PROFITABILITY AND ENVIRONMENTAL IMPLICATIONS WHEN GROWERS TRANSITION TO BEST MANAGEMENT PRACTICES

By

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Abstract

BEST MANAGEMENT PRACTICES (BMPs) have been developed on the basis that they are perceived to be beneficial for production and the environment. However research that holistically examines the economic and environmental implications of BMP adoption using 'real-farm' case studies is limited. The aim of this work was to evaluate the farm profitability and life cycle environmental implications of BMP adoption by six sugarcane growers in the Wet Tropics region of North Queensland. Economic, biophysical and farm management data before and after BMP adoption were supplied by participating growers and used in the Farm Economic Analysis Tool (FEAT) and Cane Life Cycle Assessment (CaneLCA) tool to determine the farm profitability and environmental implications of BMP changes. Despite variations between farms, the economic benefit or, more specifically, the annualised equivalent benefit, revealed a positive result for all farms ranging between $25 and $220 per hectare per year, suggesting that the changes toward BMP were economically beneficial for each farming business analysed. BMP adoption also resulted in reduced environmental impacts over the life cycle of sugarcane production, including reductions in potential water quality impacts from nutrients and pesticides, as well as energy use and greenhouse gas emissions. Under some conditions, the degree of economic and environmental benefits were found to be sensitive to increases or reductions in cane yield, and the yield necessary to break-even in terms of annual (economic) benefit was quantified in each case study. Overall, the project findings indicate that BMP implementation in the Wet Tropics can be a win-win for both economic and environmental outcomes. Communication of these findings may give confidence to growers to encourage further adoption, and may promote the industry's efforts to the wider public. The methods employed in the project could be used for further analysis of BMPs in other regions.

Introduction

The philosophy of the Smartcane Best Management Practice (BMP) program being implemented in the Queensland sugarcane industry (www.smartcane.com.au) is that 'management of inputs and operations in sugarcane production should be aimed at sustainability' (Schroeder *et al*., 2008).

The program responds to the desire to maintain and improve soil heath and yields (Troedson and Garside, 2005) and to concerns about water quality impacts from releases of nitrogen (N) (Thorburn *et al.*, 2013), sediment, and pesticides to waterways (Kroon *et al*., 2012). The 'concept of BMP recognises that the sugarcane production system is continually evolving [and] adoption of [BMP] on-farm should be underpinned by appropriate farm management planning that incorporates economic assessments' (Schroeder *et al*., 2008).

The BMP core modules are related to improving soil health and nutrient management, weed, pest and disease management, irrigation and drainage management.

Past research has focused largely on productivity, environmental and economic benefits in isolation of each other. Research related to the economic implications of BMPs has tended to focus on production outcomes (cane yields) with some limited consideration of operating costs. For example, production implications have been considered for practices addressing soil health (reduced tillage and controlled traffic) and nutrient management (optimising N application rates, legume fallow) (Braunack *et al.*, 2003; Garside *et al.*, 2004; Young and Poggio 2007; Halpin *et al.*, 2008; Schroeder *et al.*, 2009; Schroeder *et al.*, 2010; East *et al.*, 2012; Skocaj *et al.*, 2012). Production is a key determinant of income, but does not consider the capital costs or changes to expenses associated with practice change.

Consideration of operating costs in the literature has often been limited to costs directly associated with individual practice changes, instead of considering multiple practice changes to farming systems and their interactions. In this project, the evaluation of changes in farm profitability after BMP adoption considers capital investments and changes to whole-of-farm operating expenses, following the approach of Poggio *et al*., (2014), who assessed changed weed management practices (application method, rate management and herbicide selection).

The environmental benefits of BMP adoption on the water, air and soil quality of the immediate environment has been tested in former research through measurement or computer simulation. This has included: N-related water quality effects of changed N management practices (Thorburn *et al*., 2011; Webster *et al*., 2012; Biggs *et al*., 2013; Page *et al*., 2013); reduced greenhouse gas effects (nitrous oxide emissions) of changed N management practices (Allen *et al*., 2010; Thorburn *et al*., 2010; Wang *et al*., 2011; Wang *et al*., 2012; Wang *et al*., 2014); soil health and soil organic carbon effects of reduced tillage and changed trash management practices (Stirling *et al*., 2010; Page *et al*., 2013); and toxicity-related water quality effects of change herbicide management practices (Masters *et al*., 2013; Davis *et al*., 2014).

However environmental implications include not only direct impacts from activities at the farm, but also indirect impacts of up-stream supply chains producing agricultural inputs (fertilisers and pesticides, fuels and energy, transport). Life cycle assessment (LCA) considers all of these impacts to give a more complete picture of the environmental impacts. LCA has been used previously to assess the environmental implication of hypothetical practice changes (Renouf *et al*., 2014). Here we build on that prior work to assess real cases of practice change, which means that further environmental implications of practice change for the whole farming system can be estimated.

The aim of the project was to evaluate the farm profitability and life cycle environmental implications of BMP adoption by six sugarcane growers in the Wet Tropics region of North Queensland. The novelty of this work is the joint consideration of the economic and environmental implications, based on ‘real-farm’ case studies using comprehensive assessment methods. The results provide a more holistic ‘economic-environmental’ understanding of the implications of BMP adoption in the Wet Tropics region. Growers also provided complementary insights into the social dimensions of practice changes on real farms that highlighted the complex variations between farming systems and helped identify ‘whole-of-farm’ interactions between practice changes.

The findings from each of the six individual case studies have been reported in case study reports available at the DAF website (www.publications.qld.gov.au/dataset/best-management-practices-for-sugarcane). This paper summarises the findings from the six case studies overall. It is noted that some aspects of case studies have been simplified due to, for example, limited accessibility of data in earlier time periods or limited relevance of farm changes to BMP adoption, such as unrelated machinery upgrades.

Methods

The method involved evaluating the farm profitability and environmental impacts of six case study farming operations in the Wet Tropic sugarcane growing region, before and after adoption of BMPs.

Economic, biophysical and farm management data were provided by the participating growers. The Farm Economic Assessment Tool (FEAT) was used to calculate operating costs, income and gross margins, coupled with an investment analysis to generate indicators of farm profitability. The CaneLCA tool was used to generate indicators of environmental impacts.

Economic and environmental analyses were undertaken to evaluate how BMP adoption influences the profitability of the whole farming system and the life cycle environmental impacts of cane production were then considered. The sensitivity of the results to changes in cane yields was also assessed and the risk factors that can potentially compromise profitability and environmental improvements were considered. A feature of the method was that a suite of practice changes, rather than individual practice changes, were considered in commercial, rather than hypothetical settings, thus enabling insights from a whole-of-farming system perspective.

Case studies of BMP adoption

Six case study farms (CS1–CS6) were selected to provide a representative sample of BMP adoption across the Wet Tropics sub-regions, with farms located near Ingham, Tully, Innisfail, Cairns and Mossman (Figure 1) and ranging in size from 90 to 830 ha. Each of the case study farms has progressively implemented a suite of practices changes relevant to BMP modules on improving soil health, nutrient management, weed, pest and disease control and drainage. Examples of practice changes are displayed in Table 1.

Table 1—Suite of changes adopted at the case study farms.

Soil health	Increased row spacing Reduced tillage intensity and machinery operations Introduction of GPS guidance on tractors and/or harvesters Introduction of a bare fallow to a previously ‘ploughout-replant’ system (CS3 only)
Nutrient management	Reduced nitrogen application rates Introduction of a legume break crop Introduction of mill mud application (CS3 only) Change from surface application to sub-surface application of urea fertiliser (CS2 and CS3 only)
Weed, pest and disease control	Change in the type of herbicide active ingredients towards knockdown herbicides rather than residual herbicides (there were some changes in fungicide and insecticide use, but the main emphasis of changes has been for herbicides) Reduced application of herbicide activity ingredients through more precise application (banded or variable rate application)
Drainage	Laser levelling and improved drainage structures (CS5 and CS6 only)
Others	Cessation of post-harvest burning of harvest residues (CS3 only)

For each case study farm, the details relating to the farming system and management practices ‘before’ and ‘after’ BMP adoption were collected from growers. These practice parameters were used as inputs to the economic and environmental assessments that considered the combined effect of implementing the suite of practice changes.

After considering a review of the literature on agronomic research trials regarding the implications of BMP adoption for production by Collier *et al.* (2015), yields were generally assumed to be maintained for the purpose of investment analyses

There was an exception for two case studies, due to the characteristics of the practice changes, availability of historical farm production data and supporting evidence from previous agronomic research.

As it was necessary to make assumptions about yield implications and because yield is a critical variable for both profitability and environmental performance, sensitivity analyses were conducted to test the influence of potential yield changes. A detailed assessment of yields after BMP changes are made is generally outside the scope of the analyses.

Fig. 1—Locations of case study farms.

Figure 1 is adapted from: Data by Region, 2011–16 Catalogue No. 1410.0. ABS data used with permission from the Australian Bureau of Statistics (www.abs.gov.au) licensed under Creative Commons Attribution 2.5 Australia (www.creativecommons.org/licenses/by/2.5/au). The map adaptations, including markers indicating approximate locations of case study farms, are not attributed to the ABS.

Investment analysis method

Investment analyses were undertaken to evaluate the impact of BMP adoption on the profitability of each farming business. A number of steps were required for the investment analyses. Firstly, initial investment costs were collected directly from the respective grower, which were calculated from the money spent, for example, on new equipment and machinery modifications required for the BMP transition.

Next, the farm gross margin was calculated both before and after BMP adoption using the Farm Economic Analysis Tool (FEAT) (Stewart and Cameron, 2006), developed by the Department of Agriculture and Fisheries (www.daf.qld.gov.au/plants/field-crops-and-pastures/sugar/farm-economic-analysis-tool). Comparing the gross margin before and after BMP adoption allowed the difference in annual cash flows to be calculated, which was then aggregated over the life of the investment. To take into account the time value of money, a discount rate of 7% was used. In some case studies, a transition period was necessary before certain practices were adopted over the whole farm.

Gross margins were calculated by subtracting the variable costs for growing and harvesting the crop from the revenue received from the crop. Revenues were calculated using production data from the relevant mill (generally a five-year average) and a five-year average (2010–15) net sugar price of $430 per tonne (Queensland Sugar Limited, 2015). Growing costs were based on farm operational data that were collected directly from the respective grower (e.g. fuel usage, work rates, labour, machinery operations, types of products applied and application rates), while input costs were collected from local suppliers.

The outcome for each investment analysis was a set of financial performance indicators for the BMP investment, including the Annualised Equivalent Benefit (hereafter, annual benefit), Internal Rate of Return, Discounted Payback Period and Investment Capacity (see Table 2 notes for definitions). Changes in operating return were also considered in each case study. Sensitivity analyses were carried out to examine the influence that yield changes would have on the annual benefit.

Environmental analysis method

The environmental implications of BMP adoption were estimated using the CaneLCA tool (Version 1.03) (www.eshop.uniquest.com.au/canelca), which is an environmental life cycle assessment (LCA) tool customised for sugarcane growing (Renouf and Allsopp, 2013).

It streamlines the complex LCA process to make it more accessible to researchers, agricultural advisors, policy makers and farmers. CaneLCA generates environmental impact indicators, which represent the amounts of resources consumed and the amounts of pollutants emitted per tonne of harvested sugarcane.

The indicators are estimates of potential impacts and not actual measured impacts. They are calculated over the life cycle of sugarcane production, including not only those associated with on-farm operations, but also the off-farm production of cane growing inputs (fertilisers, pesticides, fuel, electricity, etc.), and harvest and haul out of cane up to the transport siding.

The environmental impact indicators generated accounted for the most relevant environmental implications of the practice changes except for effects on soil quality (for example, erosion, compaction, soil organic carbon). The environmental impact indicators include:

- Fossil fuel use, represented as kg of oil equivalent per tonne harvested cane (kg $\text{oil}_{\text{-eq}}$/t cane) over the life cycle;
- Greenhouse gas (GHG) emissions, represented as kilograms of carbon dioxide equivalents per tonne of harvested cane (kg $CO_{2\text{-eq}}$/t cane) over the life cycle;
- Losses of nutrients to water contributing to water quality impacts (aquatic eutrophication potential), represented as kilograms of phosphate equivalents per tonne of harvested cane (kg $PO_{4\text{-eq}}$/t cane). The nitrifying substances accounted for were nitrogen (N), phosphorus (P) and sugar (COD);
- Losses of pesticides active ingredients (AI) to water (kg AI/t cane) and the associated water quality impacts (freshwater eco-toxicity potential) represented as comparative toxicity units for ecosystems per tonne of harvested cane (kg CTUe/t cane).

Further details of the methods used in CaneLCA are outlined by Renouf *et al.* (2018). The CaneLCA analysis utilised data collected for the FEAT analysis and additional data regarding, for example, the delivery of agrochemicals and the distances travelled by general farm vehicles.

Environmental impact indicators were generated for each of the case study farms before and after BMP adoption. Comparing the before and after results allowed the changes in environmental impacts to be estimated. The sensitivity of the results to potential changes in cane yield was evaluated by repeating the analyses for decreased and increased yields.

As part of deriving indicators of water quality impacts, general assumptions were made about the rates of nutrients and pesticide losses to the environment. For nitrogen, 2% of applied N was assumed to be emitted to air as N_2O and 20% was assumed to be emitted to water via runoff and leaching, both based on National Greenhouse Gas Inventory accounting methods (Commonwealth of Australia 2016). For phosphorus (P), 13% of applied P was assumed to be lost via runoff (based on an industry P budget of Bloesch *et al.* (1997).

For pesticides, around 10% were assumed to be lost via the various pathways to water, which is a conservative estimate in the absence of typical loss factors. The uncertainty of these estimates is recognised.

The analysis in each case study, however, was focused on identifying the changes in potential environmental impacts rather than the absolute scale of the impacts.

Results

Economic implications of BMP adoption

Case study farm size and results of investment analyses are summarised in Table 2. The results indicate that the annual benefit after making the BMP changes is positive, suggesting the BMP changes added value to all farming businesses. The annual benefit ranges from \$25/ha/y to \$220/ha/y (Table 2).

The results and reasons for cost changes after BMP adoption vary depending on a range of factors including the nature of the BMP changes and the particular parameters of each case study. The results should not be used for the purposes of comparing the farming businesses given that each farming system is unique and the starting point (before BMP changes) and finishing point (after BMP changes) is different for each grower. The findings of the case studies are specific to the individual businesses evaluated and therefore the parameters and assumptions used in each case study reflect the situation of the particular case study grower only. Consideration of individual circumstances must be made before applying case study findings to another situation.

In a number of case studies, reductions in money spent on fuel, oil and labour were mainly due to wider row spacing, which reduces tractor hours through the reduction of the total number of rows and therefore distance travelled.

Table 2—Case study farm size and investment analyses results.

	CS1	CS2	CS3	CS4	CS 5	CS 6
Farm Size	830 ha	167 ha	240 ha	150 ha	90 ha	760 ha
Cost of implementation	\$338,700	\$28,300	\$2,200	\$100,475	\$151,500	\$735,016
Investment capacity	\$999,320	\$134,654	\$99,868	\$125,749	\$287,770	\$1,041,142
Annual equivalent benefit (AEB) \$/ha/y	\$101	\$100	\$58	\$25	\$220	\$57
Discounted payback period	5 years	2 years	6 years	8 years	6 years	10 years
Internal rate of return	29%	66%	33%	12%	20%	14%

In table 2, investment capacity refers to the maximum amount of money that can be spent before an investment becomes unprofitable. Annualised equivalent benefit (AEB) is calculated by taking into account the initial investment and the discounted annual change in gross margin aggregated over the life of the investment, which is then transformed into an annualised value. Discounted payback period indicates the number of years it will take to recover the initial capital investment. Internal rate of return represents the amount of money returned to the farming business each year as a percentage of the initial investment.

Figure 2 shows the capital costs incurred to make BMP changes and the corresponding investment capacity of growers displayed in order of farm size. The analyses indicate that the investment costs of each farming business did not exceed their respective investment capacities and growers could have invested between \$175/ha to \$1 544/ha more than the actual amounts invested, before the cost savings would be insufficient to provide the required (7%) return on investment. For example, in Case Study 2, the grower could have invested more than four times his actual investment.

The positive difference between investment capacity and cost of implementation in CS4 depended on the grower sharing the cost with a neighAll rights reserved. No part of this publication may be bouring grower.

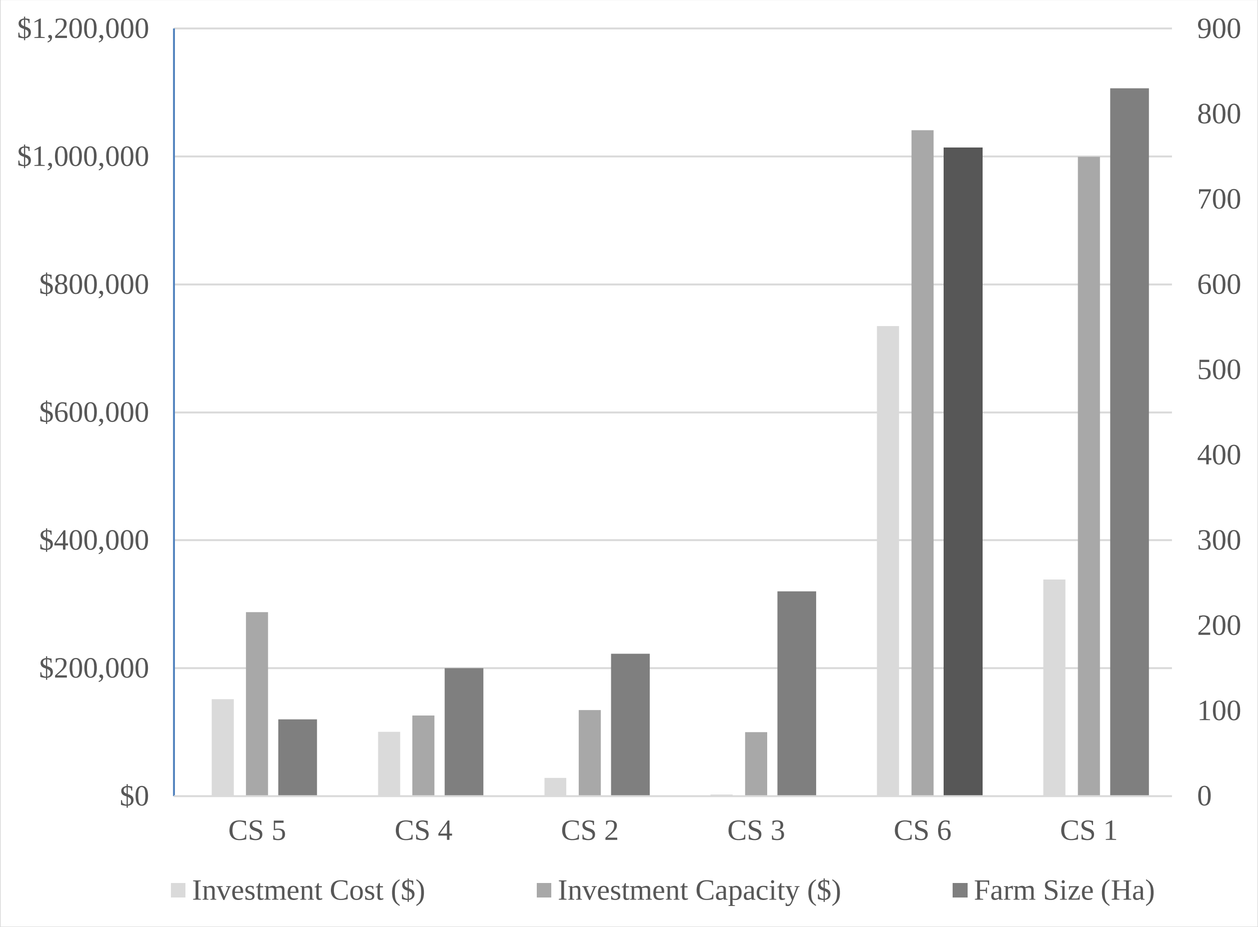

Fig. 2—Investment cost and investment capacity in order of farm size.

To understand the risk and uncertainty of practice changes in each case study, the sensitivity of the economic results to changes in cane yields were considered (Figure 3). Table 3 shows the yield change or, more specifically, the percentage change in cane yield (t/ha), required for the annual benefit to breakeven in each of the case studies. For four of the case studies, the analyses suggest that a drop in cane yield of between 1% and 9% could be experienced and the grower would still ‘breakeven’ in terms of annual benefit (Table 3). For the other two case studies (CS3 and CS5), cane yields were assumed to increase as a result of BMP adoption, based on the grower’s historical production data or previous agronomic research. The yield improvements considered in CS3 and CS5 were above the break-even yield change levels noted in Table 3 and corresponded with a positive annual benefit.

Notably, if improvements in yield are experienced, the annual benefit can increase significantly. For example, the grower in CS4 would derive an annual benefit of $299/ha if cane yields increased by 10% after BMP adoption.

Table 3—Break-even yield percentage change.

	CS1	**CS2**	**CS3**	**CS4**	**CS5**	**CS6**
Break-even yield change	–7.2%	–7.3%	14.4%	–0.9%	10.8%	–2.0%

BMP adoption for the CS3 farm involved a transition from a ploughout-replant cycle to a cycle incorporating a fallow. Given that research by Garside and Bell (2011) indicates that cane yield per hectare can increase considerably in response to a fallow period, it is assumed in the investment analysis in CS3 that cane yield per hectare increases and, in turn, overall farm production is maintained after BMP adoption (by a 20% increase in cane yield per hectare across all crop classes). A review of the grower's historical production data in CS5 indicated a progressive improvement in yield was experienced at the home farm compared with the productivity zone, and a 27% yield improvement was examined based on the productivity zone data and his mill data.

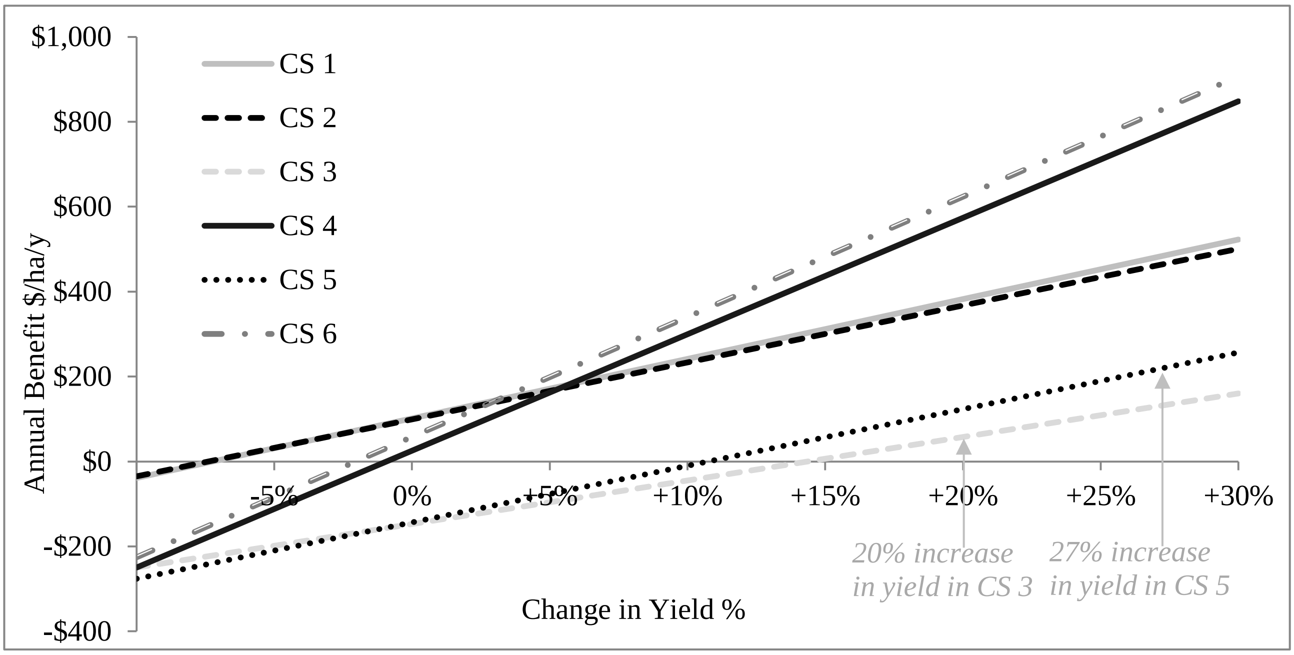

Fig. 3—Sensitivity of annual benefit to changes in cane yields (t/ha).

Environmental implications of BMP adoption

The changes in the environmental impact indicators as a result of BMP adoption are summarised in Table 3. The results should not be used for the purposes of comparing the farming businesses, given that each farming system is unique and the starting point (before BMP changes) and finishing point (after BMP changes) is different for each grower.

For all environmental impacts except one, BMP adoption resulted in reduced environmental impacts for all case studies (the exception is discussed further below). The results have been presented as the percentage reduction in impacts. The scale of impact reductions per tonne of harvested cane and also for the whole farming operations per year are shown. For some farms the total scale of the environmental improvement may be small compared with other farms due to a small farm size, but the impact reductions can still be very significant per tonne of cane.

The potential for nutrient losses to water was estimated to reduce by as little as 2% but as high as 31% (per t cane), depending on the extent to which N application rates were reduced. The lower impacts were due to a reduced potential for N loss to surface water runoff and leaching because less N has been applied.

The potential for pesticide-related water quality impacts was estimated to reduce by as little 9% or as much as 78%, due to both changes in the type of herbicide AI applied and reductions in the amounts applied. For one case study (CS4) it was estimated to increase very slightly, even though the overall amount of herbicide AI applied had decreased. This was due to an increased application of one AI, negating the benefits from reduced application of other AIs, due to it having a higher assumed toxicity factor. The uncertainty in the eco-toxicity emission factors means that this change is insignificant.

Fossil fuel use was estimated to reduce by between 10% and 21%. More than half of this was due to reduced N application rates and the introduction (or increase in the area) of legume break crops to supply organic N. This leads to avoided fertiliser application (and production). Avoided urea-N production is a large saver of fossil fuels because commercial urea production requires an energy-intensive process. The remaining fossil fuel savings are due to reduced diesel use in tractors and harvesters (due to reduced traffic from the wider row spacing), and reduced tillage.

Greenhouse gas (GHG) emissions were also estimated to reduce, by between 7% and 23%. The reductions are due mostly to lower emissions of nitrous oxide (a strong GHG) from reduced application of N fertiliser (urea) and the use of legume crops to supply organic N. Reductions are also due to the previously-mentioned reductions in fossil fuel use for producing and supplying fertilisers (mostly urea) and reduced tractor and harvester operations.

For five of the six farms, the annual GHG savings per farm are equivalent to taking 28–86 cars off the road for a year. For the smallest farm, yield increases were considered and the GHG savings from lower N-application and tractor fuel use were partly offset by the higher fuel use required to harvest a bigger crop. Consequently the overall GHG savings were equivalent to taking one car off the road.

The most significant environmental improvements were generally due to the changed nitrogen application practices (reduced N application rates and alternative sources of N) and changed pesticide application practices. Reduced tractor and harvester operations due to greater row spacing and reduced tillage were less significant.

Table 3—Reductions in environmental impact indicators for case study farms.

		CS1	**CS2**	**CS3**	**CS4**	**CS 5**	**CS 6**
Farm size		830 ha	167 ha	240 ha	150 ha	90 ha	760 ha
Reduction in fossil fuel use ($\text{oil}_{\text{-eq}}$)	% (/t cane)	**10%**	**18%**	**21%**	**14%**	**18%**	**10%**
	t/y	30	14	28	11	0.2	35
	kg/t cane	1.8	1.4	1.7	0.9	1.9	0.5
Reduction in greenhouse gas emissions ($\text{CO}_{2\text{-eq}}$)	% (/t cane)	**17%**	**19%**	**23%**	**15%**	**20%**	**7%**
	t/y	266	123	205	87	1	174
	kg/t cane	16.4	11.6	12.6	6.8	12.9	2.9
Reduction in nutrient losses to water ($\text{PO}_{4\text{-eq}}$)	% (/t cane)	**18%**	**17%**	**17%**	**31%**	**31%**	**2%**
	kg/y	1,000	650	833	1,250	250	435
	kg/t cane	0,06	0.06	0.05	0.10	0.14	0.007
Reduction in pesticide active ingredient (AI) losses to water	% (/t cane)	**35%**	**14%**	**21%**	**6%**	**48%**	**36%**
	kg/y	121	13	41	7	46	370
	g/t cane	7.4	1.3	2.5	0.6	15.1	6.1
Reduction in pesticide-related ecotoxicity potential	% (/t cane)	**44%**	**78%**	**48%**	**–9%**	**22%**	**53%**
	CTUex10^6/y	15,762	3,149	2,109	–267	9,126	47,580
	CTUex10^6/t cane	0.97	0.30	0.13	–0.02	1.67	0.79

The environmental sensitivity analyses found that the improvements in fossil fuel use, GHG emissions and nutrient-related water quality impacts are fairly resilient to potential reductions in cane yields. In five of the six case studies, cane yields would have to reduce by 15–40% for there to be no improvements. For the other farm, yields would have to reduce by a 5–15% depending on the impact category. This is because the farm was already quite eco-efficient before BMP adoption and so the scale of improvements was lower and hence more sensitive to any yield decline.

The yield response of pesticide-related water quality impacts is much more variable. For four of the six case studies, cane yield reductions in excess of 45% would be needed before there was no improvement. For the other two farms the changed herbicide practices were less significant, and yields would need to reduce 5% and 20% respectively for there to be no improvement.

One objective of the BMP program is to protect water quality by reducing nutrient and pesticide losses to waterways. The analysis suggests that BMP adoption makes good in-roads to achieving these outcomes. BMP adoption also provides added benefits of reduced fossil fuel use and greenhouse gas emissions over the life cycle of sugarcane production, through associated reductions in demand for fertiliser production and machinery usage.

Discussion

The economic results and grower insights shared in CS4 indicate that growers may take steps to manage risk and achieve positive annual benefits. By taking a collective approach and sharing costs with a neighbor farm, the investment costs of this grower did not exceed his investment capacity.

Further, while economic results can be sensitive to changes in yield, the results and insights shared in CS5 also suggest that progressive decision making and increased involvement in extension activities may help address a grower’s aversions towards the risk of BMP changes. The grower in that case study progressively made a number of BMP changes after seeking information on practice changes to improve yield. After implementation, the grower noticed yield improvements and made additional BMP changes and ‘rolled out’ the changes to his second farm.

Monitoring on-farm data may assist growers in evaluating the production outcomes of BMP changes. In CS5, additional data were available and the grower’s farm productivity was compared with that of his productivity zone. Such comparisons of farm productivity to productivity zones may provide valuable insights in future studies and ongoing collection of farm data may assist growers in evaluating production and profitability outcomes.

The impact of BMP changes on soil health, subsequent production outcomes and the number of ratoons in a production cycle also warrants further consideration, as longer ratoons may help minimise average annual expenses. The grower in CS6 noted that after ‘improving drainage and shifting to controlled traffic’ he obtained ‘better yields and extra ratoons due to being able to do operations on time when they are needed and having better soil health from reduced compaction.’ Such insights highlight the importance of a more holistic approach that considers the various aspects of BMP adoption and interactions between farm practices through evaluation of real (not hypothetical) practice change case studies.

The positive economic and environmental results of each of the case studies suggest win-win outcomes may be obtained if yields are maintained or, in some instances, improved. The variance in outcomes between case studies highlights the uniqueness and complexity of farming systems and, in turn, suggests that ‘one-size-fits-all’ policies that fail to regard variability between farms may be of limited benefit. Grower decision making should therefore be informed by agronomic research when implementing BMP changes to help manage the risks of making such changes.

Overall, the case study results improve current knowledge about outcomes for farm profitability and the environment from adopting SmartCane BMPs and can be used to enhance decision-making for cane growers and their advisors and provide supporting research on the adoption of BMPs.

Conclusions

A joint analysis of the farm profitability and environmental implications of BMP adoption in the Wet Tropics found that BMP adoption can lead to win-win outcomes.

Economically, an investment analysis indicated the annual benefit to participating growers increased by between $25 and $220/ha/y after BMP changes were made, and varied depending on a variety of factors including the practice changes made and the amounts invested. Farm profitability can be sensitive to cane yield changes highlighting the need to manage risks when implementing changes. The case studies provided examples of growers managing risks through various means including the progressive implementation of practice changes and co-investment to reduce capital costs.

Environmentally, the results indicate that BMP adoption can be expected to contribute to water quality protection with the added bonus of improving energy efficiency and mitigating greenhouse gas emissions. The environmental benefits are quite resilient to the risk of cane yield reductions.

For five of the six farms assessed, yields would need to reduce quite considerably (15–40%) for the environmental improvements to be compromised. The sensitivity of environmental results to potential changes in yield was higher in the case of the remaining farm that was already quite eco-efficient before BMP adoption (and the degree of change in environmental impacts after BMP adoption was relatively small).

The findings of the case studies provide confidence that BMP adoption in the Wet Tropics can result in improved farm profitability as well as environmental performance. However, investment risks such as potential yield changes need to be considered.

Taking a whole-of-farm perspective when considering farm profitability implications and the interactions between practice changes can help manage risk factors. Communication of the case study findings may encourage further grower engagement and practice adoption.

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