Department of **Employment, Economic Development and Innovation**

Paddock to Reef Monitoring & Evaluation

Economic analysis of ABCD cane management practices for the Mackay Whitsunday region

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1. Background

1.1 ABCD Framework

The economic analysis is based on the A, B, C and D management practice framework for water quality improvement developed in 2007/2008 by the respective natural resource management region. The Mackay Whitsunday ABCD management framework for sugarcane management practices was published in 2009 by the Department of Primary Industries & Fisheries (DPI&F), following the original version that was published in the Water Quality Improvement Plan: final report for Mackay Whitsunday region (2008).

The ABCD framework used in this economic work is based on the ABCD framework as at 2007-2008. Therefore, some of the mechanical operations, chemical use and fertiliser use may not necessarily link up with what growers may think should be in each management class today. The framework for Mackay Whitsunday 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 the Paddock to Reef project has used the most current available version of the framework for the modelling and economics.

While the ABCD framework provides descriptions, level of planning and record keeping, and machinery for each management class, it does not go to 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 in the FEAT program. The final list of machinery operations, chemical application and fertiliser applications used for the modelling and economic analysis are detailed in the CSIRO MTSRF project 3.7.5.

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 economic work are one possible set of figures to show the changes in profitability of a grower operating in different management classes. It is recommended that each individual grower who may look to progress towards A class management practices undertake their own research and analysis into the expected costs and benefits for their own soil types and property circumstances. From a policy perspective, it is important to note that the results in this report are not prescriptive of every landholder. Some landholders will have higher/lower costs of transitioning to improved practices, and some landholders will end up with higher/lower gross margins than those provided here even if similar operations are practiced.

1.2 APSIM

Information obtained from APSIM crop modelling programme:

- Cane yields for plant cane and each ratoon
- Legume grain yield

Note also that the fertiliser application rates detailed in MTSRF project 3.7.5 are not supported by growers from the Mackay Whitsunday region in the B and A class management categories. While B class fertiliser application rates are based on the 6 Easy Steps programme accepted by industry, for modelling and economic purposes a specific fertiliser application rate had to be chosen, whereas in reality the application rate is determined using 6 Easy Steps after relevant soil tests. For A class management, this project has used the Nitrogen Replacement Theory developed by CSIRO. This method of calculating fertiliser application rates is not yet accepted by industry, and has not yet been proven to be either scientifically or economically sound, although further scientific work is on-going. Therefore, particularly for the A class management category, the cane yields (particularly the ratoon yields) modelled by APSIM may not be achievable in reality with the low rate of fertiliser application. In addition, even if the nitrogen requirements are met by the legume fallow crops grown in rotation with the sugar cane, fertiliser application will still be required in both plant cane and ratoon cane to alleviate phosphorus, potassium and sulphur deficiencies.

1.3 Economic Analysis

An economic analysis was undertaken to determine the economic impact of a change in management practice as detailed in the A, B, C and D management practice framework. The economic analysis focused on the implications of changing from D–C, C–B and B–A practices. It is recognised that these management practices have certain limitations and in many cases the grouping of practices may not be reflective of the real situation. The aim of this report is to provide a guide to the economic impact that may be expected when undertaking a particular change in farming practices and will ultimately lead to more informed decisions being made by key industry stakeholders.

Because of the complexity involved in the economic calculations, a combination of FEAT, PiRisk 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 Net Present Value of transitioning across different management practices.

Each farming business is unique in its circumstances and the parameters and assumptions used in this economic analysis do not reflect every individual's situation. Consideration of individual circumstances must be made in order to make an informed investment decision.

1.4 FEAT

FEAT (Farm Economic Analysis Tool), developed by the DPI&F FutureCane initiative, is a computer based economic analysis tool designed specifically for the sugar industry (Stewart and Cameron, 2006). FEAT was primarily designed to enable the economic analysis of various farming system practices. Population of FEAT enables calculation of the gross margin 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 gross margins to obtain a sugar enterprise gross margin. The gross margins for sugar cane and any other included fallow crops are combined to give the farm or property gross margin. This property gross margin takes into account all income received from the cane and fallow crops and the variable costs associated with growing the crops. The property gross margin does not take into account the fixed costs of running the business such as telephone, electricity, depreciation, etc. Note that the property gross margin is directly influenced by the size of the property. Viewing the results as Gross Margin 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.

1.5 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. It 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 an economic analysis and determine the potential risk associated with a change in value. In this economic analysis, a risk analysis was completed for sugarcane price, sugarcane yield, soybean price and soybean yield to determine their impact on gross margin.

2. Assumptions

- Eton soil type and rainfall assumed to approximate cane yields in the rest of the region
- Net sugar price: $349.30: This is the 5 year average price from 2005 to 2009
- 150 hectare farm: average farm size for the Mackay region
- CCS: 13.706: This is the 5 year average CCS for the Mackay Sugar Mill
- Contract harvest cost: $7/tonne + 1.25L fuel/tonne without GPS guidance for D and C class management, and $7.30/t with GPS guidance for B and A class management
- Contract planting cost: $358/ha without GPS guidance for D and C class management, and $370.65/ha with GPS guidance for B and A class management
- Fuel price without GST and after rebate: $0.85/L
- Labour cost: $30/hour
- 10% of land as bare fallow in D and C class management
- 50% of third ratoon is taken and ploughed out and re-planted before reaching the fourth ratoon
- 17% of land as a legume fallow crop grown for mulch in B class management
- 17% of land as a legume fallow crop grown for grain in A class management
- $17/ML Part B water charge for irrigation
- 1ML/ha irrigation on all cane and soy (note that this should be 3ML/ha, but the APSIM run only used 1ML, so the economic analysis had to do likewise)
- All chemical and fertiliser prices are April 2010 prices for Mackay
- Soil test cost: $130/test
- Leaf test cost: $50/test
- Detailed machinery operations, fertiliser application rates and chemical application rates are contained in the MTSRF project 3.7.5 document

- 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 gross margins are considered to be steady state gross margins, for a representative property operating exclusively in each management class. In reality, most farms would operate across a few management classes, and there would be long periods of transition. The transition time from one class to the next class has not been included in the analysis.

3. Gross Margins

The gross margin is the income received from the crop minus the costs of growing the crop. Cane growing enterprises differ significantly to other broadacre crops due to the ability to harvest the crop multiple times before replanting costs are again incurred. Therefore, the growing costs in the first year “the plant cane” year are always higher than the growing costs of the “ratoons” due to the additional machinery operations involved in preparation of the soil for cane planting.

The Table 3.1 below details the gross margins for plant cane, each ratoon and the soy fallow crop for each class of management practices. Fallow management costs for D and C management practices are also included. The changes in labour requirements for each class of management practices are included in the gross margins. All machinery operations include $30 per hour for labour. Thus as cultivation decreases as a grower moves from D class practices to A class practices, the labour savings contribute to the higher gross margin.

Table 3.1: Gross Margins

Scenario Name	Plant Cane GM/ha	Ratoon 1 GM/ha	Ratoon 2 GM/ha	Ratoon 3 GM/ha	Ratoon 4 GM/ha	Total Cane GM/ha	Bare fallow GM/Ha	Soy GM/ha	Farm GM/ha
D class	-$441	$1,026	$934	$740	$586	$498	-$123	N/A	$498
C class	-$276	$1,208	$1,137	$933	$772	$655	-$130	N/A	$655
B class	$227	$1,382	$1,305	$1,089	$933	$823	N/A	-$660	$713
A class	$677	$1,484	$1,381	$1,156	$996	$949	N/A	-$610	$847

The table shows that the gross margin per hectare improves for plant cane and all cane ratoons as a grower moves from D class practices to A class practices. However, the soy fallow crop gross margin per hectare is negative indicating that the income received from the crop is insufficient to cover the costs of growing the crop. In B class this negative return is expected, as it has been assumed that the crop is not harvested, but rather left as mulch. Therefore, the growing costs of the soy are incurred, but there is no income to offset the growing costs. In A class it is assumed that the soy crop is harvested, but the negative gross margin indicates that the yield and price received are insufficient to cover the costs of growing the crop. However, there are other benefits to the grower of growing a legume fallow crop such as improved soil structure, nitrogen fixation, and disease management, that may induce a grower to plant a legume fallow crop even if the gross margin is negative.

4. Costs of changing management classes

4.1 Practice changes

It has been assumed that all growers have already adopted Green Cane Trash Blanketing, even in D class, and no longer burn cane before harvest. It has also been assumed 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. The transitioning process has been modelled to occur over a 12 month period with the whole benefit received in the first year. It is acknowledged that this may not be the case for all businesses and any grower seeking to make the transition should seek individual economics advice.

Table 4.1 shows 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 slightly for every individual business depending on their soil type, scale, machinery, access to contractors, and desire to improve. Most of these potential changes are captured in the economic analysis, however, some are not, such as the costs of better record keeping, improvements in computer skills, and laser levelling.

Table 4.1: Potential practice changes

D class to C class
Slight reduction in the number of soil preparation passes before cane planting
Reduction in cultivation in ratoon cane
Reduction in fertiliser application rates
New implement: stool splitter
More flexible chemical strategy across the farm
Slightly better record keeping
Many blocks with short rows – inefficient harvesting
Some laser levelling to improve water drainage
C class to B class
Planting and harvesting contractors to have GPS capacity
Cane beds retained between crop cycles
Zonal tillage instead of whole block tillage
Further reduction in tillage passes before cane planting
No tillage in ratoon cane
Possible new/modified planter: either double disc opener, wide shute planter, or other suitable planter modifications
Modification of implements to wider rows and controlled traffic farming
Possible new implements: zonal ripper, zonal rotary hoe, bed renovator, etc.
Harvester changes: automated base cutter height and yield monitors fitted
Soil tests undertaken
Fertiliser application rates based on soil tests
Use of legume crops in fallow – either for mulch or for grain
Increased chemical use – but targeted to each blocks 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
Development of computer skills
Much better record keeping
Longer harvesting rows by harvesting through multiple blocks – greater efficiency
Storm water storages/ sediment traps
Use of climate and weather forecasts
B class to A class
Purchase and use of GPS for controlled traffic
All machinery controlled by GPS guidance including haulouts and dunder trucks
Further reduction in tillage passes before cane planting

Electromagnetic (EM) mapping of farm
Possible new implements: bed renovator, further modification of zonal implements
Possible new/modified planter: either double disc opener, wide shute planter, or other suitable planter modifications
Variable chemical application within blocks using maps and GPS
Knockdown chemicals used more and residual chemicals used less
Probably some zonal spraying with a hooded sprayer
Continued development of computer skills
Use of irrigation software to plan, monitor and record irrigations

4.2 Capital Costs

The capital costs incurred by any grower transitioning from one management class to another will vary substantially as discussed in Section 4.1. The capital costs that have been included in this economic analysis are shown in Table 4.2. It is assumed that at the end of the 10 year investment period there is no salvage value, although for each grower this list would be different. Therefore, the capital costs used in the analysis represent just one possible investment scenario. It must also me noted that in transitioning from D management practices immediately to A management practices capital costs not all capital costs were included i.e. C to B class capital costs, therefore the capital cost are not cumulative. 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 4.2: Capital Costs

Capital Item	**Cost**
D class to C class	
Stool splitter	$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
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

In addition to the capital costs in Table 4.2, there are some annual costs associated with changing management classes. 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 gross margins as they resemble a capital cost of transitioning classes. For B class management, 3 soil tests and 3 leaf tests are included per annum, while for A class management 6 soil tests and 6 leaf tests are included per annum.

5. Investment Analysis

An investment analysis has been undertaken to determine if the increases in gross margin are sufficient to cover the costs associated with changing management practices. The investment analysis framework implicitly accounts for the opportunity cost of the decision.

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). This accounts for the generally large initial capital costs associated with making a change, and the smaller but longer term benefits of the change over the life of the investment. The result is the net present value (NPV) of future cash flows, and provides decision makers with a profitability indicator for selecting investments from an economic perspective. The net present values calculated in this work takes into account the difference in gross margin for the different management classes and the capital and annual costs incurred in moving to the new management class.

A positive NPV implies that the investment earns a rate of return in excess of the opportunity cost of capital and the business will be better off over the period of analysis by the amount of the NPV if the investment is undertaken. On the other hand, a negative NPV for an investment indicates that the business will be worse off if the investment is made.

Table 5.1 below shows the net present values associated with changing from one class to another class over both a 5 year and 10 year investment period. The NPV's are higher 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 5.1: Net Present Values

	NPV (10 year analysis)	NPV (5 year analysis)
D to C	$ 155,386	$ 86,548
C to B	$ (75,212)	$ (107,300)
B to A	$ 83,387	$ 28,204
D to B	$ 80,174	$ (20,751)
D to A	$ 186,559	$ 25,715
C to A	$ 12,508	$ (76,342)

6. Risk Analysis

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 which 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 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.

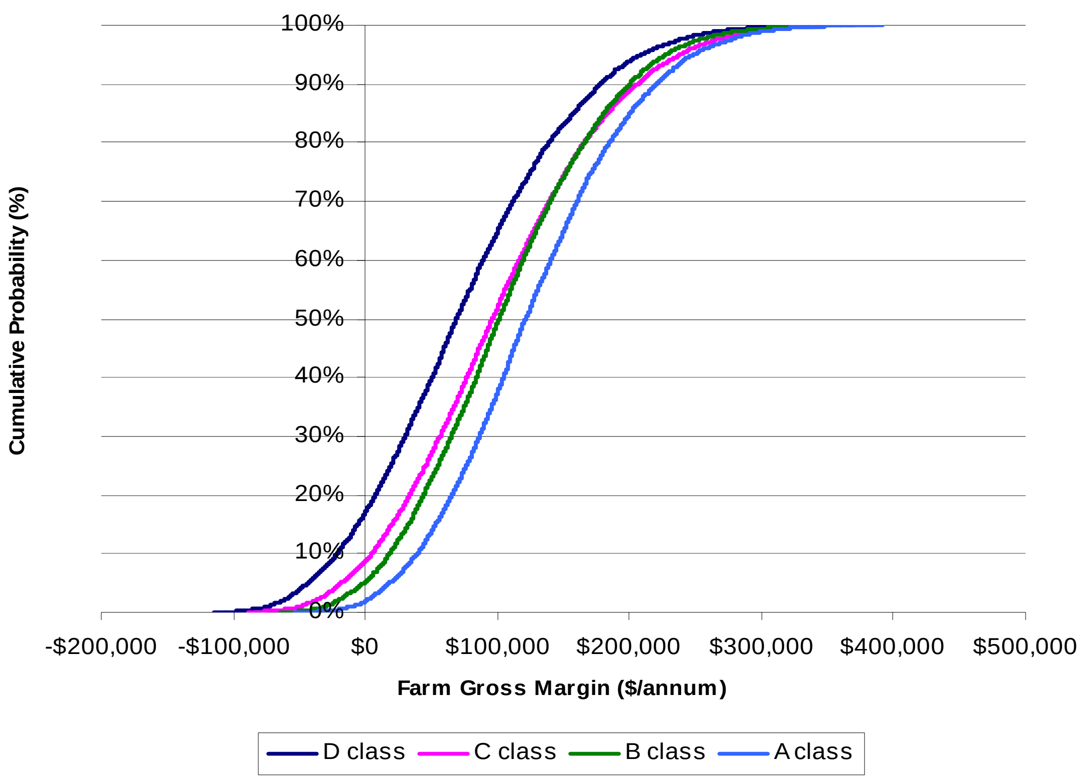
The average soy price has been assumed at $450/tonne in the base case. For the risk analysis, it is assumed that the minimum price will never be less than 50% of the base case price and the maximum will never be more than 50% higher than the base price.

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 gross margins with random values being chosen from the probability distributions for prices and yields of both cane and soy. The total property gross margins obtained from each of the ten thousand simulations for each management class are plotted on the cumulative probability graph in Figure 6.1.

The gross margins associated with each management class are shown in Figure 6.1. For D class management practices, there is a 18% chance of earning a negative gross margin for the business in any year, while this chance is reduces to 9% for C class management, 6% for B class management and 2% for A class management.

Figure 6.1: Distribution of Farm Gross Margins



Conversely the grower has a 50% chance of earning a gross margin greater than $71,000 and up to $292,000 in any year when operating with D class management practices (Figure 6.1). When operating with C class practices the grower has a 50% chance of earning a gross margin greater than $99,000 and up to $300,000 in any year; for B class greater than $103,000 and up to $313,000 in any year, and for A class greater than $124,000 and up to $366,000 in any year (Figure 6.1).

Figure 6.1 shows that all growers could expect their farm gross margin to be higher with any improvement in management practices undertaken.

7. Conclusions

This economic analysis is based on APSIM modelled cane and soy yields, the assumptions discussed in Section 2 and the costs associated with transitioning discussed in Section 4. Using this variety of assumptions, yields and costs shows that from an economic perspective, a grower currently operating with D class management practices would be better off transitioning to C class management practices with either a 5 year or 10 year investment period. However, a grower currently operating with C class management practices may not be better off transitioning to B class management practices, depending on the capital investment required and the length of the investment period. A grower currently operating with B class management practices is expected to be better off transitioning to A class management practices.

Overall, this economic analysis has shown that there are expected to be benefits to growers in the Mackay Whitsunday region through transitions to improved cane management practices, although the benefits will vary for each individual grower depending on their starting point and their individual property scenario.

The risk analysis showed that in any specific year, a grower will receive a higher gross margin per hectare when operating with an improved class of management practices, although the difference is small between C and B class management practices.

Therefore, this analysis indicates that education regarding the expected benefits of transition to improved cane management practices 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 practices will be different for each individual grower.

If the benefits of transitioning to improved management practices are not greater than the costs, 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.