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How are global megatrends likely to provide opportunities and challenges for Northern Australian rangelands?

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Abstract

Over half of Australia's beef cattle are managed in extensive rangeland systems in the north and are vulnerable to climate challenges, infrastructure and labour limitations, and disruptions to trade. In this paper we consider research and industry viewpoints to explore opportunities for the northern Australian beef industry to ensure a sustainable, productive and profitable future. Our analysis is framed by the following megatrends; (1) adaptation to a **warmer and more variable climate** to protect livelihoods, infrastructure, and quality of life, (2) the **technology revolution and expansion** into northern Australia, providing new solutions to old problems, (3) **geopolitical shifts**, which change trade dynamics, disrupt supply chains, and offer alternative domestic and international markets, (4) the push for **more efficient resource use, with reduced impacts** on animals and the environment driven by changing consumer and market expectations, and (5) changing **regional demographics and human capital constraints**, which limit operational efficiency and social capital. While all megatrends will create some universal magnitude of effect, the unique landscapes and agricultural systems of the northern Australian rangeland system require a tailored, place-based assessment.

Introduction

Northern Australian rangelands encompass the tropical savannas, woodlands, shrublands and grasslands of the Northern Territory, Queensland, and Western Australia. Land use is dominated by cattle production based on unmodified native pastures, with other areas used for conservation, mining, defence, and as designated Indigenous Protected Areas. Livestock production in this region is typified by extensive pastoral properties used for cattle breeding operations and managed by a mix of family-owned and corporate enterprises. Production is orientated towards live-export, with cattle often transported long distances to one of four northern ports, before being shipped to Indonesia, Vietnam and other international destinations. The harshness of the landscape and unreliability of seasonal rainfall on a marginal feedbase is reflected by low livestock growth rates, sub-par reproductive efficiency and high mortality in both breeding stock and calves (McCosker et al, 2023). Complex land tenure rights, a sparse population that limits investment and expansion of infrastructure and historically poor phone and internet connectivity have all contributed to

slow development. However, recent advances in technology and shifting overseas markets have the potential to be transformative. In this paper, we explore the influence of global megatrends, and the unique challenges and opportunities they present for northern Australian beef production systems going forward.

Adaptation to a warmer and more variable climate

The climate of northern Australia is characterised by distinct wet (October and April) and dry (May and September) seasons, though total annual rainfall is highly variable between years. There is high certainty that average temperatures and extreme heat events will increase into the future (CSIRO and Bureau of Meteorology, 2015), impacting the productivity and welfare of both livestock and people. Northern Australian cattle production systems are already adapted to hot conditions, with the region currently dominated by tropically-adapted *Bos indicus* breeds and their crosses. However, this region may also experience an increase in the frequency and/or intensity of extreme events such as heatwaves, cyclones, floods and bushfires (CSIRO and Bureau of Meteorology, 2015). These events affect the northern beef industry via impacts on livestock (reduced feed intake, mortalities), landscapes (soil erosion, damage to pastures) and infrastructure (loss of roads, fences, buildings), in turn impacting supply chains and rural communities. In addition, changing climates may be accompanied by biosecurity challenges, with changes in the range of endemic pests and diseases combined with new incursions.

While producers already make tactical decisions such as adjusting herd sizes to cope with harsh conditions and seasonal variability, extreme events are harder to prepare for because they are difficult to predict at local scales (temporally and spatially). There is also often very little that producers can do in advance to mitigate the impacts of these events in such extensive systems. Advice from local and state government agencies focuses on pre-emptively moving livestock out of high-risk areas, but the effectiveness of such approaches relies on having sufficient warning, human resources and capital to move animals, and the existence of safe refuge areas.

The technology revolution and expansion into northern Australia

With such expansive rangeland properties, remote resource monitoring and animal management are almost essential for any measurable improvement in operations and productivity. The commercialisation of connectivity options has borne a strong focus on cloud-supported robotics, the Internet of Things (IoT) and sensors, artificial intelligence (AI) and drone capability as well as renewable energy options for operations such as solar-powered bore pumps. For example, remote monitoring of water resources, feed biomass, and land condition combined with in-field animal weight sensors and monitoring of diet quality via eDNA can support decisions on stocking rates and paddock allocations, which could in turn be facilitated by virtual fencing and the use of drones for mustering. The adoption of such technologies can potentially help to improve animal welfare and productivity and reduce landscape degradation, whilst concurrently reducing human labour resource requirements. As the use of this technology increases, there will likely be changes in animal management protocols, for example the incorporation of drones allowing cattle to be mustered at night when there is a lesser risk of acute heat stress.

At the animal level, IoT and sensors, including water intake sensors, GPS and accelerometer tags and collars for behaviour monitoring provide an opportunity for remote data collection as well as decision-making and treatment at the individual animal level. Machine learning and AI are being used extensively on the developmental phase of product creation, for example as a mechanism to refine algorithms and eliminate arduous video annotation for animal behaviour and health monitoring and is also critical for the proceeding data aggregation step (Tedeschi et al. 2021).

While all purposeful technology can support the goal of informed decision-making, the accumulating breadth of technology options is also creating a clear signal that thoughtful yet simplified data analytics is also needed so that it is understandable, useful and real-time for informed decision-making that is appropriate for current conditions. Commercialised systems that master integration of data types are a necessity given the diverse sensor monitoring for non-confined, extensive rangelands. Development of predictive technologies to support management decision-making will rely on data accrual; however, historical data availability is a limiting factor and data ownership and privacy continue to be challenges.

Geopolitical shifts

As an export dependent nation, global trends provide opportunities and challenges for northern Australian beef. Climate challenges, political tension and conflicts influence price volatility and supply chains. However, an estimated increase in beef consumption over the next decade (in Australia and key live export markets Indonesia and Vietnam; ANZ Group Holdings Limited; MLA 2024) provides confidence in beef export demand. High Australian cattle prices and public animal welfare concerns lead to frequent disruptions in live trade (a cornerstone market for northern beef supply chains) in addition to the risk of trade disruption if Australia loses its disease-free status from lumpy skin disease or foot and mouth. Domestic efforts to improve access to premium market supply chains (EU, Japan) are challenging due limited potential to diversify land use across the pastoral zone both due to inherent land productivity and to restrictive (and inconsistent) State legislated lease terms. A dominant live export market, limited opportunity to diversify the feedbase and sparse road and rail infrastructure, impacted by seasonal cyclones and floods all contribute to a vulnerable northern beef supply chain. Yet half of the Australian beef herd is produced under these conditions. Where land productivity and legislation align pivot irrigation or dryland cropping as well as vertically integrated cattle businesses that move cattle to more fertile regions provided opportunities for diversified trade and access to higher value markets.

The focus of premium markets on sustainability has resulted in declining EU per capita beef consumption and an 8% shrinkage of the EU beef herd (European Union, 2021). Australia's response to welfare breaches has resulted in a 'clean, green beef' ethos underpinned by the Exporter Supply Chain Assurance System (ESCAS) (Windsor 2021). This leadership has encouraged Vietnam to set equivalent welfare standards providing opportunities for trade expansion. Megatrends affecting Brazilian supply chains indicate welfare compliance will be mandatory by 2040 (Malafaia et al. 2021). Australia's commitment to welfare, and the relative sustainability of northern beef production provide opportunities to capitalise on these markets where integrated supply chains allow for feedbase improvement.

As de-globalisation looms, the low tariffs negotiated through Australia's 1980s-2020s Free Trade Agreements (FTAs) are met by similar FTAs negotiated with other nations, increasing competition in export markets. At home, global volatility in key import markets imposes price volatility and supply chain instability on imported minerals (phosphorus and nitrogen from the Middle East, China and Russia). Development of domestic green ammonia plants and circular economy initiatives may provide cost-savings, food security and a sustainability advantage for Australian livestock producers. Potentially northern Australian producers can capitalise on broader megatrends influencing affluent Asians; digitisation of shopping, tailored personal experiences and Gen Z and Alpha as the largest consumer demographic. Could northern beef supply chains capitalise on a direct, personal shopping experience, emerging welfare-based priorities and build brand based relationships in the secure beef markets of Asia?

More efficient resource use, with reduced impacts on animals and the environment

Arguably, as long as grazing is managed to limit its negative impact on the landscape, beef produced in the northern Australian rangelands has the opportunity to be among the most sustainable in the world.

Therefore, northern Australian producers are perfectly placed to capitalise on consumer preference for beef certified for sustainability credentials. To achieve this, measurement and monitoring of biodiversity, natural capital and other sustainability metrics needs to occur, and the marketing of the products needs to be clear and tailored to the market preferences. Whether consumers are willing to pay for sustainable practices or simply demand them as standard is yet to be seen. Furthermore, existing nature-based markets enable producers to gain financially from not only potential price differentiation for sustainable practices, but also directly from implementing practices that reduce carbon emissions/sequester carbon (carbon markets) or improve/protect biodiversity (e.g. Nature Repair market). The northern rangelands are extremely well placed to enter these markets due to large property areas (e.g. average property size in NT in 2010 was >2700 km^2) and naturally high biodiversity due to limited land clearing. Additionally, projects using the Australian Government's savanna burning methodology have been able to earn significant carbon credits, mainly on the Indigenous estate (Edwards et al. 2021), and it is possible that the pastoral industry could also benefit from such schemes in the future.

Improving production efficiency of northern beef systems is also likely to be a focus into the future-particularly regarding identifying and removing non-performing animals, improving the quality of the feedbase and using the land for multiple purposes (e.g. solar farming and beef production using agrivoltaics). As long as stocking rates are maintained or reduced, improved efficiency also has the co-benefits of reduced methane intensity and less impact on the pasture. While the outlook holds promise, improving resource efficiency in remote and dispersed locations has inherent challenges. Additionally, there is increasingly a tension between using the northern rangelands for beef production and other land uses-particularly energy production, and mining for critical minerals. Satisfying the needs of a growing population and their future requirements is likely to put the northern rangelands under pressure.

Changing regional demographics and human capital constraints

In 2020, 76% of people in Australia lived in urban areas (Hill et al. 2021), and this urbanisation of the population is predicted to increase into the future. Attracting and retaining skilled workers in the northern beef industry is currently a challenge, but is potentially an opportunity, particularly for First Nations peoples and remote communities. For example, according to the 2021 census, the percentage of employed people aged ≥15 years in the NT was 76% for non-Indigenous people compared to 28% for Indigenous people (Australian Bureau of Statistics, 2021). However, as Indigenous Business Australia (2023) have said '*Aboriginal people are the most overtrained people in the country and still can't get a job*' and therefore investing in linking talent, training and opportunities is important. As well as attracting and retaining more on-ground staff, the rise of remote working (e.g. working online) is likely to also start to apply in the northern beef industry with the adoption of technologies and remote management opportunities outlined above. Recent climate modelling has suggested that due to rising temperatures, the duration people are able to work outside in northern Australia will be reduced by 20-50% by 2080 in comparison to a 1986-2005 baseline (Hunt et al. 2023). This could increase remote working, as it is likely to affect people's ability to work in the northern rangelands, as well as their desire to live in these conditions.

Conclusions

The global megatrends discussed above provide both opportunities and challenges for Australia's northern beef industry. Access to knowledge and upskilling for livestock producers remains critical for businesses to access new opportunities and compete. Potentially, a review of the varied and complex legislative requirements for diversification needs to be adapted to cover a northern Australian based land system, rather than different and complex rules between arbitrary State borders. This is particularly true where large land holdings span jurisdictions. In summary, future climate challenges will not be insignificant, and primary

producers will need access to knowledge, tools, supportive legislation and novel markets to remain competitive in a secure market for animal protein.

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