Demonstration Farms – A Sustainable and Profitable Future

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Abstract

The Demonstration Farms project, led by Queensland Primary Industries and Fisheries, implements best management practices (BMPs), on commercial scale, into sugar-based farming enterprises in North Queensland's Wet and Dry Tropics. A collaborative effort between producers, government, industry, and research bodies, the project employs grassroots extension methodologies based on a total systems approach. It showcases BMPs for the cane industry. Currently, the project comprises 6 privately-owned blocks and an experimental 'cutting edge' technologies block run in partnership with the Australian Agricultural College Corporation. From each block, economic and biophysical monitoring data are compiled to demonstrate that improved profitability and environmental sustainability can be achieved with a systems-based approach. Paddock and farm-scale data collected from the project will also be used to assist catchment-scale water quality modelling. The first project's production year has concentrated on installing monitoring equipment and protocols and collecting baseline water quality and economic data. Project collaborators anticipate carrying this process through a complete production cycle (five years) to capitalise on the achievements of the project to date. The project is part of the sugar industry's response to community concerns regarding potential losses of pollutants from farms entering the GBR lagoon and its commitment to improved farming practices.

Introduction

The Demonstration Farms project, led by Queensland Primary Industries and Fisheries (QPIF), implements, on a commercial scale, best management practices (BMPs) into sugar- based farming enterprises in the Wet and Dry Tropics of North Queensland. The project is a collaborative effort between producers, government, and research and industry bodies. It employs grassroots extension methodologies based around a total systems approach to effectively showcase best management practises (Thorburn et al, 2007) for the cane industry. Economic and biophysical monitoring data are compiled from the participating farms to demonstrate that improved profitability and environmental sustainability can be achieved with a systems-based approach. Paddock and farm-scale data collected from the project will also be used to assist catchment-scale water quality modelling.

The original intent of the project was to implement a 'Demonstration' farm, using current best management practices ranging from farm planning through to crop production and harvest. The demonstration farm's economic and biophysical performance would then be compared with another more conventional farm. However, as the project evolved, growers involved in the 'comparison' farms have displayed a keen interest in implementing the management practises on their own farms. Consequently, these growers are now beginning to modify their management practises to better align with industry BMP. While this change has removed the opportunity for comparisons based on conventional versus progressive management, the change is viewed as a success for the project, as it has resulted in an increase in adoption of improved farming practices and has also provided alternative sites to monitor water quality. The project is part of the sugar industry's response to community concerns regarding potential losses of pollutants from farms entering the Great Barrier Reef lagoon, and its commitment to improved farming practices.

Project Design

Currently, the project comprises 6 privately owned blocks and a further experimental 'cutting edge' technologies block run in partnership with the Australian Agricultural College Corporation (AACC). These blocks are located in two distinctly different areas. The first group of farms is located in the Lower Burdekin area and represents irrigated systems within the dry tropics. The second group is situated in the Tully area and represents rain-fed systems in the wet tropics (annual rainfall approx 3500mm (http://www.bom.gov.au)). As well as contrasting climates, the farms also have their own unique soil and landscape attributes.

Using research (Garside et al, 2004) from the Sugar Yield Decline Joint Venture (SYDJV), key management practises were selected for implementation on the demonstration blocks. These included:

- Controlled traffic farming
- Legume rotational crops (where possible with seasonal conditions)
- Minimum tillage
- Optimised irrigation scheduling and water re-use
- Optimised nutrient management (BSES "6 Easy Steps")
- Minimal usage of residual herbicides
- Farm planning and record keeping

Monitoring

To assess the efficacy of these practises, a range of monitoring approaches has been undertaken. Nutrient, pesticide and sediment loss is measured in run-off water samples collected during and after major rainfall events and periodic irrigation events. Profitability of the practises are assessed through detailed financial analysis undertaken using the FEAT program (Farm Economic Analysis Tool) developed by QPIF. Irrigation monitoring is performed using capacitance probes to measure soil moisture and the irrigation modelling software SIRMOD (surface irrigation modelling tool).

Results to Date

The first production year of the project has concentrated on installing monitoring equipment and protocols and collecting baseline water quality and economic data. Project collaborators anticipate carrying this process through a complete production cycle (five years) to accurately gauge the affect of the imposed management system.

Biophysical Results

Current results from the project have been consistent with past research (Ham 2007), particularly involving nutrient movement off paddock. These results include:

- All blocks recorded the highest nutrient (nitrogen and phosphorous) loss during the second irrigation after application of nutrients;
- All blocks recorded the highest herbicide losses during the 1st irrigation after application;
- The highest herbicide losses occurred during the first flush of water leaving the paddock;
- The highest nitrate concentration was consistently found toward the end of each irrigation event.

Nutrient Loss

Nutrient export (primarily nitrogen) from cane farms into receiving water bodies has been identified as a major process linked to water quality decline in northern Queensland. Mitigation of nitrate losses is, therefore, a key focus of the demonstration farms project, with the monitoring of water quality flowing off farms as a key component of the program.

Results from monitoring nitrate levels in runoff water have shown that the highest nutrient (nitrogen and phosphorous) loss occurs during the second irrigation after application of nutrients. Results have also shown that the concentration of nitrate in runoff water increases with irrigation time (see figure 2), with the last water to leave the block containing the highest concentration of nitrate. However, further data will need to be collected before any conclusions can be made.

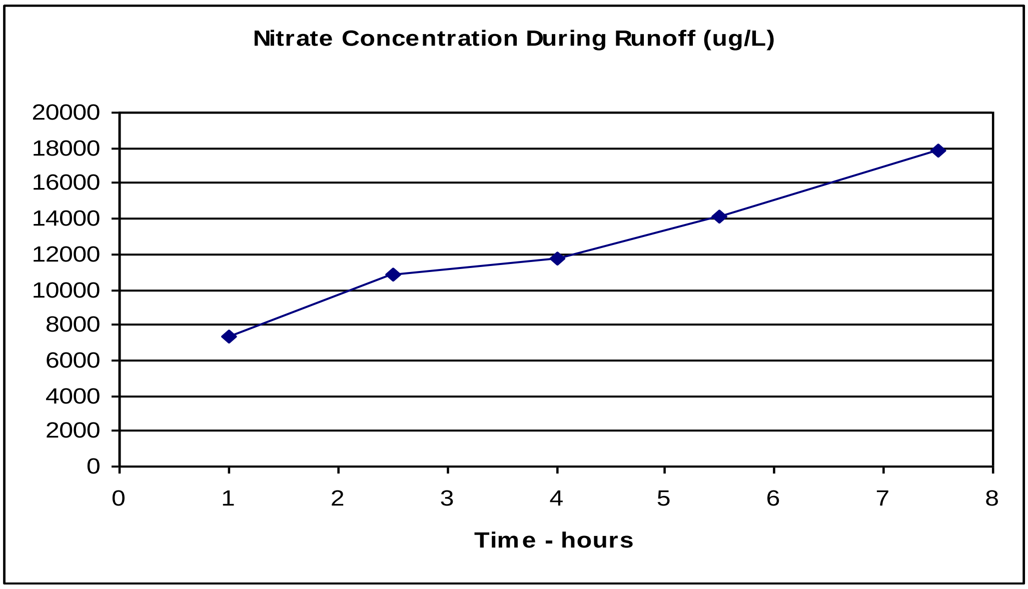

Figure 2: Increasing concentration of Nitrate-N loss over an irrigation event

* While nitrate concentrations in figure 2 are quite high, it is important to note that 100% of farm irrigation runoff in this example is captured and reused on farm; thus ensuring no losses to the wider environment.

The 'cutting edge' trial block has also highlighted potentially significant water quality benefits. A replicated strip trial carried out in partnership with Incitec Pivot to explore the use of a slow release fertiliser product – ENTEC. Results from the first five irrigation events after application are very promising, showing up to 10 times less concentration in nitrate-N losses when compared to standard fertiliser (see figure 3) in tail water. This trial will continue throughout the crop cycle and will include a full economic analysis. At the time of writing, the crop had not been harvested so the ability to compare productivity differences between the treatments has not been recorded. ENTEC is not yet commercially available, although it is anticipated to be released in the near future.

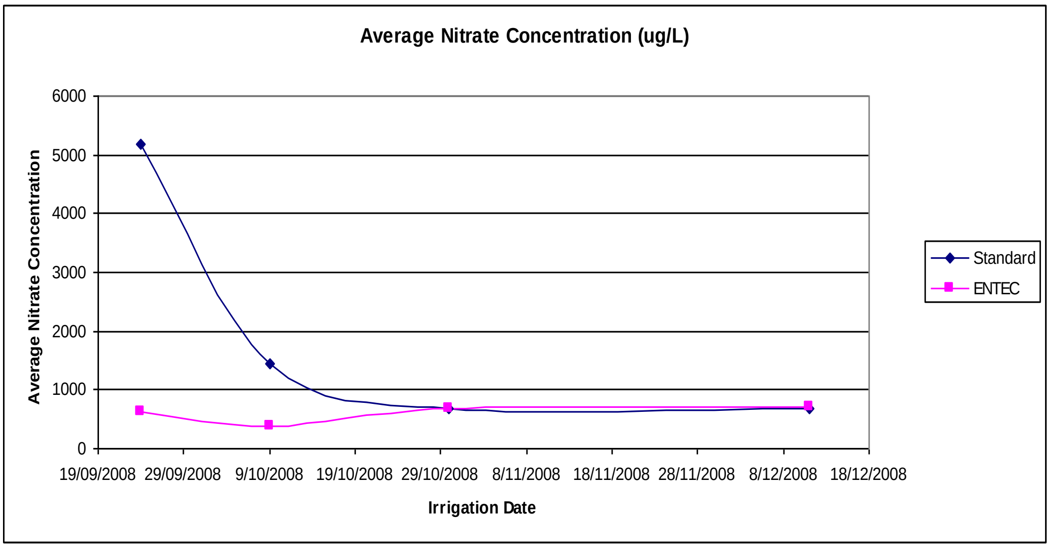

Figure 3: Difference in nitrate-N concentrations in irrigation runoff water between ENTEC and standard fertiliser

Pesticide Loss

Pesticide losses are a concern for reef catchments, particularly residual products such as atrazine and diuron. A field-scale trial[1] explored the use of an enzyme to break down atrazine into a benign products. The first trial was an outstanding success with 90% of atrazine removed from a recycle pit within 3.5 hours of applying the enzyme. Figure 4 shows the decrease in atrazine concentration after product application.

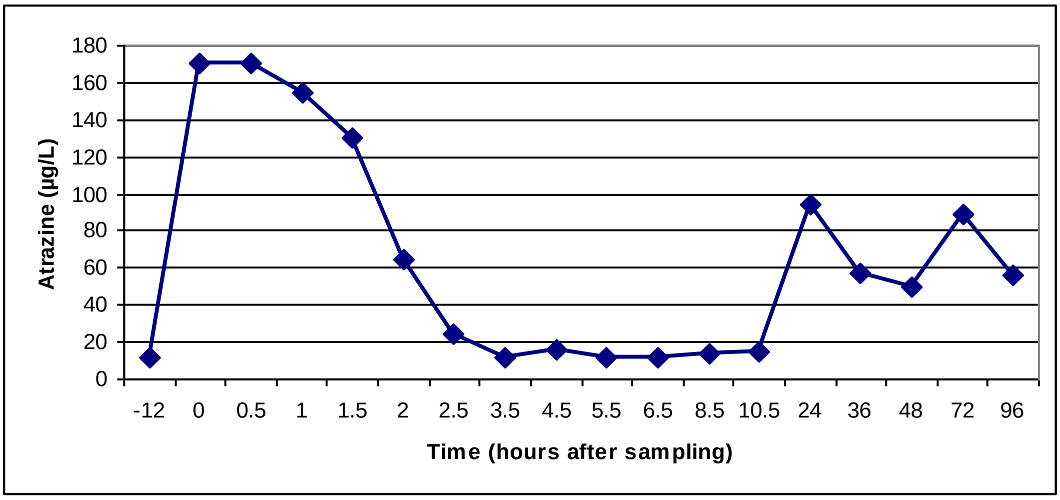

Figure 4: Effect of enzyme on Atrazine concentration in tail water

Background levels of atrazine in the recycle pit were around 16 µg/L prior to irrigation tailwater input, and once irrigation tail water entered the pit, the levels increased to around 170 µg/L. After treatment at this point in time, the enzyme reduced atrazine concentrations to around background levels over a 3 hour period. Atrazine is a relatively persistent herbicide that has a half-life of 60 days (in soil). Therefore, the pronounced decrease evident in atrazine concentrations was due to enzyme action. The increase in concentration 24 hours after treatment is due to diluted runoff water entering the pit from a separate irrigation event. Further trials of this product are planned, and CSIRO are seeking a commercial partner to ensure this product can be available for commercial use.

Agronomic and Economic Results

Irrigation Efficiency

Throughout the cane industry, the most widely used method of irrigation is furrow irrigation. While this method of irrigation is often inefficient, modifications to irrigation

[1] Carried out, in partnership with CSIRO, James Cook University (JCU) and the Great Barrier Reef Marine Park Authority (GBRMPA)

scheduling on demonstration farms has led to significant improvements in water use efficiency and crop performance.

An example of this improvement was seen when capacitance probes were installed on a co-operating producer’s blocks. Previous irrigation practise, which used furrow inflow rates of around 1.2 L/s with irrigation events running for up to 36 hours, showed periods of water logging of up to 8 days. This period of water logging increased potential for nutrient loss and decreased crop growth. With the aid of SIRMOD (surface irrigation modelling tool), it was demonstrated that an increased furrow inflow rate of around 3.5 L/s and subsequent decrease of irrigation time to 12 hours should result in approximately 20% water savings. These results were then applied to the demonstration block, with inflow rates increased to 3.6 L/s, and irrigation time decreased to 12–13 hours. Data from the capacitance probes showed a decrease in waterlogging time to 2–3 days which resulted in an increase in uniformity of irrigation run times as well as a 20% water saving. The potential for nutrient losses is also decreased due to less waterlogging and increased crop growth.

Nutrient Management

Significant improvements in nutrient management occurred as a result of project activity. Application rates and methods were determined by ‘6 Easy Steps’ the current industry BMP for nutrient management. A resulting reduction of around 30% of applied nitrogen was achieved in some cases, with cost savings around $380/Ha. Crop yield was not affected by this reduction due to the fact the project took a systems based approach. If the co-operating growers had not improved irrigation management (ie: reduced waterlogging potential and meeting crop demand) in combination with nitrogen management, a yield penalty could have very well resulted.

Another significant improvement was the introduction of a harvested legume crop as part of a fallow management strategy as well as soil health and nutrient improvements. The soybean crop was harvested to generate a profit of around $610/Ha. Cane was planted with a double disc opener planter into the existing soybean beds the day after harvest. Applied nitrogen chemical fertiliser was further reduced to 50kg/Ha (compared to 150 – 170 kg/Ha) due to the nitrogen supplied by the legume crop. This led to a further cost saving of around $350/Ha in fertiliser costs.

Pesticide Management

The overall approach on the Demonstration sites in relation to pesticide management was to minimise use of residual pesticides while maintaining appropriate weed control. On two of the sites, due to a high level of weed pressure, some residuals were used. On the third demonstration site, due to less weed pressure, residual chemicals were not used. A shielded sprayer was used with only knockdown products being used (2,4-D and glyphosate) sprayed under the shields – resulting in application of only 50% of the paddock. This strategy resulted in savings of around $50/Ha when compared to past practices on that block. Importance was also placed on irrigation management in relation to pesticide applications. Irrigation events were delayed at least 5 days after pesticide application to minimise potential off farm movement.

Farming System

The success of the project to date has been a result of implementing a farming systems based approach as well as collaboration between all project partners – most importantly the co-operating producers. Significant emphasis was placed on the importance of managing the whole farming system rather than looking at only improving selected components. The adoption of a complete well managed farming system resulted in a range of profitability increases for the three demonstration sites from 11% to 59% improvement in whole of farm operating return when compared to previous practices. Caution should be taken using these results as they are specific to the individual enterprise and involve some production assumptions (due to the fact the project has only just obtained one year's worth of productivity data). Major aspects of the system that contributed to these improvements were; optimised nitrogen application, integration of a harvested legume crop (Dry Tropics only), improved irrigation management (Dry Tropics only) and significantly reduced tractor operating hours – up to 70%.

While the results to date have been extremely promising, caution is being exercised by the project team as the data generated are from only one year when a full cane production cycle lasts for 5 years. Until a production cycle has been completed, the true economic and biophysical benefit of an improved system for water quality outcomes can not be calculated.

Future Direction

Initial results from the project have been discussed with the grower groups involved, and with most other growers in the regions using shed meetings, field days and newsletters. Feedback from growers and project partners has been very positive as this project is demonstrating the use of improved management practices in a systems context that lead to improved water quality leaving farms as well as improved profitability.

To date, the project has been resource intensive, requiring significant time inputs from extension and research staff. Fortunately, solid relationships have been formed between the co-operating producers and project partners with the intent to continue the project if ongoing funding is available. Future work will involve continuing economic and biophysical monitoring over a full crop cycle (5 years) as well as continuing to trial and develop cutting edge technologies that have potential to make significant water quality improvements.

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