SYNTHESIS REPORT
2009/10 - 2012/13 Wet Seasons

Runoff and Water Quality from Best Management Practices in Sugarcane Farming

Reef Water Quality Science Program in the Mackay Whitsunday Region

K. Rohde, B. Billing, K. McDuffie and J. Agnew

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Project Catalyst

Project Overview

This synthesis report brings together four years of water quality and agronomic monitoring at the Victoria Plains sugarcane trial site located west of Mackay. The monitoring program was funded through the Paddock to Reef Integrated Monitoring, Modelling and Reporting Program in years 2009/10, 2010/11 and 2011/12 and by the Queensland Government's Reef Water Quality Science Program (RWQSP) for 2012/13.

Under the Paddock to Reef program, paddock scale monitoring of water quality from various levels of management practices were implemented in selected GBR catchments and agricultural industries (Carroll *et al.* 2012). As part of this program and in conjunction with Project Catalyst, two sugarcane blocks (Victoria Plains and Marian sites) in the Mackay Whitsunday region were used to measure levels of herbicides, nutrients and sediments in runoff. Different sugarcane management strategies were investigated, with the emphasis on improving water quality with improved management practices. Each treatment and site was instrumented to measure runoff and collect samples for water quality analyses (total suspended solids, total/filtered nutrients and herbicides).

Two additional sites, Multi-block and Multi-farm, were used to measure the effects of changes in management strategies at larger scales (results not included in this synthesis report). Under the Reef Water Quality Science Program, a rainfall simulation experiment was used to improve the understanding of nitrogen and sediment losses at the Marian site. The rainfall simulation data is compiled in a separate report.

This synthesis report focuses on the Victoria Plains site (uniform cracking clay) which was initially divided into two treatments of soil, nutrient and herbicide management practices, with an additional two treatments added in 2012/13 (Table 1). The Marian site (duplex soil) was divided into five treatments of soil, nutrient and herbicide management practices but is not included in this synthesis due to inconsistent quality of data due to site flooding.

Table 1: Description of the Victoria Plains sugarcane trial treatments

	ABCD Classification[1]	Soil Management	Nutrient Management	Herbicide Management	No. of years active
Treatment 1	CCC	1.5 m current practice	Generalised recommendation	Regulated broadcast[3]	4
Treatment 2	BBB	1.8 m controlled traffic	Six Easy Steps[2]	Non-regulated broadcast[4]	4
Treatment 3	BCC	1.8 m controlled traffic	Generalised recommendation	Regulated broadcast	1
Treatment 4	BBB	1.8 m controlled traffic	Six Easy Steps	Regulated banded	1

[1] – ABCD classifications for soil/sediment, nutrients and herbicides, respectively
[2] – Farm-specific nutrient management plan designed by BSES
[3] – Herbicides identified in the Chemical Usage (Agricultural and Veterinary) Control Regulation 1999
[4] – Herbicides not identified in the Chemical Usage (Agricultural and Veterinary) Control Regulation 1999

Key Findings

Annual runoff was reduced by 16% with controlled traffic (1.8 m row spacing), despite the above average rainfall over the four year monitoring period

At the Victoria Plains site, we found that there was on average 16% less runoff from the 1.8 m row spacing (Treatment 2), despite receiving above average annual rainfall for the three year monitoring period (Figure 1). Furthermore, Treatment 2 also had a delayed onset of runoff (average 17 minutes) and a lower peak runoff rate (average 18%). These results suggest that by matching row spacing to machinery wheel spacing, there will be reduced compaction, improved infiltration and consequently reduced runoff.

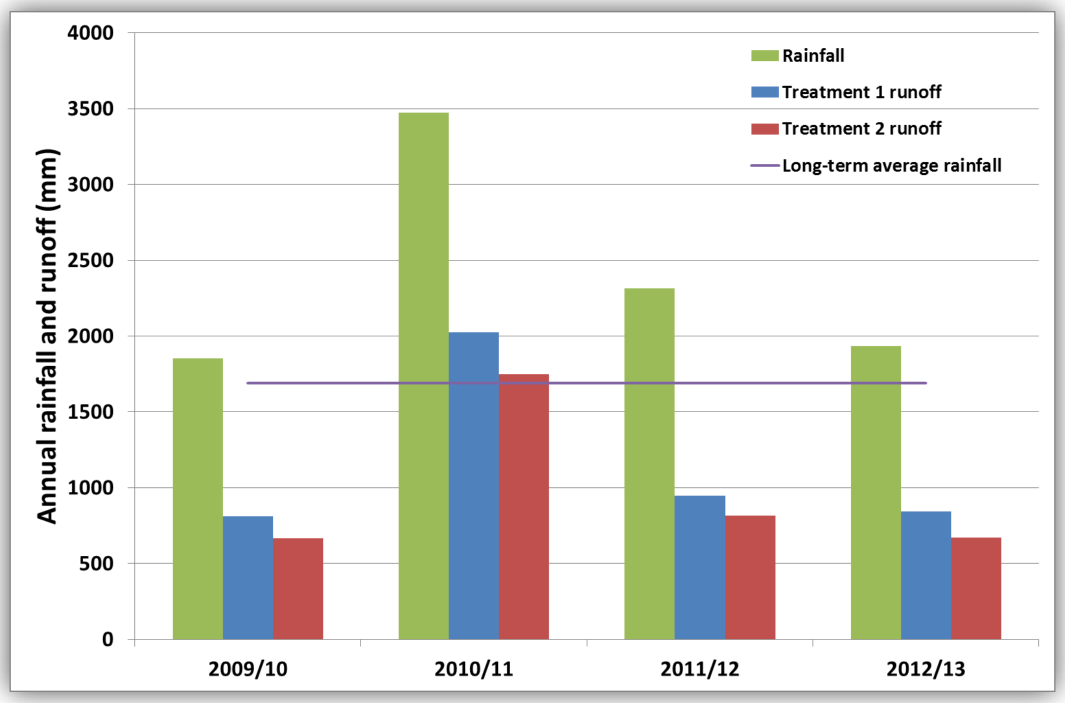

Figure 1: Runoff from the 1.8 m row spacing (controlled traffic) consistently had less overall runoff than the 1.5 m row spacing.

Sediment losses were reduced by maintaining a green cane trash blanket and reducing cultivation

At the Victoria Plains site, sediment concentration in runoff revealed that by maintaining ground cover (green cane trash blanket – GCTB) and reducing cultivation, sediment losses to runoff could be reduced (Figure 2 and Figure 3). In the initial trial year, the ground was bare following a fallow with a legume crop ploughed into the soil. With no ground cover, sediment losses were significantly higher than the subsequent years where the GCTB was retained after harvest and the soil was undisturbed by cultivation. The difference shown in 2009/10 is thought to be due to sampling differences rather than treatment differences, with Treatment 2 being low rather than Treatment 1 being high. This is despite higher than average rainfall in each of the four years.

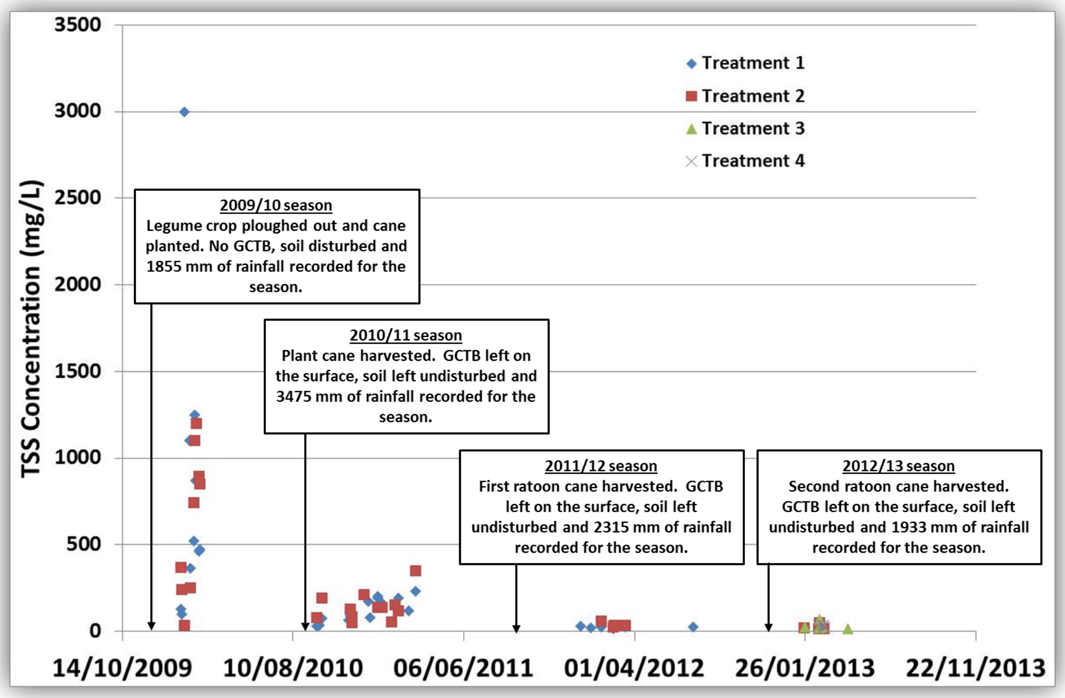

Figure 2: Sediment concentrations decreased over the four year monitoring period due to the retention of a GCTB and no cultivation being undertaken in the 2010/11, 2011/12 and 2012/13 seasons.

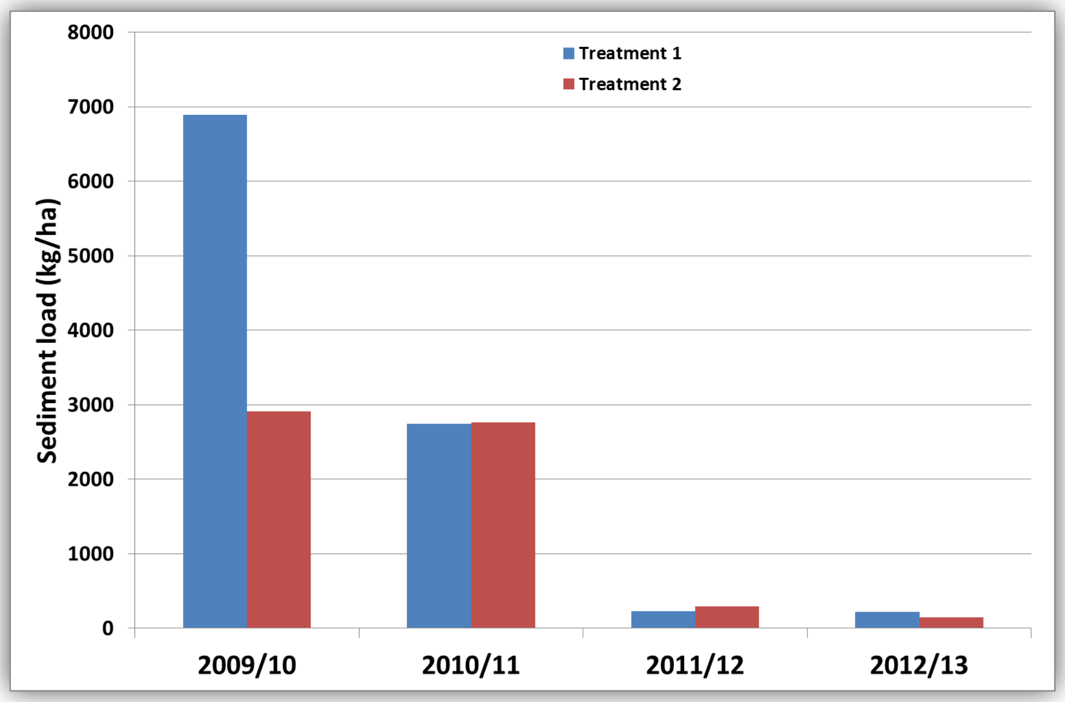

Figure 3: Sediment loads decreased over the four year monitoring period due to the retention of a GCTB and no cultivation being undertaken in the 2010/11, 2011/12 and 2012/13 seasons.

The amount of nutrients applied and timing of application were critical in reducing runoff losses

It was found that the greater the time between application and the first runoff event, and the amount of infiltrating rainfall during this period, between application and the first runoff event, reduced the amount of nitrogen lost in runoff (Figure 4). The urea-N to NO_x-N ratio also appeared to decrease with the increase of time between application and the first runoff event, and the amount of infiltrating rainfall during this period (Figure 4). Furthermore, it was evident that the lower the application rate of nitrogen, the lower the amount of nitrogen lost via runoff (Figure 4). Moreover, background nitrogen levels in the soil also had an effect on the amount of nitrogen lost via runoff with the 2009/10 season having higher levels of soil nitrogen than the other seasons due to a legume fallow prior to the planting of the cane for this field trial.

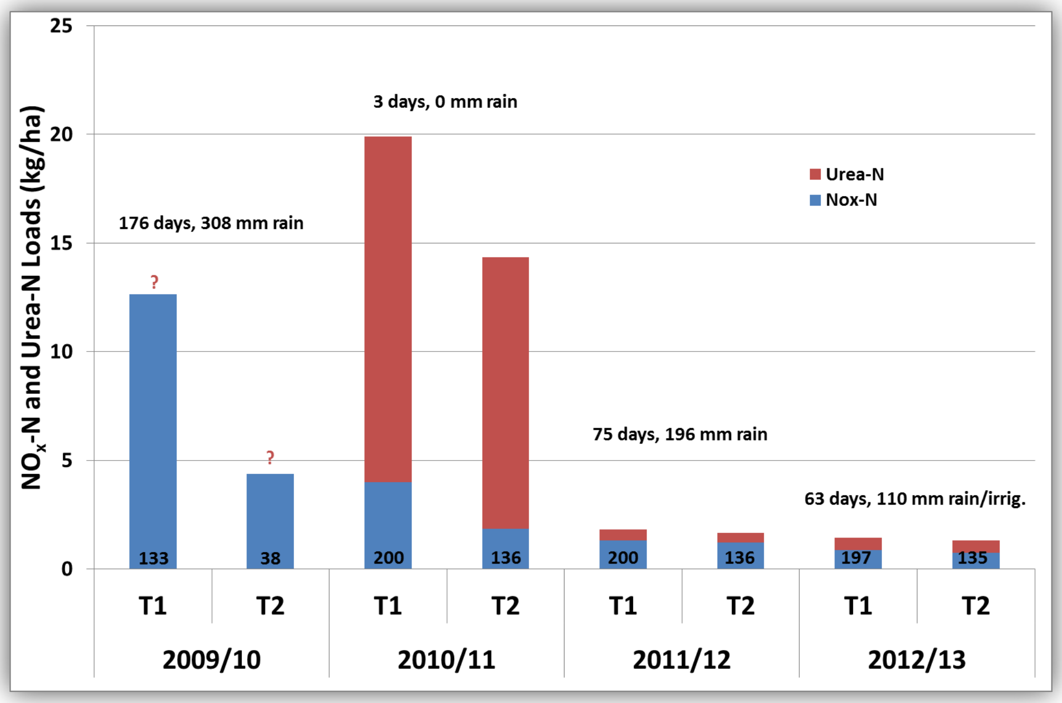

Figure 4: Nitrogen loads and the urea-N to NO_x-N ratio in runoff decreased with increasing time between application and the first runoff event, as well as with the amount of infiltrating rainfall during this period. Nitrogen loads in runoff also decreased with lower application rates of nitrogen.

Timing and amount of herbicide application were critical in reducing runoff losses

The greater the time between application and the first runoff event, the less herbicide was lost in runoff (Figure 5) – every additional 25 days halved runoff losses. Also, the amount of infiltrating rainfall during this period, between the application and the first runoff event, reduced the amount of herbicide lost (Figure 6) – every additional 50 mm halved runoff losses. The critical period for reducing herbicides losses to runoff is therefore within ~25 days of herbicide application. Prior to the 2012/13 season, an additional treatment of banding regulated residual herbicides was added to the trial site. Results showed that a 33% band (over the cane stool area) vs broadcasting herbicides (100% blanket) resulted in a reduction of runoff losses of approximately 50% (Figure 7). Row spacing had little effect on herbicide runoff losses.

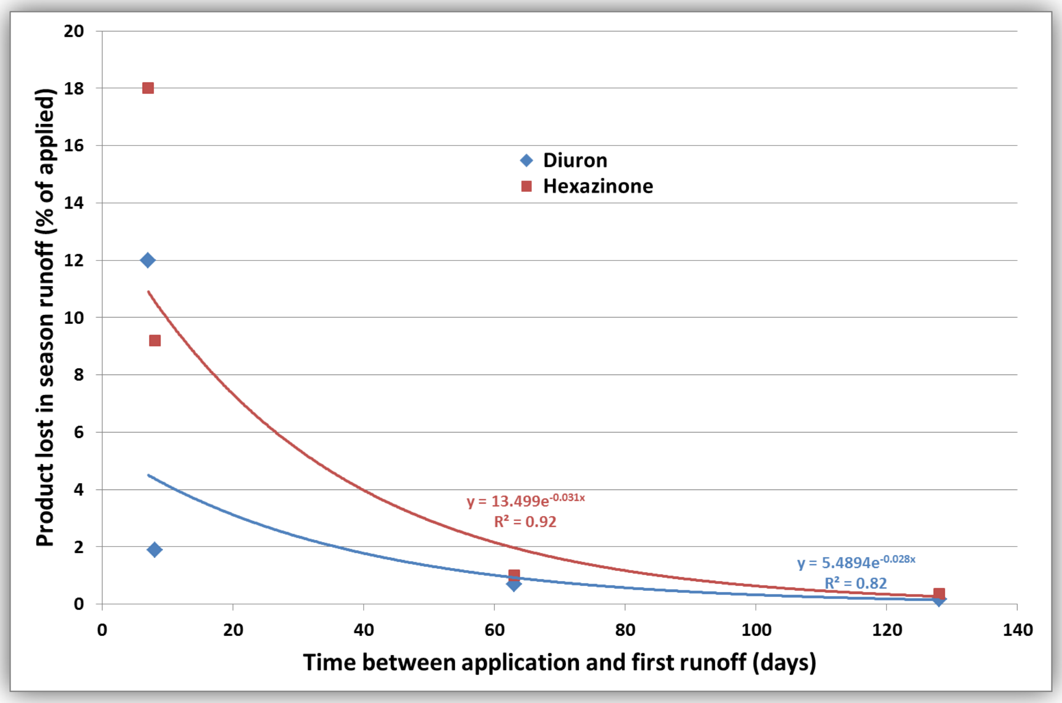

Figure 5: The amount of herbicides lost to runoff halved with every additional 25 days between application and the first runoff event.

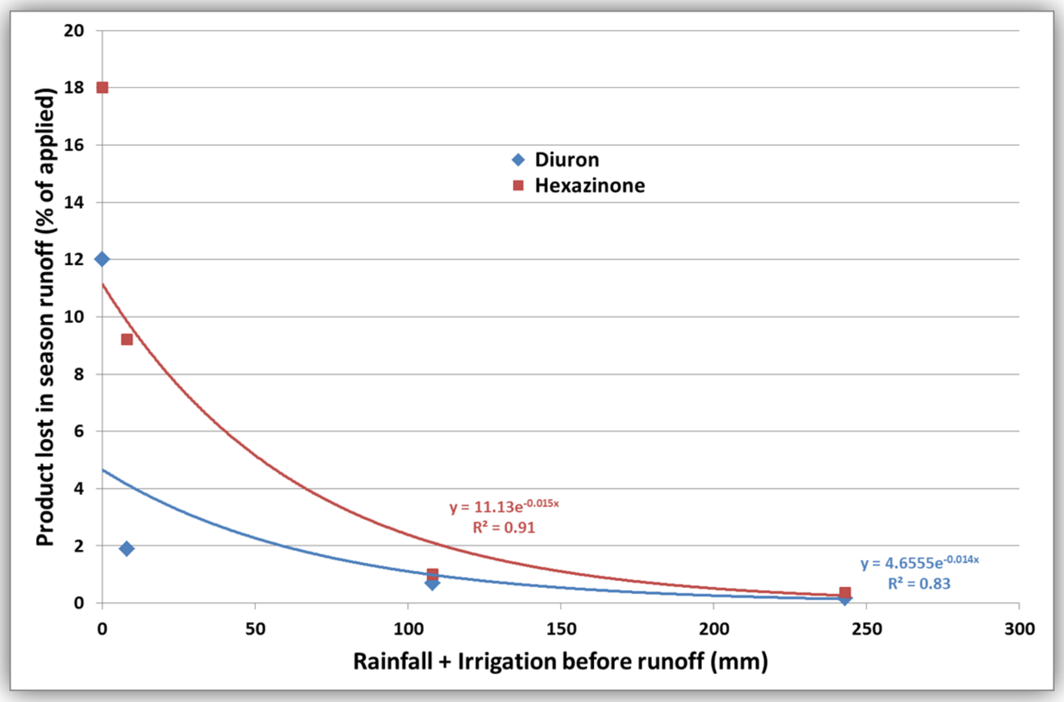

Figure 6: The amount of herbicides lost to runoff halved with every additional 50 mm of rainfall/ irrigation before runoff.

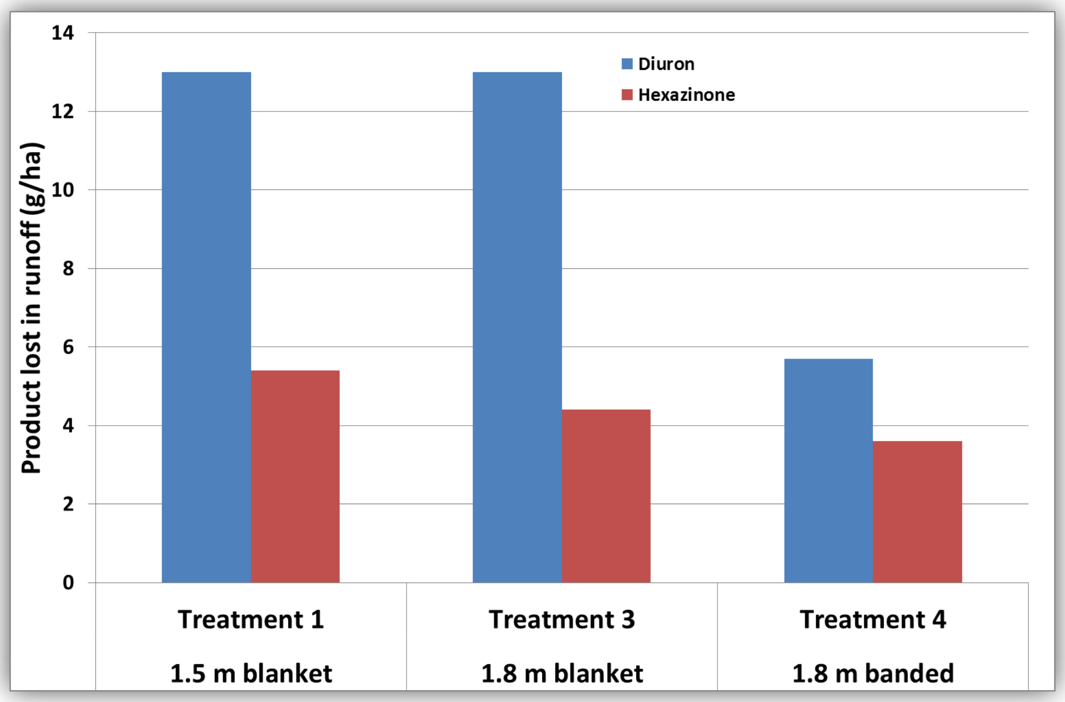

Figure 7: Banding herbicides (33% band) halved runoff losses. Row spacing had little effect on herbicide losses.

Implementing best management practices did not significantly affect productivity

The data suggests that by implementing best management practices (BMP's), there will not be a significant effect on productivity with BMP's (B-class practices) performing as well as current management practices (C-class practices) even in a monitoring period that exhibited extreme weather events (Table 2).

Table 2: Productivity was not significantly affected by implementing best management practices (BMP), with the BMP (BBB) performing as well as current management practice (CCC).

a) Average of 2009/10, 2010/11 and 2011/12 seasons

	ABCD Classification[1]	Nitrogen applied (kg/ha)	Cane yield (t/ha)	Sugar yield (t/ha)	Sugar content (%)	Net return ($/ha)*
Treatment 1	CCC	183	79	13	17	2365
Treatment 2	BBB	112	75	12	16	2395

b) 2012/13 season

	ABCD Classification[1]	Nitrogen applied (kg/ha)	Cane yield (t/ha)	Sugar yield (t/ha)	Sugar content (%)	Net return ($/ha)*
Treatment 1	CCC	197	69	13	18	2500
Treatment 2	BBB	135	71	13	18	2680
Treatment 3	BCC	197	77	14	18	2815
Treatment 4	BBA	135	72	13	17	2660

1 – ABCD classifications for soil/sediment, nutrients and herbicides, respectively
* Excluding irrigation, other fertiliser (nutrients) and fixed costs other than harvesting

Overall, these results are not surprising and are all supported by other studies. For further details, please refer to the Mackay Whitsunday Paddock to Sub-catchment Scale Water Quality Monitoring of Sugarcane Management Practices Final Report for the 2009/10 to 2011/12 Wet Seasons (Rohde *et al.* 2013a) and 2012/13 Wet Season (Rohde *et al.* 2013b).

Caption: Extension activities undertaken on site with a wide range of field day participants, delegates and stakeholders during the course of the project.

References

Carroll C., Waters D., Vardy S., Silburn D.M., Attard S., Thorburn P.J., Davis A.M., Halpin N., Schmidt M., Wilson B., and Clark, A. (2012). A Paddock to reef monitoring and modelling framework for the Great Barrier Reef: Paddock and catchment component. *Marine Pollution Bulletin* **65**, 136-149.

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Rohde, K., McDuffie, K., and Agnew, J. (2013b). *Paddock to Sub-catchment Scale Water Quality Monitoring of Sugarcane Management Practices. Interim Report 2012/13 Wet Season, Mackay Whitsunday Region.* Department of Natural Resources and Mines, Queensland Government for Reef Catchments (Mackay Whitsunday Isaac) Limited, Australia.

Authorship

K. Rohde, B. Billing, K. McDuffie and J. Agnew

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Reef Catchments **Mackay Whitsunday Isaac**

PHONE (07) 4968 4200
EMAIL info@reefcatchments.com
WEB www.reefcatchments.com.au
ADDRESS Suite 1/85 Gordon Street | Mackay QLD 4740