ON-FARM WATER QUALITY MONITORING FOR IRRIGATORS IN THE LOWER BURDEKIN - THE WQ PIXEL PROJECT

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Abstract

The Burdekin River is one of Queensland's largest and most economically important river systems, supplying irrigation water for intensive sugarcane and horticulture production as well as grazing. The Burdekin Delta discharges into the Great Barrier Reef (GBR) lagoon. Run-off from production land has been identified as a source of pollutants for the GBR and pressure is increasing to monitor and reduce sediment, nutrient and chemical losses from farmlands. BBIFMAC with funding from Burdekin Dry Tropics NRM is undertaking an innovative project that works with the local farming community to monitor and improve the quality of water leaving farms. Irrigators are supplied with free, easy to use water quality monitoring kits to measure nitrate, phosphate and conductivity levels 'on-the-spot'. Water samples are collected by BBIFMAC staff and analysed in the laboratory to verify farm results. A secure, password protected website allows farmers to access individual and regional results online. Water quality data is regularly collected from over 150 farm sites in the Lower Burdekin. The project's collaborative approach supports irrigators to manage their own farming practices, improving efficiency and reducing impacts on the local environment, floodplain ecology and the GBR.

Introduction

Poor water quality has been identified as one of the greatest threats to Great Barrier Reef (GBR) ecosystems. Major causes of damage to the GBR are sediment, nutrients and chemicals in water originating from land based activities, in particular farming (Lankester et al, 2007). Intensive irrigated farming areas of the Lower Burdekin floodplain are under increasing scrutiny to improve farming practices and improve the quality of water entering the GBR lagoon. Within the Lower Burdekin sugarcane production is the main intensive agricultural system with horticulture and grain cropping making up a smaller component.

The Burdekin River has been identified as the largest single source of nutrient and sediment pollution to the GBR lagoon, although the majority of this is believed to originate from the extensive inland grazing lands (Brodie et al., 2004). Much of the run-off water from the Lower Burdekin's irrigated intensive farming area actually enters the Barratta Creek and Haughton River catchments rather than the Burdekin River itself. Run-off from these catchments flow downstream to the wetlands and estuaries of Bowling Green Bay, which includes the World Heritage RAMSAR Convention listed wetlands, and eventually to the GBR lagoon.

The Burdekin Falls Dam supplies Lower Burdekin farms with irrigation water and is the largest dam in Queensland with a capacity of 1,860,000 ML. Water is released from the dam and flows down the river to a series of weirs and dams where it is pumped into artificial channels or

natural overflow distributary streams (Perna, 2003). Water is also used to recharge the shallow underground coastal aquifer, which is used to irrigate crops in the Burdekin Delta area.

Groundwater Quality is a farm management issue in the Burdekin. Like all costal irrigation areas, the lower Burdekin is at risk from both rising groundwater tables and saltwater intrusion. Monitoring of salinity in these areas is important for farmers when evaluating the suitability of groundwater for irrigation and also for identifying the changes in salinity over time.

Groundwater nitrates are also an important water quality issue for the region. Nitrates can be found in the groundwater throughout the region and it is important for growers to monitor the seasonal nitrate levels so they are able to adjust their fertiliser applications.

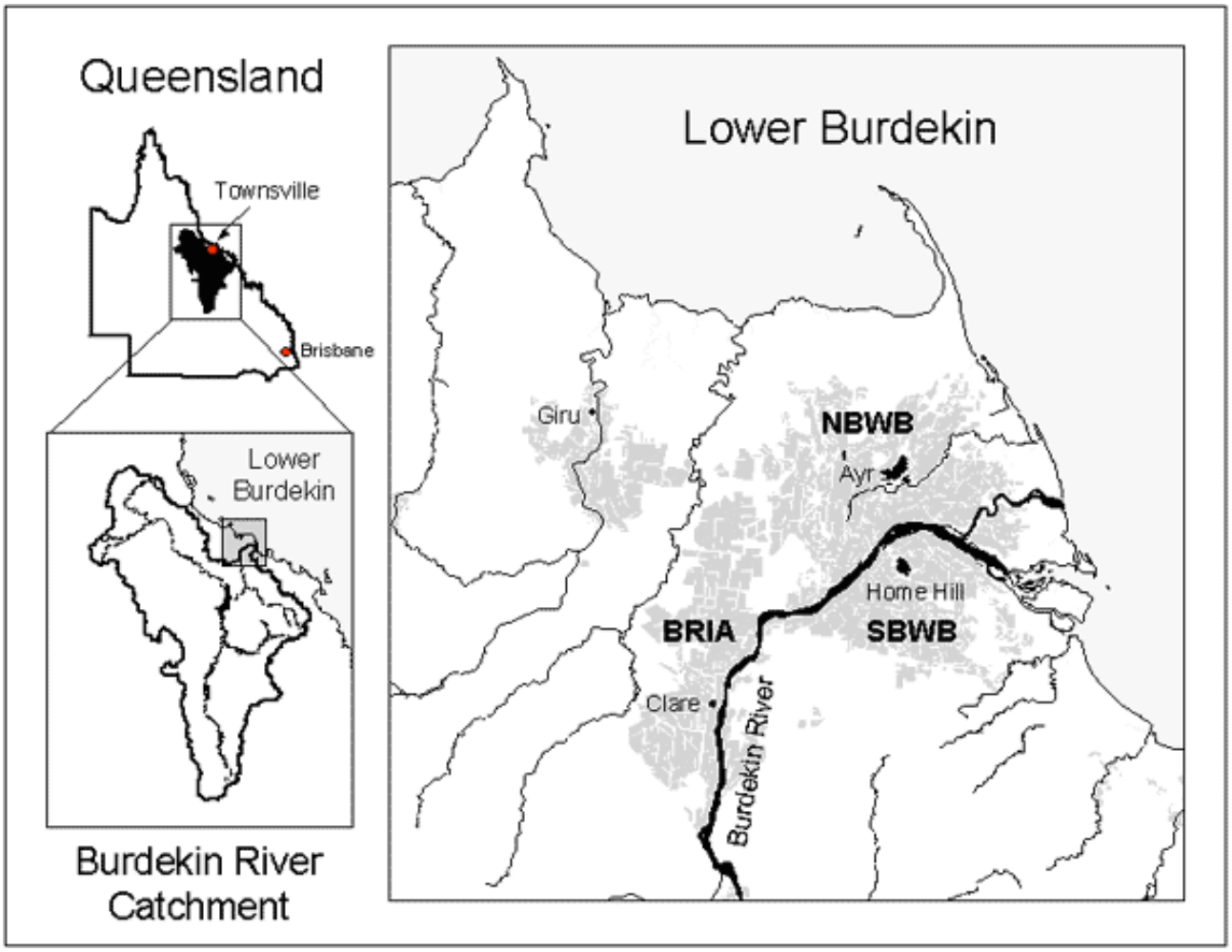


Figure 1. Map of the Lower Burdekin intensive irrigation areas (shaded). Burdekin River Irrigation Area (BRIA), North Burdekin Water Board (NBWB) and South Burdekin Water Board (SBWB). (Source: CSIRO)

Farm water quality for the Lower Burdekin

Historically, farming practices in the Lower Burdekin have been unregulated in terms of water, fertiliser and chemical management. In many cases this has lead to inefficient use of the available resources. Factors influencing the management practices on Lower Burdekin farms are complex and varied. The main driving force is economics, as in any other industry, but other

important factors influencing grower decisions include; knowledge and education level, practicality, industry dynamics, new technology, government regulation, environmental impact and family tradition.

From an outsiders perspective it may seem straight forward to immediately adopt best management practices (BMPs) to improve water quality, but it is quite a complex issue and unlikely to succeed without a strong support network from government and industry to support the required changes. Many Lower Burdekin growers are currently under financial pressure, with high production costs and low value product, making practice change economically unviable. Financial strain coupled with a lack of education and knowledge within the farming community of BMPs reduces the industry's ability to improve. Current low profit margins for sugarcane combined with other issues in the Lower Burdekin sugar industry have seen a significant shift toward diversification into alternative crops. Many of the growers diversifying have little experience or knowledge of these crops and this can lead to poor management practices and subsequently poor water quality leaving farms.

Recently, there has been a recognisable change in attitude of many Lower Burdekin growers to actively adopt improved practices. This attitude change has been brought about by a combination of many factors, these include:

- Improved government policy, funding and support for farmers,
- Improved education and support by industry programs,
- Pro-active approach to farming by industry-best growers, with flow on effects to the rest of the industry,
- Improved and more open communication between growers,
- Increased awareness and education of BMPs,
- Education of the effect of farming practices on the wider environment, and
- Improved monitoring and evaluation of practices.

One reason for the lack of regulations on water quality leaving farms is the massive costs and labour involved in regulating the industry. A government regulatory approach would be unviable, economically and practicably, due to the sheer size of the industry. A self-regulated approach to water quality monitoring is a practical alternative, allowing growers to take ownership of their own water quality issues, and is much less cost and labour intensive. Growers can evaluate their own farming practices and manage the effects of those practices immediately. This not only has environmental benefits but also significant financial benefits for the grower. Fertiliser and chemical prices are at an all time high, so identifying and reducing the amount lost in run-off water has a financial appeal to growers. This is important for convincing growers to take-up self-regulation of water quality and will become more appealing in the future with further increases in the cost of inputs.

The WQ Pixel Project

The WQ Pixel project has been developed as a pilot project to test the effectiveness of grower self-regulation of water quality on farms in the Lower Burdekin. Participation in the project is entirely voluntary. The aim is to provide a free service to encourage growers to become pro-active with monitoring their water quality. The project predominately involves sugarcane and horticultural growers using furrow irrigation and is coordinated by two BBIFMAC staff.

Methodology

60 irrigators in the Lower Burdekin have been provided with test kits to monitor water quality on-farm. Approximately 150 monitoring points have been selected from participating farms including approximately 50 bores, 10 tail-water recycle pits, 15 intake channel points and 75 individual paddock runoff points. The information from these sites is collected by growers and BBIFMAC staff then collated and analysed by staff. Results are communicated to growers and industry through the WQ Pixel Project monthly newsletter, BBIFMAC website, industry publications and information sessions.

Samples from monitoring sites are collected during each irrigation cycle (usually 10 -14 days) and/or during rainfall events. BBIFMAC staff also collect samples from five creek sites in the Lower Burdekin on a fortnightly basis. Any significant rainfall events are also monitored. This is to gain an understanding of background water quality levels and compare to the results from individual farm run-off points.

Participating growers are provided with a test kit for monitoring water quality “on-the-spot”, providing almost immediate results (Figure 2). The kit is meant to be used as an indicator of water quality, not a precise measurement, allowing the grower to quickly identify any problem with their water quality. On-farm testing is backed up with laboratory analysis of water samples collected for each site. These give the grower an accurate reading for nitrate and phosphate levels.

The test kits provide the following equipment designed to measure the following parameters:

• Hand held electrical conductivity (EC) meter - indicator of salinity;

• Nitrate test strips - level of nitrate-nitrogen in water, potentially from fertilisers;

• Phosphate test strips - level of phosphate in water, potentially from fertilisers, and

Some kits also include:

• Turbidity tube– indicator of sediment in water, potentially from soil erosion.

Sample bottles are included in the test kits to allow samples to be collected for routine water analysis at the local laboratory.

Any kits not being used by farmers are recovered and given to farmers that will actively participate.

Figure 2. Water Quality monitoring kit given to participants.

The kit contains a field record sheet, laminated instruction card and a CANEGROWERS Field Guide for Water Quality Monitoring in the Australian Sugar Industry (see figure 2). The Field Guide was developed by CANEGROWERS to act as a guide for farmers wishing to conduct water quality monitoring, and is largely based upon the WQ Pixel project. An ice block is included to keep samples cool while in the field.

Training and Support

Comprehensive training is delivered to participants through one-on-one, hands on, field based training. BBIFMAC officers visit the grower on farm and explain how to use the kit components. Sampling sites are selected and growers are trained in the correct procedure for water sampling and recording data. Growers are also encouraged to record farm management practices including; fertiliser used, method of application and application rates. These are recorded on field record sheets to help identify best practices in terms of water quality. The importance of each parameter is explained to give growers a better understanding of why it is being monitored. Emphasis is placed on the importance of obtaining accurate and robust data.

To maintain interest and participation in the project, growers are visited on a fortnightly basis by BBIFMAC staff. Water samples are collected, kits are maintained, results are delivered and any questions are discussed with the grower. This maintains a good rapport and builds trust between growers and BBIFMAC staff. Any questions or concerns that cannot be answered by BBIFMAC staff are referred to the relevant industry partner.

Laboratory analysis

Three phases of analysis are conducted on the samples for nitrate and phosphate:

1. Simple test kit analysis of nitrate and phosphate is conducted by participating farmers.

2. Water samples are collected and stored by growers under quality assurance conditions. Frozen samples are collected by BBIFMAC staff on a fortnightly basis and transported to the laboratory. Samples are thawed at the laboratory and tested by photometer analysis for nitrate and phosphate. The photometer used is a Palintest 7000.

3. To maintain quality control of the local laboratory, 1 in 20 samples are sent for analysis of nitrate and phosphate by James Cook University's Australian Centre for Tropical Freshwater Research (ACTFR) laboratory. All samples to be sent to ACTFR are collected by BBIFMAC staff in accordance with relevant sampling guidelines to maintain consistency and accuracy.

Water Quality Guidelines

The CANEGROWERS Field Guide for Water Quality Monitoring in the Australian Sugar Industry provides a generalised set of guidelines that growers can use to evaluate their water quality (Wrigley et al., 2008). The Field Guide was produced to educate growers in the sugar industry on water quality monitoring, and to help evaluate and improve their management practices. The guide has drawn on advice from many of the industry’s experts. The results are for general advice only and, as with any guidelines, should be adjusted to suit the individual farm situation. The guidelines are meant for on-farm water quality and are not relevant for rivers, creeks and other waterways where nutrient levels are likely to be diluted. The Field Guide has been distributed to all participating growers, including those in the horticultural industry as a reference guide for their water quality.

For the purpose of the WQ Pixel project the guidelines provide growers with guidelines for nitrate-nitrogen, orthophosphate-phosphorus, turbidity and electrical conductivity.

The guidelines for nitrate-nitrogen state that levels below 1 mg/L are naturally occurring in waterways. Levels from 1-2 mg/L are elevated above natural levels and fertiliser management practices should be reviewed. Levels greater than 2 mg/L have a moderate risk of excessive algal and plant growth and possibly have adverse effects on freshwater ecosystems.

For orthophosphate-phosphorus, levels below 0.5 mg/L are stated as naturally occurring in waterways. Levels from 0.5 – 2.0 mg/L are elevated above natural levels, and levels above 2 mg/L have a risk of excessive algal and plant growth.

For turbidity, levels below 10 NTU are regarded as good water quality. Levels of 10-50 NTU are considered a low risk to water quality, and levels above 50 NTU are considered a moderate risk to water quality. For any levels above 10 NTU the guide suggests reviewing farm management practices to minimise sediment loss.

Acceptable EC levels in irrigation water are highly dependent on the individual farm dynamics. Soil type plays a large role in this and thus it is not adequate to have a specific set of guidelines for EC. Sodic and heavy clay soils are especially susceptible to elevated conductivity levels and thus the guideline states that levels above 1.5 ms/cm should not generally be used to irrigate sodic soils.

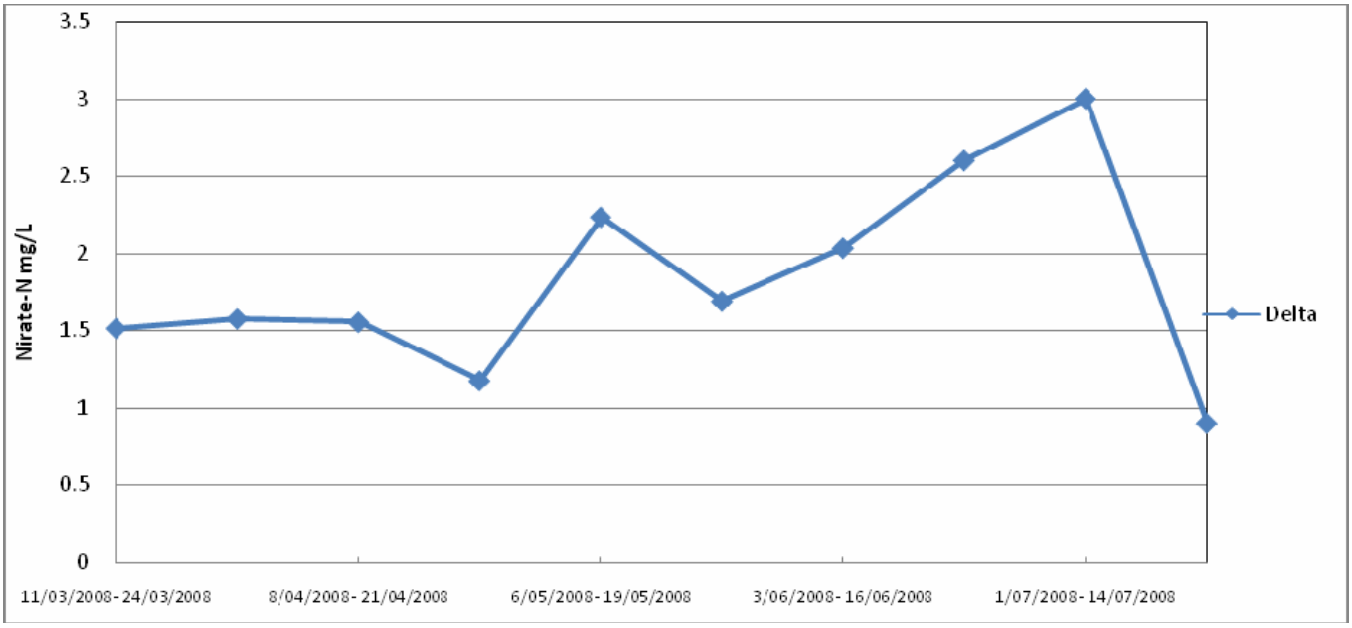
The guidelines suggest following farm nutrient management guidelines and reviewing fertiliser management practices for any elevated levels.

Feedback of results

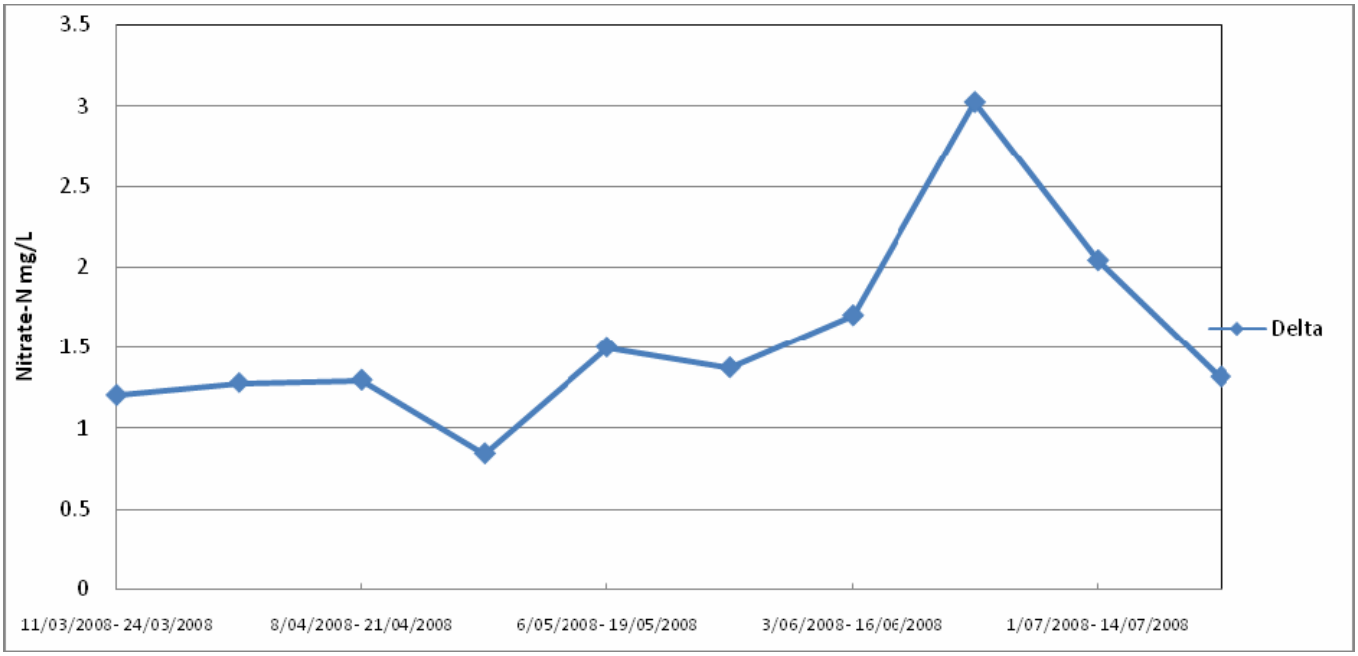
Results from the laboratory analysis are communicated to the grower as soon as they are analysed. This is being done via email or delivered to the property the following fortnight. The BBIFMAC website will soon have a secure login section for growers to access their results online. It is anticipated over 90% of growers will use this method to view their water quality results.

Example of results

Graphs 1 and 2 display the fortnightly average nitrate levels in intake water and run-off water respectively for Delta farms. The majority of Delta farms are irrigated using groundwater. Nitrates are found in groundwater across the region, as indicated by the nitrate levels in the intake water. The nitrate-N levels in the irrigation water mirrors closely the nitrate levels in the run-off. In most cases the nitrate-N level in the run-off is actually lower than the irrigation water, indicating net uptake of nitrate across the paddock or cleaner water leaving the paddock than being applied. This indicates that little nitrate is being lost from farms through fertiliser applications. It also indicates good fertiliser management practices by participating growers. The dynamic nature of the groundwater system means nitrate levels are constantly changing. Growers need to regularly monitor the groundwater nitrate level so they can adjust their fertiliser practices accordingly and reduce nitrate lost to run-off.



Graph 1. Fortnightly average nitrate-N levels in intake water from Delta farms in the Lower Burdekin



Graph 2. Fortnightly average nitrate-N levels in run-off from Delta farms in the Lower Burdekin

Grower participation

Initially there was a lot of scepticism from growers and industry bodies about the project's ability to recruit 60 actively participating growers. Participation is voluntary, which means growers need to identify benefits from participating. Partnerships built between BBIFMAC and government and industry bodies in the Lower Burdekin were essential for the success of recruiting participants. The project was promoted to growers through these partnerships by raising awareness and interest for the project within the farming community.

Initially there was limited interest shown by growers in the project despite an extensive promotion. The initial growers involved in the project were signed up after project presentations. Some growers were also referred through industry partners such as BDTNRM, BSES, Growcom and Government Departments. After slow initial signings, the last 30 growers were easily recruited through word of mouth from participating growers or referrals from industry bodies. Participation rates have stayed high throughout much of the project.

Growers interested in participating were contacted and an initial farm visit was arranged. During this visit the project was explained to the grower and the use of the kits was demonstrated. The grower then decided whether they wanted to participate in the project. The success rate of initial visits to grower participation was 100%. This indicates the appeal and value that growers see in the project. The majority of growers have regularly taken samples with only 5 growers being inconsistent with their sampling regime.

Although the project is voluntary for all participants, a small proportion of growers were referred to the project to fulfil a water quality monitoring requirement in their farm's Land and Water Management Plan. Generally these growers have been the least reliable with taking samples and in several cases it appears as though they are just doing the bare minimum required to stay involved in the project. Thus, it appears that making it compulsory for growers to participate in such projects is ineffective in producing the desired results. The aim of the project is not to regulate growers but to give them the opportunity to take control of their management practices and to work with them to improve their water quality. In most cases this has occurred and the majority of participants show a great interest in the results from their water quality samples.

Part of the reason for the increasing interest in water quality monitoring within the Lower Burdekin farming community is the considerable increase in the cost of fertiliser inputs. Any fertiliser lost from the paddock means significant financial and production losses. With the current small profit margins and financial difficulties experienced by many growers, having a low cost, simple method of evaluating nutrient losses from the paddock can be critical in staying profitable.

There has also been a growing awareness in the farming community of the environmental concerns faced in the Lower Burdekin. Growers are increasingly taking responsibility for their effects on the wider environment and looking at ways to reduce their impact by uptake of BMPs. The Federal Government's pending Reef Rescue package will inject significant sums of money into improving the water quality on farms in catchments draining into the GBR lagoon. With the increasing focus on improving the water quality entering the GBR, there will be an increasing need to monitor and evaluate the effects of management practice changes on water quality.

The financial and environmental issues faced by growers mean this project and similar ones that give growers the opportunity to cheaply and easily evaluate management practices are becoming increasingly relevant as an essential farm management tool.

Table 1 shows the number of samples collected for the project, from 26/2/08 to 28/7/08. The high number of samples collected indicates the acceptance of the project by growers as a tool for evaluating management practices. The table also shows the demographics of sample collections, with a higer proportion of Delta samples coming from groundwater than in the BRIA, where channel water is the predominant irrigation type and is not normally monitored. Other sample site types such as recycle pits and intake channels have been included in the totals column.

Table 1. Number of samples collected for groundwater (GW) and run-off (RO) sites in the Delta and BRIA. (Results are accurate up to 28/7/08)

	Delta		BRIA		Total samples
Site type	**GW**	**RO**	**GW**	**RO**	**All sites**
Number of samples taken	86	118	42	95	392

Practice Changes

Current grower results have yielded several practice changes and identified areas for future improvements. These include:

- Reduction of applied fertiliser due to use of groundwater nitrate as fertiliser.
- Changes in fertiliser application methods, due to identification of unwanted losses in run-off water.
- Identification and evaluation of nutrient losses from plant cane following a legume fallow crop
- Identification and evaluation of nutrient losses from liquid fertiliser application methods and improvement of these methods
- Accurate mixing of high conductivity groundwater water with low conductivity channel water for irrigation through the use of the hand-held EC meters.
- Evaluation of recycle pit effectiveness in retaining nutrients from run-off.
- Evaluation of water quality from green cane trash blankets.
- Identification and evaluation of cultivation practices and their effect on sediment losses.
- Evaluation of alternative crops for growers diversifying from sugarcane.

Future Directions

The pilot stage of the project has been relatively successful and exceeded most people's expectations. Many lessons have been learnt in the initial stages of the project and will help in the design of any ensuing projects. The results obtained by growers are invaluable to assessing management practices both for individual growers and for the entire region. The collection of this data over several years will provide growers and industry with an excellent picture of the change in health of the region's water quality. The pending Reef Rescue package will provide substantial funding for farm practice changes and aims to significantly improve water quality leaving farms. Measuring the success of these changes will be important in evaluating the success of the program and the WQ Pixel Project could provide this service as well as provide data on farm water quality prior to the practice changes.

The current results have shown that water quality is generally acceptable for most parameters, with some individual results exceeding the recommended guidelines. However the project is still in its infancy and there needs to be more data collected over the coming months and years to produce a better picture of the state of water quality on farms in the Lower Burdekin.

Nitrate levels are the most evident cause for concern from the results so far. Working with growers to reduce the nitrate lost from farms should be a priority for industry and government. Issues with groundwater nitrate are difficult to address and the utilisation of this water to irrigate crops and reduce fertiliser inputs is worthwhile, however, irrigation efficiencies need to be improved to reduce the release of this nitrate back into the wider environment through run-off and deep drainage.

Phosphate levels are of lesser concern and have been low in almost all samples across the region. Phosphate should still be monitored to identify those practices that produce elevated phosphate levels.

BBIFMAC staff have been working closely with growers in improving water quality and have listened to the concerns and suggestions for improvement and further expansion of the project. Some of the points regularly raised include:

- The ability to monitor pesticides in run-off water after a spray application.
- The ability to test water used for mixing chemicals, so that it can be done accurately and efficiently.
- The testing of rivers, creeks and waterways which drain farming land to evaluate the water quality of the wider environment.
- Concerns about improper manipulation of results to the detriment of the farming community.

Further expansion of the current project, as well as introduction of similar projects in other regions, would be beneficial for improving water quality and evaluating management practices. The project is highly adaptable and can easily be modified to suit a variety of farming situations. With the increasing pressure on water resources across Australia it is important for farmers to have a cheap and effective method of evaluating their water quality and subsequently improve management practices.

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