Targeted sugarcane grower extension improves reef water quality

Adam Royle & Lawrence Di Bella

Herbert Cane Productivity Services Ltd (HCPSL), 181 Fairford Rd, Ingham, Qld 4850
Email: aroyle@hcpsl.com.au

Abstract. Environmentally, economically and socially the Great Barrier Reef (GBR) is a high value asset. To protect this asset, the quality of water leaving sugarcane farms and entering the GBR has come under the spotlight. While the science behind improving water quality has received much attention, a targeted extension program to deliver research outcomes has been critical in achieving adoption of best management practices (BMP). Primary causes of water quality concerns have come from the use of pesticides and fertilisers. With the assistance of state and national funding, an extension program targeting group activities, one-on-one extension and demonstration trial plots was employed to improve adoption of BMP. Information gathered through the Herbert Cane Productivity Services 'green sheet' data collection system has also indicated that there has been a positive change in on-farm management practices, in particular with improvements to nitrogen use efficiency (NUE).

Keywords: BMP, Enhanced Efficiency Fertiliser, GBR, HCPSL, nitrogen, NUE, sugarcane.

Introduction

Background

The Wet Tropics sugarcane industry is situated on the doorstep of the world's largest living structure, the Great Barrier Reef (GBR), which covers over 344,400 km^2 (GBRMPA 2017).'The Great Barrier Reef is Queensland's most treasured ecosystem and is worth around $6 billion a year to the economy, supporting 69,000 jobs' (Queensland Government 2016).

Sugarcane farming has operated in the wet tropics of North Queensland for over 150 years. At the southern end of the wet tropics, the Herbert region produces approximately 40% of all sugarcane grown in this area and is the primary economic driver for the region (Di Bella 2013). With over 550 growers supporting a local population of approximately 12,500 people, the survival of the local community relies on the prosperity of the sugarcane industry.

With reef resilience under question, there is concern that the sugarcane industry in the wet tropics is negatively impacting the quality of water entering the GBR. 'Sugarcane is one of the major land uses contributing nitrogen (N), phosphorus (P) and pesticides to the reef'(Queensland Government 2016).

Amongst the primary threats are the use of pesticides, such as PSII herbicides and nutrients, in particular N and P. As one of the primary nutrients applied to sugarcane crops, N is typically applied in the form of urea fertiliser. With the ability to quickly transform into the more mobile form of dissolved inorganic nitrogen (DIN) known as nitrate, urea-based fertiliser can easily be lost in run-off water during high intensity rainfall events. This run-off enters the local environment through drains, streams and creeks before finding its way into larger rivers, coastal estuaries and eventually to the GBR lagoon (Di Bella et al. 2015).

Regulations and BMP Smartcane accreditation had been established to set goals for growers to achieve targets for improved water quality (WQ) outcomes and set out farming practices that assist in achieving these targets. They did not however offer growers tailored solutions to transition from conventional to sustainable farming practices.

In 2013, the Queensland Department of Natural Resources and Mines, with funding from the Australian government, engaged Herbert Cane Productivity Services Ltd (HSPSL) to establish a targeted extension program to drive practice change that would lead to WQ improvements, while maintaining industry productivity.

A targeted extension strategy was developed to educate and assist growers in their transition from conventional to sustainable practices, that would benefit WQ outcomes as well as improve, or at very least sustain, current farm productivity and profitability. The project was named Project NEMO (Nitrogen Efficient Management On-farm) and included the Herbert and Burdekin cane growing regions.

Objectives

The primary objective of Project NEMO is to improve NUE through improved NUE. NUE was the preferred method of assessing N use as it is conducive to measuring benefits to WQ and grower profitability. Three key areas were identified to improve grower NUE, these being:

- improved N management practices (rate, placement, timing)
- introduction of enhanced efficiency fertiliser (EEF) products
- a move to sustainable farming systems (fallow management and planting systems).

The secondary objective required the monitoring of changes in farm management practices through the collection of type and rate of practice change. This information could be used to review, assess and progressively tailor a strategic extension program to achieve longer-term beneficial outcomes.

Methods

Group extension

The primary tool for delivering broad scale extension is through group extension activities. These included regional field tours, of up to 150 growers and industry representatives, sub-district shed meetings and grower forums involving 10 to 30 participants at a time.

Strategic group activities involved targeted workshops and sustainable forums. Nitrogen and farming system workshops targeted growers and sub-districts identified as N loss hotspots through the Herbert water quality monitoring program (HWQMP).

Growers from known 'hotspot' areas were invited to attend workshops on improving NUE, through improved management practices and/or implementation of sustainable farming systems.

A sustainable farming forum and field tour was conducted on an annual basis. These group activities typically involved 15-20 pro-active Herbert sugarcane growers and industry stakeholders. Stakeholders included researchers, millers, agronomic advisors and industry extension personnel. This group activity was aimed at recognising the efforts of those growers in progressing improved farm management practices and, just as importantly, a stimulant for future improvements and promotion of collaboration between growers, researchers and other industry stakeholders.

Demonstration plots

Grower demonstration plots, or grower-assisted trials, were most often implemented after following up on grower queries from group activities, particularly workshops targeting N loss hotspots.

Demonstration plots were established to assist growers in assessing for themselves how improved N management and/or sustainable farming systems would be of benefit to them. To establish demonstration plots, extension providers worked hand-in-hand with growers to determine the best treatments to apply and ensure that plots were designed, applied and assessed to get the best possible results.

Six to eight demonstration plots were established annually with treatments ranging from applications of different N rates, EEF products, and application methods and timing. Sustainable farming systems, including controlled traffic, improved planting methods and various other practices play a major role in NUE and were also established at two sites. Demonstration plots were used as part of group activities such as field visits and dissemination of productivity and profitability results at grower shed meetings and forums.

One-on-one extension

One-on-one extension was employed by phone or in person. Although one-on-one extension provided the least amount of contact hours it played an important role in tailoring practice changes that fitted with each grower's particular circumstance. One-on-one extension was critical in developing a level of trust between the extension provider and the grower.

Monitoring engagement

To gauge the level of grower engagement it was important to develop a system to monitor how growers were engaging. Engagement was assessed using two criteria. The first being type and extent of contact, and the second the type and reason for contact. The extent of contact measured both hours of contact and the sub-district that the contact was likely to affect. The type of contact was split into three categories:

- seeking general information
- seeking information on practice change
- seeking information on evaluating practice change.

A more detailed reason for contact was also recorded and grouped into one of the following categories.

- Nitrogen use efficiency (NUE)
- farming systems
- fallow management
- weed management
- pest and diseases
- varieties
- other.

Monitoring practice change

One driver for establishing a targeted extension program, the HWQMP, was also utilised to monitor practice change. Although improvements to water quality from practice change may take several years, or even decades, it was still beneficial to monitor smaller scale hotspots, particularly when comparing different levels of grower engagement.

Whilst reporting from the HWQMP was beneficial, the most effective way to monitor practice change was achieved by collating and evaluating grower practices over a set period of time. This was primarily achieved through the HCPSL grower data collection process referred to as the 'green sheets'. Using green sheet data, a comparison of on-ground practices between 2011-12 and 2015 seasons was conducted.

The assessment focused on practice change associated with NUE and sustainable farming systems by looking at N rate, N application method, use of EFF, planting systems (conventional furrow and mound), and fallow management.

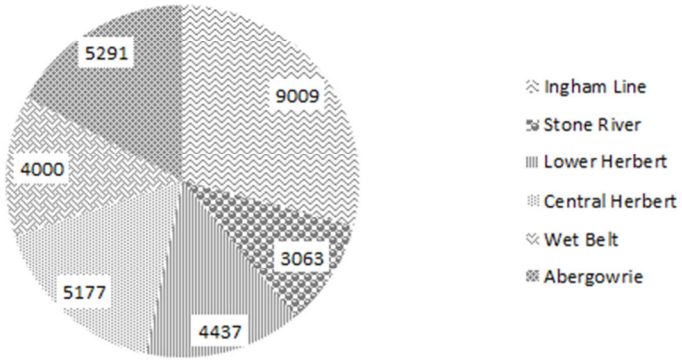
Results

Engagement

A database of grower contact details was kept over the course of the targeted extension project (NEMO), showing that in 2015 66% of growers were contacted through group activities and 34% by one-on-one extension.

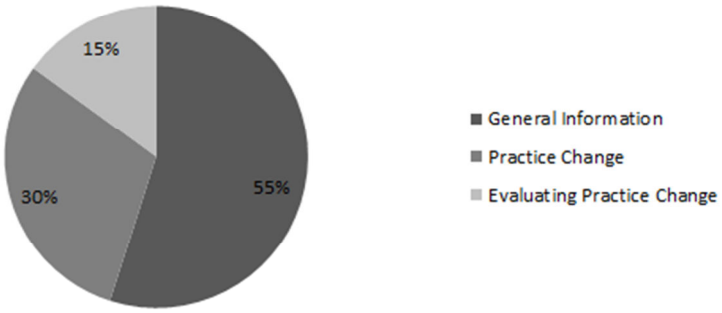
Figures 1 and 2 show the various levels of engagement in 2015 measured by area (ha) and purpose. Each of these charts gives an indication of the quantitative 'where' and 'how', but they do not give a qualitative answer as to whether this contact achieved actual change.

Figure 1. Grower contact under project NEMO in 2015 based on area influenced in the Herbert's six major sub-districts



Source: Royle 2015

Figure 2. Grower contact based on the grower's primary reason for making contact in 2015



Source: Royle 2015

Practice change

A comparison between surface applied and sub-surface applied N fertiliser indicates that sub-surface applied N had increased from 58.7% in 2012 to 79.5% in 2015: an overall increase of 20.8%.

A similar trend was seen with legume fallow crops over the same time period. Green sheet data show a shift from 2.4% of fallow land planted to legume fallow crops in 2011-12 to 14.2% in 2015. This sixfold increase benefited NUE through increased organic carbon, nutrient cycling and general soil health by breaking of the traditional sugarcane monoculture cropping cycle.

Figures 3 and 4 look at the breakdown of actual practices applied by growers over time and are better indicators of positive practice change. In these figures the percentage of total area planted to conventional and sustainable mound planting systems is compared between the years 2011 and 2015. The result is a 10% increase in the area planted to the sustainable mound planting system.

Figure 5 takes a more focused approach by looking directly at growers who took part in a strategic workshop aimed at improving N management in N loss hotspots, as identified by the HWQMP. A group of 30 growers attended a series of workshops and information meetings in 2014. Further work was conducted with this group including several demonstration plots looking at N rate, based on the Six Easy Steps (6ES) guidelines, and the use of EEF products.

From those 30 growers, 18 growers had sufficient data to investigate the change in N rate applied between the two sample periods. The results show that 10 of the 18 growers had reduced their N rates to equal or below the 6ES guidelines. The results also showed that on average the 18 growers had reduced their mean N rate applied by greater than 10kg/ha and were now in line with the district average as prescribed under the 6ES guidelines.

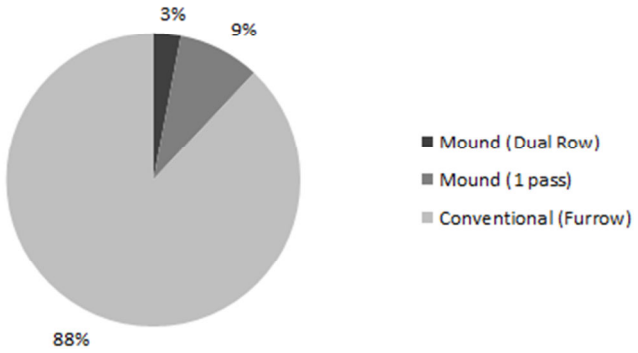
Discussion

It should be acknowledged that due to the nature of sugarcane cropping and lag time in monitoring water quality the timeframe for assessing whether real and sustained practice change has been achieved cannot be accomplished within the life of project NEMO.

However, with the use of data collection tools, such as the HCPSL green sheets, monitoring of actual changes in grower practices can be assessed and monitored past the cessation of the project. With a better understanding of dynamics future data can be assessed and used strategically to drive practice change through local extension programs.

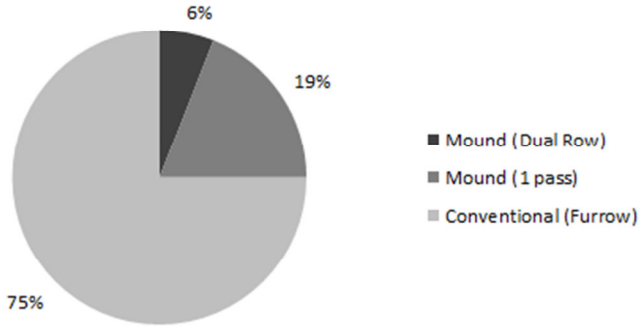
To date the targeted extension approach delivered by project NEMO has been successful in identifying individuals and/or hotspots within the Herbert sugarcane region and delivering timely and strategic extension activities in order to drive and, in many cases, fast track practice change. It should be also noted that several other programs running in conjunction with project NEMO should also be recognised as attributing to beneficial practice change.

Figure 3. The percentage of total area planted in 2011 to conventional and mound planting systems



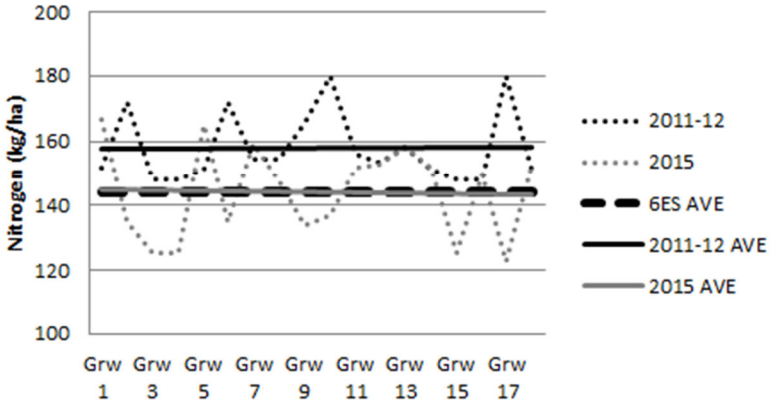
Source: Royle 2016

Figure 4. The percentage of total area planted in 2015 to conventional and mound planting systems



Source: Royle 2016

Figure 5. The rate of N applied (kg/ha) in 2011/12 compared to 2015



Source: Royle 2016

Through the data collected and reported in the Herbert Extension & Practise Change Report (Royle 2016), Project NEMO highlighted the importance growers have placed on accessing one-on-one extension. One-on-one extension has been seen as a less productive extension tool due

primarily to the level of resources required to provide this type of service. Under this project however, one-on-one extension has been critical in providing tailored solutions to individual growers seeking to assess the benefits of changing management practices on their own farm. 'My neighbour grows better cane than me and I have been applying more and more fertiliser for no result. I just want to talk to someone about trying something different with my fertiliser to see if I can improve my production' (J Gollogly 2016,Herbert sugarcane farmer, pers.comm.).

An example of how a targeted extension program can fast-track practice change is in the Abergowrie sub-district west of Ingham. Within only a few years a large proportion of growers have moved from broadcasting urea to sub-surface fertiliser application combined with EEF products. This change has been achieved through the use of targeted group, one-on-one and grower demonstration sites. The investment into targeted extension has built the region's capacity in the way described in Coutts et al. (2005, p. 4) by 'increasing the abilities or resources of individuals, organisations and communities to manage change'.

Macadam et al. (2004, p. 9) described the building of capacity in agriculture as:

> Externally or internally initiated processes designed to help individuals and groups to appreciate and manage their changing circumstances, with the objective of improving human, social, financial, physical and natural capital.

The project has demonstrated that local water quality data coupled with a targeted extension strategy can build capacity within a region to deliver better managed cane production systems. All evidence to date suggests that better managed production systems will lead to improved water quality entering the GBR.

Conclusion

This report has definitely shown that extension programs can have an impact on water quality entering the Great Barrier Reef lagoon, if they are well planned, targeted and managed accordingly. It must however be acknowledged that the success of any extension program is measured in its lasting effectiveness and as such cannot be fully measured at this point in time.

Acknowledgements

I would like to acknowledge the project funders, the Australian Federal Government and the Queensland Department of Natural Resources and Mines. I would also like to acknowledge the staff at the Herbert Cane Productivity Services Ltd. for their assistance with extension and demonstration activities relating to project NEMO.

References

Coutts, J, Roberts, K, Frost, F & Coutts, A 2005, *The role of extension in capacity building: What works and why?*, Publication No. 05/094, Rural Industries Research and Development Corporation, Kingston, ACT.

Di Bella, L, O'Brien, D, Nash, M & Wegscheidl, C 2015, 'Targeted extension strategies to improve water quality outcomes in the Australian sugar industry', *Rural Extension & Innovation Systems Journal*, vol. 11, no. 1, pp. 184-190.

Di Bella L, 2013, *Herbert demonstration farm project: final report (2009-13)*, unpublished report.

Great Barrier Reef Marine Park Authority (GBRMPA) 2017, *Facts about the Great Barrier Reef*, Available from <http://www.gbrmpa.gov.au/ >, [27 February 2017].

Macadam, R, Dinan, J, Inall, N & McKenzie, B, 2004, *Growing the capital of rural Australia: The task of capacity building*, Rural Industries Research and Development Corporation, Canberra , pp.1-68.

Queensland Government 2016, *Reef protection regulations*, Available from: <https://www.qld.gov.au/>, [27 February 2017]

Royle A 2015, *Project Nemo – Breakdown of grower contact (28th October 2014 – 31st December 2015)*, unpublished report.

Royle A 2016, *Project Nemo – Herbert: extension & practise change report (2016)*, unpublished report.