fred Chudleigh (personal communication, namely \$87/ha for high productivity land in B class condition, \$69/ha for medium productivity land in B class condition). Incentive payments were scaled to zero where there was estimated to be high profitability and low non-profit related barriers.

Table 2: Estimated required incentive payments based on profitability and non-profit barriers (excluding up-front cost considerations) for Burnett Mary grazing enterprises.

Non-profit barriers	Profitability of practice shift			
	Negative	Low	Medium	High
Low	60	10	5	0
Medium	75	25	15	10
High	100	50	25	15
Very High	125	75	50	25

Required incentive payments (excluding up-front costs) for each practice shift by land productivity class

For each practice shift, workshop participants provided ratings of practice profitability and non-profit barriers. We assumed that these ratings applied to the medium productivity case. As noted earlier, we adjusted the rating for different productivity levels to reflect our assumption that farmers have more to gain financially by adopting BMPs on high-productivity land than on low-productivity land. We assumed that the ratings were the same for large, medium and small sized farms. For each combination of ratings, we used Table 2 to look up the required incentive payment level. Results are shown in Table 3.

Table 3: Estimated required incentive payments on land productivity classes based on profitability and non-profit barriers (excluding up-front cost considerations) for Burnett Mary grazing enterprises.

Practice shift	Land productivity type		
	High	Medium	Low
P1 D-C	25	50	75
P1 C-B	25	50	50
P1 B-A	25	25	25
P2 D-C	25	25	50
P2 C-B	50	75	75
P2 B-A	25	25	25
P3 D-B	100	100	100
P4 D-C	10	15	25
P4 C-B	10	10	10
P4 B-C	10	10	10

Putting it all together - Required incentive payments including up-front costs

The incentive payments in Table 3 were increased by adding in annualised up-front costs from Table 1. They were annualised over 20 years using a 6% real discount rate. Results are presented in Tables 4 to 6. Because up-front costs are different per hectare for different farm sizes (because some of them are the same per farm irrespective of farm size), results are presented for small, medium and large farms.

For high productivity land classes the incentive payments required on small farms range from being similar to those on large farms (P1 and P2) to much greater (P3 D-B, P4 C-B), the differences being

mostly due to having to account for large upfront costs for practices 3 and 4. The highest incentive payments are calculated for restoring degraded land (P3), particularly on small farms. This is due to negative profitability of the change (associated with large upfront costs) and high non-profit related barriers (large management intervention required).

Table 4: Required annual incentive payments (\$/ha) estimated on high productivity land classes (including up-front costs)

Practice shift	Small farm (288 ha)	Medium farm (880 ha)	Large farm (4143 ha)
Required annual incentive payment (\$/ha of land in the initial land condition)			
P1 D-C	25.76	25.25	25.05
P1 C-B	27.44	25.80	25.17
P1 B-A	27.93	25.96	25.20
P2 D-C	25.76	25.25	25.05
P2 C-B	50.24	50.08	50.02
P2 B-A	27.93	25.96	25.20
P3 D-B	160.45	134.58	115.94
P4 D-C	10.76	10.25	10.05
P4 C-B	67.87	43.11	25.26
P4 B-A	67.87	43.11	25.26

Table 5: Required annual incentive payments (\$/ha) estimated on medium productivity land classes (including up-front costs)

Practice shift	Small farm (288 ha)	Medium farm (880 ha)	Large farm (4143 ha)
Required annual incentive payment (\$/ha of land in the initial land condition)			
P1 D-C	50.76	50.25	50.05
P1 C-B	52.44	50.80	50.17
P1 B-A	27.93	25.96	25.20
P2 D-C	25.76	25.25	25.05
P2 C-B	75.24	75.08	75.02
P2 B-A	27.93	25.96	25.20
P3 D-B	160.45	134.58	115.94
P4 D-C	15.76	15.25	15.05
P4 C-B	67.87	43.11	25.26
P4 B-A	67.87	43.11	25.26

The pattern is broadly similar for medium-productivity land types (Table 5), namely that the incentive payments required on small farms range from being similar to those on large farms (P1 and P2) to much greater (P3 D-B, P4 C-B) and it being most expensive to restore degraded land on small

farms. Incentives to change practices 1 and 2 are approximately \$25/ha higher on medium productivity land types than on high productivity land for practice 1 (D-C and C-B) and practice 2 moving from C-B. These higher calculated incentive payments are due to the lower overall profitability of the practice changes on medium than high productivity land types. Incentives for practice 4 are calculated as similar on medium land productivity classes as for high productivity (Table 4).

Incentive payments required for low-productivity land are shown in Table 6. Again the pattern is similar as that for higher-productivity land types, but the general level of payments is higher.

Table 6: Required annual incentive payments (\$/ha) estimated on low productivity land classes (including up-front costs)

Practice shift	Small farm (288 ha)	Medium farm (880 ha)	Large farm (4143 ha)
Required annual incentive payment (\$/ha of land in the initial land condition)			
P1 D-C	75.76	75.25	75.05
P1 C-B	52.44	50.80	50.17
P1 B-A	27.93	25.96	25.20
P2 D-C	50.76	50.25	50.05
P2 C-B	75.24	75.08	75.02
P2 B-A	27.93	25.96	25.20
P3 D-B	160.45	134.58	115.94
P4 D-C	25.76	25.25	25.05
P4 C-B	67.87	43.11	25.26
P4 B-A	67.87	43.11	25.26

Conclusions

Previous work has established that small farms (McCosker et al. 2009) pose large challenges for adoption of practices from a profitability perspective. Large farms, particularly on medium and high productivity land classes, are likely to be able to adopt profitable new practices more readily than small and medium farms on lower productivity land classes.

Our work adds to previous work which has established that adoption drivers are complex and landholder heterogeneity is very large (Rolfe and Gregg 2013). We further highlight that non-profit related barriers can be important in practice adoption. Attempting to accounting for non- profit barriers our results suggest that incentives are required over all land productivity classes, farm sizes and practice shifts, including moving from C-B practice.

Based on a conservative incentive payment rate of \$25/ha/year for a single practice shift, over the close to 3million ha of grazing land in the Burnett Mary region, total incentive costs would be \$75million/year.

The results highlight the importance of farm heterogeneity. Incentive payments required for different farms in different circumstances are very different. This suggests that strongly targeted approach to the provision of incentives would be highly beneficial. Market mechanisms for land stewardship may form a valuable part of the strategy.

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