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Optimising Capital Investment and Operations for the Livestock Industry in Northern Australia

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Abstract

Despite the northern beef industry's longevity, scale and importance, recent disruptions to external markets have demonstrated a degree of industry vulnerability to supply chain shocks. Matching the industry's long-evident resilience to climatic variability with resilience to changes in markets and supply chains will require careful planning and investment in logistics. This paper provides an outline of a new project, funded by a collective of northern Australian Governments, to provide the northern beef industry and related stakeholders (e.g. state and federal governments) with tactical and operational dynamic models of industry logistics along the supply chain from farm gate through to export port. A valuable novelty of the model is the high granularity of individual vehicle movements and the ability to scale up to a holistic view of logistics costs across the entire northern industry. This enables an iterative examination of how changes in logistics infrastructure could result in improved efficiency and increased productivity that, in turn, suggest further possible changes in infrastructure investment and operations under different market scenarios. This project is one of a suite of projects that support beef and allied industry development across northern Australia.

Key Words: transport, infrastructure, optimisation, northern Australia, beef

1 Introduction

Investment to support enhanced beef industry logistics and profitability needs to be informed by a range of possible future scenarios for industry scale, structure and markets. In general the northern beef industry's on-shore supply chains have long transport distances almost exclusively reliant on road for both inputs and outputs, with most cattle properties a substantial distance from the major domestic markets or export ports. Investment to support the resilience of the northern beef industry must anticipate and capitalise on future challenges and opportunities, while forecasting where the variety of processing facilities (such as abattoirs, rendering, and meat packers) will be located, and future market conditions. Understanding what those scenarios may mean for herd and industry growth and structure and, hence, supply chain flows and stressors, will be critical to optimising investment in and operation of the industry's transport and processing infrastructure. Any consideration of new markets or processing opportunities (e.g. Strategic Design and Development, 2010; Meateng, 2012) by investors and by government should proceed in concert with an examination of logistical and supply chain considerations.

This project will provide the northern beef industry and related stakeholders (e.g. state and federal governments) with a range of clearly defined industry growth and diversification pathways, and methods for exploiting them efficiently and effectively, based on the identification of whole of industry supply chains that minimise cost and increase long-term profitability. It will achieve this by identifying the scale, type, and capital and operating costs of infrastructure (e.g. roads, bridges, yards, feedlots, abattoirs, cold stores, export facilities) along with policies (e.g. driver fatigue, animal welfare and heavy vehicle regulations) that best exploit and support a range of industry structures. It will provide a clear view of the ongoing costs associated with supply chains that maximise long-term productivity, and where future investments are required to support growth, changes in productivity and markets.

The project will provide a comprehensive view of the inter-relatedness of the industry across northern Australia, based on the aggregation of specific supply paths that vary regionally with factors such as potential productivity, herd structure, distance to market and market type. Consequently, the project will provide information that is relevant to the needs of individual businesses, as well as those seeking to support sustainable growth at a higher scale (e.g. state or all northern Australia). By this means, the project will support decision making by enterprises as well as regional and public-good investors. The project will materially inform and support the growth of the industry's productivity and resilience.

Importantly, the project will be based on the development of a dynamic model of industry productivity, structure and supply chain. This will enable the iterative examination of how changes in infrastructure could catalyse changes in productivity that, in turn, suggest further possible changes in infrastructure investment and operations under different market scenarios. A lasting legacy of the project will be a tool to assess the effectiveness of investment decisions in infrastructure and to support businesses to optimise their freight tasks.

In this paper we outline the methodology that is being developed for the project, particularly the approach to developing tactical and operational models. Whilst the project is in its early stages and no results are available, we highlight key questions and scenarios formulated by the stakeholder working groups that will be addressed using the modelling tools.

2. Methodology

There have been limited projects in Australia aimed at modelling food freight logistics in a holistic sense. A State of Logistics study was carried out by CSIRO in 2006/2007 (Higgins et al. 2011) which aimed to *"Develop and test a methodology that estimates the costs of logistics in Australian food industries, and to apply this methodology to better understand the structure, drivers and challenges of these logistics."* Due to data availability, the analysis was limited to small regional case studies. In a later project, Marquez et al. (2012) developed a freight flow model for all fruit and vegetables movements within and in and out of Victoria. It was used to evaluate the costs of transport logistics under various scenarios of extreme weather events. There are several technical challenges to developing a logistics model for a large multi-enterprise industry such as the northern livestock industry. They typically require large volumes of data from multiple sources, which often have commercial in confidence or license restrictions. Key requirements include the following:

- Location of each cattle property, number of cattle, and turn-off scenarios;
- Location and scale of downstream supply chain enterprises (sale yards, feedlots, holding yards, abattoirs, etc) and existing supply chain pathways between properties and market;
- Livestock carriers and costing models;
- Road and rail network and uncertainty of access in the wet due to flooding.

These data need to be applied in a way that does not limit future model use by federal and state government industry stakeholders beyond the life of the project. A further technical challenge was to develop a model that accommodates the range of issues and questions raised by the stakeholders, which are diverse in terms of investment size, geographical location and operational approaches. As a result, an integrated analysis capability linking two models was developed. The "tactical" model focuses on the number of head of cattle (or vehicle trips) across each supply chain path per month. It is a higher level model to understand long term or annual consequences of large infrastructure investments to different enterprise owners. It is being written in a transparent proprietary platform such as MS Access, with an interface in ArcGIS or Google Earth, to create a holistic decision support capability. It will allow the flexibility of easily updating inputs on property boundaries, livestock numbers and supply chain parameters (e.g. paths, costs). In terms of scale, the model will enable consideration of all supply chain pathways from the farm gate through to ports and domestic wholesale. It will be constructed using a method with similarities to the database developed for all fruit and vegetable chains in Victoria (Marquez et al. 2012). Additional methods in mathematical optimisation will link with this model identifying locations for new infrastructure and upgrades, as well as optimising freight movements to maximise vehicle utilisation (e.g. backhauling opportunities).

The "operational" model will be a real-time simulation tool of movements of individual transport vehicles (truck and trains) between elements of the supply chain, particularly between holding yards, abattoirs, ports and rail/road interfaces. It will accommodate design features of individual ports and holding yards, vehicle and yard capacities, loading/unloading times, queue times, and other site specific site management issues. This "operational" model will provide a capability to analyse smaller scale investments that improve operational efficiency, and help maximise operational efficiencies of existing and new infrastructure investments. Instead of a single model for all northern Australia, separate models will be developed for port catchments. These types of models are commonly used in mining applications, particularly for mine to port logistics, but have hitherto been unavailable for livestock movements. The "operational" model will be written in a transparent animated language such as AnyLogic, where a "licence free" end-user version can be provided to stakeholders.

A diagram of the methodology is contained in Figure 1, which shows linkages between model components.

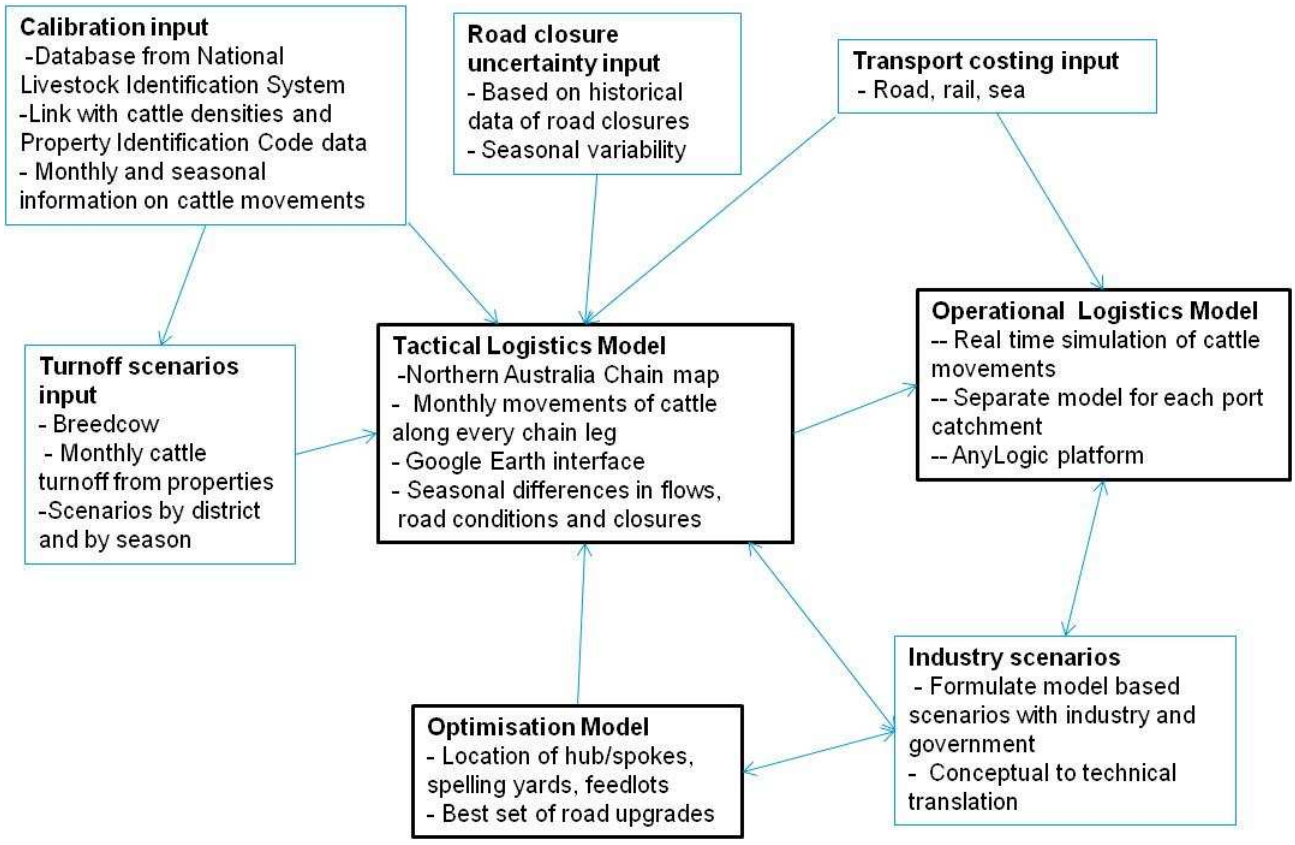

Figure 1. Process map of the livestock logistics project showing relationship between inputs and main model components (bold).

3 Scenario Analysis

Workshops were held in Brisbane (April 2012) and Darwin (July 2012) for industry stakeholders to collectively identify initial priority questions for the model to address. These workshops comprised representatives from state government departments as well as property, feedlot and abattoir enterprises. The remainder of this section outlines key scenarios to be analysed. While many seem closely related they collectively offer the chance to refine the model outputs for different end-users, while ensuring the input data and model optimisation provide meaningful output. As part of the data collection and stakeholder meetings, the baseline situation will be described. This will profile various zonal/regional supply chain characteristics and outline their current constraints, pinch points and opportunities of the various parts of the supply chain. This will form the basis of the scenario analysis, which will assess the following categories.

New Beef Development

A new abattoir being proposed by the Australian Agriculutral Company (http://www.aaco.com.au/media/63874/nt_processing_facility_update_20120530121841859.pdf) at Darwin will have several implications for existing supply chains. It would alter supply chain paths, particularly those moving east and off-loading in Cloncurry, and then backload with export cattle. There are opportunities to optimise transport schedules to maximise backloading. There will be a requirement for forage or hay close to the abattoir, to hold stock and potentially to finish them. This will create opportunities for mosaic irrigation or feedlots, possibly in the Ord Irrigation Area if production economics allow. As throughput is increased, this may have implications for supply to other abattoirs which can be holistically evaluated. Supply during the wet season will be a challenge and long term feedlots (e.g. Tipperary Station) will need to be utilised for bulking up and stockpiling of cattle for processing when transport is restricted.

Several other initiatives are currently exploring the potential for the northern beef industry to produce forage using small scale, or mosaic, irrigation. Reliable supply of well-priced hay or silage could make a substantial difference to beef supply chain logistics. These feedstocks could be used to build up cattle in yards close to export ports or for new abattoirs, or could be used to fundamentally alter beef enterprises by enabling them to turn off different classes of cattle or at finished liveweights.

Investing in New Transport Infrastructure

Current issues with roads include: inaccessibility due to low grade or wet season and the need for long detours; restrictions for Type 1 (overall vehicle length of 36.5m or less) and Type 2 road trains (>36.5m and <53.5m in length), which is particularly the case in Queensland. This can cause a 300 km diversion to places such as Clermont. There are also issues associated with curfews and available spelling yards.

Several road links in NT were identified as having the potential, via upgrade, to significantly reduce transport cost and increase in accessibility. These include movement of cattle into Queensland through the Plenty and Sandover Highways, and when these are closed due to flooding, through the Barkly Highway. The Tanami and Warburton Roads also require major detours (and increased costs) or isolate significant areas of beef production chains when flooded.

Road suitability for large vehicles is a problem in some areas. For example, Tipperary Station could be used as a major staging property. However the old highway provides the only access, which is a significantly longer travel distance than the direct route. This road also links into the Douglas Daly area where hay or forage production may be important.

Investment in infrastructure to allow better utilisation of multi-modal transport would provide significant benefit. This might include hubs and depots, and an analysis can be conducted to assess where they be best located to minimise handling costs and optimise animal welfare and driver fatigue outcomes.

Optimising Existing Transport Infrastructure and Utilisation

These scenarios particularly involve innovative utilisation of existing infrastructure modes and improved transport scheduling. In Queensland and the NT, there are opportunities to increase rail utilisation, where available. There is a trade-off in cost per km, double handling of cattle, delays, animal welfare and availability of trains, all of which can be holistically considered in the modelling. To utilise the Adelaide to Darwin rail in NT, there would be the need for provision of facilities for loading cattle in suitable locations, and a depot at Katherine

could be an option. To reduce double handling, cattle trains could go direct to wharf, rather than off load at the cattle yards. Also, a railway siding at Livingstone may be worth considering as a loading option.

Coastal shipping is a potential alternative to long distance road transport, to move cattle from the north to the various abattoirs. Analysis will consider the trade-off in costs and other benefits such as animal welfare and weight.

Through tactical transport and turnoff planning, there are opportunities to reduce the seasonal variability or other (e.g. Easter) pulses of supply to abattoirs and increase backhauling.

Regulatory Impacts

There is a need to map out the impact of current fatigue management rules (http://www.ntc.gov.au/filemedia/Reports/2HVDFRemAreLiveTranOpPolDevJul06.pdf) on transport and freight tasks, especially around the quality of rest rules that could come into place from the National Heavy Vehicle Regulator. The model can also map out options to better accommodate livestock that are adversely affected from long travel distances, or are at risk due to wet weather. Road upgrades will reduce travel time and risk, thus making it possible to make additional trips within fatigue and animal welfare guidelines. This will require determining optimum location of rest areas for vehicles and spelling yards. There is also the opportunity to optimally co-ordinate driver rest with animal welfare, given uncertainty of travel times.

In many Queensland locations, there is the need to break road-trains down to get to an abattoir through urban areas, which is an amenity cost. The model can be used to evaluate the cost to the beef industry versus alternatives (e.g. new bridge, change in curfew for Type 1 and 2 access, better breakdown facilities). That is, what acceptable changes to the High Mass Limit might make a big difference to the supply chain?

Minor changes to the administration of the tick-line (e.g. allowing movement through the tick line direct to slaughter or feedlots) may interact with road-train regulations (or vehicle load limits). The models enable exploration of options to not only lower costs to graziers but also potentially enable threshold issues to be addressed.

Fundamental Supply Chain Questions

In current live export planning, there is a short time frame between export permits and ship arrival. Import quota dictates supply of live cattle by shipment. This makes it hard to plan sources of correct weight cattle for a reliable supply to the port, particularly when affected by weather conditions. Unreliability of ship schedules a week ahead increases the difficulty of planning supply, particularly with different ship sizes. More lead time will allow planning to better take into account climate conditions. This challenge further complicated with Ramadan moving forward by about 11 days each year, which is currently putting greater pressure for supplying live cattle near the wet season. Darwin port operates within capacity as long as the shipping schedules align. Current policy is to not allow cattle to stand-by at the port. There is the ability to access Wyndham port as an alternative to cattle transport, though dredging would need to occur to allow bigger ships. Whilst it is currently expensive to load out of Wyndham, this project may reveal a whole of supply chain trade-off.

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