Banding mill by-products – economic case study, Burdekin region

Grower: Chris Hesp

The NQ Dry Tropics Project Catalyst provides an opportunity for sugarcane growers to work closely with technical specialists to examine innovative and aspirational practices that may enhance profitability, whilst reducing nutrient and pesticide losses from Burdekin farms and improving water quality entering the Great Barrier Reef. Moreover, it facilitates the communication of trial results to other growers, serving as a catalyst to sustainable farming.

This case study evaluates the relative costs of conventionally spreading and banding mill by-products (mud) on Chris Hesp's sugarcane farm at Mulgrave in the Burdekin (located ~50 kilometres from Invicta Sugar Mill). Based on these costs, the study calculates the yield improvements needed by each mud treatment to breakeven economically with a zero mud treatment, and also examines their relative profitability if mud was to improve cane yield outcomes. Furthermore, harvest results from the trial site are used to compare the profitability of the mud treatments.

Project Catalyst is a pioneering partnership funded by the Coca-Cola Foundation, through the World Wide Fund for Nature, and delivered in partnership with the Department of Agriculture and Fisheries, Farmacist, Burdekin Productivity Services and the Burdekin Bowen Integrated Floodplain Management Advisory Committee Inc.

Key findings:

- Banding mud at 65t/ha on Chris' farm saves $750/ha in costs compared to conventionally spreading mud at 200t/ha.
- The 200t/ha treatment needs to yield a total of 24 TCH more than the banded treatment to recover the extra costs.
- Trial production results show that all of the mud treatments have recovered around half of their mud cartage costs.

Banding mill by-products

The application of mud to fallow and ratoon blocks can provide a multitude of soil health benefits to sugarcane growers. Advantages may include the improvement of soil texture, structure and biology[1] as well as supplying a range of nutrients, particularly nitrogen (N), phosphorus (P), potassium (K), sulphur (S) and calcium.

Mud is usually applied directly into the furrow at application rates of two hundred tonnes per hectare (t/ha). As mud is a by-product of the sugar milling process, it is generally made available at a low cost. Nevertheless, growers must transport the mud from the mill to their farms and apply it over their fields. Haulage operators normally serve this function and charge growers by the volume or tonnage hauled and distance from the mill[2]. Accordingly, distance can be considered a barrier to applying mud due to the relatively higher haulage costs associated with carting mud larger distances.

Banding mud helps to improve the cost-effectiveness for all users as application rates can be reduced compared to conventionally applied amounts. This increases the affordability for distant farms that may benefit from using mud. The placement of mud directly on the sugarcane row permits the grower to minimise tillage operations as incorporation of the product is not required. Furthermore, the mud is not exposed to irrigation water in the furrow potentially reducing the off-site movement of nutrients.

To maximise farm profitability it is essential to account for nutrients provided by mud when developing a nutrient management plan[3].

[1] Benson, A., Royle, A., & Holzberger, G. (2013). The benefits of applying mill mud and ash in the Herbert. HCPSL, Ingham.

[2] To cover variable expenses associated with fuel, labour and truck maintenance.

[3] Qureshi, M.E., Wegener, M.K., Qureshi, S.E., and Mason, F.M. (2002) Implications of alternative mill mud management options in the Australian sugar industry. ACAARES, Canberra.

Image 1: Banded mill by-product

Site description & trial design

Farmacist established the trial in 2014 on a crop entering its second ratoon. Table 1 provides a summary of the characteristics of the trial block. The crop was planted in 2012.

Table 1: Characteristics of trial site

Element	Description
Soil type:	Clay with sodic soils
Location:	Mulgrave, Clare
Water supply:	Channel (furrow irrigation)
Crop stage:	Second ratoon
Fertiliser:	Applied with stool splitter

A fundamental question underlying the trial is whether banding mud (see Image 1) at lower application rates, can maintain or improve grower profitability relative to the common industry practice of conventionally spreading mud at 200 tonnes per hectare (t/ha). Consequently, the trial site was set-up to compare common practice with both a banded treatment and conventionally spread treatment at lower rates, together with a control treatment that has zero mud.

Table 2 shows the application rate and cost of mud for each of the three mud treatments. The banded mud treatment had 65 t/ha applied directly on the cane, while the lower rate conventionally spread treatment was applied at 100 t/ha. Cartage costs to the trial site were quoted at $6/t for conventionally spread or banded mud. All treatments were replicated three times using a randomised complete block layout.

Table 2: Mud application rates and costs

Treatment abbreviation	Placement	Rate *t/ha*	Cost *$/ha*
200t/ha conv	In furrow	200	$1,200
100t/ha conv	In furrow	100	$600
65t/ha banded	Over stool	65	$390

Nutrients supplied by mud/ash

A laboratory analysis of the mud was undertaken to identify the quantities of N, P, K and S that it contained (mill by-product contained both mud and ash). To get an indication of the nutrients supplied by each mud treatment, Table 3 shows the total nutrient composition of the mud at the time of analysis multiplied by the mud application rates for each treatment.

Notably, the N quantities identified by the analysis do not take into account the total N supplied by mud over time (N supplied by mud is gradually released). The Six Easy Steps nutrient guidelines for the Burdekin recommend reducing N rates by up to 100kg N/ha depending on the type of mill by-product applied and the time passed since application[4].

Table 3: Nutrients supplied by mud (kg/ha)

	N	P	K	S
200t/ha conv.	<1	420	260	66
100t/ha conv.	<1	210	130	33
65t/ha banded	<1	137	85	21

After applying mud, growers have the option to adjust their fertiliser rates to account for the nutrients provided by the mud and save on fertiliser costs. Consequently, the economic analysis examines two different scenarios. The first scenario assumes that fertiliser rates are adjusted to account for the nutrients provided by mud, while the second scenario assumes no fertiliser cost savings.

[4] Sugar Research Australia. (2013). Nutrient management guidelines for sugarcane in the Burdekin district. Retrieved from Sugar Research Australia: http://www.sugarresearch.com.au/icms_docs/194330_SIX_EASY_STEPS_Nutrient_Guidelines_for_BURDEKIN.pdf .

Image 2: Mud cartage truck fitted with a zonal mud applicator

Put simply, if Chris was able to reduce his fertiliser usage by the total quantity of nutrients initially delivered by the 200t/ha mud treatment then he could potentially save around $1,700/ha (when substituting with cost effective granular fertiliser products[5] - excluding calcium, micronutrients, etc.). However, it is not accurate to calculate fertiliser savings this way. For example, Chris cannot save what he would not apply in fertiliser[6] and there are uncertainties surrounding the availability of nutrients to subsequent crops (e.g. placement and movement of nutrients out of the root zone, time of uptake by subsequent crops). To gauge crop uptake, Table 4 provides an estimate of the average quantity of N, P, K and S removed by a cane crop in the Burdekin[7].

Table 4: Nutrients removed per cane crop - average

	N	P	K	S
kg/ha/crop	154	37	276	25

This analysis uses a conservative approach to calculate fertiliser savings. For instance, as it is essential to conduct soil tests at the beginning of a crop cycle to identify the soil nutrient balance, only nutrients likely to be consumed by the following three ratoon crops are included. Because sugarcane is a luxury feeder of K, and S is highly mobile in the soil, only the quantities of these elements that are likely to be consumed within the first year after application are included. Based on the guidelines mentioned above, the total prospective reductions in fertiliser applied nutrients over the three ratoon crops for the different mud treatments are shown in Table 5.

Table 5: Fertiliser and cost savings, kg/ha and $/ha

Treatment	N	P	K	S	$/ha
200t/ha conv.	60	45	96	24	$389
100t/ha conv.	20	45	96	24	$333
65t/ha banded	20	45	85	21	$313

Methodology

This study attempts to answer four key questions. The first question is: How do the costs associated with conventionally spread and banded mud applications differ for a commercial farm located approximately 50 kilometres from the mill? The main cost differences include mud cartage costs, fertiliser costs and cultivation expenses.

Due to the distance of Chris' farm from Invicta Sugar Mill, mud cartage costs are considerable. Consequently, the second research question explores: How much extra cane needs to be grown to offset these costs for each mud treatment to breakeven with the zero mud treatment? To calculate revenue, the analysis uses trial production data for the second ratoon crop (harvested in 2015) and historical data to approximate future ratoon yields. Table 6 outlines these yields – tonnes of cane per hectare (TCH) and commercial cane sugar (CCS).

Table 6: Estimated cane yield and CCS

	TCH	CCS
2nd ratoon	118	15.0
3rd ratoon	115	14.7
4th ratoon	88	14.4

[5] Urea, Di-Ammonium Phosphate, Muriate of Potash and Sulphate of Ammonia.
[6] Importantly, costing additional nutrients that are not normally applied would be double counting given that yield improvements are taken into account in the economic analysis.
[7] Calcino, D. V., Kingston, G., & Haysom, M. (2000). Nutrition of the plant. *Manual of cane growing. Bureau of Sugar Experiment Stations (BSES), Indooroopilly, Australia*, 153-193.

Uncertainty exists around the influence the different mud treatments will have on crop yields. To examine this uncertainty, the third question examines how changes in yield influence the profitability of the different mud treatments by calculating the difference in gross margin from the no mud treatment.

The fourth question explores: How have the mud treatments performed so far at the trial site? The analysis draws on 2015 harvest data from the site to calculate and compare the gross margin for each treatment. In addition, the analysis investigates what improvements are still needed in future ratoon crops for the mud treatments to breakeven with the no mud treatment.

The Farm Economic Analysis Tool (FEAT) was used to evaluate the revenues and costs of each treatment. From these results, the gross margin[8] from each treatment is compared. The analysis uses a discount rate of 7 per cent and the five-year average (2010-14) sugar price of $430/t. Input prices were collected from local suppliers in 2015.

Crop growing expenses

Figure 1 compares the costs for mud cartage, fertiliser and cultivation[9] during Chris' second, third and fourth ratoon crops for each treatment. The total costs are shown above each column in the chart. A comparison of the treatments highlights a substantial difference in costs. Compared to the 200t/ha conventionally applied treatment, the 65t/ha banded treatment saves around $750/ha in expenses, over the three ratoon crops.

While not included in Figure 1 or the following analysis, if soil tests completed in the next fallow reveal that the soil has surplus P for another crop cycle then $380 to $560/ha[10] in additional savings could be made if fertiliser rates were adjusted accordingly.

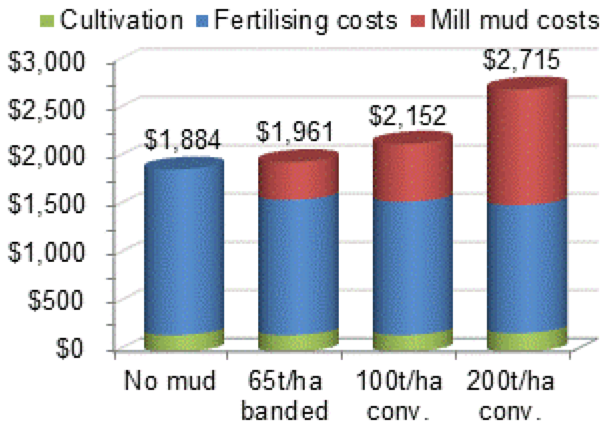

Figure 1: Mud cartage, fertiliser and cultivation expenses in ratoon crops ($/ha)

Breakeven yield analysis

To put the cost differences into perspective, Figure 2 shows the total yield improvement needed in the following crops under each treatment to maintain the same profitability as the no mud treatment (assuming CCS remains constant). The shaded area shows the results including fertiliser cost savings while the cross sectioned area identifies the extra tonnage required when excluding fertiliser cost savings. When adjusting fertiliser rates, a yield improvement of 2.7 TCH is required by the banded treatment to breakeven with the no mud treatment, while the 200t/ha treatment needs an extra 26.5 TCH. Comparatively, the 200t/ha treatment needs to yield around 24 TCH more than the banded treatment to breakeven.

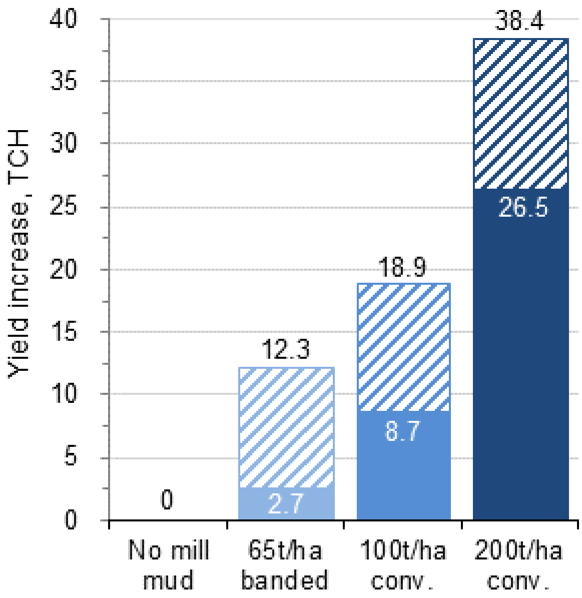

Figure 2: Yield increase required to maintain profitability with no mud treatment (TCH)

[8] The gross margin is a measure of profitability and is calculated by subtracting variable growing expenses (e.g. cartage and fertiliser) from revenue.
[9] The 200t/ha conv. treatment required an extra cultivation to incorporate the mud.
[10] $380/ha based on Chris' past P application rates, and $560 based on 37 x 5 crops = 185kg/ha.

Cane yield improvement

Figure 3 examines the comparative profitability of each treatment to the no mud treatment based on expected changes in cane yield (inclusive of fertiliser cost savings). It charts the annualised equivalent benefit[11] (or cost) of applying mud respective of any expected yield increase/decrease. For instance, if Chris perceives that the banded mud treatment will boost cane yield by a total of 20 TCH over the three subsequent ratoons (relative to the no mud scenario) then he could expect a comparative improvement in annual earnings of ~$200/ha.

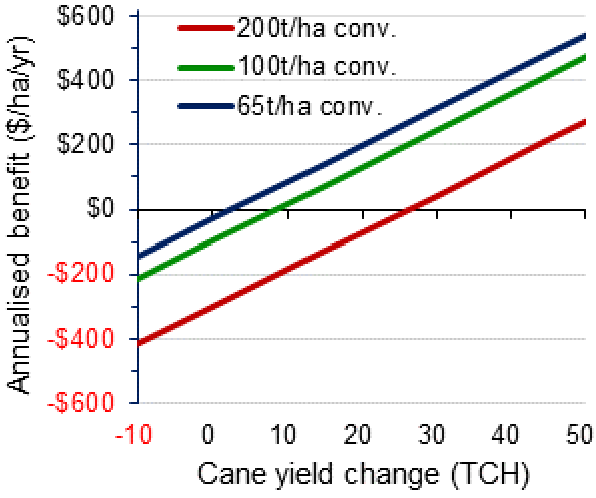

Figure 3: Sensitivity of the annualised benefit to variations in cane yield (inc. fertiliser savings)

2015 production analysis

Table 7 compares the trial block's production results from the 2015 harvest: TCH, CCS and tonnes of sugar per hectare (TSH). Analyses of variance were performed on the production results, which found that the F-tests for TCH and TSH were statistically significant at a 5 per cent level indicating effects of treatment. Pairwise comparisons established that the 200t/ha conventionally spread mud treatment had both significantly higher cane yield and sugar yield than all of the other treatments.

Table 7: Production results from 2015 harvest

	TCH	CCS	TSH
No mud	118.4 a	15.0 a	17.7 a
200t/ha conv.	131.7 b	14.7 a	19.3 b
100t/ha conv.	124.1 a	14.8 a	18.3 a
65t/ha banded	120.1 a	14.8 a	17.7 a
Prob. (F)	*0.014*	*0.46*	*0.023*
95% LSD[12]	*6.7*	*n/a*	*1.0*

Figure 4 uses the 2015 trial production results to calculate the mean gross margin for each treatment after the first harvest. As illustrated in the graph, the no mud treatment achieved a higher mean gross margin than each of the mud treatments. Importantly, the gross margin results take into account the (high) mud cartage costs (due to the long distance from mill) but only incorporate the yield improvements obtained by each treatment in the first production year after mud was applied. If production improves in the following years, or fertiliser cost savings are made, then these will improve the relative economic performance of the mud treatments.

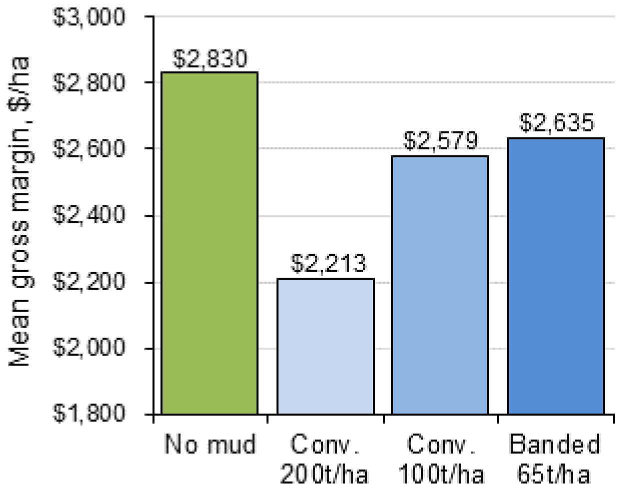

Figure 4: Gross margin comparison, 2015

Figure 5 is similar to the previous chart, but splits up the mean gross margin into two components to identify the proportion of mud cartage costs that have been recovered by increased yield and fertiliser cost savings. Together, the shaded[13] and cross-sectioned areas represent the mean gross

[11] The Annualised Equivalent Benefit (or AEB) is a transformation of an investment's net present value and enables a comparison of each investment's average annual return over the period that mud generates benefits (e.g. a crop cycle). This measure takes into account the cost of applying mud as well as relative differences in growing costs (e.g. fertiliser).

[12] 95% least significant difference (LSD).

[13] The shaded area represents the gross margin of the no mud treatment minus the respective mud cartage costs of each mud treatment.

margin, just like in Figure 4, while the cross-sectioned area alone denotes the proportion of mud cartage costs that have so far been recovered (relative to the no mud treatment). The areas represented by the dashed lines and arrows (above the gross margins) identify the improvements still needed by each treatment to breakeven with the zero mud treatment.

As the 200t/ha treatment has much larger mud cartage costs than the rest of the mud treatments, it requires relatively larger yield improvements and fertiliser costs savings to recover these costs. So far, all of the mud treatments have recovered around half of their respective mud costs after the first harvest. Consequently, all the mud treatments require improvements during later ratoon crops to recover the whole sum and breakeven.

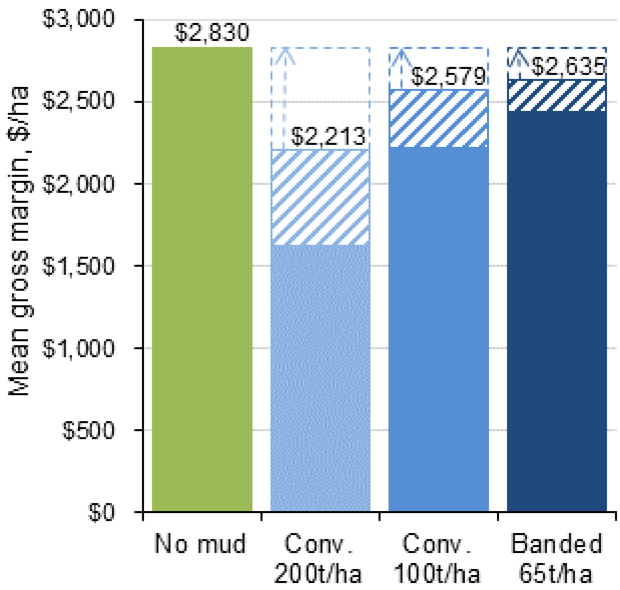

Figure 5: Gross margin comparison, separated

Updating the breakeven analysis with the 2015 results shows that the 200t/ha and 100t/ha conventionally spread treatments need an extra 16.8 and 5.6 TCH[14], respectively, in total during subsequent crops to breakeven with the no mud treatment. Comparatively, the 65t/ha banded mud treatment only needs 3.6 TCH more than the no mud treatment to breakeven.

Conclusion

While the application of mill by-products can provide soil health benefits, banding mud directly on the cane row helps to reduce application costs and may decrease the risk of runoff. This case study evaluated the relative costs and savings associated with conventionally-spread and banded mud applications on a farm located 50 kilometres from Invicta Sugar Mill. Based on these results, the study calculates the yield improvements needed by each mud treatment to breakeven with the no mud treatment. Harvest results from the trial site are also used to compare the gross margin for each treatment and the improvement still needed in future crops to breakeven.

The analysis indicates that banding mud at 65t/ha on Chris' farm saves around $750/ha in expenses compared to the 200t/ha conventionally applied treatment (inclusive of fertiliser cost savings). Consequently, the 200t/ha treatment needs to yield an additional 24 TCH more than the banded treatment, during the subsequent ratoons, to recover the extra costs and breakeven.

The 2015 trial production results show that all of the mud treatments have recovered around half of their mud cartage costs so far and need further improvements in later ratoons to breakeven with the no mud treatment. Nevertheless, the performance of each treatment in subsequent ratoon crops is unknown and future harvest data is needed to identify the most profitable treatment overall.

Acknowledgements

This publication was compiled by Matthew Thompson from the Department of Agriculture and Fisheries (DAF). Chris Hesp and Farmacist (Burdekin) contributed research data and technical expertise to this case study. Chris Hesp operates a 606-hectare farm at Mulgrave in the Burdekin and grows mostly sugarcane. DAF provides economic support to Project Catalyst. For further information, please call 13 25 23.

Citation

Thompson, M., McDonnell, P., & Dowie, J. (2016), Banding mill by-products – economic case study, Burdekin region. Department of Agriculture and Fisheries (DAF), Queensland.

[14] Average, but dependent on when increase/s occur.