Final report

Producer lead deployment of Smart GPS ear tags for livestock

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Abstract

This project was undertaken to address the challenge of real-time livestock traceability in remote and extensive production systems through the deployment of smart GPS ear tags. The aim was to demonstrate the practicality and effectiveness of tagging large numbers of cattle and sheep while assessing tag retention rates, integration with farm management systems, and overall system benefits.

Smart Paddock worked with a range of commercial farms across Australia to deploy GPS-enabled ear tags and LoRaWAN network infrastructure. The project targeted tagging 2,000–5,000 head of livestock and achieving a minimum tag retention rate of 85% over two years. Live location data from the tags was integrated with existing farm software, enabling real-time tracking and operational insights for producers.

The project achieved an average tag retention rate of 90%, and tag deployment spanned over 3,000 animals across properties covering more than 1.2 million hectares, showcasing the scalability of LoRaWAN solutions. Key system features included near real-time animal location, solar-powered energy management, and signal strength mapping for gateway placement. Integration with 3rd party platforms demonstrated seamless bi-directional data sharing capabilities. These findings demonstrate the potential for red meat producers to monitor mob and individual animal movements across large areas with no to limited telco connectivity by demonstrating practical deployment scenarios, assessing tag retention, and integrating tracking data with other farm management tools.

Executive summary

Background

This project explored smart GPS ear tags to improve real-time livestock traceability and operational efficiency, especially in remote grazing systems. It focused on helping red meat producers monitor large areas with limited connectivity by demonstrating practical deployment, assessing tag retention, and integrating tracking data with farm management tools.

Objectives

1. Develop and design a commercially practical procedure to deploy GPS smart ear tags for high volumes of sheep and cattle targeting within +/-100% the time it takes for deploying a standard NLIS RFID tag
2. Minimum of three trial sites established at commercial sheep and cattle operations with 2,000-5,000 head of livestock tagged.
3. Real-time location data captured from the smart GPS ear tags and integrated into relevant farm management platforms, the ISC data platform and systems
4. Demonstrate capability to reliably support tracking livestock over 100,000-250,000 hectares of paddock area in remote locations (i.e. no terrestrial telecommunications coverage)
5. Demonstrate tag retention rates of a minimum of 85% over two years with ability to locate and retrieve 25% of any tags 'lost'
6. Evaluation of system benefits vs cost completed with secondary/unexpected benefits accounted for.
7. Development of a communication package including case studies and training videos to be used to communicate project findings.

Methodology

Smart Paddock deployed over 3,000 GPS ear tags across various Australian properties, supported by LoRaWAN network infrastructure. Producers accessed real-time tracking via web and mobile apps. Feedback informed improvements to tag design and placement, and integration was completed with a 3rd party software provider.

Results / Key Findings

The project achieved a 90% average tag retention rate across over 3,000 deployed tags and demonstrated scalable LoRaWAN coverage across 1.2 million hectares. Integration with a 3rd party platform and development of a set of standard APIs enabled real-time location and data sharing, and enabled the ability to introduce distressed animal detection. Software and hardware improvements—including enhanced GPS accuracy, streamlined tag-to-animal association, and expanded mobile app functionality—contributed to strong producer engagement and system reliability.

Benefits to Industry

The project demonstrated the potential for red meat producers to monitor individual animal movements across large areas with limited connectivity by successfully deploying and testing smart tags, assessing tag retention, and integrating tracking data with 3rd party farm management tools. These outcomes create opportunities for producers to adopt smart tagging technologies in support

of future use cases such as improved traceability, animal safety and security, animal health monitoring to give informed on-farm decision-making tools to the end producers.

Future Research and Recommendations

Future R&D should focus on reducing tag weight to further improve retention, develop animal status and health detection and investigate integration with other hardware systems including virtual fencing platforms. There is also a need to evaluate the ROI of smart tags across the full supply chain and on larger scale properties through the use of direct to satellite technologies. Large-scale deployments that incorporate production data from birth to processing would help validate and extend the benefits observed in this project, ensuring greater adoption across the red meat industry.

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1. Background

One of Integrity Systems Company's (ISC) primary targets is lifetime traceability which may include on-farm tracing either 'real-time' or close to real time. This demonstration project embedded and tested GPS tracking ear tags showcasing improved traceability, assurance and other value-add initiatives. While the development of the smart GPS tracking ear tags is ongoing, there have been few large-scale deployments to test, trial and demonstrate the processes to deploy such technology at scale and in remote locations.

This project deployed existing smart ear tag technology within a range of production systems to document and develop the most effective and efficient processes, with a focus on tag deployment. GPS tracking ear tag retention rates were also captured for both cattle and sheep, targeting 85% over the duration of the project. Devices integrated real-time location into existing farm management platforms.

The results of the project will assist producers in understanding the benefits of GPS tracking ear tags by providing valuable insight into the product, as well as providing the information needed to build education material to share with producers to support the deployment of these tags.

2. Objectives

The objectives of the project included:

1. Research a commercially practical procedure to deploy GPS smart ear tags for high volumes of sheep and cattle targeting within +/-10% the time it takes for applying a standard NLIS RFID tag to an animal.
2. Secure deployments on a minimum of three trial sites of commercial sheep and cattle properties to install smart GPS ear tags with an end project goal total of 2,000-5,000 head of livestock to be tagged.
3. Real-time location data captured from the smart GPS ear tags and integrated into relevant farm management platforms and/or ISC data systems.
4. Demonstrate capability to reliably support tracking livestock over 100,000-250,000 hectares of paddock area in remote locations (i.e., no terrestrial telecommunications coverage)
5. Demonstrate tag retention rates of a minimum of 85% over two years of use with ability to locate and retrieve 25% of any tags 'lost'.
6. Evaluation of system benefits vs cost completed with secondary/unexpected benefits accounted for.
7. Development of a communication package including case studies and training videos to be used to communicate project findings.

3. Methodology

3.1 Methodology Overview

The project followed a staged methodology designed to demonstrate large-scale deployment, performance, and integration of Smart Paddock GPS ear tags across commercial livestock operations. Each phase built upon the outcomes of the previous one to refine the hardware, software, and deployment processes.

Participating commercial properties were selected to represent diverse livestock types, climates, and geographical conditions. For each site, LoRaWAN network requirements were analysed remotely to determine optimal gateway locations and ensure complete coverage of grazing areas. Smart GPS ear tags were then deployed progressively across cattle and sheep, beginning with small-mob trials before expanding to full-scale deployment.

Throughout the project, data was collected from tags via installed gateways and transmitted to Smart Paddock's cloud infrastructure for storage and analysis. Collected parameters included GPS location, accelerometer activity, temperature, signal strength, and power performance. Continuous monitoring enabled assessment of tag reliability, retention, and network coverage under real-world operating conditions.

Producer feedback and field observations informed iterative improvements to both hardware and software, including enclosure redesign, antenna optimisation, and user interface enhancements. Integration testing with third-party software platforms demonstrated interoperability and provided pathways for future integrations with other livestock management tools.

This structured, evidence-based approach ensured that both the technical and operational objectives of the project were met while providing robust data for evaluating system performance, usability, and scalability across extensive grazing environments.

3.2 Planned Third Party Participants

The below table lists the Third-Party Participants which were initially planned to take part in the project. Updates to the below will be outlined in later sections of the report. Third party participants have been anonymised.

Name	Role
Participant 1	Trial host
Participant 2	Trial host
Participant 3	Trial host
Participant 4	Trial host

3.3 Phase 1: Project Planning

Milestone 1 required the completion of project planning, signing of agreements and animal ethics assessment. The planning requirements included the completion of an overall project plan submitted to MLA/ISC, provision of a project monitoring and evaluation plan for data capture and storage and the development and submission of evaluation and communications plans. It was also required to confirm 3-5 farm properties for inclusion in the project and to scope the necessary network requirements for those properties. Consent to commercialise agreements with ISC/MLA and a data sharing agreement were also executed. An animal ethics assessment was completed.

Smart Paddock was in contact with Animal Welfare Victoria, Queensland Department of Agriculture and Fisheries, and the NSW Department of Primary Industries to determine Animal Ethics requirements in relation to conducting the project and they confirmed there were no additional approvals needed for the planned deployment of the commercially available Smart Paddock tags.

3.4 Phase 2: Ear Tag and Network Infrastructure Acquisition

Milestone 2 required the acquisition and ordering of smart GPS ear tags and the on-farm network infrastructure. To complete this milestone Smart Paddock ordered the required network infrastructure that was installed on the participating farms to collect the data from the Smart GPS ear tags and transmit the data to the central hosting servers. The network infrastructure is primarily made up of a rugged outdoor LoRaWAN gateway, power supply, required antennas, mounting equipment and Telstra SIM data card for the backhaul internet connection. Smart Paddock obtained 12 LoRaWAN network gateway setups, which was sufficient to supply a minimum of 5 properties. Smart Paddock had supplied 900 of the Smart GPS ear tags in the initial deployments with further batches of 1,100 and 3,000 planned as the project progresses.

3.5 Phase 3: Initial Deployment

To complete Milestone 3, Smart Paddock secured and tested an initial batch of Smart GPS ear tags, installed the required network infrastructure on the participating farms and verified transmission of data off farm to a central hosting server for analysis and storage.

Smart GPS Tag Deployment

A minimum target of 1,000 (50% of 2,000) head of livestock was planned to be tagged to meet the requirements of the Milestone 3. To accommodate this milestone Smart Paddock had produced 1,200 (1st generation) smart ear tags which had been the primary tag for all initial deployments. During the previous milestones, deficiencies had been detected in this 1st generation tag which led to a delay in the overall project. Modifications to the existing tags had been undertaken including changes to the plastic enclosure moulding tools and electronic components to improve performance. These modifications allowed Smart Paddock to begin the deployments. The participating farms deployment process included an initial batch of tags put on a small mob before proceeding to the larger scale deployments since this was a new experience for each producer.

Tag Deployment Status

Property	Tags Deployed/ Allocated Milestone 3	Tags Allocated for Milestone 4	Project Total	Gateways Deployed/ Allocated	Animal / Notes
Participant 4	**25/100**	**540**	**640**	**1/2**	**Cattle**
Participant 3	**40/40***	**0**	**40***	**2/2**	**Sheep**

					***350 tags re-allocated to new properties**
Participant 1	**10/100**	**300**	**400**	**1/2**	**Cattle**
Participant 2	**0**	**TBD**	**TBD**	**0**	**Cattle - On hold**
New Properties	**Tags Deployed/ Allocated Milestone 3**	**Tags Allocated Milestone 4**	**Total**	**Gateways Deployed/ Allocated**	**Notes**
Participant 5	**10/50**	**-**	**50**	**1/1**	**Cattle**
Participant 6	**0/200**	**800**	**1000**	**0/2**	**Cattle**
Participant 7	**5/100**	**-**	**100**	**1/1**	**Cattle**
Total	**90/590**	**1640**	**2230**	**8**	

Initial producer feedback on the small mob deployments (summarised):

- Attachment of Smart Paddock tags using existing tag tools easy and straightforward.
- Time to attach tag similar as NLIS and/or management tags.
- Web based software easy to use and navigate.
- They see the potential of the technology in their operations.
- Producers require mobile phone app that can run in an offline mode (for times no internet in paddock).
- Tag retention on sheep was lower than expected and raised concerns on ability of sheep ears to hold tag properly (drooping ears) as compared to cattle.
- Overall tag GPS performance was too low/unreliable to be useful (i.e., number of GPS points received per day per animal).

Participant 4, Participant 1, Participant 5 and Participant 7 had installed gateway(s) and completed the initial small mob deployment and were satisfied to continue the project as the tags became available.

Due to the withdrawal of the sheep test site (Participant 3) 350 tags had to be reallocated to the following alternative farm sites:

- Participant 5 – NSW – Cattle Operation
- Participant 6 – NSW – Cattle Operation
- Participant 7 – Northern QLD – Cattle Operation

Network Equipment

Deployment of network equipment at host farms was actioned with modifications. The network equipment was successfully deployed at the participating sites: Participant 4, Participant 3, Participant 1, Participant 5 and Participant 7. Second gateways originally allocated to Participant 4 and Participant 1 were temporarily allocated to Participant 5 and Participant 7. Replacement gateways were on order to be delivered in February 2023 to backfill as needed and to be used at Participant 6 and Participant 2.

Confirmation of tracking data was captured by the platform and confirmed at Participant 4, Participant 3, Participant 5 and Participant 7.

Integration

Following a meeting on 29 August 2022, it was mutually agreed with MLA not to proceed with integration with MLA systems at that time.

Smart Paddock and Cibolabs successfully integrated their platforms for the Participant 4 property with a data sharing agreement in place and data synching successfully established.

Participant 3 – Sheep Deployment

As part of the Milestone 3 tasks, tags were deployed on young ewes over a period of 6 weeks (Trial 1 start date: 8 August 2022) on the Participant 3. Over this trial period there was a high tag retention failure rate (20%) in our opinion due to the size of the ewe's ears compared to cattle that these. In consultation with the farmer and the results of the first trial, another trial was conducted over a second 6-week period (Trial 2 start date – 06 November 2022) using more mature and larger sheep. Tag retention was 100% over this relatively short time period, however it was mutually agreed to not continue with further trials at that time.

Participant 4 – Cattle Deployment

Participant 4 ran a test of 25 tags on different mobs for a minimum of 6 weeks. This short initial trial resulted in a successful 100% retention rate. Due to the success of this test, full deployment of the remaining tags was undertaken for Milestone 3 and Milestone 4 once sufficient tags became available.

As part of the project goals, 3rd party data was integrated within the Participant 4 property on the Smart Paddock platform which is shown in the Participant 4 Dashboard image below.

Figure 1. Participant 4 Dashboard with CiboLabs

Figure 2. Participant 4 Tagged Cattle

Figure 3. Participant 4 Gateway

Property	Site Visit	Location	Livestock details	Paddocks	Software integration
Participant 4	29/10/2022	Clermont, Central Queensland	To be tagged: 640 Type: Cattle Tagging date: various	Count: 24 Size: ~4,000 hectares	Software: Agriwebb Blackbox CiboLabs

Initial project interview summary

Our initial project interview with Participant 4 included the following highlights and key points to be consider in the overall project:

- Knowing where the cattle are at any time is most important when the cows are calving so they can monitor for calving issues.
- Participant 4 already uses CiboLabs and Blackbox and would like for Smart Paddock to investigate integration options.
- Tracking the count of animals in each paddock can be useful and viewing their grazing patterns across each paddock.

Interview Questions

- How many tags were deployed, and on which type of animal?

  - *25 cattle tags.*
- How long did the tag deployment in question 1 above take in total and per animal estimate?
  - *I would estimate 30-60 seconds once animals are in yards and ready to go.*
- How does this time taken compare to the deployment of other tags (NLIS, Management)?
  - *Should be the same.*
- Was the deployment of tags difficult in any way, and how did the process compare to other tags?
  - *Need to remember to put on back of the ear not like other tags.*
- Do you have any suggestions for the overall improvement of the tag deployment?
  - *Having an easy way to note the tag number (scan?)*

Participant 1 – Cattle Deployment

Participant 1 deployments had been delayed due to extensive rain and flooding in the Victorian region over the spring period 2022. Deployment of network equipment and tagging was scheduled to take place in the second week of December 2022, however Participant 1 was unable to fully participate in the full deployment of allocated tags after the initial test deployment.

Figure 4. Participant 1 Cattle Initial Tagging

Initial project interview summary

Our initial project interview with Participant 1 included the following highlights and key points to be consider in the overall project:

- Knowing where the cattle are at all times is very important especially with the bulls and being alerted when the leave the property boundaries.
- Smart Paddock needs to map out all the paddocks to be more useful for animal tracking.
- Ability to detect bull performance and activity levels also key feature.
- Participant 1 uses Stockbook for their animal management and would like for Smart Paddock to investigate integration options.
- Unable to continue with full deployment.

Deployment Updates and Design Issues

The additional farms added to the project (Participant 5, Participant 6, Participant 7) were in early stages of engagement and still require scheduled interviews, data collection and site visits at this point in the project.

Milestone 3 was delayed from the original project timeline, with hardware design issues identified during early on-animal trials subsequently addressed and refined for later project trials.

A variation was approved to allow Smart Paddock to:

- Modify the GPS antenna to improve power usage, GPS fix time and accuracy. A new antenna layout has been designed with an airspace moulded around the antenna location on the PCB. This airspace allows for better GPS signal reception from the satellites. GPS fix time and accuracy is a key requirement to a commercially viable ear tag product.
- Modify the tag enclosure design to fix a failure caused by a weak point in the plastics. This weak point was found at a flex point just below where the ear tag is fixed to the animal's ear. This flex point caused the enclosure to crack after a period of time from the constant movement of the tag.

This failure point was discovered in our initial animal trials that were completed with our tags very early in the project timeline. To fix this design issue we needed to modify the enclosure plastics tooling and make changes to the GPS electronics which required significant time and costs. These modifications were then completed manually on the existing 1,200 (1st generation) tags.

Smart Paddock decided, based on producer feedback from these initial small mob deployments, to put on hold any further deployments of these modified GPS ear tags. After the production of these 1,200 1st generation tags, Smart Paddock committed to use its learnings and update our tag electronics and design to increase tag performance to match farmer expectations before completing our next production run. This final step also increased the overall tag GPS performance (accuracy and power usage) due to removing inaccuracies caused by the manual modification process.

Figure 5. 2nd vs 1st Generation Tag 1

Based on producer feedback and identified opportunities, the following integrations were suggested for future consideration:

- Integration with the Pairtree software platform to support broader data interoperability and simplify information sharing for producers.

- Exploration of the MyMLA single sign-on API for use within the Smart Paddock platform. This would enable MyMLA users to access Smart Paddock using their existing credentials and could streamline collaboration with other MyMLA partners such as CiboLabs.
- Review of potential integration pathways with Agriwebb and Stockbook to enhance compatibility with existing livestock management tools used by producers.

3.6 Phase 4: Full Deployment

To complete Milestone 4, Smart Paddock deployed all network equipment and smart GPS tags to the trial sites with ongoing live tracking of livestock across each property. All data from the livestock is sent via LoRaWAN network gateway(s) installed on each property. Each property had at least one network gateway with several hosting gateways to get sufficient network coverage of the trial paddocks. The network gateways forward the data from the tags utilising Telstra's 4G network to Smart Paddock's Microsoft Azure hosted secure servers for data storage and analysis.

The tags update the livestock's location on a timed interval with a minimum of every 15 minutes upwards to every hour depending on power availability on the tag. Each tag is solar powered and will monitor its "battery" level to determine how often to send an update and therefore during the nighttime or in poor sunlight conditions it will extend the update interval to ensure sufficient power to continue to run in low light conditions for extended periods of time.

Each tag was laser engraved with a unique ID number allowing us to maintain accurate tracking and allow the primary producer to associate each tag to their livestock with their own animal identification system (i.e. NLIS, management tag number).

The primary producers had access to the live tracking and historic data of the livestock via an online web portal and mobile phone application. These applications allow the primary producer to locate specific animals, receive animal alerts and review historical movement of the herd from anywhere with mobile phone or internet connection. The primary producers also have the option to download their data from the web portal at any time to be used in other applications of their choosing.

Timed with the final deployment of tags, Smart Paddock made several significant updates to our software platform both for the web portal and mobile phone application relevant to this project. The initial plan was to rely broadly on feedback from the primary producers for monitoring tag retention and tags that had been removed from the animals. To lower the time requirement and effort on the producers and to track retention more accurately we developed a specific software algorithm for the detection of tags that have fallen off. Any tag that has been automatically detected to have fallen off will generate an alert in our system and be flagged as a "Dropped tag". This algorithm will distinguish the difference between a "downed" animal and a tag that has fallen off to lower false positive detection. We still relied on feedback from the participants, but this allowed us to more easily monitor the status of each tag during the life of the project.

Smart GPS Tag Deployment

A minimum target of 2,000 head of livestock was to be tagged to meet the requirements of the Milestone 4 project tasks. As previously noted, Smart Paddock produced ~3,200 (1st and 2nd generation) smart ear tags which had been the primary tag for all initial deployments. During the previous milestones, deficiencies had been detected in these tags which led to a delay in the overall project schedule.

Modifications to the existing tags electronics had been undertaken between generations 1 and 2 versions including changes to the plastic enclosure and electronic components to improve performance. With the deployments that have been underway the electronics component of the tags has been working very well and exceeding expectations, but we continued to have higher than acceptable issues in the plastics primary around water penetration and failures due to cracking. After a detailed material engineering analysis, it was decided to change plastics manufactures to a more experienced local manufacturer. This change required a retooling, and materials change so that all new tags produced now utilise the same material (TPU) used in standard cattle management tags. The material used was independently tested for the environmental conditions related to deployments on cattle in Australia.

Smart Paddock replaced any previous generation(s) tags that were deployed and showing signs of potential failures with new generation tags.

Property	**Tags Count (approx.)**	**Gateways**	**Animal**	**Notes**
Participant 4	350	2	Cattle	Integration with CiboLabs
Participant 1	450	1	Cattle	
Participant 5	120	1	Cattle	
Participant 6	400	2	Cattle	
Participant 7	450	2	Cattle	
Other	*1,000+*	*5+*	*Cattle*	*Additional properties being monitored*
Total	**3020+**	**8+**		

Updates to the initial producer feedback:

- A new mobile phone application was released by Smart Paddock that can now run in an offline mode.
- Since the initial deployments, the firmware on the tags has been updated giving a much higher (5-10m) GPS accuracy and update frequency.

Around this time, Smart Paddock manufactured 9,000 of the updated version of the tags with the new plastics (3rd generation). From this additional stock any failed tags that were deployed were replaced in order to achieve accurate data for the remainder of the project. This additional stock allowed us to deploy commercially to many additional properties that were not a pre-determined participant in this project but allowed us to gather further statistics on tag retention across many more locations across Australia.

Network Equipment

Deployment of the LoRaWAN network gateway equipment at host farms was fulfilled as per the project plan. Remote analysis of each property was completed to determine the optimal location(s) and minimum number of gateways that were needed to deploy to give full coverage. Full coverage includes 100% coverage of grazing areas, noting environmental factors could cause some lost messages, such as an animal standing behind a tree. As the monitoring continued over the project lifetime, we captured radio strength (RSSI, SNR) of the tag transmissions to allow us to do a detailed analysis of the coverage in real world conditions. For example, the largest deployment over 300,000 hectares was able to achieve full coverage with three strategically placed gateways. This demonstrated the project's capability to reliably support livestock tracking across 100,000–250,000 hectares in remote locations without terrestrial telecommunications coverage, achieving the stated project objective.

Software Integration Update

As of November 2023, Smart Paddock developed new standardised APIs that we could utilise for integration with any 3rd party software platform. The two APIs comprise of one basic data stream and one detailed data stream. The basic API offers the last known location of the individual animals and any alerts related to each animal. The detailed API offers an intensive live stream of all collected tag data: GPS location, temperature, status and alerts for use in commercial integration opportunities. These APIs potentially allow for integration with applications like Pairtree and Agriwebb with no customisation required and will be completed on a case-by-case basis by customer request.

Participant 7 – Cattle Deployment

Participant 7 is a ~9,500-hectare property situated north of Bowen and was established in the 1950's.

Figure 6. Participant 7 – Tagged Bulls

Figure 7. Participant 7 – Tagging Cattle

Property	Site Visit	Location	Livestock	Paddocks	Software integration
Participant 7	26/09/2023	Bowen, Qld	Cattle	Count: 58 Size: ~9,500 Ha	Software in use: Breedplan

Initial project interview summary

Our initial project interview with Participant 7 included the following highlights and key points to be consider in the overall project:

- They have concerns of cattle theft in the more remote paddocks on the station and are keen to see if they can identify if theft is occurring and where the animals are leaving the property.
- Knowing where the bulls are at all times is key to ensure they are in the correct paddock and with the correct cows. The feature of stray paddock alerts will be useful, so they do not need to constantly check the software.
- While on site for the initial interview they were in the process of pairing cows with their calves. The time and effort for their staff to complete this task was significant and it was discussed if we could develop automated pairing feature if they tagged their calves.

Interview Questions

- How many tags were deployed, and on which type of animal?
  - *20 bulls were tagged during the site visit.*
- How long did the tag deployment in question 1 above take in total and per animal estimate?
  - *Approximately 45 minutes after mustering with it taking 30-90 seconds per bull.*
- How does this time taken compare to the deployment of other tags (NLIS, Management)?
  - *About the same amount of time.*
- Was the deployment of tags difficult in any way, and how did the process compare to other tags?
  - *Forward facing application of the tag to the animals' ear would be easier.*
- Do you have any suggestions for the overall improvement of the tag deployment?
  - *Would be handy to have a spreadsheet or printed form to record Smart Paddock tag number with management tag number.*

Deployment Updates and Design Issues

A Participant 6 visit was scheduled for deployment in the first quarter of 2024 depending on the project participants availability. At the time of this report, the participant had decided to deploy instead at an alternative location to that originally planned near their original property. A site visit was completed and network equipment moved, however livestock had not been tagged at the conclusion of this project.

As discussed previously, the deployment of tags on participating properties revealed a potential failure condition that will be rectified in future deployments across participating properties and for customers more broadly. In deployments involving more aggressive animals (i.e. bulls), some cracking and loss of the plastic seal near the top of the tag were identified, allowing water ingression that can damage the electronics over time. A change of plastics manufacturer and design modifications were completed for the third-generation tag to address this issue. Any tag failures resulting from water ingression will be replaced on participating properties at no charge.

Figure 8. 3rd Generation Tag

4. Results

4.1 Smart GPS Tag Deployment

Tag Deployment

As previously discussed, the third-party participants which were initially planned for have changed throughout the project. A finalised list of properties as well as details of each, is included below. Since some of the initial participants were no longer able to participate in the trials, a number of additional deployments have also been included in the data in order to ensure well rounded datasets were collected. These additional deployments have been included below labelled as 'Other'.

Property	Tag # Planned	Tag # Deployed	Gateways Deployed	Animal Type	Notes
Participant 4	350	200	2	Cattle	3rd Party Integration
Participant 1	450	50	1	Cattle	Due to undisclosed reasons this property needed to pull out of the project after the initial test.
Participant 5	120	120	1	Cattle	
Participant 6	400	400	2	Cattle	They currently have 400 tags to deploy with first 100 going in June 2025

Participant 7	450	200	2	Cattle	200 deployed over several years testing new designs, etc
Other	*1,000+*	*2,000+*	*5+*	*Cattle*	*Additional properties being monitored*
Total	**3,020+**	**3,940+**	**8+**	-	-

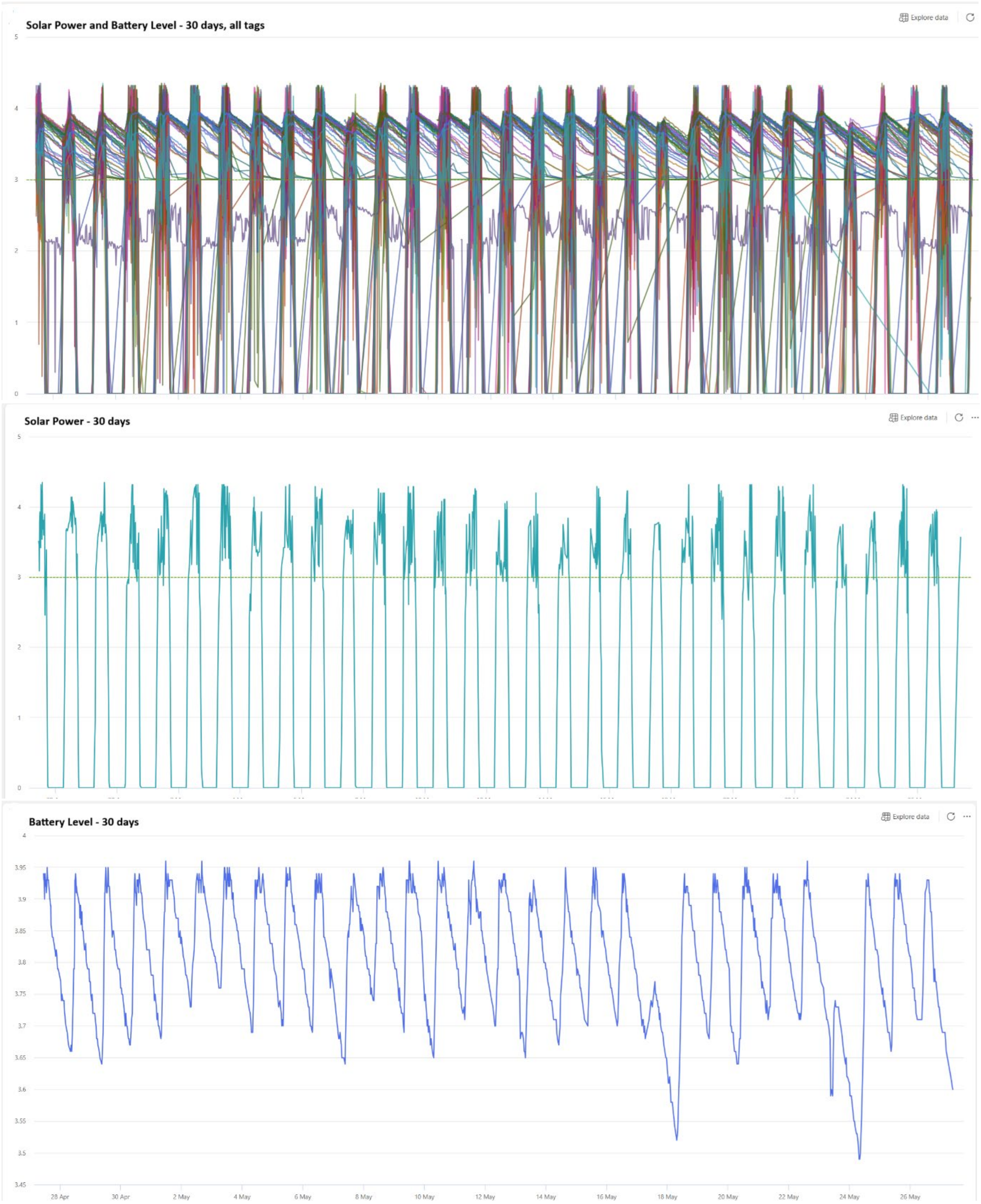
The tag was intentionally designed to mimic a standard ear tag, allowing farmers to use their existing application tools and processes without the need for new equipment or training. This familiar design ensures that the Smart Paddock tags can be applied to animals just as quickly and easily as a typical NLIS tag. Initially, integrating the Smart Paddock platform required an extra step—associating each smart tag with either a visual ID or an EID within the software. As the project progressed, improvements were made to streamline this process and reduce friction for users. Enhancements included the development of mobile app support, enabling tag associations to be completed directly in the paddock. Additionally, a spreadsheet input tool was introduced, allowing farmers to perform bulk associations back in the farm office using records collected in the field. These updates have significantly improved the ease and efficiency of incorporating Smart Paddock tags into everyday farm operations.

Data Collected

Further data collected during this project includes GPS coordinates, activity levels, temperature, LoRaWAN signal strength, solar power levels, and battery levels. A key focus has been on solar power and battery performance, with detailed data gathered over 30-day periods from individual tags as well as across entire properties. This data (see figures below) illustrates a consistent pattern of solar energy capture that aligns closely with the daily sunrise and sunset cycles. Understanding this predictable rhythm allows for effective planning of power usage within each 24-hour period. By averaging this data, the tags have been designed to operate at maximum efficiency based on expected solar input under normal conditions. Ongoing analysis across different locations in Australia—comparing northern and southern regions and seasonal variations—continues to refine power management, ensuring the tags deliver timely and accurate data that benefits the farmer.

The smart tags are also equipped with accelerometers and temperature sensors, providing valuable insights into each animal’s status throughout the day. The sensor data provides the foundation for detecting distressed or sick animals, demonstrating the feasibility of this capability and its potential to add significant value for livestock management. Future development will extend this analysis to identify key life events, such as calving, and to support ongoing performance monitoring.

In the later stages of development, a visual mapping feature was introduced to represent LoRaWAN signal strength across the property. This advancement allows both Smart Paddock and farmers to identify “black spots” where tag signals fail to reach the base station. Once these areas are mapped, targeted steps can be taken to install additional gateways, improving coverage where practical and necessary.



Area Covered

The initial properties targeted for deployment at the beginning of the project were limited in size but by expanding the data collected to an extensive property list of existing Smart Paddock Australian customers, test coverage was expanded to over 1.2 million hectares. Notably, two of the largest properties using LoRaWAN gateways spanned 296,000 hectares and over 300,000 hectares respectively. All properties were able to achieve full coverage with remote analysis, strategically placed gateways, and black spot testing in the first few weeks of deployment. For example, the largest deployment was able to achieve full coverage with three strategically placed gateways. This demonstrated the project's capability to reliably support livestock tracking across 100,000–250,000 hectares in remote locations without terrestrial telecommunications coverage, achieving the stated project objective. These deployments clearly demonstrated the effectiveness and scalability of the LoRaWAN network solution for use on large, remote properties, validating its suitability for widespread adoption in extensive livestock operations.

Property	State	Paddock Count	Size (ha)
Participant 4	Queensland	24	2,901
Participant 1	Victoria	1	115
Participant 5	Queensland	10	1,485
Participant 8 (previous Participant 6)	New South Wales	2	520
Participant 7	Queensland	57	9,447
Other	Australia wide	-	1,067,641
Total Size			1,080,623

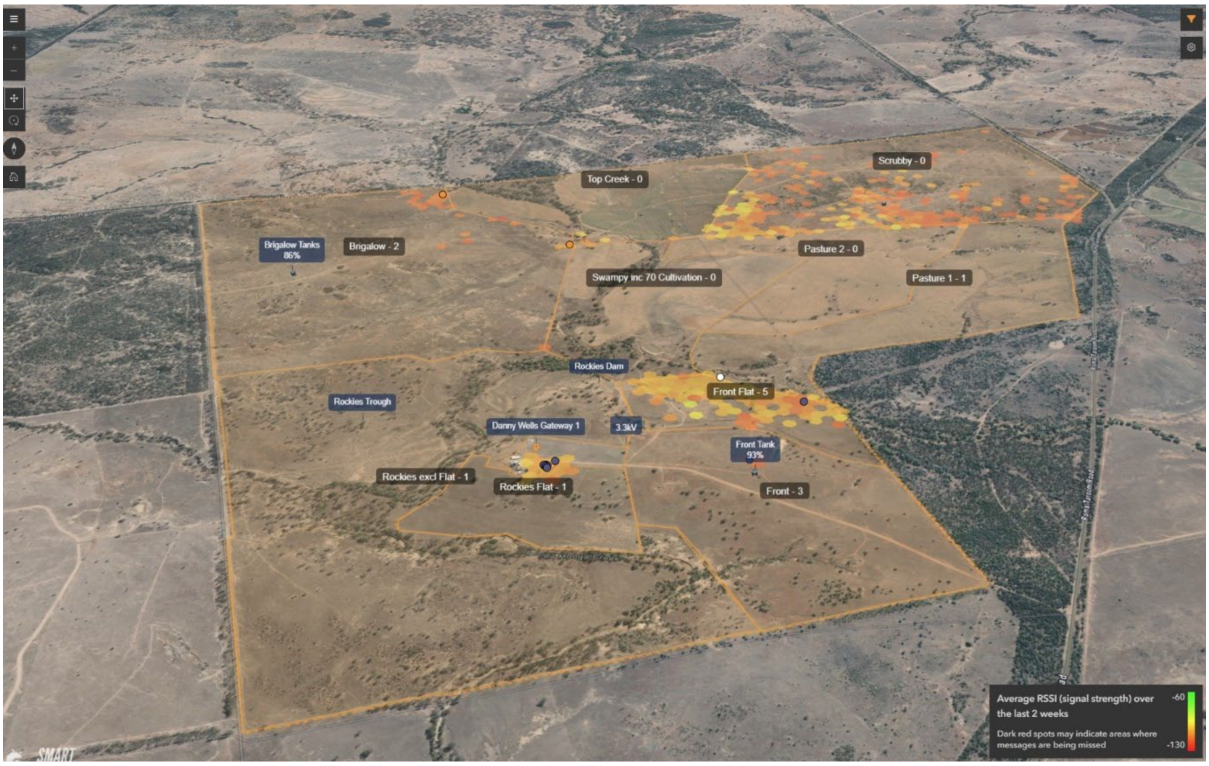


Figure 9. NSW based property showing signal strength for grazing cattle.

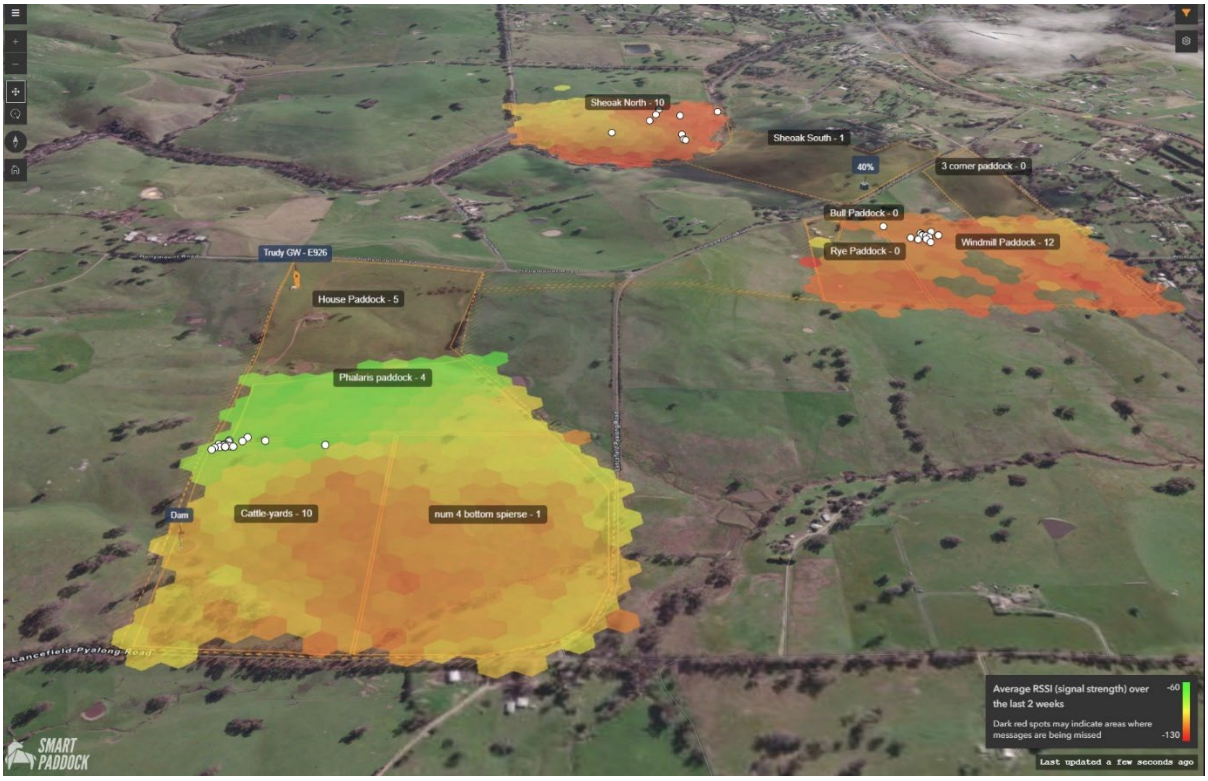


Figure 10. Victoria based property showing signal strength for grazing cattle.

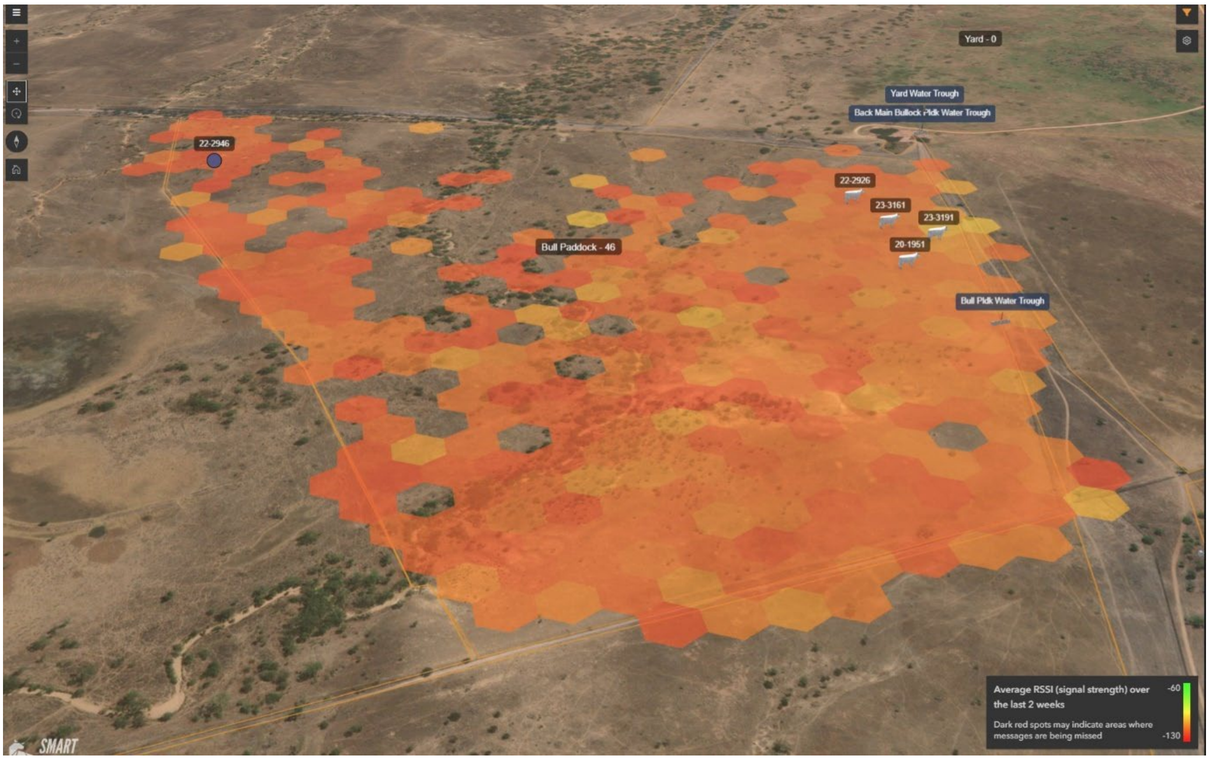


Figure 11. Queensland based property showing signal strength for grazing cattle in an specific paddock.

Software Integration

The project was initially planned to integrate the real-time location data captured from the smart GPS ear tags into ISC data systems as well as other relevant farm management platforms. Following a meeting on 29 August 2022, it was mutually agreed with MLA not to proceed with integration with MLA systems at that time.

As of October 2022, Smart Paddock made the decision to complete a test integration with the Cibolabs software platform. Cibolabs came to our attention after it was established that Participant 4 was a current customer of Cibolabs and highlighted the benefits of the integration of the two systems. Smart Paddock and Cibolabs successfully completed this test system integration for the Participant 4 property with a data sharing agreement in place and data synching successfully up and running to demonstrate the ability to show individual and mob animal grazing patterns overlaid with Cibolabs satellite imagery-based pasture feed biomass data. This combination of data can greatly assist the producer to make informed decisions related to rotational grazing and optimal pasture management.

To simplify integration with other platforms Smart Paddock has developed standardised Application Programming Interfaces (API) for our platform. These standards APIs also us to easily and securely send data to other platforms for integrations, data sharing and interoperability. We will integrate on a case-by-case basis initially but will look to provide ongoing integrations to other livestock management platforms based on the requests from our customers.

The smart tags successfully collected accelerometer and temperature data, providing detailed insights into animal activity and condition throughout the day. Analysis of this data demonstrated the feasibility of using sensor inputs to identify behavioural and physiological patterns consistent with distress or illness, highlighting the potential for advanced livestock monitoring applications. These results establish a strong basis for further development of automated event detection, such as calving and other key life-stage indicators.

4.2 Tag Retention Rates

In alignment with Objective 5, the project initially set out to test tag retention rates over 2 years, however due to hardware failures early on and updates to the tag design with 2nd and 3rd generation tags being developed, the tag retention rates were only able to be tested over a 1 year period. However, over the 1 year period, the tags achieved a cumulative average tag retention rate of 90% across all deployment sites and animals, achieving and surpassing the 85% goal set at the beginning of the project.

The primary properties involved in the project achieved between 91-100% retention rates, with an average of 89% in the additional properties. As detailed in the table below, these rates were calculated based on dropped tag detection over the 12-month period.

This outcome supports the commercial viability of GPS ear tags in terms of physical retention. Future Smart Paddock tag iterations (especially lighter, third-generation versions) are expected to further improve retention rates and support continued industry adoption.

Property Name	Number Of Tags	Dropped Tags	Retention Rate
Participant 1	10	0	**100%**

Participant 7	189	17	**91%**
Participant 5	117	10	**91%**
Participant 8	100	2	**98%**
Participant 4	221	9	**96%**
Other	3759	406	**89%**
TOTAL	**4396**	**444**	**90%**

Summary by State

State	**No. Tags**	**Dropped Tags**	**Retention Rate**
NSW	719	106	**85%**
QLD	2089	126	**94%**
SA	325	31	**90%**
VIC	392	26	**93%**
WA	42	0	**100%**
Overseas	829	155	**81%**
TOTAL	**4396**	**444**	**90%**

4.3 Producer Feedback

Informal interviews were conducted with participating producers throughout the project to gather insights on tag performance, installation practices, and on-farm usability. The feedback highlighted both practical challenges and opportunities for refinement in system design and deployment processes.

Tag Retention and Placement

Producers consistently reported that bulls presented the greatest challenge for tag retention, largely due to their natural behaviours, increased activity, and physical interactions, which led to higher rates of tag loss or damage.

- Ear placement was identified as a critical factor influencing both retention and solar charging efficiency.
- Front-of-ear placement generally provided better retention but could reduce solar exposure, particularly in Bos Taurus breeds with thicker coats and smaller ears.
- For Bos Indicus cattle, with larger and less hairy ears, either side of the ear offered adequate solar access and secure retention.

Producers emphasised the importance of correct positioning near the base of the ear, consistent with NLIS guidelines, to minimise mechanical stress and maintain tag stability. Tags placed too far from the head were more likely to be dislodged.

Training and adherence to best-practice installation procedures were considered essential. Improper placement or incomplete pin insertion increased the likelihood of tag loss. It was recommended that installers:

- Ensure the pin and button are fully inserted through the ears thicker body.
- Confirm that the tag can move freely after application.

- Re-use existing tag holes where possible to reduce ear trauma.
- Relocate existing visual tags if required to accommodate the smart tag.

Deployment and Handling

Overall, producers found the tag deployment process comparable to existing NLIS or management tags, with an estimated installation time of 30–90 seconds per animal once cattle were yarded. Reported total deployment times ranged from 45 minutes to one hour for typical herd sizes.

Minor procedural differences were noted, including the need to apply tags on the back of the ear, which differed from common tagging habits. Suggestions for improvement included:

- An easier method to record or scan tag numbers during application.
- Providing a spreadsheet or printed form to cross-reference Smart Paddock tag numbers with existing management IDs.

On-Farm Use and Value

- Producers identified several key areas where smart tags delivered value or had potential to enhance management efficiency:
- Calving management: Real-time location and activity monitoring during calving periods was viewed as highly beneficial for early detection of birthing difficulties.
- Paddock monitoring: The ability to track the number of animals in each paddock and observe grazing patterns supported improved resource management.
- Bull management: Monitoring bull location and activity was considered essential to ensure they remained within assigned paddocks and with the correct breeding groups.
- Security and theft prevention: Producers with remote properties expressed strong interest in using the system to detect potential cattle theft or identify when animals crossed property boundaries.

Producers also recommended improvements to the software to enhance functionality, including mapping all paddocks for better visual tracking and exploring the feasibility of an automated cow–calf pairing feature to reduce manual data-entry workloads during calving seasons.

4.4 System Benefits vs Cost Evaluation

Equipment Costs

At the time of the project, Bluebell Smart Tags were priced at $49 per unit with an annual recurring service fee of $12 per animal. Each tag has an estimated operational lifespan of five years or more, enabling reuse across multiple animals or throughout the productive life of a breeding cow, thereby reducing the effective cost per head over time.

The required network infrastructure consisted of gateways priced between $1,250 and $1,750 per unit, with an annual recurring fee of $240 to cover telecommunications and technical support services.

Property	Size (ha)	Network Equipment	Network Equipment Costs for 5 Years	5 Year Equipment Cost per Animal
Participant 4	2,901	2	$4,900	$7.65
Participant 1	115	1	$2,450	$24.50
Participant 5	1,485	1	$2,450	$49.00
Participant 8 (previous Participant 6)	520	2	$4,900	$7.65
Participant 7	9,447	2	$5,900	$59.00
South Australia Property Example	300,000+	3+	$13,380*	$133.80
Estimate per Gateway Capacity (1,000 cows)	1-30,000	1	$2,450	$2.45

*Includes additional point-to-point network equipment installed to establish connectivity in a remote location without existing telecommunications coverage.

ROI: Use Cases

The following examples demonstrate potential return on investment (ROI) scenarios for the implementation of smart tags under typical production conditions.

Monitoring Steers (18-month period)

In a scenario where 100 steers are monitored for 18 months in a remote paddock, the total cost per head—including the tag, tag service, and network equipment—equates to approximately $40 ($14.80 + $18.00 + $7.20). Assuming an average animal value of $2,000, the recovery or preservation of just two steers through early detection of illness, recovery of strays, or prevention of theft would offset the full cost of implementation.

Monitoring Breeding Cows (12-month period)

For a herd of 100 breeding cows monitored across a 12-month period, the combined annual cost per animal is approximately $27 ($9.80 + $12.00 + $4.90). Given an estimated combined value of $3,000 for a breeding cow and her calf, preventing the loss of a single animal or cow–calf pair during calving—such as through the early detection of dystocia—would be sufficient to recover implementation costs.

Across both scenarios, the data indicate that even modest reductions in animal loss are sufficient to achieve cost recovery. Any additional improvements in survival or recovery rates contribute to a positive ROI, exclusive of further potential benefits such as labour efficiencies, time savings, and increased management flexibility for producers operating in remote or extensive systems.

4.5 Communication Package

In order to build education material to share with producers to support the deployment of GPS tracking ear tags, Smart Paddock will be using the results of this project to create a communication package.

Communication Description	Communication Format	Timeline
Best practice video for tagging cattle with smart tags, with emphasis on how strategies to ensure good retention.	Video shared publicly (i.e. On YouTube)	Summer 2025/6
Reference document for best practice of tagging cattle with smart tags, with emphasis on how strategies to ensure good retention.	Sent to new customers and available publicly on Smart Paddock website	Live now
Online and downloadable presentation on the ROI and benefits of using smart tags.	Document shared publicly on Smart Paddock website	Autumn 2026

5. Conclusion

5.1 Key findings

- Bulls presented the highest challenge for tag retention, primarily due to their natural behaviours and increased physical activity, which led to more frequent tag losses or damage.
- Smart Paddock developed its own best practice for tagging to maximise tag retention and performance, based on field trials and feedback from producers.
- Ear placement significantly impacts tag performance:
    - Tagging on the front of the ear generally results in better retention but may reduce solar exposure, especially on Bos Taurus breeds with thicker coats and smaller ears.
    - For Bos indicus cattle, which typically have larger ears and less hair, tagging on either side of the ear provides sufficient solar access and retention.
- Correct placement near the base of the ear, following NLIS guidelines, is critical to avoid mechanical stress and ensure the tag remains securely attached.
- Improper installation or incorrect ear placement increased the likelihood of tags falling out, reinforcing the need for thorough training and adherence to best practices.
- The project successfully demonstrated scalability with deployments covering over 1.2 million hectares across diverse environments, including some of Australia's largest and most remote properties.

Best Practices

- Place the tag within a few centimetres of the head; tags positioned further out on the ear are at higher risk of being dislodged. It is recommended to use the same placement location as NLIS tags.
- Choose ear side placement based on breed:
    - Front of ear offers better retention but may reduce solar charging efficiency on Bos Taurus breeds.
    - Back or front of ear is acceptable for Bos indicus due to larger ears and less hair coverage.

- Ensure the pin/button is fully inserted into the smart tag during application, accounting for the tag’s extra thickness. Verify that the tag can move freely after attachment.
- Re-use existing tag holes where possible to maximise retention and reduce ear trauma. If necessary, move any existing visual tag to a new location to accommodate the smart tag.

5.2 Benefits to industry

This project delivers several practical benefits to the red meat industry, particularly in enhancing livestock traceability and on-farm efficiency. GPS ear tags provide real-time location tracking, allowing producers to monitor livestock movements, detect theft, and identify downed or distressed animals—especially valuable in remote or extensive operations.

Operational efficiency has improved through easier mustering, better grazing management, and more effective monitoring during key periods such as calving. These insights help producers make faster, more informed decisions while reducing labour demands. The technology also supports animal health by enabling oversight of water and supplement access.

The tags have demonstrated a strong return on investment, especially for high-value animals, with their reusability and ability to be retrieved if dislodged further enhancing their value. Best practice guidelines for tagging were developed during the project, helping to maximise tag retention and ease of use for commercial deployments.

Deployments across diverse regions and breeds confirmed the scalability and adaptability of the system. Integration with farm management platforms like Cibolabs and Agriwebb positions the technology as a valuable tool in the industry's ongoing shift toward digital and data-driven livestock management.

6. Future research and recommendations

Scenario	Assumptions	Benefits	References
Improving Reproductive Efficiency	Livestock sensors can be used to remotely and autonomously monitor animals in extensive environments	Increased profitability for primary producers	DEVELOPING AN AUTOMATED, WHOLE OF LIFE SYSTEM FOR MONITORING REPRODUCTIVE EFFICIENCY IN QUEENSLAND’S EXTENSIVE BEEF INDUSTRY Dr. Anita Chang
Remotely Detecting Pregnancy	Using the accelerometer and movement patterns to detect pregnancy	Remotely detecting pregnancy status to enable culling of non-productive cows;	Smart Tags for Beefed up Sustainability Program Lead Mark Trotter CQUniversity Australia

Detecting and optimising bull management;	Using the combination of accelerometer, GPS location and animal interactions to determine lame or lazy bulls	A decrease in the number of bulls required and increase of pregnancy percentage in mob	Smart Tags for Beefed up Sustainability Program Lead Mark Trotter CQUniversity Australia
Detecting calving events	Using the combination of accelerometer, GPS location and mob behaviours calving can be detected	Increase calf survival	Smart Tags for Beefed up Sustainability Program Lead Mark Trotter CQUniversity Australia

The project highlighted several important successes as well as areas for further development, offering valuable direction for future investment in smart livestock tracking technologies. While the Smart Paddock GPS tags demonstrated strong retention rates and clear operational benefits, one of the key challenges identified was the impact of tag weight on retention, particularly in more active animals like bulls. Future R&D should prioritise reducing the overall weight of the tags, as this has proven to be more critical than dimensional size in improving long-term retention.

Another promising area for future research is the potential integration of smart tags with virtual fencing systems. Investigating whether these tags can support or be adapted for virtual fencing could significantly expand their utility in livestock management, particularly for extensive and remote properties.

In terms of broader industry impact, there is a clear need to assess the return on investment of smart tags across the full red meat supply chain. A larger-scale deployment project should be considered to measure production gains from birth through to processing. This would involve integrating data from related systems such as in-paddock weighing, carcass and meat quality metrics, and pasture analysis. Understanding the cumulative value of this data could drive greater adoption and inform best practice guidelines for smart technology use across the industry.

To ensure the red meat sector gains full value from these findings, development and adoption efforts should focus on making tagging practices easier, more reliable, and seamlessly integrated with farm and supply chain platforms. This will help position smart tag technology as a standard tool in precision livestock management.