The impact of Smartcane BMPs on business and the environment in the Wet Tropics

Case Study 4: Chris Bosworth

This case study is the fourth in a series that evaluates the economic and environmental impact of Smartcane Best Management Practice (BMP) adoption by a number of sugarcane growers in the Wet Tropics of north Queensland. Economic, biophysical and farm management data before and after BMP adoption was supplied by the grower and the Farm Economic Analysis Tool (FEAT)[1] and CaneLCA Eco-efficiency Calculator (CaneLCA)[2] were used to determine the impact of these changes on business performance and the environment. The findings of these case studies are specific to the individual businesses evaluated and are not intended to represent the impact of Smartcane adoption more broadly.

Key findings of the Chris Bosworth case study

The transition to BMP, which began in 2008, has resulted in:

- Annual improvement in farm operating return of $78/ha ($11,305/yr total)
- 7kg less pesticide active ingredients and 1.25 tonnes less nitrogen and phosphorous lost to waterways annually
- Annual fossil fuel use (over the life cycle of sugarcane growing) reduced by 14 per cent (or 11 tonnes of fuel)
- Greenhouse gas emissions reduced by 15 per cent annually (equivalent to taking 28 cars off the road each year).

About the farm

Chris Bosworth farms 150 hectares of sugar cane in the Herbert region, north Queensland. Chris uses a contractor for planting and harvesting and shares most of his spraying, tillage and fertilising machinery with a neighbouring farm. Chris began moving to BMP in 2008 and over the past eight years has implemented a range of best management practices on his farm. Today, Chris is a Smartcane BMP accredited grower.

What changes were made?

The main changes to Chris' farming system are summarised in Table 1.

To reduce compaction and improve soil health, Chris widened his row spacing from 1.62m to 1.8m to match the wheel tracks on his contractor's harvester. It took six years to move to 1.8m spacing on all blocks.

Chris has moved from conventional to zonal tillage and plants in preformed beds. In fallow, Chris plants cowpea.

To improve nutrient management, Chris adopted the Six-Easy-Steps guidelines. Nitrogen rates recommended by

Image 1: Chris Bosworth

[1] FEAT is a Microsoft Excel® based tool that models sugarcane farm production from an economic perspective, allowing users to record and analyse revenues and costs associated with their sugarcane production systems. *https://www.daf.qld.gov.au/plants/field-crops-and-pastures/sugar/farm-economic-analysis-tool.*

[2] CaneLCA is a Microsoft Excel® based tool that calculates 'eco-efficiency' indicators for sugarcane growing based on the life cycle assessment (LCA) method. It streamlines the complex LCA process to make it more accessible to researchers, agricultural advisors, policy makers and farmers. *https://eshop.uniquest.com.au/canelca/*

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Six-Easy-Steps were 44kg/ha less nitrogen in plant cane and 22kg/ha less nitrogen in ratoons. Chris also adopted banded mill mud application in ratoon cane.

Chris uses a variable rate spray controller installed on his high rise sprayer which has improved the accuracy of his spray rate.

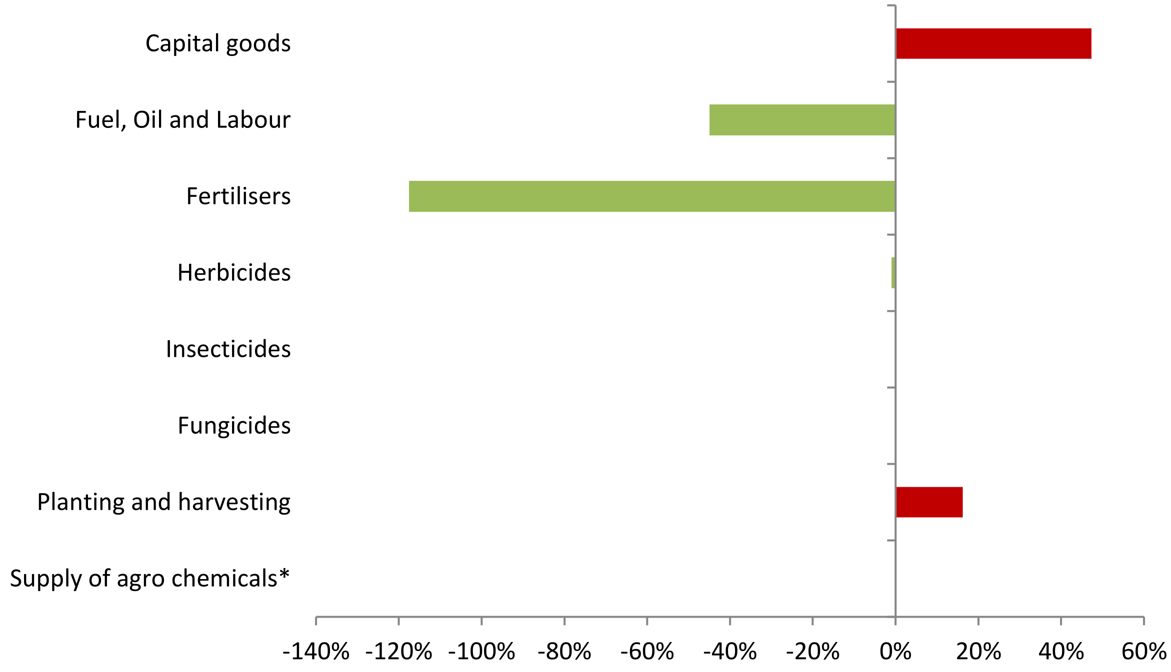
Table 1: Main changes to the new farming system

	Before	After
Weed, Pest and Disease Management	• 2kg/ha Velpar K4 (468g/kg Diuron and 132g/kg Hexazinone) in plant cane	• No Diuron in plant cane • Dual Gold (960g/L metolachlor) in plant cane • Variable rate controller
Soil Health	• Bare fallow • 1.6m row spacing	• Cowpea fallow • 1.8m row spacing • Reduced tillage
Nutrient Management	• Grower determined nutrient rate • Broadcast mill mud application	• Six-Easy-Steps nutrient rate • Banded mill mud application in ratoons

What does this mean for the business?

Economic analysis indicates that Chris' operating return has increased by $78/ha/yr ($11,305/yr total) under the new BMP farming system, due to lower operating costs. The biggest contributors to this decrease in operating costs were; fertiliser costs (-117 per cent, -$92/ha); fuel, oil and labour (-45 per cent, -$35/ha); which were partially offset by increases in capital goods costs (+47 per cent, +$37/ha) and planting and harvesting (+16 per cent, +$13/ha) (Figure 1).

Figure 1: Contribution to change in farm operating costs (%)



**Cost to supply agro-chemicals is embodied in fertilisers /herbicide /insecticide /fungicide cost.*

In terms of cost savings from BMP adoption, reduction in fertiliser and mill mud use has had a significant impact. Through adoption of the Six-Easy-Steps nutrient program and banded mill mud application, Chris now spends $92/ha less on fertiliser.

Wider row spacing, which reduces tractor hours through the reduction of the total number of rows and therefore the distance travelled, as well as zonal tillage, has contributed to additional cost savings in fuel, oil and labour of $35/ha.

Capital goods (Figure 1) refer to the cost of repairs, maintenance and depreciation of machinery and equipment. After BMP adoption repairs and maintenance costs decreased as a result of reduced tractor hours. However, these cost savings were more than offset by an increase in depreciation costs due to new machinery and equipment purchased to implement BMP.

Increased planting and harvesting costs reflect the cost of planting a cowpea fallow.

How much did it cost to make the change?

Chris moved to BMP by investing in new machinery and machinery modifications in partnership with a neighbouring farm. To move to 1.8m row spacing and zonal tillage, Chris modified a spray rig, high rise and rotary hoe. Chris also purchased a set of ratooning discs which were converted to a bedformer, as well as a GPS and steering kit, variable rate controller, and stool splitter. The total cost of implementation was $698/ha or $100,475, which was Chris' half-share in the total investment[3].

Was the investment profitable?

Results of an investment analysis show that BMP adoption was worthwhile for Chris when the investment was shared in with another grower. It would take eight years to repay the $100,475 invested.

Over a ten year investment horizon, Chris' investment has added an additional $25/ha/yr to his bottom line (when the initial investment, required return of 7 per cent and time to transition to the new system is taken into account) (Table 2).

This analysis is based on the assumption that the same rate of production is maintained after BMP adoption, which was Chris' experience.

Table 2: Total cost change, capital investment and value of investment

Cost of Implementation ($/ha)	$698
Discounted Payback Period	8 years
Annual Benefit ($/ha/yr)	$25
Internal Rate of Return	12%
Investment Capacity ($/ha)	$873

Chris could have invested up to $125,749 ($873/ha) before the cost savings made by adopting BMP would be insufficient to provide the required (7 per cent) return on investment (Table 2, Investment capacity).

What does this mean for the environment?

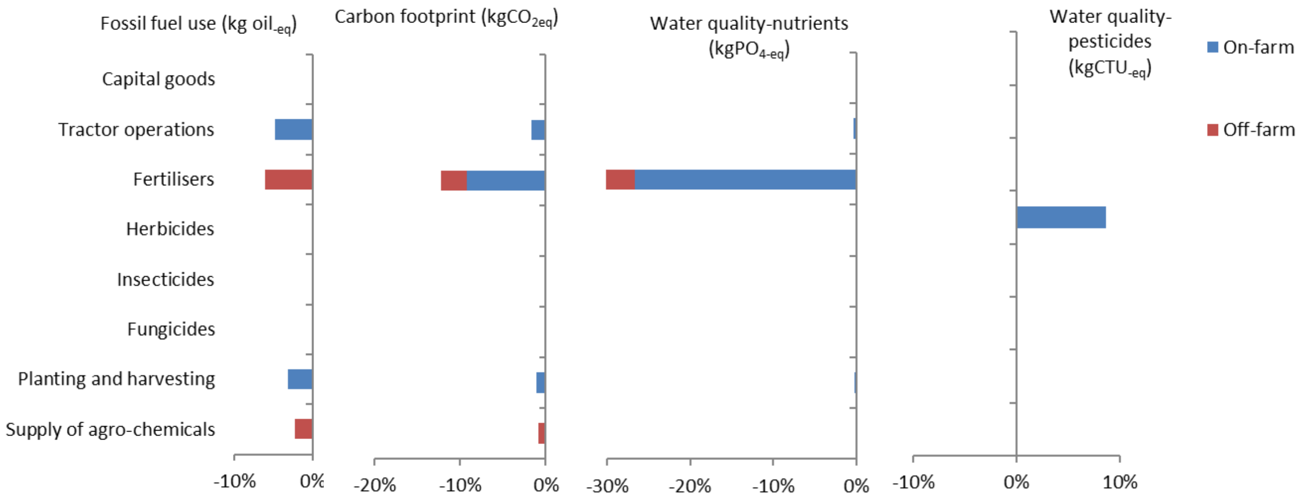
The estimated change in environmental impacts for Chris' farming system before and after BMP adoption is shown in Figure 2.

After BMP adoption, annual fossil-fuel use over the life cycle of cane growing (i.e. on-farm plus off-farm) was reduced by 14 per cent overall. This means avoiding around 11 tonnes of fossil fuel use per year[4]. Half of this occurs off-farm, due to less fertiliser being produced at the factory and supplied to the farm. Avoided urea use is the biggest fossil fuel-saver because its production is energy intensive, but there are also some savings from reductions in the use of other fertiliser ingredients (DAP, KCl, Gran-am). The other half of the fossil fuel savings are due to the reductions in on-farm fuel use for tractor and harvester operations as a result of wider row spacing.

[3] For the purpose of evaluating the economic costs/benefits of BMP adoption, grant funding was not considered in the economic analysis; however it is worth noting that, because of successful applications through Reef Rescue rounds 1 to 8, Chris' investment was further reduced by 50 per cent and this had a significant impact on the adoption decision.

[4] Fossil fuel use over the whole life cycle of the farming operation includes not just on-farm diesel consumption but also off-farm use of fossil fuels in the production of fertilisers, pesticides, lime, electricity.

Figure 2: Increase / decrease in environmental impacts after adoption of BMP (per ha)[5]



The carbon footprint (greenhouse gas emissions) of cane production is reduced by 15 per cent overall after BMP adoption. This means avoiding around 87 tonnes of carbon dioxide per year across the whole farming operation, the equivalent of taking 28 cars off the road for a year. Most of the carbon footprint reductions are due to less on-farm emissions of nitrous oxide[6] (a strong greenhouse gas) due to reductions in the amount of total nitrogen applied[7]. The rest are due to the avoidance of off-farm production and supply of fertilisers (mostly urea), and less machinery use from the wider row spacing.

The potential for water quality impacts from nutrients losses to water, via surface water runoff and groundwater infiltration, was estimated to reduce by around 30 per cent. This means the avoidance of around 1.25 t of eutrophying substances (nitrogen and phosphorus) potentially being lost to water per year. This is because less nitrogen and phosphorus are now being applied[8].

The potential for water quality impacts from losses of pesticides to water was estimated to increase by 9 per cent. The quantities of pesticide active ingredients (AI) applied decreased slightly, resulting in about 7 kg less pesticide AI being lost to water. However a change in types of herbicide AI used meant that the overall toxicity of the releases may have increased, due to the introduction of additional metolachlor applications in plant cane. It is expected that there is some uncertainty in the assumed toxicity potentials used in this analysis[9], and so there is not high confidence in this result. However it does flag the importance of understanding the comparative toxicity potential of AIs when changing to alternative pesticide products.

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[5] A negative value is a decrease in environmental impact, and a positive value is an increase in impacts.
kg oil_{-eq} = kilograms of oil equivalent, the reference substance for measuring fossil-fuel resource depletion
kg CO_{2-eq} = kilograms of carbon dioxide equivalent, the reference substance for measuring greenhouse gases
kg PO_{4-eq} = kilograms of phosphate equivalent, the reference substance for measuring eutrophication of water due to releases of nutrients (N, P) and sugar
kg CTU_{-eq} = kilogram of equivalent critical toxicity units, a measure of eco-toxicity in freshwater due to releases of pesticides

[6] The assessment assumes a generic nitrous oxide (N_2O) emission factor of 1.99% of applied N lost as nitrous oxide N, which is based on the latest Australian greenhouse gas inventory methodology. The global warming potential is 298 kg CO_{2-e}/kgN_2O.

[7] There is some uncertainty in this conclusion because the exact amount of nitrogen contained in the applied mill mud was not known. The sensitivity of our findings to this are considered in the 'What about the risk' section.

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[9] The analysis was based on assumed toxicity potentials for the applied pesticide active ingredients, which are were derived from USETox model, a scientific consensus toxicity model developed by the United Nations Environment Program (UNEP) and the Society for Environmental Toxicology and Chemistry (SETAC).

What about risk?

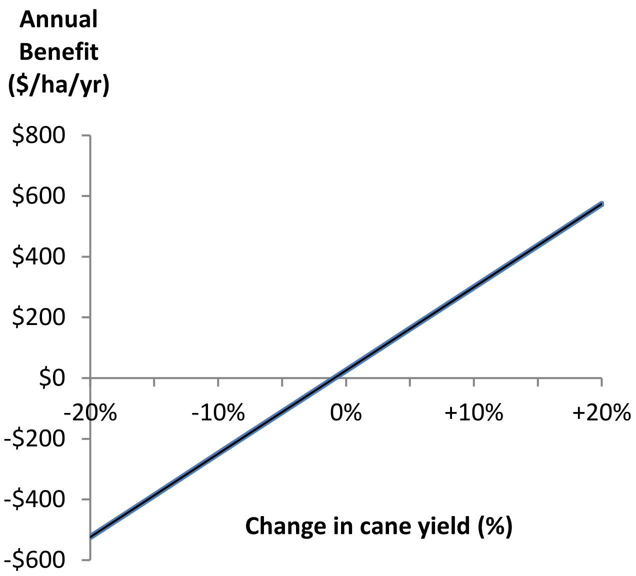
When adopting any management practice change there is always a risk that things may not go as planned (e.g. yield loss, financial risk). The adoption of management practices that have been scientifically validated, such as BMP, means that an adverse impact on production is unlikely.

Results of a production risk analysis show that profitability is highly sensitive to maintaining yield. If overall yield were to decline by as little as 1 per cent investing in BMP adoption is unprofitable (Figure 3).

From an environmental perspective, there are two aspects that the outcomes are sensitive to, the first is cane yield, and the second is the N and P content of the mill mud.

In relation to cane yields, for there to be no net gains in environmental impacts (per tonne cane produced), yields across plant and ratoon cane would need to decline by 30 per cent for nutrient-related water quality impacts, and 20 per cent carbon footprint and fossil fuel use. For pesticide-related water quality impacts, yields would have to increase by around 10 percent for there to be no net gain (Figure 4).

Figure 3: Annual benefit of investment ($/ha/yr) sensitivity to yield



The analysis was based on the assumption that the N and P content of mill mud are 0.075% and 0.065% wt./wt. respectively; however the exact N and P content of mill mud was not known and can vary considerably. Results of a sensitivity analysis show that the assumed N and P contents of the mill mud would have to double for there to be no improvement in water quality (Figure 5).

Figure 4: Environmental impact sensitivity to yield

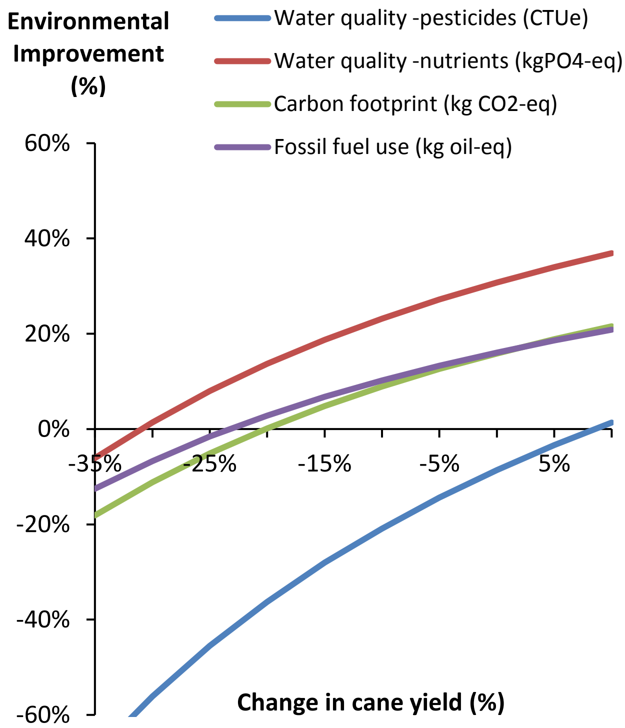
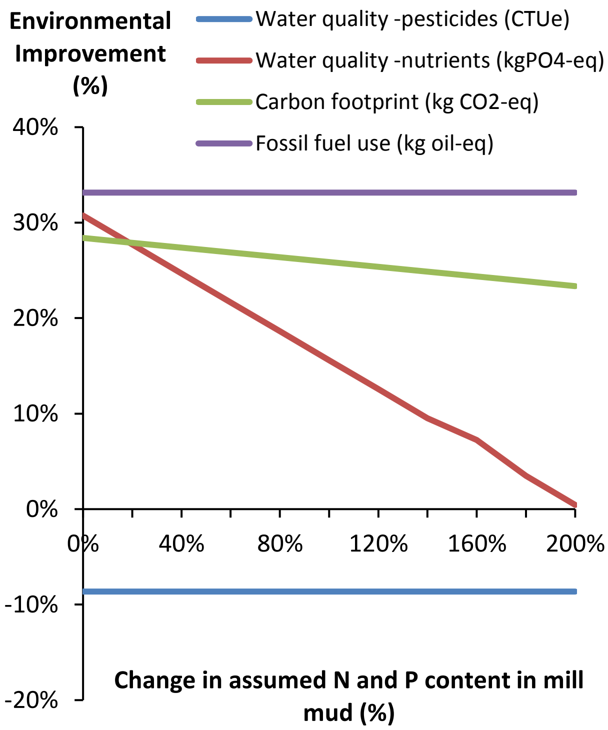


Figure 5: Environmental impact (impact/t cane) sensitivity to N and P content of mill



What's the bottom line?

This case study has evaluated the business and environmental impact of Smartcane BMP adoption for a farm in the Wet Tropics.

Results of the economic analysis indicate that BMP adoption has been a profitable investment. Cost savings were made by reducing the amount spent on fertiliser, fuel, oil, and labour, partially offset by an increase in the cost of depreciation. Chris made a substantial investment in new machinery and machinery modifications to move to BMP. By sharing this investment with another grower, Chris has reduced his investment cost and improved his return on investment. Although not included in this analysis Chris received Reef Rescue grant funding which was a key factor in Chris' decision to move to BMP.

"Without access to Reef Rescue grants it is highly likely these changes would not have been contemplated. For farmers to stay viable in the future, sharing equipment is vital. Also by teaming up with neighbours grants are easier to obtain because larger landholdings give better value for matching government funding" – Chris Bosworth

Transition to BMP has resulted in less fertiliser application and a significant reduction in the potential for water quality impacts from losses of nutrients. There has also been the added bonus of reduced fossil fuel use and greenhouse gas emissions due to less fertiliser production and use, and less machinery use. While the quantities of pesticide active ingredients applied decreased slightly, a change in the type of herbicides used meant that the overall toxicity of the releases may have increased slightly.

Each farming business is unique in its circumstances and therefore the parameters and assumptions used in this case study reflect Chris' situation only. Consideration of individual circumstances must be made before applying this case study to another situation.

This case study forms a component of SRA Project 2014/15 (Measuring the profitability and environmental implications when growers transition to Best Management Practices). For further information contact the Townsville DAF office on (07) 3330 4560