Valuing the benefits of the Ceres Tag platform

FINAL REPORT
14 February 2022

pwc

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Contents

Image: Kat Jayne

1. Introduction

Image: Daniel Anthony

Background

The meat industry is evolving

Australia's red meat and livestock industry is entering a period of unprecedented change and opportunity. Australia has a strong and successful history in agriculture, though changing market needs and wider megatrends are driving change throughout the industry.

Consumers are becoming more invested in understanding where their food comes from, demanding higher quality products and wanting to know the provenance of their goods. Resource scarcity and increasing input costs are driving producers to change farming practices in an effort to deliver more from less.

As with many sectors, technology diffusion across agriculture is challenging well-worn practices and opening up opportunities to use big data and analytics to increase efficiency, or providing other insights to support better business decisions.[1] The AgTech sector is providing new and updated solutions across all stages of the food production process. Industry associations, corporates and farmers are driving innovation in on-farm technology in an effort to improve productivity and use of resources.[2]

New technology is also being integrated into integrity systems to provide improved food safety measures, product assurance, and traceability from paddock to plate. The industry's vision is for the use of new and emerging technology to provide seamless information sharing across the value chain to deliver cost and operational efficiencies, and to build trust and security with consumers.[3]

Ceres Tag provides a technology enabled solution

Ceres Tag has developed a livestock information platform with direct satellite capability which links to a proprietary smart ear tag. Ceres Tag uses data collection and on-tag analytics to provide animal-specific geospatial location data in addition to movement and animal health monitoring. Integrating with existing (and in development) software partner platforms, the Ceres Tag platform offers opportunities to improve productivity across the livestock industry and provide a richer range of information to guide effective decision making.

This report

Ceres Tag has engaged PricewaterhouseCoopers Consulting (Australia) Pty Limited (PwC) to undertake an independent review of the potential benefits of the Ceres Tag platform.

Focusing on the Australian beef cattle industry, we developed a suite of potential use cases for the technology which are explored within this document. Using a mix of qualitative and quantitative methods we reviewed the potential benefits that Ceres Tag provides across the beef industry value chain under each use case.

The quantitative assessment focuses on the incremental gains that both the livestock information platform and smart ear tag provide to key beneficiaries (predominantly cattle producers) under each use case.

Limitations

This report has been prepared by PwC using publicly available information, information provided by Ceres Tag, and information made available through limited engagement with subject matter experts in the industry.

Beef cattle properties across Australia have a range of unique features (e.g property and herd size) and operate under various operating models. Reflecting the diversity observed across the sector, the benefits presented in this report should be seen as indicative only and may not be representative of the benefits able to be realised by any specific operator. This report does not provide a full cost benefit analysis or look at the likely impact for the economy as a whole.

1. CSIRO (2019) *What does the future hold for livestock production in Australia*
2. StartupAUS (2016) *Powering Growth: Realising the potential of AgTech for Australia*
3. Integrity Systems (2018) *Strategic Plan: Integrity Systems 20225 and beyond*

Overview of Australia's beef cattle industry

Australia's beef cattle industry

'Australia has around 1.6 per cent of the global cattle herd…[but] is the second largest beef exporter after Brazil'[1]

Australia is home to only 1.6 per cent of the global cattle herd, but is the second largest exporter of beef, behind Brazil.[2] Australia's beef cattle industry is a major contributor to the national economy, with **total revenue forecast to be $20.4bn** and providing **close to 75,000 jobs** in FY22.[3]

The sector is incredibly **diverse in terms of the scale of operations**, ranging from hobby farmers (carrying fewer than 100 head of cattle on an individual property) through to large multinational operations managing properties with tens of thousands of animals. The majority of Australian beef cattle producers are cow-calf operators that maintain a herd of breeding cows and a small number of bulls for the production of calves for later sale.[4]

Australia's cattle industry is **highly reliant on international markets**, with 76 per cent of produce exported (**worth $9.6bn per year**). Major export markets include Japan (26 per cent), the United States (US) (20 per cent) and China (19 per cent).[5]

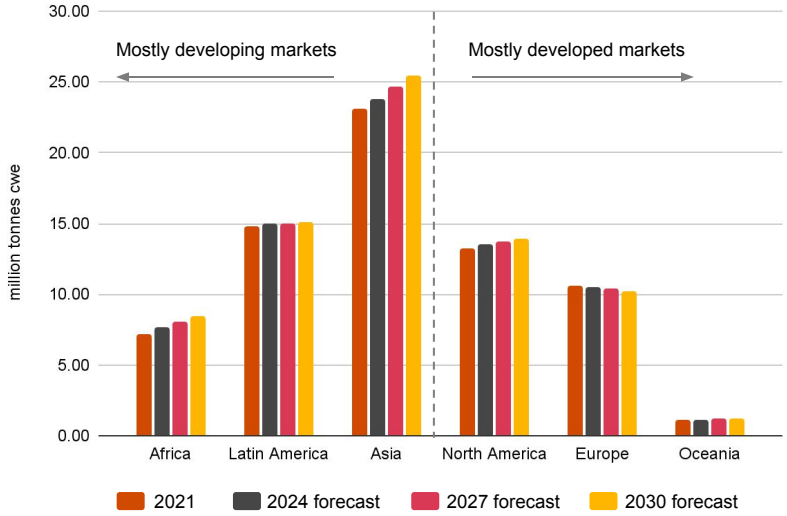
Trends in meat consumption

Growth in global beef consumption, particularly in Asia, is anticipated to increase at an average annual rate of 0.6 per cent through to 2024, driven by both population and income growth.[6]

With the ratification of the Regional Comprehensive Economic Partnership and geographical proximity to Asia, Australia is well placed to take advantage of potential opportunities. It is anticipated that both the volume and value of Australian live cattle exports is forecast to increase through to 2027.[7]

In developed markets an increased focus on environmental considerations has resulted in some consumers seeking out alternative protein sources. Despite this, organic beef and livestock in Australia is forecast as an area of potential demand growth[8]. Although a relatively niche market, revenue from organic livestock and poultry farming in Australia is forecast to increase by 14.2 per cent annually to 2026 due to greater perception of animal welfare and public concerns over environmentally sustainable practices.[9]

Figure 1: Global beef consumption forecasts[10]



1. Meat & Livestock Australia, (2021). *2021 State of the Industry Report*
2. Meat & Livestock Australia, (2021). *2021 State of the Industry Report*
3. Ibis World, (2021). *Australian Industry Report: Beef Cattle Farming in Australia*
4. ACCC, (2016). *Cattle and beef market study - Interim report*
5. Meat & Livestock Australia, (2021). *2021 State of the Industry Report*
6. Ibis World, (2021). *Australian Industry Report: Beef Cattle Farming in Australia*
7. Ibis World, (2021). *Australian Industry Report: Beef Cattle Farming in Australia*
8. Ibis World, (2021). *Australian Industry Report: Beef Cattle Farming in Australia*
9. Ibis World, (2021). *Australian Industry Report: Organic Livestock and Poultry Farming in Australia*
10. OECD FAO (2021). *Agricultural Outlook 2021-2030: OECD-FAO Agricultural Outlook 2021-2030 by country*

Overview of Australia's beef cattle industry

Cattle production systems vary significantly across Australia

Australia has 21.1 million cattle spread across 24,300 commercial producers (Table 1). However, the sector is incredibly diverse and operating models differ significantly between what are commonly described as the northern and southern cattle production regions of Australia.

As Figure 2 shows, the northern cattle region is skewed towards larger herds (averaging 1,576 head per farm)[1] with lower stocking rates and shorter haired, tropically adapted cattle (commonly Bos Indicus cattle that are better suited to warmer climates).

Cattle herds in the south are much smaller relative to northern herds, averaging 412 head per farm (with roughly 76 per cent of farms carrying between 100 and 400 head).[2] Southern producers generally have more intensive systems focused on high-value boxed beef export markets, including Korea and Japan.[3]

Figure 2: Proportion of farms by size and region, 2019-20[2]

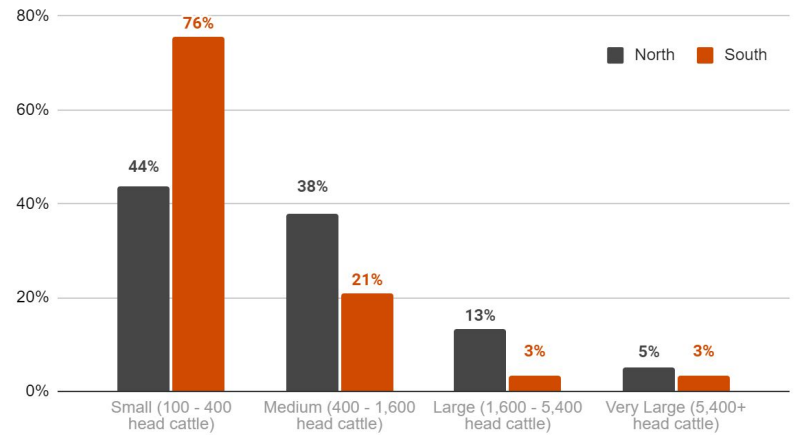
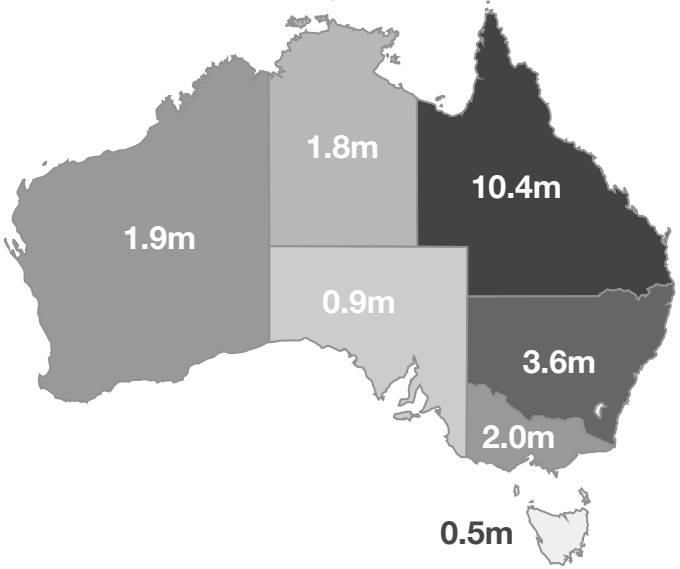


Table 1: Projections for the beef cattle industry, 2022*[4]

Industry snapshot	
Total herd size	27.2 million
Producers (100+ head cattle)	27,300
Percentage exported	77%
Beef exports	1,060 ('000 head)
Live exports	750 ('000 head)

Figure 3: Australian cattle numbers by state 2019-20[2]



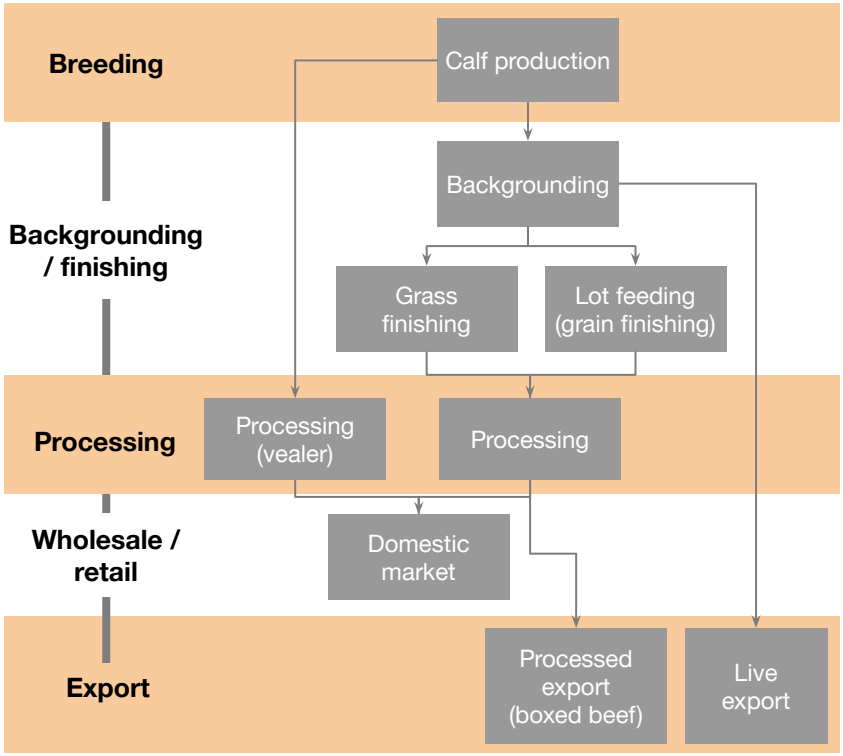
1. ACCC, (2016). *Cattle and beef market study - Interim report*
2. ABARES, (2021). *Farm Survey and Analysis: Beef Farms*
3. PwC, (2011). *The Australian Beef Industry: The Basics*
4. Meat and Livestock Australia, (2022). *Industry projections 2022 - Australian cattle.*

Overview of Australia's beef cattle industry

The beef cattle production sector feeds into an expansive and diverse supply chain

Beyond the farm gate, a range of sub-sectors comprise the broader livestock and red meat supply chain. While production systems and operating models differ significantly from entity to entity, the most common components and stages of the supply chain are outlined in Figure 4.

Figure 4: The livestock and red meat supply chain[1]



The industry continues to pursue efficiency gains and ways of differentiating their product

Accelerated global demand for red meat presents an opportunity for Australia to further excel in one of its established and traditional primary industries. Beholden to volatile global commodity markets and climatic variability, the industry continues to research ways of sustainably improving efficiency and setting its product apart in consumer markets.

To do this effectively, the industry will need to overcome a number of key challenges, including:

- sustainable growth in production with limited resources
- maintaining Australia's image of having clean and green agricultural practices
- mitigating the environmental impacts of production
- preserving the industry's disease-free status
- managing the increased focus on animal welfare.[2]

Each of these challenges is predominantly focused on on-farm activities. However, improvement in on-farm processes is anticipated to have flow on effects which create value across the broader supply chain.

Many of the innovations targeted at addressing these challenges are utilising new technology and improved data collection to guide decision making and improve operational practices.

Agriculture is adapting to meet Environmental, social, and governance (ESG) considerations

A number of major corporations have committed to promoting environmentally-friendly agriculture within their supply chains.[3] Farming that actively seeks to enhance natural capital, particularly soil health, is becoming more commonplace in Australian agriculture. There is emerging evidence that an ESG focus can also lift profits for farms. Over a 10-year period, graziers that were investing in their natural capital were found to be more profitable and resilient when compared to similar farms in their local area. [3]

1. PwC, (2011). *The Australian Beef Industry: The Basics.*
2. CSIRO, (2011). *The Australasian beef industries - Challenges and opportunities in the 21st Century.*
3. PWC (2021) *Farming for the Future*

Role of Ceres Tag

Ceres Tag provides a technology-enabled solution

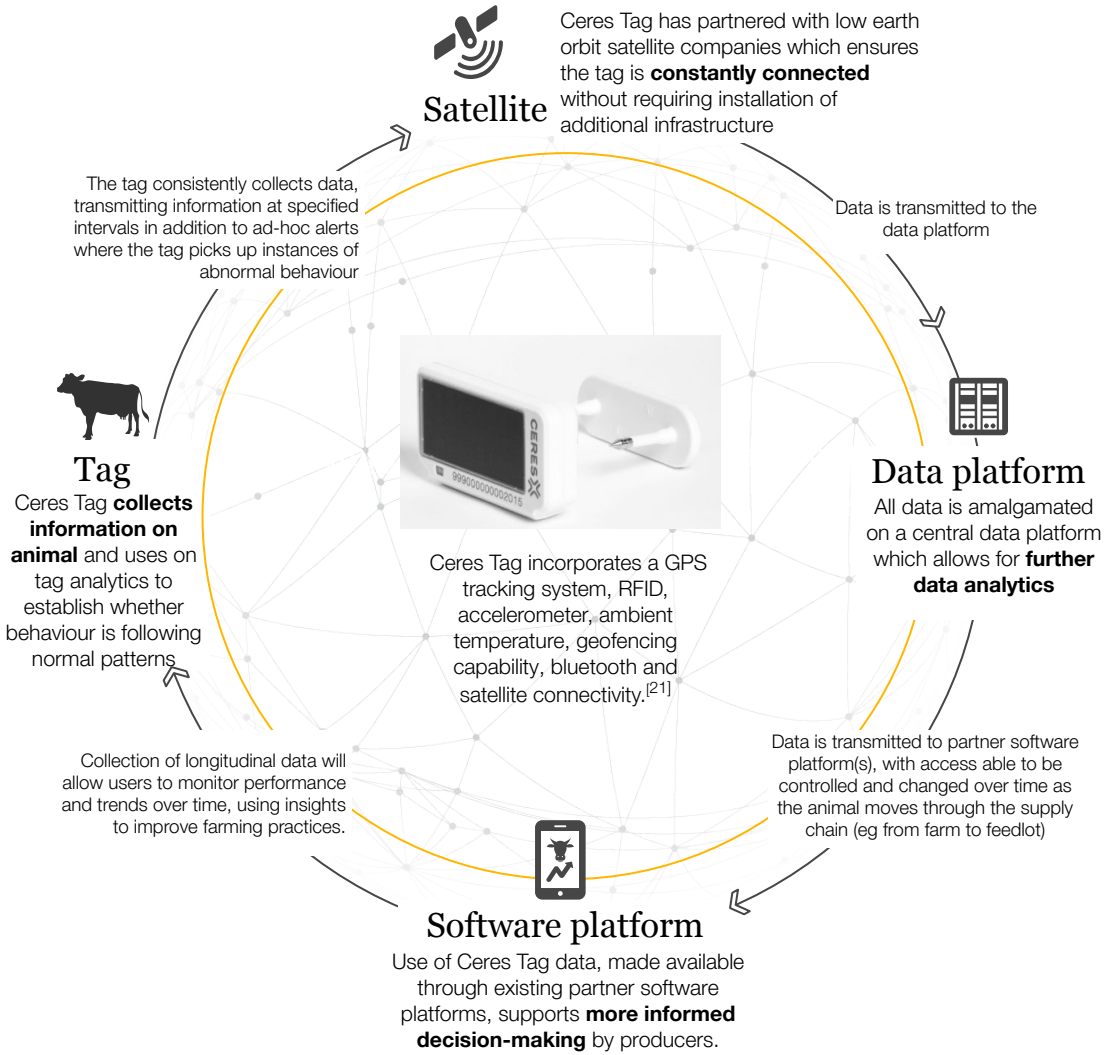
'Ceres Tag gives greater transparency over grazing management, allowing farmers to locate and monitor their animals to reduce risk and operating costs, improve efficiency and assist with traceability.'[1]

Conventional livestock ear tags use radio frequency identification (RFID) to allow farmers to identify animals to monitor weight and undertake basic husbandry. Ceres Tag enhances existing technology by providing direct to satellite enabled geolocation, with accelerometer and temperature analytic capabilities.

The proprietary smart ear tag provides real-time data collection and on- and off-farm data analytics through a data platform. This supports collection of detailed provenance information, more productive operational management, improved detection of stolen livestock, and greater insight into animal welfare and health.[2]

An overview of how Ceres Tag works is provided in Figure 5.

Figure 5: How Ceres Tag works in practice



1. The Queensland Cabinet and Ministerial Directory, (2019). *Media Statement: Smart ear tag for cattle set to revolutionise industry.*
2. Information provided by Ceres Tag (2020)

2. Approach

Image: John P Kelly / Stone RF

Approach

Identifying the benefits of Ceres Tag

This report presents an independent analysis of the benefits that the Ceres Tag platform offers to industry. A suite of potential use cases were developed which seek to highlight the benefits that Ceres Tag could provide across the beef cattle supply chain (see Table 2).

Quantitative assessment, where there was a sufficient degree of certainty in the way the platform could be applied, focuses on incremental benefits that the Ceres Tag platform provides to key beneficiaries under each of these use cases. Note, it does not provide a full cost benefit analysis or look at the likely economy-wide impacts.

The **quantitative analysis** includes use cases for:

- traceability (specifically cattle price premiums attributable to improved provenance, and administrative cost savings)
- improved on-farm operating efficiency (specifically, mustering efficiency)
- reduced financing risk from the availability of up-to-date, animal-specific data regarding location and health of the herd
- enhanced monitoring and more timely treatment of endemic disease
- greater deterrence of stock theft
- improved herd management to decrease the impact of animal attacks.

The remaining use cases are included and described **qualitatively** in this report. For these, the precise nature and scale of the impact of Ceres Tag is less certain, or at least less readily quantified. These benefits are anticipated to spread more broadly across the supply chain and would be realised as adoption and familiarity with the platform increases.

While this review focuses only on the beef cattle industry, many of these same benefit streams will apply to broader livestock (e.g. dairy, pigs, sheep). However, the magnitude of the benefit under different species is unknown and would need further analysis.

Table 2: Overview of use cases

Use case	Time horizon	Scale of impact	Probability of occurrence	Key beneficiaries
Traceability	Short	High	High	Whole of supply chain
Improved operating efficiency	Short	High	High	Producers
Finance risk management	Short	High	Medium	Producers, lenders
Endemic disease	Short	High	Medium	Producers
Stock theft/loss	Short	High	Low	Producers, government
Animal attack	Short	High	Low	Producers, government agencies
Biosecurity and disease monitoring	Uncertain	High	Low	Whole of supply chain
Breeding efficiency	Medium	Medium	Medium	Producers
Pasture management	Medium	Medium	High	Producers
Carbon management	Long	Medium	High	Producers, government

3. Part A: Quantified benefits of Ceres Tag

Image: CSIRO

Cattle price impacts on estimated benefits

Cattle prices reached record levels in 2021

During 2021 cattle producers experienced historically favourable conditions,[1] with above average rainfall easing drought conditions as the national herd rebuild began after nearly two years of contraction.[2]

Throughout 2021, the industry faced unique and unprecedented market conditions. The Eastern Young Cattle Indicator (EYCI – a benchmark indicator of general cattle markets) – set new records multiple times throughout 2021, reaching 1,076c/kg in late October, a 33 per cent appreciation in 12 months,[3] and continuing to rise through December to average 1,132c/kg cwt (see Figure 6).[4]

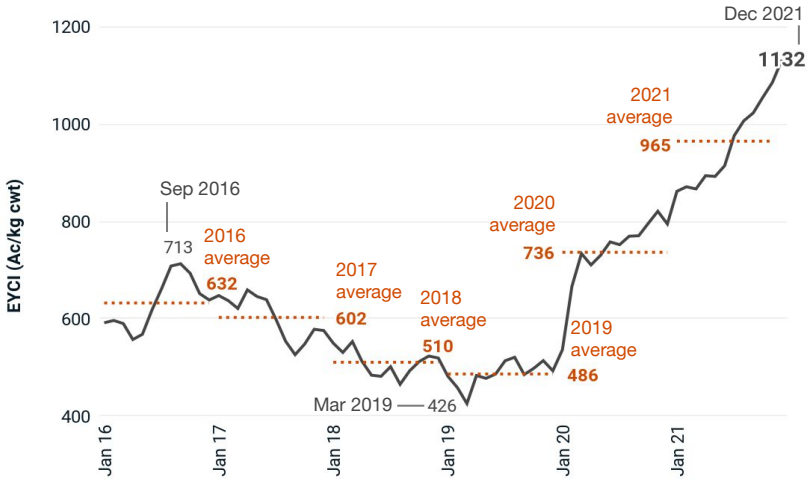
A number of factors have contributed to the continued strength in cattle prices:

- Significant rainfall and an abundance of feed[5] have supported a national herd rebuild, with herd numbers increasing 6 per cent on 2020[6] after cattle numbers plummeted to the lowest numbers in two decades in 2020 following the severe drought.[7]
- Despite increased herd numbers, supply remained tight with cattle slaughterings reaching the lowest level in 36 years.[8] This coincided with intense demand competition from lot feeders, restockers and producers resulting in higher and more volatile cattle prices.[9]
- The national herd rebuild is anticipated to continue into 2022 supported by forecast above average rainfall in the first three months of the year. Prices are anticipated to soften in the second half of 2022 on the back of increased supply as young cattle reach processor weights.[10]

ABARES forecasts prices will remain high for the rest of FY21-22 with the factors driving prices through early FY21-22 expected to continue.[11]

NAB also noted that continued favourable conditions could support further price increases into 2022, though Australia's market prices were trending significantly above global market trends and that drier weather conditions would likely result in a market correction.[12]

Figure 6: Historical movements in the Eastern Young Cattle Indicator (EYCI), 2016 - 2021



Linking prices and estimated Ceres Tag benefits

The cattle price assumption used to quantify Ceres Tag benefits will significantly influence resulting estimates for certain use cases, specifically: improved traceability, improved disease management, decreased costs associated with stock theft and decreased costs associated with animal attack.

As indicated by Figure 6, there has been a high degree of variability in prices in recent years, with early 2022 data suggesting unprecedented prices which may persist and/or continue to increase into the future. **Given the high degree of uncertainty around future prices, benefits have been estimated across a range of cattle price and weight assumptions.**

1. Meat & Livestock Australia, (2021). *Industry projections 2021: Australian Cattle - November update*
2. Meat & Livestock Australia, (2021). *Industry projections 2021: Australian Cattle. February 2021*
3. Meat & Livestock Australia, (2021). *Industry projections 2021: Australian Cattle - November update*
4. Meat & Livestock Australia Statistics Database (accessed 18 January 2021)
5. Meat & Livestock Australia, (2021). *Industry projections 2021: Australian Cattle - July update*
6. *Meat & Livestock Australia, (2021). Industry projections 2021: Australian Cattle - April update*
7. *Meat & Livestock Australia, (2021). Industry projections 2021: Australian Cattle. February 2021*
8. *Meat & Livestock Australia, (2021). Industry projections 2021: Australian Cattle - November update*
9. Meat & Livestock Australia, (2021). *Industry projections 2021: Australian Cattle - April update*
10. Meat & Livestock Australia, (2022). *Industry projections 2022: Australian Cattle. January 2022*
11. ABARES, (2021). *Outlook for livestock*
12. National Australian Bank, (2021). *Rural Commodities Wrap, November 2021*

Quantified benefits of Ceres Tag platform

Given the heterogeneous nature of cattle operations, the scale of Ceres Tag benefits will differ from farm to farm

Developing a single 'representative' Ceres Tag benefit is difficult, as consideration needs to be given to the variable nature of the cattle operations and producer location in order to determine the potential magnitude of various benefit streams.

The quantitative analysis for each use case (pages 16 to 22) presents estimates across ranges (low, mid, high) and, in some instances, also provides separate estimates for northern/southern regions as well as state-based estimates. This approach recognises the high degree of variability in terms of the scale and nature of cattle operations across Australia, as well as differences in external factors that need to be managed by producers (e.g. endemic disease and wild dog prevalence).

Price and weight assumptions will also affect estimated benefits

As noted on page 13, cattle prices will also affect benefit estimates for certain use cases. In the detailed quantitative analysis, we have used historical cattle prices (escalated to December 2021 dollars) and average animal weights to guide benefit estimates. However, given uncertainties around future price movements, we also have calculated a range of potential benefit values under varying price and weight assumptions.

This approach also provides insights into the potential benefits that can be realised by different producers and operating models - for instance, producers that generally achieve higher grades and/or weights would, all else equal, be expected to realise higher benefits than those achieving lower grades and/or sale weights.

Summary benefits

Table 3 provides a summary of estimated benefits under varying weight and price assumptions, applying the following generalised assumptions for each use case:

- **traceability (provenance):** midpoint of the estimated benefit range for administrative savings and price premium (see pages 16-17)
- **mustering efficiency**: midpoint of the estimated benefit range (page 18)
- **interest cost savings**: midpoint of the estimated benefit range associated with a 2.5 percentage point (pp) reduction in interest rate (page 19)
- **endemic disease management:** average of northern and southern region midpoint of the estimated benefit range associated with a 10 per cent cost reduction (page 20)
- **stock theft cost reduction**: midpoint of the estimated benefit range (page 21)
- **reduction in wild dog attack costs**: average of Queensland, WA, NT and NSW estimated benefit associated with a 10 per cent reduction in costs (page 22).

Table 3: Estimated benefit on a 'per tag' basis, applying midpoint benefit assumptions across various price / weight combinations

		Price (c/kg liveweight)						
		250	350	450	550	650	750	850
Weight (kg liveweight)	325	$132	$144	$156	$167	$179	$190	$202
	400	$139	$153	$168	$182	$196	$210	$225
	475	$149	$163	$180	$197	$213	$230	$247
	550	$152	$172	$192	$211	$231	$250	$270
	625	$159	$181	$204	$226	$248	$270	$293
	700	$166	$191	$216	$241	$266	$291	$315

Results based on historical price ranges over past three years

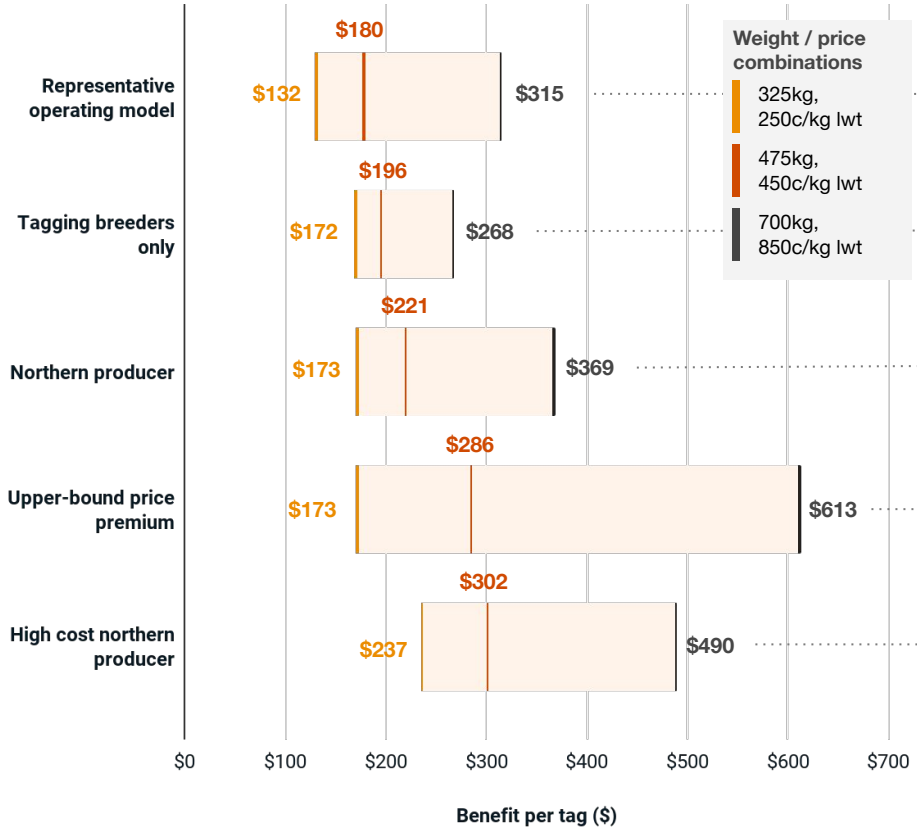
Results based on higher price forecasts (consistent with ~1,000 -1,500 EYCI)

Benefits will vary by operating model

Estimating benefits for specific operating models may provide another indication of the value of Ceres Tag

As an alternative to estimating a 'per tag' benefit based on a single 'representative' operating model, case studies can be developed that draw on a range of potential operating model characteristics to provide a more accurate indication of the potential benefits that can be derived from Ceres Tag for a given type of operation. Case studies are presented below (Figure 7) that describe cattle operations where Ceres Tag is expected to provide higher benefits, with results presented across three weight / price combinations. Detailed assumptions underpinning each case study can be found in Appendix A.

Figure 7: Estimated benefit ranges ($ per tag) under various operating models and weight / price combinations



Case study summary

Estimated 'per tag' benefit based on averages and midpoints of use case assumptions, as described on page 14.

Assumes only breeders in a herd are tagged. A longer assumed average lifespan of these animals (6 years relative to 3 years) increases mustering benefits on a 'per tag' basis, with conservative benefits for traceability, credit risk management and endemic disease also assumed.

This scenario applies assumptions likely to be more relevant to a typical northern producer. Upper-bound mustering benefits are applied (assuming larger property sizes), as well as upper-bound interest cost savings associated with a 2.5pp reduction (assuming higher existing debt levels), and midpoint disease management benefits associated with a 10 per cent cost reduction for northern producers.

Assumes the upper-bound price premium could be realised by Ceres Tag (10 per cent premium, with 75 per cent of the premium attributable to Ceres Tag). All other assumptions are consistent with the representative operating model estimates.

This scenario assumes characteristics associated with a relatively high-cost northern producer. This includes upper-bound mustering benefits, upper-bound interest cost savings associated with a 5pp reduction in interest rates, upper-bound disease management benefits associated with a 10 per cent cost reduction, upper-bound stock theft benefits and upper-bound animal attack benefits.

Quantified benefits
Use Case 1: Traceability through the supply chain

There is growing demand for traceability of animals from paddock to plate

The concept of lifetime traceability in the livestock industry is becoming increasingly important. Where previously the value of traceability has largely been seen to relate to preventing and responding to disease outbreaks, there is a growing focus on meeting the needs and demands of consumers for trustworthy and specific information related to product provenance.

Consumer expectations are changing and the demand for guaranteed food safety and sustainability is on the rise. Instances where a product does not meet this standard, especially where there are implications for consumer health, can have devastating outcomes for industry.[1]

Producers and exporters of Australian food - including beef cattle - face mounting threats to food security, with fraudulent products undermining trust in the Australian brand, and the price premiums that come with it. Retail sales of fraudulent "Australian" branded beef alone are estimated to be worth around $2 billion a year.[2] The ability to provide detailed and certified provenance is a highly marketable commodity - research indicates that meat with Australian provenance can capture price premiums of up to 25 per cent relative to other markets,[3] and consumers are willing to pay 7-9 per cent more for proof of animal welfare.[4]

This has driven changes to meat and livestock integrity systems as well as initiating a wave of data driven solutions designed to ensure consumers have access to trustworthy information on animal origin, farm location, diet history, and welfare.

Blockchain enabled platforms which are aimed at tackling food fraud, such as PwC's Food Trust Platform[5] and Aglive,[6] require verifiable data on each animal to drive transparency throughout the supply chain and build consumer confidence in the products that they credential.

The ***estimates provided in the report represent the estimated incremental benefits of the Ceres Tag platform and ear tag*** over and above the 'next best alternative'. For instance, this means *existing* benefits already realised by producers through National Livestock Identification System tags are not included in estimates (ie figures are estimated benefits over and above those derived through standard NLIS tags).

The benefit offered by Ceres Tag

Ceres Tag provides a platform through which provenance data can be captured throughout the life of an animal and readily transferred through the supply chain (ie from paddock to plate). Ceres Tag's platform can connect with external software platforms that monitor on-farm management, transport and lot feeding, transmitting animal-specific data without the need for manual data entry. This minimises the potential for human error, reduces the time taken to collect and report data, and increases the wealth of information that can be collected and reported.

The automation of the data collection and transmission process is expected to provide cost savings for producers through a reduction in time spent on manual administrative tasks.

More significantly, the data collected through the Ceres Tag platform (coupled with a bespoke tag application system which improves retention rates and minimises tag loss) offers opportunities for greater value to be realised throughout the supply chain from the increased integrity and granularity of animal-specific information that can be provided to consumers at the point of purchase.

Ceres Tag is partnering with traceability solutions that focus on the consumer end of the supply chain (ie carrying information at the point of slaughter through to the point of purchase) to improve provenance integrity, fight fraudulent products, and assist in attracting price premiums to Australian producers, processors and retailers and provide greater value to consumers.

> Enhanced traceability through the supply chain could represent a **$1 billion opportunity** across the Australian beef cattle industry.[7]

1. Department of Environment and Primary Industries, (2004). *Lifetime traceable: An emerging market requirement*
2. Marshall, A. (2018). *Beef brands turn high-tech to fight food fraud thieves*
3. Paull, J., (2006). *Provenance, Purity & Price Premiums: Consumer Valuations of Organic & Place-of-Origin Food Labelling*
4. Rural Industries Research and Development Corporation, (2008). *Requirements for New Animal Products Traceability Systems*
5. PricewaterhouseCoopers, (2020). *How PwC's Food Trust Platform uses micro tag technology to protect Australian brands from food fraud*
6. Aglive (2020). https://aglive.com/
7. *PwC calculation based on figures from ABS, (2021). 7210 - Agricultural Commodities, Australia, 2019-20 and mid-range traceability supply chain benefit estimated at $50.40 per tag, see page 17.*

Quantified benefits
Use Case 1: Traceability through the supply chain

Quantifying the benefit of Ceres Tag

Traceability benefit #1 - value-add through the supply chain

Assumptions applied to estimate the Ceres Tag benefit

1. Academic literature provides estimates of consumer willingness to pay for enhanced traceability/product provenance. Estimates of willingness to pay vary considerably, with estimates commonly between 1-10 per cent[1][2] and some research estimating up to a 30 per cent premium.[3] Benefits have been tested at a 2.5, 5 and 10 per cent price premium realised on current averages prices received by producers (relatively conservative assumptions).
2. The baseline average price per head of cattle is estimated at $1,609.[4]
3. The proportion of the total traceability / provenance benefit attributable to Ceres Tag is until slaughter. We note that while Ceres Tag forms a critical component in the traceability chain (collecting animal-specific data up to the point of slaughter), it will need to interface with external systems to carry information from the processor to the point of purchase. Given this limitation, we have tested results applying Ceres Tag benefit attribution rates of 25, 50 and 75 per cent.

Traceability price premium realised per tag

Proportion of premium attributable to Ceres Tag	Low	Mid	High
25%	$10.10	$20.10	$40.20
50%	$20.10	$40.20	$80.50
75%	$30.20	$60.30	$120.70

Traceability benefit #2 - administrative time saved

Assumptions applied to estimate the Ceres Tag benefit

1. Anecdotal evidence indicates that administrative burden associated with data entry for management of cattle differs widely based on the operating model and existing approaches to data management. For an 'average' farm of 870 head[5] a baseline of 30 minutes of administrative burden per day has been assumed (with sensitivity of 50 per cent above and below this estimate applied).
2. The cost of time for administrative tasks is assumed to be $31.90 per hour, based on the median hourly earnings for administrative and support services.[6]
3. The likely time saving afforded by the platform is difficult to estimate with certainty. Discussions with Ceres Tag suggest that the majority of the time currently associated with data entry can be avoided through adoption of the platform. To be conservative, a central estimate 50 per cent time saved has been applied, with sensitivity of 25 and 75 per cent.
4. Benefits are assumed to be realised over a 3 year period (the estimated average lifespan of an animal)[7].

Administrative time cost saving per tag

Admin time saving	Low	Mid	High
25%	$2.50	$5.10	$7.60
50%	$5.10	$10.20	$15.30
75%	$7.60	$15.30	$22.90

The mid-range estimated benefit associated with enhanced traceability through the supply chain is estimated to be $50.40 per tag

1. Choe, Y. C., Moon, J., & Chung, M. (2009).
2. Li, K., & Nguyen, C. (2015).
3. Chun, M. H., Chung, G. H., & Kim, H. D. (2007).
4. Meat & Livestock Australia Eastern States Saleyard cattle indicators - three year average for Medium steer C3, Heavy steer C4 and Medium cow D3 to Dec 2021 (adjusted to Dec 2021 dollars), multiplied by mid-point of weight range for each indicator, with average of the three resulting values used as average price per head.
5. Average cattle per farm based on PwC calculation using ABS (2021). *7121.0 - Agricultural Commodities, Australia-2019-20* and ABARES, (2021). *Farm Survey and Analysis: Beef Farms.*
6. ABS, (2021). *6333.0 - Characteristics of Employment, Australia, August 2021*.
7. Average lifespan estimated based on PwC analysis of ABARES herd composition data (ABARES, (2011). *Financial performance of beef cattle producing farms*)

Quantified benefits
Use Case 2: Improved operating efficiency

Mustering can be a major cost component for producers

Mustering is a significant operating cost for many commercial cattle properties, particularly for larger farms. These costs are not fixed, changing to reflect location and spread of the herd, the size of the property, weather conditions and variable terrain.[1]

Depending on the nature and scale of the cattle operation, mobs can be mustered multiple times per year, requiring significant resources each time. This includes the deployment of labour and capital assets (such as vehicles and helicopters).

Improving the efficiency of mustering has been a consistent point of interest for researchers and producers, with many ranking muster efficiency as one of their priorities for the use of GPS technology.[2]

The benefit offered by Ceres Tag

Research shows that the use of spatial location technology (such as GPS) to locate cattle prior to, and during, muster can provide significant operational cost savings.[3]

Ceres Tag provides GPS tracking which can be used by producers to monitor herd location and movement.[4] This allows producers to locate herds prior to commencing a muster, reducing the use of time-consuming and costly resources such as helicopters and associated labour costs.

Ceres Tag can also assist in timely decision-making during a muster, including weighing the benefits of pursuing animals which have separated from the larger herd. As a result, musters can be more targeted, reducing the resources required and allowing for a cleaner muster.

Quantifying the benefit of Ceres Tag

Assumptions applied to estimate the Ceres Tag benefit

1 Research on mustering costs suggests the benchmark cost per animal mustered can range from $50.70 to $57.90 (escalated to 2021 dollars).[5]

2 The number of times an animal is mustered over its lifetime can vary significantly - we have assumed an animal is mustered between one and two times per year (or three to six times over an average lifespan of three years).[6][7]

3 Research indicates potential savings associated with spatial location technologies ranges from 13.75 percent to 18.75 per cent of mustering costs (predominantly due to more efficient deployment of capital, namely helicopters).[8]

Operating cost saving per tag

Based on the above assumptions, the resulting Ceres Tag benefit on a per tag basis (assuming 100 per cent of animals are tagged) is estimated to range between...

Low	Mid	High
$20.90	$43.00	$65.10

Adjusting benefits estimates for potential reduction in tagging rates

This estimate of benefits assumes that tags would be applied to 100 per cent of a herd. Through engagement with producers Ceres Tag has identified that a possible approach could be to tag only a proportion of animals (thus reducing overall tag costs). Due to the herd mentality of cattle, there is potential for lower tagging rates to still realise some/all benefits in terms of greater muster efficiency. The adjacent matrix shows how the estimated 'benefit per tag' changes (using the mid-range estimate of $43.00 as a starting point) under various tagging rates and proportion of full benefits realised.

Varying the assumptions around tagging rates and proportion of benefits realised produces a range of benefits between $17.20 and $107.50 per tag.

Tagging rate	Proportion of benefits realised: 100%	80%	60%	40%
100%	**$43.00**	$34.40	$25.80	$17.20
80%	$53.80	**$43.00**	$32.30	$21.50
60%	$71.70	$57.40	**$43.00**	$28.70
40%	$107.50	$86.00	$64.50	**$43.00**

1. Department of Primary Industries and Fisheries (QLD), (2005). *Cost-effective and multipurpose self mustering enclosures for stock.*
2. Meat & Livestock Australia, (2013). *On property benefits of Precision Livestock Management.*
3. Meat & Livestock Australia, (2013). *On property benefits of Precision Livestock Management.*
4. Ceres Tag, (n.d.). *What is Ceres Tag.*
5. Department of Primary Industries and Fisheries (QLD), (2005). *Cost-effective and multipurpose self mustering enclosures for stock.*
6. ABARES, (2012). *Northern Australian beef industry Assessment of risks and opportunities.*
7. Average lifespan estimated based on PwC analysis of ABARES herd composition data (ABARES, (2011). *Financial performance of beef cattle producing farms*)
8. Meat & Livestock Australia, (2013). *On property benefits of Precision Livestock Management.*

Quantified benefits
Use Case 3: Credit risk management

Obtaining credit can be costly for cattle producers

Cattle producers can experience substantial variability in annual income given the nature of production (i.e. the lag time between calving and finishing cattle ready for sale/slaughter) and exposure to external factors such as climate and stock prices (which can be difficult to manage effectively). With significant capital tied up in livestock, an unexpected event or downturn in the market can have significant impacts on farm cash flows. This can create challenges in terms of both securing credit and servicing existing loans.

For a lender, there is significant risk associated with securing a loan against livestock given the general lack of reliable data and information regarding the number, condition and value of the livestock associated with the farming operation seeking credit. The challenges associated with accurately assessing credit worthiness creates risks for financial institutions, limiting their willingness to lend or changing the conditions under which they are willing to loan funds (e.g. through the application of higher interest rates).[1]

The benefit offered by Ceres Tag

Ceres Tag collects and regularly transmits animal-specific data, allowing for an accurate assessment of the number and condition of a herd. This information could be drawn on to provide a regular herd stocktake, allowing for greater transparency between the producer and financier. More accurate herd data (and therefore more accurate risk profiles) could allow for loans to be more readily secured against herd value on more favourable terms (i.e. lower interest rates or higher loan to value ratios), allowing for greater access to credit and / or lower costs to service loans.

Quantifying the benefit of Ceres Tag

Assumptions applied to estimate the Ceres Tag benefit

1. The average herd size for a 'representative' cattle farm is assumed to be 870[2] with an average lifespan of thee years per head.[3]
2. Average value of debt for a representative cattle operation is estimated at $815,500[4] (escalated to 2021 dollars), with a range of between $612,000 and $1,019,000-adopted (25% below and above the mid range estimate).
3. Assumed 'current state' interest rate applicable to a cattle operation loan secured against cattle is assumed at 13% p.a.[5] with a loan repayment period of 10 years.[6]
4. As the magnitude of the interest rate reduction that could be achieved through more accurate herd information is uncertain, benefits are quantified assuming interest rate reductions of 1 pp, 2.5pp and 5pp.[7]

Interest cost savings per tag

	Low	Mid	High
1.0pp ↓	$15.00	$20.00	$25.00
2.5pp ↓	$36.90	$49.20	$61.50
5.0pp ↓	$71.90	$95.80	$119.80

Adjusting benefits estimates for potential reduction in tagging rates

As noted previously, some producers may opt to apply a tagging rate below 100 per cent. A lower tagging rate would still provide lenders with a richer data set compared to the current state (thus allowing for a more accurate risk profile to be developed), it is therefore feasible that some proportion of the full estimated benefit would still be realised. As the trade off between tagging rates and benefits realised is uncertain, the adjacent matrix shows illustrative results assuming the midpoint benefit for a 2.5pp reduction in interest rates ($49.20 per tag)

Varying the assumptions around tagging rates and proportion of benefits realised produces a range of benefits between $19.70 and $123.00 per tag.

Tagging rate \ Proportion of benefits realised	100%	80%	60%	40%
100%	**$49.20**	$39.40	$29.50	$19.70
80%	$61.50	**$49.20**	$36.90	$24.60
60%	$82.00	$65.60	**$49.20**	$32.80
40%	$123.00	$98.40	$73.80	**$49.20**

1. Next Billion, (2016). *Small farmers meet big data: How the data revolution could transform smallholder finance.*
2. Average cattle per farm based on PwC calculation using ABS (2021). *7121.0 - Agricultural Commodities, Australia-2019-20* and ABARES, (2021). *Farm Survey and Analysis: Beef Farms.*
3. Average lifespan estimated based on PwC analysis of ABARES herd composition data (ABARES, (2011). *Financial performance of beef cattle producing farms*)
4. Department of Agriculture and Water Resources, (2021). *Agricultural lending data 2019-20.*
5. Informal discussions with a lender indicated that interest rates for loans against stock value average 12 to 14%.
6. This is the term applied to farm investment loans administered by the Regional Investment Corporation (see https://www.ric.gov.au/farm-investment)
7. Informal discussions with a lender indicated that more accurate herd information could result in loan terms more aligned with purchasing an asset such as a vehicle, which indicatively attracts an interest rate closer to 8%. A 5pp reduction is used as an upper bound assumption.

Quantified benefits
Use Case 4: Reducing endemic disease

The costs associated with endemic disease in cattle herds

Illness can spread quickly through a herd, resulting in reduced reproductive rates, diminished growth rates, condemnation of carcasses, and reduced milk production. This can have a detrimental impact on the value of the herd or their ability to reach required weight and quality standards prior to processing.[1] The impact of poor animal health acts to both reduce the income of a producer through poorer animal condition, and increase their expenses through costs of treatment.[2]

Early intervention can allow for effective quarantine of an infected animal. This can reduce the spread of disease across the herd, reduce the overall loss of condition within the animal, and allow for milder treatments. The severity of treatment administered is a key consideration, as withholding periods for cattle which have been treated using veterinary chemical products (including antibiotics) can have significant impacts for when an animal is able to be legally slaughtered for human consumption.[3]

The benefit offered by Ceres Tag

Cattle suffering from ill health are often sluggish in movement, have a poor appetite and show little interest in their surroundings or socialising with others.[4] These changes in behaviour can be used to identify illnesses, such as Bovine Respiratory Disease (BRD).[5]

Researchers have developed a number of disease-specific accelerometer algorithms that can interpret changes in behaviour to identify instances of illness. These algorithms can be applied to the data collected by Ceres Tag, with producers then alerted when an animal is exhibiting signs of illness. This allows for earlier intervention (both in terms of treatment and quarantining) to limit the impact of disease.

Quantifying the benefit of Ceres Tag

Assumptions applied to estimate the Ceres Tag benefit

1 A 2015 report produced for Meat & Livestock Australia (MLA) quantified the economic costs of the most damaging endemic diseases in the red meat industry, namely: Cattle tick, Bovine Viral Diarrhoea Virus, Buffalo fly, Dystocia and neonatal calf mortality (cause unknown). Costs were quantified in terms of production loss, preventative costs and treatment costs.[6]

2 Importantly, separate estimates were provided for northern and southern production systems, as the prevalence of and costs associated with endemic disease differ significantly between regions. The annual production loss and treatment cost associated with endemic disease is estimated to range from $16 - $89 per head per year in northern regions and $10 - $30 per head per year in southern regions (all costs escalated to 2021 dollars using CPI).

3 The average lifespan of cattle is estimated at three years based on analysis of the age distribution of the national herd.[7]

4 As the magnitude of the reduction in endemic disease costs that would be achieved by Ceres Tag is uncertain, indicative benefits are estimated assuming cost reductions of 1%, 5%, 10% and 20% compared to the current state.

Saving per tag from reduced disease costs

Cost saving	Northern region			Southern region		
	Low	Mid	High	Low	Mid	High
1%	$0.50	$ 1.60	$ 2.70	$0.30	$ 0.60	$0.90
5%	$2.50	$ 8.05	$13.60	$1.60	$ 3.10	$ 4.60
10%	$5.00	$16.10	$27.20	$3.10	$ 6.15	$9.20
20%	$10.00	$32.15	$54.30	$6.30	$12.35	$18.40

1. Inside science, (2015). *Fitbit for cows: Wearable tech could help cowboys spot sick animals sooner.*
2. Meat & Livestock Australia, (2006). *Assessing the economic cost of endemic disease on the profitability of Australian beef cattle and sheep producers.*
3. Integrity Systems, (n.d.). *Safe and responsible animal treatments.*
4. Animal Behaviour, (n.d.). *Cattle.*
5. Inside science, (2015). *Fitbit for cows: Wearable tech could help cowboys spot sick animals sooner.*
6. Meat & Livestock Australia, (2015). *Priority list of endemic diseases for the red meat industry.*
7. ABARES, (2011). *Australian Beef: Financial performance of beef cattle producing farms 2008-09 to 2010-11.*

Quantified benefits
Use Case 5: Deterring stock theft

The cost of stock theft in Australia

Stock theft is a unique crime with features that can make it difficult to control. Livestock are generally easily accessible, can be visible from public roads, and are often left unchecked for long stretches of time, with remote and large properties especially vulnerable to stock theft.[1]

The costs associated with stock theft vary from state to state. In Queensland, an estimated 4,000 head of cattle were reported missing in 2014.[2] In NSW, an average of 1,850 head of cattle have been reported stolen to police each year between 2015 and 2019, with an average cost of $1.9m per year over this period.[3] Extrapolating NSW figures across Australia (using the NSW proportion of national beef cattle herd) suggests reported stock theft reaches around 10,000 head per year on average, indicatively valued at close to $17m.

Importantly, research indicates that only a small proportion of livestock theft is reported to police (around 35 per cent of incidents), largely due to a perception that a lack of evidence surrounding the incident means police will not be able to do anything.[4] This suggests the total value of stolen cattle is likely to be significantly higher than indicated by police data.

The benefit offered by Ceres Tag

Ceres Tag is expected to act as a significant deterrent to stock theft. The tag is readily visible and cannot be easily removed without causing damage to the animal (e.g. removal of the ear), which would negatively impact on the value of the stolen stock and make resale difficult. In addition to acting as a visual deterrent, in instances where theft does occur, GPS data could be readily provided to police to assist in stock recovery and provide evidence for potential prosecutions.

The ability for producers to easily provide data to police may help address issues associated with underreporting (particularly given that lack of evidence is the most common reason for not reporting an incident). Data may also support greater access to insurance for producers (through lower costs and / or insurers choosing to offer products in high-risk areas).

1. Department of Communities and Justice (NSW), (2016). *NSW Stock theft and trespass review.*
2. ABC, (2015). *Police stock squad trains to target spike in cattle theft across Queensland.*
3. NSW Police data on stock theft in NSW provided to PwC
4. ABS, (2019). *7121.0 - Agricultural Commodities Australia 2017-18.*
5. Australian Institute of Criminology, (2005). *Farm Crime in Australia.*
6. Meat & Livestock Australia Eastern States Saleyard cattle indicators, see [4] on page 17
7. Nettle, D., Nott, K., Bateson, M., (2012). *Impact of a simple signage intervention against bicycle theft.*
8. Meat & Livestock Australia Eastern States Saleyard cattle indicators, see [4] on page 17
9. Average cattle per farm based on PwC calculation using ABS (2021). *7121.0 - Agricultural Commodities, Australia-2019-20* and ABARES, (2021). *Farm Survey and Analysis: Beef Farms.*

Quantifying the benefit of Ceres Tag

Assumptions applied to estimate the Ceres Tag benefit

1 NSW Police data for 2016 to 2020 indicates between 1,488 and 2,827 head of cattle are stolen each year in the state (average of 1,845 per year).[3] Extrapolating this across the Australian herd (assuming NSW accounts for 17% of total beef cattle)[1] results in reported theft of between 8,700 and 16,590 head per year (average of 10,800).

2 Data from the National Farm Crime Survey indicates only 35% of livestock theft is reported to police. Applying this figure, total cattle theft is estimated to be between 25,000 and 47,400 head of cattle per year (average of 31,000).[5]

3 Applying an average value per head of $1,609,[6] the total cost of cattle theft is estimated at between $40.1m and $76.3m per year (average of $50.0m).

4 The deterrent effect of the tag is estimated to range from 60%[7] - 100% and assumes that all animals are tagged.

Cost saving per tag from reduced theft

Low	Mid	High
$ 3.47	$ 5.74	$ 10.99

This estimate is conservative as it only accounts for deterrence effect benefits that accrue to producers. Additional benefits would likely be realised from higher success rates in recovering stolen cattle and prosecuting offenders (given availability of GPS data).

Case study - cost saving from avoided theft incident

In order to calculate theft deterrence benefits on a 'per tag' basis, the estimated annual cost of theft is defrayed over the national cattle herd (resulting in relatively low estimates on a per tag basis). An alternative conceptual approach is to consider the indicative cost saving for a specific property where a theft that would otherwise have occurred is avoided due to Ceres Tag. NSW Police data indicates that over the past five years, 14 cattle are stolen on average per reported incident (resulting in an **average cost of $22,358 per incident** based on a value per head of $1,609.[8] Assuming an average herd size of 870,[9] **the cost saving associated with avoiding a theft incident is equal to $25.70 per head**. Thus for producers that currently experience higher rates of theft, the expected value per tag could be significantly higher than the mid-range estimate of $5.76 per tag.

Quantified benefits
Use Case 6: Reducing animal attack costs

Stock loss due to wild dog attacks can be significant, particularly in northern regions

Wild dogs and dingos can have significant impacts on cattle herds through predation of calves, damage to full grown animals and the spread of disease.[1] Costs associated with attacks are highest in northern regions given the higher prevalence of wild dogs (particularly in Queensland).

These attacks were estimated to cost Queensland cattle producers $41.6m in 2009, comprising calf death, lower prices for dog bitten cattle, increased prevalence of disease associated with dog bites, and wild dog management costs (such as baiting and fencing).[2]

A report prepared for the NSW Natural Resources Commission estimated a cost associated with beef mortality loss from wild dogs of $62.5 million nationally in 2013-14, with the majority of this cost ($42.8m) incurred in Queensland.[3]

The benefit offered by Ceres Tag

Research indicates that access to data on the location, behaviour and state of cattle could assist in the detection of predation events, allowing for increased calf survival and for the more effective targeting of baiting programs.[4]

GPS tracking and data collected by the Ceres Tag accelerometer can be used to determine changes in animal behaviour. This can alert producers to instances of animal attack, enabling them to gain a detailed understanding of predation behaviour on their property (e.g. location and timing of attacks). Losses due to animal attack can be minimised through swift intervention or employment of more effective baiting and culling practices.

Assumptions applied to estimate the Ceres Tag benefit

1 The estimated benefits associated with reducing wild dog attacks focuses on cattle producers in Queensland, WA, NT and NSW, as these states are where the majority of attacks currently occur. The annual cost of wild dogs attacks (due to mortality loss) in these states is estimated at $49.0m (QLD), $7.8m (WA), $6.8m (NT) and $6.5m (NSW)[5] (escalated to 2021 dollars).

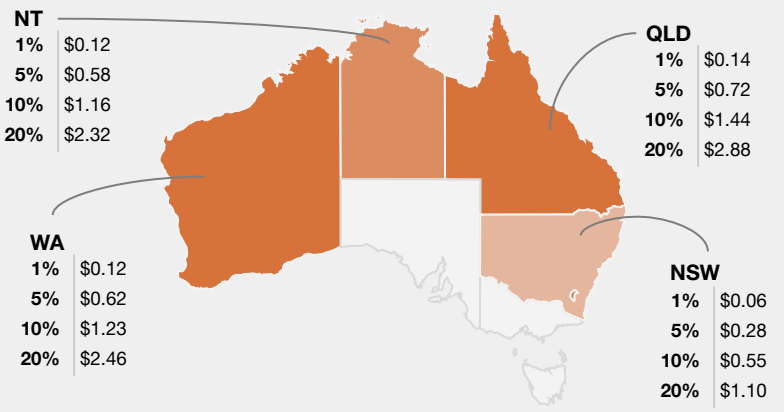
2 The total cost of wild dog attacks in each jurisdiction is divided by total beef cattle in each jurisdiction to derive a cost per head (ranging from $1.81 per head in NSW to $4.72 per head in Queensland).

3 The average lifespan of cattle is estimated at three years based on the demographics of the average herd.[6]

4 As the magnitude of the reduction in wild dog attack costs that would be achieved by Ceres Tag is uncertain, indicative benefits are estimated assuming cost reductions of 1%, 5%, 10% and 20% compared to the current state.

Saving per tag from reduction in wild dog attacks by jurisdiction

Estimated benefits associated with a reduction in animal attack costs are largest in Queensland and WA (an indicative $1.20 per tag saving associated with a 10% reduction in attack costs), followed by NT and NSW. Potential savings associated with a reduction in wild dog attacks are relatively minor compared to other quantified use cases.



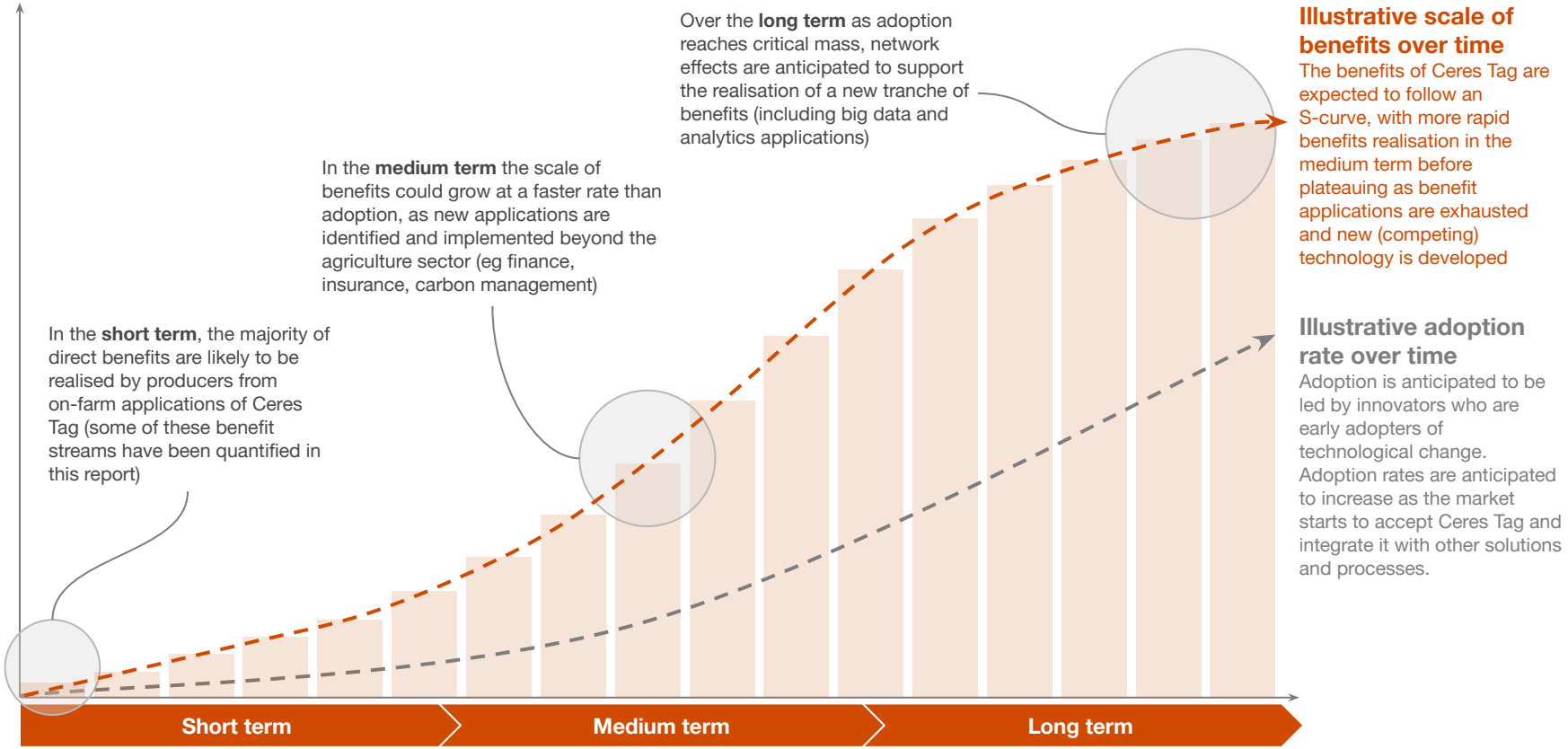
1. Meat & Livestock Australia, (2016). *Could your herd be more productive? An introduction to understanding your herd's productivity and possible causes of poor performance.*
2. Agforce, (2009). *Major economic costs associated with wild dogs in the queensland grazing industry.*
3. PestSmart, (2016). *Cost of pest animals in NSW and Australia 2013-14.*
4. Meat & Livestock Australia, (2018). *Demonstrating the value of animal location and behaviour data on the red meat value chain.*
5. PestSmart, (2016). *Cost of pest animals in NSW and Australia 2013-14.*
6. ABARES, (2011). *Australian beef: Financial performance of beef cattle producing farms 2009-09 to 2010-11.*

Wider benefits of Ceres Tag

The benefits provided by Ceres Tag are anticipated to continue growing with time

The scale and nature of Ceres Tag benefits will evolve over time as new uses for the data are identified and implemented. Given the uncertain nature of some of the longer-term benefit streams, the quantitative analysis in Part A of this report has focused on more tangible, shorter-term benefits expected to accrue to producers. The remainder of Part A of this report explores the broader medium and longer-term benefits associated with Ceres Tag in a qualitative sense.

Figure 8: Illustrative depiction of the growth in Ceres Tag benefits over time



Looking to the future

Measuring the benefits of Ceres Tag will become easier once the tag is being used on a commercial scale

Whilst quantitative analysis has focused on the shorter term benefits, which are predominantly focused pre-farmgate, it is anticipated that a much wider range of benefit streams will be recognised over time.

A number of these will eventuate as adoption of the device increases, it integrates with other technologies and familiarity with its capabilities grows. These benefits are expected to extend beyond the farmgate, with many having implications across the supply chain.

Whilst we have recognised a number of use cases which are relevant to Ceres Tag in the medium to long term, the precise scale and nature of the impact of Ceres Tag in these scenarios is uncertain and requires further investigation before they can be appropriately quantified.

These benefit streams have been explored qualitatively in this section, with the expectation that they may become more readily quantifiable once the tag is commercially operational.

Drone use in farm management

GPS data collected by Ceres Tag could be used to guide drone use on-farm. The use of drones is currently restricted to being within the line of sight,[1] which limits their applications on a large scale property. However, should this change in future, Ceres Tag can provide the necessary GPS input for producers and feedlot operators to check or audit their herd from afar.

1 Civil Aviation Safety Authority, (2020). *Drone Rules*.

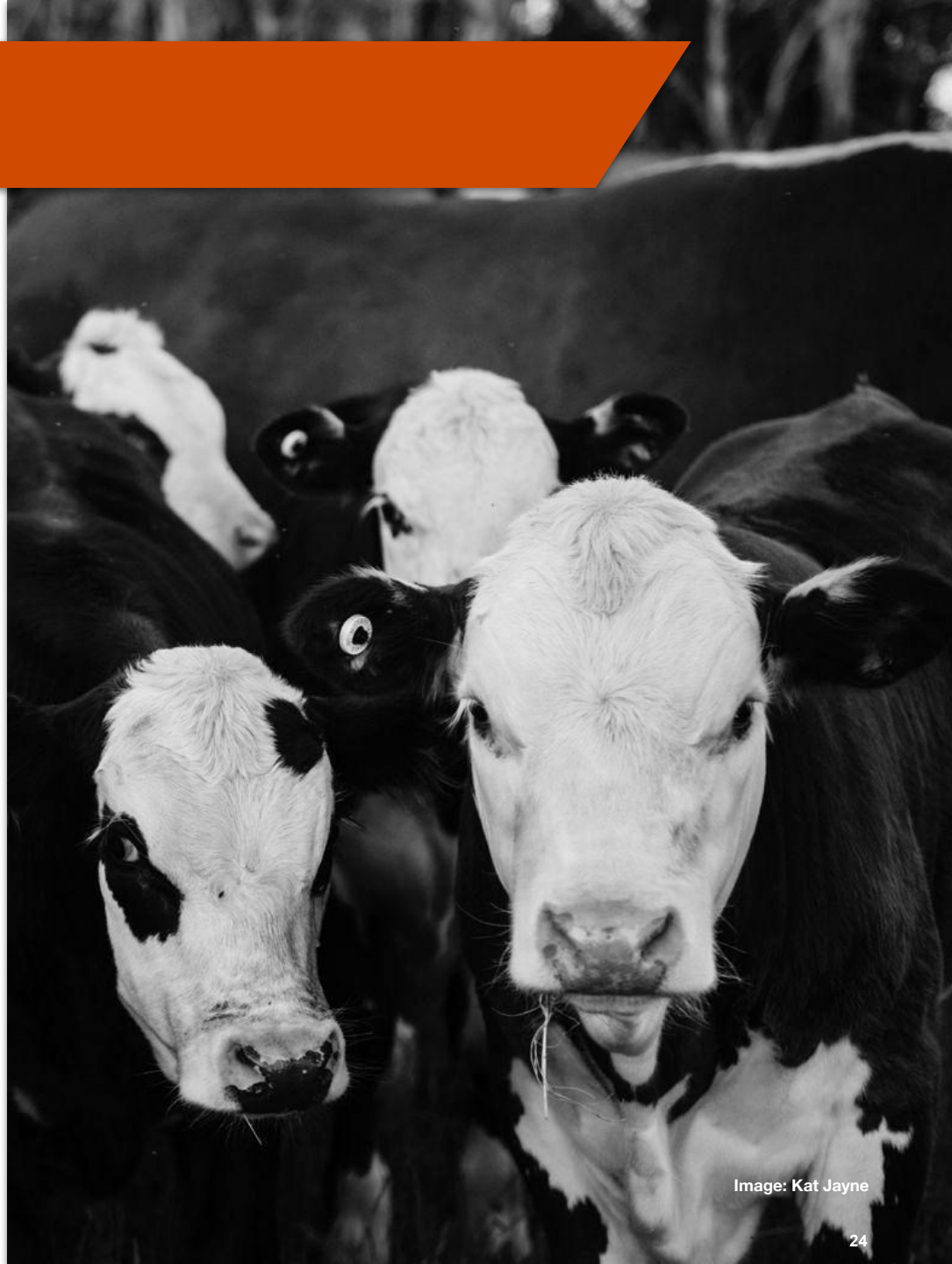


Image: Kat Jayne

Biosecurity and disease monitoring

Biosecurity & Welfare

An outbreak of highly contagious livestock disease is a constant threat to the beef cattle industry. Strict import regulations applied by Australia's main trading partners mean a biosecurity crisis would likely devastate the export industry. The anticipated cost impact of an outbreak of Foot and Mouth Disease (FMD) in Australia is estimated to be between **$17bn and $52bn**.[1]

Currently, the National Livestock Identification System (NLIS) is specific only to the farm level (or Property Identification Code number) and does not include a health register component.[2] The ability to trace animal history and disease outbreaks with commonly used NLIS tags is limited by instances of tag breakage, improper tagging, willful tag fraud, or only identified upon an animal leaving a property.

Quantification of the benefit of Ceres Tag related to biosecurity and welfare relies on an accurate understanding of future uptake rates and distribution, and long term data analysis. For example, a region with significant Ceres Tag uptake in future could produce data to detect disease entering the supply chain, indicate the extent of the spread of disease, including whether over-the-fence contact has occurred or not.

Ceres Tag data has the capacity to be integrated with other farm platform products for welfare management, such as vaccination and dipping schedules. In instances of major disease outbreaks and biosecurity threats, Ceres Tag traceability could assist in controlling livestock movements to limit the impact on the domestic industry and export markets.

The traceability benefits of Ceres Tag can also apply in other instances of natural disaster, such as fires and floods. In north Queensland's February 2019 floods, it is estimated that 500,000 head of cattle were lost due to floodwaters, loss of on farm infrastructure and pneumonia.[3] In these instances, Ceres Tag could be used to provide valuable information on the condition and location of animals to assist in recovery and prevent additional loss.

Case Study: 2001 FMD outbreak in the UK cost £8bn to control

In 2001 the UK experienced an unprecedented outbreak of the transboundary animal disease, Foot and Mouth Disease.

Over the 32 weeks it took to eradicate the disease, **a total of six million animals were slaughtered**, either due to infection or for welfare concerns.[4] Included in this number were 758,000 cattle, representing a significant portion of the national herd of only 9 million.[5]

There were **high costs to the government** to compensate farmers for slaughtered stock, as well as the significant consequential loss of income for which farmers were not entitled to claim compensation. Compensation schemes were put under immense pressure from increased valuations expected from the under-supplied market. Controlling the outbreak was estimated to have **cost the public and private sectors £GBP8 billion**.

The impact on the supply chain and broader economy was far-reaching. Red meat exports from parts of Britain were banned, and the European Commission restricted meat and animal imports from the UK.

Furthermore, there were large unforeseen consequences for non-farming adjacent industries, such as the rural tourism industry which suffered from closure of popular forest tracks and roads. A quarter of all domestic business reported an adverse impact from the crisis.[6]

1. ABARES, (2014). *Implementation of improvements to the National Livestock Identification System for sheep and goats: Decision Regulation Impact Statement.*
2. NSW Department of Primary Industries, (2020). *NLIS Cattle: Questions and answers.*
3. Major, T. (2019). *Cattle, Infrastructure losses following Queensland floods could near $2bn, farm lobby says*
4. Food and Agriculture Organization of the United Nations, (2016). *Economic analysis of animal diseases.*
5. National Audit Office, (2002). *The 2001 Outbreak of Foot and Mouth Disease.* pp17.
6. National Audit Office, (2002). *The 2001 Outbreak of Foot and Mouth Disease.* pp24.

Breeding efficiency

Better understanding of a herd's breeding capability

Reproductive performance in beef herds is a crucial component of production efficiency. However, strong performance is difficult to achieve with breeders under-producing in their lifetime, or suffering calf and breeder mortality when pregnancy is achieved.[1]

Oestrus cycles and age of puberty

Accelerometer data collected by Ceres Tag can monitor animal behaviour for signs of the oestrus cycle (e.g. mounting activity). This can be used to guide whether an animal is likely to be in heat, which can provide insight on when:

- a heifer has reached puberty and may begin breeding
- a cow may be pregnant (lack of mounting activity)
- a cow may have aborted a pregnancy (return to mounting activity within the pregnancy window)
- a cow is in heat and receptive to artificial insemination.

On average, **a producer detects only 60 per cent of the cows in heat**.[2] Therefore, this data can provide crucial information for increasing breeding efficiency. It can also assist in the identification of desirable fertility traits which can be selectively bred into future stock.

Calving

Calf death, and breeder death during calving, is a major obstacle for productivity, with **25.5 per cent of calf deaths being unexplained**. Breeder mortality rates typically range between two to 12 per cent, but can rise above 20 per cent in times of severe drought.[3]

Ceres Tag can indicate when a birth is occuring, allowing for intervention if necessary, or indicating when to avoid muster, as first-lactation cows mustered within two months of calving experience nine per cent higher calf loss.[4] Even at maximum stocking rates, increased calf and breeder survival offers producers a wider pool for selective breeding for future productivity.


Image: Patrick Bald

1. Day, M., Nogueira, G., (2019). *Management of age at puberty in beef heifers to optimize efficiency of beef production.*
2. Van Weyenberg, S., (2013). *Cattle tracking systems*.
3. Banney, S., Henderson, A., Perkins, N., (2013). *Determining property-level rates of breeder cow mortality in northern Australia.*
4. Meat & Livestock Australia, (2014). *Northern Australia beef fertility project: Cash Cow.*

Pasture management

Good grazing and pasture management is vital for ensuring a property remains productive and the degradation of natural resources is minimised. **Over-utilisation of pastures can decrease yields by up to 40 per cent** and do irreversible damage.[1]

Grazing strategies

Past research has found that producers estimate a financial benefit of approximately **10 per cent increase in revenue** due to better understanding and managing landscape utilisation.[2]

Grazing patterns can indicate which areas of the property need to be inspected for causes of under-utilisation, such as lack of water or poor grass quality. This information can be used to guide the redesign of paddock layout and to support set stocking, spell grazing or rotational grazing.[3] This can have a direct impact on the stocking rate and can greatly **increase the liveweight gains per day of growing stock.**[4]

Smaller paddock sizes have been shown to distribute grazing more evenly over the landscape and increase stocking rates, however traditional paddock division infrastructure can be prohibitively expensive.[5]

Ceres Tag has significant potential to support improved pasture management practices. Animal movement data collected by Ceres Tag over time will paint a more accurate and detailed picture of pasture utilisation and grazing intensity, meaning existing labour-intensive measurements may be replaced with Ceres Tag data and algorithms.

In addition, further technological integration with Ceres Tag has the potential to offer geofencing capabilities, allowing greater flexibility in pasture management practices without the capital expenditure associated with traditional paddock division infrastructure.

1. Meat & Livestock Australia, (n.d.). *Grazing strategies.*
2. Meat & Livestock Australia, (2018). *Demonstrating the value of animal location and behaviour data in the red meat value chain*.
3. Meat & Livestock Australia, (n.d.). *Grazing strategies.*
4. Department of Primary Industries (NSW), (2011). *Grazing management improves weight gain.*
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Image: Megan Clark

4. Part B: Carbon Market Opportunities

Image: Priscilla Du Preez

Financial Opportunities for Carbon Mitigation

Climate change represents a serious threat to the Australian agricultural sector, through potential impacts on farm productivity, animal health and water security. But climate change mitigation also presents a significant opportunity. Agriculture in Australia is a significant carbon emitter and accessing financial incentives to reduce carbon emissions could be a significant revenue opportunity for the sector. Agriculture is the fourth largest emitting sector in Australia at 15 per cent of total emissions (behind electricity at 32.9 per cent, stationary energy at 19.9 per cent and transport at 18.3 per cent).[1] The largest mitigation potential is proportional to emissions, therefore, cattle offer the largest mitigation potential opportunity (representing 65 per cent of total agricultural emissions).[2]

Many producers have already implemented changes to farm and animal management to reduce agricultural emissions. The agricultural industry has delivered a 60 per cent reduction in emissions since 2005[3] largely attributable to innovation and changes in land management in the sector. CSIRO data shows that it is possible to achieve net zero emissions for Australian livestock by 2030 without reducing herd and flock numbers below the rolling 10 year average (25 million cattle, 70 million sheep and 0.5 million goats).[4] This means that carbon emission reduction in the beef cattle sector is achievable through productivity improvements.

At this time, the only mechanism to generate a monetisable benefit for carbon reduction is earning Australian Carbon Credit Units (ACCUs) through the Emissions Reduction Fund (ERF) as administered by the Clean Energy Regulator (CER). Within that scheme, the only agricultural methods directly relevant to the beef cattle industry is the Beef Cattle Herd Management methods.

The Beef Cattle Herd Management method targets a reduction in the emissions intensity of beef cattle production by reducing emissions per kilogram of liveweight produced.[5] This equates to a more productive herd, therefore has additional benefits to producers in their business. ACCUs can be earned when emissions from the herd, as a result of an eligible project, are lower than they would have been had the project not been conducted. This can provide an additional revenue stream to supplement a cattle business. It is estimated that revenue from carbon offsets and biodiversity could represent a $20.3 billion opportunity for Australian producers over a 20-year period[4]. This is based on mechanisms that *currently* exist that translate carbon emission reduction in agriculture to a tangible, financial benefit. These initiatives have the added benefit of improving overall herd productivity, natural capital and profitability to the business. Technological advances in the agricultural sector may, over time, provide *additional* methods of measurable carbon reduction. However, Federal Government policy would need to adapt to accommodate this.

There currently are only three projects registered with the CER earning ACCUs for the Beef Cattle Management method. The low uptake of the scheme means there is very limited data on the potential value of ACCUs to the beef cattle industry. Notwithstanding this limited data, ACCUs per head of cattle being managed under the method could be valued at **around $78 per animal**, over the life of an animal, based on the price of ACCUs at this time.

Revenue from carbon offsets and biodiversity could represent a $20.3 billion opportunity for Australian producers over a 20-year period.[6]

Image: Jack Cain

1. Department of Industry, Science, Energy and Resources, (2021). *Quarterly Update of Australia's National Greenhouse Gas Inventory: June 2021*.
2. Food and Agricultural Organisation of the United Nations, (2013) *Tackling Climate Change through livestock: A global assessment of emotions mitigation opportunities*
3. Department of Industry, Science, Energy and Resources, (2021). *Quarterly Update of Australia's National Greenhouse Gas Inventory: June 2021*.
4. Meat and Livestock Australia (2020). *Becoming Carbon Neutral by 2030*
5. Clean Energy Regulator (2021). *Beef cattle herd management method.*
6. Calculated based on updated figures from PWC (2021) *Farming for the Future*, assuming $55.25/tonne value of carbon offset credits as at 8/2/22 and 75% adoption rate based on ClimateWorks Australia data (2010)

Accessing Carbon Credits

Accessing Carbon Credits through Beef Cattle Herd Management method

The CER sets out a number of requirements that must be met to participate in the scheme to earn ACCUs by the Beef Cattle Management method. The primary requirement is establishing and maintaining the herd as the project boundary. The herd must be specified from the inventory of cattle on the books of a business operation and managed as a discrete set of animals over time.

The regulatory requirements to participate as a project are costly and data-intensive, and may be a deterrent to producers participating in the scheme. Data is required for three of the previous seven years for the herd to be included in the program to establish a baseline for emissions to assist calculation of the achieved emissions reduction.

To comply with the CER scheme requirements for the Beef Cattle Management method, the following information is required annually:

- number and age of stock
- weight gain per animal - calculated four times per year
- pregnancy status, weaning statistics and survival rates of calves
- feeding period per specific feed categories (11 categories) per animal, by age
- changes in herd due to sales, purchases or mortality.

Some producers may collect this data in the course of their operations but for others there may be significant costs, especially when data is collected through manual methods.

The CER also has the ability to seek an audit on any operation, therefore increasing the cost to the producer of being involved in the scheme.

Compliance costs of accessing Carbon Credits

There are considerable costs to ensure compliance with the methodology of the scheme. The exact compliance cost will be dependent on the data being gathered for each property, its characteristics and the quality of its business management information systems.

The data collected by Ceres Tag can reduce the compliance costs associated with earning carbon credits with this method, making it more feasible for more producers to seek to access ACCUs.

Compliance costs across the sector will vary significantly, depending on the productivity enhancing procedures already in place and the associated data gathering that is already undertaken. However, some broad estimates can be determined, looking at the cost of registering with the scheme, the annual cost of updating the data to comply with the scheme and the potential additional costs of mustering and weighing animals.

The specific benefit of Ceres Tag with is through administrative savings and the reduced cost of mustering. These cost savings are outlined in Part A of the report and would reduce the costs associated with obtaining ACCUs.

The set up costs to register the scheme with the CER are estimated at around $6,500 as a one off cost. This cost is predominantly for collecting data required to register. Ongoing annual administrative costs are estimated at around $2,500 per annum.[1]

The cost of additional mustering is likely to be the highest portion of the compliance cost.

Costs	Cost	Potential Ceres Tag Saving*
Registration for the Scheme	$6,500	$3,714
Annual Administrative Costs	$2,500	$1,540
Mustering Costs (per muster/per animal)	$51 - $58	$7 - 11

*savings based on Part A of this report

1. Western Australia Department of Primary Industries and Regional Development, (2021). *Carbon Farming: the economics, Western Australia*

Benefits of using Ceres Tag to Access Carbon Credits

Ceres Tag provides a raft of information producers need to make informed decisions for emissions reduction, including information required to improve operating efficiency, grazing management and breeder performance. In addition to the stand-alone impact on a farm's carbon footprint, Ceres Tag can provide the data necessary for proof of impact, with greater accuracy than traditional data gathering techniques.

Verifiable herd data is an essential component in complying with the highly regulated carbon industry. Evidence collected through Ceres Tag could, over time, provide additional commercial opportunities to earn and sell ACCUs by providing verifiable data on the timing and therefore the extent of management for emissions reduction.

Potential Benefits per tag under various ACCU prices

The estimate of benefits assumes that tags would be applied to 100 per cent of the herd being managed under the Beef Cattle Herd Method and does not consider any future Carbon offset opportunities.

ACCU prices are difficult to predict given the price volatility over the last year and volatility in comparable carbon markets overseas.

The adjacent matrix shows how the estimated 'benefit per tag' changes under various ACCU prices and proportion of benefits realised.

The midpoint represents an approximation of the spot price as at February 2022, with a range of $15 on either side of the current price. The proportion of benefit attributable reflects the differing extent to which the tag might reduce producer compliance costs.

Proportion of benefit attributable to Tag

ACCU Prices	5%	10%	20%
$40	$2.71	$5.41	$10.82
$55	$3.72	$7.44	$14.88
$70	$4.73	$9.47	$18.94

Image: Jack Cain

Carbon Market Opportunities

Future Opportunities for Carbon Abatement

Ceres Tag collaborations with CSIRO and other technology providers has led to algorithms being regularly updated to provide more value from the data being gathered. Recent examples include the pasture intake algorithm developed by CSIRO and the New South Wales Department of Primary Industries to monitor a range of behaviours including the amount of pasture consumed by individual grazing animals. This algorithm is expected to be operational by the end of 2022.[1]

The pasture feeding algorithm (mentioned above) has the opportunity to provide for measurable carbon reduction through genetic selection aimed at reducing food intake, while maintaining productivity therefore reducing greenhouse gas emissions. The algorithm will help to make this benefit measurable and help build a case for attributable carbon abatement in the future.

In-paddock weighing can provide for regular weighing of animals, significantly increasing the data available to producers at a reduced cost of traditional methods. Adjustment to the rules of the ACCU scheme to allow technologies like this, would provide future opportunities to significantly reduce the cost of accessing ACCUs.

Ceres Tag data collection has the potential to significantly reduce the emission involved with transport. Animals with a Ceres Tag will have the distance that they travel recorded so there can be justifiable minimisation of transport attributable to each animal. The data collected also has the potential to allow for telehealth, reducing distance traveled by a veterinarian and provides important data required by banks and insurance that can be accessed remotely, further reducing attributable kilometers for each animal.

Emerging research shows that rotational grazing can increase soil carbon that has an additional benefit of protecting the natural environment and improving resilience to the impacts of climate change. However the benefit of this is difficult to measure therefore difficult to attribute to direct carbon reduction at this time.[2]

As mentioned above, these carbon abatement opportunities are not yet able to be monetised, however research and development continues. Despite not being directly monetisable as present, these incremental benefits assist to reduce the potential long term impacts of climate change on the agricultural industry.

... these incremental benefits assist to reduce the potential long term impacts of climate change on the agricultural industry.

1. CSIRO, 2020. *Ceres Tag adds CSIRO castle behaviour and pasture feed intake monitoring capabilities*.
2. CSIRO, 2020, *Soils ain't soils – carbon farming offers fertile future.*

5. Appendices

Appendix A: Operating model assumptions

Case Study 1: Baseline estimate

Use case	Assumption
Traceability	5% price premium realised, 50% attributable to Ceres Tag + 50% reduction in mid-range administrative cost estimate
Operating efficiency	Mid-range estimate
Financing costs	Mid-range estimate
Disease	Average of North and South estimates associated with a 5% reduction in disease management costs
Theft	Mid-range estimate
Animal attack	Four state average for a 10% reduction in attack costs

Case Study 2: Limit tagging to breeders

Use case	Assumption
Operating efficiency	Assumes a mid-range estimate for saving with high mustering frequency
Financing costs	Assumes a 1% decrease in interest rates
Disease	Average of North and South estimates associated with a 5% reduction in disease management costs

Appendix A: Operating model assumptions

Case Study 3: Northern producer

Use case	Assumption
Traceability	5% price premium realised, 50% attributable to Ceres Tag + 50% reduction in mid-range administrative cost estimate
Operating efficiency	Assumes a high range estimate for saving with high mustering frequency
Financing costs	High-range estimate for loan repayments and average interest rate drop
Disease	Average of North estimates associated with a 10% reduction in disease management costs
Theft	Mid-range estimate
Animal attack	Queensland average for a 10% reduction in attack costs

Case Study 4: Upper-bound traceability price premium

Use case	Assumption
Traceability	10% price premium realised, 75% attributable to Ceres Tag + 50% reduction in mid-range administrative cost estimate
Operating efficiency	Mid-range estimate
Financing costs	Mid-range estimate
Disease	Average of North and South estimates associated with a 5% reduction in disease management costs
Theft	Mid-range estimate
Animal attack	Four state average for a 10% reduction in attack costs

Appendix A: Operating model assumptions

Case Study 5: Higher-cost northern producer

Use case	Assumption
Traceability	5% price premium realised, 50% attributable to Ceres Tag + 50% reduction in mid-range administrative cost estimate
Operating efficiency	Assumes a high range estimate for saving with high mustering frequency
Financing costs	High-range estimate
Disease	Average of North estimates associated with a 10% reduction in disease management costs
Theft	High-range estimate
Animal attack	Queensland average for a 20% reduction in attack costs

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