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Economic Analysis of Sugarcane Farming Systems for Water Quality Improvement in the Great Barrier Reef Catchments

September 2010 - Martijn van Grieken, Mark Poggio, Miriam East, Jim Page and Megan Star

Reef Rescue Integrated Paddock to Reef Monitoring, Modelling and Reporting Program

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EXECUTIVE SUMMARY

In this report we analyse the private financial-economic impacts of transitioning to improved sugarcane management in the National Resource Management regions of the Wet Tropics, Burdekin Dry Tropics and Mackay Whitsundays. In order to do so, we: 1) compare farm GMs; 2) present information on capital investment associated with the transition; 3) perform a net present value analysis of the investments and; 4) undertake a risk analysis for cane and legume yields and prices. It must be noted that transaction costs are not captured within this project.

Overall, the financial-economic analysis presented in this report shows that there are expected benefits to growers through transitions to improved cane management. However, the costs and benefits associated with changing to improved management will be different for each individual grower and therefore each circumstance needs to be carefully considered before making a change in management practice. Education regarding the expected benefits of transition to improved cane management may encourage some growers in the GRB regions to begin the transition. If the benefits of transitioning to improved management are not greater than the costs, then individual growers are unlikely to change. However, this may just mean that incentives are required to assist growers to change, if the environmental benefits of the transition are deemed to be important.

The ‘ABCD’ framework used in this financial-economic analysis is based on the ‘ABCD’ framework as per reference of 2007-2008 which is the most current available version of the framework. The framework for the various NRM regions is currently being updated to clarify some issues and incorporate new knowledge since the earlier version of the framework.

It must be acknowledged that the results presented in this report are one possible set of figures to show the changes in profitability of a grower operating in different management classes in different regions. In other words, the results in this report are not prescriptive of every landholder. Each farming business is unique in its circumstances and the parameters and assumptions used in this financial-economic analysis do not reflect every individual’s situation. Consideration of individual circumstances must be made in order to make an informed investment decision.

1. INTRODUCTION

Under the Reef Water Quality Protection Plan 2009 (hereon referred to as ‘Reef Plan’), the Australian and Queensland governments have committed to the development and implementation of an Integrated Paddock to Reef Monitoring, Modelling and Reporting (PRIMMR; ‘Paddock to Reef’) Program with the objective to *evaluate the outcomes of Reef Rescue and Reef Plan by linking catchment and marine monitoring and modelling activities* (Caring for Our Country, 2009). A key component of the paddock scale monitoring and modelling under the PRIMMR Program is the analysis of the financial-economic impact of moving cane farming enterprises from current farming (practice) systems or management class through a recommended management class to an aspirational management class. For sugarcane, management practices that improve nutrient, pesticide and soil management are deemed high priority and are based on the ‘ABCD’ management (practice) class framework for water quality improvement developed in 2007/2008 by the respective natural resource management (NRM) regions of the Wet Tropics (WT), Mackay Whitsundays (MWS) and Burdekin Dry Tropics (BDT).

The objective of this project is to improve the understanding of trade-offs between water quality improvement and financial costs and identify the relative advantage and cost-effectiveness of cane management strategies for: 1) improving cane production and economic performance and; 2) improving and maintaining land condition and water quality. In order to do so, for the WT, MWS and BDT NRM regions, virtual cane growing enterprises representing an ‘average’ farm have been established for financial-economic analysis. These representative cane growing properties are characterised by sourcing region-specific research data and farm management and grounded by informed persons including producers and other regional specialists. We analyse the private financial-economic impacts of transitioning to improved sugarcane management classes by: 1) comparing farm gross margin (GM); 2) identifying potential capital investments associated with the transition; 3) performing a net present value analysis of the investments and; 4) undertaking a risk analysis for cane and legume yields and prices.

The structure of this report is as follows. First we describe the methodology used to perform the financial-economic analysis followed by a description of the assumptions that have been made to facilitate the modelling. Next we present results on steady-state farm GMs and characteristics of farming system change, such as the description of individual management practice changes and the implementation (capital) costs associated with transitioning. An investment analysis is presented to determine whether the increases in GM are sufficient to cover the costs associated with changing between farming systems. This includes a risk analysis to account for the uncertainty that surrounds future cash flows. A conclusion with discussion of the results follows.

A region specific summary of this report can be found in East and Star (2010) and Poggio et al. (2010a; 2010b; 2010c).

2. METHODOLOGY

2.1. 'ABCD' framework

The financial-economic analysis is based on the 'ABCD' management practice framework for water quality improvement developed in 2007/2008 by the respective natural resource management regions. In relation to water quality improvement potential, this is structured that management classified as 'Best' practice currently hold the highest potential for improving water quality, and 'Dated' practice the lowest. 'Aspirational' management may further improve water quality but are currently being researched and commercial viability has not yet been proven. It is recognised that these classes have certain limitations and in many cases the grouping of practices may not be reflective of the real situation. Table 1 describes the four management classes.

Table 1: Classification of management

Practice class	*Description*
'A' (Aspirational)	Proof of concept, practice being researched/scientifically sound but commercial viability not yet proven
'B' (Best practice)	Best practice currently available; industry recommended
'C' (Common practice)	Currently code of practice
'D' (Dated practice)	Dated and likely degrading practice

While the 'ABCD' framework provides descriptions for planning, record keeping 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 expert agronomist advice to prepare an initial draft of the operations that could/would be practiced by growers in each class. Grower meetings were then held to identify the specific operational requirements associated with each management practice and to provide/validate the data used for financial-economic analysis. The final list of machinery operations, chemical application and fertiliser applications used for the modelling and economic analysis are detailed in Van Grieken et al. (2010).

2.2. Productivity analysis

In order to estimate productivity (yield) information for plant cane and each ratoon the APSIM crop modelling programme (Keating et al., 2003) was utilised. Furthermore, it has been used to estimate grain yields.

The fertiliser application rates that have been used for the APSIM modelling are not fully supported by growers for 'B' and 'A' class management. 'B' class fertiliser application rates are based on the 6 Easy Steps programme accepted by industry, where the application rate is determined after relevant soil tests. For modelling purposes however, a specific fertiliser application rate had to be chosen. For 'A' class management, this project has used the Nitrogen Replacement Theory developed by CSIRO (Thorburn et al., 2010). This method of calculating a fertiliser application rate has not yet been accepted by industry. Therefore, particularly for 'A' class management, the cane yields modelled by APSIM may not be achievable in reality with the low rate of fertiliser application.

2.3. Financial economic analysis

A financial economic analysis was undertaken to determine the impact of a change in management practice as detailed in the 'ABCD' management practice framework (see Section 2.1). The analysis focused on the implications of changing from 'D' to 'C', 'C' to 'B' and 'B' to 'A' class management. The aim of the analysis is to estimate the economic impact that may be expected when undertaking a particular change in farming practice.

Because of the complexity involved in the economic calculations, a combination of the Farm Economic Analysis Tool (FEAT) (Cameron, 2005), PiRisk (DEEDI) and a custom made spreadsheet were used for the economic analysis. Figures calculated in the FEAT program were transferred to the custom made spreadsheet to develop a discounted cash flow analysis. The marginal cash flow differences for each farming system were simulated over a 5-year and 10-year planning horizon to determine the NPV of transitioning across different management classes.

2.3.1. Farm Economic Analysis Tool

FEAT, developed by the Department of Primary Industries & Fisheries (DPI&F) 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 GM for plant cane and each cane ratoon, as well as for fallow crops such as soy beans 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 or property GM. This property GM takes into account all income received from the cane and fallow crops and the variable costs associated with growing the crops. The property GM does not take into account the fixed costs of running the business such as telephone, electricity, depreciation, etc. Note that the property GM is directly influenced by the size of the property. Viewing the results as GM per hectare may allow better comparison of the enterprise to other cane enterprises; however, the costs of operating machinery are also influenced by property size.

2.3.2. PiRisk

PiRisk is a risk analysis tool developed by DPI&F that can be added into an Excel Workbook and includes macros and distributions that give spreadsheets the ability to conduct stochastic simulations to evaluate risk. This tool allows stochastic simulations to be conducted using a Monte Carlo simulation approach where random number generators select values from distributions of key unknowns such as price, yield or interest rate. The process of generating random numbers to select values from distributions is repeated and recorded thousands of times to gain a comprehensive expression of the range of possible outcomes and associated probabilities. The result is a measure of risk, usually expressed as a frequency distribution.

The process of risk analysis allows us to test uncertain parameters in a financial-economic analysis and determine the potential risk associated with a change in value. In this financial-economic analysis, a risk analysis was completed for sugarcane price, sugarcane yield, soybean price and soybean yield to determine their impact on GM.

3. ASSUMPTIONS

In this section the regional assumptions are presented that have been used for this analysis. Please 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. Consideration of individual circumstances must be made in order to make an informed investment decision. Throughout the report, 'bare fallow' is used to indicate a 'bare/weedy' fallow. Furthermore, the information presented on 'A' class management is based on practices under research and not thoroughly tested on a commercial scale. Caution must be taken with the interpretation of the actual numbers presented in this management class.

3.1. General assumptions and information

- Cane yields are provided by APSIM
- Figures are exclusive of GST where applicable
- Bare fallow is used in 'D' and 'C' class management
- All chemical and fertiliser prices are based on April 2010 figures
- 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 C class to B class management practice
- Detailed machinery operations, fertiliser application rates and chemical application rates are contained in Van Grieken et al. (2010).
- 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
- Transaction costs are not included in this analysis. Examples of transaction costs include the time spent purchasing and learning about the new equipment purchased
- 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

3.2. Region specific assumptions

	WT	*MWS*	*BDT BRIA*	*BDT Delta*
Soil type*	Coom (clay)	Eton (cracking clay)	Hat (medium clay)	Neil (silty clay with light clay subsoil)
Sugar price**	$349.30	$349.30	$349.30	$349.30
Farm size (ha)	120	150	240	120
Commercial cane sugar (CCS)***	12.86	13.706	14.94	14.94
Contract harvesting	$7.50/tonne without GPS guidance for 'D', 'C' and 'B', and $7.80/t with GPS guidance for 'A' class	$7/tonne without GPS guidance for 'D' and 'C' class, and $7.30/t with GPS guidance for 'B' and 'A' class	$6.00/tonne for 'D' and 'C' class, $6.30/tonne for 'B' class with GPS guidance and $6.80/tonne with GPS guidance and green cane harvesting for 'A' class	$6.00/tonne for 'D' and 'C' class, $6.30 for 'B' class with GPS guidance and $6.80/t with GPS guidance and green cane harvesting for 'A' class

	WT	*MWS*	*BDT BRIA*	*BDT Delta*
Contract planting	360/ha without GPS guidance for 'D' and 'C' class, $370/ha with GPS guidance for 'B' class and $400/ha (Mizzi Planter) with GPS guidance for 'A' class	$358/ha without GPS guidance for 'D' and 'C' class, and $370.65/ha with GPS guidance for 'B' and 'A' class	$370/ha without GPS guidance for 'D' and 'C' class, $395/ha with GPS guidance for 'B' and 'A' class	$370/ha without GPS guidance for 'D' and 'C' class, $395/ha with GPS guidance for 'B' and 'A' class
Contract spraying	$30/ha		$30/ha	$30/ha
Fuel price****	$0.85/L	$0.85/L	$0.85/L	$0.85/L
Labour cost	$30/hour	$30/hour	$30/hour	$30/hour
Bare fallow ('D'/'C')	17%	10%	20%	20%
Ploughout replant	-	50% of third ratoon	-	-
Legume fallow for green manure ('B')	17% (cowpea)	17% (soybean)	20% (soybean)	20% (soybean)
Legume fallow for grain ('A')	Not Applicable – green manure only	17% (soybean)	20% (soybean)	20% (soybean)
Fallow application	Lime	-	Gypsum	Gypsum
Blanketing	Green cane trash blanketing is used in all management classes.	-	Burnt cane harvesting is used in all 'D', 'C' and 'B' class. Green cane trash blanketing is used in 'A' class.	Burnt cane harvesting is used in all 'D', 'C' and 'B' class. Green cane trash blanketing is used in 'A' class.
# ratoons	4	4	3	3
Irrigation	Not Applicable	Furrow?	Furrow	Furrow
Soil test	$130/test	$130/test	$130/test	$130/test
Leaf test	$50/test	$50/test	$50/test	$50/test

* *Soil types are used to approximate cane yields in the rest of the region*
** *Based on the 5 year average between 2005 and 2009*
*** *Fuel price without GST and after rebate*
**** *Based on the 5 year mill average*

In the BRIA region, fertiliser application rates are subject to further validation for the 'A' and 'B' class management categories in this region. The rate of nitrogen to apply following a legume crop in fallow is also subject to further research and may be influenced by various biophysical, environmental and management factors. A sensitivity analysis was undertaken for plant cane nitrogen rates in 'A' and 'B' class management practices to determine the overall influence on net present value (NPV) results. The sensitivity analysis indicated that there is little to no impact on the overall NPV decision rule results when applying nitrogen (≤150kg/ha) to plant cane following a legume fallow.

4. RESULTS

4.1. Gross margins

In this section we present the results for GMs of fallow, plant and ratoon cane crops in a sugarcane farming business. The economic analysis focuses on two types of fallow management: 1) bare fallow and; 2) legume fallow grown for green manure. A cowpea legume crop is typically grown for green manure in the WT. Due to the very wet climatic conditions in the WT it is difficult to harvest the legume for grain whereas in the BDT, soybean legume crops can either be grown as a green manure or harvested for grain due to the availability of water for irrigation and suitable environmental conditions. It is assumed that no revenue is received from these green manure crops. Furthermore, it is assumed that a fallow crop is grown for green manure in half of the total fallow area for 'A' and 'B' classes, with the remainder of area in bare fallow. In 'C' and 'D' management classes, 100% of the fallow area is in a bare fallow.

Labour has been treated as a variable cost ($30/hr.) in the GM analysis to allow for a more accurate comparison between management. It should be noted that as cultivation decreases when transitioning from 'D' class management to 'A' class management, the additional labour savings contribute to the higher GM. Regional GMs are presented in Table 1, 2, 3 and 4. The farm GM equals the average GM over planting, ratoons and fallow.

Table 2: WT GMs

Scenario name	*Plant cane GM/ha*	*Rat.1 GM/ha*	*Rat.2 GM/ha*	*Rat.3 GM/ha*	*Rat.4 GM/ha*	*Bare Fallow GM/ha*	*Cowpea Fallow GM/ha*	*Farm GM/ha*
A Class	$843	$1,419	$1,487	$1,546	$1,774	-$245	-$405	$1,124
B Class	$717	$1,402	$1,510	$1,544	$1,815	-$330	-$490	$1,096
C Class	$484	$1,226	$1,334	$1,413	$1,677	-$477	NA	$943
D Class	$243	$1,148	$1,260	$1,321	$1,589	-$425	NA	$856

Table 3: MWS GMs

Scenario name	*Plant cane GM/ha*	*Rat.1 GM/ha*	*Rat.2 GM/ha*	*Rat.3 GM/ha*	*Rat.4 GM/ha*	*Bare Fallow GM/ha*	*Soy Fallow GM/ha*	*Farm GM/ha*
A class	$677	$1,484	$1,381	$1,156	$996	N/A	-$610	$847
B class	$227	$1,382	$1,305	$1,089	$933	N/A	-$660	$713
C class	-$276	$1,208	$1,137	$933	$772	-$130	N/A	$655
D class	-$441	$1,026	$934	$740	$586	-$123	N/A	$498

Table 4: BDT Delta GMs

Scenario name	*Plant Cane GM/ha*	*Rat.1 GM/ha*	*Rat.2 GM/ha*	*Rat.3 GM/ha*	*Rat.4 GM/ha*	*Bare Fallow GM/ha*	*Soy Fallow GM/ha*	*Farm GM/ha*
A Class	$3,083	$4,005	$4,194	$4,146	NA	NA	$399	$3,165
B Class	$3,743	$4,075	$4,141	$4,107	NA	-$889	NA	$3,035
C Class	$2,549	$3,694	$3,671	$3,629	-$565	NA	NA	$2,596
D Class	$1,949	$3,391	$3,358	$3,319	-$676	NA	NA	$2,268

Table 5: BDT BRIA GMs

Scenario name	*Plant cane GM/ha*	*Rat.1 GM/ha*	*Rat.2 GM/ha*	*Rat.3 GM/ha*	*Rat.4 GM/ha*	*Cane GM/ha*	*Bare Fallow GM/ha*	*Soybean Fallow GM/ha*	*Farm GM/ha*
A Class	$1,242	$2,113	$2,342	$2,267	NA	$1,991	NA	$208	$1,634
B Class	$1,722	$2,095	$2,319	$2,246	NA	$2,096	-$929	NA	$1,491
C Class	$1,324	$1,800	$2,040	$2,006	-$767	$1,793	NA	NA	$1,281
D Class	$620	$1,409	$1,650	$1,619	-$761	$1,325	NA	NA	$907

For all regions, there is a trend of increasing farm GM per hectare as management changes from ‘D’ class through to ‘A’ class. This trend is largely associated with savings in tillage, fertiliser, weed control and labour costs in the plant and ratoon cane crops. A legume crop is grown in ‘A’ and ‘B’ class management, providing soil health benefits and nitrogen to the fallowing plant cane crop. The fallow GM is negative for all management practice classes since no revenue is generated from a green manure crop. As anticipated, the GM for plant cane crops is lower than ratoon cane crops because of the higher input costs associated with plant cane operations (e.g. tillage and planting).

4.2. Practice changes

In the Wet Tropics and the Mackay Whitsundays, it has been assumed that all growers have already adopted green cane trash blanketing (GCTB), even in ‘D’ class, and no longer burn cane before harvest. It has also been assumed (for all regions) that the grower changes from narrow rows (1.5m) to wider rows (1.8-2.0m) in the process of implementing controlled traffic as the move is made from ‘C’ class to ‘B’ class management.

Table 6, 7 and 8 show the potential practice changes that a grower may undertake in the transition from one management class to another management class. The changes listed will vary for each farming business and largely depend on soil type, farm size, machinery, access to contractors and individual circumstances.

Table 6: Potential practice changes transitioning from 'D' to 'C' class management

WT	*MWS*	*BDT Delta*	*BDT BRIA*
Slight reduction in the number of soil preparation passes before cane planting	Slight reduction in the number of soil preparation passes before cane planting	Reduction in the number of soil preparation passes pre cane planting	Reduction in the number of soil preparation passes pre cane planting
Reduction in cultivation in ratoon cane	Reduction in cultivation in ratoon cane	Reduction in the number of cultivations post cane planting	Reduction in the number of cultivations post cane planting
Reduction in fertiliser application rates	Reduction in fertiliser application rates	Reduction in cultivation in ratoon cane	Reduction in cultivation in ratoon cane
More flexible chemical strategy across the farm	New implement: stool splitter	Reduction in fertiliser application rates	Reduction in fertiliser application rates
Basic record keeping	More flexible chemical strategy across the farm	Change to applying fertiliser sub-surface for all applications	More flexible chemical strategy across the farm
Limited soil tests taken	Basic record keeping	More flexible chemical strategy across the farm	Basic record keeping
Decrease in farm labour requirements	Many blocks with short rows – inefficient harvesting	Basic record keeping	Decrease in farm labour requirements
	Some laser levelling to improve water drainage	Decrease in farm labour requirements	

Table 7: Potential practice changes transitioning from 'C' to 'B' class management

WT	*MWS*	*BDT Delta*	*BDT BRIA*
GPS used for planting Controlled traffic at 1.8m row spacing	Planting and harvesting contractors to have GPS capacity	GPS used for cane planting equipment	GPS used for cane planting and harvesting equipment
Further reduction in tillage passes before cane planting	Cane beds retained between crop cycles	Controlled traffic at 1.8m row spacing	Controlled traffic at 1.8m row spacing
No tillage in ratoon cane	Zonal tillage instead of whole block tillage	Further reduction in tillage passes pre and post cane planting	Further reduction in tillage passes pre and post cane planting
Soil tests undertaken in each fallow block before planting	Further reduction in tillage passes before cane planting	No tillage in ratoon cane	No tillage in ratoon cane

WT	*MWS*	*BDT Delta*	*BDT BRIA*
Fertiliser application rates based on soil tests	No tillage in ratoon cane	Soil tests undertaken in each fallow block before planting	Soil tests undertaken in each fallow block before planting
Use of legume crops in half of the fallow area Spray-out of fallow area	Possible new/modified planter: either double disc opener, wide shute planter, or other suitable planter modifications	Fertiliser application rates based on soil tests	Fertiliser application rates based on soil tests
Increased chemical use – but targeted to each blocks requirements	Modification of implements to wider rows and controlled traffic farming	Use of soybean legume crop in fallow area, legumes grown on raised beds	Use of soybean legume crop in fallow area, legumes grown on raised beds
Development of a soil management plan	Possible new implements: zonal ripper, zonal rotary hoe, bed renovator, etc.	Increased chemical use – but targeted to each blocks requirements	Increased chemical use – but targeted to each blocks requirements
Paper based records of block activities	Harvester changes: automated base cutter height and yield monitors fitted	Development of a soil management plan	Use of more accurate spray nozzles – matched to job
Use of climate and weather forecasts	Soil tests undertaken	Paper based records of block activities	Development of a soil management plan
Decrease in farm labour requirements	Fertiliser application rates based on soil tests	Use of climate and weather forecasts	Paper based records of block activities
	Use of legume crops in fallow – either for mulch or for grain	Decrease in farm labour requirements	Use of climate and weather forecasts
	Increased chemical use – but targeted to each blocks requirements		Decrease in farm labour requirements
	Maybe applying some chemicals zonally with a hooded sprayer		
	Use of more accurate spray nozzles – matched to job		
	Development of a soil management plan		

WT	MWS	BDT Delta	BDT BRIA
	Paper based records of block activities		
	Longer harvesting rows by harvesting through multiple blocks – greater efficiency		
	Storm water storages/ sediment traps		
	Use of climate and weather forecasts		

Table 8: Potential practice changes transitioning from 'B' to 'A' class management

WT	*MWS*	*BDT Delta*	*BDT BRIA*
All major machinery controlled by GPS guidance	Purchase and use of GPS for controlled traffic	All major machinery controlled by GPS guidance	All major machinery controlled by GPS guidance
Increase in contract harvesting cost to accommodate for the GPS on harvester and haul-outs	All machinery controlled by GPS guidance including haulouts and dunder trucks	Green Cane Trash Blanketing (GCTB)	Green Cane Trash Blanketing (GCTB)
Further reduction in tillage passes before cane planting, zero tillage after planting.	Further reduction in tillage passes before cane planting	Controlled traffic at 1.8m row spacing	Controlled traffic at 1.8m row spacing
EM mapping of farm	Electromagnetic (EM) mapping of farm	Zero tillage post cane planting	Zero tillage post cane planting
Soil test taken in each fallow block and selected leaf tests undertaken	Possible new implements: bed renovator, further modification of zonal implements	Trash splitter used in ratoons for GCTB	Trash rake used in ratoons for GCTB
Fertiliser & soil ameliorant rates application rates based on soil and leaf tests and EM mapping	Possible new/modified planter: either double disc opener, wide shute planter, or other suitable planter modifications	Permanent beds kept on half of the fallow area	EM mapping of farm
Use of legume crops in half of the fallow area Spray-out of fallow area	Variable chemical application within blocks using maps and GPS	EM mapping of farm	Soil test taken in each fallow block and selected leaf tests undertaken

WT	*MWS*	*BDT Delta*	*BDT BRIA*
Variable chemical application using maps and GPS	Knockdown chemicals used more and residual chemicals used less	Soil test taken in each fallow block and selected leaf tests undertaken	Use of soybean legume crop in fallow area, legumes grown on raised beds and harvested for grain
Knockdown chemicals used more and residual chemicals used less	Probably some zonal spraying with a hooded sprayer	Use of soybean legume crop in fallow area, legumes grown on raised beds and harvested for grain	Knockdown chemicals used more and residual chemicals used less
Zonal spraying with a hooded sprayer	Detailed electronic based farm records	Knockdown chemicals used more and residual chemicals used less	Zonal spraying with a hooded sprayer
Detailed electronic based farm records	Use of irrigation software to plan, monitor and record irrigations	Zonal spraying with a hooded sprayer	Detailed electronic based farm records
Decrease in farm labour requirements		Detailed electronic based farm records	Decrease in farm labour requirements
		Decrease in farm labour requirements	

4.3. Implementation (capital) costs

The capital costs incurred by any grower transitioning from one management class to another will vary substantially. The regional capital costs that have been included in this financial-economic analysis are shown in Table 9, 10, 11 and 12. Because for each individual grower this list would be different, the capital costs used in the analysis represents just one possible investment scenario. Each individual grower investigating the economic returns to transitioning should undertake their own analysis of the expected costs and benefits associated with the transition.

Table 9: WT expected capital costs

Capital Item	*Cost*
'D' Class to 'C' Class	
No capital investment	$0
Total	**$0**
'C' Class to 'B' Class	
Stool splitter fertiliser box	$40,000
Sprayer modifications	$5,000
Harvester modifications	$12,500
Farm tractor modifications	$1,500
Total	**$59,000**

'B' Class to 'A' Class	
GPS on farm tractor	$40,000
Shielded sprayer	$28,000
Ripper/Rotary Hoe modifications	$20,000
Total	**$88,000**

Table 10: MWS expected capital costs

Capital Item	*Cost*
'D' class to 'C' class	
Stool splitter	$10,000
Total	**$10,000**
'C' class to 'B' class	
Modification of other implements to wider row spacing	$25,000
Purchase zonal rotary hoe	$75,000
Purchase shielded sprayer	$40,000
Total	**$140,000**
'B' class to 'A' class	
EM mapping of property	$2,000
Modification of zonal rotary hoe to include zonal ripper	$8,000
Purchase FarmPro GPS unit and base station for variable fertiliser and chemical application	$39,000
Total	**$49,000**

Table 11: BDT Delta expected capital costs

Capital Item	Cost
'D' Class to 'C' Class	
No Capital Investment	$0
Total	$**0**
'C' class to 'B' class	
Stool splitter fertiliser box	$40,000
Sprayer modifications	$5,000
Bed former	$10,000
Harvester modifications	$12,500
Farm tractor modifications	$1,500
Total	$**69,000**
'B' class to 'A' class	
GPS on farm tractor	$40,000
Shielded sprayer	$28,000
Trash splitter	$15,000
Total	$**83,000**

Table 12: BDT BRIA expected capital costs

Capital Item	*Cost*
'D' class to 'C' class	
Bed former	$35,000
Total	$**35,000**
'C' class to 'B' class	
Stool splitter fertiliser box	$50,000
Sprayer modifications	$10,000
Harvester modifications	$12,500
Farm tractor modifications	$1,500
Total	$**74,000**
'B' class to 'A' class	
GPS on farm tractor	$40,000
Shielded sprayer	$28,000
Trash rake (GCTB)	$18,000
Total	$**86,000**

In addition to the capital costs in Table 9, 10, 11 and 12, there are some annual costs associated with changing between management classes. For 'B' and 'A' class management, soil and leaf tests are included per annum. These annual costs are associated with improvements in fertiliser application rates in 'B' class and 'A' class nutrient management. These annual costs have been included in the investment analysis rather than the GMs as they resemble a capital cost of transitioning classes.

4.4. Investment Analysis

An investment analysis was undertaken using the NPV technique to determine if the investment in capital is worthwhile and creating value for the farming business. The investment analysis framework implicitly accounts for the opportunity cost of the extra 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 7% has been used to convert the future cash flows of the cane business to their present values (value in today's dollar terms).

Table 13, 14, 15 and 16 show the net present values associated with changing from one class to another class over both a 5 year and 10 year investment period. The NPVs are greater for the 10 year investment period due to the fact that the large capital costs are incurred at the beginning of the investment, but the smaller improvements in cash flow are received annually. Thus the longer the investment time period, the more years of increased cash flow to offset the initial capital investment.

Table 13: WT NPV analysis

Change in management practice class	*Net Capital Investment*	*NPV (10 year analysis)*	*NPV (5 year analysis)*
D class to C class	$0	$73,020	$42,627
C class to B class	$59,000	$70,538	$16,621
B class to A class	$88,000	-$64,748	-$74,426

Changing from 'D' to 'C' requires no additional capital outlays and earns a positive NPV (5 years) of $42,627 and $73,020 (10 years). The results indicate that a change from 'D' to 'C' is clearly a worthwhile proposition.

Changing from ‘C’ to ‘B’ requires an additional capital outlay of $59,000 and earns a positive NPV of $16,621 over a 5 year investment horizon. The 10 year investment horizon revealed a positive NPV of $70,538. Both scenarios indicate that the investment required to change from ‘C’ to ‘B’ is worthwhile from an economic perspective.

Changing from ‘B’ to ‘A’ requires an additional capital outlay of $88 000 and is likely to produce a negative NPV of -$64,748 (5 years) and -$74,426 (10 years). The negative NPV indicates that the transition from ‘B’ to ‘A’ class management is not a worthwhile investment.

Table 14: MWS NPV analysis

Change in management practice class	*Net Capital Investment*	*NPV (10 year analysis)*	*NPV (5 year analysis)*
D class to C class	$10,000	$155,386	$86,548
C class to B class	$140,000	-$75,212	-$107,300
B class to A class	$49,000	$83,387	$28,204

Changing from ‘D’ to ‘C’ requires an additional capital outlay of $10,000 and earns a positive NPV (5years) of $86,548 and $155,386 (10 years). The results indicate that a change from ‘D’ to ‘C’ is clearly a worthwhile proposition.

Changing from ‘C’ to ‘B’ requires an additional capital outlay of $140,000 and is likely to produce a negative NPV of -$107,300 (5years) and -$75,212 (10 years). The negative NPV indicates that the transition from ‘C’ to ‘B’ class management is not a worthwhile investment.

Changing from ‘B’ to ‘A’ requires an additional capital outlay of $10,000 and earns a positive NPV (5years) of $28,204 and $83,387 (10 years). The results indicate that a change from ‘B’ to ‘A’ is clearly a worthwhile proposition.

Table 15: BDT Delta NPV analysis

Change in management practice class	*Net Capital Investment*	*NPV (10 year analysis)*	*NPV (5 year analysis)*
D class to C class	$0	$276,107	$161,185
C class to B class	$69,000	$301,440	$147,254
B class to A class	$83,000	$26,648	-$18,990

Changing from ‘D’ to ‘C’ requires no additional capital outlays and earns a positive NPV (5years) of $161,185 and $276,107 (10 years). The results indicate that a change management practice from ‘D’ to ‘C’ is clearly a worthwhile proposition.

Changing from ‘C’ to ‘B’ requires an additional capital outlay of $69,000 and earns a positive NPV of $301,440 over a 5 year investment horizon. The 10 year investment horizon also revealed a positive NPV of $147,254. The results indicate that the investment required to change from ‘C’ to ‘B’ class management practice is worthwhile from a financial-economic perspective.

Changing from ‘B’ to ‘A’ requires an additional capital outlay of $83,000 and is likely to produce a negative NPV of -$18,990 over a five year investment horizon. The negative NPV indicates that the investment is not worthwhile. The 10 year investment horizon displayed a marginally positive NPV of $26,648.

Table 16: BDT BRIA NPV analysis

Change in management practice class	*Net Capital Investment*	*NPV (10 year analysis)*	*NPV (5 year analysis)*
D class to C class	$35,000	$594,256	$332,345
C class to B class	$74,000	$279,846	$132,567
B class to A class	$86,000	$156,474	$55,551

Changing from 'D' to 'C' requires $35,000 additional capital outlay and earns a positive NPV of $332,345 (5 years) and $594,258 (10 years). The results indicate that a change from 'D' to 'C' is worthwhile from a financial-economic perspective.

Changing from 'C' to 'B' requires an additional capital outlay of $74,000 and displays a positive NPV of $132,567 over a 5 year investment horizon. The 10 year investment horizon revealed a positive NPV of $279,846. The results indicate that changing from 'C' to 'B' class management is a worthwhile investment for the farming business.

Changing from 'B' to 'A' requires an increase in capital investment of $86,000 and is likely to produce a positive NPV of $55,551 (5years) and $156,474 (10 years). The results indicate that a change from 'B' to 'A' class management is a worthwhile proposition from a financial-economic perspective.

4.5. Risk Analysis

A risk analysis has been undertaken due to the uncertainty that surrounds future cash flows. These future cash flows can be significantly influenced either positively or negatively from variability in the prices received and yields obtained from both the cane and fallow crops. This work has used PiRisk to introduce stochastic properties (variability) into the analysis by specifying probabilistic distributions for the variables that are considered most important. The outcomes for the risk analysis are arranged as cumulative probability curves. The risk analysis focuses on variability in cane price and yield, and soya bean price and yield.

In the last 10 years, the sugar price has varied between $230 and $450 per tonne, while the average of the last 5 years is $349.30. This is the base net sugar price used for the analysis. For the risk analysis, the minimum price has been set at $230/tonne and the maximum price at $450/tonne. The average soy price has been assumed at $450/tonne in the base case. For the risk analysis, it is assumed that the minimum price will never be less than 50% of the base case price and the maximum will never be more than 50% higher than the base price.

The base case cane and soy yields were obtained from the APSIM crop modelling programme that uses approximately 100 years of weather information for a particular site and the relevant soil type to calculate expected yields. Therefore, as the modelled yields already incorporate a large number of years of data, the risk analysis has simply assumed that the minimum (maximum) yield is 50% lower (higher) than the modelled yields. Due to the fact that cane has five yields before it is replanted, and the general trend of yields during this period is a slight reduction each year, only the first year's yield has been made variable in the risk analysis. The ratoon yields are assumed to follow the same trend of reductions. This avoids the problem of the simulated yields not following a standard pattern of reduction that occurs if all yields are made variable.

For each variable, the probabilities have been set so that 50% of the time the actual price/yield received will be less than the base case and 50% of the time it will be more than the base case, bounded by the minimum and maximum prices. PiRisk was used to calculate ten thousand simulations of the GMs with random values being chosen from the probability distributions for prices and yields of both cane and soy. The total property GMs obtained from each of the ten thousand simulations for each management class per region are plotted on the cumulative probability graph in Figure 1, 2, 3 and 4.

Figure 1: WT distribution of farm GMs

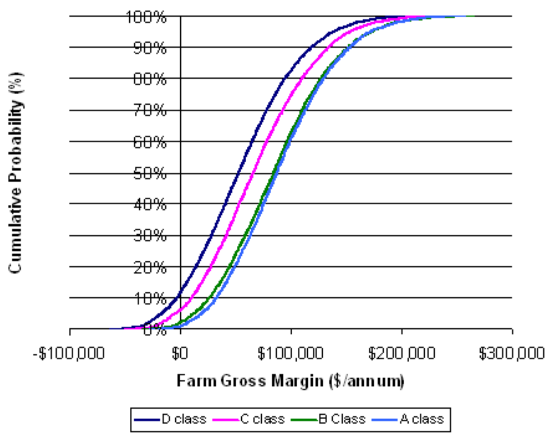


Figure 2: MWS distribution of farm GMs

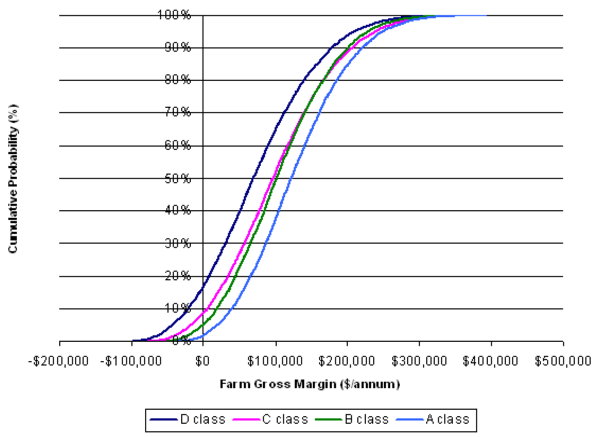


Figure 3: BDT Delta distribution of farm GMs

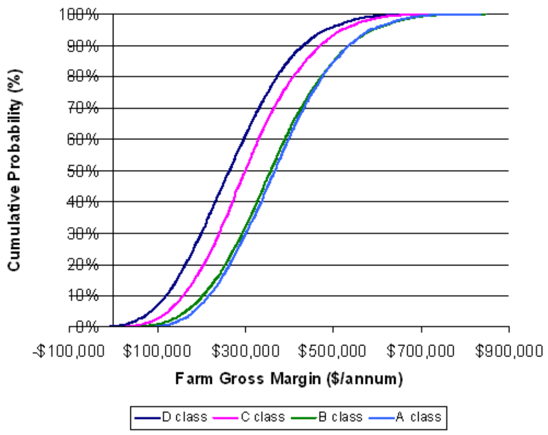
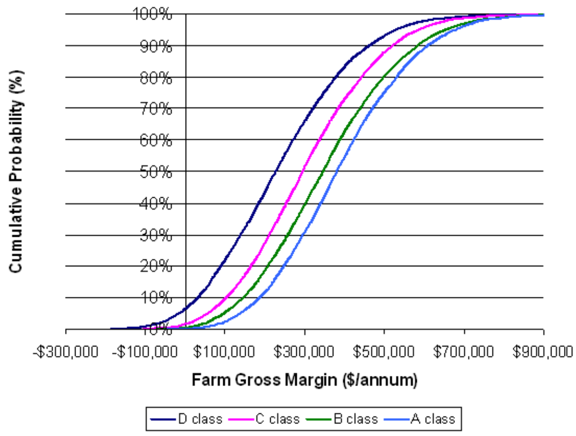


Figure 4: BDT BRIA distribution of farm GMs



The key observations from the PiRisk analysis in all regions (Figure 1, 2, 3 and 4) is that the 'D' and 'C' classes have a higher probability of making a negative (or less positive) farm GM compared with 'A' and 'B' class management. This suggests that farms using 'A' and 'B' class management will be stronger financially than those persevering with 'D' and 'C' class management, all else being equal, in any given year. The results also indicate that the maximum negative GM is substantially higher for 'D' and 'C' class management. The graph emphasises the superiority of 'A' and 'B' class management over the other options, however this does not take into account fixed costs and capital investment required to make the transition. Therefore, the interpretation of this graph should be carried out in conjunction with the NPV figures outlined in section 5 of this report.

In general, Figure 1, 2, 3 and 4 shows that all growers could expect their farm GM to be higher with any improvement in management undertaken.

5. CONCLUSIONS AND DISCUSSION

This financial-economic analysis is based on APSIM modelled cane and legume (soy and cowpea) yields, the assumptions discussed in Section 3 and the financial indicators associated with transitioning discussed in Section 4. A conclusive summary of the results is presented in this section, followed by points of discussion and caveats that should be noted.

Wet Tropics

Based on these assumptions, yields and costs it can be concluded that from a financial-economic perspective, a grower in the WT can expect financial benefits from moving from 'D' to 'C' and 'C' to 'B' class management. However, a grower currently operating in 'B' class management will not be better off transitioning to 'A' class management. Changing from 'C' to 'B' class management displayed the greatest benefit with a more resilient farm GM and a positive net present value with either a five year or ten year investment period. The risk analysis showed that in any specific year, a grower will receive a higher farm GM when operating with an improved class of management, although the difference is small between 'B' and 'A' class management. This indicates that the likelihood of a farmer operating in 'A' and 'B' class management making a negative farm operating return is lower compared to operating in 'C' and 'D' class management.

Mackay Whitsundays

A grower in the MWS currently operating in 'D' class management would be better off transitioning to 'C' class management with either a 5 year or 10 year investment period. However, a grower currently operating in 'C' class management may not be better off transitioning to 'B' class management, depending on the capital investment required and the length of the investment period. A grower currently operating in 'B' class management is expected to be better off transitioning to 'A' class management, although the benefit may be small, even over a 10 year investment period. The risk analysis showed that in any specific year, a grower will receive a higher GM per hectare when operating with an improved class of management, although the difference is small between 'C' and 'B' class management.

Burdekin Dry Tropics - Delta region

In the BDT Delta region, the NPV results indicate that the transition from 'D' to 'C' and 'C' to 'B' class management is worthwhile from an economic perspective for both the 5 year and 10 year investment period. The changing from 'B' to 'A' class management provided a marginal financial benefit over a 10 year investment horizon so is not considered to be a worthwhile investment (negative NPV) over a five year investment horizon. The risk analysis showed that in any specific year, a grower will receive a higher farm GM when operating in an improved class management; although the difference is small between 'B' and 'A' class management. This indicates that 'A' and 'B' class management will be stronger financially than those persevering in 'D' and 'C' class management.

Burdekin Dry Tropics – BRIA region

For a grower in the BDT BRIA region, the results of the financial-economic analysis indicate that the transition from 'D' to 'C', 'C' to 'B' and 'B' to 'A' is a worthwhile proposition from an economic perspective for both the 5 year and 10 year investment period. The change from 'D' to 'C' class management provided the highest NPV result. The risk analysis indicates that in any specific year, a grower will receive a higher farm GM when operating in an improved class of management. The results indicated an increase in farm GM when progressing through the management practice classes from 'D' to 'A'. This suggests that 'A', 'B' and 'C' class management will be stronger financially than those persevering with 'D' class management.

Furthermore, in the BDT BRIA region, the fertiliser application rates that have been used for the APSIM modelling are not fully supported by growers for the 'B' and 'A' class management categories and the cane yields modelled by APSIM may not be achievable in reality with the low rate of fertiliser application. The rate of nitrogen application following a legume crop in fallow is also subject to further research and may be influenced by various biophysical, environmental and management factors. A sensitivity analysis was undertaken for plant cane nitrogen application rates in ‘A’ and ‘B’ class management in the BDT BRIA region to determine the overall influence on NPV results. The sensitivity analysis indicated that there is little to no impact on the overall NPV decision rule results when applying additional nitrogen to plant cane following a legume fallow.

Overall, this financial-economic analysis has shown that there are expected to be benefits to growers through transitions to improved cane management, although the benefits will vary for each individual grower depending on their starting point and their individual property scenario. Therefore, this analysis indicates that education regarding the expected benefits of transition to improved cane management may encourage some growers in the region to begin the transition. However, as previously noted, the costs and benefits associated with a transition to improved management will be different for each individual grower and therefore each circumstance needs to be carefully considered before making a change in management practice. If the benefits of transitioning to improved management are not greater than the costs, then individual growers are unlikely to transition. However, this may just mean that incentives are required to assist growers to transition, if the environmental benefits of the transition are deemed to be important.

A few caveats must be noted. First, the ‘ABCD’ framework used in this economic work is based on the ‘ABCD’ framework as per reference of 2007-2008. Therefore, some of the mechanical operations, chemical use and fertiliser use presented in this report may not necessarily link up with what growers may think should be in each management class today. The framework for the various NRM regions is currently being updated to clarify some issues and incorporate new knowledge since the earlier version of the framework. However, this updated version is not yet complete and so this project has used the most current available version of the framework for its analysis.

Next, it must be acknowledged that the machinery operations, chemical applications and fertiliser applications modelled in this project are only one of a myriad of possible scenarios that could equally suit each management class. For example, there are several different methods of practicing zonal cultivation in ‘B’ and ‘A’ class soil management, and several ways of obtaining the implements to practice in that manner. A grower may decide to modify existing ripper or rotary hoe implements into a zonal ripper or zonal rotary hoe. Or due to individual circumstances, the grower may decide to purchase a totally new implement such as a bed renovator, combined ripper/rotary hoe, etc. Therefore, the results presented in this report are one possible set of figures to show the changes in profitability of a grower operating in different management classes. Also, the information presented on ‘A’ class management is based on practices under research and not thoroughly tested on a commercial scale. Caution must be taken with the interpretation of the actual numbers presented in this management class.

From a policy perspective, it is important to note that the results in this report are not prescriptive of every landholder. Some landholders will face higher or lower costs from transitioning to improved practices than those presented in this report, and some landholders will end up with a higher or lower GM than those provided in this report, even if similar operations are practiced. Further research into the spatial, social and enterprise heterogeneity of the sugarcane industry is recommended.

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Contact Us

Phone: 1300 363 400
+61 3 9545 2176

Email: enquiries@csiro.au

Web: www.csiro.au

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