Expression of Interest

Inviting applications for access to technologies from the Smarter Irrigation for Profit Program Phase I through the Cotton Research and Development Corporation (CRDC) and the University of Southern Queensland (USQ)

INFORMATION, TERMS AND CONDITIONS.

Issued by CRDC and USQ
27 April 2020
The invitation

CRDC and USQ are interested in initiating discussions with parties interested in gaining access to one or more of the irrigation technologies produced through the “Smarter Irrigation for Profit Program - Phase I” suite of projects. These technologies are summarised below in several attachments.

This invitation document comprises:

| SECTION A | Background |
| SECTION B | Steps to engagement |
| SECTION C | Conditions of engagement |
| SECTION D | Contact information and timeframes |
| ANNEXURE A | Technology summaries |
| ANNEXURE B | NDA Template |

This is a two-stage process with applicants indicating their interest in obtaining access to one or more technologies (Stage 1) and, if interested, commencing negotiation and gaining access to those technologies (Stage 2).

SECTION A – BACKGROUND

Introduction

The cotton industry accounts for 13.5% of Australia's total irrigation water use and more than $2 billion of Australia's agricultural production. Industry is driven to continue to address production challenges such as inefficiencies in irrigation use and access to labour. At the same time, the agricultural industry must increase productivity to keep up with global demand.

Automated irrigation application systems can increase water use efficiencies and crop productivity. They achieve this by automatically analysing spatial soil and plant measurements to identify spatial water requirements, and only applying irrigation when and where it is needed. This allows for a low-cost customised solution to be implemented paddock by paddock and rolled out at a regional scale depending on the individual requirements.

Existing commercial automated site-specific irrigation control strategies are either time-based or are based on variability maps. Typical strategies developed in research apply irrigation to achieve a desired soil moisture deficit, or assess when the plant has reached a specific stress point. These systems do not consider water availability or spatial variability and do not target seasonal performance objectives (e.g. maximise yield, profit, water use efficiency). Therefore, they cannot adapt to different weather conditions or limited water situations.

Critically, there has been poor adoption rate of automatic variable-rate hardware that enables site-specific irrigation because of a lack of decision support in determining volume and timing of irrigation.

A number of technologies have been developed at USQ-CAE through sub-projects of Smarter Irrigation. These are detailed in Annexure A and include:

- Site-specific irrigation optimisation
- Crop assessment and in-season yield prediction, and
- Surface irrigation simulation and optimisation

Additional research

There is ongoing research being conducted on the technologies included in this invitation as part of Smarter Irrigation for Profit Program - Phase 2. This invitation is to access the technologies listed herein, together with any improvements to those technologies that may come out of the additional research.
The following steps will be followed:

**Stage 1**

**Expression of interest**

This EOI will be public and is open to any organisation to apply. CRDC and USQ have identified parties that they believe will be interested in the technologies. Those parties will be contacted directly and will be made aware of this invitation.

Parties interested in applying will be required to sign a Non-Disclosure Agreement (NDA – included in Annexure B) to facilitate additional disclosures and discussions around the technology and how it may fit in with interested parties’ operations.

**Assessment criteria**

All interested parties will be required to email grants@crdc.com.au, subject line: **SMART IRRIGATION TECHNOLOGIES EOI** the following information as part of the process when indicating their assent to participate and after submitting the NDA (ANNEXURE B):

- Resourcing (internal or external) to contribute to product development and commercialisation
- Domain knowledge and track record with a focus in irrigation and water management (or particular subject matter)
- Current activities in the cotton industry and ability to deploy in cotton in first instance
- Strategy and clear pathway to market including linkages with manufacturers and/or 3rd parties to assist commercialisation or capability to deploy themselves
- Potential to integrate with existing hardware and/or software platforms (interoperability)
- Service and distribution network across Australia
- Evidence of global strategy or ability to scale Internationally

**Stage 2**

**Negotiation**

If parties are interested in securing access to one or more of the technologies, negotiation around terms of access will take place. Terms of access may include access tied to specific areas, royalties, exclusivity, deployment restrictions, time frames, access to specific technologies, support, additional research etc.

CRDC and USQ may grant access to more than one interested party, as necessary, or to one party for all of the technologies.

Negotiation will be between one or more of the interested parties, CRDC and USQ. Interested parties may join together to gain access to one or more of the technologies.

**Additional Research / Integration**

Interested parties may require access to the technologies to confirm their efficacy and/or to ensure integration with their systems. Short term research projects may be required for this purpose and USQ and CRDC would work with any interested parties to assist, as required.

**Implementation and deployment**

After negotiation, the technologies will be deployed by those parties who have secured access to the technologies. As mentioned above, additional research into the technologies is ongoing and additional improvements may eventuate from that research.

This invitation is to identify a partner/partners who wish to gain access to irrigation technology produced during the Smarter Irrigation for Profit Program.
SECTION C – CONDITIONS OF ENGAGEMENT

CRDC
The remit of CRDC is to deliver a benefit to the Australian cotton industry. As such, any interested party will need to be able to deliver the technologies to the Australian cotton industry, at least in the first instance.

This condition is not negotiable.

Intellectual property
There are no patents. All intellectual property included in the technologies is in the form of copyright, confidential information, and trade secrets.

Licence
Any licence granted to an interested party will be non-exclusive. This is required so that CRDC and USQ can continue to give rights for research to the various research organisations performing the additional research.

While the licence may be non-exclusive, CRDC and USQ are open to negotiating commercial exclusivity to one or more of the technologies. In other words, such a licence would only be non-exclusive in the sense that an on-going licence for R&D purposes is required.

SECTION D – CONTACT INFORMATION AND TIMEFRAMES

1. Indicative Timeframes

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>27th April 2020</td>
<td>Expression of interest made public</td>
</tr>
<tr>
<td>1st to 31st May 2020</td>
<td>Register interest and ask questions around the technologies in this period (email: <a href="mailto:grants@crdc.com.au">grants@crdc.com.au</a> )</td>
</tr>
<tr>
<td>15th June 2020</td>
<td>Expression of interest closes</td>
</tr>
<tr>
<td>1st July 2020</td>
<td>Stage 2 commences</td>
</tr>
</tbody>
</table>

CRDC and USQ acknowledges that many organisations are currently experiencing significant disruption and that staffing/resourcing may be problematic at this time. As such, CRDC and USQ is taking a pragmatic approach to the time management of this invitation. Please advise grants@crdc.com.au if your organisation is likely to submit an EOI, but due to COVID-19 cannot meet the advertised timeframes.

3. Contact
Please submit a signed non-disclosure agreement to grants@crdc.com.au, subject line: SMART IRRIGATION TECHNOLOGIES EOI to register your interest in participating in Q&A relating to this EOI. All questions in relation to this invitation and related technology must be put in writing to grants@crdc.com.au with the subject line: SMART IRRIGATION TECHNOLOGIES EOI. CRDC will endeavour to answer questions within three (3) business days of receipt, with Q&A sent to all registered participants. A webinar on the technology will be scheduled in late May. Participants with signed NDAs will be invited to participate.
ANNEXURE A – TECHNOLOGY SUMMARIES

A  VARIwise: Improving cotton and dairy pasture productivity under limited water.
B  Automated cotton and pasture assessments using UAV and infield sensors and machine vision systems.
C  Yield prediction for cotton and pasture using UAV imagery and VARIwise.
D  Furrow irrigation advance sensors and SISCO optimisation for manual control of irrigation and remote control of automated gates.
**Technology title:**
VARIwise: Improving cotton and dairy pasture productivity under limited water

**Industry problem:**
The cotton industry accounts for 13.5% of Australia's total irrigation water use and more than $3 billion of Australia's agricultural production. Industry is driven to continue to address production challenges such as inefficiencies in irrigation use and access to labour. At the same time, the agricultural industry must increase productivity to keep up with global demand. Automated irrigation application systems can increase water use efficiencies and crop productivity by automatically analysing spatial soil and plant measurements to identify spatial water requirements, and only applying irrigation when and where it is needed. This allows for a low-cost customised solution to be implemented paddock by paddock and rolled out to the regional scale depending on individual requirements.

Existing approaches for irrigation management provide irrigation timing and/or volume recommendations when the estimate soil-water content is below a set threshold based on the soil water-balance of each field. The soil-water balance is typically derived from networked weather stations, soil-water sensors and/or satellite imagery. However, these assume that irrigation water is unlimited and does not prioritise fields nor determine relative impacts on yield for different irrigation strategies. Therefore, there is potential to apply optimisation based on field yield potentials to identify irrigation application dates and volumes for each field.

**Technology solution:**
USQ-CAE has developed automated, irrigation application software ‘VARIwise’ that can adapt to any irrigation system, soil type and weather profile. While developed for cotton and pasture systems, the system can be refined for any crop. This software implements optimisation algorithms using available weather, soil and plant information in each field from online databases and infield sensors. The software links with biophysical crop models to provide predictions of crop development and yield for each field and impacts on yield potential from different irrigation treatments.

Variants of this software have been evaluated to determine uniform and site-specific irrigation requirements for surface and centre pivot irrigation machine irrigated cotton and fodder crops based for yield optimisation. Implementation of this system has led to yield improvements of 4-11% and water savings of 12-22% (McCarthy et al. 2013). Using in-season crop sensing in cotton irrigation decisions has led to 6% extra yield and 14% more efficient water use than existing standard soil sensing approaches.

The system has been evaluated for cotton and pastures but with further development can be applied to other cropping systems (e.g. broadacre, orchards). Systems developed are applicable for:

- Daily whole field/farm irrigation recommendation for any irrigated farm; and
- Automated daily sub-field irrigation linking with commercial variable-rate irrigation hardware on centre pivots and lateral moves.

**Target market:**
The initial target market is the Australian cotton industry, with an annual export value in New South Wales and Queensland ($1.3 billion and $670 million, respectively) (CA 2020). In the Australian cotton industry, there is 61,030 ha of land irrigated by centre pivot or lateral move irrigation machines and around 287,2000 ha of land developed for surface irrigation, irrigated by about 1,000 irrigation systems that could each utilise one of these units (ABS 2017a; Roth et al. 2013).

Trials have commenced to transfer these systems from cotton into the horticulture and dairy industries and create significant productivity improvements for Australian growers. These crops account of 61% of the total gross value of Australia’s irrigated agriculture production, with vegetables, fruit and dairy production contributing $2.9 billion, $2.3 billion and $2.2 billion, respectively (ABS 2017b).
There is potential for the control system to also be implemented in the grains industry, particularly in the USA where the irrigable area is 22 million ha. Over half of this area is irrigated with centre pivots and lateral moves that could utilise one of these systems. In particular, the USA is the world's largest corn producer, with an annual irrigated crop value of $13 billion and irrigated corn area of ≈5,500,000 ha (USDA 2012; WOC 2020).

**Competitive advantage over current products (value proposition):**
Existing commercial automated site-specific irrigation control strategies are either time based or are based on variability maps that may not necessarily relate to irrigation requirement. Typical strategies developed in research apply irrigation when the plant has reached a specific stress point or soil-water deficit. These systems also do not consider water availability and do not target seasonal performance objectives (e.g. maximise yield, profit, water use efficiency). Therefore, they cannot adapt to different weather conditions or limited water situations.

VARIwise also enables multi-field optimisation of limited water resources, in contrast with existing irrigation management tool which provide irrigation recommendations without considering water availability. This system has potential to produce the following direct benefits for Australia:
- 10% improvement in yield (up to $297,000 for gross value of irrigated cotton production per farm of $750 per ha increase with 396 ha of irrigated cotton) and produce an additional 88,000 tonnes of cotton through targeting available irrigation to fields with higher yield potential;
- more certainty in seasonal irrigation management production with reduced water availability and climate variability; and
- higher level of skills in irrigation management and technology, leading to increased uptake of other technology in agriculture, and further water and labour savings.

**Technology readiness level:**
The VARIwise software for site-specific irrigation is advanced and processes images and online data for VRI control. The hardware links with combination of USQ-CAE-developed and commercial UAV cameras and VRI hardware. As part of the funded Smarter Irrigation for Profit project (ends June 2022), evaluations will be conducted on centre pivot irrigated cotton comparing with irrigation strategies for both cotton and dairy pasture. The VARIwise software for field-level irrigation management will be evaluated for cotton as part of the funded Smarter Irrigation for Profit project (ends June 2022). The online software platform will also be updated to enable use by multiple users. For the cotton yield prediction, a licence for use of OZCOT model should be investigated, or a replacement AI model should be developed.

**IP Position:** The IP developed includes:
- computer code for efficient and streamlined operation on servers, rather than desktop PCs, and imagery ingestion from drones and cameras, weather sources and field sensors, and remote control of furrow irrigation and overhead irrigation machine equipment;
- hardware and software algorithms for automated crop cover, boll mapping and yield prediction; and
- know how in the integration and deployment of the VARIwise systems.

VARIwise has the following features:
- data input of in-field soil moisture and plant growth information;
- incorporation of simulated responses/predictions of crop response;
- ability to determine irrigation and fertiliser application; and
- implementation of strategies to produce a desired agronomic response for all management zones.

This system builds on concepts and algorithms that have been published in other subject areas and subsequently adapted and parameterised for the crops identified. There is significant know-how and expertise within the team that would make it difficult and time consuming for another group to replicate. Software developed as part of this program is also protected by copyright of the software code and through encryption of the program.

**References**


B  Technology title:
Automated cotton and pasture assessments using UAV and infield sensors and machine vision systems.

Industry problem:
Agronomists and growers typically manage fertiliser, irrigation, pesticide and fungicide application through infield soil sensing and visual assessment of the crop to determine appropriate management. For example, crop structure and visual appearance are strongly linked to paddock fertility. However, manual crop assessments are labour-intensive to conduct over the fields which often have spatial variability in crop growth of up to 200%. Automated sensors have been developed to assess the canopy cover size and determine stress indices from satellite and UAV images. However, these measurements are subsidiary stress measurements and require additional infield data for diagnosis and treatment.

An alternate approach developed at USQ is to automate the visual assessment of crops used by growers and agronomists using robotic vision and link these with critical spatial data maps. This involves cameras collecting images of the plants either from ground or aerial vehicles (UAVs) and image analysis software extracting crop features that are required to make management decisions. Key crop features of major crops are leaf stage and composition for pasture; tiller (branch) counts and height for grains; and height-to-node ratio and nodes above white flower for cotton. These image analysis systems could be transferred to other crops with further data collection and refinement.

Technology solution:
USQ-CAE has developed machine vision systems to automatically assess cotton and dairy pasture crop development from either UAVs or low-cost infield solar powered smartphone cameras. The cost of the sensing system is $2500 for a consumer UAV and $250 for an infield smartphone camera that captured daily images.

Trials have been conducted to develop and evaluate the systems for cotton and dairy pasture in the 2017/18 and 2018/19 seasons at 20 sites. For cotton, the mean absolute error of the open boll counting image analysis algorithm was 3.1 ± 0.3 open bolls/plant and 0.056 ± 0.004 for LAI. The number of open bolls was generally underestimated using the image analysis compared with the manual measurements. This is because of leaves or other bolls occluded the lower open bolls on the plant. In the conducted field trials, 88.7% of the open bolls were visible from the top view image (McCarthy et al. 2019).

For dairy pasture, the image analysis algorithms were implemented to extract pasture height from the daily images from infield cameras. The mean average error of the image analysis system was 2.3 ± 1.9 cm. Periods of grazing were also detected as the pasture growth reduces.

Target market:
In the future, it is expected that the machine vision system would be used by growers or consultants collecting images with UAVs or from fixed cameras during routine checks, transferring these images to an App or webpage and then receiving updated crop assessments throughout the season. The UAV system requires a consumer UAV with GPS waypoint guidance and an RGB camera ($2000 cost) and an hour of time for data collection every two-four weeks throughout the season ($500 cost). The infield camera requires no labour for data collection and automatically collect daily data at a $250 cost including data communications.

The initial target market, i.e. is the the Australian Cotton Industry, with an annual export value in New South Wales and Queensland ($1.3 billion and $670 million, respectively) (CA 2020). Dairy contributes $2.2 billion to the total gross value of Australia’s irrigated agriculture production (ABS 2017).

Competitive advantage over current products (value proposition):
Existing approaches for crop assessment are from UAVs and satellite imagery which focus on multi-spectral imagery, colour-based feature detection or height assessments by developed point clouds. Multi-spectral imagery can only infer crop status and require additional infield assessments for specific diagnosis. Colour-based feature detection (e.g. canopy cover) is useful for dairy pasture assessment when there is closed canopy. Height assessments using point clouds are data and computationally intensive and require accurate GPS positioning. In contrast, the USQ-CAE developed UAV and infield machine vision systems use image analysis algorithms that directly detect detailed crop
features (e.g. bolls, pasture blades). This enables more straightforward conversion of data to decisions as inferences are not required. Machine vision system can also detect additional and expandable datasets to multi-spectral or point-cloud based datasets (e.g. flowers, density of plants).

**Technology readiness level:**
Machine vision systems have been developed for processing images and online data with national trials conducted in cotton crops over two seasons. The systems have been refined through trials at 20 sites since 2016/17 for cotton and dairy pasture. As part of the funded Smarter Irrigation for Profit project, evaluations will continue for cotton and pasture growth assessment.

**IP position:**
Hardware and machine vision software algorithms for crop assessment are available. USQ-CAE’s machine vision system has the following features:
- transferrable between infield fixed camera with no labour in data collection, and UAV assessment conducted weekly or fortnightly; and
- assessment of cotton or dairy pasture with potential to expand to other crop types.

This system builds on concepts and algorithms that have been published in other subject areas and have then been adapted and parameterised for the crops identified, e.g. cotton. There is significant know-how and expertise within the team that would make it difficult and time consuming for another company to replicate.

Software developed as part of this program is protected by copyright of the software code and through encryption of the program.

**References**


C Technology title:
Yield prediction for cotton and pasture using UAV imagery and VARIwise.

Industry problem:
Accurate yield prediction enhances growers’ ability to market and give assurance as to how much cotton they forward sell. Yield is currently often estimated using experience and rules of thumb from counting bolls or assessing the look of the field. However, the accuracy of yield estimations using these methods may be not be transferrable between seasons and fields. Existing research on automated yield prediction often involves developing machine learning models linking infield measured yield with multi-spectral satellite images of the field. The relationship between spectral response and yield are site and season-specific and significant data collection and model development are required to identify relationships for each variety of the cotton and soil type.

Another approach for yield prediction involves seasonal forecasts using process-based models that incorporate soil-plant-atmosphere relationships to simulate specific crop production outcomes (e.g. APSIM). For example, the tool Graincast uses satellite imagery-derived plant features to calibrate the APSIM model for yield prediction. This approach has low spatial and temporal resolution of infield data for model calibration leading to lower accuracy (e.g. Graincast yield predictions have 33% error). The yield forecasts can be improved by incorporating high temporal and spatial resolution infield imagery and machine vision with process-based models. UAVs enable increased spatial and temporal resolution of infield data collection than satellite imagery.

Technology solution:
USQ-CAE has developed software ‘VARIwise’ to combine in-season, spatial UAV imagery with process-based models to provide yield prediction throughout the season. The following data sources obtained and automatically analysed in VARIwise for yield prediction are:

1. plant parameters extracted from UAV imagery using image analysis;
2. online soil and weather data; and
3. on-farm management information.

The cost of the sensing system is $2500 for a consumer UAV and labour which would provide data collection for each farm by the grower or agronomist.

In the 2017/18 and 2018/19 seasons, VARIwise was evaluated at one cotton site in Goondiwindi and 16 sites in Griffith. Management zones in the field monitored using the UAV were identified from vegetation index surveys, yield maps or satellite images. Phantom 4 UAV imagery was collected monthly at each site between January and picking for calibrating the crop model. The sites had varying levels of fruit removal, hail damage and heat stress. These trials have indicated that yield prediction improved with more frequent data and as season progressed. The overall percentage yield prediction errors were: 10.2-18.8% in January; 4.9-8.9% in February; 2.5-9.5% in March; 0.5-10.1% at picking.

Target market:
In the future, it is expected that the yield predictor would be used by growers or consultants collecting images with UAVs during routine checks, transferring these images to an App or webpage and then receiving an updated yield prediction in mid and late season. The system requires a consumer UAV with GPS waypoint guidance and an RGB camera ($2000 cost) and an hour of time for data collection every two-four weeks throughout the season ($500 cost).

The initial target market, the Australian Cotton Industry, has the highest gross value of irrigated agricultural production in New South Wales and Queensland ($1.3 billion and $670 million, respectively) (CA 2020). These calibrations and yield prediction are also being transferred from cotton into the dairy pasture industry and have the potential to create significant productivity improvements for Australian growers. Dairy contributes $2.2 billion to the total gross value of Australia’s irrigated agriculture production (ABS 2017).

Competitive advantage over current products (value proposition):
A comparison of yield prediction technologies is shown below.
<table>
<thead>
<tr>
<th>Product</th>
<th>Operation</th>
<th>Commercial sensor cost</th>
<th>Accuracy</th>
<th>Spatial resolution</th>
<th>Temporal resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rule of thumb</td>
<td>Agronomist assesses crop throughout season with weather forecasts</td>
<td>Labour for crop assessment</td>
<td>Variable</td>
<td>Area covered by agronomist</td>
<td>Weekly</td>
</tr>
<tr>
<td>Remote sensing with machine learning model</td>
<td>Model developed using final yield data and satellite imagery</td>
<td>Free if NDVI or red edge used, if more frequent data required, $2000 per image</td>
<td>Reported errors of 33%</td>
<td>10 m²</td>
<td>Every 5 to 10 days depending on cloud cover</td>
</tr>
<tr>
<td>Process-based model</td>
<td>OZCOT model calibrated using in-season weather, soil and crop information</td>
<td>Commercial UAV $2500</td>
<td>10%</td>
<td>1 m²</td>
<td>Weekly</td>
</tr>
</tbody>
</table>

A study in 2006 showed that 94% of irrigated cotton growers and 69% of dryland cotton growers used forward markets as a price risk management strategy as a defence against changes in commodity prices and exchange rates (Ada et al. 2006). Over 20 years until the 2014 Australian cotton season, cotton prices have traded between $380 and $520 per bale (a $140 difference). If the sale of the cotton at the end of the season was at the bottom of the market the grower could market another thousand bales if predicted yield was known, then there could be up to $140 000 additional profit to the grower.

**Technology readiness level:**
Machine vision systems have been developed for processing images and online data with national trials conducted in cotton crops over two seasons. As part of the funded Smarter Irrigation for Profit project, evaluations will be conducted for the pasture growth prediction. For the cotton yield prediction, a licence for use of OZCOT model should be investigated, or a replacement AI model should be developed. The online software platform will also be updated to enable use by multiple users.

**IP position:**
VARIwise computer code for yield prediction, including imagery ingestion from drones and cameras, weather sources, and field sensors. VARIwise for yield prediction has the following features:
- data input of in-field spatial variability of soil moisture and plant growth;
- incorporation of simulated responses/predictions of crop response from crop models;

This system builds on concepts and algorithms that have been published in other subject areas and have then been adapted and parameterised for the crops identified, e.g. cotton. There is significant know-how and expertise within the team that would make it difficult and time consuming for another company to replicate.

Software developed as part of this program is protected by copyright of the software code and through encryption of the program.

**References**
D  Technology title:
Furrow irrigation advance sensors and SISCO optimisation for manual control of irrigation and remote control of automated gates.

Industry problem:
The irrigation performance of most surface irrigation in the Australian cotton, sugarcane and dairy industries is entirely dependent on the timely attendance of on-farm personnel to cut-off irrigation flow into the field. Traditionally, very few surface irrigation events are measured in an objective manner to determine the current irrigation performance (application efficiency and uniformity), despite a good understanding of the principal need for measurement to understand current performance, and to thereby improve it.

Optimisation of over 700 furrow irrigation events by consultants in the cotton industry over the last fifteen years using USQ’s IrriMATE technology has shown that an average of 15% (range of 5% to 40%) of the irrigation water applied in traditionally managed furrow irrigation systems can be saved in each irrigation event. This water is available for use elsewhere on the farm for further crop production, for additional irrigations in each field in seasons with limited water availability, or for opportunistic temporary sale in that season.

The common misconception with furrow irrigation is that inflow to the field can be terminated immediately after water reaches the end of the field. This is the likely approach taken by alternative end of row sensor technologies, which do not have the functionality to simulate the hydraulics of the irrigation system. While this practice can sometimes lead to improved application efficiencies, there is no guarantee that events managed in this way will be capable of replenishing the soil water deficit down the length of the field, running the risk of under irrigation of the crop. With suitable criteria defined by the grower, an IrriMATE style analysis can reliably determine the optimal cut-off time to achieve the desired level of application efficiency and irrigation adequacy.

The furrow irrigation of sugarcane in the Burdekin, and increasingly in other sugarcane growing regions is facing pressure to reduce off farm drainage of nutrients and pesticide residues. Such issues are dealt with by greater control of runoff through pumped tail-water recovery, or runoff minimisation using optimised cut-off times.

Optimal surface irrigation event management in dairy pasture systems using high-flow automated water delivery systems requires very accurate control over the duration of irrigation in-flow to limit water recycling costs and nutrient removal.

USQ has led substantial research and development on furrow irrigation optimisation for over 25 years, is recognised globally for our technological advances in simulating furrow irrigation with SISCO (Gillies and Smith, 2015), has previously developed and supported the commercial measurement and modelling system known as IrriMATE, and has been awarded the highest national recognition by the Australian Research Council for Industry Engagement and Impact in 2018. Consultant use of the IrriMATE measurement and optimisation technique has fallen away in recent years, with expensive manual data collection techniques, aging measurement technology, and a limitation for asynchronous optimisation, all regularly cited as key limitations.

In addition, the opportunity to use any irrigation water saved through optimisation of flowrates and cut-off times in surface irrigation for further crop production, reducing pump operation and energy costs for water supply and recycling, and reducing expensive nutrient leaching and runoff, all support a continued need for surface irrigation optimisation with systems such as IrriMATE.

Automated surface irrigation gate control technology has been commercially deployed in Australia for over ten years, and this mature remote control technology is slowing being taken up by the cotton and sugarcane industries following extensive deployment in the irrigated dairy pasture sector. None of these remote control technologies take advantage of existing surface irrigation optimisation systems.

Technology solution:
USQ-CAE has developed SISCOWeb software for automated server operation, and novel sensors for delivery of in-field advance data, to provide automated synchronous surface irrigation event optimisation.
Two separate but related commercialisation opportunities are now available based on these developments:

1. Irrigation advance sensors and SMS notification system to deliver SISCOWeb optimisation to irrigation event managers for manual control; and
2. Integration of SISCOWeb API into the wide range of existing commercial automated surface irrigation gate control systems.

The following data sources are obtained automatically for analysis by SISCOWeb to synchronously optimise each surface irrigation event with SMS notification for irrigation managers, and these are: (i) water advance data in each irrigation event from Taggle IrriMATE advance sensors; (ii) flowrate per unit field width during the irrigation event (technology available); (iii) fixed field constants, once a season, for parameterisation of SISCOWeb; and (iv) the mobile phone numbers of irrigation managers for TagAlert SMS notifications.

**Target market:**
The initial target market, the Australian Cotton Industry, normally has the highest gross value of irrigated agricultural production in New South Wales and Queensland ($1.2 billion and $915 million, respectively).

This surface irrigation optimisation technique has also been transferred from the cotton industry into the sugarcane and dairy pasture industries in the past with success, and has the potential to create significant productivity improvements for Australian irrigated growers. The Australian Dairy industry contributes $2.29 billion to the total gross value of Australia’s irrigated agriculture production.

**Competitive advantage over current products (value proposition):**
This automated synchronous surface irrigation optimisation technology has no commercially available competition.

There are a number of end-of-furrow advance sensors on the market that deliver simple information about when irrigation water reaches their position, but none have the complimentary connected capability to synchronously optimise and control irrigation gates for best surface irrigation performance.

**Technology readiness level:**
Components of this existing system have been in commercial use in our large commercial research trials over a number of summer seasons. As part of the current funded Smarter Irrigation for Profit 2 project, evaluations of the entire connected system of these components will be continued. Existing automation systems installed in the Sugar and Dairy industries represent a market where this technology could be retrofitted at minimal additional cost.

The Taggle IrriMATE advance sensors have been manufactured in production runs of up to 50 units at a time, and have now been deployed in multiple fields for the entire season length for the third summer cropping season. This technology has been proven to be robust enough to transmit from the soil surface under fully irrigated cotton crops, withstand inter-row cultivations, and be redeployed in three successive seasons in hot irrigated cotton fields for five(5) months per season.

The server based TagAlert SMS notification system has been deployed over the last two summer seasons for cotton trials, and has proven to be highly valuable for growers and researchers involved in monitoring individual irrigation events. TagAlert allows users to gather the GPS coordinates of each advance sensor and configure SMS alerts. The position and status of each sensor is then displayed on Google Earth.

Trials of SISCOWeb deployments on commercial servers (Azure & AWS) have been completed over the last twelve months, with verification of the SISCOWeb model performance using field data sets from previous seasons.

The estimated cost of this furrow irrigation optimisation system is $50/ha for a grower to manage 250 ha, assuming sensors are deployed using access to an existing communication network, and existing surface irrigation gate controllers.

**IP position:**
SISCOWeb model to optimise furrow irrigation in real time and TagAlert server deployments, and Taggle IrriMATE advance sensors, combined for surface irrigation optimisation. Systems have the following features:

- automated surface irrigation data capture, transmission to server, ingestion, and synchronous optimisation by SISCOWeb;
- delivery of SMS notifications for manual control of irrigation inflow for optimal surface irrigation performance; and
- delivery of control over surface irrigation gates to stop irrigation inflow for optimal surface irrigation performance.

This system builds on concepts and algorithms that have been published previously in peer-reviewed literature. There is significant know-how and expertise within the team that would make it difficult and time consuming for any other company to replicate.

Software developed as part of this program is protected by copyright of the software code, and through encryption of the code beyond the current server based deployment.

References:

# Confidentiality Agreement (mutual)

## PARTIES

| USQ | The University of Southern Queensland ABN 40 234 732 081, a body corporate established pursuant to the provisions of the University of Southern Queensland Act 1998 of West Street, Toowoomba, Queensland, Australia, 4350 |
| CRDC | The Cotton Research and Development Corporation ABN 71 054 238 316, a body corporate operating under the Primary Industries Research and Development Act 1989 (PIRD Act), of 2 Lloyd Street, Narrabri, NSW, Australia 2390 |
| Party 3 | [insert name] ABN [insert] of [address] |

## DETAILS

| Commencement Date | The date this agreement is signed by the third of the parties. |
| Confidential Information | [insert] |
| Permitted Purpose | To assess the Confidential Information in regards to the Project with a view to obtaining access to technology from the Rural Research and development for Profit (RRDP) research program “Smarter Irrigation” |
| Project | Rural Research and development for Profit (RRDP) research program “Smarter Irrigation” |

## SIGNATURES

| USQ | Signed for and on behalf of by: |
| Signature: |  |
| Name: |  |
| Date: |  |

| CRDC | Signed for and on behalf of by: |
| Signature: |  |
| Name: |  |
| Date: |  |

| Party 3 | Signed for and on behalf of by: |
| Signature: |  |
| Name: |  |
| Date: |  |
Background

A. Each party may have in the past provided and may in the future provide the Recipient with Confidential Information.

B. Each party acknowledges that the other party’s Confidential Information has a unique value, including as the basis of applications for patents, and that the other party will be prejudiced by any unauthorised use or disclosure of the Confidential Information, including being precluded from being granted patents, and may suffer loss or damage as a result of unauthorised disclosure or unauthorised use of the Confidential Information.

C. Each party agrees to keep the Confidential Information of the other party confidential and to use or disclose the Confidential Information only as permitted by this agreement.

Terms

1 Definitions and Interpretation

1.1 In this agreement:

Commencement Date means the date this agreement is signed by the second of the parties.

Confidential Information means the description provided above and incorporates the following, whether or not in material or permanently recordable form:

(a) all information already disclosed or to be disclosed or made available by a party to the other party in connection with the Project;

(b) any patent applications or specifications for the patent, patentable invention or concept;

(c) that part of all notes and other records prepared by the Recipient or the Discloser based on, or incorporating, the Confidential Information;

(d) all copies, records and notes of any Confidential Information.

Intellectual Property Rights means all industrial and intellectual property rights, both in Australia and throughout the world, and includes any copyright, moral right, patent, registered or unregistered trade mark, registered or unregistered design, registered or unregistered plant breeder’s right, trade secret, knowhow, right in relation to semiconductors and circuit layouts, trade or business or company name, indication or source or appellation of origin or other proprietary right, or right of registration of such rights.

Permitted Purpose means the permitted purpose specified in the Details.

Project means the project specified in the Details.

2 Disclosure and use of Confidential Information

2.1 Each party must:

(a) keep the Confidential Information in strict confidence and only use the Confidential Information for the Permitted Purpose;

(b) not disclose, or cause or permit the disclosure of, the Confidential Information of the other party, except with the other party’s prior written consent;

(c) not make use of the Confidential Information to the other party’s commercial, financial or competitive disadvantage; and

(d) not reproduce any Confidential Information, except with the other party’s prior written consent.

2.2 The obligations of confidence in clause 2.1 do not apply to the extent that Confidential Information:

(a) is required to be disclosed by applicable law, or under compulsion of law by a court or government agency, as long as:
Outputs from RRDP part I
Invitation to participate

(i) the party discloses the minimum amount of Confidential Information required to satisfy the law; and
(ii) before disclosing any information, gives all available notice to the other party to allow the other party to legally challenge the required disclosure and takes all available steps (whether required by the other party or not) to maintain such Confidential Information in confidence; or

(b) is in the public domain otherwise than as a result of a breach of this agreement or other obligation of confidence.

2.3 If a party discloses Confidential Information as permitted under this agreement, the other party must ensure that the person to whom the Confidential Information is disclosed keeps the Confidential Information in strict confidence and enters into a confidentiality agreement on terms no less favourable to the disclosing party than the terms of this agreement.

2.4 Each party acknowledges and agrees that:
(a) the other party makes no representations or warranties as to the accuracy or completeness of the Confidential Information;
(b) the Confidential Information may be inaccurate or incomplete; and
(c) the other party is not liable for any loss or damage however caused (including by the negligence of the other party) suffered or incurred by the party in connection with the Confidential Information or this agreement.

2.5 Each party acknowledges that:
(a) the other party may suffer financial and other loss and damage if any unauthorised act occurs in relation to Confidential Information of the other party, and that monetary damages would be an insufficient remedy; and
(b) in addition to any other remedy available at law or in equity, the other party is entitled to injunctive relief to prevent a breach of, and to compel specific performance of this clause 2.

3 Intellectual property

3.1 Each party acknowledges that:
(a) as between the parties, each party owns, or legally entitled to, and retains the Intellectual Property Rights in and in connection with the Confidential Information; and
(b) nothing in this agreement is intended to give the other party any Intellectual Property Rights or other rights in or in connection with the Confidential Information.

4 Return or destruction

4.1 If requested by a party, the other party’s right to use the Confidential Information ceases and the Recipient must immediately, at the party’s sole option:
(a) return to the party; or
(b) destroy,
all Confidential Information.

5 Capacity Warranties

5.1 Each party represents and warrants, and it is a condition of this agreement, that the Recipient
Outputs from RRDP part I
Invitation to participate

has full power and authority to enter into and perform its obligations under this agreement.

6 Term and termination
6.1 This agreement commences on the Commencement Date and continues until terminated in accordance with this clause 6.
6.2 If a party commits a material breach of this agreement then the other party may terminate this agreement by notice to that party in which case this agreement will terminate immediately.
6.3 On termination of this agreement accrued rights or remedies of a party are not affected.
6.4 Termination of this agreement will not affect clauses 2, 4 and 6.3 or any provision of this agreement which is expressly or by implication intended to come into force or continue on or after the termination.
6.5 Notwithstanding clause 6.4, the obligations under clause 2 of this deed survive for a period of 3 years after termination of this agreement.

7 General
7.1 The laws of Queensland, Australia govern this agreement.
7.2 Each party irrevocably submits to the non-exclusive jurisdiction of the courts of Queensland, Australia and courts competent to hear appeals from those courts.
7.3 Each party must not assign, in whole or in part, or novate that party’s rights and obligations under this agreement without the prior written consent of other party.
7.4 A clause or part of a clause of this agreement that is illegal or unenforceable may be severed from this agreement and the remaining clauses or parts of the clause of this agreement continue in force.
7.5 This agreement supersedes all previous agreements about its subject matter. This agreement embodies the entire agreement between the parties.
7.6 This agreement will be validly executed if signed in any number of counterparts and the counterparts taken together constitute one agreement.