Future Farming: the road to real-time remote on-farm monitoring

On-farm connectivity, IoT solutions, platform farm demonstrations

Case studies from the eConnected Grainbelt: WA IoT DecisionAg Grant Program

August 2020
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Introduction

In 2018 the Department of Primary Industry and Regional Development’s (DPIRD) eConnected Grainbelt project opened the WA Internet of Things (IoT) DecisionAg grant program. This initiative was designed to assist in overcoming challenges that remain with regards to on-farm connectivity.

The grant program launched in 2019 with $580,000 awarded in 15 projects to grower groups and agricultural schools/colleges to demonstrate on-farm connectivity options, remote on-farm monitoring IoT solutions and farm data displayed on a data platform.

The 15 projects have installed different types of technologies to facilitate practice change in the industry on 63 host-farm sites across the south west agricultural region of WA.

WA IoT DecisionAg grant project locations

The on-farm connectivity network solutions on host-farms installed include both low and high bandwidth technologies with Low Power Wide Area Networks (LPWAN) using the LoRaWAN, SigFox and CatM1 communication protocols, and higher bandwidth on-farm Wi-Fi networks and the 3G/4G mobile network.

A total of 232 IoT sensors and devices were installed on the host farms across the State with 16 different types of IoT sensors and devices including.

<table>
<thead>
<tr>
<th>42 Soil moisture probes</th>
<th>36 Rain gauges</th>
<th>24 Cameras</th>
<th>16 Weather stations</th>
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<tr>
<td>13 Water tank level</td>
<td>9 Frost</td>
<td>7 Soil pH</td>
<td>4 Saline soil moisture</td>
</tr>
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<td>3 Water flow</td>
<td>2 Electric fence</td>
<td>2 Fuel tank</td>
<td>2 Lick feeder level</td>
</tr>
<tr>
<td>2 Temperature</td>
<td>Spray tank level</td>
<td>Gate controller</td>
<td>Shed door</td>
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</table>
Details of the funded projects can be viewed at [WA IoT DecisionAg Grant Program](#) on the DPIRD website.

Listed below are the 13 groups that hosted an IoT project, with two of the groups hosting two projects each:

- Corrigin Farm Improvement Group (CFIG)
- Edmund Rice College
- Esperance Farm Training Centre: Esperance Senior High School
- Kiara College
- Lakes Information & Farming Technology (LIFT)
- Mingenew Irwin Group (MIG)
- Moore Catchment Council/Moora Miling Pasture Improvement Group
- South East Premium Wheat Growers Association (SEPWA)
- WA College of Agriculture Cunderdin
- WA College of Agriculture Morawa
- Yuna Farm Improvement Group (YFIG).
- Merredin and Districts Farm Improvement Group (MADFIG) – two projects
- Stirlings to Coast Farmers (SCF) – two projects.

Each of the projects developed a case study, intended to assist a wider audience to evaluate and build knowledge on the technologies installed by the projects to assist decision-making and support the change management process. This document is a compilation of the case studies completed to date.

Kari-Lee Falconer
WA IoT DecisionAg program leader
5 August 2020

**Project Partners**
Stirlings to Coast Famers – Smart Farm broadacre cropping demonstration

Phillip Honey, Smart Farm Co-ordinator, SCF

Snapshot

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<tr>
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<tr>
<td><strong>LoRaWAN:</strong></td>
<td>rain gauges, soil moisture probes</td>
</tr>
<tr>
<td><strong>Cellular:</strong></td>
<td>weather station, soil moisture probe</td>
</tr>
<tr>
<td><strong>Satellite</strong></td>
<td>rain gauges</td>
</tr>
</tbody>
</table>

**Dashboards:** Pairtree

Background

**Hosts:** Yaralla Pastoral Company, Adams family

**Location:** Woogenellup

**Enterprise:**

- 95% cropping, 5% livestock

**Management:** Family business

**Size:** 4700ha (arable)

**Existing Farm connectivity**

Satellite

**NBN, Telstra mobile broadband**

**Internet capacity:** 150GB mobile broadband; 22Mbps down, 2.15 Mbps up (satellite)

Background

Located in the Great Southern region of Western Australia, Yaralla Pastoral Co is a family-based farming operation with numerous properties stretching approximately 25 kilometres in width, within the Great Southern region of Western Australia. Predominantly grain cropping, the Adams family were looking for solutions that helped improve farm efficiencies through data, such as predictive weather forecasting, soil moisture monitoring, satellite and UAV plant health/pest monitoring and variable rate applications. For the Adams family, they found that the current lack of support to run and use IoT equipment, and reliability concerns were the biggest drivers for preventing AgTech adoption.

Installation

A range of suppliers and technologies were utilised on the Stirlings to Coast Famers’ (SCF) Cropping Demonstration Site. These included:

- LoRaWAN Remote Rain gauges from GoannaAg
- Satellite Remote Rain gauges from GoannaAg
- Custom Built Soil Moisture Probes and Rain gauges Stations built by Stirlings to Coast Farmers
- Weather stations with hyper-local forecasting services by DTN
- Remote Security Cameras by Axistech
- Point to Point WiFi system produced by Ubiquiti
- Mesh WiFi system produced by Ubiquiti
- LoRaWAN farm coverage by Laird Technologies and Stirlings to Coast Farmers
- Pairtree Intelligence for SCF soil probe data display
- Satellite imagery and virtual weather station service.
The complete IoT LoRaWAN network and sensors were built and installed by Stirlings to Coast Farmers; however, SCF recommends the use of a registered cabler for any network and cabling work. Stirlings to Coast Farmers implemented a full LoRaWAN based service at the main Yaralla property, utilising the existing Windmill as the foundation base for the gateway; maximising the overall LoRaWAN coverage across the property. SCF’s Smart Farm Coordinator Philip Honey developed the RF propagation maps, to help identify the potential locations of where stations could go, and what the potential coverage map looks like if the antenna height was increased/decreased.

Two remote rain gauges were installed eight and ten kilometres away from the gateway, to enable rainfall monitoring on the eastern and southern edges of the property, giving the Adams family a method of mapping rainfall distribution across the landscape.

Although they had successfully connected with the LoRaWAN gateway, they stopped working part-way through the season. The company that had sent them down is currently in the process of swapping the two units out for two new replacements, as well as delivering two recently developed satellite-based rain gauges.

These additional rain gauges will be installed on the most eastern property, where there currently is no LoRaWAN coverage. The rain gauges were easy to install, with no other requirements than a star-picket to sit on top-of, and a connected gateway.

One challenge that Stirlings to Coast Farmers noticed was that some sensors had difficulty connecting to the gateway at times. The generic ‘rubber ducky’ aerial on some stations provided coverage only up-to 5kms from the gateway. It is important to keep in mind that sensor stations do often have limitations built-in to minimise issues with interference with other sensor stations. Upgraded external antennas are one method of improving a connection.

According to the Adams family, the DTN weather station is the most used piece of IoT equipment, and quite often, they are looking at the current and forecasted decisions 2-3 times a day. Accurate weather forecasting has been of great benefit for managing spraying and spreading operations. The self-learning weather-stations appears to be correct in the prediction of maximum temperatures, and the accuracy of wind speeds is
improving each day as well. Fitted with a 15-day forecast, the DTN system provides grain-growers with a traffic-light (red, yellow, green) system for planning spray events, something the Adams family were looking forward to implementing and using this year for spray management. It’s a little too early currently to make management decisions based on soil moisture data yet, as the probe starts to settle towards field conditions, but the family look forward to utilising this data to better understand the moisture levels, especially towards the end of the year when it comes time to nutrient management decisions.

The Calculable, Immediate Benefits

The most visible immediate savings on-farm was the ability to monitor rainfall variation and record differences across the landscape. Currently, the Adams have five rain gauges scattered across the main property, with another two satellite-based systems currently in transit from the supplier (Goanna Ag). If the family were to collect rainfall recordings from these original five points manually, the return trip would take approximately 1 hour to complete 50km of travel on the gravel roads. Based on an average 1.5 trips per week across the year at $25.00/hr labour, and the average cost of rain gauges at $700/each (and average $100/year device fee), the system would net a potential five-year saving $17,010. These rain gauges would be effectively paid off with-in the first year, on the 68th trip out of the 78 visits in the first year.

Indicative pricing for equipment installed

<table>
<thead>
<tr>
<th>Item</th>
<th>Upfront cost</th>
<th>Ongoing cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTN Weather Station and Hyper-Local Weather Forecasting Package</td>
<td>$2,200</td>
<td>POA</td>
</tr>
<tr>
<td>Automatic Tipping Rain Gauges (LoRaWAN and Satellite)</td>
<td>$700*</td>
<td>$120</td>
</tr>
<tr>
<td>SCF Custom built 800mm Soil Probes and Remote Rain Gauges</td>
<td>$1500</td>
<td>$60</td>
</tr>
<tr>
<td>Ubiquiti Point to Point WiFi</td>
<td>$360</td>
<td>-</td>
</tr>
<tr>
<td>Ubiquiti Mesh WiFi System</td>
<td>$187-360</td>
<td>-</td>
</tr>
<tr>
<td>LoRaWAN Gateway + External Antenna + Cabling</td>
<td>$850</td>
<td>-</td>
</tr>
<tr>
<td>Customised PairTree Dashboard</td>
<td>POA</td>
<td>POA</td>
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</tbody>
</table>

Notes: Prices are subject to change and exclude GST. Please confirm pricing directly with manufacturer or reseller. * Pricing includes the first year of subscription

Key messages

The critical message to smart farm implementation is plan, plan, plan!

- Define what problems you are trying to solve first, and then identify the sensors that are needed to help achieve that: Can the problem be measured or managed by practice change? Will it boost farm productivity or quality, and improve overall efficiency?
- Identify what connectivity types are available in your region (Sigfox, LoRaWAN, Satellite or Cellular), and methods of creating a LoRaWAN network if required.
- It may be cheaper to implement cellular or satellite-based stations in remote areas where LoRaWAN coverage does not exist, for example.
- Calculate the costs of implementation, and compare it against the savings you could potentially make in time, travel and efficiency gains. There are quite a few technologies available that can create significant savings.
- Plan for future upgrades and additional equipment in upcoming budgets
- Start small and work out what works in your situation and what doesn’t. If you ever need help, there are resources and organisations to assist you.
- Consider your long-term goals, and how you would like to access your information when you’re all set up. Would you like all your data in one place?
- Undertake network planning activities and take the time to consider Gateway locations if you are self-hosting. Network propagation maps will help suggest “potential coverage” areas, and a great feel of what sort of coverage is possible if you vary your antenna height.
- Optimise your LoRaWAN gateway to ensure maximum efficiency and longevity. Protect it from the elements and use a high-quality low-loss cable with high-gain antennas.
- If you are developing your own LoRaWAN sensor systems, organisations such as Pairtree can aggregate your data and customise the presentation to suit your requirements.

To calculate the potential savings you could make from implementing remote rain-gauges or water level monitoring, please visit [https://bit.ly/smartfarmcalculator](https://bit.ly/smartfarmcalculator).

**More information**

- Contact Philip Honey, SCF Smart Farm Co-ordinator philip.honey@scfarmers.org.au
Moora Miling Pasture Improvement Group – LoRaWAN sensors for broadacre farm businesses
Michael Young, AgPro Management

Snapshot

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<td>Water tank level, soil moisture probes</td>
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Dashboard: MoteNet

Background

<table>
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<tr>
<th>Hosts: Gardiner family</th>
<th>Location: Moora-Miling</th>
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<tbody>
<tr>
<td><strong>Enterprise:</strong> Sheep (3500) and cropping</td>
<td><strong>Management:</strong> Family business</td>
</tr>
<tr>
<td><strong>Size:</strong> 1500ha crop</td>
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Key Points

- LoRaWAN sensors are independent of mobile networks and have a wide range of uses. In this project we use the sensors to monitor soil moisture, tank water level and weather condition.
- Key benefits outlined by producers in this project include, increased labour efficiency and greater peace of mind.
- The future of these sensors will include further labour saving and improved farm management decisions such as targeting of inputs.

Background and situation

The sensors were employed on a mixed enterprise broad acre farm in the Moora-Milling region of Western Australia. The farm has a mixed focus on sheep and cropping, running 3500 sheep and cropping 1500 hectares. The farm is family run, employing casual labour only for busy periods such as seeding and harvest. The farm is split over two blocks, the home block where the sensors were installed, has an undulating landscape with reasonable phone reception all over. The second block is over 60kms away with particularly poor reception.

Access to the internet is required for viewing the data recorded by these LoRaWAN sensors. Their house has a standard wireless Wi-Fi setup with an 80GB/month capacity. However, any method of internet access will work.

During the summer months the farmer checks livestock water tanks and troughs 3 times per week, to ensure that everything is operation smoothly and the sheep have enough water. Checking 10-20 troughs and tanks can take up to 5 hours each week. Replacing this simple monitoring task with sensors would save time, vehicle running expenses and provide constant piece of mind knowing the tanks and troughs have adequate water.

Installation

For this project Libelium’s agricultural sensors were installed on the home farm. These sensors use the LoRaWAN network, so they are independent of all mobile networks.
Over a flat landscape the sensors can transmit reading up to 15-20kms however, hills blocking the line of sight can reduce the transmission range by up to 50%.

The sensor module supports over 130 sensors probes, a full list can be found here. These sensors can be purchase as a ready-made product (see figure below) or the separate parts can be purchased separately and assembled, which is cheaper although it does requires extra know how. For this project, the sensor parts were purchased separately, assemble and installed by a consultant from Agpro Management. The parts were purchased from 'The IOT Store' located in Perth. Throughout the project three different sensor probes were tested:

- Soil moisture
- Weather station
- Distance sensor – used to monitor fuel bowser level and livestock water level.

The sensors are contained in weatherproof boxes and each sensor has a solar panel allowing the sensors to operate hassle free in the background. The sensors are programmable to take readings at specified intervals, currently set to every 5 minutes.

The data is sent an online platform accessible via the internet providing the user with live updates.

![Water Level Trends (by Percent Full)](image)

Figure 1 Dashboard showing water tank level

**Operation and decision making**

Feedback throughout the project indicated that using the distance sensor to monitor livestock water was the most practical with obvious benefits straight away. Although checking the tanks was still required it did reduce the trips from 3/week to 1/week. Additionally, we do see potential to use the soil moisture sensor and other soil monitoring sensors to improve targeting of inputs although we did not get to this point during the initial project.

Shortly after installing the sensors, the farmer was away in Perth for a few days, using the new system to monitor the tank levels. He noticed the water level in one of the tanks was dropping faster than usual. This turned out to be a burst pipe. Catching the
issue straight away saved thousands of litres of water and potentially hundreds of sheep’s lives. This simple story illustrates how powerful remote sensing can be.

The financial cost of each sensors is $600-$800. Based on the fact that a sensors system saves two trips around the farm each week – which equates to 3 hrs, valued conservatively is $75/week saved in labour and further saving on fuel and vehicle wear and tear – it takes approximately 7-10 weeks to pay off each sensor.

Having seen the benefits of remote sensing the next stage for this farmer is to install tank sensors on the second block. Saving one or two trips a week to the second block would be a huge time saver. Additionally, the farmer is looking at installing a remote camera. LoRaWAN sensors only transmit small data packages and do not have the capacity to record images.

More information
Contact Helen Watkins, Executive Officer Moore Catchment Council
moorecc@bigpond.com
WA College of Agriculture, Cunderdin – Cunderdin Connect

Leanne Grant-Williams, Assistant Farm Manager

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<td>Soil moisture probes, saline soil moisture probes, frost sensors, weather stations</td>
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<tr>
<td><strong>Dashboards:</strong></td>
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<tr>
<td>Stratus Imaging – custom</td>
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</tbody>
</table>

Background

**Hosts:** WA College of Agriculture Cunderdin

**Location:** Cunderdin

**Enterprise:** Cropping and livestock

**Management:** College farm

**Size:** 4063ha, 2473 ha arable

Figure 1 Students assisting operation of the weather station

Farm profile

WA College of Agriculture – Cunderdin has a long and proud history of providing agricultural and trades related education in a residential setting to 130 young people from across Western Australia. The College is located 3km north of the Cunderdin town site, approximately 130km from Perth.

The College farming property is 4063 ha in total, with 2473 ha arable. Our cropping program includes coarse grains, canola and oats grown for hay and silage. Students are engaged in all activities relative to the farming operations during the growing season including seeding, spraying, crop monitoring, post emergent spraying, nitrogen applications and finally harvesting. We have approximately 1000ha of unproductive saline land adjacent to the Mortlock River which flows through the middle of the property.

About 70 staff (including full-time and part-time) are employed across the College. This includes 12 technical officers employed to run College farming operations and instruct students.
The WA Internet of Things (IoT) DecisionAg Grant Program is funded by the Department of Primary Industries and Regional Development (DPIRD). The College received this generous assistance in 2019. Our grant was required to have a grain focus so our network of sensors are associated with soil, cropping and weather.

Network Installation

![Figure 2. WACOA Cunderdin sensor map](image1)

![Figure 3. WACOA Cunderdin dashboard of sensor locations (Paddocks can be colour coded to show different crop types each year).](image2)

We chose to use a LoRaWAN system as we felt this would allow better connectivity, cheaper to run in the long term and not reliant on the Telstra mobile network. The time
frame was pretty tight for the grant applications, but following extensive research a successful grant application was submitted.

As this was a totally new initiative for the College, we didn’t know the right questions to ask and what we needed prior to the establishment of our extensive network across the College site. If you don’t know the questions to ask then you don’t know the answers you require, as there was limited information available at the time. Having now done the journey we are now well aware of what we want to monitor and how the IoT network works.

It is essential to have a great working relationship with the company that supplies and installs your equipment. During all phases of the installation process Stratus Imaging has worked with us to fine tune as many aspects of our network as problems arose. They listened to our feedback and were available to work through any problems that arose either on the phone or coming onto site.

We have learnt many new skills at being able to diagnose problems within our network, resetting probes that have stopped working, checking that solar panels are charging batteries and checking gateways ensuring they are sending signals back to the base station. Students have used multi metres to check charging into batteries, checked circuits and assisted with a soil moisture probe relocation.

The network installation went very smoothly and once our gateway was installed adjacent to the farm workshop, we were pretty much live from then on. Students were keen to be involved with the install and there has been a great deal of interest, across the whole College, in the data generated and then using that data in a practical way.

Data is used in class room activities and in particular our maths department is using data to use in real time exercises in maths, estimations, graphing and analysis. Our plants curriculum is able to utilize data to demonstrate to students Delta T, soil moisture availability and effects of soil moisture following rainfall.

Following six months of live data and having seen the benefit of this network, we are now looking at additional sensors to add to the network to complement the daily operations of the College Farm. We have identified water tank sensors and temperature sensors and associated alarms for our piggery, farrowing and weaner sheds. These are all able to be added very easily to our existing network. The piggery sensors have proven very valuable when an air-conditioning unit failed and an alarm activated which sent a message to the piggery manager’s phone. We continue to investigate silo sensors and as the technology becomes more reliable these will be added to the network.

When we proposed a variety of sensors to be included with the network we really did not have a very clear picture of what data we would gather. Following seven months of data our choices of sensors has been validated. We installed soil moisture probes, saline soil moisture probes, frost sensors and weather stations. All sensors have given us data that we can now work with to make better informed decisions during the cropping phase of production. Could we have chosen less sensors? We have identified that we could ideally have had more soil moisture probes to cover the whole of the farm area, plus more saline sensors to monitor the effects of rising salinity on our farming land.

The salinity probes are giving us a real time picture of upcoming problem areas, so we can formulate some counteracting strategies and then monitor the effectiveness of those strategies, for example planting of salt bush. As we rotational crop, additional sensors will continue to be added over a larger area of the farm as funds become
available. The reason behind having a great coverage for the sensors is to have an accurate assessment of available soil moisture in all the cropping paddocks towards the end of the cropping phase to make more informed decisions regarding late fertiliser applications. This could potentially save money by withholding a planned fertiliser application due to, now visual, sub soil moisture constraints.

We are using the data generated on a daily basis, with students having access to the dashboard both in the classroom and when they come on farm. We also have a public dashboard where interested people can see live data from home.

We would like to once again extend our gratitude, for giving the College the financial support, to start us on this journey of discovery.

**Weather station**

Weather stations were identified as a good fit for our extensive monitoring network. As weather is so important to farming operations, having our own network of stations on our farm helps us make more informed decisions. The local BOM data is not always relevant to parts of our site as we are spread over a large area.

Each weather station has an extensive data capture to include rainfall in real time, being able to track rainfall over the previous 30 days, temperature and humidity, wind direction and speed.

Our weather station network has helped us make better decisions on when it is the best time to spray, including wind speed, direction and in particular Delta T. The Delta T reading is calculated on our dashboard and we no longer have to individually compare differences between air temperature and humidity.

Having this information allows our spraying operators to choose when to spray in ideal conditions as identified on the dashboard using a very easily read graphing display and ‘smiley face’ icon. This is a valuable learning tool for students, as they are able to read the Delta T in a very visual way.
Soil moisture probes

These have been a very worthwhile addition to our remote sensing network. We strategically placed these over the whole property and now, understanding them a lot more, we regret that we did not get more in the initial start-up phase. Some of our observations:

- Following a rainfall event in February this year we saw the difference between rainfall and stored soil moisture across all sensors. We identified from the weather stations that there was a difference of 65ml in some parts of the farm down to 13ml in other places. The stored soil moisture identified on the soil probes was startling, showing a huge difference between areas. Knowing there is a moisture bank will give us more confidence with times for seeding.
• It would be ideal to have every cropping paddock serviced by a comprehensive network of frost and moisture sensors, although cost constraints may not allow this.
• As indicated during our research we could use the data to confirm that there is sufficient moisture for nitrogen up take post seeding.

As we gain more confidence using this technology predictability for managing tasks both pre and post emergent will improve over time.

Figure 5. Students checking the soil moisture probes

As we have had such a good outcome from our LoRaWAN network we are enthusiastic to add additional sensors to our already extensive network.

• We are looking into water tank sensors, as all our water is from the Kalgoorlie pipeline. One tank overflow in an isolated area that not be identified for at least 3 months cost $1800 in water charges.
• We have also identified silo sensors as a good fit for our requirements and as the technology becomes more accurate these will be installed on our silos. We mill a lot of grains in the feed mixing area to be able to better track grain used in the piggery, feedlots and feed out to sheep would justify their install. Tracking grain is so simple but people forget to enter grain used and there are always errors and this may assist with grain tracking.

Public dashboard

We have designed a public dashboard allowing students and their families to see what is happening at the College in real time. This allows a snapshot of what is happening across the site and this is available to our neighbours so they can compare rainfall and possibly use data from adjacent weather stations.
Saline probes
As the College farm surrounds the Mortlock river system we have installed a number of saline probes to monitor the saline water table. We are aware that the land adjacent to the river system has salinity close to the surface.

- We have extensive salt bush plantings and the monitoring will validate the positive effect of this planting on the water table.
- We have seen considerable positive effects from the salt bush and being able to monitor the salinity levels has been a good learning tool for students to gain additional knowledge on sustainable farming practices utilizing fodder crops.
- We plan to continue adding sensors to our network and building on this information with the hope that our salt bush planting, surface water management methods are all assisting us to produce more return off land traditionally left idle.
- By using weather data from rainfall and saline probes we are able to accurately measure effects of rainfall on the water table and to plan further development of our salt bush areas.

Figure 6(a) Dashboard showing data output and (b) students installing saline probes

Frost monitoring
In the initial investigations on types of sensors we had the idea to install frost sensors as are used in vine yards. This technology has not been adopted in broad acre agriculture so we thought that this would be interesting to trial.
• We purchased seven frost sensors and these were strategically placed across the farm. We have two particularly frost-prone areas of differing soil types, one been sand over clay with the other very sandy loam soil structure.

• Following install, we watched very carefully each morning to monitor the overnight temperature. Following a well-publicised regional frost, when checking our dashboard, we found that one monitor had shown that particular area had experienced a -7°C frost event overnight.

• When checking the paddock subsequently we were able to see the damage to some triticale which was planted around an oat crop. As expected the oats suffered less damage from the frost that the Triticale.

This year using the frost sensors will allow us to demonstrate to students that the time of sowing, is critical to reduce the likelihood of certain crops suffering damage during frost events if they are flowing during the frost periods.

Educational benefits

From very early on as our students saw the additional people working with the installation on site they were all keen to know what they were doing. When we were able to show them in the first instance the sensors, briefly explain what they would be doing and eventually show them our Dashboard.

• Most students involved with the cropping enterprise have shown a keen interest in being able to see this live data. This interest and due to the dashboard being very easy to understand and navigate, students are able to navigate around the dashboard. We have made login permission for the Dashboard available for all staff and I have noted that there has been a lot of interest in particular to the soil moisture profile following the last rainfall event.

• We have had tutorials in classrooms for students to learn about the applications of the IoT network. As students engage with the curriculum, our Plants Teacher uses the dashboard to emphasise actions, in particular the management of rainfall – soil moisture probes and making sound decisions for cropping operations.

• Since the College has been impacted by the Covid-19 virus and all students have left, we have put up on the School network access for students to see what is happening at the College while they are at home.

• Following Open Day September 2019 where we showcased our Dashboard and explained to our parent community the workings of the IoT network there has been a lot of interest. This has included speaking to groups within our community, friends of the College and particularly parents seeking additional information. We have submitted articles on Facebook, the Local newsletter and in the Rural Press publications.

• Being able to see rainfall data from the weather stations then nearby soil moisture probes has been a huge winner. We have noticed a wide variation of rainfall across the site and without moisture probes would not have the confidence to make early seeding decisions. One of our sites adjacent to a weather station shows that we have had 112ml of rainfall and the soil profile is full down to 30cm. At another site near a weather station at the other end of the property this shows that this area has only had 22ml and the soil moisture profile is only 18% full at 30cm. This huge variation in rainfall was initially hard to believe but with this data we now have confidence that having real data so that we do not use “gut instincts” thus proving that this concept has a huge application in Agriculture in 2020 on into the future.
• We have recently given access to DPIRD Northam and they have used our Dashboard live at GRDC events and recently Wagin Woolorama. The College continues to engage with this new and emerging technology and have experienced firsthand the huge benefit and this will assist in decision making in grain growing. We have identified additional applications to add to the IoT network including sensors in our piggery to monitor temperature, sensors to monitor electric fencing connectivity, water tank sensors, vehicle tracking and we continue to investigate options to add.

Figure 7 WACOA Cunderdin’s Assistant Farm Manager, Leanne Grant-Williams demonstrating one of the IoT project dashboards at DPIRD’s display at Wagin Woolorama in March 2019.
Fault finding

The installation company Stratus Imaging listened to our feedback and were available to work through any problems that arose either on the phone or coming onto site. We have learnt many new skills at being able to diagnose problems within our network, resetting probes that have stopped working, checking that solar panels are charging batteries and checking gateways ensuring they are sending signals back to the base station. Students have used multimeters to check charging into batteries, checked circuits and assisted with a soil moisture probe relocation.

It is essential that when choosing the siting of probes that these will not be damaged by machinery during tillage. We have sited ours adjacent to fence lines. Fencing to exclude stock rubbing against them is also a wise option. We have had to move one sensor as we changed the paddock dimensions and pulled out a fence line where a probe was situated. This was very strenuous and delicate work! It also meant we can’t get reliable data from that probe, until the probe has embedded itself in the soil.

When considering the installation of any type of network we feel that it will be prudent to have an agreement in writing for servicing and fault repairs. Having expensive callouts for simple adjustments that you would be able to do with telephone assistance may be quite expensive over the life of the network.

More information

Contact WACOA, Cunderdin’s Acting Assistant Farm Manager, Maddi Corsini Cunderdin.WACoA@education.wa.edu.au
Mingenew Irwin Group – Remote sensing for increased efficiency and productivity

Kathryn Fleay, Executive Officer, MIG

Snapshot

<table>
<thead>
<tr>
<th>Trialled – Connectivity</th>
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<td><strong>On-Farm connectivity</strong></td>
<td><strong>IoT sensors &amp; devices</strong></td>
<td></td>
</tr>
<tr>
<td>LoRaWAN:</td>
<td>Automated weather stations, soil moisture probes, rain gauges, tank gauges</td>
<td></td>
</tr>
</tbody>
</table>

**Dashboards:** Goanna Ag's GoApp suite

Background

**Hosts:** Viridis Ag (The Grange)  
**Location:** 858 Tabletop Road, Mt Horner

**Enterprise:** Cropping – wheat, barley, canola lupins  
**Management:** Corporate farm  
**Size:** 16 752 ha

**Existing Farm connectivity** Satellite broadband (Skymuster), Telstra 4G mobile  
**Internet capacity:** Skymuster: 25/5Mbps max; Telstra 4G 2-50Mbps download

Figure 1. Weather station installed by Viridis Ag in a paddock at Tabletop
Background
The company Viridis Ag owns The Grange aggregation of paddocks located in the Mingenew Irwin Group area (figure 2). Dimensionally, the aggregation is approximately 15–20km wide (east to west) and 20–25km in depth (north to south).

The topography varies from flat to undulating hills. Networks need to cover at least these extreme distances and take into consideration the hills when determining overall coverage capability. Figure 3 shows that the 4G mobile network coverage doesn’t cover the whole of the Viridis Ag farm (circled). Therefore in this project a low power LoRaWAN system was installed which was considered cheaper and more reliable than other systems.

Figure 2. Map of Viridis Ag’s property located east to north-east of Dongara showing all paddocks making up The Grange aggregation

Figure 3. Telstra 4G mobile coverage in the area of the Viridis Ag property
**Technology & Installation**

**Previous IoT Devices at Aggregation:** None whilst under Viridis Ag ownership.

**Current IoT Partner:** Goanna Ag: [https://www.goannaaq.com.au/](https://www.goannaaq.com.au/)

**Previous Data Platforms at Aggregation:** None known prior to Viridis Ag ownership.

**Current Data Platforms:** Currently Viridis Ag utilizes the following:

- GoApp Telemetry: Proprietary Goanna Ag data platform, this includes their proprietary “Go Sat” that provides insights utilising data generated from IoT devices
- Agworld: For farm management/ agronomic planning

**Equipment Installed:** The following equipment was installed by The Grange farm team in conjunction with support from Goanna Ag representatives:

- LoRaWAN base station
- Automated Weather Stations (AWS)
- Soil Moisture Probes
- Rain Gauges
- Tank Gauges.
- All (except the automatic weather station) are connected via private (Goanna Ag) LoRaWAN network.

Unfortunately there is no further information available from Viridis Ag relating to the products’ useability over the time of this project.

Figure 5. Data logger for soil probe installed at Mt Horner paddock

**More information**

Contact Kathryn Fleay, MIG Executive Officer at [ceo@mig.org.au](mailto:ceo@mig.org.au)
Stirlings to Coast Famers – Smart Farm mixed livestock and cropping demonstration

Phillip Honey, Smart Farm Co-ordinator, SCF

**Snapshot**

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<tr>
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<td><strong>SigFox:</strong> Soil moisture probes, rain gauges x 2</td>
</tr>
<tr>
<td></td>
<td><strong>3G/4G:</strong> Weather station</td>
</tr>
<tr>
<td><strong>Dashboards:</strong></td>
<td>Pairtree</td>
</tr>
</tbody>
</table>

**Background**

<table>
<thead>
<tr>
<th>Hosts: Andrew Slade – Glenridge Park</th>
<th>Location: Kendenup</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enterprise:</strong> 50% cropping, 50% livestock</td>
<td><strong>Management:</strong> Family business</td>
</tr>
<tr>
<td><strong>Size:</strong> 6000ha</td>
<td><strong>Internet capacity:</strong> 60GB mobile broadband; 5Mbps download, 1.5 Mbps upload</td>
</tr>
</tbody>
</table>

Currently, Glenridge Park utilises the Telstra mobile network as their primary internet source, while a recently installed Pivotel network is being finalised. The undulating terrain of the farm and limited nearby Telstra towers have resulted in quite variable mobile phone coverage across the property, with some areas receiving no signal at all.

When the new network is operating, the majority of Andrew’s farmland will have access to the Pivotel 4G LTE network for high-speed internet and voice communications, with the future capability for NB-IoT enabled devices to connect directly to the network at a low cost.

As Glenridge Park stretches approximately 20km in width over numerous properties, the importance of developing a strong communications and sensor network was paramount for Andrew to maximise the value of the data he was collecting. For Andrew, the lack of support, high-sensor pricing and reliability concerns were some of the issues that were slowing adoption.
SCF wanted to design a trial solution that helped the Slade family adopt ‘ag technologies’ that would help mitigate risk on their farm through the integration of livestock and pasture management into their cropping enterprises. This would be achieved through a range of digital technologies including remote water level monitoring, remote rain gauges, weather predictions and soil moisture monitoring.

**Installation**

A range of suppliers and technologies were utilised on the SCF Cropping and Pasture Demonstration Site. These included:

- Remote rain-gauges, soil moisture probe and Sigfox in a box from Axistech
- Weather stations with hyper-local forecasting services by DTN
- Tank level monitoring solution with remote rain gauge from Farmbot
- Tank level monitoring solutions from Ellenex
- Mesh WiFi system produced by Ubiquiti.

The majority of the IoT devices were self-installed by SCF however, it is recommended to use a registered cabler for any network and cabling work. Overall, the AgTech installations were virtually “Plug and Play”, particularly for the Sigfox enabled systems, with little effort beyond powering the device on after install.

As the Sigfox network is managed directly by Thinxtra in Australia, the data automatically streams into the dashboard when the sensors come in range. Unfortunately, with one of the Sigfox based soil moisture probes and remote rain-gauges installed; we had difficulty in getting a stable connection to the Sigfox network, even after checking the network coverage map and placing it in an area where there didn’t appear to be any issues. Our Sigfox partner, Axistech, organised a “Sigfox in a box” system, which works by creating a mini Sigfox network with a 5-10km coverage range. This instantaneously provided the coverage that we needed to get these sensors to work and appearing on with readings on our dashboard. It is crucial that time is taken to verify what coverage is available in the area prior to installing equipment, and if there isn’t sufficient coverage available, create a plan to boost your chances of connection via external aerials and/ or coverage boosting devices like “Sigfox in a Box”.

**Operation and Decision Making**

Overall, the different technologies assisted in farm management operations and could be easily applied to both grain-growers and mixed crop and livestock operations. The use of the DTN weather station helped in some situations in providing advice to potential future harvest and spray conditions through hyper-local weather forecasting. However, its accuracy and model improves over time and as the nearby station count increases.

At this stage it is still too early to make management decisions based off soil moisture data generated as it can take a while for the soil moisture probes to settle. It is still perceived these soil moisture probes will help with operation decisions based on nutrient application improving yields and grain quality as well as modifying grazing habits through soil water conservation and predictive growth rates.

**The Calculable, Immediate Benefits**

The most visible immediate savings on farm was the usage of water-monitoring technologies. One example of this was where SCF employed a single Farmbot Tank
Monitoring solution on a recently purchased farm, located approximately 14 kilometres from the main homestead. This was based on an equipment purchase price of approximately $1200 (ex GST) for the water level monitoring device and a $342/year connectivity and dashboard fee. It was calculated that, even if only there was one trip taken per week to check the tank level, the system would have paid itself off within the first eight months. Approximately $900 savings in labour and travel would occur in year one, with savings in excess of $9,300 over an estimated 5-year period. [Based on assumptions of 28km round-trip at $0.68/ km, taking 1-hour of labour at $28.00/hr]. It is also important to note that these savings are most likely understated, as additional benefits and efficiencies could be gained through the effective re-allocation of work tasks, in lieu of other production and economic benefits such as better water management in dry years, or early warning of water leaks/loss prior to affecting operational tasks or animal product and welfare.

Future plans

Currently the Sigfox coverage over the Glenridge Park property is limited to particular sectors, as the signal is coming from Mount Barker. Unfortunately, in its current form, the fees to keep the additional Sigfox coverage operating can’t be justified at a single farm level for very few sensors compared to the other connectivity sources available. Where there is no Sigfox coverage available, there has been the progression to add LoRaWAN sensors and LoRaWAN gateways into the Smart Farm Demonstration site. Particular planned add-ons into the Smart Farm ecosystem include:

- Silo & Feed bin level monitoring
- Water flow sensors for tanks and inside the feedlot
- Livestock GPS Trackers
- Farm security cameras
- Dashboard aggregation for all IoT and production data to be displayed in one place.

Indicative pricing for equipment installed

<table>
<thead>
<tr>
<th>Item</th>
<th>Upfront cost</th>
<th>Ongoing cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTN Weather Station and Hyper-Local Weather Forecasting Package</td>
<td>$2,200</td>
<td>POA</td>
</tr>
<tr>
<td>Automatic tipping rain gauges</td>
<td>$785*</td>
<td>$60</td>
</tr>
<tr>
<td>600mm Aquacheck soil moisture probe</td>
<td>$1200*</td>
<td>$60</td>
</tr>
<tr>
<td>FarmBot water level monitor, rain gauge and LoRaWAN station</td>
<td>$1200</td>
<td>$342</td>
</tr>
<tr>
<td>Ellenex water level monitors</td>
<td>$700*</td>
<td>$60</td>
</tr>
<tr>
<td>Ubiquiti mesh WiFi system</td>
<td>$187-320</td>
<td>-</td>
</tr>
<tr>
<td>LoRaWAN gateway, external antenna and cabling</td>
<td>$850</td>
<td>-</td>
</tr>
</tbody>
</table>

Notes: Prices are subject to change and exclude GST. Please confirm pricing directly with manufacturer or reseller. * Pricing includes first year of subscription.

Key Messages

The key message to smart farm implementation is plan, plan, plan!

- Define what problems you are trying to solve first, and then identify the sensors that are needed to help achieve that: Can the problem be measured or managed by practice change? Will it boost on farm productivity or quality, and improve overall
efficiency? You will also need to consider how this all fits into your budget and where your limitations are.

- Identify what connectivity types are available in your region (Sigfox, LoRaWAN, Satellite or Cellular), and methods of creating a LoRaWAN network if required.
- Calculate the costs of implementation, and compare it against the savings you could potentially make in time, travel and efficiency gains. There is quite a few technologies available that can create significant savings.
- Start small, and work out what works in your situation and what doesn’t. If you ever need help, there are resources and organisations to assist you.
- Consider your long-term goals, and how you would like to access your information when you’re all setup. Would you like all your data in one place?

To calculate the potential savings you could make from implementing remote rain-gauges or water level monitoring, please visit https://bit.ly/smartfarmcalculator.

More information

- Contact Philip Honey, SCF Smart Farm Co-ordinator philip.honey@scfarmers.org.au
Kiara College – Pastoral Improvement program

Suzanne Loveland, Business Development Manager, AxisTech

Snapshot

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<tr>
<th>Trialled – Connectivity</th>
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<tr>
<td>On-Farm connectivity</td>
<td></td>
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</tr>
<tr>
<td>SigFox:</td>
<td></td>
<td>Weather stations, rain gauges, soil pH probes</td>
</tr>
<tr>
<td>Dashboards:</td>
<td></td>
<td>AxisTech and Pairtree</td>
</tr>
</tbody>
</table>

Background

<table>
<thead>
<tr>
<th>Hosts: Kiara College</th>
<th>Location: Kiara, Perth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprise: Sheep, cattle, pigs, horticulture, aquaculture, poultry</td>
<td>Management: School farm</td>
</tr>
</tbody>
</table>

Installation

As part of the WA IoT DecisionAg Grant Program, Kiara College embarked on a Pastoral Improvement Program with an IoT solution provided by AxisTech. At the commencement of the project, the following devices were installed at the College:

- Sigfox Base Station for device connectivity
- 1 x weather station (rainfall, wind speed, wind direction, temperature, relative humidity, barometric pressure)
- 1 x rain gauge • 7 x soil moisture probes (moisture and temperature)
7 x soil pH probes.

Upon completion of the grant program, we have identified several key learnings which will help us and others make the most of future IoT projects.

**Key learnings**

**Planning**

Before commencing an IoT project, significant planning needs to take place to ensure the right solution is implemented. Some of the questions that need to be answered include:

- What outcomes do you want to achieve from your IoT project?
- How many devices and what types do you need to achieve your outcomes?
- Where do the devices need to be installed for the best results?
- What do you need to learn from the data delivered by your IoT devices?
- How can IoT devices help you with efficiency in your operations?
- Do we need a control site to compare data with?
- How will the data be displayed and how will it be used?
- Who needs access to the data?
- What other information or data is required to assist with your project?

**Animal Protection**

We have discovered from this project that adequately protecting devices from animals is crucial. Unfortunately, we had many devices damaged by livestock which impacted the overall project and the delivery of data as well as rodents chewing on cables for the Sigfox base station which at one point affected connectivity. Animals should never be underestimated!

AxisTech has been working to replace and repair these devices and reinstall them with adequate animal protection so that we can continue collecting data for future projects and implement IoT into our school curriculum.

**IoT is for the long term**

When it comes to projects that require analysis of data, such as soil moisture, salinity and pH levels, it needs to be understood that the more data collected over time the better the results. For example, changes to soil is impacted by weather and treatments but the more data collected enables the user to assess changes due to inputs or other environmental factors and then make comparisons to the changes in different soil types. Agricultural climates are very cyclical and need to be observed for at least a full season to be able to develop a base line understanding.

The project that we commenced as part of the WA IoT DecisionAg Grant was a pastoral improvement program. We intended on proving whether adding clay to a paddock improves the moisture retention qualities of the soil and therefore the crop output in comparison to other paddocks that did not receive the clay input. Preliminary findings are that clay has a significant impact at a surface level and requires deeper tillage to have an effect at a deeper sub-surface level and that a mid-range application level appears to be optimal for moisture retention benefits but more data collection and further analysis is required to confirm this and provide a more technical understanding. This project is ongoing and will continue beyond the grant period and will be introduced into the school curriculum along with other data related projects.
Understanding IoT Data

As part of the WA DecisionAg Grant project, AxisTech provided Kiara College with a dashboard that displays data from the following devices:

- Weather Station (Temperature, Relative humidity, Wind speed, Wind direction, Rainfall, Barometric pressure)
- Rain Gauge (Rainfall)
- Soil probes (Soil moisture, Soil temperature)

The data is displayed on the dashboard in graphical form so that trends and changes can be identified and observed in relation to specific events including weather or soil treatments. There are many ways in which we can use this data now and into the future including:

- Observe changes in weather patterns from month to month and year to year
- Compare localised rainfall at Kiara College
- Compare local weather information at Kiara College with information provided by BOM
- Ascertain which paddocks at Kiara College have the best water retention and discover why this is happening
- Measure soil moisture in the irrigated paddocks and determine whether the paddock is being over or under watered and adjusted the irrigation system accordingly
- Monitor soil moisture levels during each season
- Determining type and quantity of inputs to soil and how this impacts moisture retention Kiara College will continue working with AxisTech on further understanding our knowledge of IoT devices and how to interpret and use the data to achieve our outcomes.

Context is important

For projects to be successful, as part of the planning process, additional contextual information needs to be acquired and utilised in line with the real time data. In the case of our Pastoral Improvement program, information regarding timing and amounts of clay input to soil is important to enable observation of changes to such things as soil water retention and crop output to be attributed to the input.

Kiara College is very grateful to the Department of Primary Industries and Regional Development for their support in our participation in the WA IoT DecisionAg Grant Program. We also thank AxisTech for their ongoing support for the life of the project and beyond.

We look forward to continuing our IoT journey and sharing our future learnings and experiences with our students, the Department and the wider community

More information

Contact

- Suzanne Loveland, Business Development Manager, AxisTech
  suzanne@axistech.co
- Kiara College https://www.kiaracollege.wa.edu.au/
Esperance Farm Training Centre (Esperance SHS) – Technology to improve student outcomes
Danny Pollard, ESHS Farm Training Centre Coordinator

Snapshot

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</tr>
<tr>
<td>CatM1:</td>
<td>Weather Station, water flow meter, soil moisture probe</td>
<td></td>
</tr>
<tr>
<td>Dashboard:</td>
<td>Origo FarmHub</td>
<td></td>
</tr>
</tbody>
</table>

Background

Hosts: Esperance farm training centre  
Location: Esperance  
Enterprise: Cropping, sheep, cattle  
Management: School farm  
Size: 800ha

As a productive farm and a training facility for students at Esperance Senior High School we identified some issues with connectivity and farm data requirements that the technology solutions could address.

The technology solution provides data to feedback into software programs, to be used to improve student outcomes (Certificate II Ag Competencies) and to improve farm operations, with the hope of increased yields. The students are required to complete the following Certificate II Competencies; "Collect and Record production data" and "Observe and Report on weather".

In partnership with Origo and Philip Honey (Digital Agronomy Environmental and Cropping Technologies Australia), and with support from our Agricultural Advisory
Committee (in particular Phil Longmire and Brendan Nicholas), we applied for a grant that would enable us to install a state of the art 6m weather station (which gives wind speed/direction, rainfall and temperature/humidity at 0m, 3m and 6m).

We have also installed water flow monitors and a soil probe, all of which provide real time data to the cloud for staff and students to access.

The grant provided funding of approximately $5700 in 50:50 partnership with the school.

**So what did we get?**

Esperance Farm training Centre received a 900MHz long range antenna, 900MHz gateway for paddock stations, UPS medium, farm hub (standard), paddock station 6.5m wireless, 900 MHz repeater for paddock stations, water monitoring station ultrasonic tank level and pipe measurement wireless monitoring station, network design and equipment configuration, Origo membership, as well as initial training and support.

**How does this new infrastructure and technology benefit our students?**

The data produced by the weather station allows students to complete Certificate II in Agriculture competencies, such as “Collect and Record Production Data” and “Observe and Report on Weather”.

Some of the specific tasks would include:

- Check weather and climate information to determine likely conditions
- Recognise changed weather and climate situations
- Anticipate likely impact of changes in weather and climate in respect to work tasks, safety of others, property, natural resources and local environment
- Report anticipated impact of weather and climate to supervisor
- Disseminate information and advice to relevant personnel
- Determine the preventative action required according to the known effects on livestock, crops and work tasks
- Implement actions to minimise loss and damage
- Adjust livestock, horticultural or crop management program or schedule of work tasks according to weather and climatic changes
- Access regular updates to determine ongoing suitability of current programs
- Review the viability of livestock, horticultural or crop management practices to ensure suitability with meteorological conditions
- Research forecasting techniques to maintain currency of information
- Determine the specific requirements of the data to be collected by discussion with the supervisor or by reading work instructions
- Communicate advice about the proposed data collection to others as required
- Record production data in the correct format and to meet specific requirements
- Present production data in the correct format and to meet specific requirements
- Download or enter production data into a computer where required, using specified formats and applications.

We will also be setting up activities for students at the High School site to complete; this would range from lower school Agricultural students to upper school Geography students, where these students can use the data provided to help complete components of their syllabus.
Our farm students have told us that the site was helpful in completing their Certificate II work.

**How can this resource be utilized by the wider community?**

The website is open to community members and we have shared it with two local volunteer fire brigades, Gibson and Neridup, via WhatsApp, so it can be used as a tool when combined with other data sources to support firefighting in the local community.

We have also shared our website address with all our neighbouring farmers so they can access data and we are looking at other ways our website can be used by other members of our community.

Contractor sprayers on site have also used the website to plan their spraying program. The data can be used to determine ideal spraying conditions (using Delta T). Our contractor said that the website was easy to use and the real time data made his job a lot easier.

**What issues have we had to overcome?**

The process has been smooth and reasonably easy from start to finish; the only real issue we have experienced is to do with the WA Education Department’s firewall restricting access when using school computers. We have allowed students to use their own devices when accessing the site and we are working with the Department to overcome this problem.

Some images of the weather station outputs accessible from the website are shown below.

---

**More information**

Contact Danny Pollard, Daniel.Pollard@education.wa.edu.au
Merredin and Districts Farm Improvement Group – Digital rain gauge network
Sian Paddy, Administration Officer, MADFIG

Snapshot

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<tr>
<td>Dashboards:</td>
<td>Wildeye</td>
<td></td>
</tr>
</tbody>
</table>

Background

**Hosts:** Doug McGinniss  
**Location:** Merredin

**Enterprise:** Cropping  
**Management:** Family business  
**Size:** spread across a large area (35km east/west and 30 km north/south).

Merredin and Districts Farm Improvement Group Case Study Grain producers across Western Australia’s wheatbelt have always known that weather conditions, and in particular rainfall, has the largest impact on their farm business production and profitability. While there is nothing farmers can do to control the weather or how much rain they get, better farm management outcomes can be achieved when decisions are optimised in response to the given weather conditions if the weather data is made available to growers in a timely fashion.

Getting access to timely weather data has historically been an issue for WA farmers, particularly in the central and eastern wheatbelt where farms can be very large and potentially spread out over a great distance. The simple task of determining how much rain has fallen across the farming business could involve spending half a day and a 250km round trip to check and manually record measurements from 20+ rain gauges. The time and expense of the exercise has meant gathering rain and weather data has
been carried out infrequently and management decisions have not been made on timely data.

The Merredin and Farm Improvement Group (MADFIG) sought to solve this issue by installing Automatic Rain Gauges as part of the Department of Primary Industries and Regional Development's (DPIRD) WA Internet of Things Decision Ag Program. The WA IoT Program and MADFIG growers contributed to funding the installation of 58 IoT devices that would provide real time rainfall, weather and soil moisture data to MADFIG members so that the farm management decision making process could be improved and achieve better business outcomes (Figure 1).

Figure 1: Extent of the IoT devices in the MADFIG project

Doug McGinniss is one of the MADFIG members involved in the project and has previously found it difficult to accurately record weather conditions and rainfall data as the McGinniss family’s farms are spread across a large area (35km east/west and 30 km north/south). As a participant in this project, Doug is hosting a number of IoT devices that continuously record weather conditions and upload this data to the internet cloud every 15 minutes.

Devices installed

There are 6 IoT devices spread across the McGinniss family’s farms and include two rain gauges, two rain gauges with frost sensors, one rain gauge with soil moisture probe and one weather station. This effectively allows Doug to examine rainfall, frost, weather conditions and soil moisture across the entire farm business in almost real time. The devices across the McGinniss farms are show in Table 1.

Table 1. A list of the IoT devices available to MADFIG members via the WA IoT DecisionAg Program and their uses.

Figure 1: Extent of the IoT devices in the MADFIG project

Doug McGinniss is one of the MADFIG members involved in the project and has previously found it difficult to accurately record weather conditions and rainfall data as the McGinniss family’s farms are spread across a large area (35km east/west and 30 km north/south). As a participant in this project, Doug is hosting a number of IoT devices that continuously record weather conditions and upload this data to the internet cloud every 15 minutes.

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<table>
<thead>
<tr>
<th>Device type</th>
<th>Conditions recorded</th>
<th>Data provided</th>
<th>Improved decisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rain gauge only</td>
<td>Rainfall</td>
<td>Accurate and timely rainfall</td>
<td>Rainfall records, yield prediction</td>
</tr>
<tr>
<td>Rain gauge + frost sensor</td>
<td>Rainfall, minimum</td>
<td>Accurate and timely rainfall, duration/severity of</td>
<td>Rainfall records, yield prediction, frost damage</td>
</tr>
<tr>
<td></td>
<td>temperature</td>
<td>frost events</td>
<td></td>
</tr>
<tr>
<td>Rain gauge + soil moisture</td>
<td>Rainfall, soil</td>
<td>Accurate and timely rainfall, plant available soil</td>
<td>Rainfall records, yield prediction, nutrient requirements</td>
</tr>
<tr>
<td></td>
<td>moisture (0-80cm)</td>
<td>water</td>
<td></td>
</tr>
<tr>
<td>Weather station</td>
<td>Rainfall, wind (speed and direction), temperature, humidity</td>
<td>Accurate and timely rainfall, spraying condition records, Delta T, fire danger index</td>
<td>Rainfall records, yield prediction, spraying conditions, harvest and vehicle movement bans</td>
</tr>
</tbody>
</table>

**Operations and decision-making**

Doug has chosen to place a weather station in the geographical centre of the farms as this provides wind speed and direction, temperature and humidity data which is relevant to spraying conditions at all times of the year.

Most recently, the weather station has been used for this year’s summer spraying operations, with Doug using the Delta T values from the station to determine when conditions are no longer suitable for spraying.

Doug noted that the weather station provided useful fire danger information during harvest 2019 as he could use the on-farm device to check if conditions were too dangerous to continue harvesting.

Doug commented that the network of weather stations across the Merredin region proved invaluable over summer for local bush fire control officers who could check the temperature, wind speed and humidity conditions which helps determine when to call a Harvest and Vehicle Movement Ban.

Rain gauges with frost sensors have been used in areas that are low lying and have a history of frost damage so that he can better determine if a frost event has taken place and how severe it has likely been. This information can be used to decide if the crop needs to be assessed for significant damage that could justify cutting the crop for hay instead of allowing it to go through to harvest.

The rain gauge only devices have been placed in areas that are higher in the landscape and do not have a history of frost and therefore do not need the extra frost sensor. Though the rain gauges have not been in for very long, Doug has found that the rainfall variation across the properties is significant and it is very useful to see how much has fallen at each farm without having to drive there and check the gauges manually.

Doug has found the soil moisture probe data to be very interesting and thinks that the information it provides could be very important for making decisions in the coming season. Doug has noted that there have been two spikes in soil moisture since the probe was installed. The first was when 17mm fell on 17 March 2020 and soil moisture increased to a depth of 30cm (blue line: 0-10cm, green line: 10-20cm and red line: 20-30cm).
Figure 3. Soil moisture levels increased with rainfall since March 2020.

Doug noted that the soil moisture in the 0-10cm layer slowly declined as it slowly moved deeper into the 10-20cm layer and evaporated from the surface. The last rainfall event, 3mm on 20 April 2020 slightly increased the soil moisture in the 0-10cm but wasn’t enough to impact the subsoil. Doug has said that he will check this information during seeding to help with nitrogen decisions at seeding and for later top-up nitrogen applications. Doug may pull back on additional nitrogen in-season if there is low soil moisture which could lower the crops yield potential if there is not above average rainfall in spring.

Overall, Doug is very happy with the data that has become available from the different types of IoT devices and can only see it will become more useful as the 2020 season progresses. There are a total of 58 IoT devices on the network which are accessible by all participating MADFIG members. Doug sees the benefit of sharing data from the devices that he hosts as a major advantage to the MADFIG weather network is that everyone benefits from the extra information.

**More information**

Contact Sian Paddy, MADFIG Administration Officer [admin@madfig.com.au](mailto:admin@madfig.com.au)
Corrigin Farm Improvement Group – Utilising weather data, frost sensors and soil moisture probes for in-season crop management

Veronika Crouch, CFIG

Snapshot

<table>
<thead>
<tr>
<th>Trialled – Connectivity</th>
<th>IoT</th>
<th>Dashboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-Farm connectivity</td>
<td>IoT sensors &amp; devices</td>
<td></td>
</tr>
<tr>
<td>3G/4G:</td>
<td>Weather station, frost sensors, soil moisture probe</td>
<td></td>
</tr>
<tr>
<td>Dashboards:</td>
<td>Dataview Web</td>
<td></td>
</tr>
</tbody>
</table>

Farm 1 Wallwork property

**Background**

<table>
<thead>
<tr>
<th>Hosts: Simon Wallwork and Cindy Stevens</th>
<th>Location: Corrigin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprise: Livestock and cropping</td>
<td>Management: Partnership</td>
</tr>
<tr>
<td>Size: 3710ha</td>
<td>Topography: Undulating with patches of trees on 10% of property</td>
</tr>
<tr>
<td>Enterprise Mix: 50% barley, 10% wheat, 20-30% canola, 5% lupins, 15% sheep and cattle</td>
<td>Mobile coverage: across farm (% of farm) 3G-20%, 4G-70%, No reception-10%</td>
</tr>
</tbody>
</table>

Farm 2 Turner property

**Background**

<table>
<thead>
<tr>
<th>Hosts: Lance Turner</th>
<th>Location: East Pingelly and East Corrigin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprise: Cropping</td>
<td>Management: Partnership</td>
</tr>
<tr>
<td>Size: 6800ha</td>
<td>Topography: Undulating with patches of trees on 15% of property and areas of salt</td>
</tr>
<tr>
<td>Enterprise Mix: 80% wheat/barley, 10 canola, 15% fallow</td>
<td>Mobile coverage: across farm (% of farm) 3G-40%, 4G-20%, No reception-40%</td>
</tr>
<tr>
<td>Existing Farm Connectivity: Satellite and mobile broadband</td>
<td></td>
</tr>
</tbody>
</table>

Project Background

This project was part of the WA Internet of Things (IoT) DecisionAg Grant Program, funded by the Department of Primary Industries and Regional Development (DPIRD).

This project aimed to demonstrate a 3G/4G mobile cellular network connectivity solution to support the operation of IoT devices on grower properties. These IoT devices should allow growers to make more informed decisions based on having reliable and real time weather data and soil moisture levels, to aid in-season crop management to achieve production gains.

The Corrigin Farm Improvement Group worked with growers Simon Wallwork and Lance Turner to install the ICT international IoT devices: including soil moisture probes,
a frost sensor and weather station. The ICT International platform was used as a data platform solution.

Simon has 4G coverage and has installed IoT devices on farm such as tank monitors. He also has experience with data analytic dashboards such as iEKBase and Viewpoint.

Lance has a range of 3G/4G mobile coverage across his properties, therefore would need to look to alternative connectivity solutions if he continues to investigate other IoT devices. He has currently no IoT devices installed other than the soil moisture probes through this project and minimal dashboard experience.

**ICT International IoT devices and data platform**

**Devices**

Initially the group were very interested in testing Teralytics NPK soil moisture probes, however we experienced many difficulties with getting access to these devices and had to find other means and available devices that could address our solution.

ICT International, among others, have a range of soil sensors that were suitable to the growers needs and we therefore chose the EnviroPro® sensor to install. This sensor is designed and made in Australia. The EnviroPro® is a sub-surface soil probe that has been designed to be accurate, long-life, and maintenance-free for all soil types. It measures for variations in salinity, as well as compensating moisture and salinity measurements for temperature variations. The sensors are in 10cm vertical intervals. The soil probes installed by CFIG are 80cm in length which would be more than sufficient for most crops grown within the Corrigin region to give suitable indication of soil moisture stores for in-season decision making. These soil probes each have their own data logger so they can be standalone units, where the grower can have multiple in one paddock and utilised to facilitate fertiliser optimisation.

![Figure 1. Left - ICT International EnviroPro® sensor; 80cm in length with YDOC data logger. Right - Soil probe after installation.](image-url)
CFIG also installed ICT weather sensors. These sensors are self-installed on-farm after being built and calibrated prior to shipment of the devices. To install the devices on-farm a mounting pole is firstly required to be securely erected in the ground or to a secure structure that will not interfere with the weather sensors. As seen in the image below, the group chose to install the devices in the paddock to a pole of suitable size. Each of the devices have a cable that is linked to the YDOC data logger. This data logger requires a data SIM to be inserted to be able to connect to the 3G/4G mobile network to remotely access the data through the ICT International custom dashboard data platform. The sensors that were installed for the weather station include; Wind speed, wind direction, temperature, relative humidity, atmospheric pressure, vapour pressure, rainfall, leaf and bud temperature (for frost detection) and solar radiation.

Figure 2. Left - ICT International weather sensors installed on-farm at host farmer in Corrigin. Right - Data SIM inserted into the YDOC data logger for connecting to the 3G/4G mobile network.

Installation and considerations

The installation of devices isn’t as straightforward as many companies may lead you to believe and some devices have a long wait list. Therefore, it can pay to look for more locally supplied devices and customer service as overseas technology may have limitations depending on which connectivity/signal you are using with the device. For example, it was much easier for the group to source our devices from a reputable company within Australia such as ICT International and they have a great service team to assist their customers.

Having good instruction manuals for wiring and setting up the devices is very useful if it does not come fully fitted and operational.

When selecting the length of soil probe you want to install consider how you are going to dig the hole for installation as many of the WA soil types are shallow and very hard to get down to the required depth. We have a very hard time getting down to 80cm and
needed the use of soil sampling trailers with hydraulic soil corers to be able to reach the required depth. Making the slurry to insert the soil probe was also difficult when trying to keep the soil samples in their 10cm increments to ensure the soil goes back around the soil probe in the soil layer it was taken from to have reasonably accurate readings.

Figure 3. Simon Wallwork with Darian Smith CSBP Corrigin Area Manager, with installed soil moisture probe. Soil tests were taken whilst drilling the hole for installation.

There are many different types of soil probes on the market so consider this when you are selecting which type would be most suitable to the task at hand and they type of data you require.

The weather station was reasonably easy to install on-farm once all the items had arrived. ICT had great support and instruction manuals to follow to ensure the devices with installed correctly. We chose to have a more permanent structure for the devices to be secured to, so it logs data from one location all year round. If you are wanting the devices to be relocated you many want to consider the base structure you are fixing the devices to such as a solid portable stand rather than a fixed pole.

Make sure you have all the parts and tools when installing your devices. If they are not sent with the devices, work out what you will require before going into the paddock to erect the pole and fix the devices to it.

Choosing to go with 3G/4G mobile made the most sense for the devices, however double-check what connectivity you have in the area and if you can go with another provider if you have issues getting the IoT data sim cards through the online ordering system. Alternatively contact your regional manager as they are very efficient. As we
are using the Telstra data sim cards the devices need to be adjusted to select the correct VPN.

When choosing a dashboard/platform to view your data, firstly consider how you want to see it. We wanted to see all our weather data on one dashboard even though we have multiple devices in different locations. This is where the customised dashboard from ICT was perfect for what the group wanted to look at. With ICT we also have the ability to insert a URL on to the groups own website so that all members of CFIG are able to see the weather information as well as another source of information for the region.

If we were to do this again, we would order the data sim cards at the same time as ordering the devices rather than wait for the devices to arrive first before ordering the data sim cards. Other than weather devices we would also look at tank and trough monitors/sensors. This way we could track water use over the summer months for livestock.

**Operation and Decision Making**

The benefits of installing the IoT devices and project on the host farms allow the group to collect additional trial data which the growers are also involved in. This allows the growers to test some technologies on-farm with growers whilst also collecting additional trial data such as soil moisture at depth throughout the growing season, to determine its impact on the trial results.

The initial benefits for the host farmers are that they will be able to see accurate weather such as temperature and rainfall on farm in their own paddock, as well as soil moisture stores associated with each soil probe. At present the group are unable to comment on the impact this has had on their host farms as we have experienced some technical difficulties.

As the group have experience many setbacks throughout the duration of this project, we are unable to say a great deal about the outcomes of the data platform and its usability with working devices. The group has done a little with the basics of the dashboard with preliminary data from when ICT International prepared the weather sensors.

We experienced many delays with getting appropriate IoT Data SIMs, and once they were finally installed, there were network connectivity issues. This is something that would like to highlight to growers that the installation may not always be straightforward if they are installing the devices themselves on-farm.

Prior to the devices being shipped ICT International does calibrate the sensors to ensure they are all working correctly before you receive them. This is a great step to making sure the devices are working before you install them on farm. Once installed on farm they can then see if anything has gone majorly wrong on your end.

The installation of the devices is most certainly the most difficult part, getting everything set up. Once the devices are installed the dashboard is then your main operating tool, combined with tools such as Decipher – soil sampling results and in-season nutrient application. This gives a clear picture as to the weather and soil moisture conditions at the time of seeding, in-season for making nutrient decisions and yield predictions. The frost sensor and weather station can also be utilised for insurance purposes.
Figure 4. Preliminary data of the CFIG (a) weather sensors and (b) soil moisture probe sensors on the custom ICT International web view dashboard platform.

The dashboard once logged into is very straightforward and easy to follow. Some of the issues we experienced were changing over the VPN once the data sim cards were received. You need to plug into the YDOC and adjust this. After this step ICT are able to do a network test to determine if the data logger can now connect to the network and log in and adjust settings etc.

As the group have experienced difficulties with the devices connecting to the 4G network CFIG have not been able to successfully improve the data problem at each of the host farm at present. However, it is hoped that once the devices are trouble free, the data they provide will allow the growers access to information they will find beneficial to their in-season decision making.
Figure 4 shows examples of the customised dashboard utilising preliminary data that was taken when ICT International were calibrating the equipment prior to shipment to CFIG.

**Farm 1 Wallwork property**

At the Wallwork’s property the group installed the ICT weather sensors, frost sensor and a soil moisture probe.

The chosen devices operate on a 4G network that each have their own data logger and data SIM which allows the data to upload directly to the customised ICT dashboard which can be accessed when in mobile reception. The distance the connectivity network needs to cover on the host property is 16km.

Simon and Cindy are already utilising FarmBot monitors on their property to take water levels in their livestock enterprise. They have previous experience with data platforms, including but not limited to; Paddock Action Manager (PAM), Viewpoint (a spatial data storage and analysis program), GIS and apps such as iEKBase analytics and Decipher.

Installing weather devices on farm is of interest to Simon and Cindy as they are able to utilise climatic data for making agronomic decisions which impact on their business. Monitoring soil moisture, in particular in paddocks that have undergone chemical fallow or soil amelioration, is of interest to Simon as this may impact his in-season nitrogen application, timing of soil amelioration and sowing of forage crops in late autumn and spring for livestock grazing over the summer months.

Simon would use the data from the weather sensors and the soil probe once every fortnight.

**Farm 2 Turner property**

At the Turner property in Kurrenkutten WA, the group installed two ICT International soil moisture probes.

The soil probes operate on a 3G/4G mobile network that each have their own data logger and data SIM which allows the data to upload directly to the customised ICT International dashboard which can be accessed when in mobile reception.

Lance has little experience with data platforms, however regularly utilised John Deere guidance systems and yield data information. He is looking to start using programs such as AgriTrack or AgWorld.

Monitoring soil moisture is of interest to Lance, in particular in paddocks that have undergone chemical fallow on their eastern property where the season is shorter and crops often undergo heat stress. Lance would use the data from the soil moisture probes throughout the growing season to make decisions on nitrogen application, fungicide and insecticide applications and timings of these applications, and yield potential. Having a better understanding on the soil moisture stores on their eastern property will help Lance in making the decision to continue with these in-season applications or if the yield potential is not there to warrant the additional nitrogen or fungicide application if the moisture isn’t available for grain fill. As they do a large amount of chemical fallow on this property, maximising soil moisture is essential to growing their subsequent crop following the chemical fallow rotation.

**Economics/Costs**

The costs of the IoT Devices used in this project are indicated in the tables below.
<table>
<thead>
<tr>
<th>Item code</th>
<th>Description</th>
<th>Unit price</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>YDML-417DS-PV</td>
<td>4G LTEM global modem and Quad band GPRS fallback. 3 Digital inputs and serial port (no analog ports). Integrated 1Wp solar panel and NiMH charger, 3xAA holder.</td>
<td>$ 1,440.00</td>
<td>Once</td>
</tr>
<tr>
<td>YDUFL-SMA-100</td>
<td>UFL to SMA cable (100mm)</td>
<td>$ 30.00</td>
<td>Once</td>
</tr>
<tr>
<td>YDPMB</td>
<td>Pole Mounting Bracket (no clamps, nuts, bolts or washers)</td>
<td>$ 30.00</td>
<td>Once</td>
</tr>
<tr>
<td>YDCON-USB</td>
<td>Waterproof external USB connector for MLx15 only (IP68)</td>
<td>$ 35.00</td>
<td>Once</td>
</tr>
<tr>
<td>DECA</td>
<td>ATMOS-14 w/Passive Radiation Shield, w/ bare tinned lead wires, 5m cable</td>
<td>$ 571.00</td>
<td>Once</td>
</tr>
<tr>
<td>DECA</td>
<td>ATMOS-22, Sonic Anemometer, w/ bare tinned lead wires, 5m cable</td>
<td>$ 1,058.00</td>
<td>Once</td>
</tr>
<tr>
<td>DECECRN-100</td>
<td>ECRN-100 High resolution rain gauge (0.2mm)</td>
<td>$ 663.00</td>
<td>Once</td>
</tr>
<tr>
<td>SF-421-SS</td>
<td>SDI-12 Leaf and Bud Temp Sensor</td>
<td>$ 609.00</td>
<td>Once</td>
</tr>
<tr>
<td>SP-421-SS</td>
<td>Silicon-cell Pyranometer, SDI-12 Output, 3m lead with SS Connector</td>
<td>$ 654.00</td>
<td>Once</td>
</tr>
<tr>
<td>AM-120</td>
<td>Solar mounting bracket with leveling plate</td>
<td>$ 116.00</td>
<td>Once</td>
</tr>
<tr>
<td>AM-220</td>
<td>IR Sensor Mounting Bracket</td>
<td>$ 72.00</td>
<td>Once</td>
</tr>
<tr>
<td>YDUFL-SMA-100</td>
<td>UFL to SMA cable (100mm)</td>
<td>$ 30.00</td>
<td>Once</td>
</tr>
<tr>
<td>YD-PMB</td>
<td>Pole Mount Bracket</td>
<td>$ 30.00</td>
<td>Once</td>
</tr>
<tr>
<td>YD-USB</td>
<td>YDOC external waterproof USB</td>
<td>$ 35.00</td>
<td>Once</td>
</tr>
<tr>
<td>EP100GL-08</td>
<td>8 Sensor Soil Probe - std (80cm)</td>
<td>$ 990.00</td>
<td>Once</td>
</tr>
<tr>
<td>Dataview</td>
<td>Dataview Software only</td>
<td>$ 350.00</td>
<td>Once</td>
</tr>
<tr>
<td>Dataview</td>
<td>Dataview Web platform. Access for 1 year $240/site/year. User supplies</td>
<td>$ 240.00</td>
<td>Annually</td>
</tr>
<tr>
<td>Data SIM</td>
<td>IoT Data SIM 50MB per device</td>
<td>$ 7.92</td>
<td>Monthly</td>
</tr>
</tbody>
</table>

**Telstra IoT Data SIM Plans**

Critical Information Summary
This summary may not reflect any discounts or promotions which may apply from time to time

<table>
<thead>
<tr>
<th>Telstra IoT Data SIM Plans</th>
<th>PAYG</th>
<th>50KB</th>
<th>100KB</th>
<th>500KB</th>
<th>1MB</th>
<th>5MB</th>
<th>10MB</th>
<th>50MB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly Charge Casual month to month</td>
<td>$0.90</td>
<td>$1.76</td>
<td>$2.09</td>
<td>$2.53</td>
<td>$2.97</td>
<td>$4.95</td>
<td>$6.05</td>
<td>$7.92</td>
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<td>Monthly Data Allowance 0KB</td>
<td>50KB</td>
<td>100KB</td>
<td>500KB</td>
<td>1MB</td>
<td>5MB</td>
<td>10MB</td>
<td>50MB</td>
<td></td>
</tr>
<tr>
<td>What's Not Included</td>
<td>Your plan does not include IoT/M2M equipment, hardware, calls, SMS, MMS, circuit switched data services or international roaming.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excess Data Charge</td>
<td>$30 per MB</td>
<td>$19.60 per MB</td>
<td>$9.80 per MB</td>
<td>$4.75 per MB</td>
<td>$2.85 per MB</td>
<td>$0.9c per MB</td>
<td>$0.5c per MB</td>
<td>$0.14 per MB</td>
</tr>
<tr>
<td>Maximum Early Termination Charges</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Your plan does not have any Early Termination Charges
Next Steps
The group will confirm that the devices are connecting to the Telstra network and logging data over the 4G network.

The ICT International dashboard when working will be accessible on the CFIG website for all grower members to access the weather data.

More information
Contact Veronika Crouch, CFIG Executive Officer cfig@cfig.asn.au

Acknowledgements

- The WA Internet of Things (IoT) DecisionAg Grant Program is funded by the Department of Primary Industries and Regional Development (DPIRD).
- CFIG Host Growers – Lance Turner and Simon Wallwork.
- ICT International for their on-going assistance with our chosen devices and dashboard.
Yuna Farm Improvement Group – Measure of soil plant available water for improved tactical cropping decision making to maximise profit

Belinda Eastough, Elders; YFIG IoT Project manager

**Snapshot**

<table>
<thead>
<tr>
<th>Trialled – Connectivity</th>
<th>IoT</th>
<th>Dashboard</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>On-Farm connectivity</strong></td>
<td><strong>IoT sensors &amp; devices</strong></td>
<td></td>
</tr>
<tr>
<td>3G/4G:</td>
<td>Soil moisture probes x 16</td>
<td></td>
</tr>
<tr>
<td><strong>Dashboards:</strong></td>
<td>Wildeye</td>
<td></td>
</tr>
</tbody>
</table>

**Background**

**Hosts** Craig and Samantha Thompson  
**Location** North-east Yuna  
**Enterprise** Cropping  
**Management** Family farm business  
**Rainfall zone** 250mm annual average  
**Soils** Red loams and yellow sands

Craig and Samantha Thompson farm north-east of Yuna in a 250mm average rainfall zone with a mix of red loams and yellow sandplain.

In 2019 the IoT project hosted by YFIG installed soil moisture probes across 16 properties in the Yuna region. The Thompsons received a total of 162mm of rain (Decile 1) in 2019 so we were able to determine where the approximate crop lower limit was in September/October and how the soil probes should be reading.
Installation of equipment and soil characterisation May 2019

The Sentek enviroscan soil moisture probe was installed as part of the project in May 2019 in combination with Wildeye IoT devices that use 3G/4G mobile connectivity to upload readings every six hours to our YFIG soil moisture probe website which can be monitored remotely by Craig and Sam.

The installation of the probe at Thompsons was relatively easy into red loam soil until 50cm when the corer encountered a thin layer of limestone based rock, then underneath a red clay, making installation of the PVC tubing more difficult than yellow sand.

The soil moisture probes were reading well from the beginning of the project. The soil characterisation was a problem when we put the data into the two programs we used to calculate available soil moisture. We entered the data into Soil Water Express but it continued to show high negative values of plant available water which were incorrect. We revisited the data at Wildeye in a meeting between myself, Wildeye and DPIRD in February 2019.

We have now adjusted the calibration for plant available water for the soil types and the data appears to be more reflective of the soil moisture situation.

Table 1. Comparison of values calculated using Soil Water Express tool to lower moisture readings during the 2019 season

<table>
<thead>
<tr>
<th>Soil sample depth (cm)</th>
<th>Probe’s lowest actual moisture reading during season (assumed to be WP)</th>
<th>SWExpress Wilting point (WP) mm</th>
<th>SWExpress Field capacity (FC) mm</th>
<th>SWExpress Plant Available Water (PAW = FC-WP) mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20cm</td>
<td>1.35</td>
<td>7.6</td>
<td>18.5</td>
<td>10.9</td>
</tr>
<tr>
<td>20-40cm</td>
<td>5.5</td>
<td>7.7</td>
<td>17.2</td>
<td>9.5</td>
</tr>
<tr>
<td>40-60cm</td>
<td>7.6</td>
<td>16.9</td>
<td>22.1</td>
<td>5.2</td>
</tr>
</tbody>
</table>

Note: Wilting point (WP) and Field capacity (FC) (columns 2-5) calculated from Particle Soil Analysis test results using Soil Water Express tool compared to probe’s lowest actual moisture reading during the season (column 1) The calculated values appeared to be incorrect as probe output was showing negative values of PAW. Probes were re-calibrated using new wilting point from column 1.

Decision making information

Over the length of the project information has been gathered regarding how much soil moisture in the profile. Craig and Sam Thompson use this information with the aim of making the following management decisions.

1. Value of summer rainfall

Craig and Sam Thompson farm in a variable low rainfall environment and summer rainfall events impact on their rotation decision making, as canola and lupins have a high degree of risk at North East Yuna when planted without summer rain. This area can be subject to erratic summer thunderstorms generated due to low pressure systems moving through the Gascoyne which impact greatly on profitability. The soil probe enables them to put a value on how much soil moisture has been stored due to summer rain, generally based on farmer experience in this area 10mm of plant available moisture at seeding equates to 50-150 kg/ha grain depending on the crop type, temperature etc.

2. Post-seeding nitrogen application

The amount of stored moisture in June/July will impact on how much post emergent N will be applied. Usually 20kg/N/ha is applied at seeding and whether any follow up is
applied depends on the potential of the crop. The plant available water probe reading will enable the Thompsons to make an informed decision of the risk of applying more nitrogen.

3. Grain filling, crop yield potential

The amount of available plant available moisture will assist in decision making in September/October with regards to forward selling of grain, and potential expenditure for the following season. If there is a low chance of finishing rain, grain fill will depend entirely on temperature and plant available moisture as we saw from the soil moisture probes in 2019 in September. These tools enable better financial decisions to be made when combined with forecast temperatures and the probability of rainfall events.

Presentation of information on the YFIG/Wildeye platform

The Thompsons received approximately 35-40 mm in late March in a thunderstorm during which their rain gauge was destroyed (they do not have an automatic rain gauge). You can see from the below graph the increase in stored soil moisture that would correspond with the rainfall.

![Figure 2. Wildeye dashboard display of Thompson's soil moisture probe](image)

The total soil moisture graph assists in seeding decisions such as species choice in marginal areas that are dependent on summer rain to successfully grow lupins and canola.

The soil probes take up to 18 months to “bed in” but at this stage Craig and Sam’s soil moisture probe appears to be reflective of the rainfall received and corresponds well with the closest DPIRD soil moisture probes.
Figure 3. Kim Batten (YFIG) and Craig Thompson, “Yamma”, validating Craig’s soil moisture probe after 35mm rainfall on 24 March at north-east Yuna.

More information
Contact Belinda Eastough, Elders agronomist belinda.eastough@elders.com.au
SEPWA – Internet of things project highlights strengths and weaknesses in current technology

Niki Curtis, Executive Officer, SEPWA

Snapshot

<table>
<thead>
<tr>
<th>Trialled – Connectivity</th>
<th>IoT</th>
<th>Dashboard</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>On-Farm connectivity</strong></td>
<td><strong>IoT sensors &amp; devices</strong></td>
<td></td>
</tr>
<tr>
<td>WiFi:</td>
<td>Weather Stations, Paddock Stations, tank level sensors</td>
<td></td>
</tr>
</tbody>
</table>

**Dashboards:** Origo FarmHub

Background

<table>
<thead>
<tr>
<th>Hosts</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mark and Hayley Wandel</td>
<td>Scaddan and Beaumont</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Enterprise</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cropping</td>
<td>6 permanent staff plus casuals at seeding and harvest</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>10,500ha arable (4 properties)</td>
<td>Belgium Road, Scaddan</td>
</tr>
<tr>
<td>Home farm Scaddan (50km N or Esperance)</td>
<td>Regal Heights, Scaddan (32km WNW of the home farm)</td>
</tr>
<tr>
<td>Beaumont (100km NE of Esperance)</td>
<td></td>
</tr>
</tbody>
</table>

Lessons learned

- Paddock weather stations, soil moisture probes and tank sensors can all support efficient, streamlined and consistent management decisions in larger broad-scale operations that rely on staff.
- Technology is changing fast and in-paddock hardware, such as soil moisture probes, need to be maintained and serviced.
• Growers will need to have confidence in a technology business before they purchase equipment in the future.

Mark and Hayley Wandel wanted to be involved with the Department of Primary Industries and Regional Development (DPIRD) Internet of Things project so they could stay abreast of technology from the outset. The Internet of Things project ended in March 2020.

The Wandels and Phil and Bindy Longmire funded 50% each of the cost of equipment which was installed into both properties by Phillip Honey of Environmental and Cropping Technologies Australia and Origo Farm. DPIRD invested almost $40,000 into the project which utilised 3G/4G mobile and Wi-Fi in a mesh network as a connectivity solution to support IoT operation through a collaboration of data sharing between the two neighbours with several adjoining properties at Beaumont and then back to Scaddan.

Having properties spread in a 170km radius in varying climates presents challenges for staff making decisions based on seasonal conditions. Time and money were often wasted by driving to another farm, only to find that conditions weren’t right. Mark said installing weather stations, soil moisture probes and tank sensors across their properties last year was already helping his employees to make good and timely decisions using the technology to back them up. Although the technology had only been working a short time, already the business was seeing benefits.

“We rely on our staff to make many of the day to day management decisions now, and this technology gives them more information which in turn makes them more confident in their jobs,” he said.

Tank sensors on another property 30km away meant that they could pump water between tanks and know when to turn it on and off remotely.

“Quite often we didn’t really know what was going on at the Belgium Road property. Even though it was only 30km away, quite often we would get up there and find it was very different to conditions at the home farm,” Mark said. This would result in time and money wasted in a 60km round trip.

Spraying chemical was a sensitive issue and to avoid any drift, operating in the right conditions was essential, especially given that some paddocks at Beaumont were 800ha and were prone to inversion issues.

Sharing the data with neighbour, Phil Longmire gave a broader picture of such things as soil moisture, rainfall, humidity, temperature and wind speed and direction across the adjoining properties. Knowing how much rain and soil moisture would give confidence in that final N application decision and earlier in the season, a good indication of inputs at sowing.

“Although the information on its own isn’t always reliable, it all helps with the gut feel,” Mark said.

Mark and Hayley said they were still waiting on some hardware to be installed and the process had been frustrating at times. The technology provider had been slow to source and install the equipment and had suffered a lot of staff changes and technology glitches along the way.
“We understand that this is a newly developing industry, so it will take time for providers to get established and we hope the companies involved have learnt from this project also”, Hayley said.

The Wandels expected most growers in marginal areas couldn’t justify purchasing technology, still due to the cost and lack of confidence in the many start-up technology providers.

“If you purchase equipment, you want to know if you are going to get serviced after, and that the equipment is still going to be working for you in 10 years.”

Hayley said although the set-up process had been frustrating at times, it was still good to get involved with new technology now and be more prepared for what else was coming. One of the best things to come from the project for the Wandels had been the installation of a repeater station in the shed that beamed back to the house. This enabled a lot more data to be shared from the mobiles owned in their company.

“We used to only have 50GB to run the farm office on and hardly any reception from the Scaddan tower, especially at peak usage times, but we now have 300GB to share between us and it hardly ever drops out anymore,” Hayley said.

The Wandels hoped that once the entire system was up and running, they could eventually have an App that could process the data and make it more user-friendly. They found the current dashboard “clunky” to use.

This project is one of fifteen sharing in $583,000 of funding through the eConnected Grainbelt Project’s WA Internet of Things (IoT) DecisionAg Grant Program.

**More information**

Contact Niki Curtis, SEPWA Executive Officer [eo@sepwa.org.au](mailto:eo@sepwa.org.au)
Merredin and Districts Farm Improvement Group – Broadband in the Paddock
Sian Paddy, Administration Officer, MADFIG

Snapshot

<table>
<thead>
<tr>
<th>Trialled – Connectivity</th>
<th>IoT</th>
<th>Dashboard</th>
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</thead>
<tbody>
<tr>
<td>On-Farm connectivity</td>
<td></td>
<td>IoT sensors &amp; devices</td>
</tr>
<tr>
<td>WiFi:</td>
<td></td>
<td>Weather station, rain gauge, soil moisture probes, cameras</td>
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<tr>
<td>Dashboards:</td>
<td></td>
<td>GoannaAg</td>
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Background

<table>
<thead>
<tr>
<th>Hosts: Dolton family</th>
<th>Location: Bruce Rock</th>
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</thead>
<tbody>
<tr>
<td>Enterprise: Mixed cropping</td>
<td>Management: Family business</td>
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<tr>
<td>Size: 3640ha</td>
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</table>

Background

Leigh Dolton and his family, along with his parents, farm north east of Bruce Rock in the eastern wheatbelt. Leigh crops wheat, canola, barley, oats, hay, peas and lupins. Connectivity has always been an issue on their property, with numerous black spots, particularly where it could be most useful, around their sheds and workshops. Leigh has a lot of experience in data collection and IoT devices, previously being a part of the Digital Rain Gauge Network with MADFIG and having a DPIRD weather station on his property; plus numerous other data collection platforms.

Farm security was high on Leigh’s priorities when looking at this project. By installing cameras over fuel tanks on his home block, Leigh can have peace of mind if anything did happen, with 24/7 recordings available to play back. Connectivity around the sheds and workshop is pivotal for the day to day running of any farm. It is something that is taken for granted. Leigh mentioned the ability to make calls, to google or search for parts or repair manuals online was missed while working at the shed.

Installation and Set Up

Agrinet supplied a complete Sleepy WiFi system for Leigh to install himself. Leigh purchased and installed several masts to set the system up on, including several to go on top of his sheds. The dashboard and connected devices (weather station, rain gauge and soil moisture probe) were all supplied (and supported) by Goanna Ag.

Installation was hampered with delays due to supplier issues and the timing of farming operations (harvest). Therefore, the system is not completely set up and functional. Leigh has experienced several issues with component failures which have had to be fixed by the supplier.

The WiFi set up around the sheds and workshops has been of immediate benefit to Leigh. He now can make and receive calls, as well as has a speedy internet connection. The camera above the fuel tank is completely operational and Leigh is pleased with the ability to look back on 24/7 footage if needed. Due to the delay in installation, some component failures and the day to day running of the farm, Leigh has yet to make any informed decisions with the data available to him through this project.
In saying that, Leigh has found the set-up of the Goanna Ag dashboard easy to use and understand. Leigh’s vision for the future is to see all his data platforms rolled into one. From that he can make informed decisions, often on the spot, by opening this ‘dashboard’ and using the data available at that time.

More information
Contact Sian Paddy, MADFIG Administration Officer admin@madfig.com.au
Lakes Information and Farming Technology – Farm Wide Wi-Fi Network: LIFT-ing awareness of IoT Technologies

Georgia Reid, LIFT

Snapshot

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<td><strong>On-Farm connectivity</strong></td>
<td><strong>IoT sensors &amp; devices</strong></td>
<td><strong>Dashboard</strong></td>
</tr>
<tr>
<td>WiFi:</td>
<td>Rain gauge, water tank monitor, Lick feeder level, Agritracking, cameras</td>
<td>Custom build</td>
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Background

**Hosts:** Gary and Aaron Guelfi, Alfranco Farms

**Location:** Newdegate

**Enterprise:** Mixed farming

**Management:** Family farm business

**Size:** 6000ha, 4800ha arable

**Existing farm connectivity:** 3G/4G mobile, NBN Sky Muster at the house; no internet access at the sheds or yards

**Background**

Gary and his family farm in Newdegate on 6 000ha hectares, of which 4 800ha is arable. Connectivity on the property consists of patchy 3G coverage, with limited 4G coverage at one end of the farm. NBN Sky Muster is being used at the house with no internet access at the sheds or yards.

In a previous life Gary was the owner of Newdegate Computers, so has had extensive experience with technology. The farm currently has AgriTracking in all of its vehicles, supplying location and tracking data. Two Vantage Vue weather stations or rainfall gauges are currently being used to track weather data.

The varying topography of Gary’s property adds to the patchy connectivity issue. One of the biggest issues on farm is the limited supply of water; so any devices that can be used to monitor water supply is of benefit. It also saves the time during the day doing manual water tank checks.

Security of property and supplies can also be an issue in regional Western Australia, so the use of 24-hour cameras will provide peace of mind.

**IoT Devices**

Alfranco Farms had three tank monitors installed and one roving PTZ camera. All hardware was supplied through Simply Farms.
Figure 1. Example of the dashboard showing tank water levels

Figure 2. Overview of Alfranco’s device locations and topography

Tower 1 was positioned to provide Wi-Fi coverage across much of the property. Using LoRa technology means distances of up to 20-30 km of coverage are not uncommon and any drop out issues are down to the device rather than Wi-Fi signal. As the tower was made from a recycled SES tower, height (and therefore coverage) was not an issue.

Solar panels and batteries were also installed to power the unit. Tower 1 was fitted with a point to point antenna to Aaron’s PTZ camera, a point to point antenna to the
workshop where a 2nd base tower was installed, an omnidirectional antenna which would omit and radiate Wi-Fi and a LoRa antenna.

A PTZ camera was fitted at Aaron’s to cover two main entrances and access the house and current sheds. The PTZ will be programmed to continually scan between the four points over the 24 hour period.

Three tank sensors were also installed, these tanks varied in distance from the main workshop. Two were installed on critical tanks essential to stock and the property. All were connected to the IoT software being designed and shaped by Olaf for each individual property owner. Everything was installed by Gary, Aaron, Jim and Olaf, the local contractor for this project. The majority of fittings and structures were recycled on farm.

One of the key findings upon installation, was that line of sight was key for signal strength. Plans had to be adjusted and trees had to be trimmed to be able to achieve
this at Gary’s. The ability of the hardware to be flexible was one of the most surprising, but beneficial, findings in this install. Receiving the daily emails in the morning provides Gary with a snapshot of his tank levels meaning he can make decisions on his day around the information that is provided. Gary agrees that it is a huge time saver and this system can be anything the grower would like it to be.

Gary believes he will build on his system, with a moisture probe next on the agenda. Rain gauges would be a benefit to Gary’s business, especially for its historical data.

“It’s got to be relevant to us”, mentions Gary, “and we’ve got to establish whether it will work for us here. I’ve enjoyed being involved in this project and it has proven of benefit to our business.”

Figure 6. Aaron enjoying the newly installed camera

More information
Contact Georgia Reid, LIFT georgia@agpromanagement.com
WA College of Agriculture, Morawa – Developing on Farm IoT technology

Leanne Grant-Williams, Farm Manager

Snapshot

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<thead>
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<tr>
<td>On-Farm connectivity</td>
<td></td>
<td></td>
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<tr>
<td>WiFi:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil moisture probes, weather station, camera monitors (fuel bowser, water tank and water point, front gate, electric fence) vehicle repeaters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dashboards:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GoannaAg</td>
<td></td>
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</tr>
</tbody>
</table>

Background

Hosts: WA College of Agriculture Morawa
Location: Morawa
Enterprise: Cropping and livestock
Management: College farm
Size: 3242ha,1200ha arable

Background

WA College of Agriculture – Morawa is situated 360km north of Perth, adjoining the Morawa town site. Total property area is 3242ha with 1200 ha arable. In addition to cropping, the college also has enterprises in cattle, merino and crossbred sheep, a piggery and an abattoir with a retail licence. The College offers a hands on approach to education using traditional classroom teaching combined with learning through Farm Skills, Automotive and Engineering workshops and Plant and Animal Science based subjects.

In the beginning

The staff thought it would be easy — we saw some really cool applications that could be ground-breaking in the learning for our students and staff. Did we choose the right sensors and did we know what we were getting into? Did we have any understanding of what the equipment could do? After much consultation we chose a company from the eastern states and we hoped that we had chosen a great network option. We were so wrong!!

Eventually we were able to engage a local electrician who could do the installation. It went pretty well but not all sensors arrived with the main group and these came in dribs and drabs over the coming months. Cameras and solar panels were first to come on line, followed by weather stations. We only found out after 10 months that some sensors were not connected to the network and that they had never been installed correctly.

Lack of communication

Many months passed with no communication from our supplier and no one knew what was required to finalise the install. Still nothing happened for over 10 months and the timeframe for the end of the grants process was looming.
On 1 May a new farm manager came and took over the project. It was established that we needed an additional modem to ‘sync’ with the wifi cameras as the Department of Education firewall could not be configured.

Trying to find out information from the supplier and electrician was challenging as no one seemed to want to release information. We learnt a lot about fault-finding but due to the complexity of the network we were not able to see if we were successful in eliminating the faults. Each time a fault was identified the provider would remotely access the network. This is proving costly as remote access uses a lot of data and we are mindful of the costs we are encountering. After a log of emails and telephone calls towards the end of June (2020) we had connectivity.

The IoT devices

Weather stations

These will give up to date weather information which will be used for spraying identifying Delta T readings, rainfall, wind speed and dew points. The weather stations that we have do not have a very clear user friendly dashboard for data analysis. Dashboards were not a priority during the design phase by our supplier nor did they understand our needs. We will continue to work through this issue.

One weather station developed a flat battery as this was not being charged from its solar panel. We have since purchased an additional battery for future failures. We are not able to purchase these batteries locally and will need to buy one from Geraldton.

We had one weather station that was problematic and we shifted it back to the main area at the College. As we have demonstrated that stations can be moved we will in
the future move this station back to the outlying property. This will be a good learning opportunity for our students and staff to take away following year 12.

**Live feed cameras – front gate**

We are able to see the live feed for the front gate. We can clearly see people and vehicles coming through the front gates. We have used this live feed to identify a thief who stole a fuel container from the farm truck, with clearly identified vehicle number plates on film. This information was given to the local police officers. This data is being stored and we can go back at least four weeks, as live feeds are date and time stamped.

**Front gate remote closing**

While the remote closing front gates were installed along with the majority of sensors this has not be operational until 30 June. Following trial operations, we have identified that we will need to have a keypad mounted at the front gates to allow entry to staff who work ‘unsocial’ hours. Some cleaning staff start at 5am and they will need to gain access. The gate equipment includes some key fob clickers but, as the unit is only supplied with two clickers and we have over 50 staff members working on site, we will be putting in a keypad at the front gate for access. At times during holidays and weekends we will need to have these gates shut. With a keypad entry this will allow people coming on site for maintenance work to be issued a separate code for entry and these entries can be monitored.

**Live feed camera – fuel bowser**

We have used this live feed to identify a thief who stole a fuel container from a farm truck over a weekend late at night.

**Water tank sensors**

These remote sensors will in time prove to be very useful to the farming operations. On our outlying blocks we will be able to ensure that there is adequate water for our stock over the summer time. As we become more adept at using the clunky dashboards we will gain expertise. Hopefully we will be able to get all data coming to one dashboard for analysis.

**Vehicle WiFi repeater**

These are yet to be installed by our electrician. On further investigations one of our staff will connect these to the harvester and the main seeding tractor. We have been told that we will be able to send data generated from our John Deere GreenStar software back to our main computers and also send to our agronomist for analysis. With the changing face of agriculture, by using live information, this will have huge benefits with our grain marketing as we will be able to see on-the-go grain analysis for marketing and segregations.

**Soil moisture probes**

These are yet to be installed but will be installed by farm staff as soon as they arrive. With previous experience these should be valuable tools for making decisions for urea and fertiliser applications, estimation of crop readiness for harvest and assisting with crop harvest estimates. As we will have data on effective water use efficiency this tool will be a bonus when making cropping and harvest decisions.
Electric fence monitoring
This is only just working — we have insufficient information on its effectiveness at monitoring our fence network. We have not been able to look at data generated and need to get this information put onto one of the three dashboards.

Student learning and engagement
Due to the lateness with the complete installation there were limited opportunities for students to see possible applications for the network.

Students are all keen to see what the network will offer as a learning tool. Most have seen other dashboards and applications as used at Cunderdin agricultural college. They are keen to see live feeds from cameras strategically placed around the college site — this is very popular with all students.

The live feeds will be developed further and these should be very interesting to monitor livestock movements at watering points and check water tanks to serviceability. When students can visualise an application they are more likely to want to know more about concepts and activities.

Where to now? The learning begins
Now we have full connectivity we will be working to overcome some of the problems we have inherited to include:

- Seek assistance and investigate if we are able to have one dashboard to monitor all the devices and applications in one site. Currently we have to log on to three different sites to see all the applications.
- Commence on-farm learning over the school holidays so when students return farm staff are all familiar retrieving data from our sensor network and use in the day-to-day operations on the college farming property.
- Hold instruction sessions for teaching staff so that they are able to navigate the dashboards, use data within the context of classroom lessons. Ensure all staff are able to login to the webpages and navigate around the data.
- Continue to develop network sensors and fine-tune fault finding so we can involve students to gain additional skills using a variety of hand-held tools and electronic gadgets.
- Investigate with students other applications for consideration in 2021 budget. Students to research with assistance possible additional sensors to add to the network.
- Develop understanding of how the data will assist in the farming operations working with agronomists and dealer networks to retrieve data.

More information
Contact Leanne Grant-Williams, WACOA Morawa Farm Manager Elizabeth.Grant-williams@education.wa.edu.au
Edmund Rice College, Bindoon – Supporting training and education in on-farm technologies

Salomee Poongavanon, Science / API teacher

**Snapshot**

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<tbody>
<tr>
<td>On-Farm connectivity</td>
<td>IoT sensors &amp; devices</td>
<td></td>
</tr>
<tr>
<td><strong>Sleepy WiFi:</strong></td>
<td>Weather station. Soil moisture probes, electric fence, water tank level, cameras</td>
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</tr>
<tr>
<td><strong>Dashboards:</strong></td>
<td>Easyviewer</td>
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</table>

**Background**

<table>
<thead>
<tr>
<th>Hosts: Edmund Rice College</th>
<th>Location: Bindoon</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enterprise:</strong> Cattle, sheep, olives, oat hay production</td>
<td><strong>Management:</strong> School farm</td>
</tr>
<tr>
<td><strong>Size:</strong> 3300ha</td>
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</tr>
<tr>
<td><strong>Existing farm connectivity:</strong> 3G/4G</td>
<td><strong>Topology:</strong> Undulating</td>
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</tbody>
</table>

**School background**

Edmund Rice College is located on 3300 hectares of farming land in the Chittering Valley north of Bindoon which is just over one hour's drive from Perth. The College focuses on agricultural training in a practical and hands-on learning environment. The College is committed to providing training in innovative farming techniques for our students to equip them to become conversant in leading agricultural development. The College strives to demonstrate best practice in farming within the local community.

Despite being only one hour from Perth metropolitan area, communications and mobile coverage is not available across the whole farm and internet connectivity is unreliable. For this reason, the College has not installed any IoT (Internet of Things) devices before.

Recently, the College was honoured in receiving the WA IoT grant from the Department of Primary Industries and Regional Development (DPIRD), and that has reshaped Wi-Fi connectivity across key parts of the farm and allowed us to benefit from IoT devices.

**Problems/issues to be solved by installing the technology**

Due to the irregular terrain and topography of the farm, there was a need to integrate a range of IoT devices on the farm, to ensure Wi-Fi network coverage. We needed high bandwidth connectivity not just to the farm office but to all the outbuildings such as the sheds, the yards and the paddocks.

In partnership with Agrinet, (an innovative Wi-Fi technology company) which is experienced in regional applications, Edmund Rice College was able to install ‘Sleepy’ Wi-Fi repeaters in various key areas of the farm site which can provide a high bandwidth Wi-Fi network that is fast enough for internet browsing and VOIP calls as necessary. These technological installations have proved extremely successful in enabling us to integrate a range of IoT technologies.

**Installation**

Relocatable IP cameras were installed in strategic sites around the farm, for example, cattle club, shearing shed and equine, which has allowed for remote monitoring.
Photo 1 shows the camera mounted at the shearing shed showing all the shearing area, tables and other side of the partitions to the wool press.

Photo 2 shows a camera placed on an extended arm 45 degrees angle from the corner of the cattle shed. This allows the camera to be rotated 360 degrees viewing into the pens, easterly yards, and other paddock. This camera will allow students to witness birthing and to monitor cattle in the yards.
Photo 3 shows a screen shot of the cameras mounted at various points around the farm site which allows the farm manager(s) to monitor activities on the farm when off site.

Monitoring the water tank has often been challenging at the College. A water level monitoring system was one of our priorities. One of the key aspects of this system is the high sensitivity water sensor that can also sense leakage of water and determine the water level. This can be monitored and analysed on a smart phone from anywhere.

Wi-Fi connected weather stations, soil moisture probes and electric fence monitors are integrated on the school farm but are not yet operational.

Once fully installed, these devices will enable us to collect and maintain a record of the storage and analysis data generated from the IoT apps.
Staff and students from the various learning areas at ERC actively participated in discussions relating to the diverse technology being installed at the farm site and demonstrations were given with respect to the installation of a weather station (Photo 5).

The project at ERC has been a journey for many staff and students. Everyone has had some input, and all were given insights and ideas about the project. The key questions of IoT installation of devices to integrate learning, was perfectly adapted to the process of Project Based Learning, (PBL) which has been rolled out across all learning areas of the college. With the installation of cameras and water tank monitors, students and teachers were quite excited about the prospect of being able to collate and analyse data once obtained.

Edmund Rice College is grateful to the DPIRD for the generous grant received towards this project, the partnership with Agrinet and to all agencies and individuals who have contributed in many ways, making this a success. However, due to the current COVID 19 restrictions, we have had to postpone some events until it is safe to proceed. When the event does go ahead, we intend to invite all the local farmers and this will assist us in the networking process within the local community. Additionally, we intend to explore other application(s) of IoT on farms and hope to subsequently expand the knowledge to the wider community at the annual Bindoon show, through the school Facebook page and the coming college open day in September.

More information
Contact Salonee Poongavanon, salonee.poongavanon@cewa.edu.au
### WA DecisionAg IoT Project - Equipment Providers – Quick Reference

<table>
<thead>
<tr>
<th>Project ID</th>
<th>Organisation</th>
<th>Solution Provider</th>
<th>Connectivity Provider</th>
<th>Third party providers</th>
<th>IoT – sensors &amp; devices</th>
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<td>Stirlings to Coast Farmers</td>
<td>Telstra 3G/4G LoRaWAN Satellite</td>
<td>DTN AxisTech GoannaAg SCF AxisTech</td>
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NB: *Technology not chosen by Wildeye

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