Deploying LoRaWAN-based IoT Solutions for Enhanced Sustainability and Efficiency in Sugarcane Farming

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Background

Efficient water management and real-time environmental monitoring are crucial to achieving sustainable agriculture, enhancing water quality, and responding to climate-related challenges, especially in water-intensive crops such as sugarcane. This ongoing study describes the deployment, validation, and continuous operation of a robust, user-friendly, and cost-effective LoRaWAN [1] (Long Range Wide Area Network) sensor network tailored specifically for Australian sugarcane farms.

Data Infrastructure for Farms

A network infrastructure for a cane farm must address many criteria:

- **Robustness** Cane farms are hot, wet & sticky; tractors move fast.
- **Simplicity** The network must be easy to deploy and to use.
- **Battery life** Replacing batteries is costly and reduces reliability.
- **Privacy** Many farmers prefer not to share resource usage data.
- **Reliability** Unreliable systems waste water, energy and resources.
- **Low cost** Low unit cost allows denser coverage. Minimise deployment/support skills and reduce service costs.

Methods

Why LoRaWAN?

A network infrastructure that needs cabling for data and/or power is not appropriate for a farm: it's expensive, inflexible and often undeployable. Radio-based options include: Wi-Fi, Cellular networks (4G/5G), NB-IoT, Bluetooth, Zigbee, Z-Wave, LoRaWAN [1], and Satellite. Of these only ***LoRaWAN*** is ***long range*** (up to 15 km), ***low power*** (up to 10-year battery life) and ***cheap to run*** (no per-node servicing costs).

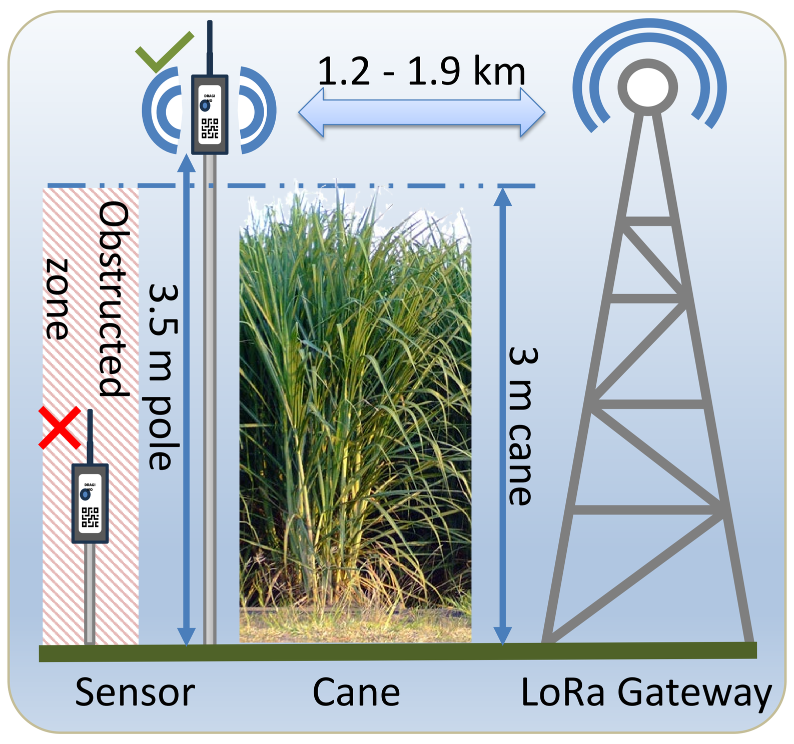
Line of Sight ▪ Robustness ▪ Deployment

LoRaWAN is a star network – each node communicates directly with a gateway. It requires line-of-sight (LoS) between the node and the gateway, without interruptions by trees, buildings or crops.

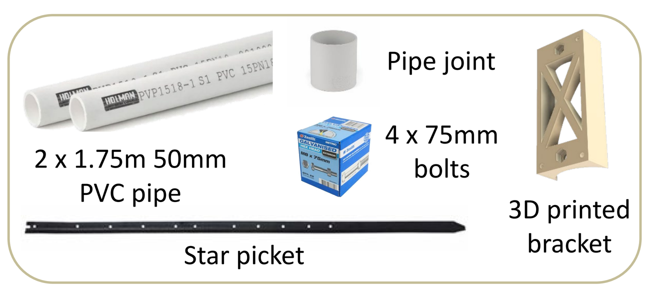
We addressed the ***line-of-sight*** problem by raising the height of the sensors using 3.5 metre poles made from standard PVC 50mm plumbing pipe.

This approach also provided ***robustness.*** The poles are tough and flexible: our units have survived tropical heat, heavy rain & collisions with farm machinery.

Furthermore, the deployment is ***simple*** and ***cheap***: the parts cost less than $50; parts & equipment all fit into the back of a ute.



LoS: "We can't go through it. We can't go under it. Oh no! We've got to go *over* it!" After [2]



Privacy

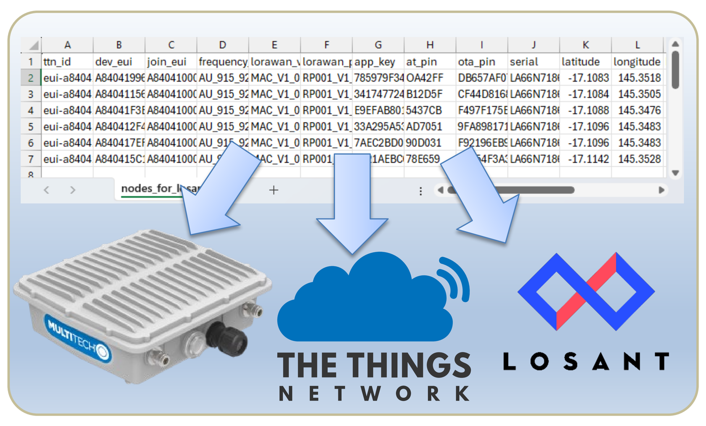
The software and platforms that we used allow the farmer to retain ownership and control of their data at all stages. If preferred, all software components (including databases) can be installed and run locally, without recourse to the cloud.

CotS vs Cost

Supplying a robust, high-quality sensor node requires reliable and economic access to components and to manufacturing capacity. The bill-of-materials for our components alone totaled AU$97.56 (ex-GST); this excludes the costs of assembly, testing, packaging, delivery and support. We bought a component-off-the-shelf (CotS) for AU$77.99 (about AU$20 less), assembled, tested and fully supported: the ***Dragino SN50v3-LB***.

Use this QR code to find out more, or browse to https://bbelson2.github.io/lofdata

Simplicity



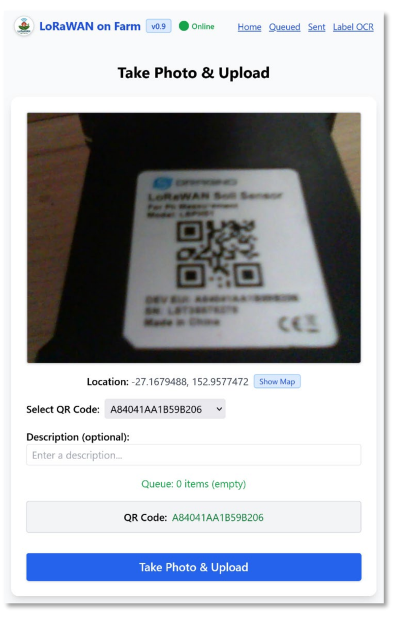
"One list to rule them all"

Configuring LoRaWAN nodes can be extremely complex and require a deep knowledge of languages & platforms. We created a unified list for each farm - a single source of truth - which controlled all phases and destinations of deployment.

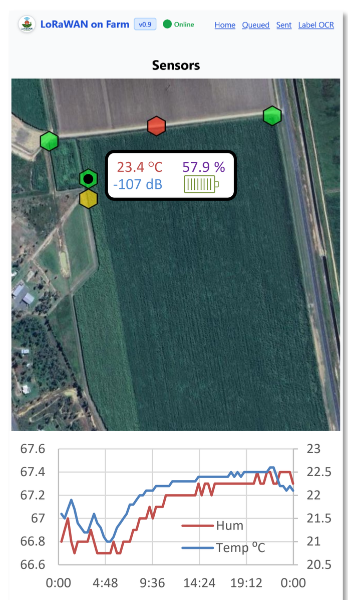
Results

End-user Experience

The farmer can control the system using two intuitive and simple phone apps. The first app lets the farmer connect and locate a sensor in a single step, by capturing the node's QR code, using the phone's camera and GPS location.



The second app shows the state of all sensors and monitored devices, in real-time and historically.



Network Reliability

The network was set up with 4 sensor nodes, each transmitting every 20 minutes, and then left unattended for its 18 months of operation. The nodes were unaffected by severe weather and flooding. When knocked over by harvesters, the poles were easily replaced in position, without any data loss.

Table 1: Gaps in service

Gap size	Gap count	Total
0	48437	92.82%
1	3020	5.79%
2	513	0.98%
3	142	0.27%
4	51	0.10%
5	20	0.04%

During this time 7.18% of packets were dropped and did not reach the server, potentially creating gaps in the record. Of these gaps, 5.79% were single packets, 0.98% were double packets, and 0.41% contained three or more packets.

By using a transmission frequency twice the required data rate, the effective loss rate can be reduced from 7.18% to 1.39%.

Of the four sensors, one showed a 2% drop in battery voltage over 18 months; the others showed 0%. The results support the manufacturer's estimate of a 10-year battery life.

Discussions ▪ Conclusions

Preliminary results indicate that the LoRaWAN system not only simplifies deployment and operation but also significantly enhances the precision of monitoring essential agricultural parameters, while maintaining privacy. This innovative approach improves farmers' ability to manage resources sustainably, optimize crop yields, reduce run-off, and increase resilience to climate variability.

Our findings demonstrate the potential of LoRaWAN technology as a scalable and sustainable solution for modern agriculture, promoting better resource management practices and facilitating a practical response to the urgent need for climate-smart agricultural systems. Further work is planned, including a ***wider range of sensor*** types, and time lapsed ***video data***, analysed locally (on the node) using ***machine learning***.

References

[1] Almuhaya, M. A. M., Jabbar, W. A., Sulaiman, N., & Abdulmalek, S. (2022). A Survey on LoRaWAN Technology: Recent Trends, Opportunities, Simulation Tools and Future Directions. Electronics, 11(1). https://doi.org/10.3390/electronics11010164
[2] Rosen, M., Oxenbury, H., & Aldred, S. (1989). We're going on a bear hunt. Walker London.

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