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

Case Study 3: Adrian Darveniza

This case study is the third 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 Adrian Darveniza case study

The transition to BMP, which began in 2010, has resulted in:

- Annual improvement in farm operating return of $160/ha ($38,400/yr total)
- 41kg less pesticide active ingredients and 833kg less nitrogen and phosphorous lost to waterways annually
- Annual fossil fuel use reduced by 21 per cent (or 28 tonnes of fuel over the cane life cycle)
- Greenhouse gas emissions reduced by 23 per cent annually (equivalent to taking 67 cars off the road each year).

About the farm

Adrian Darveniza farms 240 hectares of sugar cane in South Johnstone, far north Queensland. Adrian plants his own cane using a whole-stick planter and uses a contractor for harvesting. Adrian took over as manager of the family farm in 2010 and over the past six years has implemented a range of best management practices. Today, Adrian is a Smartcane BMP accredited grower.

What changes were made?

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

To reduce compaction and improve soil health, Adrian widened his row spacing from 1.5m to 1.8m to match the wheel tracks on his contractor's harvester. Adrian has also moved away from a plough-out/replant cane system and now includes a bare fallow in rotation with cane.

Image 1: Adrian Darveniza

To improve nutrient management,

[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/*

Sugar Research Australia
lifecycles.
Queensland Government

Adrian adopted the Six-Easy-Steps guidelines together with banded mill mud application in ratoon cane. Nitrogen rates recommended by Six-Easy-Steps were 18kg/ha less nitrogen in plant cane and 47kg/ha less nitrogen in ratoons than previously applied.

To improve weed management, Adrian, with assistance from the Department of Agriculture and Fisheries, converted his Irvin spray boom to a Dual Herbicide Sprayer (DHS). Adrian uses the DHS in ratoon cane which has resulted in reduced Diuron, Paraquat and 2,4-D application.

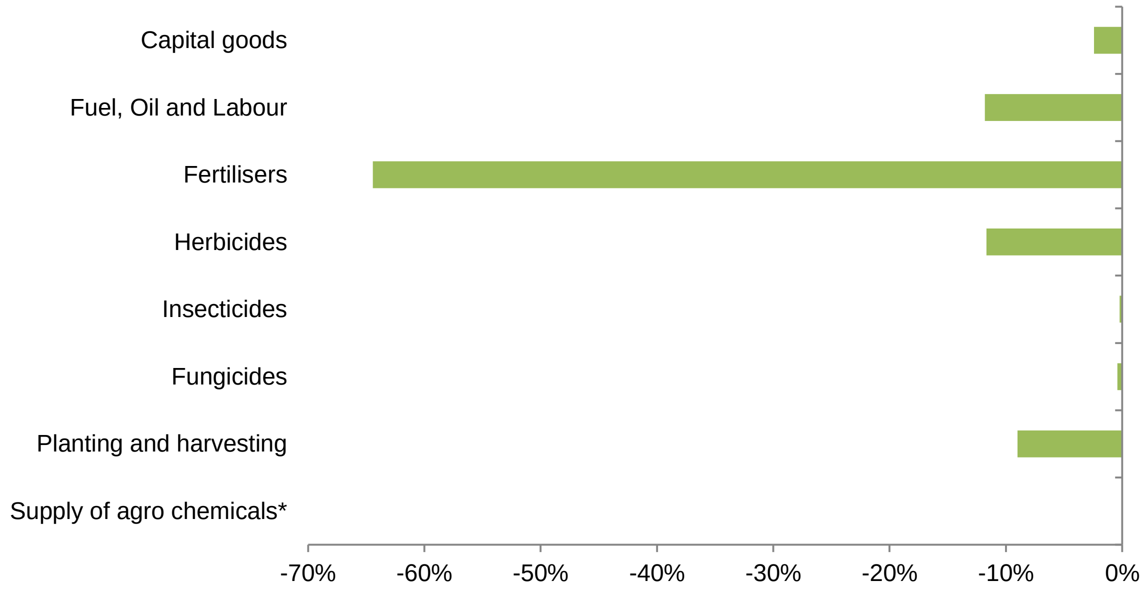
Table 1: Main changes to the new farming system

	Before	After
Weed, Pest and Disease Management	• Irvin legs	• Dual herbicide sprayer – reduced herbicide application (Diuron, Paraquat and 2,4-D).
Soil Health	• Plough-out/replant • 1.5m row spacing	• Bare fallow • 1.8m row spacing
Nutrient Management	• Grower determined nutrient rate	• Six-Easy-Steps nutrient rate • Banded mill mud application in ratoons

What does this mean for the business?

Economic analysis indicates that Adrian's operating return has increased by $160/ha/yr ($38,400/yr total) under the new BMP farming system. This is the result of lower operating costs after BMP adoption. The biggest contributors to change in operating costs were; fertiliser costs (-64 per cent, -$103/ha); fuel, oil and labour (-12 per cent, -$19/ha); herbicides (-12 per cent, -$19/ha) and planting and harvesting (-9 per cent, $14/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 use has had a significant impact. Through adoption of the Six-Easy-Steps nutrient program and bare fallow system which has reduced farm area under cane, Adrian now spends $103/ha less on fertiliser. Cost savings made by a reduction in synthetic fertiliser have more than offset the cost of mill mud, which in Adrian's case (due to banded application and Adrian's close proximity to the South Johnstone mill) is a cost effective alternative.

Wider row spacing, which reduces tractor hours through the reduction of the total number of rows and therefore distance travelled, has contributed to additional cost savings in fuel, oil and labour. Herbicide costs were reduced as a result of greater herbicide application efficiency due to modification of Adrian's Irvin spray boom to a DHS.

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. As there was no investment in new capital, depreciation expenses remain the same both before and after BMP adoption.

How much did it cost to make the change?

The total cost of implementation was $9/ha or $2,200 reflecting money spent on parts and Adrian's own labour to widen tractors and implements to move from a 1.5m to 1.8m row spacing. The DHS used in Adrian's new production system was constructed by modifying Adrian's existing Irvin spray boom with assistance from the Department of Agriculture and Fisheries.

Was the investment profitable?

Results of an investment analysis show that BMP adoption was a worthwhile investment. It would take six years to repay the $2,200 invested, reflecting the transition from a plough-out/replant to fallow system in which reduced area under cane results initially in a loss of income before yield and income is gradually increased as a result of fallowing.

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

Cost of Implementation ($/ha)	$9
Discounted Payback Period	6 years
Annual Benefit ($/ha/yr)	$58
Internal Rate of Return	33%
Investment Capacity ($/ha)	$416

Over a ten year investment horizon, Adrian's investment has added an additional $58/ha/yr to the bottom line (when the initial investment is taken into account) (Table 2).

This analysis is based on the assumption that overall production is maintained after BMP adoption. Moving from a plough-out/replant to a bare fallow system has resulted in a loss of cane growing area, however research by Garside and Bell (2011) indicates that cane yield per hectare can increase considerably in response to a fallow period. It is therefore assumed that total production is maintained by a 20 per cent increase in yield across all crop classes[3].

Adrian could have invested up to $99,868 ($416/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).

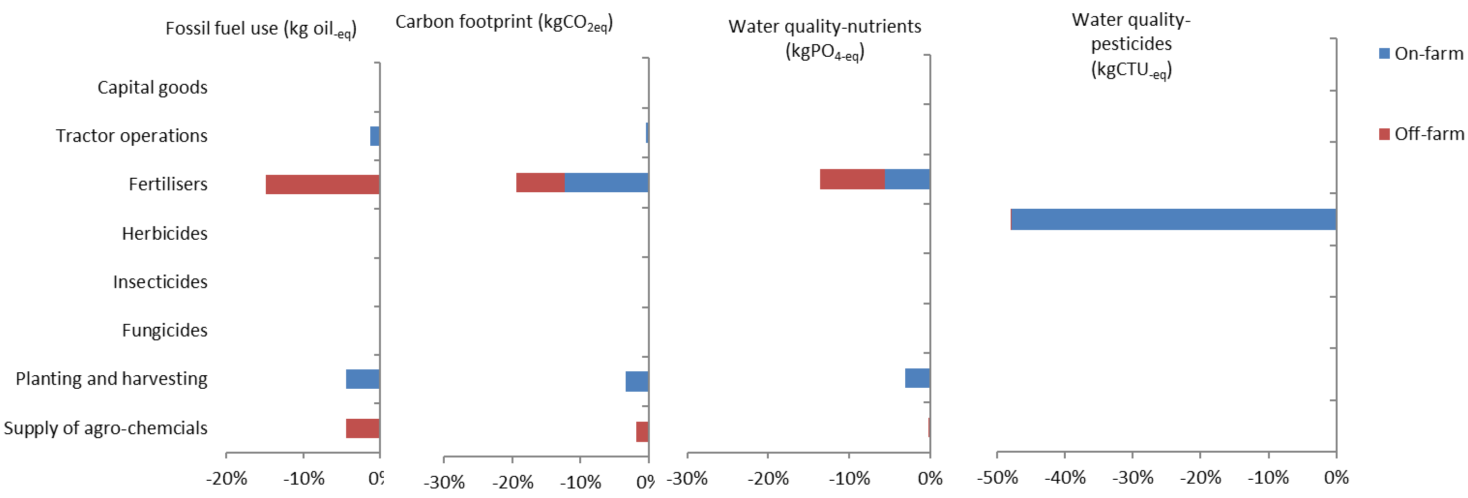
What does this mean for the environment?

The estimated change in environmental impacts for Adrian's farming system before and after BMP adoption are shown in Figure 2.

[3] Garside, A.L. and Bell, M.J. (2011) Growth and yield responses to amendments to the sugarcane monoculture: effects of crop, pasture and bare fallow breaks and soil fumigation on plant and ratoon crops. Crop and Pasture Science 62(5), 396-412.

After BMP adoption, annual fossil-fuel use was reduced by 21 per cent overall. This means avoiding around 28 tonnes of fossil fuel use per year over the whole life cycle of the farming operation[4]. Most of this occurs off-farm, due to less fertiliser being produced at the factory and supplied to the farm. This is because Adrian now uses mill mud to provide some of the nutrient requirements. 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 remainder of the fossil fuel savings are due to the slight reductions in on-farm fuel use for tractor and harvester operations as a result of the wider row spacing.

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 23 per cent overall after BMP adoption. This means avoiding around 205 tonnes of carbon dioxide per year across the whole farming operation, the equivalent of taking 67 cars off the road for a year. Around half of the carbon footprint reductions are due to less on-farm emissions of nitrous oxide[6] (a strong greenhouse gas) from 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), less machinery use from the wider row spacing, and the fact that post-harvest trash burning of plough-out cane is no longer undertaken since Adrian moved away from a plough-out/replant system.

---

[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.

[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 $CO_{2\text{-}eq}$ = kilograms of carbon dioxide equivalent, the reference substance for measuring greenhouse gases

kg $PO_{4\text{-}eq}$ = 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 $CO_{2\text{-}e}$/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.

The potential for water eutrophication from nutrients losses to the environment was estimated to reduce by around 17 per cent. This means the avoidance of around 833kg of eutrophying substances (nitrogen and phosphorus) lost to water per year. This is due to a reduced potential for nitrogen and phosphorus loss to surface water runoff and groundwater infiltration, because less nitrogen and phosphorus has been applied[8].

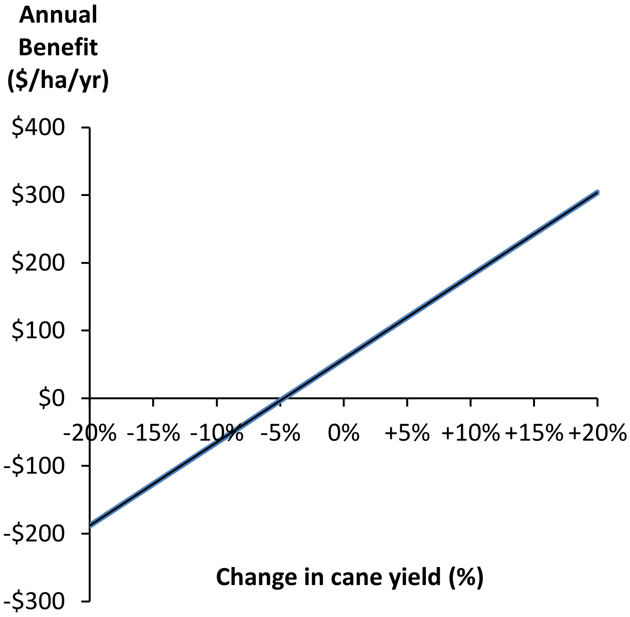
The potential for aquatic eco-toxicity impacts from losses of pesticides to water was estimated to reduce by 48 per cent overall. This is due to the avoided loss of around 41kg of pesticide active ingredients to water, because of slight reductions in the application rates of some herbicides, but mostly because the transition from a plough-out/replant system to a fallow system meant that there was less herbicide applied overall because of the reduced area under cane.

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 overall yield would need to decline by more than 4 per cent before investing in BMP adoption is unprofitable (Figure 3).

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



From an environmental perspective, the outcomes are sensitive to both cane yield and 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 of cane produced), yields across plant and ratoon canes would need to decline by 22 per cent for nutrient-related water quality impacts, 33 per cent for carbon footprint and 40 per cent for fossil fuel use. For pesticide-related water quality impacts, yield decline would have to be around 50 percent for there to be no net gain (Figure 4).

This 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 N and P content of mill mud can vary considerably. Results of a sensitivity analysis show that if the N and P contents of the mill mud were actually around 0.1% there would be no improvement in water quality (Figure 5). If N and P contents are higher than 0.1%, there is a worsening in the potential for nutrient-related water quality impacts. The N content of mill mud also influences the carbon footprint (in relation to nitrous oxide emissions), however it is less sensitive. The N content of mill mud would need to be more than 0.4% for there to be no net improvement in carbon footprint.

[8] 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.

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, labour and herbicides. Adrian made a relatively small investment to implement BMP. Transitioning to a fallow system has resulted in a gradual increase in profitability therefore increasing the likely payback period.

Transition from a plough-out/replant system to a fallow system has resulted in less overall herbicide application and a significant reduction in the potential for aquatic eco-toxicity impacts from losses of pesticides. Additional environmental benefits from the transition to BMP are reduced fossil fuel use, reduced greenhouse gas emissions and reduced potential for water eutrophication from nutrients losses as a result of reduction in fertiliser.

Each farming business is unique in its circumstances and therefore the parameters and assumptions used in this case study reflect Adrian's 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

Figure 4: Environmental impact (impact/t cane) sensitivity to yield

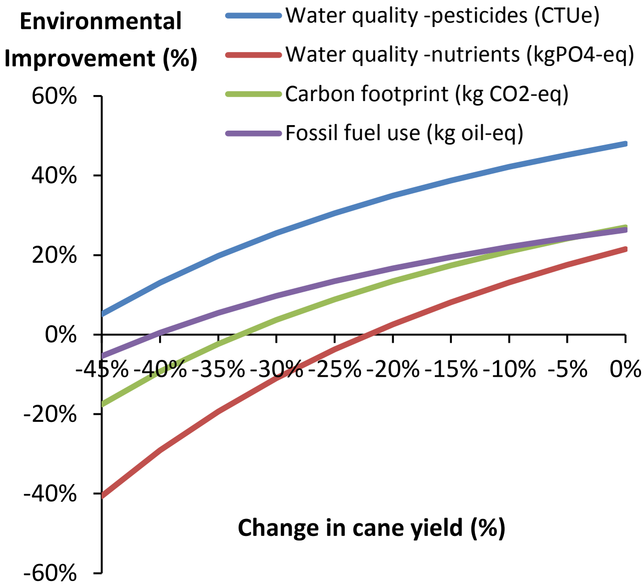


Figure 5: Environmental impact (impact/t cane) sensitivity to N and P content in mill mud (%)