Project Catalyst Trial Report

Wireless Moisture Sensors

Grower Information	
Grower Name:	Willy Lucas
Entity Name:	LUCAS WB
Trial Farm No/Name:	BKN-01492A
Mill Area:	Pioneer
Total Farm Area ha:	48.41
No. Years Farming:	
Trial Subdistrict:	Home Hill
Area under Cane ha:	48

Trial Status
• Completed.

Background Information

Aim:
This project aims develop a low cost wirelesss moisture sensor that can be installed in the middle of a canefield and transmit wirelessly back to a basestation which will then display values on a website. There will be one sensor placed in each individual paddock of a farm, and the data will be displayed on the Farmacist Connect website colour coded by KPA values allowing grower to determine areas of moisture stress in a paddock.

Background: (Rationale for why this might work)
There is currently many growers that are irrigating in a way that is not using scheduling tools but instead are using a 7 day cycle regardless of the level of stress that the cane may be under. If we can develop a low cost tool that will monitor moisture in the paddock to give real time data to allow a grower to understand his crop needs, we may be able to reduce the amount of water applied to a paddock and therefore the amount of runoff produced. This will also enable us to determine which paddocks are driest when it comes times to harvest, along with which paddocks will need irrigating first after a rainfall event.

Potential Water Quality Benefit:
If water can be applied in accordance with the crops needs as opposed to a 7 day cycle, there is the potential for applying a reduced total volume of water for the duration of the crop. The can lead to the potential for reduced runoff and more optimised irrigation efficiency.

Expected Outcome of Trial:
The expected outcome is that growers will be able to use this technology to irrigate efficiently, allowing irrigation scheduling, irrigation drydown preparation along with scheduling after irrigation events. Can also be used to determine how fast or slow irrigation events will occur.

Service provider contact: Farmacist

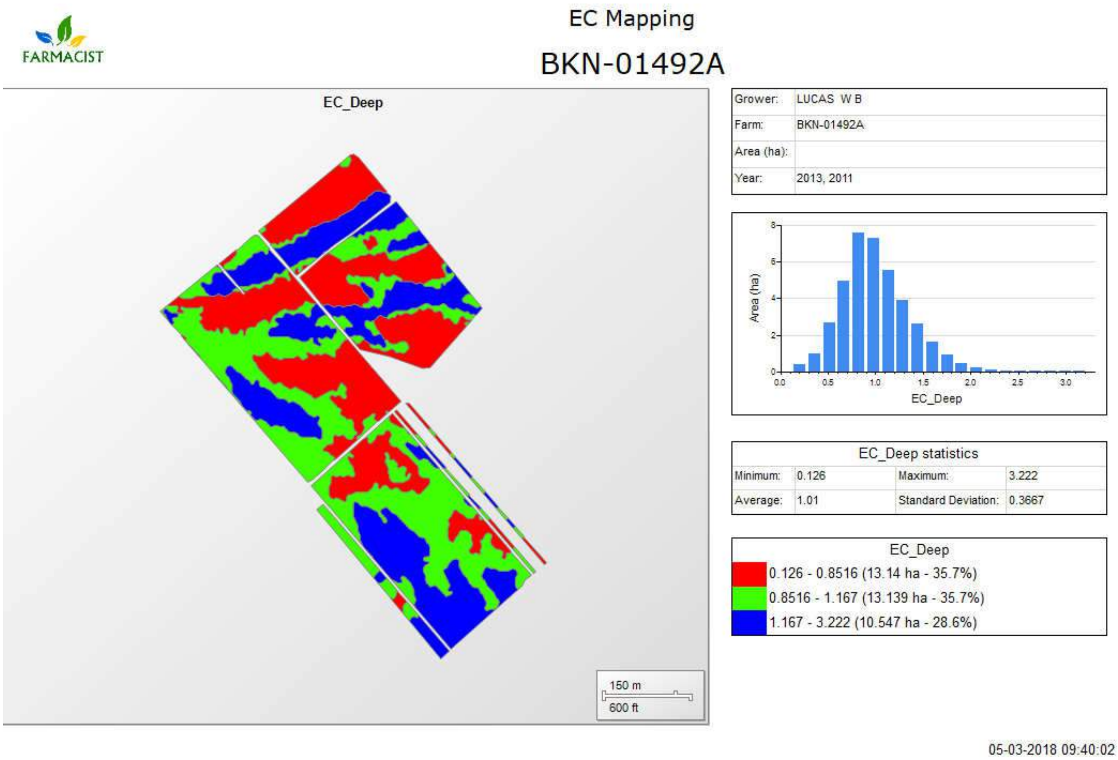
Where did this idea come from: Advisor

Plan - Project Activities	Date : (mth/year to be undertaken)	Activities :(breakdown of each activity for each stage)
Stage 1	**November/ December 2016**	• Trial Plans and direction will be developed
Stage 2	**January- December 2017**	• Development of a prototype moisture sensor
Stage 3	**January 2018 – October 2018**	• Testing of prototype sensor, update prototype based on findings • Software setup for data display
Stage 4	**October 2018 – May 2019**	• Installation of sensors on farm one • Monitoring of data and calibration against field conditions.
Stage 5	**May 2019 - December 2019**	• Installation of sensors on farm two. • Monitoring of data and calibration against field conditions.
Stage 6	**December 2019**	• Final Reports

Project Trial site details	
Trial Crop:	Sugarcane
Variety: Rat/Plt:	Multiple paddocks.
Trial Block No/Name:	All paddocks on farm BKN-01492A
Trial Block Size Ha:	48
Trial Block Position (GPS):	147.351584, -19.710262
Soil Type:	BUfc

Block History, Trial Design:

Paddock has been previously EC mapped during the years of 2011-2013 and soil types distinguished across the vast majority of the farm.



Moisture Sensor Rollout

Data will be configured to use a radio from the taggle network to send data back through to the Farmacist Application where it will be easily accessible and viewable to the grower.

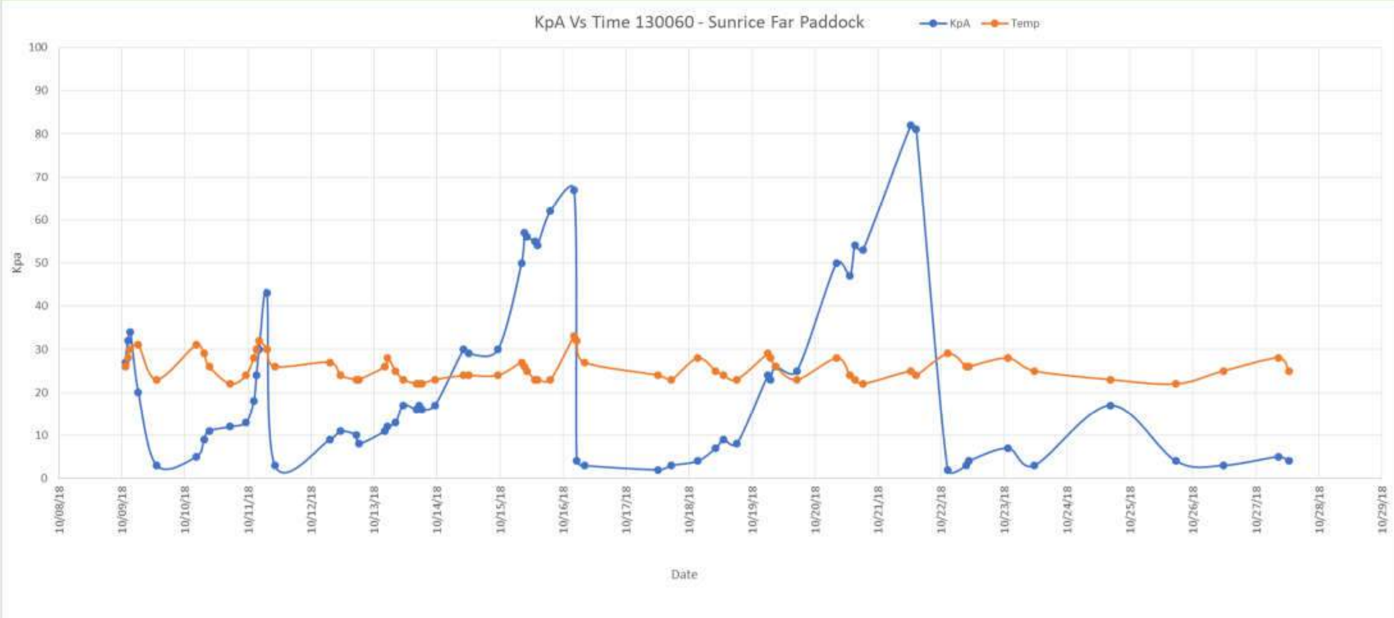
Results:

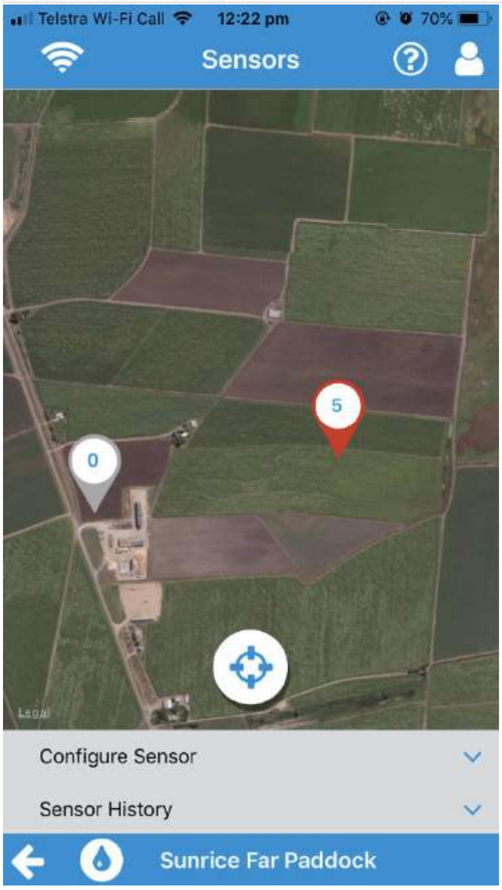
As of March 2018, prototype sensors have been developed and installed for testing at Willy Lucas'. This allowed us to identify a range of issues that needed to be overcome to allow the sensors to work correctly in field conditions. The sensors were then removed, modified and reinstalled in pot trials which enabled us to test the sensors more accurately with more standardised conditions.
Small modifications were made and once confidence was gained in the data they were moved back out on farm for further testing.
Farmacist connect was configured and data is now transmitting from the selected farm back to the website for viewing individual readings and graphing the respective data.
Version 2 of the moisture sensor is planned for development which adds slightly more features and makes some small adjustments on the componentry.

Steps further will include more software development to allow the paddocks on farm to change colours based on the readings of the sensors to indicate whether it is wet or dry in a visual way.
Continual updating of the sensor with the potential to add in a second gypsum block to enable measurement of soil water content at two different depths.
A phone app is also planned which will allow growers to visualise on their phone the relative moisture content of the soil.

Update November 2018:
Since the last update in March 2018, the wireless Moisture sensor has been developed quite substantially. We are now fully confident in the readings that it is providing us with version 2 of the sensor proving to be a success. Housing for the electrical components has also been finalised. Two sensors have been set up on the sunrice farm in different paddocks with both moisture and temperature wirelessly logging back to our server through the taggle network. The data is currently going through a verification process to ensure it is aligned with conventional irrigation scheduling tools such as a G-DOT.

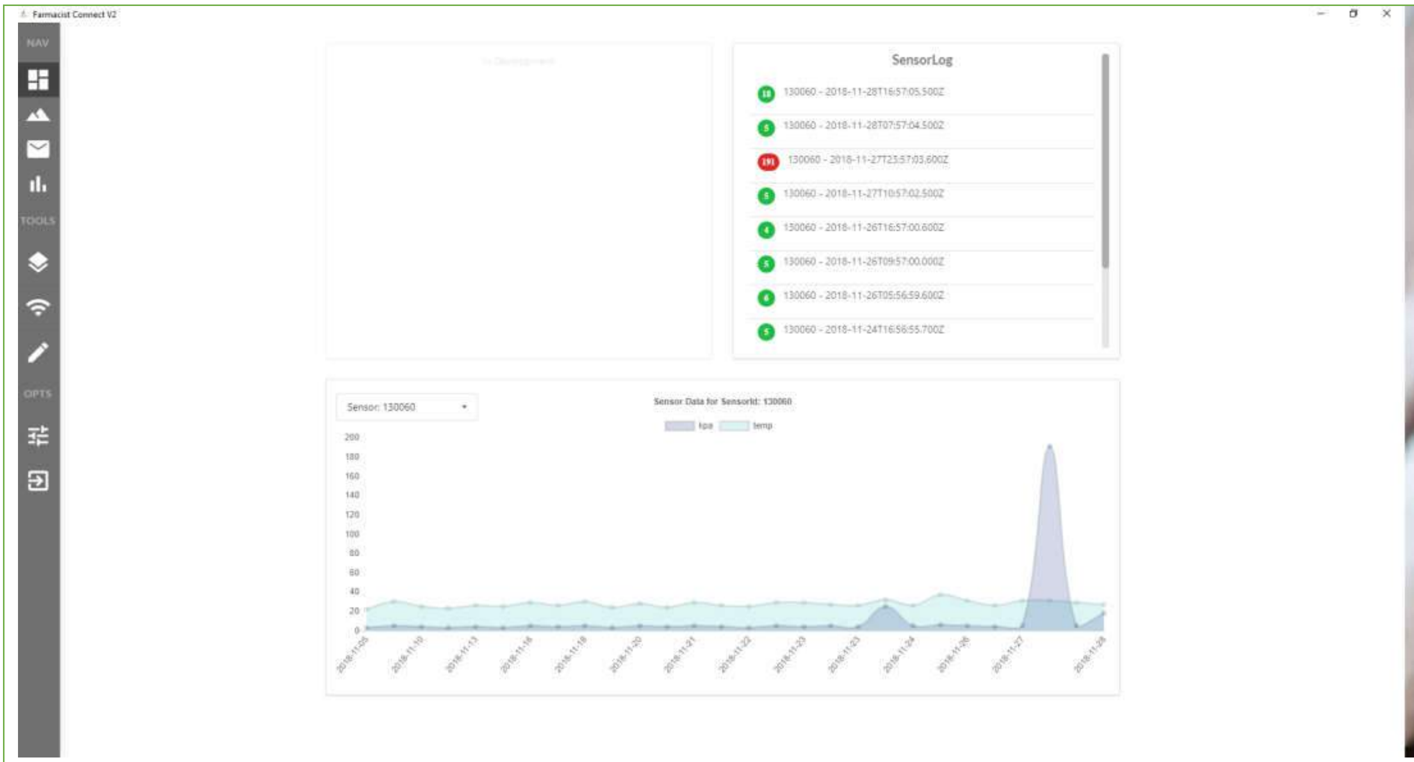
The below image is from a paddock at sunrice that is currently growing rice. It shows exact wetting and drying cycles that are happening within the paddock, with some of the drier times due to spraying events. The temperature shows small fluctuations but considering the depth of install at 10cm this is to be expected.



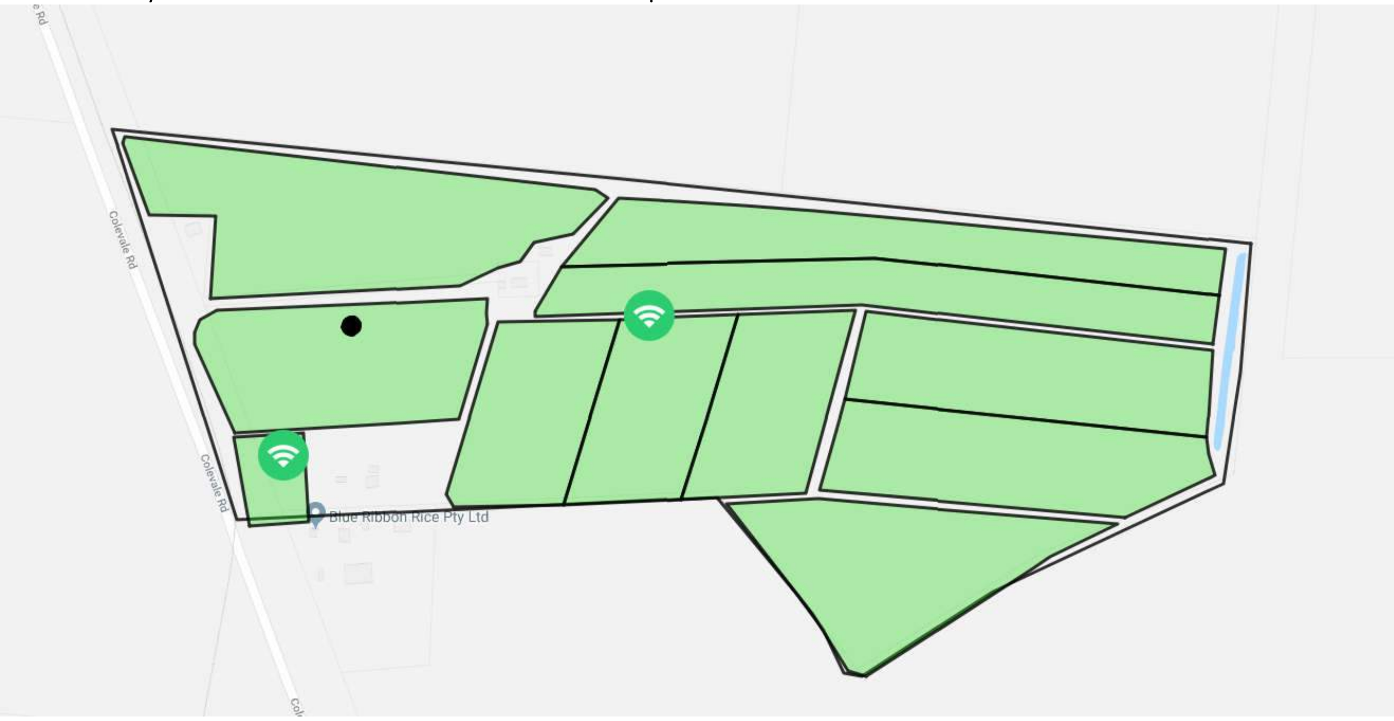


The sensors have been set up in the Farmacist Application to allow the grower to see live KPA on their phone as per example above. This is still in the development phase, with the display of the KPA being first step. Second step will be to display the data via coloured polygon.

A desktop computer program has also been created to allow growers to login and see a live moisture graph from there computer. This allows them to select the sensor that they want and view a graph over a select period of time.

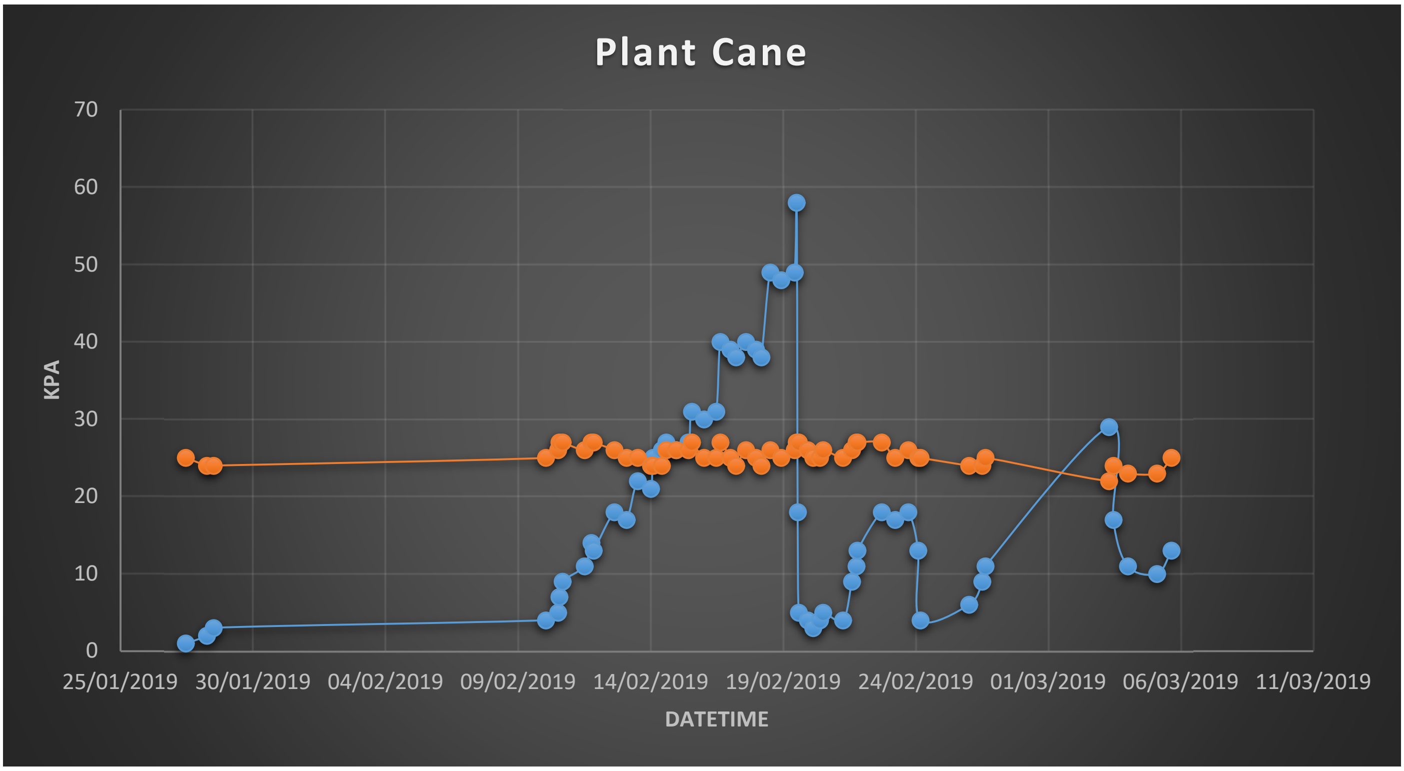


It also allows you to see the location of the sensors via a map



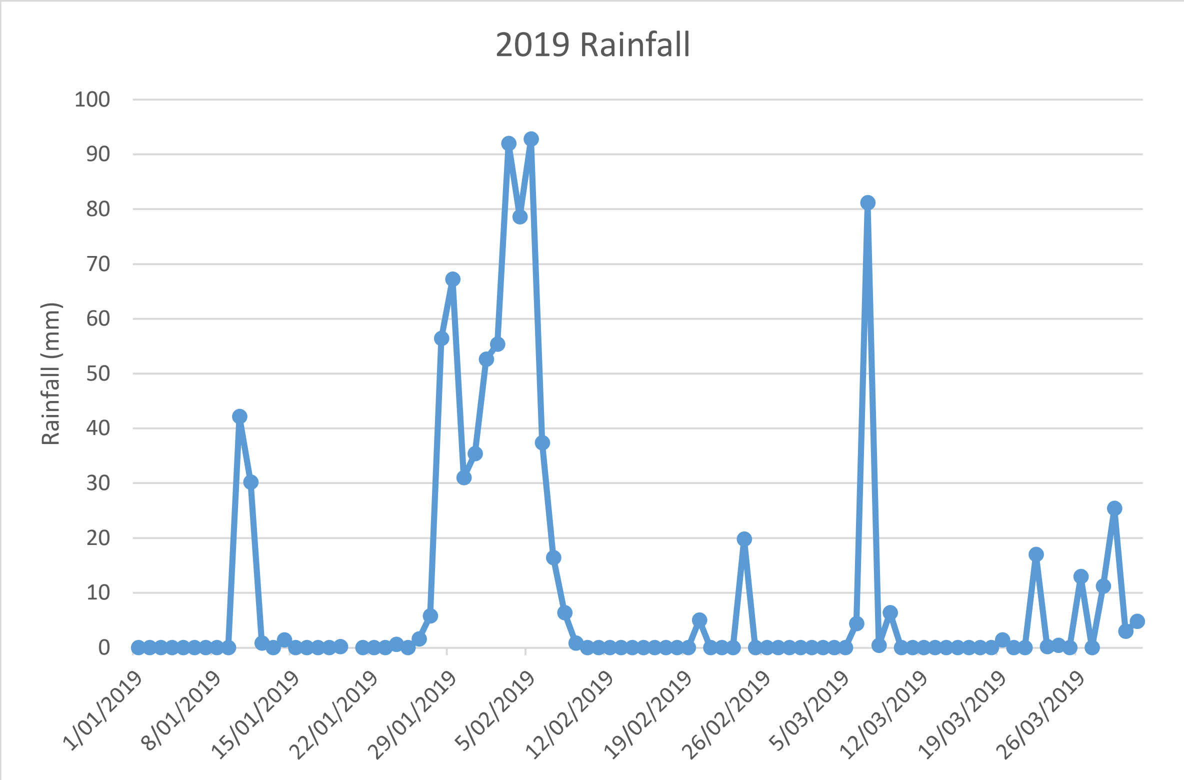
And by clicking on the sensor you are then able to see the kPa of the device.

10 more sensors are now in production with an added feature which adds the user the ability to put the sensor in test mode, removing the need to open the housing when testing. Once these 10 are built, 5 will make their way to sunrice to complete the project out there with continued monitoring over the next 6 months.
The other 5 will be installed on Willy's farm to begin monitoring in small ratoon cane.



The above graph shows the recent data from 1 of 4 sensors installed on farm. Gathering data that shows the wetting up and drying down cycles of an irrigated cane crop has been difficult due to the high amount of rainfall that we have received in ayr since Jan 2019 (See below). The signal strength of the sensors has been a major issue throughout the process and installation into the large cane proved difficult. The antenna was installed on a bamboo that was approximately 5mtrs tall. This was to ensure that the signal was able to reach the closest base station.

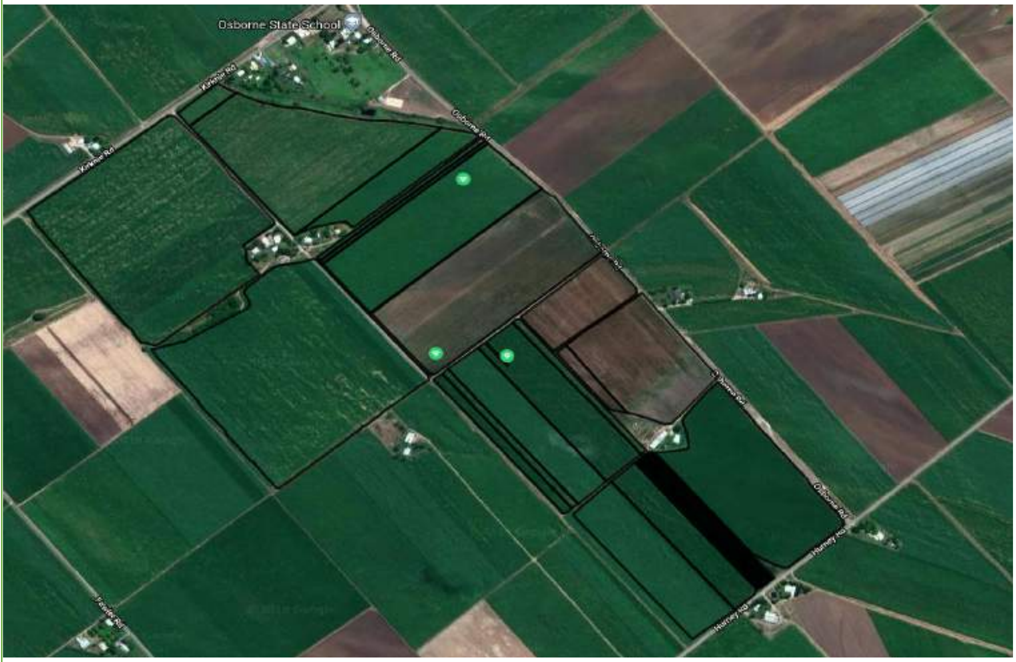
Despite our best efforts in securing this is was still difficult to maintain this during the lodging of the cane and it was only just tall enough to get through to the top of the canopy.



The website that is hosting the data- Farmacist Connect has had minor improvements to stability and viewing of the data since the last update. The below image shows the updated locations of the sensors that are installed on Willy's farm. Two sensors were installed into soybean paddocks whilst two were installed into plant cane.

The next steps for this innovation project is to continue gathering data to support the correct functioning of these devices and look into investigating the potential to use 3G signal coverage as opposed to radio coverage. It was noticed that whilst in the cane full service was accessed on the mobile phones even while very low in the crop canopy. Telstra have also just realeased their IOT package which allows for the lost cost of sensors to be produced using the Telstra network. Parts have been ordered to set this up for a test case to understand the technology and understand its suitability to the project.

PROJECT CATALYST

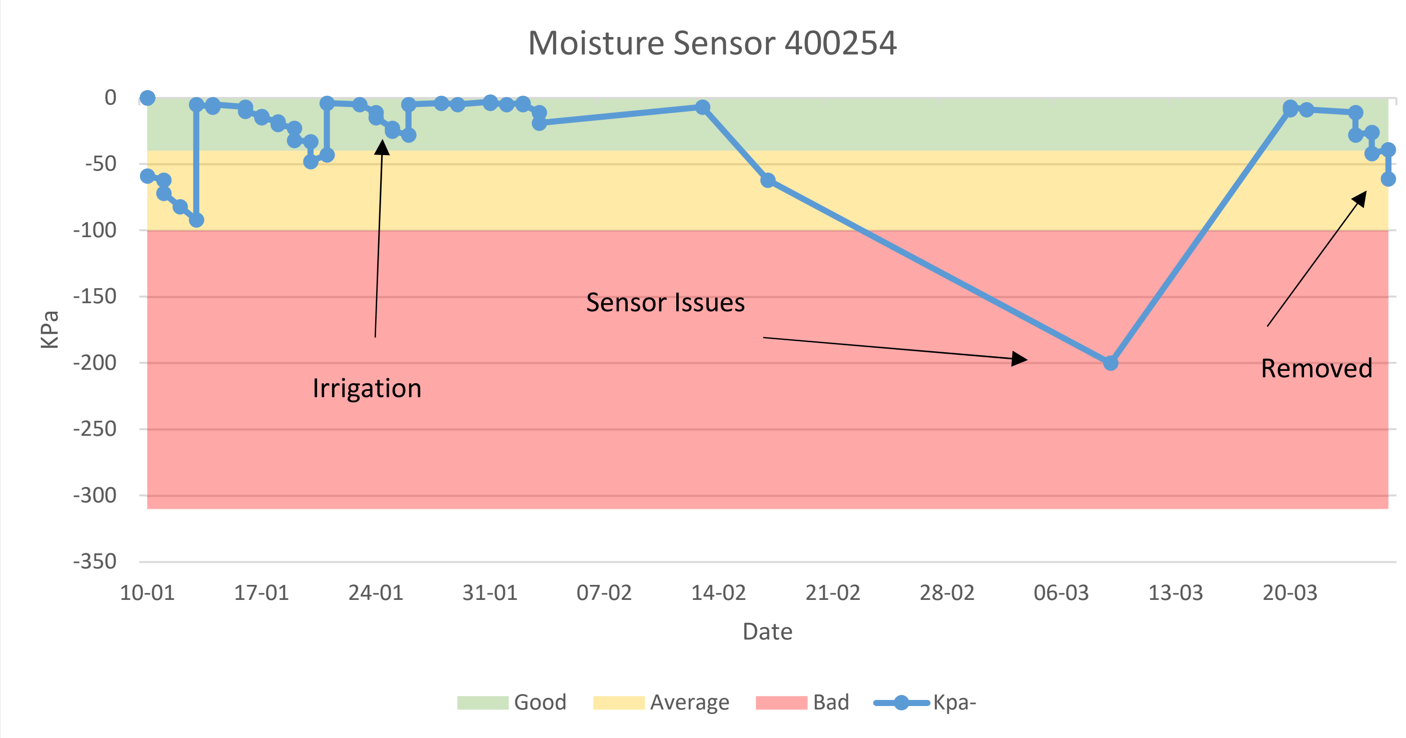


Over the last 6 months significant development has taken place investigating the 3G potential of the sensors. Telstra was investigated as an option however Telstra is a relatively closed network and they were unwilling to accept these moisture sensors onto the network. Alternatively, Hologram an international IOT communications company had sims easily accessible and available for testing. These sim cards connect to the Telstra network, with the option of also connecting to the optus and vodaphone networks. Initial testing showed that using 3G coverage vastly increased communication potential of the moisture sensors through the cane canopy. It is now possible to get signal with a small antenna siting at ground level in admist cane canopy.

Production continued with the focus on now adapting and developing the moisture sensor to work with the new power demands of the 3G components and finding antennas that were optimised for the bandwidth.

3G sensors were installed onto willy's farm for reliability testing throughout a crop of soybeans.

The graph below shows a subset of the data that was collected.

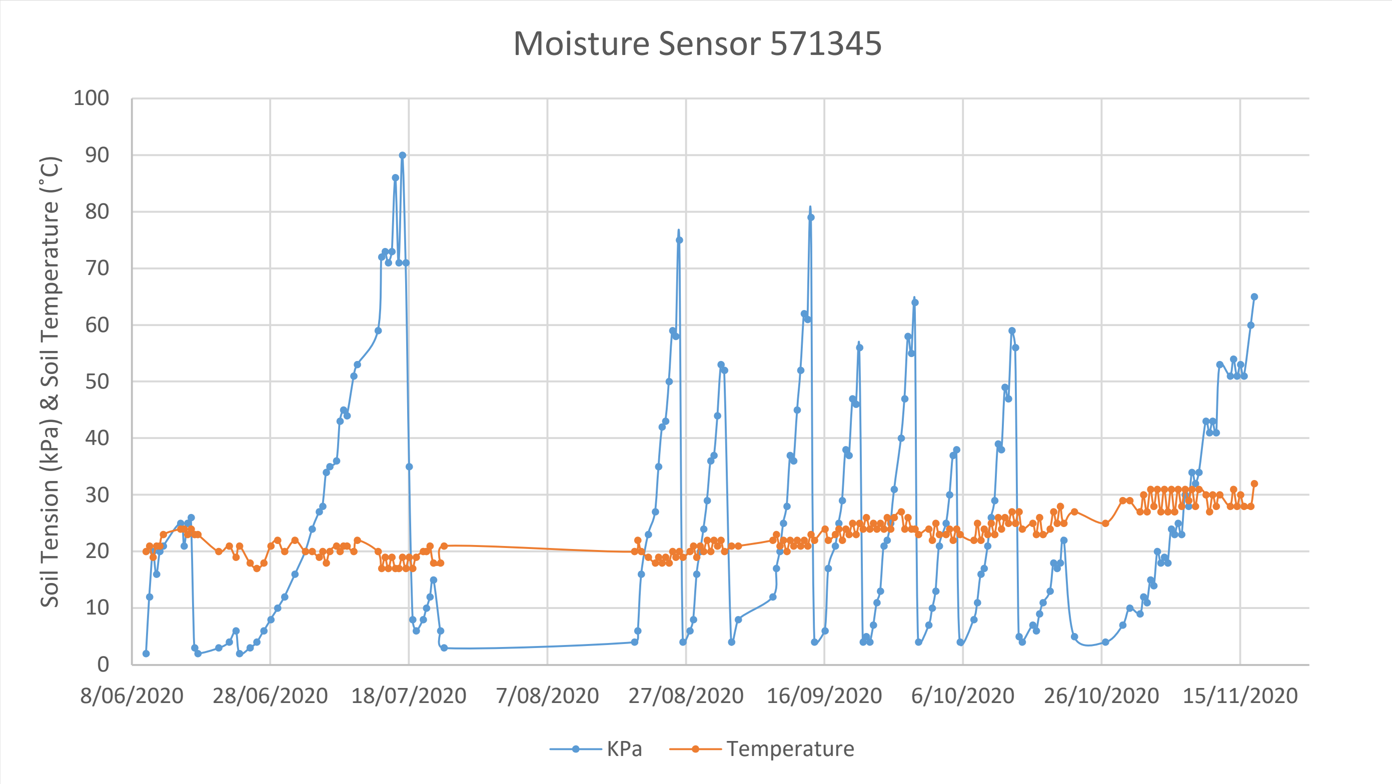


The sensor, while having a few power consumption issues worked reasonably reliable throughout the season. The moisture values that were returned showed correct patterns of paddock wetting and drying throughout the soybean crop. The design of the moisture sensor has being once again more refined to include a testing button on the outside of the box to enable any user of the device to trigger sending a moisture reading to the network at any given time without having to open the box. This is in line with moving the sensors to more of a commercial solution. In line with other non catalyst related projects, these moisture sensors were installed on 5 other farms and tested for reliability and accuracy. There was good grower feedback and the data that was returing was reliable.

The next steps of this project include further refinement and installation of sensor on each one of willy's paddocks at the rifle range farm and on each paddock at Peter McDonnell's sunrice farm in line with their freshly planted cane. Data monitoring can then occur from June throughout the crop cycle hopefully through to harvest the following year to test the sensors over a long period of time.

2021 Results

The table below depicts 12 months of data from one of the sensors installed at Willy Lucas' farm:



The above graph clearly depicts the when irrigations have been applied. As the soil dries out, and soil tension increases (shown by the rise in kPa) until an irrigation is applied. After said irrigation, the soil tension drops back to low numbers, indicating that water has soaked across to, and saturated, the gypsum block. This data provides a good start to irrigation record keeping as it shows the time of irrigation in response to soil moisture (tension).

As the moisture sensors have worked quite well in the recent delivery it would beg the question whether this technology could be adopted to the broader community. The biggest issue with sensors is not the sensor itself but rather the scenario they are being utilized in. Cane is a tall, leafy crop that is prone to lodging and gets harvested annually, all things that make placing a retrievable sensor in the middle of a difficult situation. As the crop grows and develops its canopy it starts to engulf the area surrounding the sensor and although mobile signal can penetrate a dense canopy, we have a battery-operated sensor where the primary goal is to conserve battery consumption of the ever-hungry cellular module. As a combination of both situations, you get a diminished signal that is likely to not make it to a cell tower and although this does work most of the time it reduces the reliability to a point where it would be hard to have unwavering confidence in the device. On-top of all this we have the additional facts that the crop, lodges and gets harvested annually meaning the device would need to be stood back up (in case of lodging) or retrieved from a potentially hard to access location, such as the middle of the paddock which was the original intention of these sensors. Lastly, is maintenance. Small electronics in the field is how the industry is going forward but with a small device in an environment as harsh as this its likely you would need a maintenance team to constantly manage sensors, battery replacements, installation, removal and troubleshooting. This drastically reduces the feasibility, all these factors would have to be heavily considered before taking this any further.

Conclusions and comments

Advantages of this Practice Change:
It is very useful for irrigation scheduling. The grower sees potentially more benefit for growers that are new to the region or cane farming in general. As in-experienced growers could use the sensors to develop an understanding of crop water requirements throughout the year, to aid in the development of their overall irrigation management. The grower also sees an opportunity for this type of technology to be adopted in areas where growers only have access to supplementary irrigation, to determine when the ideal time to irrigate may be throughout the growing season.

Disadvantages of this Practice Change:
As this technology is still being tested, the reliability is questionable because of the issues mentioned above. In order for the technology to be adopted growers need to have 100% confidence in the outputs and the timing of these outputs, as missing a single irrigation by more than a few days in a fully irrigated cane region can potentially lead to significant yield losses at harvest.

Ongoing maintenance is also an issue raised by the grower, as these sensors are not 'set and forget'. Ongoing maintenance and updates are required for the sensors to function correctly over the crop cycle and this needs to be considered in the adoption process.

Will you be using this practice in the future:
If a more reliable option was available to the grower, he would adopt the technology more broadly. As this was trialling new technology the reliability was not as consistent as an 'off-the-shelf' type product. More specifically the grower sees greater potential with this product in alternative crops with a high water demand such as rice.

% of farm you would be confident to use this practice:
40% or all fallow ground with alternative crops