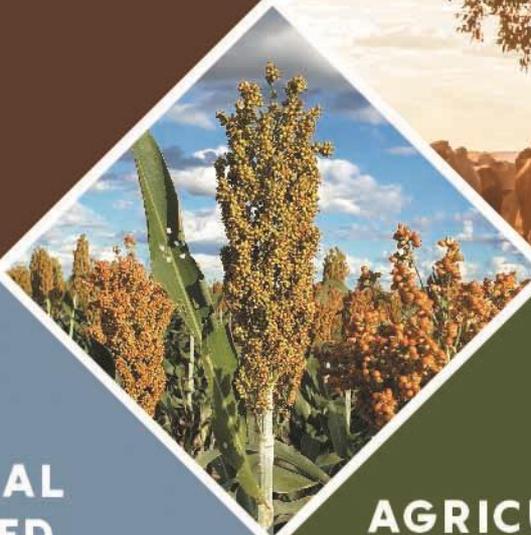


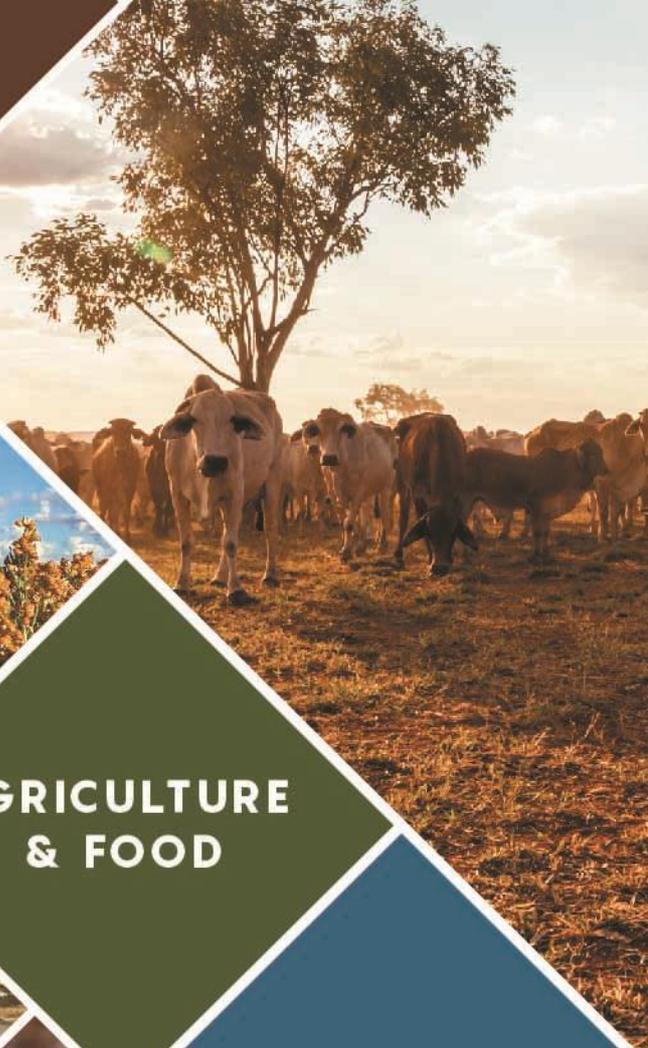
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Northern Australia agribusiness supply chains

A review of the literature

Pascal Tremblay, Hurriyet Babacan and
Jennifer McHugh





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Acronyms

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ASEAN	Association of South East Asian Nations
CRCNA	Cooperative Research Centre for Developing Northern Australia
CSIRO	Commonwealth Scientific and Industrial Research Organisation
ICT	Information communications technology
LGA	Local Government Area
NAIF	Northern Australia Infrastructure Facility
NRDAA	Northern Regional Development Australia Alliance
NT	Northern Territory
ONA	Office of Northern Australia
QAAFI	Queensland Alliance for Agriculture and Food Innovation
QLD	Queensland
R&D	Research and Development
RDA	Regional Development Australia
SMART	Specific, Measureable, Attainable, Realistic, Time-related
TRaNSIT	Transport Network Strategic Investment Tool
WA	Western Australia



Introduction

The CRCNA project Reframing Smart Supply Chains in Northern Australia recognises that supply chains are fundamental to improving the competitiveness, prosperity, productivity and sustainability of Northern Australia. To support a renewed examination and reframing of agricultural supply chains in Northern Australia, a combination of stakeholder analysis, interviews and data analysis are undertaken prior to a planned major roundtable with selected stakeholders taking place in 2020.

The current review overviews literature research and policy work undertaken within and around Northern Australia to inform the roundtable itself about latest developments relevant to supply chain thinking, and to elicit policy, budgetary and regulatory measures backing the development of alternative models of supply chain management which are more efficient, effective, smart and agile. This work will also recognise potential partnerships for collaborative planning and implementation of supply chain initiatives across the North. The literature review was conducted in 2019-2020, using academic and grey literature. Key search words used included supply chains, agile and smart supply chains, Northern Australia and economic development.

Given the wide assortment of relevant research (with rapidly evolving themes and technological insights), of emerging policy domains and of political commentary by governments, industry bodies and advocacy groups on the topic within and outside Northern Australia, key information sources and topics were selected carefully to reflect both currency, relevance and the methodology.



Contextualizing the Northern Australia supply chain dilemma

Among the well-accepted challenges facing Northern Australia's economic growth, supply chain shortcomings play a prevalent role. This can be attributed to the infrastructure development lag that the Northern region has accrued as a result of Australia's economic history. It is frequently claimed that the North's deficient supply chains constitute the key source of comparative disadvantage the region faces, despite its outstanding resources, people and locational advantages. The reality is that Northern Australia boasts excessive freight costs (in particular for low volume agricultural products) served by networks where limited alternatives or options exist. It suffers from inadequate access to markets due to capacity constraints, high costs due to low volumes and network unreliability more generally. This results in a relative powerlessness to attract capital investments and skills (except during mining booms), and stickiness issues typical of peripheral regions around the world. This prevents the retention of key human capabilities and impedes efforts to build a sustainable economic base. These dilemmas are particularly potent with respect to Northern aspirations to produce and trade targeted agribusiness commodities, especially perishable food which require particular care and consistent distribution conditions and cannot tolerate unpredictable transport conditions.

Northern Australia is also currently ill-reputed for its excessively high freight costs, its low volume infrastructure that discourages cost recovery, maintenance and re-investments. The limited production scales on which its key industries operate, and the overall dependency of its producers on southbound traffic flows lead to Australia's southern capitals continuing to be the main domestic distribution centres or export gateways.

The timing is right to re-examine these key issues as acknowledged by government, key industry sector bodies and other stakeholders. These issues have been identified as key industry sector agencies as they interact with the challenges of inadequate infrastructure, barriers to expand and increase the scale of their agri-food economies, productivity limitations, trade competitiveness, and distribution and transport costs. The more recent Northern Australia agenda has reiterated those issues and contributed to the identification of broad factors inhibiting agricultural development in its diverse regions, unavoidably stumbling on the causes of and solutions to the ineffectiveness of Northern supply chains.

While the key factors that have triggered the aspiration to reframe Northern supply chains have been frequently expounded by those directly affected by inadequate transport and logistics services over time, this has never led to a concerted program for Northern action. Despite the recognised central importance of supply chains and freight networks behind Northern trade challenges, no systematic attempt to assemble evidence and undertake comprehensive consultations to examine options for reframing Northern supply chains has occurred. The roundtable meeting that this review supports will attempt to set priorities and examine a variety of investment options articulated around the rising supply chain threats and opportunities in an orderly and systematic manner. This will hopefully set a broadly endorsed agenda for action around freight improvements and investments in key capital assets and human capabilities required to reframe Northern Australia's supply chains. To do so, the review has benefited from recent CRCNA-funded research featuring sector-based expertise engaged in assessments of main Northern opportunities and barriers (for the expansion of those specific sectors) and sub-regional appraisals of freight network and infrastructure needs based on local business stakeholder consultations. This evidence alone suggests that supply chains dilemmas are central to overcoming the disadvantages facing Northern agricultural opportunities and deserve a methodical examination.



Contemporary supply chain concepts in the global literature

Interest in supply chains as a research field across policy and academic circles has increased considerably in the last couple of decades. There has been an explosion of descriptive studies about specific commodities or particular national challenges and strategies. Additionally, an extensive body of sanctioned practices has emerged, formulating systematic ways to examine supply chains and derive implications for competitiveness. These works, however, continue to evolve and have resulted in a variety of diverging and siloed interpretations regarding the content of supply chain analysis and have led to differing perspectives about the key dimensions behind supply chain thinking, from the role of private and public sector stakeholders involved in supply chain developments, and the appearance of novel trends regarding the key principles and essential features required for best practice.

The most state-of-the-art handbooks and key international organisations attempting to provide a comprehensive coverage of supply chain analytical methods now confess that there is no single, widely-accepted definition of supply chains, and that the scope and nature of what is meant by those terms has evolved rapidly in recent years. In this section, we revise briefly the issues and topics that have come to play a greater role in that field, as well as some of the trends affecting recent practice which are bearing on various policy domains, and that ultimately impact on Northern Australia's agribusiness sector.

Early references to supply chains originated from the fields of marketing and economics, where it emphasized the need for businesses to manage distribution channels, including in agriculture applications where attention was originally directed towards the need to 'link the farmer to the market'. Research on supply chains soon progressed to consider the evolution of relationships between vertically-connected business entities, the roles of different intermediaries, and the impacts of transaction costs on the extent and viability of greater integration between stages of production, packaging and distribution. The general framing of supply chains in the literature was significantly influenced by the contributions of Porter (1985, 1990), merging traditional logistical and distribution thinking with issues of market and production boundaries within his 'competitive advantage' framework. In this interpretation, aspects of competition and collaboration were combined, and would inform the formulation of alternative value propositions or strategies contrasted at the business or national level.

Porter's value chain approach specifically led to examining stages of production in the light of the deliberate but provisional relationships they held with neighbouring businesses, across vertical and horizontal dimensions. This redirected the analysis towards the 'value' added at each stage of production or transformation, thereby determining the benefits (or costs) of further integration between business units. It signalled a different perspective which became not only influential in business schools, policy circles and among consultants advising business decisions, but has also had considerable influence on key Aid organisations (i.e. Food and Agriculture Organisation) providing research and policy advice to less developed countries tackling food shortages. Agri-food and agribusiness supply chains have been predominant in all these theoretical developments as well as supplying a majority of empirical sectoral studies across different parts of the world.

Concurrent to this methodological progression as a research field, important global social and industry trends occurred that have led both to extensions and to disruptions in the field's thinking and its development. The majority of these new 'themes' have been absorbed or eventually integrated within supply chain analysis, as they became key strategic concerns and influential analytical components. For instance, social values fuelling concerns about the sustainability and health attributes of food production systems related to their origins (including their nutritional value and the ethical dimensions surrounding their production contexts) somehow reinforced earlier attempts by industry to control food quality along their supply chains and led to increasingly advanced methods to track and map food origins, transformation and treatment.

This has resulted in present-day interest in 'traceability' both as a response to consumer-driven social movement values, and as a marketing strategy to support sectoral product differentiation based on the provision and communication of information to the consumer. Emerging producers well-placed to initially disrupt existing chains by offering opportunities to target niche needs, were later replaced by more extensive supply chain redesign strategies, and eventually saw the appearance of specialized intermediaries focusing on foreseeing and reaching new food markets valuing that information.

A related trend which has led to calls for reframing supply chains across various sectors stems from the contemporary significance of recycling and reuse of scrapped products and the increasingly visible costs associated with managing the 'consumer-to-trash' component of products delivery and disposal. A circular supply chain notion has been developed to incorporate the reverse logistics process by which limited resources become the notional responsibility of selected businesses within those sectors, irrespective of whether they can or cannot be reused. This is in effect an attempt to address a recently articulated market failure by 'privatising' the costs of disposal among shared relevant parties, to ensure the funding of waste treatment infrastructure and activities. While generally 'circular', the mechanisms and terms by which waste management impacts should be administered remain context- and sector-specific. What is generally agreed is that specialized business opportunities are emerging, especially in countries imposing waste management targets and regulation. The concept of 'agricultural circular economies' has become influential in agribusiness policy debates in the European Community for instance. While circularity has been formerly considered less problematic in agriculture because of its perishable nature and customary reuse in some areas, this is changing significantly as rapid food production growth is anticipated. Furthermore highly disrupting biosecurity risks have emphasized the need to ensure that agricultural products and inputs remain carefully separated and managed (in production and in disposal), and that the use and discarding of increasingly scarce water resources around waste treatments be well accounted for. The issue of traceability

associated with agribusiness supply chains is therefore relevant from a marketing angle (underpinning product differentiation based on health and political attributes) as well as with respect to biosecurity (in particular around the identification of possible contamination threats and the costs of disposing or reusing wastes and by-products, etc).

Other major influences became linked with the business models and innovation strategies developed around chains. Enhanced contemporary value chain modelling has been proposed around the following domains:

- ICT-enabled supply chain logistics which appraise how new technological developments can impact on the supply reliability, allocation of transaction costs and ultimately risk allocation between supply chain partners with the potential to cause multi-level disruptions and dislodge or bypass powerful distribution intermediaries;
- Financial monitoring and investment concerned with the flows of funds to and within a value chain to meet the financial needs of chain actors to secure sales, to buy inputs or enhance production, or to improve efficiency; including strategies to bypass formal financial institutions that have in the past extracted excessive economic rents; and
- Information and knowledge modelling reflecting the growing importance of intangible activities (away from the tangible aspects of production) and focused on the development of human capabilities (including supply chain skills) and workforce flows affecting the sustainability of supply chains underpinning regional competitiveness.

Although they are unequally developed as theoretical frameworks, these domains have become increasingly influential sub-fields of supply chain analysis and research. The wave of 'SMART' (following the well-known acronym) analysis and strategic thinking has also entered the supply chain vocabulary and nowadays refers to an amalgamation of the fields listed above. As supply chains have increasingly become used as strategic tools to reposition regions, the influence of 'supply chain thinking' has widened substantially. It nowadays plays a role in public sector investment decisions and drive regional economic policies across multiple domains such as transport infrastructure, telecommunication networks, land governance, population attraction and government services delivery, etc.), and this could be interpreted as significant level of scope creep. Currently, policies and documents considering rural development, examining ways to enhance regional employment, or preparing communities for anticipated industrial decline or disruptions routinely frame their discussions around supply chain reasoning.

Stank et al.(2015) envisage 10 global marketing and business megatrends set to revolutionize supply chain logistics that have been tested for their predictive value and general relevance to industry with stakeholders from both research and industry backgrounds. The bulk of these trends anticipate well some of the tensions currently observed in North Australia and validate the necessity of rethinking Northern Australia's challenges while reframing what 'smart supply chains' in that context entail. A key cross-cutting dimension and megatrend featured in their work is the shift from 'function focus to process focus to systemic focus', which depicts how the field of supply chain analysis has seen its concerns broaden since its initial representations of stages efficiently linking producers and markets. It has initially evolved towards comprehending the determinants of production inter-operability and network efficiency, and more recently encompassed the examination of supply chains as systems, complemented by the cross-cutting dimensions discussed above (finance, ICT, risk analysis, knowledge flow strategies, etc.).

These academic and somewhat abstract developments provide a useful basis to reflect on the current project's concerns with the nature of North Australia as a spatial system with distinct attributes, as well as the agribusiness sector as a technical-logistical system that ought to be considered beyond the commodity or product level, despite the political-sectoral conflicts this necessarily creates. This emphasis on systemic analysis should cut across each of the recent supply chain conceptualisations that have come to dominate the research and policy landscapes. It provides an avenue for rethinking how information and systematic analysis of Northern infrastructure assets and transportation priorities can be invested in and utilised for future-proofing purposes. It also seems imperative that our understanding of the nature of regional and sectoral systems be reframed to incorporate new types of connections between new and identified stakeholders. Uncovering new collaboration possibilities around and within chain actors will assist Northern Australia in reaching greater functional agility and support its aspiration to attain a level of strategic maturity commensurate to its envisioned potential.



The Northern Australia context and supply chain challenges

Recognising the ‘systemic’ perspective emphasized by recent conceptualisations of supply chains, it is useful to consider some scope limitations of the current review related to the sources of information selected, as well as their broader backgrounds. The three key framing dimensions for the review scope were:

- a) Supply chain concepts and models;
- b) Agri-food or agribusiness sector considerations; and
- c) North Australia context.

Each of those includes potentially a vast literature spanning academic publications and grey literatures published by agencies and consultants, as well as policy position papers. For instance, much has been written about issues and challenges associated with North Australia economic development that is pertinent, or about the Australian agri-business sector and its competitive position. Usually those literatures originating from the 3 distinct perspectives can treat similar topics in relatively disconnected ways, and the bulk of their wisdom applies to other contexts or domains. As this review attempts to focus on issues reflected by those joint domains, it is tempting to narrow the analytical frame of selection to pragmatically concentrate on the literature that fulfils all criteria, as represented in figure 1 below.

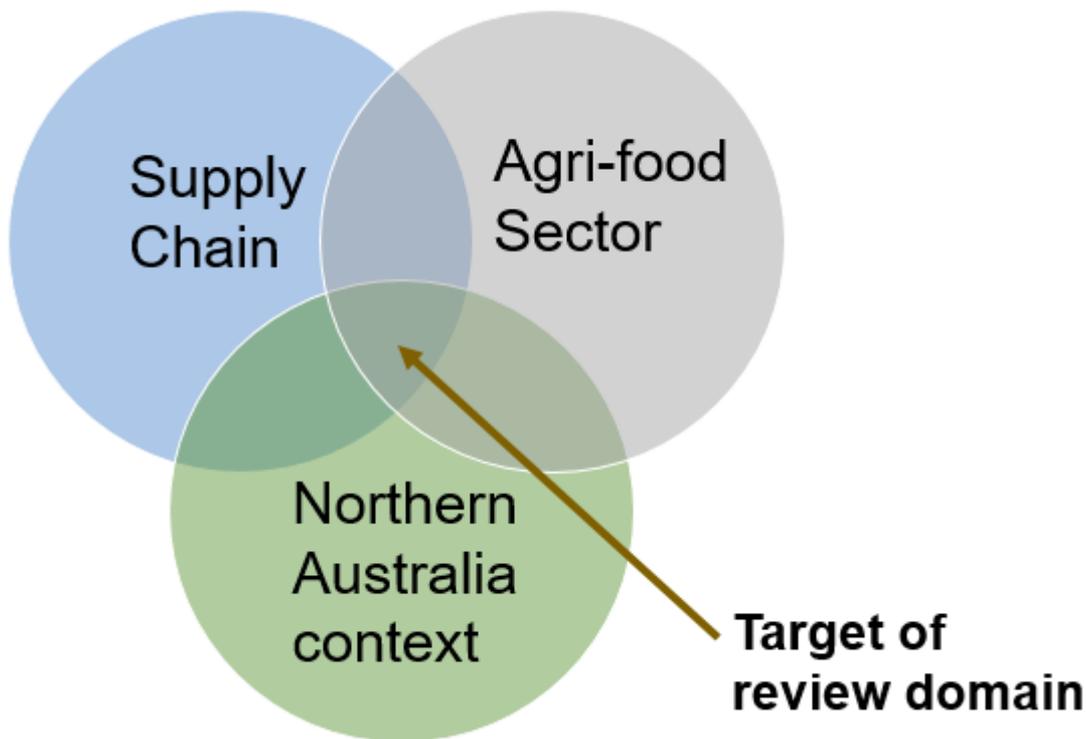


Figure 1: Scope of the review

Yet, much of the analytical work which has framed present-day efforts to develop the North originated from broader research and policy agendas is located outside the narrow core. They reflect the historical deliberations and standpoints of a variety of organisations which have encountered challenges or identified noteworthy differences associated with Northern Australia but did not necessarily approach it as a discrete policy agenda (i.e. organisations developing national strategies regarding Infrastructure, roads, ports development, freight, trucking, beef industry, agribusiness, horticulture, siloed interest groups etc.). But this has changed noticeably in the last decade with the Northern Australian agenda having increasingly been framed as distinct from mainstream supply chain and policy literatures.

Naturally, recent research funded by the CRCNA deliberately extends that recognition and some recent outputs from those efforts are used as raw evidence and analytical background for the next section. The fact that Northern Australia faces distinct social, economic, environmental and cultural challenges and barriers has been increasingly well documented in

recent policy documents. Freight and supply chain considerations have emerged as a major issue in a range of research publications (Chilcott et al., 2020; KPMG, 2020). Central to the White Paper on Developing Northern Australia (Australian Government, 2015) was the identification of fundamental gaps in industry-supporting infrastructure and major challenges in attracting investments in remote regions. That report notes in particular that much Northern Australia infrastructure has historically been provided by the private sector under user pays principles and complemented by governments supply where charging users is difficult. This has inhibited shared use (across industries and user types), as well as reduced incentives to invest in public assets because networking (or co-investing) was made difficult by lack of system cohesion, cross-sector and cross-jurisdictional Northern collaboration.

Inconsistencies in funding principles, priority settings, types of uses and users, and connectivity have resulted in barriers debated at length in policy documents describing Northern transportation challenges and road infrastructure gaps. Recent initiatives to fill those gaps in ways more consistent with industry needs include the Northern Australia Beef Roads Program backed by CSIRO modelling and scenarios using state, territory and local governments data combined with their Transport Network Strategic Investment Tool (TraNSIT) to assist in the prioritisation of projects (Higgins et al., 2015, 2017).

A key often observed challenge associated with agricultural supply chains using road transportation is the first and last mile dilemma which occurs when linking and accessing key freight and processing facilities. Significant proportions of Northern Australia's agricultural market are not serviced by any other freight option than roads. These limited road options are most often of inadequate quality and reliability, and a main source of uncertainty for the delivery of many key commodities commonly resulting in excessive freight costs, as well as related impacts in the form of road deterioration, and time delays getting products to market.

Digital connectivity is an issue for Australian agriculture in general as reported by Advancing Digital Agriculture in Australia (Nolet, 2018). Australia is judged to lag behind other countries (such as the US) with respect to the level of advancement in adopting IT applications and its limited automation maturity across all stages of production. The situation for Northern Australia appears particularly patchy because some technological applications have become promising for their capacity to deal with remoteness challenges, but their applicability remains limited due to poor connectivity. Yearly reporting of the Australian Digital Inclusion Index has confirmed that geography plays a strong role in digital inclusion, and that 'remoteness' presents significant negative challenges relevant to both Indigenous (one of the highly excluded cohorts) and to non-Indigenous Australians, in general owing to lesser access and affordability.

Infrastructure Australia is attempting to prioritise identified 'black spots' pertaining to both roads and mobile communications access through targeted programs. These refer sometimes to locations featuring high levels of uncertainty (statically associated with crashes for instance) and to telecommunication disruptions preventing businesses from being able to track freight movements which affect their ability to put in place measures to both increase safety and reliability of freight movements.

Despite incremental improvements in addressing infrastructure issues such as those noted above, a major difficulty lies with the current freight traffic flows dominated by ongoing transport movements linking producers (across the three Northern jurisdictions (QLD, NT and WA)) predominantly to southern markets and southern ports, which drive contemporary infrastructure investment (discussed in the next section). This is partially due to the deficiency in terrestrial freight and transport infrastructure across large parts of Northern Australia (noting that remote aerodromes and barge networks also play a role in freight and transport networks), but also importantly caused by the overwhelming obstacle that reversing such perverse logic presents. It is possible to speculate that a variety of policy influences, cross-jurisdictional inconsistencies or rivalries, and perceived benefits that individual states associate with channelling trade through their own southern hubs play an ongoing role.

An exception perhaps lies in the recognition that Northern Australia displays radically different industry features and challenges with respect to beef cattle production. Beef and cattle industry studies typically divide Northern from southern systems acknowledging the different markets, animal stocks, technologies, distribution logics, resources issues (land, water and soils) and politics between North and South (ACIL Allen, Northern Beef Infrastructure Audit, 2016). Yet, the next section will show that there are critical challenges ahead in this key sector of the Northern agribusiness economy.

Notwithstanding slow progress, the long-recognised distinctiveness of Northern Australia is increasingly incorporated in the decision frameworks of those in charge of funding and allocating key infrastructure (Infrastructure Australia, 2019). The stylized challenges below have been recognised to 'have acted as a handbrake on development and investment across many parts of Northern Australia', and call for new ways of framing priorities and supporting investment efforts:

- Exposure to more extreme weather and climate impacts, including high temperatures, high seasonal and variable rainfall in tropical regions, and events such as cyclones and floods;
- Higher costs of living and doing business, driven by remoteness, lack of scale and lack of historical investment in transport and essential services;
- Higher levels of risk and barriers to investment in some regions, particularly for those trying to establish or extend supply chains to new areas;
- A historical lack of coordination in planning and investment across jurisdictional boundaries, resulting in disconnected transport and energy networks and inefficient supply chains;



- Higher rates of mobility, as workforces follow projects rather than settle in communities; and
- Large variation in the quality of life and diversity of needs from infrastructure, particularly in remote parts of the country and among Aboriginal and Torres Strait Islander peoples.

In that spirit, Infrastructure Australia (2019) has reaffirmed the need for a distinctive approach to development, and made a call for more detailed and evidence-based studies embedded in Northern-local values and scenario-testing. The current project constitutes a step in that direction.



Barriers and opportunities across Northern agricultural commodity groups

Any approach aimed at identifying strategies that a region could pursue to reframe its institutions and achieve economic objectives needs to detect 'opportunities' (often through market analysis):

- Its resources and assets (such as infrastructure and industry or workforce capabilities);
- Surrounding competitive forces; and
- Its macro-economic environment (Porter 1985, 1990).

Subsequently identifying barriers affecting the region's capacity to exploit these opportunities becomes the basis to the formulation of a pathway to achieving desired developmental objectives. This is the approach adopted by the majority of sectoral and regional reports supported by the CRCNA that serve as raw materials for this section. Two general observations must be made:

1. The reports reviewed in this section contain both barriers and opportunities, and note the differences and similarities across regions and commodities. The ways to address barriers and challenges may present important commonalities across sectors and geographic locations. While the review just below proceeds by aggregating those 'barriers', they are clearly contingent on distinct visions of the future (across commodities), and subjective assessments by stakeholders and experts of the value and feasibility of any coveted opportunity. In some cases, significant future dilemmas and developmental pathways confront Northern Australia, and the review of barriers that must be addressed only makes sense in the context of those presented pathways;

2. Across all sectoral reports, supply chain aspects feature strongly, but the boundaries and representations of supply chains can differ. The emphasis in this section is on the following key elements:

- Freight networks and logistical connections between production stages;
- Infrastructure needs (transport, under-developed handling and processing facilities, etc.);
- Supply chains challenges linked to disruptions and limited connectivity;
- Transportation and multi-modal connections for inputs and outputs within regions; and
- Connections with chain aspects in importing markets or countries.

To reiterate, the identification of opportunities and barriers below stems from very recent CRCNA reports focused exclusively on Northern Australia agribusiness sector. Each sectoral report was produced by agribusiness experts, usually in collaboration with consultants and industry participants. Some background work was also undertaken by export markets and investment analysts, who have taken into consideration key social and economic trends as well as the potential for technological advancements to impact on the agri-business competitive advantage of the Northern regions considered.



Live cattle and beef products

The current and future (expected) relative importance of beef and live cattle exports for Northern Australia justifies its prominence in the review, which by necessity must pay some attention to the key structural challenges facing that sector. The opportunity of increasing 'protein demand' stemming from projected socio-demographic and economic transformations among Australia's immediate Northern neighbours (in ASEAN in particular and Asia in general) warrant the level of attention given to live cattle and beef products exports which are sometimes treated as competing propositions, other times as complements. In contemplating the diverse options and barriers to their expansion, as well as the implications for supply chains development, it makes sense to discuss both products, yet it is necessary to highlight how strategic expansion in one direction will affect the other.

The two CRCNA-funded reports most relevant to examine the Northern Australia beef sector do so from different but complementary perspectives. The Beef sector report (Chilcott et al. 2020) appraises the long-term future of the beef and cattle industries by examining production industry trends, technology, climate, water, supply chain efficiency, etc). In contrast, the ASEAN markets report (Austcham ASEAN, 2019) considers and assesses both short- and medium-term opportunities to extend current export activities to the ASEAN region, and the investments required to achieve those. The resulting priorities for industry and government actions and investments needed arising from those differing perspectives vary, although the central roles and consequence of supply chains limitations to be addressed (for both live cattle and beef products) are relatively congruent.

A key finding (consistent with the regional supply chain reports consulted) is that in the short/medium term, there is a significant opportunity to increase the volume of both live cattle and beef trade towards ASEAN nations, by far the largest opportunities for the immediate future in terms of potential trade value. That report (Austcham ASEAN) refers to accelerated export growth where "the products with highest untapped export potential and supply feasibility in Northern Australia are live cattle [highest] and beef, with a potential "upside" opportunity of A\$13 billion. ... The major country opportunities for live cattle and for beef in ASEAN are Vietnam (71%), followed by Indonesia (13%) and Malaysia (7%)". The short-to-medium term and long-term opportunities and barriers are discussed in turn.

Barriers to extending live cattle trade opportunity in the short-run

- According to (Austcham ASEAN, 2019), the live cattle sector presents the greatest 'upside opportunity'¹ for short-term agricultural export potential growth from Northern Australia into the ASEAN region;
- While valuable and within reach, the live cattle trade also presents noteworthy challenges and risks, some originating in Northern Australia and others abroad. In Australia, the report identifies technical trade requirements and standards, erratic custom processes and animal rights activism as presenting significant obstacles to expansion, while red tape occurring at both ends of export activities, protectionist policies of trading partners and corruption are expected to continue slowing potential growth;
- Live cattle trade in Northern Australia has traditionally been successful because of its ability to combine dispersed farming activities across the Northern Australia and transferring meat processing activities close to specific markets benefiting from cheap labour (and in some countries with specific cultural Halal requirements best performed and monitored close to customer locations). By design, live cattle trade makes a restricted contribution to regional economies because of its reduced value-added footprint;
- Redesigning supply chains to intensify trade volumes is made difficult by the fact that simultaneous and compatible investments are required at both ends of the live cattle supply chain, Australian producers can only partially influence downstream trade partners. Any efforts to redesign strategic supply chains to exploit the highest source of untapped export potential will require greater cross-country collaboration, and even cross-business infrastructure. In Northern Australia specifically, regulatory bottlenecks and lack of supporting trade infrastructure are claimed to constitute critical barriers, which would need to be addressed concurrently to supply chains remodelling and extension; and
- The above issues being recognised, live cattle exports from Northern Australia to ASEAN are already noteworthy and comparatively well-developed, although climate-related risks, animal welfare politics, and regulatory barriers pose

¹ 'Upside opportunity' is an incremental annual opportunity defined as the difference between the highest and lowest projected exports in 2025 in the growth scenarios, but does not constitute a specific export forecast or target and is a thought experiment to highlight potential growth in the near future.

undisputable challenges to this trade in the longer term. According to Austcham ASEAN, drivers of competitiveness in the live cattle exports sector are:

- o Production-related largely to scale-dependent (but constrained by climate-related risks and workforce limitations);
- o Supply-chain and infrastructure in Northern Australia (further discussed below);
- o Regulatory barriers and customs (stability and efficiency of tariffs and quotas, licences, price controls, technical restrictions, product certifications, etc.) that also constitute sources of scale economies; and
- o Market-related concerns and inadequate investments in promotion and brand recognition.

All four driver categories above are somewhat affected negatively by the limited scale of current exports and themselves limit the speed of intensification (the obvious incentive to expand trade). Producers must weigh the need to grow production and supply networks (to achieve more efficient scales) against the lack of consistency and integration along the value chain once live cattle exit Australian shores. Current Northern Australian exporters identify the excessive purchasing power of a few buyers overseas, the inadequate facilities abroad (which limits the sectors' control over product quality and reputation abroad), as well as sporadic attempts by Indonesian and Vietnamese governments to reduce their trade deficits as the main challenges preventing significant scaling up of live cattle production and exports which would allow them to increase their productivity.

Supply chain challenges for live cattle export in Northern Australia

- Darwin and Townsville are the current key live cattle ports, which benefit from dedicated infrastructure, vessels and equipment and other specialized facilities usually not sharable with other commodities. They constitute the central nodes connecting lengthy road and track interior networks to ASEAN port facilities, distribution infrastructure and markets;
- Most reports claim that the stock of road infrastructure in Northern is inadequate, even when considering jointly privately-owned tracks/roads and public roads. Those roads are often shared with many types of users and suffer from slow network expansion, rare upgrades and deficient maintenance deemed to constitute a key limitation on potential growth rates for the sector. Significant investment is currently taking place around upgrading transport infrastructure supporting cattle trade (i.e. A\$100 million Northern Australia Beef Roads Program to upgrade high priority roads) to improve its reliability, productivity, and the resilience of cattle supply chains;
- The report examining ASEAN opportunities (Austcham ASEAN, 2019) notes that foreign investments into Northern Australia by beef importers originating from ASEAN countries in assets supporting simultaneously is live cattle supply chain efficiency as well as beef intensification and could create contradictory inducements for and against live cattle exports growth;
- Similarly, efforts by Australian exporters (and government agencies) to support processing and distribution capabilities in key ASEAN markets aim to tackle animal mortality and mistreatment concerns across stages of the supply chain otherwise outside their control (abroad transport to feedlots, abattoirs, refrigerator car or 'reefers', etc.). It has been observed that foreign government influence or interventions sometimes pushes those supply chain initiatives where they seek to create economic activity, which can be away from the main urban centres where rapidly growing demand for the product is located; and
- The proper management of those markets also require that those activities be certified by Australia's Exporter Supply Chain Assurance System (ESCAS) and applied consistently in ways that can be monitored by export country authorities without creating undue red tape if logistical expansion occurs.

Barriers to extending the NA beef export opportunity in the short-run

- The report examining export prospect to ASEAN (Austcham ASEAN, 2019) identifies beef as the second largest export opportunity for Northern Australia through 2025, with Vietnam, Malaysia, Indonesia, Philippines, Thailand, Lao PDR, and Cambodia identified as key markets in which to extend this trade featuring Australian boxed beef, manufacturing beef, and offal;
- Both premium and mass market Australian beef products benefit from an advantageous competitive position in many ASEAN markets (where Australia ranks among the 1st-4th sources of imported beef sources – depending on the country). Yet, Northern Australia's share of those Australian exports is relatively small;



- In the low-value mass market segment, intense competition has emerged in the last decade, in particular from Indian buffalo meat which has gradually come to dominate Southeast Asian countries' beef imports (Indonesia being a notable exception);
- In the premium or high-value beef consumption segments (e.g. boxed loin cuts for high-end hotels, supermarkets, and restaurants, etc.), Australia retains a dominant position in ASEAN, but Northern Australia's share of that market is extremely slow, partly because the variety of cattle raised in the North is considered 'inferior' for the purpose of supplying those types of products;
- Competitive market analysis applied to Northern Australia suggests that upside opportunities to ASEAN markets apply to both the beef mass and premium markets but would require investments in scale. Beef intensification (to increase scale and reduce costs of low-value products in the medium-term) would be needed for the mass market to compete with Indian buffalo products, while entering the premium markets would require R&D investments to explore breed alterations be investigated, if it was found that some Northern regions met the right conditions and trials took place (which suggests that high-value beef product penetration from Northern Australia constitutes a long-run proposition);
- Irrespective of exact time scales in which such changes could be implemented in Northern Australia, it is clear that both propositions would have considerable implications for production methods. For cattle farming business models and ultimately would require substantial rethinking of cost-effective logistics and supply chains.
- In its SWOT analysis, the beef sector report (Chilcott et al., 2020) highlights the following interdependent challenges to sustain Northern Australia's beef products competitiveness in the medium- and long- term:
 - o Critical lack of abattoirs, feedlots, storage facilities and associated supply chain logistics allowing for increased production scale;
 - o Shortage of sophisticated skills and indispensable capabilities to adapt contemporary cattle management technology to Northern Australia's context and adhere to national standards (across many domains such as safety, hygiene, microbial assessment and monitoring, etc.);
 - o Similar concerns apply to developing homegrown R&D capabilities needed to support the development of breeds adapted to Northern Australia (including extreme weather events) and suitable for the cost-effective supply of premium beef products;
 - o In many Northern regions, the lack (or cost-ineffective prospects) of complementary agriculture to produce feed and support beef intensification constitutes a major disincentive to grow existing beef production operations and/or to invest in larger scale ventures.
- Furthermore, there are considerable trade barriers of a regulatory nature affecting beef exports towards ASEAN especially in markets where domestic producers pressure their governments for protection (including through tariffs on high-value commodities that also help those government curb their own trade deficits). These issues can affect considerably the profitability of targeting beef product exports and are partially being addressed through multilateral (and bilateral) discussions and agreements, as well as through Australian investments in affected ASEAN markets that shift industry incentives. Indirect barriers in the form of certification (including idiosyncratic Halal requirements for Australian beef products found in some key importing countries), extensive red tape or sometimes widespread corruption.

Supply chain challenges for Northern Australia beef exports

Beyond the uncertainty regarding the feasibility of producing beef products on a reasonable scale in Northern Australia, the supply chain infrastructure required is clearly under-developed and would require considerable rethink. The following elements are those most commonly identified in all reports:

- The lack of abattoirs which is a critical gap in the Northern production system;
- A lack of packing and freight facilities accessible to support an expansion of beef production;
- Insufficient expertise in Northern ports (Darwin, Cairns and Townsville) to manage increased trade volumes (in operational, administrative and logistical terms);
- To take advantage of the beef opportunity, road infrastructure would require major investments as larger freight volumes would be involved, given the quasi-exclusive reliance on road transport for both inputs (to cattle) and exports (to markets). This is the case currently (for live cattle) with the sector contribution in the order of approximately 5.3 million movements per year, with most movements (2.4 million) between properties and over 1 million to export depots. Many roads are inaccessible during the wet season and access remains restricted for some time after flooding has occurred which means that cattle properties attention and energy is directed towards anticipating difficulties with cattle road transfers



rather than new product development or improving marketing. To this day, transport costs remain a significant proportion of the price of live cattle and beef products;

- Most cattle properties are at a substantial distance from their major domestic market or export ports. They almost never transact directly with the final buyer of their product and are affected by the concentration of value chains beyond the farm gate which contribute to reduced returns given the market power held by buyer;
- The inefficiency and inadequacy of transport options and infrastructure in Northern Australia has a clear impact on access to inputs to improve productivity. It also limits diversification opportunities and impedes the ability to link cattle production with irrigated agriculture and develop the feed-on sector required for beef sector expansion (recognising that not all NA regions could do so cost-effectively even if transport was adequate). The Queensland government is already working towards the development of a Northern export hub; and
- Significant investments in supply chain infrastructure within targeted ASEAN markets would also be needed to support the expansion of beef product exports. The more critical requirements noted arise around port management, cold storage facilities and logistic, proper handling from ship to storage, transportation infrastructure abroad, professional conduct of quarantine services, protection and safety of distribution services in remote regions, etc.; without which heavy chilled or frozen beef product losses commonly result.

Barriers to transitioning Northern Australia from live cattle to beef production, logistics and exports in the long-term

The beef sector study (Chilcott et al., 2020) considers the many forces at play and argues that 'business as usual' cannot be sustained, and therefore must address the supply chain barriers limiting the expansion of Northern Australia beef exports into Asia, and particularly ASEAN countries where Australia already has established significant trade links. It is therefore valuable to contemplate the challenges of implementing such a far-reaching shift even in the long-term, and to understand the concurrent investments, technological conversions and logistical rethinking that would be required from both private and public sector stakeholders:

- Requisite investments in research, infrastructure and human capital is crucial in meeting the challenges, being innovative and resilient;
- Unless a large proportion of properties willing to convert to supply beef are spatially concentrated and close to key export routes or ports, the barriers arising from the inadequate condition of the Northern road transportation network would in all probability grow proportionally to the scale of production. Most likely the increased flow of cattle making their way to feedlots and abattoirs could be managed (and afforded) by upgraded transport system as efficient scale is reached in regions where intensification is possible. But this would likely leave more dispersed properties (and regions) considering beef production and exports unsure about their ability to transition to and connect with beef supply chains because of the freight cost challenges that would prevent them from joining in those export markets. Uncertainty about freight investments and road infrastructure support constitutes a major source of risk to attempt a Northern Australia-wide beef export-driven conversion, whose success depends largely on intensification and widespread access to effective logistical coordination;
- The beef sector review (Chilcott et al., 2020) states that proof of concept investments (in specific logistical chain pilots or business model prototypes) with subsequent scaling-up assessments that span all production and distribution stages (beef intensification, supply chain and market testing) are required, which could perhaps be funded by the NAIF. It is likely that the viability of large-scale conversion would differ considerably across Northern Australia's sub-regions. Given soil variability, unequal access to water and to animal feed, challenges in attracting and retaining a skilled workforce and varying travel times and distances to main ports, some regions would have greater difficulties contemplating such a transition (the viability probably decreasing as one moves from the more densely populated, serviced and diversified South-East towards its North-West areas of Northern Australia);
- The limited feasibility of abattoirs' expansion, of processing, packing and further handling is expected to remain a critical limitation to Northern Australia's long-term competitive prospects, in particular relative to low-labour cost foreign competitors, including ASEAN countries themselves who will pursue investments supporting their objectives of becoming protein self-sufficient; and
- Pre-export certification to supply according to Halal standards could be problematic for beef product exports when it conceals protectionist measures or political interference (especially if it differs across country-specific expectations). It must be noted that Australia's expertise in that domain has arguably been beneficial in the past and could have become a source of competitive advantage (as in live cattle exports management) but any large-scale conversion to beef in Northern Australia could create considerable administrative costs if competition for beef product exports from other countries to Indonesia or Malaysia intensifies and required technical services are lacking in the North.



In all, experts examining the beef sector in Northern Australia (Chicott et al. 2020) suggest that shifting away from live cattle into beef product markets is almost inevitable in the long-run, but also highly risky given the minor share of such products originating from Northern Australia at the moment, the implications for cattle herds in the North, the uneven feasibility of undertaking that transition, and the difficulties of testing new products and concepts when large numbers of adjustments along the supply chain need to be factored. It is unclear whether the sector can carry such a vision of the future where almost all supply chain stages would require to evolve; with new breeds, new facilities in Northern Australia (such as abattoirs, feedlots, packing, and freight handling equipment), new feed-on producers, new cool/cold/frozen freight and handling arrangements linking cost-effectively abattoirs to Northern Australia's ports, as well as new distribution networks into growing sustainable Asian markets. It is unclear how such a complex proposition involving so many highly inter-dependent transformations can be tested, unless collaboration leadership is developed and manages to coordinate the multiple investments required from both Northern Australia's private and public sectors.

But the fact that the sector has historically not been particularly proactive in tackling logistical issues in Northern Australia raises questions about the changes needed for a sustainable conversion. Beef sector experts observe that the combination of numerous and complex cattle movements (given climate events, seasonality, required inventory changes) combined with the long distances separating cattle properties from downstream (foreign or domestic) markets has created a problematic disconnect between inventory decisions that are shaped by local production conditions made well in advance of any actual market outcomes, which ultimately prevent strategic investments. Hence the sector suffers from 'limited market feedback' which produces poor responsiveness to changing external forces (economics, environmental, political, social) that will shape future competitiveness (Chilcott et al., 2020). Inefficient supply chains due to extremely slow improvements in road networks and insufficient handling capabilities in Northern Australia not only limit the options of producers, but also critically prevent the sector from adopting new technology, from testing new freight arrangements and 'result in long lead times to transform individual businesses and industry as a whole' (Chilcott et al., 2020:3).

Cross-cutting beef sector issues and implications for Northern Australia supply chains

- There is general agreement about the need to upscale and to value-add in Northern Australia: This has huge implications for future investments in infrastructure in the region if the sector is committed to undertake a comprehensive transition, and profitable pathways to markets are reliably identified;
- It is imperative to find a way to improve freight and related transport infrastructure, particularly roads, in ways that could accommodate the short-term intensification opportunity (Austcham ASEAN 2019, KPMG, 2019) and the long-term conversion scenario (Chilcott et al., 2020). This would entail:
 - o Supporting intensification in the short run so as to exploit the safest and highly valuable upside opportunities connected with ASEAN markets, with Indonesia and Vietnam identified as offering particularly profitable prospects;
 - o Helping the region's most likely candidates for scaling beef production (and achieve price competitiveness) as well as already equipped with abattoirs and other beef processing equipment to intensify and develop new markets, with a view to slowly scale up in countries appreciating North Australia's beef product exports; and
 - o Planning strategically for a sequence (based on regional readiness) of systematic industry conversions from live cattle towards intensive production and widespread beef product processing capabilities (with multi-use refrigerated facilities located nearby water access, feedlots and grain storage facilities, abattoirs, modern wastewater treatment, packing, shipping, handling and holding equipment and infrastructure). This would have to be done in ways that allow producers to test products, learn from consumers in foreign markets, and develop new technical certification standards when necessary, etc.
- All the equipment, services and technical capabilities required above need to be relatively close to regional centres with suitable amenities given the need for sustainable skilled workforces, at a time where the agribusiness sector is struggling to attract workers;
- The ASEAN market report (Austcham ASEAN, 2019) recommends the development of a supply chain diagnostic tool from "farm-to fork" to identify impediments in live cattle and beef trade from Northern Australia into ASEAN markets. This tool could measure time and cost at each stage of the supply chain and identify key impediments (e.g. missing infrastructure) to trade to address in specific sub-regions and incentivise investment towards select partners such as Indonesia, Vietnam, and Thailand, with the intention of complementing work on priority trade routes currently driven by the ASEAN Secretariat under the Masterplan for ASEAN Connectivity 2025 (ASEAN, 2016); and
- For much of Northern Australia, the supply of quality feed is likely to constitute the most significant hurdle for the development of sustainable intensive beef industry. The high costs of transporting grain and roughage are a critical barrier, unless local grain production can be increased in specific sub-regions. The proximity and linkages with a variety of crops production are likely to become important determinants of competitiveness. This highlights the possibility that inadequate road access will likely constitute one of the most potent constraints on the development of abattoirs and other key supply chains in regional areas across North Australia. All reports considering cattle and beef industry challenges note that rural roads are not developed to a standard suitable for the high volume of heavy vehicles required by a busy abattoir. The costs



associated with the upgrade of these roads may prohibit the realisation of transitional and differentiation aspirations unless sufficient investment is secured.



Aquaculture

While the overall value of that sector in Northern Australia is small relative to the beef industry, aquaculture has repeatedly been portrayed as a major longer-term opportunity for its export potential based on locational advantage, and the fact that some farming can take in a variety of locations, as long as distribution channels are accessible and water access is unproblematic. Indeed, there has been significant growth in the last decade for both onshore and offshore farming. Some of the key attributes and opportunities highlighted in the CRCNA report (Cobcroft et al., 2019) are:

- Key product-species at present are (by value) pearls (non-edible) 38%, prawns (38%), and barramundi (23%) with several other species (oysters, redclaw and other finfish) making up the remaining 1% of value. Specific emergent opportunities have been identified in sub-regions that could increase the level of diversification of that sector (i.e. on-shore tropical rock lobster farming);
- Northern Australia's aquaculture export potential is usually associated with perceptions and reputation of high-quality/high-value, as well as reliability of supply currently targeting demand in high income Asian markets. The sector is also experiencing growing demand domestically and in other parts of Asia, including countries that are both competitors and markets;
- With current levels of investment from existing businesses alone, the sector is set to at least double in the next decade, but new projects are also emerging that are driven by overseas demand and new businesses that have recognised existing opportunities to link Northern Australia's resources to Asian demand. The report, (Cobcroft et al., 2019) describes high levels of industry optimism that could lead "given the right incentive and conditions" to as much as a fivefold expansion by 2028 (greater than \$1v per annum);
- It has been observed that in many cases, new entrants (and new technology or species) might need to initially rely on domestic testing before piloting export growth strategies across selected overseas markets in the medium run. Establishing the distinctiveness and supply reliability of Australian produce is important (and a key investment in that industry) and can be difficult to ascertain for some species, unless strong collaboration with importers or high degrees of logistical integration can be engineered; and
- The major production cost, logistical and supply chain disadvantages associated with being in Northern Australia are described below. It is useful to note that because many Northern aquaculture farmers target different species, they do not necessarily compete directly with their southern counterparts and that North Australian aquaculture expansion might in fact be perceived as benefiting the entire national industry. The varying degree of substitution within and between specific seafood species at present implies that many producers might face more intensive price-based competition from South Asian aquaculture industries, which explains why quality, biosecurity measures and reputation are at the centre of the real opportunity.

Aquaculture broad challenges and logistical barriers

The barriers applicable particularly to Northern Australia highlighted in the report (Cobcroft et al.) are:

- From recent sectoral surveys conducted by the project, the top 5 perceived industry challenges (as reported from across all survey respondent categories) were:
 1. Power (costs, reliability, accessibility, optionality/competition);
 2. Liveability (of Northern Australia) – workforce attraction and retention;
 3. Environmental and regulatory risks (associated with environmental approvals, regulation and community perceptions of the industry), as well as biosecurity and red tape;
 4. Supply chain & infrastructure (examined further below); and
 5. Transport (costs, accessibility, optionality/competition).
- Combining with a review of literature, the three key thematic issues for the Northern Australia aquaculture sector identified are:
 - o R&D and breeding infrastructure: Broodstock/breeding/fingerlings/stock performance;
 - o Infrastructure and government support: supply chain/power/transport/market access/development; and
 - o Workforce: Liveability/labour recruitment/labour costs.
- Similarly, a 'threat analysis' pertaining specifically to Northern Australian aquaculture found 'top-of-mind' concerns within the industry:



- o Biosecurity (disease outbreak/introduction of exotic diseases);
- o Power costs and inadequate telecommunications;
- o Excessive regulatory processes hindering expansion (for breeding and exporting);
- o International competition (from South East Asia particularly); and
- o Consumers unable to correctly identify Australian produce (inadequate labelling measures).

Although not strictly freight-related, power costs reveal perceptions of insufficient or unreliable energy infrastructure in the North and apprehension of increasingly high cost imposition on energy-hungry producers (as most onshore aquaculture involves equipment required to circulate water and feed, move stocks, ensure oxygenation, and in Northern Australia involve extensive refrigeration or freezing in excessively hot climatic conditions). Current energy debates across Australia probably fuel those concerns, and it is apparent that many Northern aquaculture operations have invested in their own solar energy sources.

The last two elements in the list above relate to the 'threat of substitution' associated with ineffective product differentiation and limited domestic consumer knowledge, which leads them to purchase cheap substitutes due to insufficient or ineffective labelling. In terms of economic management for the broader sector, this could be interpreted as setting Northern industry (demanding more effectual place-based branding) against southern markets and fish import businesses (who profit from purchasing cheap alternatives from overseas).

Supply chain challenges for Northern Australia aquaculture

Recognizing the sizeable opportunities of this sector, the recent CRCNA report, (Cobcroft et al., 2019), identifies key supply chain challenges in Northern Australia arising from:

- The high land freight costs typical in Northern Australia which apply both to transporting final products and to bringing inputs to production locations. This is especially relevant if farms need to be deliberately distant from other concentrated human activities for biosecurity and product quality reasons, while breeding stocks, and factories need to be where the workforce can be attracted, and energy access is reliable;
- The critical dependence on effective cold chain logistics and reliable refrigerated/frozen commodities supply chains (for outward-moving final products) which is both limited (in terms of ports and facilities as discussed below) and overall very costly in Northern Australia – resulting in much production channelled south by road, irrespective of whether the final destination is domestic or export; and
- The limited number of port facilities with sufficient handling/storage/shipping facilities (for high-value products that need dependable refrigeration), monitoring traceability and reliability, with sufficient traffic and regular movements to support growth. Port facilities inadequacies exacerbate the dependency on long haul transportation, given the few choices that exist to link aquaculture locations to export markets. To circumvent time issues and the losses linked to time restraints, many aquaculture operations trial various air services, but usually face unworkable constraints and high costs.

Industry stakeholders also identified issues that can be product-specific:

- High maintenance and high cost requirements for transport by road and air (need for water tanks, ice facilities, aeration devices, drainage systems, etc.), including feed; and
- Connectivity of transport and communication systems and infrastructure highly problematic for transportation of fragile products.

Implications and recommendations for Aquaculture in Northern Australia

The top recommendations for expansion of the aquaculture industry in Northern Australia (as reported from sectoral consultations in were associated with:

1. Market expansion support abroad (e.g. access to new export markets, market volume, promoting 'brand Australia') concurrent with domestic recognition and labelling – given the higher costs and quality boasted by Australian products;
2. Additional and improved freight infrastructure and facilities – investment in new infrastructure and upgrades of a generic nature (e.g. roads, bridges, power, airports, telecommunications, ports, cold chain) with the intent on creating efficient and reliable 'logistical hubs' that would entice industry co-investments; and



3. Need for increased Government support towards joint exporting and production requirements (government policy and regulation around approvals, increased aquaculture site availability, bio-security protocols, country of origin labelling, research, development & extension in key areas disease management, automation, breeding and genetics, etc.) (Cobcroft et al., 2019).

Regional reports (KMPG, 2019, KPMG 2019a, Acil Allen 2019, KMPG 2020) that have identified aquaculture products in their priorities also comment on:

- Additional and improved infrastructure; commenting on the need for ‘investment in new infrastructure and upgrades (e.g. roads, bridges, power, airports, telecommunications, ports, cold chain) focussed on delivering efficient and reliable ‘hubs’ which industry can co-develop with’;
- The need to specifically establish supply chain plans that redirect traffic towards Northern markets and Northern distribution channels, and the “need to reduce inputs from the south of Australia and expand export opportunities directly from the North into Asian markets”;
- The need to establish imports and export hubs in Northern regions with customs and quarantine capabilities, as well as supply chain plans for responses to severe weather events; and
- The possibility of collaborating with other commodities, sectors or industries to investigate dedicated air freight services for high-value products towards priority destinations (i.e. Townsville airport services or connections to China).



Horticulture

The information below stems from a preliminary report (Supply chain intelligence – An overview for CRCNA Horticultural project (Hine & Cao, 2019) extracted from a not yet completed project funded by the CRCNA, as well as the ASEAN opportunity report (Auscham ASEAN, 2019). Supplementary and emerging horticulture developments that hold significant prospects in specific regions have also been extracted from the regional reports on supply chain strategies (KMPG, 2019, KPMG 2019a, Acil Allen 2019, KMPG 2020).

Notionally, horticulture presents appealing prospects in Northern Australia the nature of which parallel those from the aquaculture sector. The sector offers opportunities if it can take advantage of the combined conditions of [a] climatic differentiation capable of supporting crops different from those produced in Australia's southern regions, and [b] the abstract closeness to Northern markets. The following stylized facts about Northern Australia's horticulture are generally reported:

- From a competitive advantage viewpoint, worthy agri-food export opportunities to ASEAN include table grapes oranges, macadamia, avocados and soybeans, which the Auscham ASEAN (2019) claims constitute 'small bets' relative to live cattle and beef;
- The trade potential of those products depends largely on technology advancements with the potential to reduce trade infrastructure costs, such as organic food packaging and solar-powered cold storage techniques (of particular relevance for high-maintenance products such as avocado, and less so for macadamia);
- The products selected are currently highly feasible in some regions, but the viability of exports will increase if production productivity grows faster than that in competing regions or countries. Growth scenarios present typical sequences of production volume growth, followed by scale economies fuelling export competitiveness, eventually triggering further product differentiation options (i.e. processed guacamole for avocado); and
- Supply chain competitiveness in the North is problematic, although it is currently favourable for avocado (at current scale, but it could soon be strained if production and export levels increased significantly as Northern Australian facilities are limited). Furthermore, poor handling and management in importing countries can lead to substantial losses and must be carefully considered or integrated within logistical planning, and this has not yet been properly developed.

Barriers for horticulture in Northern Australia

- Currently, a very large proportions of Northern Australian horticultural production goes through Brisbane (for most Qld/NT mangoes, avocados and lychees) with Sydney and Perth with smaller shares;
- Specific commodity studies note that Australia ranks poorly in global comparisons of productivity of freight and logistics, that this sector suffers because of inefficient supply chains that require far more transport modes and carriers, involves further distance than is optimal, combined with disadvantageous turnaround times for produces that require careful handling and consistently cool conditions;
- In North Australia, horticulture suffers a similar fate to many other industries in this respect, because much production moves south, whether it is bound for domestic markets or for exports targeting Northern countries. For instance, very small proportions (<1%) of mango exports originating from the North leave Australia through Cairns or Darwin;
- The long supply chains for North Australia's horticultural products not only lead to increased logistics costs, but also result in more handling, which increase the risk of reduced fruit quality upon arrival at their international destination (to which further destination handling and freight must be added). This is problematic when the price of Australian horticultural product is generally already at the higher end;
- Interviewees commenting on Northern Australia horticultural supply chains identified cost, timelines, quality, efficiency and presentation either separately or in combination as main supply chain-related constraints for the sector;
- In a stakeholder consultation, about barriers the following categories had the highest frequencies:
 - 'Cold chain gaps and breakdown;
 - 'Disinfection treatment processes'; and
 - 'Local transport capacity, practice and delay' among other aspects.

These all point at inadequate supply chains, with respect to coordination, facilities and technical expertise, as well as freight networks.

The Queensland regions reporting on their distinct supply chain priorities (KMPG, 2019, KPMG 2019a, Acil Allen 2019, KMPG 2020) identify some consistent barriers related to transportation, handling and exporting, but also provide specific observations about their logistical challenges:

- Far North Queensland Industry trends for high-value products point at the competitive advantage arising from logistical traceability across phases of the supply chain. That region also reported extensive freight connectivity issues linked with roads (investments required for 'growers in black spot regions'), lack of centralised sorting, drying, processing and storing facilities and skills, vulnerability to transport damage and climate threats, and need for temperature control technologies that are energy-efficient. All these dimensions (applicable to fruits and vegetables) have the potential to determine regional competitiveness by influencing overall production scale and ability to control final-mature product quality;
- North Queensland stakeholders advocate a broad 'land use transition' towards horticultural production with an emphasis on avocado, macadamia and soybean productions, involving potentially rotation or in some instances the replacement of sugarcane production. They note that supply chain infrastructures (for those priority products) have been observed to be underdeveloped or inefficient, that collaboration with respect to temperature-controlled storage facilities, processing equipment and workforce linking into the Townsville port and airport, investments in cold chain logistics, shared biosecurity and customs services and general R&D developments would be critical for growing those sectors and reaching sustainable production scales. As much production is currently aimed at domestic markets, that region has identified a number of pilot proposals to develop export supply chains bypassing southern ports and distribution channels;
- The 'Mackay-Isaac-Whitsunday' region is also considering the delicate relationship between cane production and alternatives, including the possible transition of some areas to other viable horticultural products with positive market prospects, cost-effective supply chains and suiting diverse land-owning farmers with different access to good soil and water. While that region is on the surface more diverse with respect to agri-food activity than those further North, beef, broad acre cropping, and aquaculture remain dominant. The Whitsunday area is judged relatively more favourable for horticulture. While diversity can be a strength, the report notes that much production is not at scale, and that most products transit to Brisbane for redistribution domestically or for exports, which places Northern regions at a competitive disadvantage relative to southern producers, underuses existing infrastructure found in the Mackay region, and suggests untested opportunities towards Northern ports;
- Those regional supply chain reports show that alternatives to Brisbane port (from Gladstone to Cairns) have unequal capacity to deal with temperature-controlled containerised traffic (inexistent in Mackay) which is critical to scale up horticultural exports. These feature currently prohibitive costs and charges, and the levels of traffic is insufficient to capture some of Brisbane's market share; and
- The ASEAN market report recommends that a market research study for Australian macadamias in ASEAN be developed would provide a deeper understanding of logistics (major importers, retail partners, distribution networks, and the competitor landscape). This could well apply to a number of connected products that could benefit from cold chains.

Bulky agri-food products in Northern Australia: Broadacre cultivation, rice and forestry products

Some of the products considered under this heading are already produced in North Australia but generally in much smaller quantities than what is found in the rest of Australia. Some offer new opportunities (arising from new demands, changing product techniques or new diversification approaches) that have not yet been convincingly tested (but the CRCNA project (Hine and Cao, 2019) is conducting and reporting on a number of pilots). Bulky agri-food and forestry products usually raise different supply chain challenges due to their bulkiness, whereby the volumes considered cost-effective rule out some forms of freight and require specialized or dedicated port handling facilities (i.e. Tiwi Islands timber enterprises linking directly to Japanese and Chinese markets). In some instances, grain and cattle feed productions are closely connected to cattle farming for exportable beef products and can complement those by providing valuable inputs if competition for land and water is well managed.

The upcoming report on broadacre cropping sector will summarize the issues related to broadacre agricultural production north of the Tropic of Capricorn and undertake preliminary scoping work on:

- Issues around infrastructure, transport, storage, handling facilities, capacity and capability, markets, continuity of supply, indeed supply chain issues adversely impacted organisations' either willingness, confidence or capability to invest (Maclean et al, forthcoming);
- R&D closely tied to the development of profitable crops in the North – as there is currently limited knowledge about production dimensions and market facilitation and reaction towards distinct Northern varieties (the project involves trials/growth pilots of varieties in a number of locations, with facilities/equipment being tested for the tropics, involving significant testing of the relationship between water and soils against various crops growth measurements); and
- Incomplete knowledge regarding 'grain storage' in tropical contexts – part of logistics and closely associated with freight design concerns (requires R&D and testing of 'insect pests' resistance for instance; lessons from southern regions do not readily apply).



The upcoming report on the rice sector features similar concerns related to technological feasibility and infrastructure limitations (in particular storage and drying in high-humidity contexts) in Northern Australia.

The report on forestry opportunities (Stephens et al. 202) produced a roadmap of Northern Australia's emerging potential based on soil, land, human occupation, security of access and supply, and climatic conditions, and assessed the level of commerciality based on these aspects, as well as processing facilities and distribution to market access. The report that the main stakeholder feedback identified is that:

- 'Key opportunities are consistently constrained by logistical challenges and economies of scale that will be best overcome by an integrated and regional approach'; and
- Forestry potential would be best served around an 'integrated agribusiness development approach that creates a range of enterprises using common infrastructure', arising from clustering or joint investments in processing facilities.

An alternative approach (not yet fully tested but occurring in the Tiwi Islands) is to develop a dedicated infrastructure jointly for carefully chosen long-term investors and customers, and suiting the type of wood products targeted.

The regional supply chain reports (KMPG, 2019, KPMG 2019a, Acil Allen 2019, KMPG 2020) identify generic logistical barriers which certainly are relevant for bulk commodities freight and logistics, but more difficult to generalise without detailed understanding of the potential scales of operations:

- The Far North supply chains report recounts the infrastructure gaps encountered around storage (including for grains) and uncertainty about humidity and the treatment of pests. It also notes the difficulties surrounding road train access in the region and the poor state of roads in general (due to inadequate road design for heavy or regular freight traffic, narrowness in many instances, black spots and poor connectivity and extreme weather event hazards capable of causing road closures or even production interruptions) – all of which would affect seriously the viability of bulky agriculture commodities in that region. They also note uncertainty surrounding pests and diseases linked to storage and handling in that region:
- The North Queensland report does not discuss bulky product opportunities specifically; and
- The Mackay-Isaac-Whitsunday supply chains report discusses:
 - o Cane regional production characterized by relatively small-scale land allocation restricting potential for exports (depending on local conditions, but often involving older farmers occupying smaller blocks of land, insufficient attention given to succession planning, water allocations and land consolidation);
 - o New broad acre cropping possibilities to replace cane in some localities, with chickpeas, sorghum and ethanol being considered as warranting further research and pilots, but not yet established;
 - o Recent improvements in the road network of this region is noted as an under-exploited strength complementary to other logistics infrastructure found in the regions. The Mackay LGA is where sugar cane production is dominant and where underutilised infrastructure (related to grain storage and segregation capacity) as well as bulk grain export shipping facilities can be found. But it suffers from considerable seasonality which can threaten continuity of supply at scale. Stakeholders in that region raise the possibility of exporting some bulky products through containers as an alternative, and the fact that the Mackay port cannot currently handle containers.

Policy and freight governance issues impacting Northern Australia supply chains

Improving the economic efficiency of freight networks is repeatedly recommended as a necessary step to unlocking productivity gains in key economic sectors of the Australian economy and to enhance trade competitiveness, although priorities can be different across regions. While the key issues in Southern states are generally around congestion and the inability of infrastructure funding and expansion to keep up with population sprawl and land use restructures surrounding large metropolitan areas, the challenges in the North are markedly dissimilar with an intricate range of challenges. However, there is important rationale for uplifting the effectiveness of Australian supply chains in the North and ensuring that the North's challenges are equally prioritized, not only for the development of the North but also as a way to support economic development nationally.

The vast majority of policy statements around Northern Australian economic development place Northern freight performance as the key source of comparative disadvantage and identify under-performance in that domain relative to the rest of the country. Evaluations and research reports concerned with the agri-food business posit that addressing Northern Australia's freight gap is key to improving sectoral competitiveness as discussed in the previous section. A number of specific stylized features are claimed to undermine Northern Australia's freight systems' performance in ways ultimately detrimental to its rural economies. They are:

- Distances to destination (markets, intermediaries, processing facilities or key export infrastructure) are exceptionally large on average, while traffic on individual roads appearing insufficient to justify upkeeping or improving road networks;
- Dispersion of producers (i.e. cattle, horticulture or other types of farms) amplifies the distance issue by creating a burden on producers (or intermediaries) having to themselves invest in private and rarely adequate complementary infrastructures (i.e. roads on private lands). The scarcity of multi-modal freight transfer and storage facilities is in large part due to low road usage (at the individual road level) and the inability to aggregate traffic on key roads account for the lack of viable cost recovery mechanisms capable of sustaining those infrastructure networks;
- Although different in their management implications, seasonality and extreme weather events pose related yet dissimilar challenges for Northern agri-food businesses which affect the freight networks on which they depend. On the one hand, the predictable but somewhat severe Northern seasonal cycles affect both agricultural production and road conditions, leading to periods of intensive road uses alternating with periods of relative neglect, sometimes used to undertake maintenance or overhaul. In contrast, extreme weather events (particularly floods, fires and cyclones) are erratic and can unexpectedly prevent access to entire communities, can interfere directly and severely with agricultural production and obstruct entire regions' freight activities. Together both these regular-seasonal and intermittent events impose significant maintenance costs on road assets and can interrupt major business activities with a frequency and severity unparalleled in southern states. This not only creates discontinuities around vulnerable supply chains, but also results in costly and protracted road network restorations that ultimately slow down any attempts to attain efficient freight network scales. In the context of perishable products' distribution, the need to minimise handling, carefully control temperatures and prevent physical damage can encourage logistics chains to circumvent or establish themselves away from such levels of unpredictability;
- As infrastructure assets, roads undoubtedly dominate Northern Australian freight networks because of their flexibility, convenience and ability to connect distant and dispersed supply chain stages from producers to markets. But the dispersion of products coupled with disparate vehicle access conditions invariably create 'first' and/or 'last' mile bottlenecks (Northern Regional Development Australia Alliance, 2017), which contribute disproportionately to the overall cost of transporting produce in the North. These arise for instance when routes approved for high-capacity trucks (efficient on long distances and predictable corridors) are not fully integrated with local road networks, often because of local government road budget pressures. In Northern Australia, overwhelming reliance on unsealed roads further compounds the joint negative impacts of distance, dispersion and seasonality by weakening whole network reliability, by precipitating vehicle deterioration costs, and by undermining the safety of the transport workforce; and
- Significant efficiency and productivity challenges stem from the lack of consistency exhibited by rail and road freight systems across jurisdictions (mainly in terms of rail gauges and axle load limits). While such misalignment of physical standards (as well as regulations surrounding operating environments) is not strictly a Northern issue, its impact is more acute in the North due to the limited extent of the rail network, and the relative dependence on a few infrastructure assets (limited options). This has become particularly noticeable with current efforts to increase East-West collaboration within Northern Australia. The Northern RDA Alliance (2017) comments on the lack of rail options and intermodal facilities which constrains transport to occur by roads across an heterogeneous and inefficient system where the "compilation, weight distribution and other legal requirements for a vehicle carrying agricultural stock, commodities or freight, will often have to change several times across state and territory boundaries, across road zoning and into the last mile to access export or processing facilities" which "results in higher freight costs, more impact on roads and greater time delays getting products to market".

As alluded above, those stylized challenges exist elsewhere but are felt especially frequently and acutely in Northern Australia because they are superimposed and magnify each other within the freight system. This means that the perceived level of effort required to fix any discrete barrier is in reality compounded by the others. Unless decisive explicit actions are

taken to reduce the freight infrastructure gap between North and south, as a system, current methods to allocate public infrastructure funding could play against Northern Australia. Traditionally, new infrastructure investments have been in theory selected and funded on their 'merit' as discrete marginal projects (i.e. road extensions or improvement) related to alternative investments in high traffic contexts. Given the assortment of inter-related factors identified by regional authorities reviewed above, legitimate freight network improvements in the North should be treated as systemic investments undertaken with the explicit purpose to reframe region-wide supply chains, recognising the combined interests of the agribusiness and other key sectors.

Harmonization and/or Competitiveness

Frequent industry calls to rethink how road network investments in the past reinforced Northern Australia's connections with and perhaps dependency on Southern freight roads and equipment at the expense of improving Northbound trade and gateways (shipping and aviation) builds on the insights above, and the possibility that redirecting traffic could lead to more efficient freight solutions. A number of CRCNA reports (presented in the previous section) condemned their reliance on North-South freight flows (to Brisbane in the case of Queensland Northern sub-regions) at the expense of furthering the development of their own regional processing and port facilities. It is likely that the conventional infrastructure funding principles based on comparative and incremental valuations of discrete projects can only favour the reinforcement of ever-larger traffic flows towards key established Southern gateways undermining the development of Northern gateways.

Attempting to successfully overturn the North's dependency on Southern networks and facilities might entail deliberately attempting to disrupt through policy and planning some of these North-South road-based freight flows, which would in the short-term invariably suit some stakeholders and be opposed by others. Yet it might be possible to conceive of deliberate policy initiatives and directions to impact on the relative costs of substitute routes (or to modify positively some of their other key attributes such as reliability, flexibility, time, risks, etc.) in ways that compensate Northern industries for ongoing cost disadvantages and impact on the transport choices made by Northern (and perhaps even some southern) producers aiming grow their exports to the North. This would require different policy principles to guide investments around Northern infrastructure, as suggested by Madew (2019) as well as developing further scenario-based modelling to ascertain the intricate long-term implications of deliberately affecting the relative costs of using alternative freight routes on Northern Australia's agribusiness future.

The notion of a Northern Australia Freight Equalisation Scheme (Chain Consulting, 2019) has been proposed and rationalised by the remoteness of Northern Australia and the challenges it presents for accessing domestic and International markets which ultimately inhibit the development of key manufacturing industries and sustainable agricultural and aquaculture products. It could notionally emulate some elements of the Tasmanian Freight Equalisation Scheme (TFES)² and be conditionally applied across industries and destinations (with clearly-defined export sectors or products destined to domestic and/or international markets) to minimize or remove the additional costs of trade associated with Northern production and freight.

Political realism and process considerations must be appended to the interrogations and strategic questions raised above. Given that two of the Northern Australia jurisdictions incorporate large metropolitan areas with international gateways and facilities that themselves compete with other cities further south for traffic volumes and economic pre-eminence, both Brisbane and Perth realistically benefit from the volumes of freight (agribusiness and other) that are channelled through their trade gateways. It is therefore an added dimension that must be realistically considered if assessing the net freight productivity implications of attempting to reframe supply chains. A glance at the recent Queensland freight strategy (Department of Transport and Main Roads, 2020) reveals that it unsurprisingly aims to establish stronger integration of systems within that state and plans for greater alignment with its transport investment programs and priorities. It clearly positions supply chains as critical enablers needed to unlock economic opportunities, and shaped by the themes of smarter design, connectivity, resilience, safety, environmental considerations.

Likewise, the long awaited National Freight and Supply Chain Strategy (Transport and Infrastructure Council, 2019) which has involved extensive consultation across all levels of government within Australia highlights its drive towards reform as arising from the need to prepare for a countrywide freight boom, aiming to achieve the delivery of increased supply chain efficiency backed by performance data, better planning, regulation and coordination leading to smarter and targeted investments. Key influencers and basis for future investments is the intention to adapt to new vehicle types, advances in data integration and analysis, and to achieve greater level of freight networks amalgamation. The central themes of the strategy are therefore 'smarter' and 'more integrated' which are endorsed by the Australian Logistics Council mandate and communications role. The latter has recently established a working group for Northern Australia with a broad membership

² The Tasmanian Freight Equalisation Scheme (TFES) was created to provide Tasmanian industries with equal opportunities to compete in other markets in recognition that Tasmanian shippers do not have the option of transporting goods interstate by road or rail. The TFES provides financial assistance for cost incurred by shippers of eligible non-bulk goods moved by sea across the Bass Strait (Department of Infrastructure, Transport, Regional Development and Communication, 2020)



and strong industry representation, still in the process of developing its mission. Its early terms of reference appear to be around two-way communications between Northern Australian advocacy (to the Commonwealth and relevant states) as well as communicating the implications of major national reforms (such as the recent national strategy and NAIF priorities) to Northern stakeholders. The need for greater consistency of vehicle and transport laws between North and South (especially surrounding heavy vehicles and road trains) is believed to play a key role towards greater Northern productivity.

The implications for funding and principles for future allocations are progressively being worked out. In anticipation of these agendas and issues, the NRDA submission to the Inquiry into National Freight and Supply Chain Priorities, had also stressed the implications of new vehicles for the North and warned that unless significant policy changes are considered (ruling out rapid changes in traffic intensity), the Northern road sector could face funding shortages due to the comparatively weak links between usage and charging, which might result in increasing the freight efficiency gap. This appears unavoidable if the use of alternatively fuelled vehicles increases and prevents future reliance on the fuel excise (which has represented up to half of average annual road bill per vehicle in the North in the recent past) as the main mechanism to deal with road funding shortage issue (Northern Regional Development Australia Alliance, 2017). They noted that any reform in road user charging would need to consider carefully regional and remote disadvantages impacting the North.

It is clear that the impact of new technologies and innovations on freight network design will play a critical role in shaping future freight strategies for the North and determine whether its supply chains put it in a position to catch-up or increase its productivity gap. As a simple example, the implications of driverless vehicles for the North are unclear, given that on one hand they could be well suited for low traffic and monotonous conditions in some parts, yet would prove limited by the state of the road system itself, and the challenges linked with both unreliable connectivity, road conditions volatility and potential limited or costly maintenance services. While autonomous vehicles already are used in other sectors (on private roads in mining contexts), deploying them in the North on the current public road network could once again offer significant opportunities mitigated by high risks (given current state of the freight network challenges) and might or might not end up to be a source of competitive advantage for Northern agribusiness.



Conclusion: key supply chain challenges for discussion

Key themes and challenges can be identified from the review of the literature, particularly ones focused on research across sectors and Northern regions. Others arise because changes in policy environments indicate that significant political and investment decisions need urgent attention across Australia as a whole. It is critical for Northern regions to examine whether those Australia-wide choices will improve or further diminish the efficiency and/or sustainability of Northern agricultural supply chains. Other challenges and opportunities follow from new trends and insights whose impact on Northern Australia are highly uncertain yet require renewed reflection.

The key challenges for action on Northern Australia's supply chains identified are highly intertwined, and have been categorised around overarching themes:

1) The scaling-up challenge:

- a) Which transformational Northern infrastructure investments are needed to take advantage of significant short-term opportunities to scale up key agricultural sectors (i.e. cattle and beef exports to key ASEAN markets)?
- b) Which innovative infrastructure strategies and decisions could simultaneously assist the expansion of current trade opportunities and support diversification, including vertical processing and improved value-add identified as a necessary longer-term need for the Northern region (i.e. conversion from live cattle export dominance towards beef products)?
- c) Which infrastructure investments and freight improvements would support scaling up across sectors and product categories (horticulture and aquaculture in particular identified opportunities requiring major scale expansion)?

2) The inter-modal integration challenge:

- a) What strategic investments does Northern Australia need to make to facilitate the development container-based multi-product flexible chains? For instance how could cool/cold/frozen product chains be expanded to create scope economies (for instance by concurrently servicing the needs of the beef, horticulture and aquaculture growth opportunities identified)? To which extent could this produce more direct, reliable and affordable Northern routes to access ASEAN export markets?
- b) What strategic investments in ports and airports are required to allow for both scale and scope increases (containerisation, reefer vessels access, processing and transfer facilities, etc), who should take the lead in developing those, and what research is needed?
- c) What technological-connectivity investments are needed to significantly increase supply chains efficiency and reliability in the North?

3) The cost of freight, network design and cost-recovery challenges

- a) What investments are needed to both address the need to harmonize road/rail networks with the rest of Australia and to actively attempt to overturn current dependency on North-south freight corridors and southern gateways?
- b) What scope is there to subsidise freight costs until critical mass payloads can be secured, for instance through a Northern Australia 'Freight Equalisation Scheme' specifically targeting the cost of transporting and exporting sanctioned non-bulk agricultural making use of selected Northern gateways and supporting their short-term cost-recovery?
- c) What policies are required to address the cost and reliability disadvantages resulting from Northern infrastructure shortcomings?
- d) What transformation in supply chain governance and financing mechanisms would assist the financially responsible development of Northern supply chains (public-private partnerships, assisted Northern collaboration in research and scenario-testing, innovative supply chain finance models applicable at a regional scale, etc.) and create incentives for private producers to test new routes, new markets and experiment with new logistical combinations?

4) Cross-theme strategic challenges with high disruptive potential

- a) What investments are required in export country distribution and logistics chains to address uncertainty and gaps occurring in key commodity destinations, forestall political risks and expand into further markets (pre-conditions to the main opportunities in ASEAN)?
- b) Is greater collaboration in both research, in policy development and in industry-led vocational transport/logistics training feasible (in particular to connect with Indonesia, Vietnam, Thailand and other growing Asian markets)? What role should Northern Australia play in promoting and contributing in this possible training market?



- c) What is the likely impact of digital connectivity on supply chain governance and skills, on the ability to develop new products and test their distribution potential in new markets, on the development of alternative freight routes (for instance when unpredictable weather events occur), and ultimately on the relative competitive advantage of Northern supply chains?
- d) What are the likely impacts of automation on the combined agricultural, transport and logistics sectors and how would North Australia be affected relative to Australia's south? Is there a technological adoption gap in Northern Australia that would benefit from specific forms of support or investment?

These questions, which emerge from the literature are critical to ensuring the prosperity and development of Northern Australia. They entail complex questions which will require multi-stakeholder and cross jurisdictional collaboration. The future of smart agile supply chains in agricultural industries rely on addressing these fundamental issues.

References

- Acil Allen. (2020). Regional Agribusiness Supply Chains, Greater Whitsunday Alliance and CRCNA, Brisbane.
- Acil Allen. (2016). Northern Beef Infrastructure Audit, Department of Agriculture and Food, WA and Meet and Livestock Australia, Perth.
- ASEAN .(2016). Masterplan for ASEAN Connectivity 2025, Association of South East Asian Nations, Jakarta.
- Ash, A., Gleeson, T., Cui, H., Hall, M., Heyhoe, E., Higgins, A., Hopwood, G., MacLeod, N., Pains, D., Pant, H., Poulton, P., Prestwidge, D., Webster, T., & Wilson, P. (2014). Northern Australia: Food and Fibre Supply Chains Study Project Report, CSIRO & ABARES, Canberra.
- Ash, A. & Gleeson, T. (2014). Northern Australia: Food and Fibre Supply Chain Synthesis Study. CSIRO & ABARES, Canberra.
- Austcham ASEAN. (2019). Capturing the ASEAN Agricultural Opportunity for Northern Australia, AustCham ASEAN and CRCNA, Townsville.
- Australian Government. (2015). Our North, Our Future, White Paper on Developing Northern Australia, Australian Government, Canberra.
- Australian Logistics Council. (2017). Charting the Course for a National Freight and Supply Chain Strategy: An Industry Perspective, ALC Working Paper 2, Sydney.
- Australian Trade Commission/Australia Unlimited. (n.d.). Northern Australia: Emerging Opportunities in an Advanced Economy, Australian Government, Canberra.
- Centre for Supply Chain and Logistics. (2017). Scenario Planning to Inform Australia's National Inquiry into Freight and Supply Chain Priorities, Deakin University, Melbourne.
- Chain Consulting. (2019). Considerations for a Northern Australia Freight Equalisation Scheme, unpublished paper by Grant Williams.
- Chilcott, C., Ash, A., Lehnert, S., Stokes, G., Charmley E., Collins, K., Pavey, C., Macintosh, A., Simpson, A., Berglas, R., White, E. & Amity, M. (2020). Northern Australia Beef Situation Analysis: A Report to the CRCNA, unpublished report, CSIRO, Darwin.
- Cobcroft, J., Bell, R., Fitzgerald, J., Dietrich, A. and D. Jerry. (2019). Northern Australia Aquaculture Industry Situation Analysis, Project A.1.1718119. Stage 1 Report, CRCNA, Townsville.
- Deloitte Access Economics. (2019). The Impact of Freight Costs on Australian Farms, Agrifutures National Rural Issues, Publication No. 19-005, Wagga Wagga NSW.
- Department of Agriculture and Fisheries. (2018). Queensland Agriculture Snapshot 2018, Queensland Government, Brisbane.
- Department of Agriculture. (2014). Joint Select Committee on Northern Australia: Inquiry into the Development of Northern Australia, Submission from the Department of Agriculture, April 2014 (submission 238). Australia Government, Canberra.
- Department of Infrastructure Transport, Regional Development and Communication. (2020). Tasmanian Freight Equalisation Scheme, retrieved from <https://www.infrastructure.gov.au/maritime/tasmanian-transport-schemes/tasmanian/>
- Department of Infrastructure, Planning and Logistics. (2018). Discussion Paper. Territory-Wide Logistics Master Plan, Northern Territory Government, Darwin.
- Department of Infrastructure, Planning and Logistics. (2017). Submission from the Northern Territory Government to the Australian Government's Inquiry into National Freight and Supply Chain Priorities, August 2017, Northern Territory Government, Darwin.
- Department of Infrastructure, Regional Development and Cities. (2018). Inquiry into National Freight and Supply Chain Priorities, Report March 2018, Commonwealth of Australia, Canberra.
- Department of Infrastructure and Regional Development & PWC. (2017). Technology and Supply Chains for Critical Industries: Agriculture Sector, Working Paper 2 of 3, Sydney.
- Department of Industry, Innovation and Science/Office of Northern Australia (ONA). (2018). Developing Northern Australia: Implementation Report 2018, Commonwealth of Australia, Canberra.
- Department of Industry, Innovation and Science/Office of Northern Australia (ONA). (2017). Our North, Our Future: Developing Northern Australia 2017 Implementation Report, Commonwealth of Australia, Canberra.
- Department of Primary Industry and Fisheries. (2014). Submission from the Northern Territory Government to the Federal Government Agricultural Competitiveness Issues Paper, Agricultural Competitiveness White Paper Submission – IP414, submitted 17 April 2014., NT Government, Darwin.
- Department of Transport and Main Roads Western Australia. (2020). Revitalising Agricultural Region Freight Strategy – Responding to Change, Government of Western Australia, Perth.

- Department of Transport and Main Roads. (2019). Queensland Freight Strategy – Advance Freight in Queensland, Queensland Government, Brisbane.
- Freight and Logistics Council of Western Australia Inc. (2017). Submission to the Inquiry into National Freight and Supply Chain Priorities, Canberra.
- Gleeson, T., Agbenyegah, B., Deards, B., Leith, R., Mifsud, C., Mobsby, D. & Murray, C. (2014). Northern Australia Food and Fibre supply Chains – Commodity Market Analysis, Appendix 4.1 of the Northern Australia: Food and Fibre Supply Chain Study Project Report, CSIRO & ABARES, Canberra.
- Gray, E.M., Oss-Emer, M. & Davidson, A. (2013). Looking beyond the Farm Gate: Closer Vertical Coordination Along Value Chains as a Means of Improving Farm Performance, ABARES Science and Economic Insights Report, April. CC BY 3.0., Canberra.
- Henry, R. (2019). A Situational Analysis for Developing Rice Industry in Northern Australia, Interim Report, Report to CRCNA, Queensland Alliance for Agriculture and Food Innovation (QAAFI), the University of Queensland, Brisbane, Australia.
- Higgins, A.J., McFallan, S., McKeown, A., Bruce, C., Marinoni, O., Chilcott, C., Stone, P., Laredo, L., & Beaty, M. (2017). TraNSIT: Unlocking Options for Efficient Logistics Infrastructure in Australian Agriculture, CSIRO, Canberra.
- Higgins, A., McFallan, S., Laredo, L., Prestwide, D., & Stone, P. (2015). TRANSIT- A Model for Simulating Infrastructure and Policy Interventions in Agriculture Logistics: Application to the Northern Australian Beef Industry, Computers and Electronics in Agriculture, Vol. 114: 32–42.
- Hine, D. and Cao, S. (2019). Horticulture Supply Chain Intelligence – An overview for CRCNA Horticultural Project, CRCNA, Townsville.
- iMove. (2019). Freight Data Requirements Study. A Research Report for the Department of Infrastructure, Regional Development and Cities, Port Melbourne.
- Infrastructure Australia.(2019). Infrastructure Priority List – Project and Initiative Summaries, Canberra.
- Infrastructure Australia. (2019). Northern Australia Audit, Infrastructure for a Developing North, Australian Government, Canberra.
- Lane, J. (2015). Economic Analysis of Irrigated Agriculture Development Options for the Pilbara, Report from GHD for Department of Agriculture and Food, WA Government, Perth.
- KPMG. (2020). Export 2030: Delivering Fresh Food Fast- The Opportunity to Double High Value, Food Exports from Far North Queensland, Advance Cairns and CRCNA, Townsville.
- KPMG. (2019). North Queensland Agricultural Supply Chain Study, Townsville Enterprises, and CRCNA, Townsville.
- MacLean, B., Thomas, S. and Narustrang, M. (forthcoming). A Situational Analysis for the Northern Australian Broadacre Farming Sector, Report to CRCNA, Townsville, Australia.
- Madew, R. (2019). Opening address by the CEO of Infrastructure Australia, at the 5th annual Developing Northern Australia Conference in Karratha, Western Australia on 11 July 2019.
- Nolet S. (2018). Seeds of Success: Advancing Digital Agriculture From Point Solutions to Platforms, The United States Studies Centre, University of Sydney, Sydney.
- Northern Regional Development Australia Alliance. (NRDAA 2017.) Submission to the Inquiry into National Freight and Supply Chain Priorities, Submitted 11th August 2017.
- Porter, M.E. (1990). The Competitive Advantage of Nations, Free Press, New York.
- Porter, M.E. (1985). Competitive Advantage, Free Press, New York.
- Rama, I. & Harvey, S. (2009). Market Failure and the Role of Government in the Food Supply Chain: An Economic Framework, Economics and Policy Research Branch Working Paper, Victorian Department of Primary Industries, Melbourne.
- Stank, T., Autry, C., Daugherty, P. & Closs, D. (2015). Reimagining the 10 Megatrends That Will Revolutionize Supply Chain Logistics, Transportation Journal, 54(1):7-32
- Spencer, S & Kneebone, M. (2007). FoodMap: A Comparative Analysis of Australian Food Distribution Channels, Australian Government Department of Agriculture, Fisheries and Forestry, Canberra.
- Stephens, M., Woods, T., Brandt C., Bristow, M. & Annandale, M. (2020). Northern Forestry and Forest Products Industry Situational Analysis, Timber Queensland, NT Department of Primary Industry and Resources and CRNA, Townsville.
- Transport and Infrastructure Council. (2019). National Freight and Supply Chain Strategy, Commonwealth of Australia, Canberra.
- Transport and Infrastructure Council. (2019). National Freight and Supply Chain Strategy: National Action Plan, Commonwealth of Australia, Canberra.



Transport and Infrastructure Council. (2016). National Policy Framework for Land Transport Technology. Action Plan: 2020-2023, Commonwealth of Australia, Canberra.