Sugar Research Australia

Lower Burdekin Irrigation Extension Action Plan Project.

A NEW HORIZON FOR IRRIGATION IN THE LOWER BURDEKIN

Discussion Paper / April 2020

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Queensland Government

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A new horizon for Irrigation in the Lower Burdekin – Industry and Grower Focused.

A Discussion Paper for the Lower Burdekin five-year Irrigation Extension Action Plan.

Introduction

The lower Burdekin is a highly productive irrigation area blessed with abundant sunshine, ample water and produces 25% of Australia's annual sugar production. It is an area rich in history, boasting a reputation for high yields and the highest quality sugarcane in Australia. It is also a region experiencing real pressures from increasing irrigation costs (energy and water) and environmental impacts on iconic assets such as the Great Barrier Reef (GBR).

For the past 15 years, many of the lower Burdekin extension programs have had a primary focus of changing land management practices to improve water quality and reduce the impact on the GBR. Targets for improvement typically quote load reductions which are a function of the concentration of pollutants (e.g. land management practices to reduce losses of fertiliser or pesticide through changes to product, rate, placement and timing) and the volume of irrigation water leaving a farm.

Water availability is the primary driver of production in the Burdekin and when lost from the farm is also the pathway that transports the pollutants. Increasing water and energy costs turns the table on the typical Burdekin catch cry of abundant water. A new horizon is emerging where 'Irrigation Efficiency' is increasingly important to growers and the outcome of that approach is improved farm economics (productivity and profitability) and sustainability.

The aim of the Lower Burdekin Five Year Irrigation Extension Action Plan is to achieve real change in farm irrigation practices and systems by taking an industry and grower focused approach. This Discussion Paper synthesises the issues and attempts to find the real drivers for change that will actively engage cane growers to invest in improved irrigation systems and management.

Purpose of the Discussion Paper

Irrigation in the Lower Burdekin is at a crossroad. Sugarcane growers have identified Irrigation Efficiency (IE) as a high priority because low efficiencies are threatening the bottom line of their sugarcane businesses. Meanwhile the water and energy losses associated with low efficiencies are affecting water quality and producing greenhouse gas emissions which in turn affects natural assets, the sustainability of the industry and the social licence to farm.

This discussion paper has been prepared following 'one on one' and group consultation with a range of stakeholders in the lower Burdekin irrigation community. Feedback from this discussion paper will help guide and inform the development of the Lower Burdekin Five Year Irrigation Extension Action Plan. This project is jointly funded by Department of Agriculture and Fisheries (DAF) and Sugar Research Australia (SRA) and endorsed by the Burdekin Cane Extension Group (BCEG).

Key components of the discussion paper include:

- Developing a ***Vision*** for irrigation in the Lower Burdekin.
- Gaining consensus about the meaning of the term '***Irrigation Efficiency' (IE).***
- Reveal the issues facing the irrigation sector in the Lower Burdekin and to open a discussion about each with regards to importance, priority and options to resolve/address each issue.

Achieving a common Vision for the Lower Burdekin is important too for clarity, successful collaboration and the motivation to make change. The Vision should provide a common goal for growers, industry and the broader community alike to give a direction or pathway for improved irrigation over the next five years. **T**he Discussion Paper presents a draft ***Vision*** for consideration and comment.

Through the consultation process it has become clear that **IE** has different meanings to different people. The definition of **IE** presented here has been developed collectively but is open for comment. The definition attempts to unpack the components that make up IE and this DP invites feedback about the relevance and practicality of the components described or any omissions that should have been included.

Context of Irrigation in the Lower Burdekin

A SHORT HISTORY OF THE LOWER BURDEKIN

AN IMPORTANT SUGAR AREA

Century Since Discovery

50 YEARS SINCE SHIRE PROCLAIMED

The present year is an important one in the [illegible]ory of the Lower Burdekin, for it is the Jubilee of the proclamation of the Ayr Shire, in which the rich sugar lands of the Burdekin D[illegible] and surrounding areas are located. The shire was proclaimed in 1888, and the area took the name of the town which was its headq[illegible]ters, and which was named by a former Premier of the State (Sir Thos. McIlwraith), after his birthplace in Scotland. To mark the [illegible]tainment of the Jubilee a "Back to Ayr Week" has been organised and it opens on Saturday. An attractive programme has been [illegible]awn up and there should be much to interest residents and visitors during the celebrations.

The Lower Burdekin catchment is located in the Dry Tropics, with high temperatures and highly variable rainfall. There are short periods of heavy rainfall typically in the wet season, followed by extended periods of dry weather requiring irrigation to support cane production.

There are approximately 90,000 ha of available irrigated land in the Lower Burdekin. This can be divided into two distinctly different districts:

1. The older and eastern District is known as the Delta (42,592 ha) and irrigation began in the 1870's with the water resources now managed by *Lower Burdekin Water*, and
2. The newer and western District which was established in the 1980's and is known as the Burdekin River Irrigation Area (BRIA)/ Burdekin Haughton Water Supply Scheme (BHWSS) (47,485 ha) and is managed by Sun Water.

The Delta and the BRIA are largely furrow irrigated (98%) but have contrasting soils and surface runoff and deep drainage characteristics.

Map of the Lower Burdekin

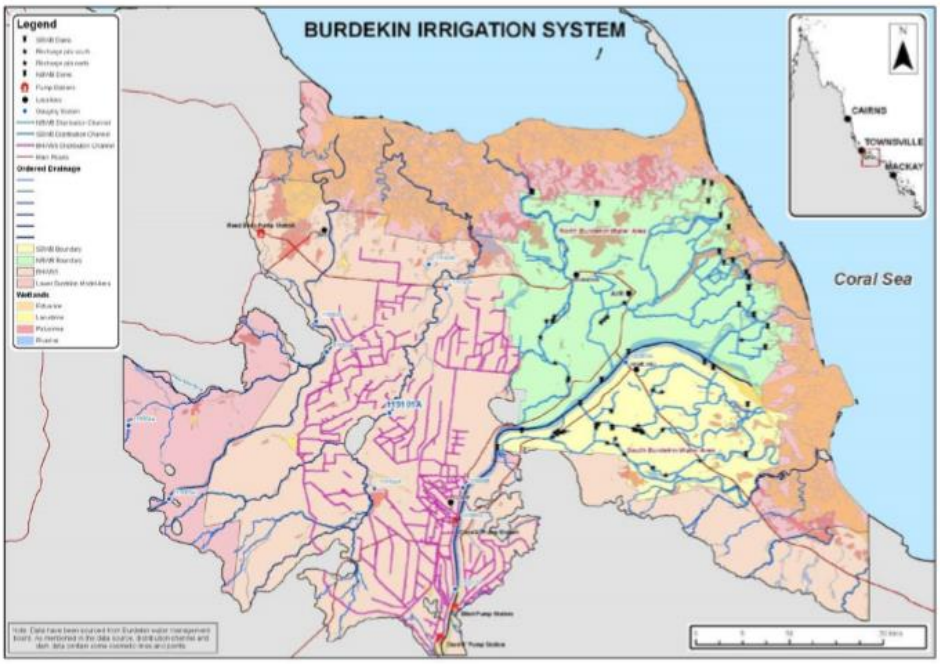

Figure 3 Map of the lower Burdekin floodplain showing major irrigation infrastructure.

Key characteristics of the Lower Burdekin Irrigation Districts.

Table 57. Key characteristics of the BRIA and Delta sugarcane growing areas in the Lower Burdekin. Reproduced from Waterhouse et al. (2016).

Characteristic	BRIA	Delta
Area:	47,485 ha	42,592 ha
Establishment	Since 1980s	Since 1880s
Approx. Farm size[1]	Up to 3,500ha Median farm size: 94ha Average farm size: 140ha	Up to 500ha Median farm size: 56ha Average farm size: 72ha
Dominant soils	Sodic duplex/and light to medium and heavy clays (high denitrification potential)	Coarse sands, sandy loams and light to medium clays (Low denitrification potential)
DIN loss pathway	Large proportion in surface runoff	Large proportion in drainage
Modelled annual average DIN load[3]	460t/yr	586t/yr
Average production[2]	110 tonnes per ha	120 tonnes per ha
Fertiliser application rates[4]	214 kgN/ha Plant 227 kgN/ha Ratoon	193 kgN/ha Plant 216 kgN/ha Ratoon
Water source and use	Surface water and groundwater in Northcote, Jardine and Selkirk areas 10-12 ML/ha Volumetric charge for water Gravity fed systems leading to lower electricity costs	Groundwater and surface water from Water Board supply 20+ ML/ha Largely area based charges for water Pumping leads to higher electricity costs
Irrigation systems	Predominantly furrow irrigation	Predominantly furrow irrigation

Data sources:
[1]Wilmar, January 2016.
[2]Wilmar, March 2016.

The Burdekin is not a homogeneous irrigation area as shown from the above table. Another significant difference between the Delta and BRIA are the demographics, any extension effort needs to include a range of strategies to engage with growers at the block, farm and sub-district scale.

The Delta District overview:

The Delta is a groundwater-based Irrigation District that commenced farming in 1870's. It is located on the eastern edge of the Lower Burdekin Valley to the north and south of the Burdekin River. As a consequence of evolving land use and farming, enterprises in the Delta farms have been established in a mosaic pattern, are generally smaller in size (average farm size 72 hectares), have aged infrastructure and are farming on sandy to sandy loam soils which are highly permeable.

The District is dotted with approximately 3,000 unmetered groundwater bores (pers com *Lower Burdekin Water*) and the underlying shallow aquifer is naturally recharged from the Burdekin River, the rainfall events in the wet season (such as the 2020 Australia day event) and overland flow during floods. Growers are charged for water on an area basis (ha) – not on the volume pumped.

While the Delta irrigation supply is a groundwater driven it is now heavily supplemented by an artificial recharge system that was engineered after the 'supply shock' caused by the 1960's drought. *Lower Burdekin Water* hold a bulk water entitlement from the Burdekin River of 225,00 ML/yr and pump river water into the open water distribution channels (e.g. Sheep Station and Plantation Creeks) and constructed recharge pits.

The open water distribution system (creeks) provides three functions:

1. It provides additional water to the Delta growers who pump from the distribution channels via open water licences.
2. The creeks have been 'engineered' to leak to provide recharge to the aquifer and,
3. They capture any surface runoff from Delta farms as the distribution channels are in the lowest part of the Delta landscape. The Delta is effectively a closed surface water system as the creeks have constructed tidal barriers at the ends of the system so no irrigation runoff leaves the Delta - apart from the flows during the large episodic rain/flood events.

Essentially *Lower Burdekin Water* is managing the shallow Delta aquifer water levels to ensure supply to growers but also very importantly to prevent saltwater intrusion into the aquifer. There has been significant work over the years to better understand the Delta aquifer and the groundwater dependant ecosystems it supports along with the magnitude of the natural discharge to the ocean.

The contemporary furrow irrigation approach on the permeable Delta soils result in very significant farm ***deep drainage losses*** and associated nitrate and possibly pesticide leaching. Some studies report ocean discharges to be in the range of 50,000 to 400,000 ML annually.

The annual irrigation water requirement for sugarcane in the Burdekin is approximately 10 ML/ha. This contrasts with the estimated average annual irrigation volume of 20+ ML/ha applied to cane in the Delta and Application Efficiencies as low as 45%. A consequence of this low Application Efficiency and dramatic increase in electricity prices over the past 10 years is the pain felt by grower in the cost to irrigate cane. A conservative monetary estimate of the wasted energy is - 10 ML/ha over 42,000 ha = 400,000 ML. At an average pumping cost of $20/ML that is an electricity bill in the vicinity of eight million dollars.

When it comes to farm economics, any loss of water, fertiliser, or crop protection products negatively impacts on crop profitability. The Irrigation Extension Plan needs to help growers address the volume lost from farm as this is a pumping cost with no productivity benefit. Low pumping efficiency is also affecting the farm bottom line as shown in a 2013-15 Burdekin Energy in Irrigation project. Project results found that ageing irrigation infrastructure is often operating at low efficiencies and the energy audits found savings of between 20 and 40% possible.

Agronomically, improvements to irrigation in the Delta need to focus on minimising deep drainage losses and excessive energy use along with scheduling irrigation for maximum crop productivity. It is very likely that changes to run length, flow rate and duration of the irrigation will be needed, this is essentially a shift from the contemporary layouts to an optimised furrow irrigation system. Enabling technologies such as pump timers, some level of automation, and scheduling tools along with a higher level of irrigation record keeping will be necessary. Alternative irrigation systems will have a better fit on some soil types and block layouts.

The BRIA District overview:

The Burdekin River Irrigation Area (BRIA) was established in the early 1950s as a soldier settlement scheme on 7,500 ha of the lower Burdekin floodplain around Clare, Millaroo and Dalbeg. The BRIA covers the western side of the Lower Burdekin valley.

In the late 1980's the construction of the Burdekin Falls Dam and establishment the Burdekin Haughton Water Supply Scheme (BHWSS) enabled the expansion of irrigation across a total of 47,500 ha. Today the dominant crop is furrow irrigated sugarcane, with complimentary legume and maize crops in the cane rotation. The underlying aquifers provide additional water for irrigation. All water sources in the BRIA are metered with annual volumetric allocations, however the ground water is managed by Department of Natural Resources, Mines and Energy (DNRME) and the surface water by SunWater.

Soils of the BRIA are described as fine textured with medium to heavy clays to depth and often sodic in nature (35% by area). The plant available water holding capacity is limited by soil structure and texture. These soils are often considered ideal for surface (furrow) irrigation because it is relatively easy to manage deep drainage losses (unlike the soils of the Delta District) but waterlogging can be a real productivity issue. Irrigation water requirement for cane in the BRIA is similar to the Delta, being approximately 10 ML/ha per year.

The major water loss pathway for a BRIA Farm is reported to be via surface flow. Even for best practice furrow irrigation, approximately 15 to 20% runoff is required to achieve acceptable levels of application uniformity. Recycle pits have been widely adopted in the BRIA and a large proportion of the runoff from blocks is reused on farm (approximately 70% is currently captured). Further adoption of recycle pits is warranted. Runoff that is not captured and recycled continues to significantly increase the quantity and decreased the quality of water entering Bowling Green Bay's Ramsar listed wetlands and the Great Barrier Reef lagoon.

The other important farm water loss pathway is as deep drainage below the root zone of the crop. Despite the heavier textured soils, deep drainage losses have been estimated in the BRIA to be as high as 2 ML/ha per year and is certainly more prevalent where high rates of gypsum have been used to address soil sodicity problems. The impact of the deep drainage losses is reported to be a rise of over 10m in the water table over the last 20 years , however the situation is more acute in localised areas where the groundwater levels are at only 0.5m below the surface. The high-water table is causing water logging and secondary salinity which is affecting productivity and limiting opportunities for future development.

Irrigation losses as either runoff and deep drainage are a major concern for an irrigation business and represents a lost opportunity to either decrease production costs and/or increase productivity. The general rule of thumb used in the region is 1 ML of water can grow 10 tonnes of cane under ideal conditions. Optimised furrow irrigation in conjunction with enabling technologies can minimise both the runoff and deep drainage losses.

Agronomically, improvements to irrigation in the BRIA need to focus on irrigation scheduling, a reduction in water logging and minimising and recycling irrigation runoff. Blocks that have the combination of long furrow lengths and long irrigation sets are most prone to waterlogging which adversely affects cane yields. Optimised furrow irrigation in the BRIA must be the long-term objective and a significant move in that direction over the next 5 years should be the goal. To adopt optimised furrow irrigation enabling technologies ranging from simple pump timers, scheduling tools along with a higher level of irrigation record keeping and some level of automation will be necessary. Alternative irrigation systems may have a better fit on the moderate to high permeability soils which are infrequently found in the BRIA.

Seeking a Consensus – the way forward

The five year Burdekin Irrigation Extension Action Plan is an opportunity to develop a coordinated and collaborative approach to achieve real change in farm irrigation practices which is vital for individual growers, to protect industry viability as well as iconic environmental assets.

The Plan should present a clear Vision, but it needs to be owned by all organisations including growers, extension providers, broader cane industry and the investors that have an interest in the Burdekin irrigation space. The Vision is where we as a community want to be and sets us on a direction that can keep the efforts focused.

An agreed *Vision* for the irrigation in the Lower Burdekin:

A suggested five-year Vision:

> ***Lower Burdekin Irrigators (supported by industry, extension providers and community) are actively measuring and managing water and energy use, to modify irrigation systems and management that maximise cane sugar (and other crops) productivity while minimising input costs, runoff and deep drainage losses and the resulting environmental impacts.***

This vision statement has been developed in consultation with the Burdekin Cane Collectives including:

- *Canegrowers Burdekin Ltd,*
- *Invicta Cane Growers Ltd,*
- *Kalagro Cane Growers and*
- *Pioneer Cane Growers Ltd.)*

And representatives of the following organisation during one on one discussions with representatives, and in meetings of the Project Technical Advisory Group **(TAG)**:

- *Agritech Solutions,*
- *Burdekin Bowen Integrated Floodplain Management Advisory Committee Inc (BBIFMAC),*
- *Burdekin Productivity Services (BPS),*
- *BRIA Irrigators,*
- *Burdekin Water Futures,*
- *C2o Consulting,*
- *Department of Agriculture and Fisheries (DAF),*
- *Department of Natural Resources, Mines and Energy (NRME),*
- *Farmacist,*
- *Lower Burdekin water,*
- *NQ Dry Tropics,*

- *Sun Water,*
- *Sugar Research Australia (SRA), and*
- *Wilmar.*

As the author of this discussion paper, I welcome feedback on the Vision statement.

Discussion question 1.

Is a Lower Burdekin cane crush of 9,000,000 tonnes annually and a farm average yield of 125t cane/ha driven by increased irrigation efficiency a 2025 goal supported by growers and industry?

A collective definition of 'Irrigation Efficiency (IE)'.

Irrigation efficiency is one of the top three issues mentioned by lower Burdekin cane farmers in a recent SRA survey. Again, like the Vision, everyone working in the irrigation space needs to have a common understanding of what the components of Irrigation Efficiency are and how it can be measured. The following proposed definition has been developed with the same reference group as noted for the Burdekin Irrigation Vision.

Irrigation Efficiency (Grower Focused) is:

> ***Growers have irrigation systems and management practices that are block appropriate and uses water, energy and labour (to achieve the minimum acceptable Application Efficiency (AE) whilst maximising the economic return per ML and ha, and minimising all off-farm impacts on the environment.***

Components of the definition include:

- *Depth applied at each irrigation meets the crop water needs (and leaching component) whilst minimising irrigation runoff and deep drainage leaving the farm. (Right Amount)*
- *Irrigation water is applied at the correct time, avoiding unintended crop stress and maximising the sugar produced / ML (Right Time)*
- *Irrigation systems are designed and operated to minimise energy use / ML but still maintaining uniformity - evenness of application.*
- *Labour and capital inputs are acceptable whilst achieving the first three points.*

To assess an improvement to Irrigation Efficiency or gauge progress, there needs to be some way of measuring change. Water is the driver of productivity and the primary measure of **Application Efficiency (AE)** is proposed.

Application Efficiency is simply the ratio of crop water requirement (nominally 10 ML/ha/yr) divided by the irrigation volume applied to the crop e.g. 20 ML/ha/yr in the case of many Delta farms and this results in a low AE of 50% and is an indicator of wasted water and energy, higher cost of production and possibly forgone yield. For many growers, the most important measure to encourage change at the current time is the pumping cost per ML ($/ML) and extension activities should be using this in conjunction with Application Efficiency.

The focus on Irrigation Efficiency has value for many cane growers given the 2015 estimates of current Application Efficiencies for the BRIA and DELTA. From the following table there is a huge scope for growers to improve their farm irrigation position and cost of production.

Table 60. Current (2015) estimates for representative proportions of growers at each irrigation management class. Prepared in conjunction with S. Attard, AgriTech Solutions and M. Davies, SRA December 2015 as part of the Burdekin Region WQIP update.

Irrigation management class	BRIA		Delta	
	Application efficiency (%)	Current adoption (% area)	Application efficiency (%)	Current adoption (% area)
A	>85%	2	>75%	2
B	70-85%	35	60-75%	33
C	50-70%	40	40-60%	35
D	<50%	23	<40%	30

Suggested Application Efficiency Targets – over the next five years,

- Growers farming the High to Very High permeability soils (predominantly Delta district) should be assessing each block's current **AE** and redesigning blocks to achieve a minimum AE = 75% (this is a high target from what appears to be a very low base).
- For the Growers farming the Very Low, Low and Moderate permeability soils (predominantly BRIA district) irrigation improvements should be targeting a minimum **AE** of 85%.

Discussion question 2.

Are these irrigation Application Efficiency targets (page 11) for the BRIA and Delta too high and un-realistic?

Issues / Influencing factors facing the irrigation sector in the Lower Burdekin

The following is a summary of the broad range of issues facing the lower Burdekin irrigation industry. (Some are beyond the scope of the five-year Irrigation Extension Action Plan).

Water Measurement and Irrigation Efficiency

- Lack of water meters on Delta bores means measurement of water use / irrigation efficiency is difficult.
- Water charges in the Delta are based on land area ($/ha) and not volume – so historically there has been little incentive to reduce the volume of water used.
- Yield/ha (alone) is the 'Grower' measure of good irrigation practice but in fact the true measure of good irrigation should be measured as tonnes of cane or sugar /ML.
- Cost of pumping water (seen as an energy cost) has emerged as the major issue for farmers because of impacts on crop gross margins

Farm Productivity

- Runoff and deep drainage losses impacts on farm productivity.
- Lack of adoption of irrigation scheduling is holding back Irrigation efficiency (productivity).

- Nitrates in Delta groundwater could be used to offset expensive bag nitrogen – integrating water and nutrient budgets is needed.

Irrigation Infrastructure

- Deep drainage losses are significant on some soil types due to contemporary furrow irrigation design on the high to very high permeable soils.
- Growers and possibly extension staff, laser grading designers, pump and pipeline suppliers don't know what an ***optimised furrow irrigation design*** looks like for the different soil permeabilities in the Lower Burdekin.
- Optimised furrow irrigation on the high to very high permeable Burdekin soils may not be able to achieve the suggested minimum Application Efficiency of 75%.
- Recycle pits can be very effective at capturing end of block runoff losses (most BRIA soils) and approximately 30% of the BRIA do not have recycle pits installed.
- No clear guidelines exist for the construction and management of recycle pits in the BRIA.
- Irrigation efficiency is being compromised for the sake of machinery efficiency (long row length).
- Sugar cane grown on beds and centre pivots are not compatible?
- Centre pivots and cyclones are not a good combination.
- Growers are not adopting the available technology such as scheduling equipment, end of row sensors, automation etc to help with irrigation - reasons not well understood but possibly include cost, skills, perceived benefit?

Economics

- Metering of the many thousands of bores in the Delta is difficult to justify based on the size of the capital expenditure required and grower perception of little additional value.
- Economics (returns) of sugar cane does not support the level of investment required to change to more efficient irrigation systems.
- Cost of pumping water is affected by three factors including the ML/ha, pump efficiency and the tariff – possibly a key message for irrigators.
- Incentives may be needed to accelerate the rate of change and to acknowledge the public benefit (cost share e.g. water quality improvements) provided by the on-farm changes.

Practice change / Extension

- Age of growers (demographic) reluctant to change.
- Lack of water measurement being a culture within the Burdekin.
- Delta bore metering is not supported by growers – distrust of government.
- Changes to irrigation systems and management are complex and need adequately resourced extension and specialist assistance.
- Little adoption of technology to measure water use.
- Conventional furrow irrigation is cheap to develop and there is reluctance to change.
- Adoption rates of technology are low which prevents to adoption of the more complex/ efficient irrigation systems.
- Irrigation farm planning is not a culture in the lower Burdekin – laser grading designs are not integrated with pump and pipeline plans.

- P2R modelling process and the farm rating system ABCD is not well supported by growers – a great deal of scepticism surrounds the subjective questions (scale) and modelled DIN/ PS II.
- Growers with many 'years of experience' generally believe they are doing a pretty good job.
- Resources may not be available to complete energy assessments on the vast number of grower bores in the Delta (>2500) – targets for change need to be realistic.
- Generally, growers are not motivated to change farm systems/practices for the sake of water quality.

The Environment

- Deep drainage losses are causing high nitrate concentrations in groundwater (Delta).
- Deep drainage losses are causing rising water tables, waterlogging and salinity issues (BRIA).
- Groundwater quality in areas of the BRIA (e.g. Mulgrave) have salt levels so high that even conjunctive use with channel water is not possible.
- High groundwater nitrates (Delta) are affecting GBR water quality issues.
- The Lower Burdekin irrigation runoff and groundwater ocean seepage is transporting dissolved inorganic nitrogen (DIN) and PS II pesticides which are entering the GBR lagoon.
- Water authorities and growers are using ephemeral wetlands/water courses as water conduits to farms and degrading flood plain environmental assets.

Policy

- Water policy (BRIA) discourages groundwater use for water table depth control.
- Insufficient ground water pumping (BRIA) to control water table depth at acceptable levels
- Public groundwater pumps needed where water quality is unsuitable for irrigation – pumped to basins or disposed of to the Burdekin River.
- BRIA water pricing structure does not provide incentive to reduce applications (largely fixed charges).

Addressing the Irrigation Issues:

Irrigation efficiency and particularly energy costs are of great interest to growers and the extension approach must capitalise on this opportunity.

A nine step 'Improved Irrigation Efficiency Pathway' has been collaboratively designed by key extension stakeholders in the Lower Burdekin. The Extension Pathway provides an endorsed framework to address the important grower irrigation issues and the impacts of low irrigation efficiency on the cost of production, profitability and water quality leaving the region.

The benefit of this approach is that it allows the grower and extension person to connect at the issue level and scale (irrigation set/block/farm) that is appropriate for the grower at the time. The pathways provide an opportunity to progressively tackle the more complex irrigation changes or increase the scale of farm irrigation change over time.

Improved Irrigation Efficiency Pathway

Step 1	• Evaluate current water use
Step 2	• Energy assessment
Step 3	• First recommendation on improving irrigation efficiency
Step 4	• Measure/monitor (log) multiple 'improved' irrigation events
Step 5	• Review recommendations, test practicality and identify opportunity to upscale
Step 6	• Infrastructure Assessment & Recommendation
Step 7	• Agronomic Assessment & Recommendation
Step 8	• Develop an Irrigation Farm Plan
Step 9	• On going adoption support to provide legacy

The proposed ***Practice Actions*** outlined in this Discussion paper aligned with the steps and focus on triple bottom line outcomes for the growers. The basis for all *Practice Actions* is a grower focus on improving irrigation efficiency and productivity, reducing costs, and the establishment of a business pathway for investment.

Another crucial aspect and key learning from previous projects, is the need to base adoption of improved irrigation practices strategically as per an 'irrigation management unit' which will require site specific context and will vastly improve the legacy of extension efforts.

Proposed Irrigation Extension Actions:

Practice Action One (PA1).

Helping growers understand crop water use and the current cost of pumping.

Measure to manage - The first step is for extension staff work with growers to get a measure crop water use in ML/ha and the pumping cost in $/ML. This is a benchmarking activity to identify opportunities to reduce the volume pumped ML and to assess pumping cost/ML looking to reduce costs without affecting production. Data collection is largely manual at this point but introduction to technology to make data collection easier is encouraged.

Components include:

- Measurement of the area of the set/block (ha) and flow assessments will be required (using permanent or portable flow meters) to calculate the amount of water applied (ML) and calculate the ML/ha.
- Records from energy bills used to calculate the pumping cost/per ML.
- Agronomic assessment of the cane/sugar yield per ML.

Outcome:

- Opportunities to reduce water and energy costs are uncovered based on the benchmarking outcomes.
- Growers are measuring water use and able to keep records at least on limited blocks.
- Growers understand the 'block water balance' in terms of crop water use, runoff and deep drainage losses in ML/ha.
- Grower are using irrigation performance to help identify opportunities to improve.
- Measurement is leading to management changes on farm.
- Economic analysis can be used to quantify the value proposition for change.

Case studies of what are effectively demonstration sites to be developed for future extension activities.

Discussion question 3.

Over the next 5 years (to 2025) what percentage of farmers can we expect to have block by block water use numbers and pumping cost/ML figures at their fingertips?

Practice Action Two (PA2),

Assessing irrigation system energy efficiency.

Growers that already have water and energy use records may wish to start their improved irrigation pathway at this point. PA2 aims to identify preliminary energy savings where the benchmarked irrigation cost per ML is found to be high. It is likely that to manage extension capacity, the PA2 will focus on a particular farm irrigation management units rather than a whole of farm approach.

Components include:

- Recording of all components including pumps and motors, suction and delivery pipelines, valves and other irrigation infrastructure
- Measurements of flow rate.
- Measure of energy consumed.
- Calculation of energy used per ML and per ML/m and benchmark the results.
- Identify the components that are contributing to low efficiency.
- Energy saving recommendations provided to the grower.

Outcome: This is an energy/ hydraulic assessment and the results of this (kWhr/ML/m) would lead to preliminary recommendations for changes to pumping infrastructure including pumps, motors, and pipelines. In addition to the recommended systems changes, electricity tariffs or alternative energy sources can also be considered.

Case studies of what are effectively demonstration sites to be developed for future extension activities.

Discussion question 4.

Is an Irrigation Extension Plan that focuses on reducing energy costs, water use and increasing productivity (sugar yield from improved irrigation) the right approach to get growers involved in a new irrigation improvement project in the Burdekin?

Practice Action Three (PA3),

Proof of Concept - growers trialling recommended changes on a small scale to gain confidence.

Extension staff will work closely with the grower and other irrigation specialists to develop options to be trialled on a small scale. The options (improvements to either water use or energy) will be driven by soil type, grower preference and be site specific but may include furrow length, flow rate, irrigation duration, recycle pit assessment, introduction of scheduling, small scale adoption of enabling technologies. Optimised furrow irrigation vs alternative irrigation system discussions.

The purpose of this Practice Action is to:

- Ensure the irrigation systems and/or management changes will achieve the desired outcome in reduced energy cost and increased irrigation efficiency for the block in focus.
- Test the practicality of upscaling the recommendation to multiple blocks.
- Develop and trial smart systems to measure and record irrigation information which is critical for better management.
- Quantify the benefits (energy, yield, water use, labour etc) on farm and within the grower's farming systems.
- Align the possible options with the grower's goals and aspirations
- Ensure the grower has developed confidence in the options.

This is a proof of concept stage, and as farms are not homogeneous (with respect to soil type, water quality, travel distance etc) the one solution may not fit all situations on the same farm. The grower assessment of the new technologies and how they would integrate into their farming system is an important step.

Outcome: Growers will have proven solutions to reduce energy costs and water losses (productivity and water quality outcome) and confidence to plan for broader adoption. Potential funders can see proven value in the proposed changes and have confidence that positive public benefits such as improved water quality will be recognised from extension and incentives support.

Practice Action Four (PA4),

Farm Irrigation Infrastructure Scan and Redevelopment Planning

Extension staff work in collaboration with Irrigation Specialists and the grower to survey the current irrigation farm infrastructure as the first step to preparing an irrigation redevelopment plan. This allows the redevelopment plan to be staged to fit in with the annual farm operating plan and development opportunities.

This scan determines what infrastructure can support the redevelopment and what needs to be changed. It considers alternative irrigation systems and how they can integrate with the existing irrigation infrastructure. The scan needs to include assessment of each grower's future goals and aspirations and to match the appropriate technology to their needs.

Outcomes:

- Farm design and irrigation systems planning for better layouts and management – soil permeability informs furrow irrigation design or need for alternative irrigation systems.

- Alternative irrigation systems are being considered to bring applied volume of water closer to the crop water requirement (minimum application efficiency for the Delta 75% and BRIA 85%).
- Greater on farm use of technology – enables higher efficiency systems, water and energy.
- External Investment has confidence to support irrigation redevelopment plans and on ground activities with financial incentives.

Discussion question 5.   ***Should Whole Farm Irrigation Redevelopment Plans become part of the culture of the Burdekin by 2025?***

Practice Action Five (PA5),

Farming Systems Assessment

It is critical that any proposed changes the farm irrigation system mesh in with all farm operations. Achieving high Irrigation Efficiencies is only possible where soil health, crop nutrition, crop protection and the farming systems (complimentary crops) are in harmony.

Irrigation extension staff will need to work with the grower and agronomic support to identify any limitations of the proposed improved irrigation system or practice. Where limitations are identified an iterative approach with PA 4 may be needed.

Outcome:

- Growers are actively seeking extension and service provider assistance to modify existing irrigation systems to achieve application efficiencies of 75% or greater.
- Farm productivity is enhanced by the collaborative approach
- Extension and knowledge – grower see value in the changes being promoted, minimum standards improve grower confidence, grower seeking irrigation and soil management knowledge.

Practice Action Six (PA6), Broader Extension Activities

One on one extension is important given the complexity of practice change in the farm irrigation space. However, the sharing of knowledge requires other extension approaches to be run alongside and includes:

- Grower shed meetings
- Field days
- Farm walks
- Case studies
- Seminars
- Information sheets
- Education/ Training – growers, industry and extension staff
- Learning groups – peer to peer
- Online, apps and tools

Outcomes:

- The complex nature of irrigation extension (the integration of skills and knowledge with geophysical dimensions and hydraulic and energy physics) is acknowledged by funders and adequately resourced (experienced technical and extension people) to enable change in the Lower Burdekin.
- Affordable (or cost share) technology for monitoring pumping duration and flow data is available to all irrigators.
- Burdekin Cane growers are aware of the new Irrigation Extension Plan and how it can help their business to improve Irrigation Efficiency and the value proposition – what its outcomes mean for them in terms of economic and/or social benefit.
- Extension staff and industry service providers will have access to different levels of appropriate irrigation technology that will be suited to different growers needs – careful selection of the appropriate tool is a skill of the extension practitioner.
- Financial support (incentives/ rebates etc) to acknowledge public benefit of farm changes on environmental assets needs to be part of the extension landscape.
- Irrigation extension support is critical to assist growers gain the knowledge, attitudes, skills and aspirations for change.

Discussion question 6.

From a grower perspective what kind of irrigation demonstrations or trials are needed to? E.g. optimised furrow irrigation on the different soil permeabilities, alternative irrigation systems, or maybe enabling technologies such as sensors and automation?

The Irrigation Extension Action Plan and the Next Steps:

The Project Management Committee seeks **your feedback** on this Discussion Paper **by the 18th May 2020.**

All comments can be directed to Gavan Lamb via email at glamb@sugarresearch.com.au or contact him on 0436 937 555 for more information.

From your feedback, the Five-Year Lower Burdekin Irrigation Extension Action Plan will be refined and a final draft is expected by 15nd June 2020. .

Summary of the Discussion Paper Questions:

Discussion question 1.

Is a Lower Burdekin cane crush of 9,000,000 tonnes annually and a farm average yield of 125t cane/ha driven by increased irrigation efficiency a 2025 goal supported by growers and industry?

Discussion question 2.

Are these irrigation Application Efficiency targets (page 11) for the BRIA and Delta too high and un-realistic?

Discussion question 3.

Over the next 5 years (to 2025) what percentage of farmers can we expect to have block by block water use numbers and pumping cost/ML figures at their fingertips?

Discussion question 4.

Is an Irrigation Extension Plan that focuses on reducing energy costs, water use and increasing productivity (sugar yield from improved irrigation) the right approach to get growers involved in a new irrigation improvement project in the Burdekin?

Discussion question 5.

Should Whole Farm Irrigation Redevelopment Plans become part of the culture of the Burdekin by 2025?

Discussion question 6.

From a grower perspective what kind of irrigation demonstrations or trials are needed to? E.g. optimised furrow irrigation on the different soil permeabilities, alternative irrigation systems, or maybe enabling technologies such as sensors and automation?