Economic Analysis of Sugarcane Farming Systems for Water Quality Improvement in the Burnett Mary Catchment

Martijn van Grieken[1], David Pannell[2,3] and Anna Roberts[3]
1 – CSIRO / 2 – University of Western Australia / 3 – Natural Decisions Pty. Ltd.

January 2014

A report prepared for the Burnett Mary Regional Group in cooperation with Natural Decisions

Water for a Healthy Country Flagship Report series.

Citation

Van Grieken, M.E., Pannell, D. and Roberts, A. 2014. Economic Analysis of Farming Systems for Water Quality Improvement in the Burnett Mary Catchment. A report prepared for the Burnett Mary Regional Group in cooperation with Natural Decisions. CSIRO Water for a Healthy Country Flagship. Brisbane, January 2014.

Copyright and disclaimer

© 20XX CSIRO To the extent permitted by law, all rights are reserved and no part of this publication covered by copyright may be reproduced or copied in any form or by any means except with the written permission of CSIRO.

Important disclaimer

CSIRO advises that the information contained in this publication comprises general statements based on scientific research. The reader is advised and needs to be aware that such information may be incomplete or unable to be used in any specific situation. No reliance or actions must therefore be made on that information without seeking prior expert professional, scientific and technical advice. To the extent permitted by law, CSIRO (including its employees and consultants) excludes all liability to any person for any consequences, including but not limited to all losses, damages, costs, expenses and any other compensation, arising directly or indirectly from using this publication (in part or in whole) and any information or material contained in it.

Contents

Tables

Figures

Acknowledgments

We would like to acknowledge Fred Bennett and the Burnett Mary Regional Group for funding this research and Natural Decisions for valuable collaboration. Furthermore, we would like to acknowledge QDAFF for providing access to the FEAT tool to perform the financial-economic analysis in this research. We also like to thank Jody Biggs and Peter Thorburn (CSIRO) for providing APSIM data underpinning the productivity analysis in this research. Last but not least we would like to thank Matthew Leighton and Trevor Wilcox for valuable contributions to the financial-economic analysis and Mark Poggio and Marcus Smith for providing constructive criticism and/or comments throughout this research.

Executive summary

This study considers the attractiveness (assessed as annual equivalent benefits) for cane growers in the Burnett Mary region to improve management practices. This work was undertaken to inform development of the Burnett Mary WQIP. It builds on previous work conducted in other sugarcane regions in Queensland, incorporates local knowledge and includes a preliminary assessment of non-financial barriers associated with farmer adoption. The ABCD framework, Agricultural Production Systems Simulator (APSIM) modelling and previous Farm Economic Analysis Tool FEAT modelling, supplemented by participation of people with local knowledge and assumptions about non-financial barriers form the basis of the approach used.

The main findings from the work are that moving from D to C or D to B practices appears to be profitable for farms ranging from small to large in size. Furthermore, it appears generally not profitable for farmers to move to A class practices. Both of these findings are consistent with current industry and government views in other regions.

The degree to which it is attractive for landholders to move from C to B practices is strongly related to farm size, it being somewhat profitable on large farms and unprofitable on small farms. Overall our results suggest a less optimistic view than currently held by many. The implications are that relatively low levels of adoption from C to B practices are likely to occur using only extension and temporary incentives, particularly on small farms.

1 Introduction

The Burnett Mary Regional Group are developing a new Water Quality Improvement Plan (WQIP) which has major emphasis on both the sugarcane and grazing industries. As part of developing a transparent and integrated approach to assess the net benefits associated with farmer adoption of management practices, a bioeconomic model is being developed (Roberts et al. 2013) to inform the WQIP. 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 reduction targets.

For the bioeconomic model and INFFER™, estimates of the level of net benefits associated with management practice change for the sugarcane and grazing industries are required. Given that there has been limited financial-economic analysis undertaken for sugarcane in the Burnett Mary region, and that limited time and funding were available to complete the work, an approach which built on sugarcane economic work in other regions (NRM regions of the Wet Tropics, Burdekin Dry Tropics and Mackay Whitsundays) was developed. Furthermore, previous work conducted by both CSIRO and DAFF has not seriously considered incorporation of non-financial barriers to adoption. This report outlines the approach undertaken for sugarcane financial-economic analysis to inform the Burnett Mary WQIP which incorporates local knowledge and a preliminary assessment of non-financial barriers.

2 Methodology

2.1 ABCD Framework

The financial-economic analysis is based on the 'ABCD' water quality risk framework developed through the Paddock to Reef Monitoring and Modelling Program. In relation to water quality improvement potential, management classified as 'A' is likely to have the highest potential (however commercial viability of these practices is not yet proven), followed by 'B' class management, 'C' class management and 'D' class management. Table 1 describes the four management classes.

Table 1: Classification of management

PRINCIPLE	PRACTICE CODE	DESCRIPTION
Fertiliser rates	A	Rates based on N-Replacement
	B	Rates based on Six-Easy-Steps (-20% for FEAT)
	C	Rates based on Six-Easy Steps
	D	Rates based on Old Industry Recommendations
Fallow management	A	Grain legume crop
	B	Cover legume crop
	C	Bare fallow
Split application of fertiliser	B	Single split in ratoon
Surface application of fertiliser	B	Sub-surface application of fertiliser
	C*	Surface application of fertiliser
Tillage	A	Zero till
	B	Minimum till
	C	Conventional till
	D	Full till
Traffic	B	Controlled traffic
	C	Conventional traffic
Trash blanketing	B	Green cane trash blanketing

C	Trash burned

*Not modelled in APSIM

While the above mentioned water quality risk framework provides descriptions for operations and machinery for each management class, it does not go into the fine detail of specifying the exact number and type of machinery operations used by growers in each management class. Therefore, this project utilised regional expert advice to define the type and number of operations that could be practiced by growers in the Burnett Mary in each class, as well as local estimates of costs (upfront and maintenance).

2.2 Regional input and local participation

Because very limited economic financial analysis has been conducted in the Burnett Mary region compared with other cane growing regions, and also because the ABCD framework is generic in nature (having been developed Reef wide with large emphasis in the Wet Tropics), it was important to make sure that both management practices and cost information were locally relevant. To do this, a workshop of local cane stakeholders was conducted, facilitated by Geoff Park and Anna Roberts and involving Trevor Wilcox, Matthew Leighton, Wayne Stanley, Trevor Turner, Fred Bennett and Mike Moller. At the workshop information on representative cane farm sizes for each of the three cane growing regions (Bundaberg, Isis and Maryborough) was collected through discussion and consensus, as well as which individual ABCD practices were relevant to particular soil types (well drained, poorly drained). For each agreed practice the following additional information was collected:

- Which of the following practice shifts should be considered – D-C, D-B, D-A, C-B, C-A, B-A
- Ranking of the profitability of moving between individual practice shifts – ranked 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 5 years time 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)
- 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, transaction costs and other non-financial barriers) – ranked as Very High (VH), High (H), Medium-High (M-H), Medium (M), Low (L) or zero.

Follow up individual meetings with Trevor Wilcox and Matthew Leighton were held to determine the practices and products to match regional specifics and practicality. For example for each class it was determined which fertiliser products were used, the amount of tillage passes and which exact implements, etc. The Farm Economic Analysis Tool (FEAT) (Cameron, 2005), as described in more detail in Section 2.4.1, was used to capture this data, to provide estimates of cane and farm gross margins.

2.3 Productivity analysis

Cane yields for management classes considered were simulated with the APSIM (version 7.3) cropping systems model (Keating et al., 2003; http://www.apsim.info) for two soils (see Table 2) and management systems relevant to the Burnett Mary region. This model was chosen because of its proven capability for modelling complex farming systems including sugarcane within the same or similar regions of Australia as this work refers to. APSIM has the capacity to represent important features of sugarcane production systems and the related environment. Soil types analysed in this work were a red dermosol and a redoxic hydrosol (Table 2), these being two of the three soil types used extensively for APSIM applications in Reef Rescue research, and selected to represent well drained and less well y drained soils respectively.

Geographic Information Systems (GIS) data for the BMRG cane growing regions indicate thatwell drained soils cover 53% of cane areas, with more poorly drained soils covering 47% area. Dermosols (sealing loamy surface, structure clay, clay loam surface) represent 37% of cane growing areas and hydrosols 20% (Fred Bennett and David Freebairn, personal communication, excel spreadsheet available).

Table 2: Soil type descriptions for APSIM soils

SOIL CODE	SOIL TYPE	EXPERIMENT LOCATION
bu-02 / sff1	Red Dermosol	24°48'S, 152°16'E
bu-13 / fmd3	Redoxic Hydrosol	24°48'S, 152°21'E

2.4 Financial Economic Analysis

Financial economic analysis was undertaken for cane growing in the Burnett Mary region to help assess realistic 'ballpark' costs associated with achieving nutrient load reduction targets in the Burnett Mary WQIP. The cane work, along with complementary analysis done for grazing, will inform bioeconomic modelling and cost-benefit analysis being undertaken using INFFER™. The financial economic analysis deployed here is based on previous work in the region by Van Grieken et al. (2010), Van Grieken et al. (2013) and Poggio et al. (2013). In line with Van Grieken et al. (2010), the analysis described in this report was undertaken to determine the financial impact of a change between management classes (a suite of individual management practice combinations; as described in Section 2.1), where Van Grieken et al. (2013) and Poggio et al. (2013) analyse the financial impact of a change between individual management practices. The analysis focused on the implications of changing from D to C, D to B, D to A, C to B, C to A and B to A class management. Note that separating net benefits of individual practices within ABCD categories was not possible within the time and information constraints available. Because of the complexity involved in the economic calculations, a combination of the FEAT and a custom made spreadsheet (bases on Van Grieken et al. 2013 and Poggio et al. 2013), with additional modifications made by David Pannell to include non-profit barriers, were used for the economic analysis. Figures calculated in the FEAT program were transferred to the custom made spreadsheet to support the investment analysis.

2.4.1 FARM ECONOMIC ANALYSIS TOOL

FEAT, developed by the Department of Primary Industries & Fisheries (DPI&F) under the FutureCane initiative, is a computer based economic analysis tool designed specifically for the sugar industry (Cameron, 2005). FEAT was primarily designed to enable the economic analysis of various farming system practices. Population of FEAT enables calculation of the Gross Margin (GM) for plant cane and each cane ratoon, as well as for fallow crops such as soybeans and peanuts. FEAT combines the plant cane and ratoon GMs to obtain a sugar enterprise GM. The GMs for sugar cane and any other included fallow crops are combined to give the farm GM. This farm GM takes into account all income received from the cane and fallow crops and the variable costs associated with growing the crops. The farm GM does not take into account the fixed costs of running the business such as telephone, electricity, depreciation, etc. Note that the farm GM is directly influenced by the size of the property (Van Grieken et al. 2010).

2.4.2 ASSUMPTIONS

In this section the assumptions used for this analysis are presented. Note that each farming business is unique in its circumstances and therefore the parameters and assumptions used in this analysis do not reflect each individual situation, instead being used to give a 'ballpark' estimate so as to inform bioeconomic modelling and INFFER™ analysis. Consideration of individual circumstances must be made in order to make an informed investment decision.

The parameters listed below are based on information provided by the regional experts mentioned in section 2.2 to develop specific representative farms for the Burnett Mary region, as well as from Van Grieken et al. (2010).

General assumptions

- Cane yields are provided by APSIM
- Figures are exclusive of GST where applicable
- Grower changes from narrow rows (1.5m) to wider rows (1.8m) in the process of implementing controlled traffic as the move is made from D and C class to B and A class management
- All tractor repairs and maintenance costs are assumed to be 75% of the new purchase price of that tractor over a 20 year life span
- Out-of-field tractor hours for each individual tractor is assumed to be 10% of the total working hours for each respective tractor
- The information presented on 'A' class management is based on practices being researched, scientifically sound but commercial viability not yet proven and caution must be taken with the interpretation of the actual numbers presented
- The economic analysis is a steady state analysis for a representative property operating exclusively in each management class. This analysis assumes that the transition to a new management practice occurs in the first year

Specific assumptions

- Farm sizes: Small (75ha); Medium (125ha) and Large (250ha)
- Soil types: Red Dermosol (representing well drained soils) and Redoxic Hydrosol (less well drained)
- Sugar price: $410
- Commercial Cane Sugar: 13.80
- Contract harvesting: $7.50 per tonne
- Labour cost: $30/hour
- Bare fallow: 20%
- Legume crop: Soybean
- Number of ratoons: 4

2.5 Non-Profit Barriers

As outlined in section 2.2, participants in expert workshops qualitatively estimated an overall level of non-profit barriers for each change in management. Here, we assume that there are two broad components to these non-profit barriers: transaction costs, and other, where the 'other' category includes risk, social pressures, inconvenience, and complexity.

There is locally relevant evidence from research into the levels of transaction costs borne by landholders in the Reef Rescue program (Coggan et al. 2013). In the absence of other information we assumed that transaction costs for the WQIP would be similar to the values estimated for Reef Rescue. From the research by Coggan et al. (2013), average transaction costs from participation were $9,026 per farm, and this amount was found to similar on all farm sizes. We converted this into per hectare values for small medium and large sized farms based on farm areas of 75, 125 and 250 hectares. The results were $120/ha for small farms, $72/ha for medium and $36/ha for large.

It was assumed that these values correspond to a "medium" level of non-profit barriers, as rated by the local experts. It was expected that, of the two components of non-profit barriers (transaction costs and other), the 'other' category would be relatively more sensitive to the expert rating levels. For transaction costs, we assumed modest changes relative to the Medium category, as follows.

- Low non-profit barriers: Medium –20%
- Medium to high non-profit barriers: Medium +10%
- High non-profit barriers: Medium +20%
- Very High non-profit barriers: Medium +30%

For the 'other' category, there was much less quantitative evidence about the financial disincentive corresponding to the non-profit barriers. We know from detailed research into the adoption process for various farm technologies that these other non-profit barriers can be very significant factors inhibiting the adoption of practices that otherwise appear to be profitable. The most extensive research is on the impacts of risk and uncertainty. For example, Abadi et al. (2005) found that a farmer's attitude to risk and his or her perception of the relative riskiness of the new practice were highly influential on the adoption process – more so than any of the 17 other factors that were measured. Barroga (2012) studied the influence of complexity in the adoption decisions of new farming systems in the Philippines, and found that it played an important role for many farmers.

In the absence of evidence about the dollar-equivalent values of 'other' non-profit barriers for adoption of BMPs in the study region, we faced a choice between omitting them and making judgement about them. Given their demonstrated importance in other contexts, we chose the latter course.

Two sets of judgement determined the assumptions we made. Firstly, it was judged that, for a medium non-profit barrier rating, the dollar value of 'other' non-profit barriers would be half of the transaction costs. Secondly, as it was judged that, as we move through the ratings (from Low to Very High), the relative change in 'other' costs would be twice as high as for the transaction costs. We think that these costs are more variable between farms than are the transaction costs. Therefore the adjustments made were as follows:

- Low non-profit barriers: Medium –40%
- Medium to high non-profit barriers: Medium +20%
- High non-profit barriers: Medium +30%
- Very High non-profit barriers: Medium +40%

2.6 Investment analysis

An investment analysis was undertaken using the net present value (NPV) and annualised equivalent benefit (AEB) technique to determine if the investment in capital is worthwhile and creating value for the farming business. For detailed information regarding these techniques in a context similar to this research, refer to Van Grieken et al. (2013) and Poggio et al. (2013).

Figures calculated in the FEAT program were therefore transferred to a custom made spreadsheet to develop a discounted cash flow (DCF), NPV and AEB analysis which included the non-profit barrier estimates. The marginal cash flow differences for each farming system were simulated over a 10-year planning horizon at a 6% discount rate to determine the NPV and AEB of transitioning across different management classes. The AEB approach provides an annualised measure of the NPV that is appropriate to compare investments in capital that have different economic life spans).

The investment analysis framework implicitly accounts for the opportunity cost of the capital investment involved. Given the economic parameters used in the analysis, an investment should be accepted if the NPV is positive and rejected if it is negative. A discount rate of 6% has been used to convert the future cash flows to their present values (value in today's dollar terms). However, landholders may require a higher rate of return to compensate for a greater level of business risk (e.g. production risk). This can be accounted for by assigning a higher discount rate to evaluate whether the NPV still yields a positive result. A sensitivity analysis is therefore performed with regards to the discount rate, for the standard 6% as well as 12%.

3 Results

3.1 Gross margins

In this section we present the results for gross margins (GMs) of fallow, plant and ratoon cane crops. Regarding fallow management, this analysis focuses on two types of fallow management: 1) bare fallow and; 2) legume fallow grown for grain. A soybean legume crop is typically grown for grain (harvested and brought to market) in the Burnett Mary region. As mentioned in Section 2.3.2, the yields underlining the revenues from cane are based on APSIM modelling.

Table 3: Gross Margins ($/ha) on a Red Dermosol soil

MANAGEMENT CLASS	PLANT CANE GM/HA	RAT. 1 GM/HA	RAT. 2 GM/HA	RAT. 3 GM/HA	RAT. 4 GM/HA	BARE FALLOW GM/HA	SOYBEAN FALLOW GM/HA	FARM GM/HA
A Class	$390	$1,370	$1,350	$1,384	$1,221	-	$295	$1,002
B Class	$97	$1,484	$1,524	$1,553	$1,424	-	-$72	$1,002
C Class	-$100	$1,224	$1,273	$1,318	$1,201	-	-$375	$757
D Class	-$312	$1,106	$1,124	$1,166	$1,061	-$1,160	-	$498

Table 4: Gross Margins ($/ha) on a Redoxic Hydrosol soil

MANAGEMENT CLASS	PLANT CANE GM/HA	RAT. 1 GM/HA	RAT. 2 GM/HA	RAT. 3 GM/HA	RAT. 4 GM/HA	BARE FALLOW GM/HA	SOYBEAN FALLOW GM/HA	FARM GM/HA
A Class	$396	$1,399	$1,467	$1,450	$1,304	-	$295	$1,052
B Class	$97	$1,533	$1,641	$1,630	$1,495	-	-$72	$1,054
C Class	-$214	$1,198	$1,293	$1,327	$1,198	-	-$375	$738
D Class	-$415	$1,115	$1,204	$1,224	$1,124	-$1,160	-	$515

For both soil types, farm GM per hectare increases as management changes from D class through to A class. This is largely associated with savings in tillage, fertiliser and labour costs in the plant and ratoon cane crops. At C class practices, growing cane on red dermosol soils is slightly more profitable ($757 versus $738/ha), whereas for A, B and D practices the reverse appears to be true. Whether this is a real result or an artefact of the modelling and assumptions is unclear. Overall, given that the difference in GM between ABCD practices is much larger than the differences in GM between soil type, it is likely that management factors and farm size will have more impact on the bioeconomic modelling results.

3.2 Capital costs associated with practice change

In order to transition between classes, it is likely that machinery needs to be adjusted, or new equipment is required. From participants in expert workshops, capital expenditures associated with specific implement changes were elicited for each management change researched (D to C, D to B, D to A, C to B, C to A and B to A). The estimated capital expenditure requirements for the Burnett Mary region are shown in Table 5. Note that these are also 'ballpark' figures and likely to vary significantly for individual farms in reality.

Table 5: Capital expenditure requirements ($) for management change for small, medium and large farms in the Burnett Mary region

CHANGE	DESCRITPION OF CAPITAL CHANGE / IMPLEMENT REQUIREMENTS	SMALL/MEDIUM		LARGE	
D to C	Planting technology	$	25,000	$	40,000
	Fertiliser box	$	13,000	$	26,000
D to B	Change fert box, spraying ops, shift harvesting strategy, tillage equipment	$	65,000	$	150,000
	Planting technology	$	25,000	$	40,000
	Zonal till implements	$	40,000	$	80,000
	VR Equipment	$	10,000	$	10,000
	Fertiliser box	$	13,000	$	26,000
	Boom sprayer / Weed seeker	$	18,000	$	18,000
D to A	Change fert box, spraying ops, shift harvesting strategy, tillage equipment	$	65,000	$	150,000
	GPS Equipment	$	45,000	$	100,000
	Planting technology	$	25,000	$	40,000
	Zonal and zero till implements	$	70,000	$	140,000
	VR Equipment	$	10,000	$	10,000
	Fertiliser box	$	13,000	$	26,000
	Shielded application technology	$	18,000	$	18,000
	Boom sprayer / Weed seeker	$	30,000	$	30,000
C to B	Change fert box, spraying ops, shift harvesting strategy, tillage equipment	$	65,000	$	150,000
	Zonal till implements	$	40,000	$	80,000
	VR Equipment	$	10,000	$	10,000
	Boom sprayer / Weed seeker	$	18,000	$	18,000
C to A	Change fert box, spraying ops, shift harvesting strategy, tillage equipment	$	65,000	$	150,000
	GPS Equipment	$	45,000	$	100,000
	Zonal and zero till implements	$	70,000	$	140,000
	VR Equipment	$	10,000	$	10,000

	Shielded application technology	$	18,000	$	18,000
	Boom sprayer / Weed seeker	$	30,000	$	30,000
B to A	GPS Equipment	$	45,000	$	100,000
	Zero till implements	$	30,000	$	60,000
	VR Equipment	$	10,000	$	10,000
	Boom sprayer / Weed seeker	$	30,000	$	30,000

3.3 Non-profit related adoption costs

The monetised non-profit barriers for each of the three farm sizes and non-profit barrier ratings are shown in Table 6

Table 6: Monetised values of non-profit barriers to adoption of BMPs ($/ha)

	NON-PROFIT BARRIER RATINGS				
	Low	Medium	Med-High	High	Very High
$ value (Small farm)	132	180	204	228	252
$ value (Medium farm)	79	108	122	137	151
$ value (Large farm)	40	54	61	68	76

3.4 Investment analysis

Table 7 shows AEB values, before adding the cost associated with non-profit related barriers to adoptions, for Small, Medium and Large farms on both soil types researched. It furthermore shows the rating of the non-profit related barriers, as well as the estimated monetary value of the non-profit related barriers. The net AEB shows the AEB net of the non-profit barrier annual cost.

Table 7: AEB, non-profit barrier rating, non-profit barrier annual cost and net AEB for management changes on two soil types for Small, Medium and Large farms

SOIL	RED DERMOSOL			REDOXIC HYDROSOL		
FARM SIZE	SMALL	MEDIUM	LARGE	SMALL	MEDIUM	LARGE
CHANGE (over 10 years at 6%)						
D to C						
AEB ($/ha/year)	$190	$218	$223	$154	$181	$187
Non-profit barrier rating	L	L	L	L	L	L
Annual non-profit costs ($/ha)	$36	$22	$11	$36	$22	$11

Transaction cost ($/ha at year 1)	$96	$58	$29	$96	$58	$29
Net AEB ($/ha/year)	$141	$189	$209	$105	$152	$172
D to B						
AEB ($/ha/year)	$194	$318	$328	$229	$353	$363
Non-profit barrier rating	L	L	L	L	L	L
Annual non-profit costs ($/ha)	$36	$22	$11	$36	$22	$11
Transaction cost ($/ha at year 1)	$96	$58	$29	$96	$58	$29
Net AEB ($/ha/year)	$145	$289	$313	$180	$323	$348
D to A						
AEB ($/ha/year)	$4	$204	$25	$37	$237	$257
Non-profit barrier rating	M	M	M	M	M	M
Annual non-profit costs ($/ha)	$60	$36	$18	$60	$36	$18
Transaction cost ($/ha at year 1)	$120	$72	$36	$120	$72	$36
Net AEB ($/ha/year)	-$72	$158	$2	-$40	$191	$234
C to B						
AEB ($/ha/year)	$4	$100	$105	$75	$172	$176
Non-profit barrier rating	M	M	L	M	M	L
Annual non-profit costs ($/ha)	$60	$36	$11	$60	$36	$11
Transaction cost ($/ha at year 1)	$120	$72	$29	$120	$72	$29
Net AEB ($/ha/year)	-$72	$54	$90	-$1	$126	$161
C to A						
AEB ($/ha/year)	-$186	-$14	$1	-$117	$55	$71
Non-profit barrier rating	H	H	M-H	H	H	M-H
Annual non-profit costs ($/ha)	$84	$50	$22	$84	$50	$22
Transaction cost ($/ha at year 1)	$144	$86	$40	$144	$86	$40
Net AEB ($/ha/year)	-$290	-$76	-$26	-$221	-$7	$44

B to A						
AEB ($/ha/year)	-$208	-$125	-$109	-$211	-$127	-$111
Non-profit barrier rating	H	H	M-H	H	H	M-H
Annual non-profit costs ($/ha)	$84	$50	$22	$84	$50	$22
Transaction cost ($/ha at year 1)	$144	$86	$40	$144	$86	$40
Net AEB ($/ha/year)	-$312	-$187	-$136	-$314	-$189	-$138

Overall conclusions are that moving from D to C is always profitable (range $105-209/ha), and moving from D to B even more so ($145-348/ha), while moving from D to A showed mixed results. If the differences in soil type are accurate, moving from D to A appears to be relatively profitable on large farms with less well drained soils and medium farms on both soil types, but of marginal or negative profitability in the remainder. In reality, the large jump associated with moving from D to A practices is unlikely to occur. The conclusion of it being profitable to move from D to C and D to B practice is consistent with local industry views.

Of most interest are the results from moving from C to B practices. Overall, when non-profit barriers are considered (albeit for the first time to our knowledge and in a preliminary way), results suggest that it is costly to move from C to B on small farms (-$72/ha for well drained soils and -$1/ha for poorly drained soils). There is positive but albeit not stellar profitability in moving from C to B practices on medium and large farms (range $54-161/ha, the higher values being for less well drained soils, whether this is a real result or an artefact of the modelling is unclear, as raised in section 3.1). Consistent with both industry and government views, our results suggest that in general moving to A class practices, either from C or B practice is often unprofitable and particularly so for farmers already at B practice, where the range varies depending upon farm size and soil type (range -$136 to -$314/ha).

3.5 Sensitivity analysis with respect to the discount rate

To account for the fact that landholders may require a higher rate of return than 6% for investments in practice changes that carry a potential risk, for example the risk of decreased productivity, a sensitivity analysis with respect the discount rate was performed for the Redoxic Hydrosol. Figures 1 to Figure 3 present the AEB results (i.e. the transaction costs and other non-profit barriers are not accounted for in this analysis) for a 6% discount rate as per the analysis standard in this report, as well as for a 12% discount rate to account for risky investments.

It is clear from this analysis that for some practices an investment is worthwhile (deliver a required rate of return) a 6% discount rates, however if a discount rate of 12% is used, it appears no longer viable from a financial-economic perspective. For small farms, moving from D to B and C to B, at 6% it is a worthwhile investment; however not at 12%. The same goes for C to A practice shifts on medium and large farms. This is important, because it is exactly these practice changes (moving to an aspirational practice) that often are perceived as the most 'risky'. Overall results suggest that small farms show greater sensitivity (Figure 1) than large farms (Figure 3) to altering the discount rate.

Risky investments that yield a positive return at 6% but a negative return at 12% are potentially more at risk of not be adopted than for less risky investments. An example would be management classified as Aspirational, where financial viability has not yet been proven on a commercial scale, especially concerning practices that could jeopardize productivity.

The sensitivity analysis highlights the importance of perceived risk and associated required returns. Where at a lower discount rate a number of practices may appear attractive from a financial point of view, if a higher discount rate is used, consistent with a likely higher required rate of return for risky investments, these practices are no longer a worthwhile investment.

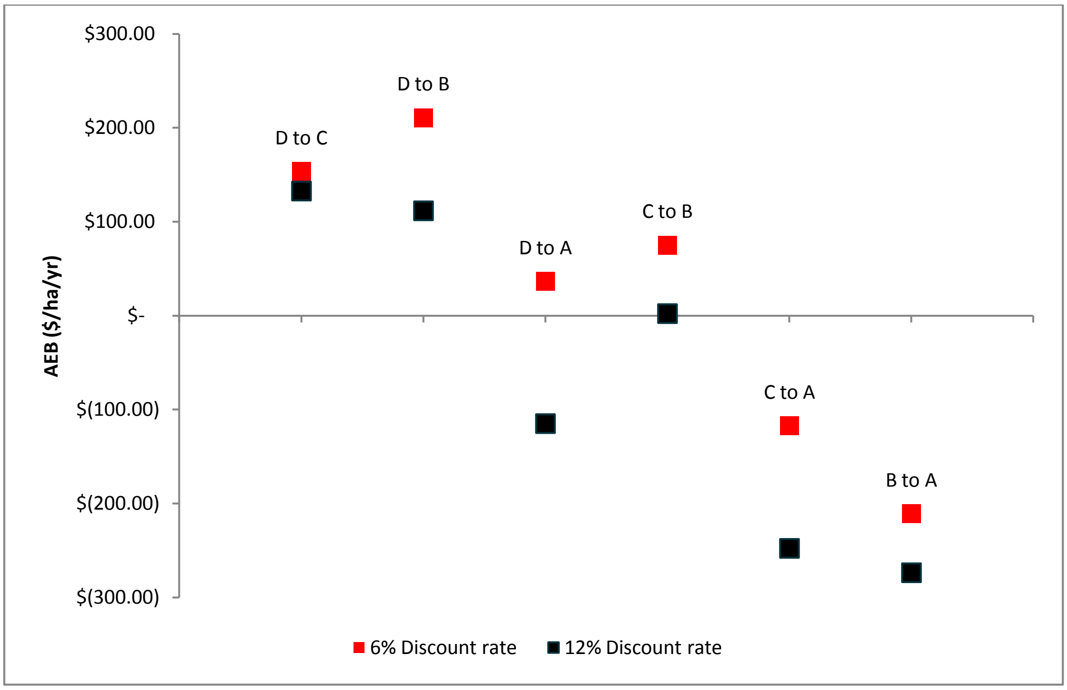

Figure 1: AEB ($/ha/yr) for practice changes at 6% and 12% discount rates for small farms on a redoxic hydrosol

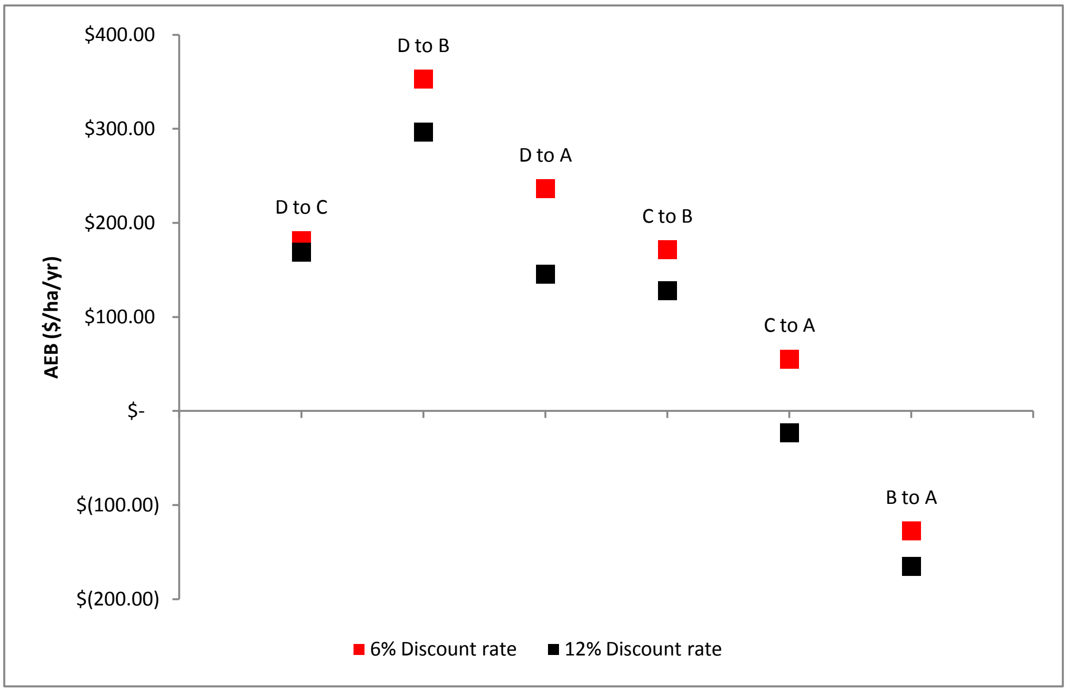

Figure 2: AEB ($/ha/yr) for practice changes at 6% and 12% discount rates for medium farms on a redoxic hydrosol

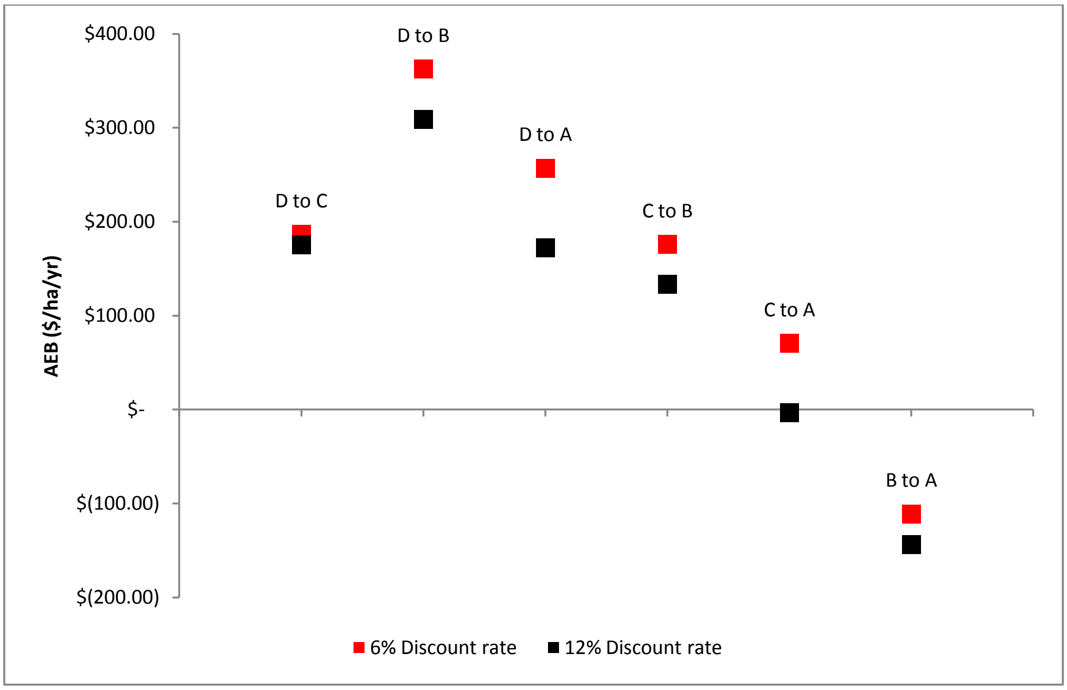

Figure 3: AEB ($/ha/yr) for practice changes at 6% and 12% discount rates for large farms on a redoxic hydrosol

4 Conclusion and implications

This study considers the attractiveness (assessed as annual equivalent benefits) for cane growers in the Burnett Mary region to improve management practices. Unlike most previous studies, as well as gross margins, we have considered non-profit related barriers in our analysis. The main conclusions are:

- Consistent with government and industry views for other regions, moving from D to C or D to B practices appears to be profitable for farms ranging from small to large in size.
- The degree to which it is attractive for landholders to move from C to B practices is related to farm size, it being profitable (but not overly so) on medium and large farms.
- Overall our results suggest a less optimistic view of the attractiveness to landholders of moving from C to B practices than the apparent prevailing views in both government and industry.
- It is generally not profitable for farmers to move to A class practices, particularly for farmers already at B class, as consistent with current industry and government views.
- The AEB sensitivity analysis highlights the importance of perceived risk and associated required returns. Where at a lower discount rate a number of practices may appear attractive from a financial point of view, if a higher discount rate is used, consistent with a likely higher required rate of return for risky investments, these practices are no longer a worthwhile investment.

Results imply that relatively low levels of adoption from C to B practices are likely to occur using only extension and temporary incentives. Small farms present large challenges because the costs to achieve water quality benefits are larger than on large farms. If benefits are to be maintained then long-term on going incentives are likely to be needed if water quality benefits are to be maintained once incentive programs finish. The extent to which this is sound policy would need to be weighed up against alternative policy approaches.

References

Abadi Ghadim, A.K., Pannell, D.J. and Burton, M.P. (2005). Risk, uncertainty and learning in adoption of a crop innovation, *Agricultural Economics* 33, 1-9.

Barroga, Karen. (2009). Adoption of Multi-component and Preventive Rice Production Technologies: A Study of Complexity in Innovations, Unpublished PhD thesis, School of Agricultural and Resource Economics, University of Western Australia.

Cameron, T., 2005. Farm Economic Analysis Tool (FEAT), a decision tool released by FutureCane. Department of Primary Industries and Fisheries, Brisbane, Australia. Caring For Our Country, 2009. Reef Rescue Research and Development Plan. (http://www.nrm.gov.au/business-plan/10-11/priorities/coastal/reef/pubs/reef-rescue-r-and-d-plan.doc)

Coggan, A., van Grieken, M., Boullier, A., Jardi, X. (2013) Private transaction costs of best management practices (BMP) through Reef Rescue. Reef Rescue Integrated Paddock to Reef Monitoring, Modelling and Reporting Program. CSIRO: Water for a healthy Country National Research Flagship, Dutton Park, Brisbane.

Drewry, J., Higham, W. and Mitchel, C., 2008. Water Quality Improvement Plan. Final report for Mackay Whitsundays region.

Keating, B. A., P. S. Carberry, G. L. Hammer, M. E. Probert, M. J. Robertson, D. Holzworth, N. I. Huth, J. N. G. Hargreaves, H. Meinke, Z. Hochman, G. McLean, K. Verburg, V. Snow, J. P. Dimes, M. Silburn, E. Wang, S. Brown, K. L. Bristow, S. Asseng, S. Chapman, R. L. McCown, D. M. Freebairn and C. J. Smith (2003). "An overview of APSIM, a model designed for farming systems simulation." European Journal of Agronomy 18(3-4): 267-288.

Poggio, M., Smith, M., van Grieken, M. & Shaw, M. (2013). The Economic Cost-effectiveness of Pesticide Management Practices Leading to Water Quality Improvement on Sugarcane Farms. Department of Agriculture, Fisheries and Forestry (DAFF), Queensland.

Roberts, A.M., Beverly, C., Park, G. & Pannell, D.J. (2013). Draft bioeconomic modelling methods development report. Report to the Burnett Mary Regional Group. Natural Decisions Pty. Ltd.

Van Grieken, M.E., Poggio, M.J., East, M., Page, J. and Star, M., 2010. Economic Analysis of Sugarcane Farming Systems for Water Quality Improvement in the Great Barrier Reef Catchments. Reef Rescue Integrated Paddock to Reef Monitoring, Modelling and Reporting Program. CSIRO: Water for a healthy Country National Research Flagship.

Van Grieken, M., Poggio, M., Smith, M., Taylor, B., Thorburn, P., Biggs, J., Whitten, S., Faure, C., and Boullier, A. (2013) Cost-effectiveness of management activities for water quality improvement in sugarcane farming. Report to the Reef Rescue Water Quality Research & Development Program. Reef and Rainforest Research Centre Limited, Cairns.

CONTACT US

t 1300 363 400
+61 3 9545 2176
e enquiries@csiro.au
w www.csiro.au

YOUR CSIRO

Australia is founding its future on science and innovation. Its national science agency, CSIRO, is a powerhouse of ideas, technologies and skills for building prosperity, growth, health and sustainability. It serves governments, industries, business and communities across the nation.