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

Case Study 5: Walter Giordani

This case study is the fifth in a series that evaluates the economic and environmental impact of Best Management Practice (BMP, as defined by Smartcane BMP) adoption on sugarcane farms in North Queensland. Information from before and after BMP adoption was supplied by the farmer 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 BMP adoption more broadly.

Key findings of the Walter Giordani case study

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

- Progressive improvement in production compared to the productivity zone (18 tch or 27%).
- Annual improvement in farm operating return of $429/ha ($37,834/yr total).
- 46kg less pesticide active ingredients and 250kg less eutrophying substances (nitrogen and phosphorous) potentially being lost to waterways annually.
- Fossil fuel use reduced by 18 per cent per tonne of cane over the life cycle (0.2 t/yr of oil).
- Annual greenhouse gas emissions reduced by 20 per cent per tonne of cane.

"The focus of my investments have centred on maximising my yield improvement and becoming sustainable into the future of the industry"

About the farm

Image 1: Walter Giordani near a ratoon crop

Walter Giordani farms 90 hectares of sugarcane in the Herbert region and recently attained Smartcane BMP accreditation. Walter purchased his home farm in 2009 and another farm in 2013. He set about identifying areas that might lift production. Firstly, he identified waterlogging issues and laser levelled the farm to improve drainage. Soon after making the change, Walter observed yield improvements from his initial investment so he looked for additional areas of improvement. He attended local productivity services meetings and was introduced to new farming practices such as soil testing to identify the nutrient and ameliorant (lime) requirements of his soils. Walter observed further yield improvements and that success spurred him on to adopt other sustainable practices including legume fallow cropping, wider row spacing, GPS guidance, minimum tillage and eventually mound planting. All of Walter's investments took a step-by-step approach with the aim to improve yield potential.

[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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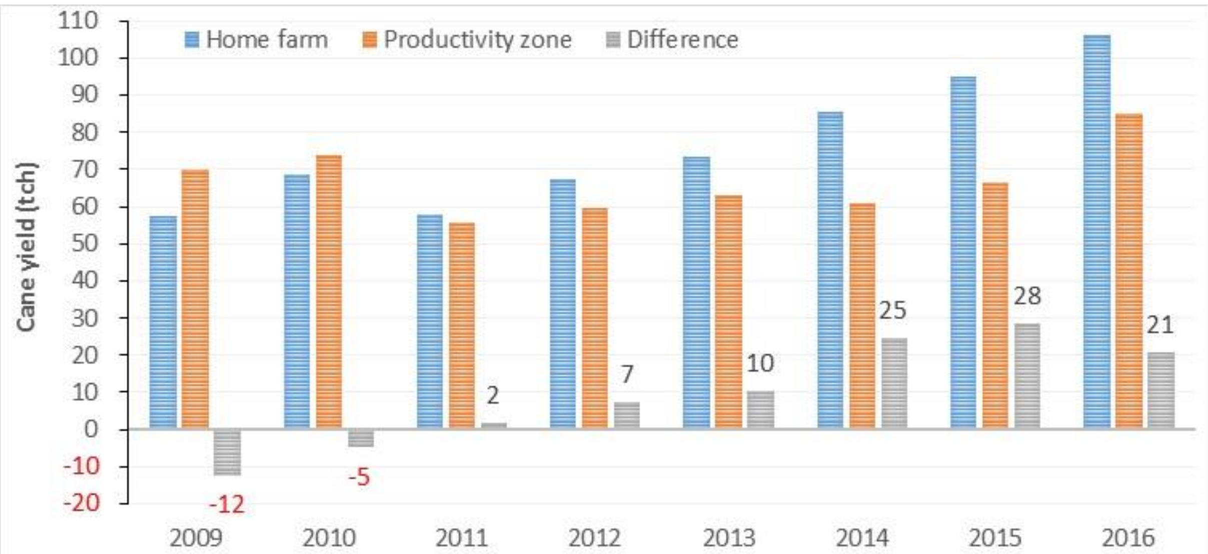
Since implementing the improved management practices over the past eight years, production has improved considerably on Walter's home farm relative to the productivity zone average. Figure 1 compares the average cane yield on Walter's home farm to the productivity zone average and shows the progressive improvement in yield since making the farming system changes. In the first few years of farm operations, he was around the productivity zone average. However, over the past 5 years (2012-16) Walter's cane yields have on average been 18 tonnes of cane per hectare (tch) above the productivity zone, which is a 27% improvement.

Figure 1: Comparison of cane yield on home farm to the productivity zone.



What changes were made?

The main changes to Walter's farming system are summarised in Table 1. Walter now laser levels to improve drainage and grows a legume crop in his fallow for green manure. He has also reduced his tillage operations[3] and started planting into preformed beds. In addition, he uses GPS guidance and has widened his row spacing from 1.52m to 1.62m. To improve nutrient management, Walter uses the Six-Easy-Steps guidelines to determine the type and quantity of nutrients and soil ameliorants required. For weed management, he now sprays with a hi-rise tractor, band sprays chemicals using shields and has changed some of the types of herbicides that he applies.

Table 1: Main changes to the new farming system

	Before	After
Drainage	• Minimal drainage work	• Laser levelling to improve drainage
Soil health	• Bare fallow • Heavy tillage	• Legume fallow crop (Cowpeas) • Reduced tillage and planting into preformed beds • GPS guidance • Widened row spacing (1.52 to 1.62m)
Nutrient management	• Grower determined nutrient rates	• Using Six Easy Steps to determine required nutrients and soil ameliorants (lime)
Weed, pest and disease	• Spraying rows and inter-rows with the same chemicals.	• Band spraying chemicals using shields • Spraying with hi-rise tractor • Changed some types of herbicides

[3] He now discs less and has stopped ripping, rotary hoeing, centre busting, grubbing and weed raking.

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How much did it cost to make the change?

Modifications of existing machinery was carried out to match wheel spaces to the wider rows ($6000). There was also a need to invest in new equipment including GPS guidance ($32,000), a stool splitter ($32,000), a bed renovator ($25,000) and a legume planter ($6,500). Also, one tractor was raised to enable hi-rise spraying and new spray tanks and shielded sprayers were purchased[4] ($50,000). The total cost of implementation was $151,500 (or $1,718/ha).

What does this mean for the business?

An economic analysis of Walter's transition to a Best Management Practice farming system indicates his operating return increased by $429/ha/yr ($37,834/yr total). This is a direct result of differences in operating costs between the conventional and improved farming system and an improvement in cane yields (27%). The main differences in operating costs are illustrated in Figure 2 and include:

- **Capital goods**[5] – machinery repair and maintenance costs decreased by $51/ha due to less mileage (wider row spacing) and less tillage but were outweighed by higher depreciation costs of $109/ha from new machinery and equipment purchases to implement BMP changes.
- **Fuel, oil and labour** – these costs decreased by $76/ha due to less tillage and wider row spacing, which reduced tractor hours (fewer cane rows equals a shorter travelling distance).
- **Fertilisers and ameliorants** – the use of Six Easy Steps reduced the quantity of nitrogen applied and identified the need for micronutrients and other soil amelioration products. The additional lime spreading costs ($59/ha) outweighed fertiliser cost savings of $9/ha.
- **Herbicides** – band spraying and reduced herbicide use has lowered costs by $21/ha.
- **Insecticides** – a switch was made from a more expensive grub control option to a cheaper product which lowered pest control costs by $49/ha.
- **Planting and harvesting** – planting cowpeas required additional costs of $15/ha.
- **Laser levelling** – laser levelling fallow blocks to improve drainage added costs of $38/ha.

Figure 2: Contribution to change in farm operating costs ($/ha)

[4] 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, some of the investments were partially funded.

[5] Capital goods refer to the cost of repairs, maintenance and depreciation of machinery and equipment.

Was the investment profitable?

Table 2 shows the results of an investment analysis based on a six year transitioning period to implement the changes. Given the additional revenue from increased production and lower costs, it would take six years to recover the $151,500 (or $1,718/ha) invested. Over a ten year investment horizon, the investment has added an additional $19,402 per year ($220/ha/yr) to the bottom line (when the initial investment is taken into account). This analysis is based on a 27% yield improvement after BMP adoption.

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

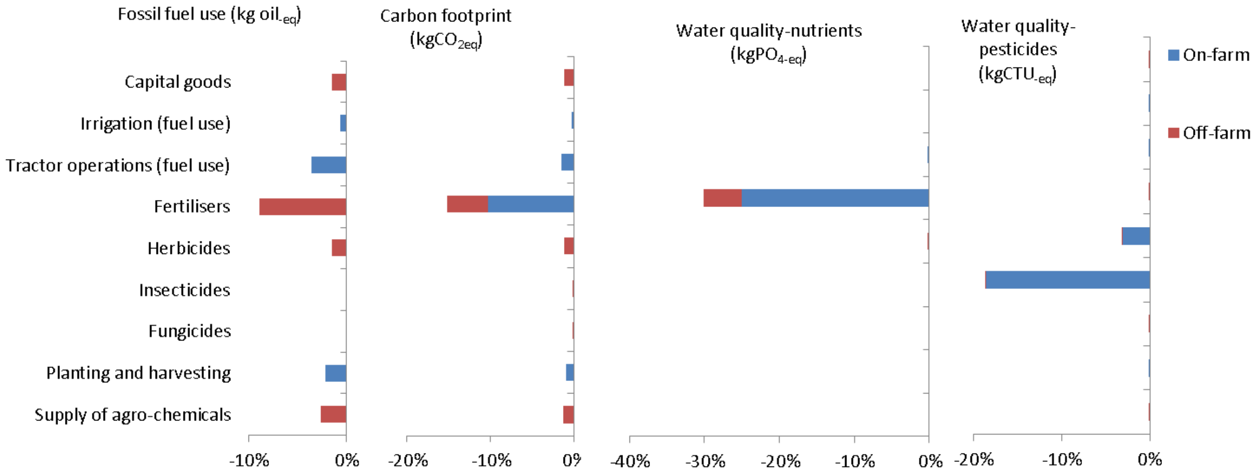
Cost of Implementation ($/ha)	$1,718
Discounted Payback Period	6 years
Annual Benefit ($/ha/yr)	$220
Internal Rate of Return	20%
Investment Capacity ($/ha)	$3,262

Investment capacity is the maximum amount of money that can be spent before an investment becomes unprofitable. Walter could have invested up to $287,770 ($3,262/ha) before the additional yield and cost savings would be insufficient to provide the required (7 per cent) return on investment.

What does this mean for the environment?

The estimated change in environmental impacts for Walter's farming system before and after BMP adoption is shown in Figure 3. After adoption, annual fossil-fuel use, over the life cycle of cane growing (i.e. on-farm plus off-farm), reduced by 18 per cent per tonne of cane overall. On-farm fuel use for tractor operations and harvesting reduced as a result of wider row spacing and less tillage. There were also off-farm reductions in energy use, due to a lower quantity of fertilisers and a slightly reduced quantity of herbicides being produced at the factory and supplied to the farm. However fuel use for harvesting was estimated to increase because the higher cane yield means a bigger crop is harvested. There was also some additional fuel use for the introduced legume crop. So, overall the total fossil-fuel use decreased marginally by around 0.2 tonnes of oil equivalent per year[6]. However increased cane yield meant fossil-fuel use efficiency per tonne of cane improved substantially (18%).

Figure 3: Increase / decrease in environmental impacts after BMP adoption (per tonne cane)[7]



The carbon footprint, which is the greenhouse gas (GHG) emissions of cane production, was reduced by around 20 per cent per tonne of cane overall after BMP adoption. The reasons for the reductions in

[6] 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.

[7] 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.

GHG emissions are the same as for fossil fuel use, because most GHG emissions are linked to fossil-fuel use. However there was also a reduction in on-farm emissions of nitrous oxide[8] (N_2O, a strong GHG), because the introduced legume fallow meant some synthetic N fertiliser was displaced, and N_2O emissions from legume-N were assumed lower than those from synthetic-N. For the farm as a whole, there would be a reduction of around 1 tonne of carbon dioxide equivalent emitted per year over the life cycle of the farming operation, the equivalent of taking 1 car off the road for half a year. However the increased yield meant a substantial improvement in carbon efficiency per tonne of cane.

A reduction in the amount of nitrogen and phosphorous applied to the production system (reduced by 31% per tonne of cane) means there is a potential for less of these nutrients to be lost through runoff and leaching. This could mean a reduction in approximately 250 kg of eutrophying substances per year being lost from the soil through the movement of water.

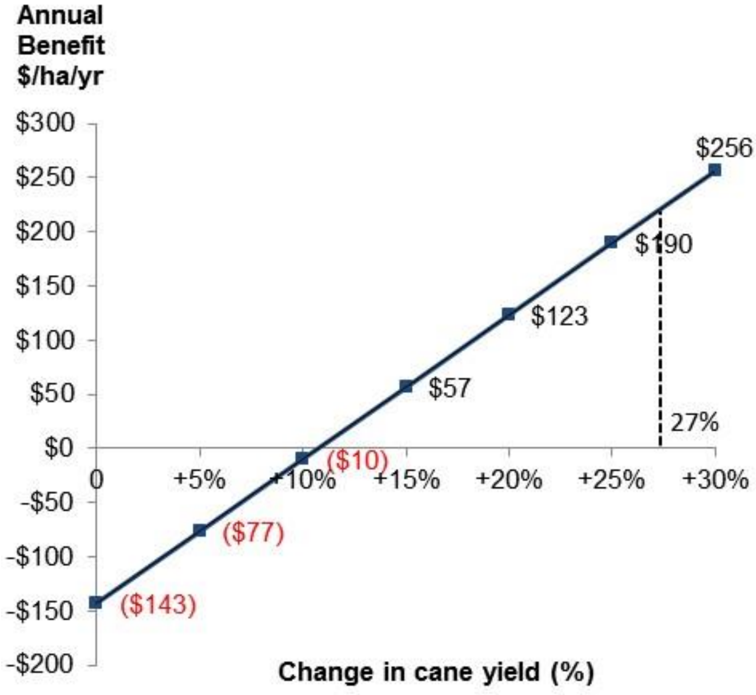
The potential for water quality impacts from losses of pesticides entering waterways was estimated to decrease by about 22 per cent per tonne of cane. The quantities of pesticide active ingredients (AI) applied decreased, resulting in about 46 kg less pesticide AI being lost through water pathways per year. However a change in types of herbicide AI used (introduction of metolachlor, hexazinone and haloxyfop) meant that overall toxicity of the releases may not have changed. 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 pesticides. Despite no net change in the overall toxicity potential of the AI lost from the farm, because the cane yields increased the impact per tonne of cane is lower (22%).

What about risk?

A key factor driving Walter's investment was improvements in yield. While the previous analysis examined a 27% yield improvement, this section examines the influence on profitability and the environment given different cane yield improvements.

Figure 4 shows the results of a yield sensitivity analysis, which indicates that the annual benefit is sensitive to the yield improvement. The average farm yield would need to improve by 11 per cent (or 7 tch) or greater to make the investment profitable, which is 16% less than the 27% yield improvement examined.

Figure 4: Annual benefit of investment ($/ha/yr)

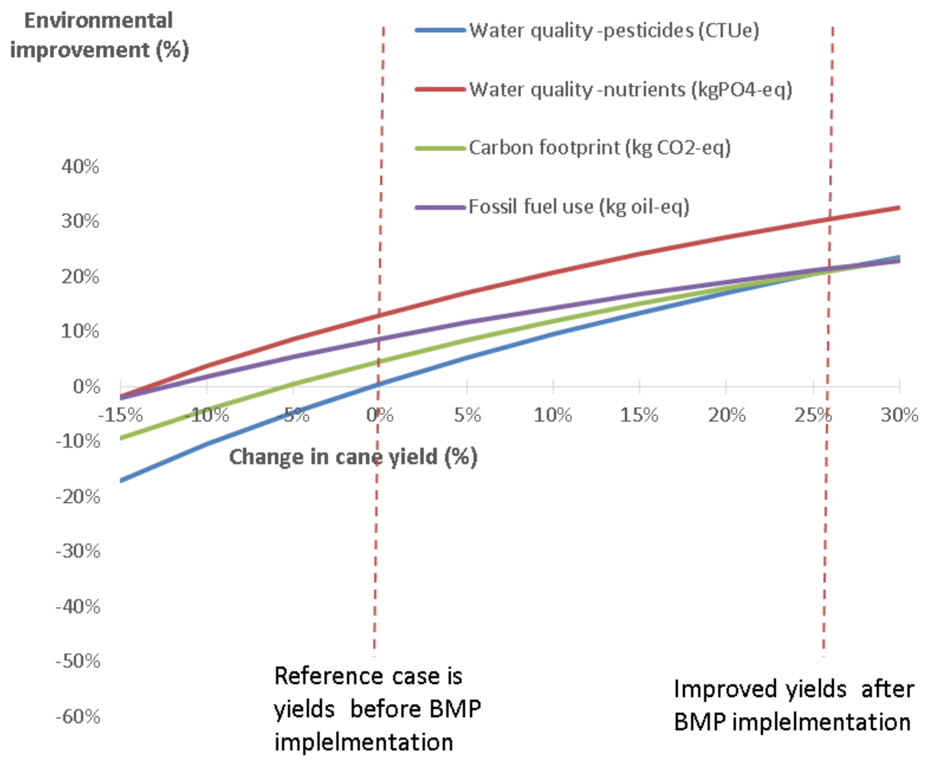


From an environmental perspective, the environmental improvements are sensitive to cane yield (Figure 5). If the cane yields after implementation had remained the same as before, there would have been environmental improvements in the order of 5-10% (per tonne of cane) for all impact categories except pesticide-related water quality impacts, which would have remained about the same. However because yields increased after implementation (by 27%), the scale of those environmental improvements per tonne of cane were greater (20-30%).

[8] 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.

[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).

Figure 5: Environmental impact sensitivity to yield



What's the bottom line?

This case study evaluated the business and environmental impact of BMP adoption for a Wet Tropics farm. Since 2010, Walter has progressively adopted BMPs to improve yield potential on his farm. Changes included improving drainage, using the Six Easy Steps, growing a legume crop, reducing tillage and widening row spacing. Walter has observed progressive improvements in production since implementing new practices and believes it is critical to continually improve his farming operation.

The results from the economic analysis indicate cost savings from lower fuel and chemical use, reduced labour requirements and less repairs and maintenance. These coincided with some additional costs from laser levelling, applying lime as a soil ameliorant and planting legumes as well as higher depreciation costs from new machinery purchases. Overall, the investment analysis shows an improvement in farm profitability and that the investment in new machinery and equipment has proved to be a worthwhile investment. The risk analysis reveals that a yield improvement of 11% would have made the investment profitable, which is 16% less than the 27% improvement examined.

Transition to BMP has resulted in less fertiliser application and a reduction in the potential for water quality impacts from nutrient loss. While the quantities of pesticide active ingredients applied decreased slightly, a change in the type of herbicides used meant that the toxicity of the releases did not decrease overall. 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. The estimated reductions in impact overall per tonne of cane can partly be attributed to increased yields.

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

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