

Opportunities to make Australia's northern beef industry more productive and resilient



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Munro Hardy, 2022 Scholar

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Executive Summary

This report explores how advanced agricultural technologies and sustainable practices can drive transformation in the Northern Territory's (NT) beef industry, addressing the critical challenges of market access, social licence, and capital acquisition. These innovations are vital to ensure the future viability of agricultural production, enabling producers to meet growing demands for transparency, sustainability, and high-quality products, not just from consumers, but from many other stakeholders throughout the industry.

The integration of substitute feeding strategies, improved feed conversion rates, and rotational grazing demonstrates significant potential for methane reduction and enhanced animal performance. Accurate data collection from technologies such as in-paddock weighing systems and livestock management platforms provides real-time insights into animal health and productivity, optimizing feed strategies and ensuring timely interventions. These data-driven approaches also support claims of ethical and sustainable farming practices, enhancing producers' marketability and competitiveness.

Agroforestry and efficient cropping practices are highlighted as critical components for improving soil health and reducing chemical dependence. Strategies such as cover cropping, crop rotation, and soil testing enhance long-term productivity and environmental resilience. Similarly, water usage is optimised through precision irrigation systems and sustainable management practices, critical in the NT's variable climate.

Methane reduction strategies, including feed additives and substitute feeding, are also explored, alongside examples of how these approaches contribute to lowering emissions while maintaining or improving productivity. This aligns with global sustainability trends, further strengthening social licence and appealing to environmentally conscious markets.

The report also highlights the role of livestock management tools in improving herd health and productivity. These technologies facilitate better grazing management, disease surveillance, and biosecurity measures, ensuring high standards of animal welfare and supporting claims of sustainable and ethical farming practices.

The adoption of these technologies not only enhances operational efficiency but can also significantly improve access to capital by showcasing commitment to innovation and sustainability. Demonstrating measurable progress in areas like animal welfare, emissions reduction, and productivity provides tangible evidence of responsibility and capability, reassuring investors and lenders. These advancements also bolster social licence, building trust with consumers and stakeholders. However, within the Northern livestock export market, challenges remain, particularly in achieving universal adoption and addressing infrastructure and logistical constraints, which require collaborative efforts to overcome.

By engaging in carbon credit markets and implementing carbon sequestration practices, producers can create new revenue streams while actively contributing to climate change mitigation. The inclusion of biodiversity credits further incentivizes conservation efforts by rewarding actions that support ecosystem health and biodiversity. These practices align with global trends toward sustainability, making them attractive to environmentally conscious consumers and investors seeking responsible agricultural initiatives.

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The report concludes by emphasising the comprehensive benefits of these technological innovations. By improving efficiency, transparency, and sustainability, producers in the NT can enhance their social licence, access new premium markets, and attract investment. These advancements ensure the long-term viability and growth of the agricultural sector, making it more resilient and profitable in the face of environmental and market challenges.

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Foreword

Originally hailing from a sheep property in Victoria, I have spent more than 15 years in the NT, where I have built a successful career in the agricultural industry fulfilling a range of roles and capacities.

I have experience working on some of Australia's largest cattle stations and have developed a deep understanding of many different operations. In the process I have built an extensive network and in-depth knowledge of the cultural, political and economic fabric of the NT agricultural industry.

Through my experience spanning diverse roles, organisations and sectors, I've seen some big challenges first-hand, as well as the day to day issues faced by producers. I've also seen some great successes from industry leaders creating change through innovation. This has given me a deep understanding of the challenges and pitfalls within the industry and where change should occur.

I worked within the Agtech sector to help deliver better solutions to the Northern Cattle Industry - not only producers, but live exporters, feedlotters and processors alike. This role has required a great deal of personal development, adapting to many new technologies, and expanding my personal network within the industry. Working across the industry in such a broad capacity has allowed me to develop valuable relationships across the country with people involved in all different aspects of the industry, particularly within the Agtech and data space.

I have also worked in many operational roles and day to day management of cattle stations, flown as a mustering pilot, and most recently I have managed production operations for an integrated business model producing hay, cattle, livestock feed & supplements as well as dipping & spelling cattle.

After moving to the Katherine Region in 2022, I embarked on an extensive learning journey to understand and implement optimal practices for soil health and hay production in this unique environment. With a focus on soil health and smart climate operations, I am committed to maximising farm efficiency and have been focussed on expanding operations for long term sustainability.

I have implemented multiple management practices and trials to support hay production including composting trials, minimum till systems, crop rotation plans, multi species cropping, grazing and soil testing.

My commitment to sustainable farming practices and my long-term vision towards sustainability extends beyond the farm gate. I have been actively engaged in many local organisations and have hosted several field day events where guests are able to engage with and learn from others.

During my scholarship, I sought to explore how producers can leverage their data more effectively throughout the northern agricultural industry. This research was aimed at identifying which technologies are best suited to northern production systems, and how the data that is being collected, can best be leveraged in regard to market access, improving social licence and access to capital.

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To investigate this further, I have spoken with stakeholders up and down the supply and in different areas that are pertinent to our businesses, not only to understand what data is valuable on farm, but who else might gain value from our data in a way that ultimately benefits producers.

I am passionate about helping the industry achieve its full potential by bringing better solutions to fuel sustainable growth. I believe that the future lies in transparency and traceability through the entire supply chain and ensuring provenance of produce, be it livestock or crops. This allows producers to accurately understand business performance, which is the key to sustainably and ethically improving production, while also satisfying requirements from a processor, consumer, investor and ESG perspective.

Table 1. Travel Itinerary

Travel date	Location	Visit / Topics
Pre CSC Week 1 March 3 - 7 2022	United Kingdom: Winchester, Bath	Bristol Port Company, Thatchers Cider Company, Frogmary Green Farm, Lye Cross Farm, Fernhill Farm
CSC Week 2 March 7 - 15 2022	UK: Norwich, London	Norwich research park, Houghton Estate, Holkham Estate, Houses of Parliament.
March 15 - 30 2020	UK: London, Cambridge, Seckington.	Old Hall Farm, Cambridge University.
Sept 2022	Tamworth Region, NSW	Goonoo Goonoo Station, Killara Feedlot, Merrilong Pastoral Company, Carroll Cotton Gin, Thomas Foods International, Peel Valley Milk
Oct 2022	Zimbabwe	Colcolm Factory, Savory Institute, Red Dane Dairy, Imire; Mixed Crops, Tobacco & Conservation, Padenga Crocodile Farm, Lake Harvest Fish Farming, Charara Estates, Zimtrade.
March / April 2023	New Zealand	Pamu Farms, Haldon Station, Align Farms, Mt Cook Alpine Salmon, Cardrona Distillery, Wilkins Farming, Mt Nicholas Station, Royalburn Farm,
May / June 2023 Global Focus Program	Singapore, Japan, Israel, Netherlands, USA	Urban Farming, MLA International Markets, Wholesale & Supply Chains, Wet markets, Specialised Industries & Local Corporate, Leadership responsibility, Asia's Growth Drivers, Ecosystems Approach to Strengthen

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		<p>Food Security & Sustainability, Natural Capital and Biodiversity, Mitsukoshi Ginza, Genpachi honey farm, Australian Embassy, Tanaka rice farm, Sagotani Dairy, Miyajima Island & Oyster Farm, Seven Foods Vertical Integration, Bamboo chopstick factory, Sugimoto Shoten Mushroom Farm, Kushima Aofarm Sweet Potato, Tsuno Winery, 'Mahaneh Yehuda' Jerusalem Market, Kibbutz Neot Semadar, Kibbutz Yotvata, Ein Hazeva Cannabis Farm, Mekorot; the National Water Company of Israel, Kibbutz Magal, Royal Flora Holland, Koppert Cress, Aeres Agricultural University, Zonnespelt; organic and biodynamic grain processing, Bio Brass; organic vegetables, US Department of Agriculture, Bayer Crop Science Headquarters, New Zealand Embassy, National Association of State Departments of Agriculture, Bowles Farming Company, Olam Agri, Olam Food Ingredients, Turlock Fruit, Cargill Meat Packing, Meyers Water Bank, HMC Farms, TIAA / Nuveen.</p>
Sept 11 - 16 2023	Perth Region, WA	<p>White Rocks Dairy, Bunge Port Terminal, Bell Pasture Seeds, Eagle Bay Brewing Co, Bunbury Farmers Market,</p>
March 21 - 31 2024	Vanuatu	<p>Thomas Monvoisin; Teouma Group. Technology integration & international marketing. 83 Islands Distillery, Kava Production, AgroForestry.</p>

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Finally and importantly, my investors – Australian Agricultural Company (AACo), S.Kidman & Co, Consolidated Pastoral Company (CPC) and Elders. I hope my findings bring insight into how technology can benefit the northern beef industry. Many thanks for your support of the Nuffield program.

Abbreviations

AACo	Australian Agricultural Company
ACCUs	Australian Carbon Credit Units
ACE	Australian Cattle Enterprises
ADG	Average Daily Gain
CPC	Consolidated Pastoral Company
CRC	Cooperative Research Centre
ESCAS	Exporter Supply Chain Assurance System
ESG	Environmental, Social, Governance
GIS	Geographic Information System
GPS	Global Positioning System
NT	Northern Territory
OFI	Olam Food Ingredients
OFIS	Olam Farmer Information System
3NOP	3-Nitrooxypropanol

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Objectives

The purpose of this study is to identify how producers leverage their data more effectively throughout the northern agricultural industry to address critical challenges and capitalise on opportunities for growth and sustainability. This research was aimed at identifying which technologies are best suited to northern production systems, and how the data that is being collected, can best be leveraged in regard to market access, improving social licence and access to capital. It aims to provide insights into the role of data-driven strategies in enhancing the resilience and competitiveness of northern agricultural enterprises.

This study has been broken down into three key fields:

Social Licence:

The north has seen a huge loss of support from financiers and insurers due to social issues and perceptions around live export. How can we better tell our story of how we produce our livestock ethically & sustainably? If we can certify our claims and have better transparency, can we gain support back from the public and finance sectors?

Access to markets:

Leveraging data to certify claims being made around carbon neutrality, grass fed, organic, natural capital improvements, regen practices, animal welfare, etc. Can we unlock new markets with better traceability? Can we drive a premium and reward producers for the effort they put into their produce?

Access to capital:

How data can play a role in unlocking both traditional and non traditional finance and capital, from banks and institutions, through to individual investors.

My key objectives are to:

1. Identify most suitable technologies for northern production systems and environmental conditions of the northern region, with a focus on maximising efficiency and productivity.
2. Examine the interest and willingness of investors and financiers in leveraging production data and certification schemes to inform investment decisions and support sustainable agricultural practices.
3. Investigate consumer preferences for ethically and sustainably produced agricultural products in both domestic and international markets, and assess the potential for premium pricing based on verified credentials.
4. Explore strategies for rebuilding public trust and support for the northern agricultural industry by enhancing transparency, certification, and communication of ethical and sustainable production practices.

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By addressing these objectives, this study aims to provide actionable insights and recommendations for stakeholders in the northern agricultural industry, including producers, investors, policymakers, and industry associations, to foster innovation, collaboration, and sustainable development in the sector.

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Introduction

Challenges & Opportunities

The northern agricultural industry in regions such as the Northern Territory (NT) and parts of Queensland and Western Australia faces a unique set of challenges and opportunities. Characterised by vast landscapes, extreme weather conditions, and a diverse range of production systems, this region plays a vital role in Australia's agricultural sector.

Despite its potential for growth and productivity, producers in the northern agricultural industry encounter several barriers that hinder their ability to thrive sustainably and competitively. These challenges include:

Social License and Public Perception: The northern agricultural industry has faced scrutiny and criticism in recent years due to concerns over environmental sustainability, animal welfare, and social responsibility. Negative publicity surrounding issues such as live export and land clearing has eroded public trust and support for the industry, leading to challenges in securing financing, maintaining social licence, and accessing new markets.

Market Access and Certification: With increasing consumer demand for ethically and sustainably produced agricultural products, there is growing pressure on producers to demonstrate their adherence to environmental and social standards. However, navigating complex certification schemes and ensuring compliance with market requirements can be daunting for many producers, particularly those operating in remote areas with limited resources.

Access to Capital: Producers in remote and rural areas often struggle to secure adequate financing and investment to modernise infrastructure, adopt new technologies, and expand operations. Limited access to traditional banking services, combined with perceived risks associated with agricultural production, further exacerbates this challenge.

In light of these challenges, there is an urgent need to explore innovative solutions that can help producers overcome barriers to growth and sustainability. Leveraging data and technology presents a promising opportunity to address these challenges by improving efficiency, transparency, and accountability throughout the agricultural value chain.

Chapter 1. Northern Beef Industry

1.1 Overview

Pastoral leases, mainly used for grazing, make up the majority of Northern Australia. Traditionally, these operations ran a simple system of harvesting weaners with little pressure on selection and have seen many challenges as mentioned in the introduction, as well as extensive operational challenges such as extreme climatic conditions, cattle infertility, weaning rates, etc.

The concept of pastoral leases dates back to the 19th century, established to promote the development of the pastoral industry. They are governed in the NT by the Pastoral Land Act, which outlines the rights and responsibilities of leaseholders and the regulatory framework for land management. The primary purpose of pastoral leases is livestock grazing where lessees are required to maintain the land in a condition suitable for this purpose. They must manage the land sustainably, preventing land degradation and protecting native vegetation and biodiversity.

Ongoing research and innovation in areas such as pasture management, livestock breeding, and water use efficiency are crucial for enhancing the productivity and sustainability of pastoral operations. The integration of new technologies and best practices helps drive continuous improvement and adaptation to changing conditions.

1.2 Herd Improvements

Weaning Rates in the Northern Herd of Australia

Weaning rates in the northern herd of Australia have remained persistently low, presenting a formidable challenge for beef producers in the region. This phenomenon is particularly pronounced in comparison to southern herds, where weaning rates tend to be higher on average.

Several factors contribute to the disparity in weaning rates between northern and southern beef operations, reflecting the unique environmental, management, and economic conditions prevalent in each region.

Environmental Factors

The harsh climatic conditions of Northern Australia pose significant challenges to reproductive efficiency in beef herds. High temperatures, prolonged dry seasons, and erratic rainfall patterns can lead to nutritional stress and reduced fertility among breeding cows.

Pasture quality and availability fluctuate seasonally, influencing the nutritional status of breeding cows and subsequently impacting reproductive performance. Limited access to high-quality forage during critical stages of gestation and lactation can hinder calf survival and overall weaning rates.

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Management Practices

Traditional management practices in the northern herd may inadvertently contribute to low weaning rates. Extensive grazing systems, characterised by large paddock sizes and minimal intervention, can result in suboptimal monitoring of breeding cows and calves, increasing the risk of calf mortality and reduced weaning rates.

Limited access to veterinary services and reproductive technologies in remote northern regions may impede proactive management interventions aimed at improving reproductive performance and enhancing weaning rates.

Genetic Considerations

The prevalence of *Bos indicus* breeds, such as Brahman and other tropical composites in the northern herd may influence weaning rates due to inherent genetic characteristics. While these breeds exhibit desirable traits such as heat tolerance and adaptability to tropical environments, they may also exhibit lower fertility rates and longer calving intervals compared to *Bos taurus* breeds.

Genetic selection practices focused on traits such as growth rate and carcass quality may inadvertently overlook reproductive traits, leading to suboptimal reproductive performance and reduced weaning rates over successive generations.

Table 2 : Potential for improvement in northern Australia (Source: Holmes and McLean, 2017).

	Area of Performance	Income Increase	Physical Result (Holmes & McLean, 2017)
5% increase	Reproductive rate	7%	Extra five weaners from every 100 cows
1% decrease	Mortality rate	2%	One less death per 100 cattle run
5% increase	Average sale kgs	4%	Average sale kgs of all animals sold increases by 5%

On top of the benefits of increased weaning rates in the northern herd, improvements in dairy herd fertility have shown that methane emissions could be reduced by between 10 and 25% (Garnsworthy, 2004).

Economic Constraints

Economic considerations, including input costs, market volatility and access to capital, may influence management decisions regarding breeding herd management and reproductive strategies. Limited financial resources may constrain investment in technologies and practices aimed at improving reproductive efficiency and weaning rates.

Addressing the challenge of low weaning rates in the northern herd of Australia requires a multifaceted approach encompassing environmental management, genetic selection, proactive veterinary care, and targeted reproductive interventions. By leveraging advancements in reproductive technologies, adopting sustainable grazing practices, and

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enhancing genetic selection criteria, beef producers can strive to improve weaning rates and bolster the long-term sustainability and profitability of the northern beef industry.

Improving weaning rates leads to fewer unproductive animals that consume resources and emit methane without contributing to production. Higher weaning rates demonstrate effective and sustainable management, resulting in more efficient resource use and a lower environmental impact. This commitment to sustainability enhances social licence and appeals to markets and financial stakeholders, reinforcing the economic viability and environmental responsibility of the operation.

1.3 Substitute Feeding

While cattle producers have done an excellent job improving the genetic base of the northern herd, they can benefit significantly by leveraging nutrition to convert that genetic potential into saleable kilograms of beef.

Ruminants such as cattle, have a complex digestive system. They have four stomachs and each does a different job. The rumen changes as the animal grows and balancing the nutrient requirements of both the rumen microorganisms and the animal is essential for good animal health and performance. The type of feed available to the animal will influence these factors. For example, mature dry grasses will be low in protein and carbohydrate, thereby limiting microbial growth. Conversely, high grain diets can lead to high acidity that is toxic to many rumen microorganisms and will also compromise microbial growth and digestion.

In our northern pastoral environment, the most important factor in feeding cattle is the source of energy, and the best source of energy is starch. Animals can be fed from a young age up to around the 160kg - 180kg range with high levels of starch before there is any risk of acidosis. This needs to be monitored closely and rations amended as necessary. Selecting raw materials is important, particularly when it comes to amino acid profiles. Raw materials containing high levels of lysine and methionine – the most significant of the essential amino acids - are best suited. These are limiting amino acids, meaning cattle will stop growing when they 'run out' of lysine and methionine.

Pelletising these ingredients locally is an economical way to efficiently process local materials and distribute them as a whole or substitute feed source across the Northern Industry. With this method, feed sources are combined into a consistent mash, which is cooked during the pelletising process. This increases the digestibility and utilisation of nutrients, especially starch, which is vital for young rumens. This delivers higher utilisation of the feed as cattle extract more nutrition from the pellets than if the raw materials were fed as a mash. This process also kills seeds which means there are no viable seeds in the pellets. This is another important factor which will help improve social responsibility regionally as weeds won't be distributed through transporting feed.

“Feeding pellets prevents selective feeding as all ingredients are digested. This is in contrast to other feeding methods, where animals leave behind important nutritional elements, resulting in wasted feed or incomplete rations. Raw materials aren't fully digestible, which is what makes cooked and pelletised feed so valuable. Overall, feed utilisation in pellet form can be 11% higher than feeding raw materials in a mash.” (Batt, Pers.comm., 2023)

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Figure 1. Pellets produced in a local facility in Katherine, NT. (Source: Author)

Early weaning and feeding can have huge benefits, but there are no shortcuts as fodder only forms part of an overall weaning program. Performance of animals can vary greatly due to the many factors that affect and influence animal performance. For example, pen and water hygiene is vital, adequate pen space is essential and requires daily attention from a competent stock person. By developing the rumen, skeletal and muscular system earlier in the life cycle, we set animals up to perform much better on pastures, as well as in quarantine and lot feeding scenarios. This has benefits on cattle temperament and sociability, which will reduce stress when being mustered, yarded, transported and fed throughout the export supply chain.

Locally produced ingredients include cavalcade hay, Rhodes hay, maize and sorghum along with other varieties being trialled.

Feeding poor-quality feed in quarantine facilities can cause cattle to become blocked with bulk fibre and roughage, leading to a depleted appetite during the first days of the voyage. This setback delays their weight gain until they empty their rumen onboard and start eating. By consistently providing good quality feed, cattle can continue to gain weight throughout the journey, resulting in quicker turnarounds, higher profitability, and increased efficiency along the supply chain. However, quantifying the benefits is complex, as stakeholders at different stages often aim to capture the compensatory gains during their period of control over the animals. Each stakeholder values performance improvements, making coordination challenging but essential for optimal outcomes.

1.4 Methane Reduction Strategies in Livestock Feed

The efforts to reduce enteric methane emissions in cattle through dietary additives have gained momentum. Various products are being trialled for their effectiveness in mitigating methane production. Below is a brief discussion of these products and their potential impact.

1. Nitrates serve as alternative hydrogen acceptors in the rumen, which can reduce methane production by redirecting hydrogen away from pathways that form methane (Hristov et al., 2015).
2. Essential Oils Products like Agolin contain essential oils that modify rumen fermentation patterns, showing potential in reducing methane emissions.
3. Biochar acts as a rumen modifier, but research has shown inconsistent results regarding its effectiveness in reducing methane emissions. Its exact mode of action remains under study.
4. Seaweed, particularly *Asparagopsis*, has shown promise in reducing methane emissions by up to 98% in some studies. This is attributed to its bioactive compounds that inhibit methanogenesis (Kinley et al., 2020).
5. 3-Nitrooxypropanol (3NOP) is an enzyme inhibitor that blocks the enzyme methyl-coenzyme M reductase, which is crucial for methane production in the rumen. Studies have demonstrated significant reductions in methane emissions when using 3NOP (Hristov et al., 2015).

There is ongoing research to explore the potential additive effects of combining various methane-reducing products. For instance, a study examining the combination of 3NOP and essential oil products, indicated an additive effect in reducing methane emissions. (Souza, et al., 2024).

Efforts to reduce methane emissions from cattle through dietary interventions are critical for sustainable agriculture. The combination of different products and leveraging their unique modes of action, could potentially offer more significant reductions in methane emissions. The ongoing research and trials will provide more insights and hopefully pave the way for effective and practical solutions.

Incorporating substitute feeding and methane reducing products not only allows animals to reach their target weight more quickly, but also compounds the benefits by further reducing overall methane emissions. The combination of high-quality feed and methane reducing strategies accelerates time to sale weight, enabling earlier sales and reducing stocking days per year. This leads to the ability to carry and turn off more animals overall and creates a highly efficient production system with lower resource consumption and significantly reduced methane output. These improvements can be precisely measured through data, contributing to sustainability goals.

Chapter 2. Diversification

Recent legislation in the NT now allows pastoral leaseholders to apply for non-pastoral lease permits which allow them to diversify into other areas such as both dryland and irrigated cropping and horticulture.

With the developing sustainability frameworks for industry and individual businesses, innovation & diversification is poised to create efficiencies in the way we produce our food, right throughout the supply chain. These efficiencies can have a major impact on our carbon footprint for our industry, by utilising locally grown and sourced products, such as supplementary feed stocks. This will mitigate emissions from sourcing products interstate, which need to travel thousands of kilometres to be delivered to producers.

Pastoral leases in the NT are evolving to encompass a broader range of activities through recent legislative changes. Diversification permits offer significant economic benefits, allowing leaseholders to reduce their reliance on a single industry and spread financial risk. This can lead to increased revenue streams, improved land use efficiency, and enhanced resilience against market fluctuations and environmental challenges. This diversification not only enhances economic resilience and sustainability but also supports the long-term viability of the pastoral industry in the challenging yet opportunity-rich environment of Northern Australia.

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2.1 AgroForestry

AgroForestry provides many benefits to farming systems. Diversity in flora and fauna plays a critical role in maintaining environmental health.

Cattle manure acts as a natural fertiliser, cycling nutrients, enriching the soil and promoting healthier trees, where grazing cattle help manage weed growth, reducing the need for chemical herbicides and promoting more organic farming practices. Utilising the space between trees for grazing maximises land use efficiency and productivity.

Diversifying with forestry offers an additional income stream for producers, reducing economic risks associated with single market dependence. (Fahad, et al., 2022).



Figure 2. Agroforestry in Vanuatu. (Source: Author)

The integration of beef cattle with coconut plantations, presents a sustainable and productive farming system that capitalises on the synergies between agriculture and forestry. This practice leverages the natural benefits of combining livestock with tree crops to enhance productivity, sustainability, and economic viability. The main advantages include improved soil health, diversified income sources, enhanced biodiversity, and better resilience against climate change. (Harrison and Saiful, 2016). Agroforestry in Vanuatu aligns with sustainable development goals by promoting environmentally friendly practices, enhancing food security, and supporting livelihood (Bayala and Sanou, 2013).

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2.2 Cropping

Crops in the NT play a crucial role in supporting the region's livestock industry by providing a reliable and nutritious source of feed. Due to the regional climatic conditions, the choice of crops and their management practices are tailored to optimise growth and sustainability.

Forage crops provide essential nutrients required for the growth and health of livestock, particularly during the dry season when natural pastures may be insufficient. They serve as a supplemental feed source, ensuring consistent and quality nutrition throughout the year, which is critical for maintaining livestock productivity and health.



Figure 3. Trial forage & cover crops in Zimbabwe. (Source: Author)

However, the NT experiences significant climate variability, including prolonged dry seasons and occasional droughts, which can affect forage crop production. Many areas in the NT have poor soil fertility, requiring careful selection of crop type and management practices to enhance soil health. An addition to these challenges, limited and variable water resources make dry land cropping a risk. Efficient irrigation and water management practices support crop growth by ensuring an adequate supply of moisture throughout the growing season.

These crops can be utilised as improved pastures for grazing, cover crops to improve soil health, cut and baled for hay, or wrapped for silage. By incorporating crops, producers become less reliant on imported feeds, reducing costs & mitigating emissions, and ultimately, these crops contribute to the economic stability and self-sufficiency of livestock operations.

Incorporating legumes into crop rotations in the NT provides substantial agricultural benefits. Legumes enhance soil health by fixing atmospheric nitrogen, a process facilitated by their symbiotic relationship with rhizobia bacteria. This natural enrichment of soil reduces the reliance on chemical fertilisers, promotes sustainability, and improves soil fertility, making it

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beneficial for subsequent crops. Additionally, legumes contribute to increased biodiversity, improve soil structure, and aid in moisture retention. The inclusion of legumes in rotations can also help break pest and disease cycles associated with continuous cropping, further supporting crop health and yield. These ecological and economic advantages position legumes as a valuable component in the NT's crop management strategies.



Figure 4. Improved pastures in Vanuatu. (Source: Author)

Cropping systems are essential for supporting the livestock industry in the NT. Through careful selection of crop species, effective management practices, and ongoing research and innovation, the region can enhance the productivity and sustainability of its forage-based livestock systems.

Integrating fodder crops into pastoral systems not only provides an alternative revenue stream for producers traditionally reliant on livestock, thereby mitigating risks associated with market fluctuations in the cattle industry, but also optimises the use of available agricultural land and water resources. This includes the adoption of both rain-fed and irrigated cropping systems, which maximises productivity on existing farmland where permits are available.



Figure 5. Examining potato crops in Zimbabwe and discussing the need for rotating crops to control blight. (Source: Author)

Crop rotation is a well-established agricultural practice that diversifies the crops in a field over successive seasons or years. This practice helps in breaking the life cycles of pests and diseases, which are often crop-specific, thereby reducing their prevalence and impact. Additionally, different crops contribute various organic matter and nutrients to the soil, which can improve its structure and fertility over time. (Lv, et al. 2023). Legumes, for instance, are known to fix nitrogen, which benefits the soil and subsequent crops that require nitrogen.

The expansion of cropping and related processing infrastructure supports rural employment and economic development, while the industry's adoption of modern agricultural technologies leads to improvements in overall farm management practices, including precision agriculture that enhances yield and reduces input costs.

Sourcing feed from local producers provides significant advantages for substitute feeding, discussed earlier in this report. By utilising high-quality feed produced locally, producers can reduce transport costs and lower carbon emissions, making the feeding process both more efficient and environmentally sustainable. This approach not only supports local agriculture but also enhances the nutritional value of feed, contributing to better cattle performance throughout the supply chain.

Cropping in the NT presents great opportunities for producers, but it's important to understand that diversification into cropping or agroforestry may require special permits. Non-pastoral use permits are essential for those looking to expand beyond traditional pastoral activities. These permits allow producers to legally transition into activities such as dryland or irrigated cropping, forestry, or agroforestry. By obtaining these permits, producers can ensure they meet regulatory requirements, opening the door to sustainable diversification while contributing to the region's agricultural growth.

Chapter 3. Water Usage

Water is an invaluable resource in the NT, playing a pivotal role in the region's irrigated cropping systems.

3.1 Regulation

The issuance of water licences is crucial for managing and regulating water use across various sectors, including agriculture, which is heavily reliant on both surface and groundwater licences. Surface water licences allow for the extraction of water from rivers, streams, and lakes, primarily used for irrigation, livestock, and aquaculture. Groundwater licences, on the other hand, are essential for accessing aquifers, especially in areas where surface water is scarce, supporting not only agriculture but also mining and industrial activities.

The process of obtaining a water licence involves a detailed application that outlines the intended use, the location, and the potential impact on existing water resources and ecosystems. This process is stringently assessed, taking into consideration factors such as sustainability, water availability, environmental impact, and community needs. This may include public consultations to incorporate community input, ensuring that all stakeholders have a say in the management of water resources.

3.2 Long term sustainability

The NT government emphasises sustainable water usage to ensure the long-term availability and health of its water resources. Water allocation plans are crafted to balance environmental needs with human activities, setting clear guidelines on the allowable extraction limits and usage priorities. These plans are particularly mindful of Indigenous water rights, integrating traditional water uses and cultural values into the broader water management strategy.

Sustainable water use practices, enabled by precision irrigation systems, play a significant role in maintaining social licence. These systems ensure that water resources are used efficiently, reducing wastage and preserving local ecosystems. This is particularly important in regions where water scarcity is a concern. By demonstrating responsible water management through leveraging accurate data recorded in production systems, producers can gain the support of local communities and environmental groups, who are increasingly concerned about water conservation.

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Figure 6. Dates grown in the desert in Israel require over 1,000,000 litres of water per tonne of saleable product. (Source: Author)

Given the challenges posed by climate change, population growth, and increasing demands on agriculture, there is a growing focus on improving water management frameworks in the NT. Innovations in water conservation and efficiency are encouraged to optimise water use across various sectors. This includes the development of technologies and practices that reduce water wastage and enhance the efficiency of water use in agriculture and other industries.



Figure 7. Capsicums grown in a greenhouse in the Netherlands require only 75,000 litres of water per tonne of saleable product. (Source: Author)

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Having data on efficient water use is crucial for improving social licence and productivity, making agricultural practices more appealing to markets and financial stakeholders. This transparency in water management demonstrates a commitment to sustainability, enhancing trust with consumers, investors, and regulatory bodies, while also securing the long-term viability and growth of agricultural operations.

Chapter 4. Soil Health

Soil health is a critical factor in sustainable agriculture in the NT, impacting everything from plant growth and water efficiency to ecosystem services and agricultural productivity. The NT's diverse landscapes support various soil types, each with unique characteristics and challenges. Some areas suffer from issues like soil salinity, erosion, and nutrient depletion, largely due to climatic extremes, overgrazing, and unsuitable agricultural practices. (Eldridge et al., 2016). These problems underscore the need for effective soil management strategies that not only address immediate agricultural needs but also ensure long-term sustainability.

4.1 Organic Matter

Incorporating organic matter into the soil is crucial for enhancing its structure, fertility, and water retention capabilities. Compost, manure, and other organic residues can improve soil organic carbon levels, which is a key indicator of soil health. Studies suggest that increasing organic matter helps improve water infiltration and nutrient availability, reducing the need for chemical fertilisers. (Aulakh, et al, 2022).

4.2 Cover Crops

Planting cover crops such as legumes, grasses, and crucifers can significantly benefit soil health. These crops help reduce erosion, suppress weeds, and enhance soil organic matter. Legumes in particular, fix atmospheric nitrogen, reducing the need for synthetic nitrogen fertilisers. (Aulakh, et al, 2022).

4.3 Minimum Tillage

Reducing tillage preserves soil structure, enhances water retention, reduces erosion, and builds soil organic matter. No-till and reduced-till farming practices have been shown to significantly increase soil carbon sequestration. Conservation tillage helps maintain soil structure, reduce erosion, and increase water permeability. Minimising soil disturbance preserves beneficial soil organisms and organic matter (Bullard, et al., 2018),

4.4 Crop Rotation

Rotating crops can prevent disease cycles, reduce pest pressure, and manage nutrient cycling. Diverse crop rotations, including the integration of deep-rooted crops, can enhance soil structure and reduce compaction. (De Corato, et al., 2020).



Figure 8. Identifying fields in Japan where we saw the lack of rotation in sweet potato production was causing significant problems with disease. (Source: Author)

4.5 Soil Testing

Regular soil testing is essential for effective soil management. It provides valuable data on soil pH, nutrient levels, organic matter content, and other critical parameters. This information helps producers make informed decisions about fertilisation and other soil amendments.

4.6 Organic Farming

The transition to organic farming has many benefits, focusing on enhancing soil health as a cornerstone of sustainable agricultural practices. This approach typically involves the use of organic amendments like compost to enrich soil fertility and structure. Producers also employ crop rotation and biological pest control to minimise dependence on synthetic chemicals, thereby fostering a more robust and healthy soil ecosystem. (Schonbeck, et al, 2019). Furthermore, the adoption of water-efficient irrigation systems is crucial in managing soil moisture effectively, which helps prevent issues like soil salinization and erosion. These strategies collectively promote a more sustainable and environmentally friendly agricultural practice. By combining crop rotation with biological pest control techniques, producers have reduced their reliance on chemical inputs, promoting a healthier soil ecosystem.

Enhancing soil health is a multifaceted approach that requires a combination of traditional knowledge and modern technology. By implementing sustainable agricultural practices and

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utilising advanced technologies for soil monitoring, producers can improve the resilience and productivity of their lands.

Much like water use, having data on soil health is essential for improving social licence and productivity, as it demonstrates a commitment to sustainable land management. This appeals to markets and financial stakeholders by showcasing responsible stewardship of natural resources, enhancing trust and securing long-term investment in agricultural operations. By prioritising soil health, producers not only improve the resilience and productivity of their land but also strengthen their position in a market increasingly focused on sustainability.

Chapter 5. Technology & Data

5.1 Types of Technology

Advancements in agricultural technology provide significant opportunities for enhancing productivity, sustainability, and profitability. This chapter explores the integration and application of various technologies suitable for northern producers, focusing on areas such as remote biomass measurement, fire management, precision irrigation, soil health monitoring, livestock management, and carbon accounting. Additionally, it discusses how leveraging these technologies can establish baselines for continuous improvement.

Livestock Management Tools

Effective livestock management is essential for maintaining pasture health and maximising livestock productivity. Global Positioning System (GPS) and Geographic Information System (GIS) software help monitor grazing patterns and manage livestock distribution. These tools allow producers to optimise pasture utilisation, prevent overgrazing, and support sustainable grazing practices. By adjusting grazing loads based on real-time data, producers can enhance pasture regeneration and soil health. Grazing management tools provide detailed maps and reports on livestock movements, grazing intensity, and pasture conditions. This information helps producers to implement rotational grazing systems, where livestock are moved between pastures to allow for recovery and regrowth. Such practices improve forage availability, reduce erosion, and promote biodiversity.



Figure 9. Cattle in a rotational grazing system on improved pastures in Vanuatu. (Source: Author)

Thomas Monvoisin from the Teouma Group in Vanuatu says he “*has been able to unlock access to international markets by leveraging the data they collect throughout their production system.*” (Monvoisin, *Pers.comm.*, 2024) Data has played a pivotal role in certifying their management practices that demonstrate best practice in animal health and husbandry along

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with land management practices that contribute to sustainability. *"We have been able to showcase our premium products and deliver information to our customers which helps them understand where their products come from."* (Monvoisin, *Pers.comm.*, 2024)

In addition to these benefits, data collected through livestock management tools can significantly improve herd selection and reproductive rates. By tracking individual animal performance, health metrics, and reproductive history, producers can make informed decisions about breeding and culling. This data-driven approach ensures that only the best-performing animals are selected for reproduction, enhancing the overall genetic quality of the herd. Furthermore, monitoring reproductive rates and identifying patterns or issues early on can help in implementing timely interventions, improving calving rates, and reducing the incidence of reproductive diseases.

Combining these technologies with comprehensive herd management practices can lead to a more efficient and productive livestock operation. For instance, integrating data from GPS tracking, health monitoring, and reproductive history allows for precise management of breeding cycles, ensuring optimal mating times and better calving outcomes. Producers can also use this data to identify and address environmental or management factors that may be impacting reproductive performance, further enhancing herd productivity and profitability.

By leveraging these advanced livestock management tools, producers in the NT can achieve a sustainable balance between maximising livestock productivity and maintaining pasture health, ultimately contributing to a more resilient and profitable sector.

Real-Time Performance Monitoring

Monitoring feed consumption, feed conversion, and weight gains through advancements in individual animal management platforms like AgriWebb allows for real-time tracking of animal performance. In-paddock weighing systems like Optiweigh provide real-time insights without the need to muster animals into yards. These technologies offer accurate data on Average Daily Gains (ADGs) and feed conversion rates, helping producers optimise feeding strategies, improve efficiency, and make data-driven decisions to maximise profitability and animal health. Leveraging these tools ensures consistent growth and timely interventions throughout the production process. This technology can also be leveraged at other stages of the supply chain such as quarantine yards and feedlots.

Real-Time Health Monitoring

Wearable sensors and GPS collars are increasingly used to monitor the health and behaviour of livestock in real-time. These devices track vital signs such as heart rate, temperature, and activity levels, providing early warning signs of health issues. For example, deviations from normal activity patterns can indicate the onset of illness, allowing for timely intervention. This proactive approach reduces the risk of disease outbreaks and ensures that animals receive prompt medical attention.

Disease Surveillance and Control

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Data analytics and machine learning algorithms are used to analyse health data collected from livestock. By identifying patterns and trends, these technologies help predict disease outbreaks and track their spread. This is particularly important for managing diseases that can quickly affect large numbers of animals, such as lumpy skin disease or foot-and-mouth disease. Early detection and containment strategies, supported by data-driven insights, are crucial for minimising economic losses and maintaining animal welfare.

Improving Biosecurity Measures

The use of data enhances biosecurity measures across the livestock export supply chain. By tracking the movement of animals and monitoring their health status, data systems ensure that only healthy animals are transported. This reduces the risk of spreading diseases to new areas and maintains the integrity of the export market. Additionally, data-driven biosecurity protocols can be quickly updated and implemented in response to emerging threats, ensuring a robust defence against infectious diseases.

Supporting Supply Chain Transparency

In the livestock export supply chain, data plays a critical role in ensuring transparency and traceability. Detailed records of animal health, movements, and treatments are maintained throughout the supply chain, providing stakeholders with reliable information. This transparency builds trust with international buyers and regulatory bodies, ensuring that the highest standards of animal health and welfare are maintained.

 Treatment records Filter all columns

Showing 68 records Reset Custom

MOB	TREATMENT	HEAD	RATE	TOTAL USED	TREATMENT COST (\$)	WHP
Blue tag Angus Cows	Abaguard Plus Selenium High Volume Oral Drench For Sheep	198	15 ml/head	2.97 l	0.00	15 Apr 2
Blue tag Angus Cows	Barricade 'S' Cattle Dip And Spray	198	20 ml/head	3.96 l	118.80	09 Apr 2
Blue tag Angus Cows	Alternate Pour-On Wormer For Cattle	198	2 ml/head	0.4 l	3.96	22 Apr 2
White tag Angus Cows	Barricade 'S' Cattle Dip And Spray	590	20 ml/head	11.8 l	354.00	24 Mar 2
Orange tag Angus Steers	Alternate Pour-On Wormer For Cattle	200	2 ml/head	0.4 l	4.00	03 Apr 2
White tag Angus Cows	Alternate Pour-On Wormer For Cattle	30	2 ml/head	0.06 l	0.60	02 Apr 2
Angus weaners	Cydectin Long Acting Injection For Cattle	706	2 ml/head	1.41 l	95.31	28 Apr 2
White tag Angus Cows	4Farmers Cypermethrin 25 Off-Shears, Pour-On Sheep Lice Control	590	5 ml/head	2.95 l	0.00	02 Mar 2
Black tag Angus Bulls	4Farmers Cypermethrin 25 Off-Shears, Pour-On Sheep Lice Control	9	5 ml/head	0.05 l	0.00	02 Mar 2
Angus Bulls	Glanvac 3 vaccine	39	4 ml/head	0.16 l	62.40	27 Feb 2
Angus Bulls	Cydectin Weanerguard 6 In 1 Vaccine And Wormer With Selenium And Vitamin B12 For Lambs	39	60 ml/head	2.34 l	8.19	26 Mar 2
White tag Angus Cows	LONGRANGE BOTULINUM VACCINE	100	2.5 ml/head	0.25 l	125.00	24 Feb 2
TOTAL					3,450.05	

Figure 10. An example of a digital record system. (Source: Agriwebb)

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Technologies such as animal health & grazing management tools improve the health and welfare of livestock. By providing detailed records of grazing practices, producers can support claims of sustainable and ethical production. This appeals to consumers who prioritise animal welfare and are willing to support producers who adhere to high standards. Healthy livestock producing high-quality meat products that meet stringent market standards also reinforce the credibility and social licence of the producers.

Remote Biomass Measurement

Remote biomass measurement technologies, including satellite imagery and drones equipped with multispectral sensors, offer precise data on vegetation cover and biomass. This information is crucial for assessing pasture and crop health and for planning grazing strategies.

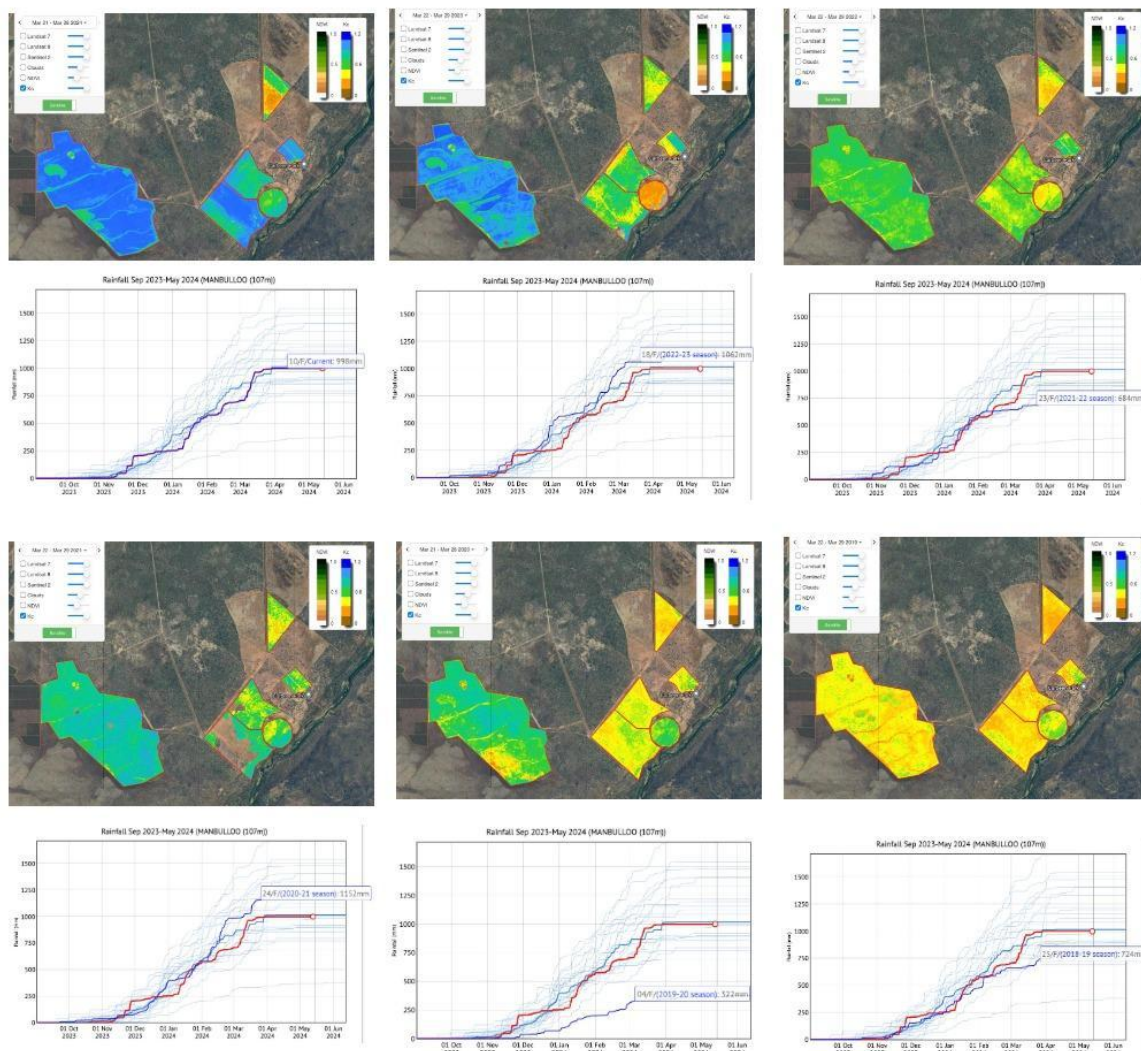


Figure 11. A simple comparison of crop biomass density from satellite imagery against historic rainfall data, measured on the same day and month, over a 6 year period. This shows dramatic improvement in crop growth at the same time of year, which can be correlated to rainfall, groundcover, moisture & nutrient retention as well as soil health. By combining this data with soil tests, we can start to understand the impact our management practices are having. (Source: IrriSAT)

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By using remote sensing, producers can monitor large areas efficiently, reducing the need for extensive field surveys. This technology enables real-time decision-making, ensuring optimal pasture utilisation and timely interventions to promote sustainable grazing practices. Remote sensing technologies provide producers with detailed images and data that help identify variations in biomass density, monitor plant growth stages, and detect signs of stress due to pests, diseases, or water scarcity. Such technologies are particularly beneficial in the vast and often inaccessible terrains of the NT, where traditional ground-based surveys would be impractical and time-consuming.

Satellite technology is increasingly used to help livestock producers verify and optimise their sustainable and regenerative grazing practices. By providing detailed information on pasture biomass, quality, ground cover, and land condition, producers can set sustainable stocking rates and estimate the number of available grazing days for each paddock.

Combining satellite imagery insights with GPS location data of the herd is a powerful tool for understanding grazing pressure in rangelands. This combination allows producers to monitor grazing patterns accurately, assess pasture utilisation, and identify areas of overgrazing. Such detailed information helps in making informed decisions on when and where to muster livestock, optimising pasture health, and ensuring sustainable grazing practices. By using these technologies, producers can enhance the efficiency and sustainability of their grazing management strategies.

Precision Irrigation Systems

Advances in remote sensing technology allow for the monitoring of soil moisture levels, vegetation health, and even soil organic carbon from a distance. Drones and satellites equipped with special sensors can detect changes in soil properties, helping producers optimise their field operations. Some of these devices provide real-time data on soil moisture conditions, enabling more efficient irrigation management. Proper irrigation practices are crucial in the NT, where water availability can be unpredictable. Precision farming techniques, which include the use of GPS and GIS technologies, allow for the precise application of water, fertilisers, and pesticides, thereby minimising waste and enhancing soil health.

Opportunities to make Australia's northern beef industry more productive and resilient

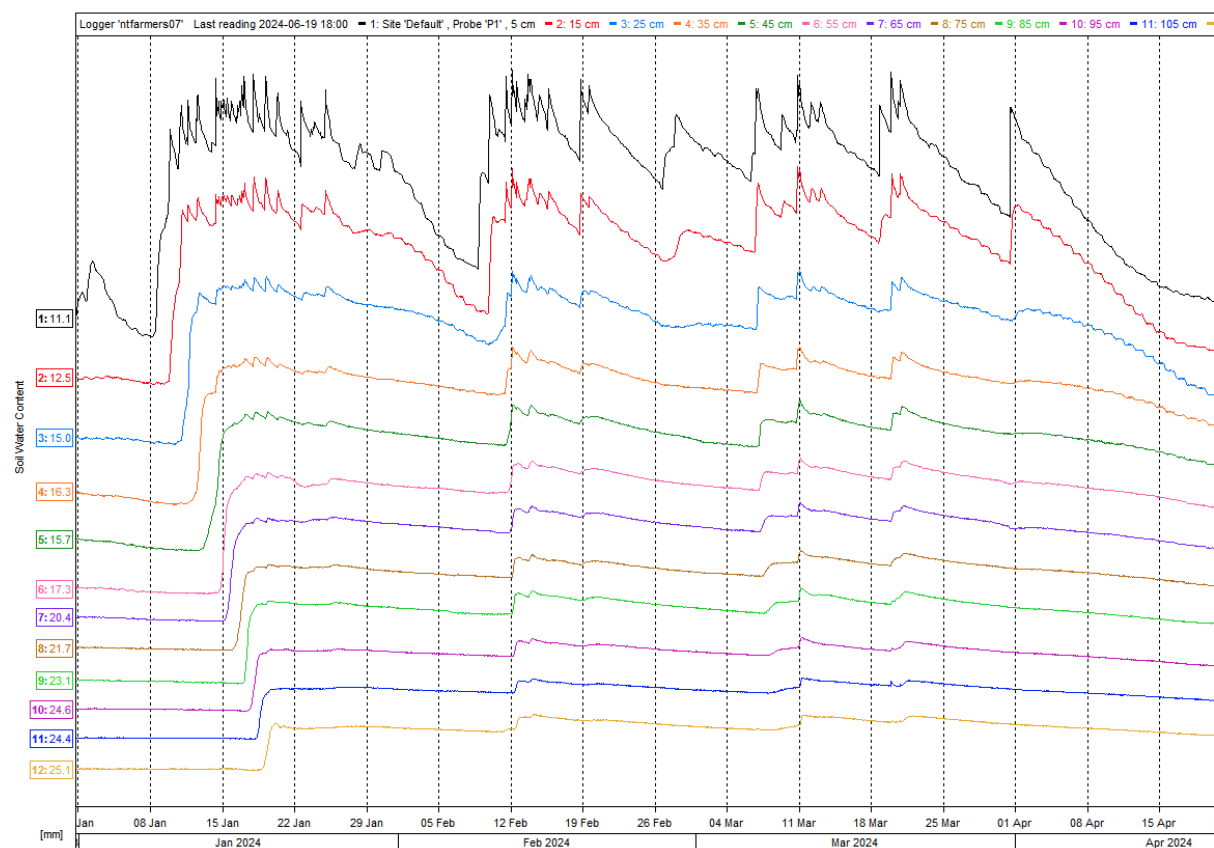


Figure 12. Remote sensors showing soil water content at different depths below the surface illustrating rainfall events through the Katherine wet season. (Source: Alpha Group)

Water scarcity and efficient water use are major concerns in the NT. Precision irrigation technologies, such as automated sprinkler controls, utilise soil moisture sensors and weather forecasts to optimise water application. These systems ensure that crops receive the right amount of water at the right time, enhancing water efficiency and crop yields. By reducing water wastage and improving irrigation practices, producers can sustain crop production even during dry periods. Precision irrigation systems are equipped with sensors that provide real-time data on soil moisture levels, weather conditions, and crop water needs. This data is processed by automated control systems that adjust irrigation schedules and volumes accordingly, ensuring optimal water use. This approach not only conserves water but also reduces energy consumption and operational costs.

Soil Health Monitoring

Maintaining soil health is fundamental to sustainable agriculture. In-field sensors and mobile labs provide real-time data on soil properties, including nutrient levels, pH, and organic matter content. This information helps producers make informed decisions about fertilisation and soil management.



Figure 13. A community workshop hosted at Carbeen Park in Katherine, NT, focussed on soil health and technology. (Source: Author)

Regular soil testing and monitoring enable the identification of potential issues early on, allowing for timely corrective actions to maintain soil fertility and productivity. Soil health monitoring technologies can detect subtle changes in soil conditions that might indicate underlying problems such as nutrient imbalances, compaction, or contamination. By addressing these issues promptly, producers can prevent long-term soil degradation and ensure that their lands remain productive and sustainable.

Advanced Fire Management

Fire management is critical in the NT's dry and fire-prone environments. Satellite data and predictive analytics allow for early detection of fire risks and behaviours. These technologies support the implementation of controlled burns and other fire prevention strategies, minimising the impact of wildfires on agricultural lands. Effective fire management not only protects crops and pastures but also maintains the ecological balance and soil health. By analysing historical fire data and current environmental conditions, predictive models can forecast fire behaviour, helping land managers to focus on effective fire prevention and response plans. Controlled burns, strategically applied, reduce fuel loads and lower the risk of uncontrolled wildfires, safeguarding agricultural investments and natural resources, demonstrating responsible management. This technology can also be used to view historical burning to ensure timely burning has occurred, assisting in certifying responsible management. Projects under savanna fire management methods can earn Australian Carbon Credit Units (ACCUs) by reintroducing controlled fire burning during the early dry season to reduce the frequency and severity of fires in the late dry season (Australian Government, 2024).

Methane and Carbon Accounting

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Environmental sustainability is increasingly important in agriculture. Technologies for measuring and managing methane emissions from livestock, such as portable methane detectors and software models, are critical for reducing the carbon footprint of farming operations. Additionally, carbon sequestration metrics, tracked using satellite imagery and ground sensors, quantify the amount of carbon captured by soils and vegetation. These measurements support carbon credit schemes and incentivize producers to adopt sustainable practices. Methane and carbon accounting tools provide accurate and reliable data on greenhouse gas emissions and carbon storage, enabling producers to monitor their environmental impact and implement mitigation strategies. By participating in carbon markets and earning carbon credits, producers can generate additional revenue while contributing to climate change mitigation.

Increasing carbon in soil and vegetation is a powerful method to reduce emissions, enhance sustainability, and tap into the growing carbon market. However, measuring carbon across expansive rangelands in the NT is cost-prohibitive and complex, presenting significant barriers for producers.

Achieving net-zero emissions by 2030 for the Red Meat industry and by 2050 for Australia requires innovative approaches to carbon management (Australian Government, 2020).

A \$6.5 million collaboration led by AACo and Food Agility Cooperative Research Centre (CRC) aims to revolutionise carbon measurement in Australian rangelands. The three-year Rangelands Carbon Project involves Cibo Labs, FLINTpro, Carbon Link, and several universities. It seeks to develop a cost-effective tool for measuring soil carbon using satellite imagery as proxies, reducing reliance on expensive soil tests. This initiative supports Australia's net-zero emissions goals and opens the carbon market to more producers, potentially generating new revenue streams from sustainable practices (Food Agility, 2023).

The project will establish baseline carbon levels, monitor changes over time, and provide actionable insights on carbon sequestration practices. The use of satellite imagery and advanced data models will significantly reduce the costs associated with traditional soil testing, making carbon management more accessible to producers. The anticipated outcomes of this initiative include increased carbon sequestration, new revenue streams for rangeland producers through participation in the carbon market, and improved productivity and resilience. By facilitating better carbon management practices, this project supports both environmental sustainability and economic viability for the northern sector (Food Agility, 2023)

Methane and carbon accounting technologies enable producers to measure and manage their greenhouse gas emissions. By participating in carbon credit markets and demonstrating efforts to reduce emissions, producers can align with global sustainability goals. Substitute feeding can, as discussed previously, also play a role in this by demonstrating the reduction in transport of fodder from interstate, methane reducing additives and improved feed conversion. This proactive approach not only enhances marketability but also strengthens the social licence by showing a commitment to mitigating climate change.

Accounting for Nature

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Accounting for Nature is a transparent, verifiable and certifiable environmental accounting framework, which can be used to inform management decisions and demonstrate performance around natural capital. The Accounting for Nature framework effectively measures the state of nature and change in condition of environmental assets such as soil, water, fauna and flora within a defined area. While the framework has been well tested at a local level, there has been limited application at the landscape scale over which we operate. In many ways, this framework is breaking new ground as new processes are defined for its implementation at a vast scale (Australian Cattle Company, 2023).



Figure 14. Biodiversity restoration project in California. (Source: Author)

Biodiversity credits are an emerging tool in environmental finance, designed to incentivise the preservation and restoration of ecosystems. Similar to carbon credits, these credits are traded in markets where buyers, often companies or governments, seek to offset their ecological impact. By investing in projects that enhance biodiversity, they can purchase credits that represent measurable conservation outcomes. Credits are created through actions that restore or preserve natural habitats, support wildlife populations, or enhance ecosystem services. These credits are quantified based on specific criteria and verified by independent bodies to ensure credibility. The goal is to create a financial incentive for landowners and organisations to protect biodiversity, integrating environmental sustainability into economic activities.

Projects like the Waterbank Project in California illustrate how biodiversity credits can be generated through conservation efforts. Producers in the NT can adopt similar practices to enhance biodiversity on their lands, creating new revenue streams and demonstrating their commitment to environmental conservation. This can appeal to environmentally conscious businesses and consumers, fostering partnerships and market opportunities while enhancing social licence. By generating and selling biodiversity and carbon credits, producers can create new revenue streams and demonstrate their commitment to environmental conservation.

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These credits appeal to companies looking to offset their ecological footprint, fostering partnerships and market opportunities with environmentally conscious businesses.

Digital Management Platforms

Digital management platforms like AgriWebb for livestock and Agworld for cropping provide comprehensive tools for data management and decision support. AgriWebb offers functionalities for tracking livestock movements, health records, and grazing patterns, helping producers optimise herd management and pasture use. Similarly, Agworld enables crop producers to plan, monitor, and analyse their operations, integrating data on soil health, crop performance, and input usage. These platforms facilitate real-time data access and analysis, enhancing operational efficiency and supporting evidence-based decision-making. By leveraging these tools, producers can improve productivity, reduce costs, and implement sustainable practices more effectively.

Data Integration and Baseline Creation

Integrating data from various technologies provides a comprehensive overview of farm operations, helping to establish baselines for different environmental and productivity metrics. Historical data on soil moisture, plant biomass, and livestock movements can be analysed to identify trends and predict outcomes. This data-driven approach enables producers to make evidence-based decisions, optimise resource use, and enhance overall farm performance. Data integration platforms aggregate information from multiple sources, providing a unified view of farm activities and conditions. By analysing this data, producers can identify areas for improvement, set realistic goals, and measure progress over time.

Leveraging Data for Continuous Improvement

The ultimate goal of integrating these technologies is to create a loop of continuous improvement. By collecting and analysing data over time, producers can build a detailed understanding of how different practices impact productivity and sustainability. This knowledge allows for the refinement of techniques, such as adjusting grazing loads or altering crop rotations, to further enhance soil health and reduce environmental impacts. Continuous monitoring and adaptive management ensure that agricultural practices remain responsive to changing conditions and emerging challenges. By fostering a culture of innovation and learning, producers can stay ahead of industry trends and adopt best practices that enhance their competitiveness and resilience.

The adoption of advanced agricultural technologies in the NT represents a transformative shift towards more data-driven and sustainable farming practices. These technologies provide valuable insights into soil health, water use, and environmental impacts, supporting informed decision-making and continuous improvement. As these technologies evolve and become more integrated, they will play a crucial role in helping northern producers meet the dual challenges of increasing productivity and reducing their environmental footprint.

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Stakeholder Engagement

The development and deployment of these tools also foster greater stakeholder engagement. By providing clear, accurate, and actionable data, these tools enable farmers, policymakers, and investors to collaborate more effectively. Farmers can demonstrate their commitment to sustainability, which can improve their market access and consumer trust. Policymakers benefit from reliable data to support environmental regulations and incentives. Investors gain confidence in funding sustainable agricultural practices, knowing that they contribute to measurable environmental benefits.

5.2 Social Licence

Social licence refers to the ongoing approval and acceptance of a business or industry by its stakeholders, including the public, local communities, and regulatory bodies. In the context of agriculture, particularly in the NT, maintaining a strong social licence is crucial for ensuring long-term viability and support. This chapter explores how the integration of advanced technologies and sustainable practices, as discussed throughout this report, enhances social licence for individual producers and the broader agricultural sector in the NT.

Transparency and Trust through Data-Driven Practices

One of the key elements in enhancing social licence is transparency. Advanced agricultural technologies, such as remote sensing, precision irrigation, and soil health monitoring, provide detailed and verifiable data on farming practices. Producers can share this data with stakeholders to demonstrate their commitment to sustainable and ethical practices. We have seen examples of producers leveraging blockchain technology to provide transparent and verifiable data on their sustainability efforts. This level of transparency builds trust with consumers, communities, and regulatory bodies, reinforcing the social licence of producers.

Community Engagement and Support

Engaging with local communities is essential for maintaining social licence, and the integration of data, technology, and storytelling plays a pivotal role in this process. By involving communities in decision-making and transparently showcasing the benefits of advanced agricultural practices, producers can build strong, trust-based relationships. Data-driven insights demonstrate the positive impact of sustainable practices, while technology facilitates real-time communication and involvement.



Figure 15. A community learning day at Carbeen Park, Katherine, NT. (Source: Author)

Additionally, storytelling helps convey these benefits in relatable ways, fostering local support. Initiatives such as education programs, local employment opportunities, and contributions to community projects further reinforce producers' roles as integral and positive parts of the community, thereby strengthening their social licence.

Building a Positive Market Image

All these technological advancements and sustainable practices contribute to a positive market image for producers. By showcasing their commitment to sustainability, efficiency, and transparency, producers can differentiate their products in a competitive market. This differentiation is crucial for accessing premium markets, securing long-term contracts, and building strong relationships with buyers. Additionally, meeting the increasing consumer demand for sustainably produced food enhances market access and profitability, further reinforcing the social licence.

Integrating advanced agricultural technologies and sustainable practices significantly enhances social licence for producers in the NT. By improving transparency, environmental stewardship, animal welfare, and community engagement, these innovations make agricultural operations more acceptable and supported by stakeholders. Producers can leverage these advancements to secure better market opportunities, achieve higher prices, and build a resilient and profitable business while maintaining a strong social licence.

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5.3 Access to Markets

Access to markets is crucial for the profitability and sustainability of agricultural producers. Advanced agricultural technologies, comprehensive data management systems, and innovative practices discussed in this report significantly enhance market access for producers. By improving transparency, efficiency, and sustainability, these advancements make products more attractive to buyers and open up new market opportunities.

Sustainability

Demonstrating a commitment to reducing greenhouse gas emissions and improving environmental sustainability enhances the marketability of agricultural products. Buyers and consumers increasingly favour products that contribute to environmental sustainability, opening up new market segments focused on eco-friendly products. This commitment can be showcased through technologies that track and verify sustainable practices, such as methane and carbon accounting. The traditional live export market often overlooks sustainable practices, but these are crucial in the NT, where producers depend on a market under constant scrutiny and facing risks like social pressures and disease outbreaks (e.g., lumpy skin and foot-and-mouth disease).

For Northern producers to diversify into different markets, they must adopt these measures to meet higher standards demanded by alternative markets. Producers who demonstrate a commitment to these practices can access premium markets and build a loyal customer base.

Transparency

Producers can leverage the data from their operation to obtain certifications, meet regulatory requirements, and provide detailed product information to buyers. This transparency and efficiency make their products more attractive in both domestic and international markets. Healthy livestock produce higher-quality meat products, which can meet stringent market standards. Detailed records of grazing practices support claims of sustainable and ethical farming practices, appealing to consumers who prioritise animal welfare. By differentiating their products through these claims, producers can further penetrate premium markets and enhance their market appeal.

In the NT, where producers are particularly vulnerable to market fluctuations and social pressures, leveraging data and technology to highlight sustainable practices is crucial for maintaining social licence and securing market access amidst risks like disease outbreaks and public scrutiny.

Market Access

Producers can access alternative markets by committing to sustainable practices, attracting environmentally conscious buyers. By focusing on the practices discussed throughout this report, they improve their ecological footprint and product quality. Producers can also utilise technology to transparently verify sustainability efforts, building consumer trust and accessing premium markets. This data-driven approach not only enhances market appeal but also

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optimises production practices, ensuring continuous improvement and operational efficiency. Through strategic technology and data use, producers can improve market access, attract environmentally conscious buyers, and achieve better prices, securing a sustainable future.

Live Export Sector

Market access is critical for the sustainability of agricultural producers, and the live export market is critical for northern producers, but this market presents unique challenges. Many of the technologies that are beneficial to producers mentioned in this report, are often overlooked further down the supply chain in this market.

Biosecurity concerns like the risk of disease outbreaks, including foot-and-mouth disease and lumpy skin disease, are a major focus. In the NT, where producers rely heavily on the live export market, leveraging data on animal health and biosecurity protocols is essential for maintaining social licence and market access.

Ensuring strict adherence to biosecurity measures builds trust with importing countries and protects the industry from disease-related disruptions. Accurate data on animal health, combined with strong biosecurity protocols, helps to mitigate risks and ensure that livestock meets international health standards. This transparency not only aids in maintaining relationships with key markets but also allows producers to navigate market volatility, social scrutiny, and the growing demands for sustainability in other segments of the supply chain.

By focusing on animal welfare, health data, and biosecurity, Northern producers can maintain and enhance their access to markets and minimise the risks associated with market fluctuations and disease outbreaks.

Having consistent data on cattle performance is also valuable for stakeholders throughout the supply chain, especially exporters. It allows them to demonstrate a strong track record of sourcing and preparing the best cattle, which is crucial for building trust with clients and securing long term business relationships. This data driven approach not only highlights the superior quality of the cattle but also reinforces the exporter's commitment to excellence and reliability, making them more competitive in the market.

Feeding practices play a crucial role in optimising cattle performance throughout the supply chain. For example, feeding poor-quality feed in quarantine facilities can cause cattle to become blocked with bulk fibre and roughage, leading to reduced appetite during the early stages of their voyage. This delay hampers weight gain until they clear their rumen onboard. Conversely, consistently providing high-quality feed allows cattle to maintain weight gain throughout the journey, improving turnaround times, profitability, and efficiency across the supply chain. However, quantifying the benefits is complex, as stakeholders at different stages often aim to capture the compensatory gains during their period of control over the animals. Each stakeholder values weight gains at different stages, making coordination challenging but essential for optimal outcomes.

Exporters like Patrick Underwood from Australian Cattle Enterprises (ACE) in Darwin acknowledge the importance of securing premium animals to fetch higher prices. He notes

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however, that it can be challenging for importers to recognise the value of data, as it's not a consistent or required aspect of the industry. *"Our animals are being discounted based on breed, driven by the perception that crossbred animals underperform,"* he says. Patrick believes that accurate data can challenge this belief, but overcoming long-standing rhetoric driven by lot feeders, butchers and consumers remains a significant hurdle. Patrick highlights the challenges within the live export supply chain, noting that it operates in silos, with little collaboration or data sharing across producers, exporters, importers, processors and retailers. According to him, the market does not yet support premium products or provide a strong commercial incentive for the use of data, as profit remains the key driver for stakeholders. However, he believes that once data shows a clear link to better commercial outcomes, it will be more widely embraced. (Underwood, Pers. comms 2024)

He notes that while ESCAS (Exporter Supply Chain Assurance System) has pushed for more data in the export process up to the point of slaughter, especially concerning animal welfare, the next step is extending data collection. This could involve tracking feed conversion, weight gains, ADGs, and other performance indicators, which would provide valuable insights for buyers and producers, creating efficiency across the supply chain.

Currently, this data remains confined within each segment of the supply chain. Underwood suggests that individual silos—whether producers, exporters, or retailers—need to demand and use this data to differentiate themselves and enhance their operations. He believes that exporters, in particular, can distinguish themselves by supplying data both upstream and downstream in the supply chain. Integration of this information can lead to more sophisticated markets, creating opportunities for higher value products and more informed decisions by all stakeholders.

Underwood underscores the importance of data in responding to the evolving needs of the rapidly expanding middle and upper classes in Indonesia, who are now demanding higher-quality products. This shift presents a growing market opportunity for premium processors and distributors who can meet these expectations with top-quality beef. By providing transparency and performance data throughout the supply chain, producers and exporters can differentiate their products, tapping into this lucrative market. High-end abattoirs and distributors have the potential to fill this demand, offering superior products and commanding premium prices.

Integrated supply chains, where one business owns and manages each stage—from cattle production in Australia, to quarantine & live export operations, feedlotting, processing through advanced abattoirs and ultimately, marketing through more sophisticated channels, give the ability to leverage consistent data across the entire process. Patrick says *"Data is more easily collated, shared, and utilised by a business with an integrated supply chain"*. He also notes the challenges with the adoption of technology and sharing of data throughout the northern supply chain by saying that *"detailed data would be of more use to a premium supply chain such as Angus Beef in hotel restaurants, rather than the wet markets and bakso ball markets that most NT beef from live cattle goes to."* (Underwood, Pers. comms 2024)

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5.4 Access to Capital

Access to capital is a fundamental requirement for producers aiming to expand their operations, improve productivity, and adopt sustainable practices. Advanced agricultural technologies and data-driven management systems discussed in this report play a crucial role in enhancing producers' ability to secure funding. By improving efficiency & transparency, and reporting on key sustainability metrics, these innovations build social licence and improve market access which ultimately make agricultural operations more attractive to investors and lenders.

The integration of the technologies discussed throughout this report provides a comprehensive overview of farm operations, enhancing transparency. Detailed records of operational data allow producers to create accurate and verifiable business plans, which are essential when applying for loans or attracting investment. *“Financial institutions value the ability to review historical data and predictive models, as they offer insights into the business's past performance and future potential.”* (Chiorean, Pers. Comm., 2023).

Building Investor Confidence

Data-driven management systems enhance investor confidence by providing transparent, reliable metrics of agricultural performance, which are crucial for securing capital. These technologies improve operational efficiency, sustainability, and financial transparency, making agricultural operations more attractive to investors. By demonstrating a commitment to innovative technologies and sustainability, producers can position themselves as resilient and forward-thinking, reducing perceived risks for insurers, lenders, and investors. This proactive approach not only protects assets and reduces carbon emissions but also supports long-term viability and financial stability in the agricultural sector.

Sustainability-Linked Finance

Sustainability-linked finance refers to financial instruments, such as loans and bonds, that are tied to a company's environmental, social, and governance (ESG) performance. These financial products incentivize companies to meet specific sustainability targets by offering favourable terms, such as lower interest rates, if the targets are achieved. By aligning financial outcomes with sustainability goals, this type of financing encourages businesses to adopt more sustainable practices, reduce their environmental impact, and enhance their overall sustainability profile, thus attracting investors focused on long-term ecological and social benefits.

“Investors and financiers are increasingly looking to fund projects that demonstrate strong environmental stewardship and sustainability.” (Spencer, Pers. Comm., 2023)

Producers can access sustainability-linked finance by strategically leveraging technology and data to document and demonstrate their sustainable production processes. By implementing advanced monitoring systems and comprehensive data management platforms, they provide verifiable evidence of their environmental stewardship. This transparency not only showcases their commitment to sustainable agriculture but also enhances their credibility with investors.

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As a result, producers can secure favourable financing terms that are tied to their performance on sustainability metrics, supporting their growth and further investment in sustainable practices.

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Chapter 6. Case Study

As a leading example, Olam Food Ingredients (OFI) aims to provide sustainable choices for customers by supporting cocoa farmers and fostering thriving communities within regenerated landscapes. They have set ambitious goals for 2030, structured around three key impact areas: Empowered to Grow, Focused on Farmers, and Investing in Nature (OFI, 2022).

They say:

“Natural Capital Accounting follows a holistic systems approach to understand the true value of nature, people, society for humans. The economy must be recognized as parts within a deeply interconnected global system and addressed together to deliver value across the capitals. It is an approach to measure the changes in the stock of natural capital at a variety of scales and to integrate the value of ecosystem services into accounting and reporting systems at national, corporate, project and product levels. This will result in better management of natural capital by these different entities.” (OFI, 2022).

Claire Loudis says that OFI has developed a 'Living Income Calculator' to estimate the proportion of farmers living below or above the living income threshold to identify income gaps and poverty hotspots across their supply chains. The calculator allows them to simulate the impact of various income improvement scenarios. Their data collection and monitoring system allows them to identify at risk scenarios, as well as measure their progress towards their goals. (Loudis, Pers.Comm., 2024).

They have also developed the Olam Farmer Information System (OFIS) which is a survey tool using data to give farmers better support. Their field teams use OFIS to collect data (such as farm and community infrastructure locations), manage training activities, and track financing, input distribution and purchases precisely. The detailed data allows them to plan development programs that are better suited to farmers' needs. Ultimately, it means they can report more precisely on sustainability, social justice, and other business indicators. They then feed the data from OFIS into another platform called AtSource to give their customers a clear and detailed view of their supply chains.

AtSource is a sustainability management system for sustainable products and supply chains which helps food, beverage and ingredient customers optimise the sustainability performance of their supply chains with actionable data. Providing data on key sustainability metrics for compliance and reporting purposes, AtSource provides assurance and 3rd party verification on sustainability performance and compliance evaluation, end-to-end traceability and identifies risk areas that brands can address through interventions to drive real change for people and the planet (OFI, 2022).

Claire Loudis reports

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"OFI secured a multi tranche sustainability linked facility aggregating \$1.75 billion from a total of 19 banks around the world. The margin on the facility is linked to the achievement of certain sustainability targets addressed in our Choices for Change sustainability strategy and could reduce if those targets are met." (Loudis,. Pers.Comm., 2024).

This demonstrates how leveraging technology and data can drive financial growth while promoting environmental and social sustainability.

Similar to OFI, which uses technology and data to drive financial growth while promoting environmental and social sustainability, NT producers can improve their social licence, access premium markets, and attract investment. By focusing on sustainability and data-driven decision-making, they can achieve significant improvements in productivity and market appeal.

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Conclusions

The Comprehensive Benefits of Technological Integration for Producers in the North

The integration of advanced agricultural technologies and sustainable practices discussed in this report offers numerous benefits to producers in the NT. These advancements significantly enhance market access, improve social licence, and provide opportunities for financial stability and growth. By leveraging data-driven practices, producers can achieve greater transparency, efficiency, and sustainability, which are crucial for maintaining a competitive edge in today's market.

Producers and stakeholders can leverage accurate data to showcase improvements across various aspects of agriculture previously discussed such as substitute feeding leading to methane reduction and increased feed conversion, weaning rates, rotational grazing. etc. The integration of agroforestry promotes soil health and reduces dependence on chemicals, while efficient crop production and water use further support sustainability. Utilising technology and data not only streamlines these practices but also provides verifiable evidence of progress.

Improving Operational Efficiency and Sustainability

The use of technology as discussed in this report, enhances operational efficiency and sustainability. By optimising resource use, reducing waste, and improving livestock and crop management, producers can achieve better productivity and environmental outcomes. Data-driven decision-making supports continuous improvement and helps meet sustainability goals, further solidifying the reputation of producers as responsible stewards of the land.

Strengthening Social Licence

Maintaining a strong social licence is essential for long-term viability, particularly in the NT where producers face scrutiny and risks such as social pressures and disease outbreaks. Advanced technologies and data transparency help demonstrate producers' commitment to ethical and sustainable practices. Initiatives like biodiversity conservation and regeneration, carbon sequestration, and responsible water management resonate well with the public, local communities, and regulatory bodies, enhancing the social acceptance of agricultural operations.

Enhancing Market Access

While technologies like remote biomass measurement, precision irrigation, and soil health monitoring are valuable in providing verifiable data and building trust in many agricultural markets, there is limited interest currently in these areas within the live export market. However, in live export, data on animal performance and health is highly valuable. Accurate, real-time information on livestock health, growth rates, and feed efficiency can help build buyer confidence, leading to stronger market access and better prices by demonstrating the quality and reliability of the animals being exported.

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Accessing Financial Opportunities

Technological integration ultimately improves access to capital. Sustainability-linked finance provides favourable financing terms tied to sustainability performance. By demonstrating their commitment to sustainable practices through verifiable data, producers can attract investment and funding, supporting growth and further innovation.

Final Thoughts

The comprehensive adoption of advanced agricultural technologies and sustainable practices is not just a trend but a necessity for the future of production in the NT. These innovations provide a pathway to enhanced market access, stronger social licence, improved operational efficiency, and ultimately, better financial stability. Producers who embrace these changes will be well-positioned to meet the challenges of modern agriculture, secure their livelihoods, and contribute to a sustainable and prosperous agricultural sector.

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Recommendations

Producers

Identify Goals and Set Benchmarks: Clearly define your sustainability goals and set benchmarks for metrics such as ground cover, soil carbon, biodiversity, stocking rates, weaning rates and production turn-off. Producers can even look at metrics and ratios like water consumption or carbon emissions per kg of beef produced.

Leverage Technological Tools: Utilise satellite imagery, precision irrigation, soil health monitoring, and livestock management tools to gather accurate data. Use this data to make informed decisions, optimise operations, and demonstrate sustainable practices.

Diversify Production Systems: Consider integrating other production systems, which add value to your operation, as well as improving natural capital. Diversification can also mitigate risks and create new revenue streams.

Engage in Carbon and Biodiversity Markets: Participate in carbon credit and biodiversity credit markets to generate additional revenue and demonstrate a commitment to environmental conservation.

Record and Report Data: Maintain detailed records of all sustainability metrics. Accurate data on soil health, livestock performance, and environmental impact can be leveraged to prove management practices and improvements over time.

Collaborate with Stakeholders: Engage stakeholders in your journey by regularly reporting progress with consistent metrics. Annual or quarterly reports can effectively demonstrate achievements and build trust.

Technology Stack

Livestock Management

- Agriwebb integrating with hardware such as Gallagher or TruTest
- Walk over weighing; OptiWeigh

Crop Management

- Agworld

Remote Biomass Sensing

- Irrisat Cloud
- Cibo Labs

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Pasture Management

- Agriwebb
- Cibo Labs

Powerful Insights

- Microsoft PowerBI

Water management

- Alpha Group

Remote Sensing

- Wild Eye

Emissions accounting

- Regrow Ag
- Accounting for Nature

OH&S

- Safe Ag Systems

Documentation

- Confluence
- Google Business Suite

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References

Aulakh, C & Sharma, S, Thakur, M & Kaur, P, (2022). "A review of the influences of organic farming on soil quality, crop productivity and produce quality." *Journal of Plant Nutrition*. 45. 1-22.

Australian Agricultural Company, (2023), "Sustainability Report 2023", Australian Agricultural Company Limited Website,
<https://aaco.com.au/wp-content/uploads/2023/06/AACo-FY23-Sustainability-Report-Final.pdf>

Australian Government (2020). "Net Zero Emissions by 2050: Strategic Pathways." Department of Agriculture, Water and the Environment.

Australian Government, (2024), "Savanna fire management methods", Australian Government, Clean Energy Regulator Website,
<https://cer.gov.au/schemes/australian-carbon-credit-unit-scheme/accu-scheme-methods/savanna-fire-management-methods>

Batt, L., National Feed Company, Personal communications., (2023)

Bayala, J., & Sanou, J. (2013). "Tree-crop interactions in agroforestry systems: Lessons from West Africa."

Bullard, J., Ockelford, A., Strong, C., Aubault, H., (2018), "Effects of cyanobacterial soil crusts on surface roughness and splash erosion." *Journal of Geophysical Research: Biogeosciences* 123.12 (2018): 3697-3712.

Chiorean, M., ANZ Singapore, Personal communications., (2023).

De Corato, U., Patruno, L., Avella, N., Salimbeni, R., Lacolla, G., Cucci, G., et al. (2020). "Soil management under tomato-wheat rotation increases the suppressive response against *Fusarium* wilt and tomato shoot growth by changing the microbial composition and chemical parameters." *Applied Soil Ecology*, 154, 103601.

Eldridge, D.J., et al. (2016). "Ecosystem structure, function, and composition in rangelands are negatively affected by livestock grazing." *Ecological Applications*, 26(5), 1273-1283.

Fahad, S., Chavan, S. B., Chichaghare, A. R., Uthappa, A. R., Kumar, M., Kakade, V., Pradhan, A., Jinger, D., Rawale, G., Yadav, D. K., Kumar, V., Farooq, T. H., Ali, B., Sawant, A. V., Saud, S., Chen, S., & Poczai, P. (2022). Agroforestry Systems for Soil Health Improvement and Maintenance. *Sustainability*, 14(22), 14877.

Food Agility, (2023), "Rangelands Carbon Project", Food Agility Website,
<https://www.foodagility.com/research/rangelands-carbon>

Opportunities to make Australia's northern beef industry more productive and resilient

Garnsworthy, P., (2004), "The environmental impact of fertility in dairy cows: A modelling approach to predict methane and ammonia emissions", *Animal Feed Science and Technology*, 112, 211-223

Harrison, S., Saiful, K Md., (2016). "Promoting sustainable agriculture and agroforestry to replace unproductive land-use in Fiji and Vanuatu". Australian Centre for Agricultural Research

Holmes, P., McLean, I., (2017) "Potential for improvement in northern Australia". Australian Beef Report.

Hristov, AN., Oh, J., Giallongo, F., Frederick, TW., Harper, MT., Weeks, HL., Branco, AF., Moate, PJ., Deighton, MH., Williams, SR., Kindermann, M., Duval, S.. (2015) "An inhibitor persistently decreased enteric methane emission from dairy cows with no negative effect on milk production." , *Proc Natl Acad Sci USA*, Aug 25, 34, 10663-8, <https://pubmed.ncbi.nlm.nih.gov/26229078/>

Kinley, R., Martinez-Fernandez, G., Matthews, M., de Nys, R., Magnusson, M., Tomkins, N., (2020) "Mitigating the carbon footprint and improving productivity of ruminant livestock agriculture using a red seaweed". *Journal of Cleaner Production*, Volume 259.

Loudis, C., Personal Communications., (2024).

Lv, Q., Chi, B., He, N., Zhang, D., Dai, J., Zhang, Y., Dong, H. (2023). "Cotton-Based Rotation, Intercropping, and Alternate Intercropping Increase Yields by Improving Root-Shoot Relations." *Agronomy*, 13(2), 413.

Monvoisin, T., (2024),. Personal communications, 2024.

Olam Food Ingredients, (2022), "Cocoa Compass Impact Report", Olam Food Ingredients Website, <https://www.ofi.com/content/dam/olamofi/products-and-ingredients/cocoa/cocoa-pdfs/cocoa-compass-impact-report-final.pdf>

Olam Food Ingredients, (2022), "Cultivate sustainability from the ground up", OFI Sustainability at Source, Olam Food Ingredients Website, <https://www.ofi.com/sustainability/sustainability-with-atsource.html>

Schonbeck, M., Jerkins, D., Lowell, V., (2019). "Soil health and organic farming. Understanding and optimising the community of soil life." *Biological management of crop diseases*, 26-32.

Spencer, L., Nuveen Capital. Personal communications., (2023)

Souza, WLd., Niehues, MB., Cardoso, AdS., Carvalho, VVd., Perdigão, A., Acedo, TS., Costa, DFA., Tamassia, LFM., Kindermann, M., Reis, RA. (2024) "Effect of 3-Nitrooxypropanol Combined with Different Feed Additives on Growth Performance, Carcass

Opportunities to make Australia's northern beef industry more productive and resilient

Traits, Enteric Methane Emissions, and Physiological Responses in Feedlot Beef Cattle Fed a High-Concentrate Finishing Diet." *Animals*. 2024; 14(23):3488.

Underwood, P., Australian Cattle Enterprises. Personal Communication, (2024)