Final report

Trial of Goanna Ag's low-cost sensors and connectivity to optimise water management across Romani Pastoral Co Redbank station and significantly improve on-farm efficiencies

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Abstract

Digital farms are important for the longevity of Australian red meat supply chains, whether that be to inform consumers of our credentials such as the CN30 program or Beef Sustainability initiative or to improve production businesses as part of the evolution of the digital age. The Romani Pastoral Company project demonstrated technology that was not available previously, or willing to be provided at the time, during a potential Carwoola Pastoral Company project- Phase 2 initiative jointly undertaken by Meat and Livestock Australia (MLA) to showcase to industry.

In November 2018, MLA hosted the inaugural Digital Forum, as a commercial testing ground for Agtech innovation. The Digital Forum was designed to push industry innovation providers to work together within networks and visualisation tools and also to commercially test the robustness of their devices and services.

Sensors are becoming more relevant to modern farming systems as agriculture, as an industry, becomes more data centric. The data from a collection of sensors can enhance the efficiency, safety and quality of a farming enterprise. This is achieved by gaining greater control and insight into on-farm assets, allowing producers to make better management decisions in a shorter amount of time.

Goanna Ag deployed a LoRaWAN telecommunications network as well as a range of sensor solutions across the Romani property "Redbank Station" to assess this thesis. Overall, both the network and sensor solutions performed well. Third party sensor providers had varied results in connecting their solutions through a standardised telecommunication medium.

This report highlights key lessons learnt in this space.

Executive summary

Background

Sensors are becoming more relevant to modern farming systems as agriculture, as an industry, becomes more data centric. The data from a collection of sensors can enhance the efficiency, safety and quality of a farming enterprise. This is achieved by gaining greater control and insight into on-farm assets, allowing producers to make better management decisions in a shorter amount of time.

The purpose of this project is to assess the value of currently available sensor technology for the livestock sector to assist producers in decision making, and to potentially inform future R&D investment where gaps are identified.

Objectives

Supplied, install and made operate the following digital components:

1. 2 Solar powered, LoRaWAN base stations
2. 10 Water trough sensors
3. 4 Water tank sensors
4. 1 Diesel fuel tank sensors
5. 15 Gate and door sensors
6. 3 Weather stations
7. 2 Rain gauges
8. 4 Water flow monitoring sensors; and
9. 3 Soil probes

Methodology

- Plan and install appropriate LoRaWAN infrastructure to provide farm wide sensor connectivity;

- Install and operate nominated sensor technology at client identified sites

- Train client staff in use of sensor technology

- Provide other sensor suppliers' support for use of the LoRaWAN network

Results/key findings

Low powered sensor solutions can provide a number of benefits including labour efficiencies, risk mitigations and more informed decision making.

Sensor solutions have some way to go to be seamlessly compatible over third party supplied network infrastructure.

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1. Background

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In November 2018, Meat and Livestock Australia (MLA) hosted the inaugural Digital Forum, as a commercial testing ground for Agtech innovation. The Digital Forum was designed to push industry innovation providers to work together within networks and visualisation tools and also to commercially test the robustness of their devices and services.

Sensors are becoming more relevant to modern farming systems as agriculture, as an industry, becomes more data centric. The data from a collection of sensors can enhance the efficiency, safety and quality of a farming enterprise. This is achieved by gaining greater control and insight into on-farm assets, allowing producers to make better management decisions in a shorter amount of time.

Goanna Ag has a fleet of hardware solutions that monitor; soil, water, weather and inventory. Goanna Ag solutions are connectivity agnostic and utilise LoRaWAN, 3G / 4G and Myriota protocols. For this project, Goanna utilised LoRaWAN. The data collected by our deployed sensors is directed to GoSat, a powerful platform that relays accuracy around irrigation scheduling, satellite imagery and benchmarking functionality, as well as yield forecasting. The GoApp, downloadable on smartphones, tablets and iPads, allows you to access your secure and reliable data at your convenience.

2. Objectives

Supply, installed and made operationalise the following digital components:

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All of the above objectives were met with the exception of the 15 gate and door sensors which proved unsuitable for installation on external equipment.

3. Methodology

3.1 Site identification

The initial task of the project was to identify the most suitable sites for network base stations to be deployed to provide coverage across as much of the properties as possible, specifically ensuring that the sensor install locations were guaranteed coverage.

A visit to Redbank station occurred in late 2019 to visually inspect the sites and to understand the terrain and property layouts. The ideal locations for gateway installations are determined by a number of factors, including:

- Pre-existing infrastructure that could be utilised for installation;
- Land height (the higher the install, the larger the coverage footprint generated);
- Surrounding infrastructure shadows; and
- Vegetation coverage.

It was determined that two network gateways would be required, with the most ideal locations sited at the following co-ordinates:

i) Garangula: 34°42'26.12"S, 148°19'54.21"E
ii) Redbank: 34°44'43.63"S, 148°23'12.57"E

The next step was the to conduct a radio-frequency (RF) network planning process to ensure that full coverage is achieved from those sites.

3.1.1 RF network planning

The network planning process involves assessment of the topography of the farm to identify the most appropriate location for a LoRaWAN network base station to be installed to provide maximum coverage both spatially and in terms of signal strength. A 20m digital elevation model of each property is combined with LiDAR imagery showing tree height, density and building dimensions as well as telecommunications coverage maps (3G, 4G and satellite) to create an anticipated coverage map known as an RF plan.

The outcome of the network planning process is a "coverage map" that shows anticipated coverage of the LoRaWAN network from the suggested installation point. If this step resulted in a coverage map with a poor footprint, alternative sites would be reviewed as alternatives.

3.1.2 Design most appropriate network installation

With gateway installation sites confirmed, the next step is to determine the most appropriate design and installation method for the LoRaWAN network base station depending on the structure the base station will be installed.

General components of a base station include a solar panel, an enclosure with the network hardware and battery array and an external antenna – all up weighing around 70kg.

In addition to the general componentry described above, there are a number of site-specific install requirements meaning that each base station installation is a custom build depending on site specification.

Given the likelihood of livestock proximity to the install location, use of guy-wires as part of design and install must be eliminated.

3.1.3 Network operation

MLA requested that Goanna Ag provide the LoRaWAN network connectivity for all LoRaWAN sensor providers rather than have a everyone install their own network instances. Part of the driver for this was to reduce physical infrastructure installed across the properties and a part was to assess the ability for different provider's technologies to work in a cooperative manner.

In preparation we documented the LoRaWAN requirements for devices to be permitted access to the network, all of which comply and reinforce the global LoRaWAN alliance operating standards. This document / process is known as the N-Tick process.

3.1.4 Sensor placement

Sensor installation points had been pre-selected by Romani Pastoral Co and MLA project officers. Other than understanding signal impact, there was no specific methodology employed for this process.

4. Results

Network and sensor installation and commissioning processes took place on Redbank in the week commencing Monday 27th January, 2019 by John Noakes and John Pattinson from Goanna Ag. The final two flow sensors were deployed at the later date of Thursday 10th September 2019 after site identification delays and border closure considerations were overcome.

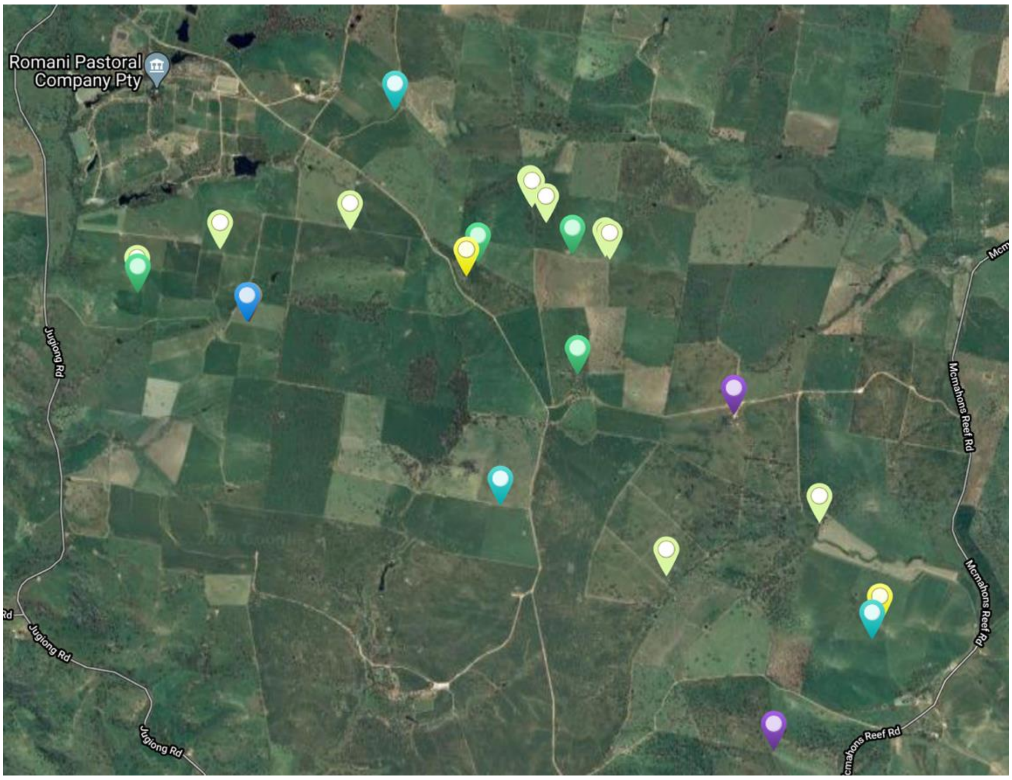

Figure 1: Network gateway and sensor locations across Redback

Key:

LoRaWAN gateway installation

Soil Moisture probe (1 is grey)

Rain gauge

Tanks – both water and diesel

Trough monitors

Weather station

The 2 network gateways were the first infrastructure deployed across both properties. This enabled installation and testing of devices to occur concurrently ensuring that all deployed assets were operational, with sensor data being received by the GoApp platform when Goanna Ag staff left the properties.

4.1Network installation and provisioning

4.1.1 RF Plan

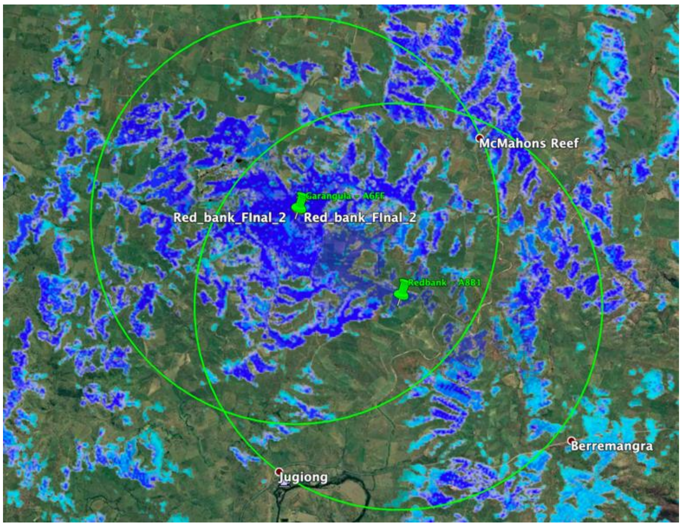

Figure 2: RF Plans for Redbank gateway installation sites

The above picture outlines a conservative expectation of LoRaWAN network coverage from each of the gateway installs on Redbank combined. The dark blue and light blue on the map is the result of different planning processes and do not demonstrate stronger or weaker signal. The green circle denotes a 10km radius which in flatter terrain is a reliable estimation of coverage.

4.1.1.1 Final site installation details

The two identified sites to provide best network coverage across the property were some distance from other significant infrastructure. It was therefore decided that the two gateways installed at Redbank Station (site names are Garangula and Redbank) were to be ground mast installations with the network componentry at least 2m above the ground to remove any opportunity for interference by livestock. The ground mount for the pole was cemented 1.5m into the ground to ensure stability.

Figure 3: Redbank gateway installation photos

4.2Sensor installation and commissioning

The project contract specified the type and number of each sensor to be installed across Redbank Stations and were as follows:

1. 2 Solar powered, LoRaWAN base stations
2. 10 Water trough sensors;
3. 4 Water tank sensors;
4. 1 Diesel fuel tank sensors;
5. 15 Gate and door sensors;
6. 3 Weather stations;
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8. 4 Water flow monitoring sensors; and
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The following sections contain photographs of some of the sensor installation across the properties, however photos of every sensor are not included due to report size implications.

It should also be noted that the 15 gate and door sensors were not delivered due to recommendations by Goanna Ag on their lack of suitability for use following trials on Windy and Warrah Stations earlier in the project.

4.2.1 Water trough sensors

Figure 4: Redbank water trough sensor

4.2.2 Water tank sensors

Figure 5: Redbank water tank sensor

4.2.3 Diesel fuel tank sensors

Figure 6: Redbank diesel fuel tank sensor

4.2.4 Weather stations

Figure 7: Redbank weather station photos

4.2.5 Rain gauges

Fugure 8: Redbank rain gauge

4.2.6 Soil probes

Figure 9: Redbank soil moisture probe

4.2.7 Water tank flow sensors

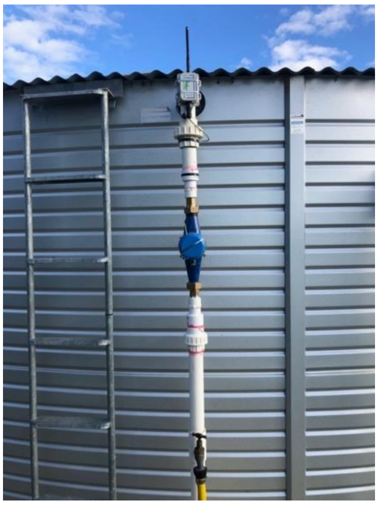

Figure 10: Redbank water flow sensor

5. Key findings

5.1 Network Performance

Since installation, the two gateways deployed under this project have operated seamlessly with a total of 76 minutes of downtime out of 1,054,080 minutes of possible operation time. This represents average network availability above 99.99%. The following graph outlines the Network performance statistics required here.

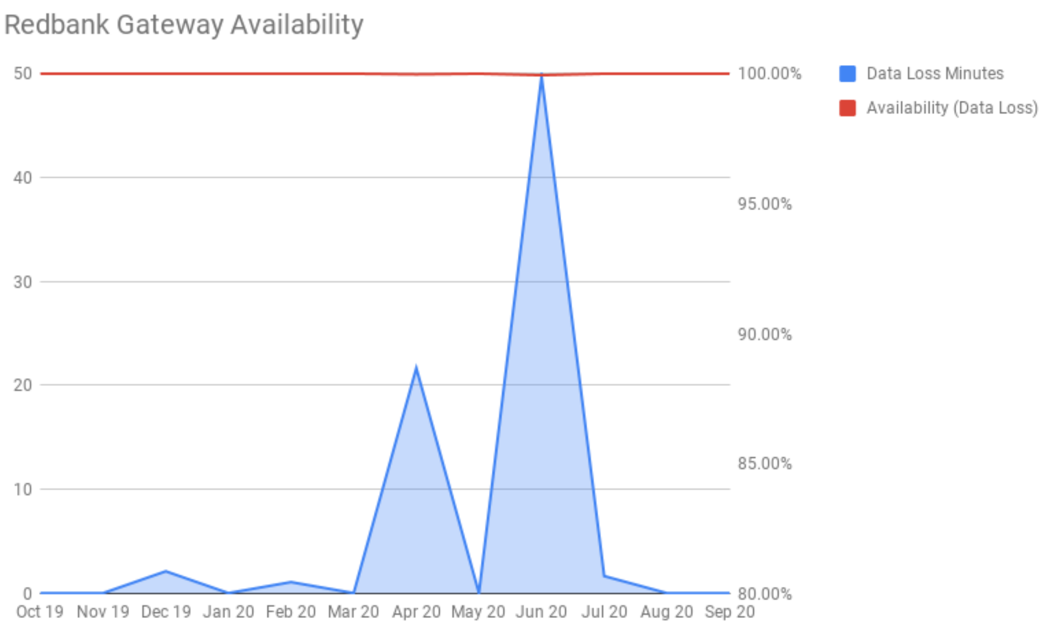

Figure 1: Redbank gateway performance

5.2 Network onboarding

Whilst base requirements to join the LoRaWAN network had been documented for other sensor providers, the reality of on-boarding other manufacturers proved challenging. All other sensor providers were at different points of development maturity and had implemented LoRaWAN with varying degrees of success.

Goanna Ag utilises services from the National Narrowband Network (NNNCo) to manage user authentication, device provisioning and general network management. Whilst this relationship brings the benefit of a telecommunications license for broad operation as well as being able to provide a Service Level Agreement of 99.7%, there are technical requirements imposed on any device on the network to ensure that no device can interfere with signal transmission of other devices.

There was a general misconception amongst other providers that the network would operate as a publicly available network in that any person could join any LoRa (Note not necessarily LoRaWAN sensor) on to the network.

Goanna Ag worked closely with each provider, and the network manager NNNCo, to assist with technical difficulties experienced. Goanna Ag provided separate LoRaWAN gateways to 4 of the providers to establish a test environment to assist with finalising development changes required prior to deployment at no charge.

This combination of issues proved a hurdle for a number of suppliers. Goanna worked with the other LoRaWAN sensor providers to onboard devices for the RPC project. As at the date of this report the other providers have now been successful with their implementation on the Goanna Ag network.   It should be noted that there were broader technical issues than simply joining the network, at least two other providers did not have the software backend to handle and display data ready for implementation which further delayed their ability to successfully install hardware.

5.3 Sensor Performance

Since installation, most of the Goanna Ag sensors have operated relatively seamlessly with the exception of the trough sensors which have proved problematic. The trough sensors have suffered from battery life issues as well as other more technical issues where we have been unable to identify the root cause to date. The batteries have been replaced and performance of these devices continues to be monitored.

5.4 Durability and Reliability of installation

Goanna Ag implemented a number of variations to our standard builds after initial deployment of our sensor solutions on to a livestock property through the MLA Carwoola Pastoral Company trial. We made further modifications to our sensors for use in livestock post deployment on Windy and Warrah stations in late 2019. These modifications were deployed to Redbank:

- more ruggedized deployment of trough sensors, ensuring that the device was sufficiently far enough away from the reach of an animal with a cage enclosure; and
- more ruggedized fencing utilised to protect the sensors and gateways more generally.

Most of these improvements have proved invaluable to the ongoing operation of the device with the exception of the trough sensor as outlined in 4.1.3 above.

We sourced gate sensors from a third-party supplier and found them to be unsatisfactory. After our experience on Windy and Warrah stations, we made a recommendation to not deploy these devices at Redbank.

5.5 Data provision

It was a noted requirement of the project to pass data on to centralised web applications for use by RPC. We have trained the RPC staff on use of our GoApp. We also provide data upon authentication in to the Pairtree platform.

6. Conclusion and recommendations

Overall Goanna Ag's LoRaWAN network and sensor solution deployments are far more rigorous and stable in the RPC trial when compared with eighteen months ago after implementing a number of learnings from MLA's Carwoola Pastoral Company trial. We recognise that our traditional footprint is broadacre and irrigated cropping and the introduction of live animals into the operating environment increases the requirement for ruggedized and protected installations.

Whilst IoT devices will bring significant value pre-farm gate, the maturity of the IoT eco-system needs further refining and agreement on a standard to ensure one type of network infrastructure can support a broad range of solution providers. The current approach for providers to supply their own network installation will make the technology either too complex or too expensive for most producers to engage with.

It is recommended that MLA continue to explore novel AgTech solutions and data platforms with the early adopting producers to drive awareness and uptake in this space.