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Technology and Supply Chains for Critical Industries

Agriculture sector (Working paper 2 of 3)

Department of Infrastructure and Regional Development

Agriculture sector

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Executive summary

PricewaterhouseCoopers Consulting (Australia) Pty Limited and Ranbury Pty Ltd (Ranbury) have analysed the agriculture sector supply chain on behalf of the Department of Infrastructure and Regional Development (the Department) as part of the Inquiry into National Freight and Supply Chain Priorities (the Inquiry). This report analyses three key commodities in the agriculture sector – grain, cotton and livestock.

The study analyses at a high level:

- the infrastructure underpinning the typical supply chains for each industry;
- supply chain costs;
- user needs and bottlenecks impacting the supply chain; and
- technology, innovation and changing business practices impacting supply chains in the future, particularly in relation to infrastructure, service requirements and cost.

The agriculture sector

Grain

Australia's, grain and oil seed industry, with average production of 45 million metric tonnes (MMT) each year. Western Australia and NSW are responsible for the bulk of production; roughly 25 MMT. Grain is farmed by local, family run operations and is mostly exported overseas to countries such as China, Indonesia and Japan.

Cotton

Australia produced 626.2 kilotonnes of cotton lint and 885.5 kilotonnes of cottonseed, which can be processed into oils and meal, in 2016. There are around 1,250 cotton farms in Australia, with approximately 60 per cent of production occurring in the inland regions of New South Wales and 40 per cent in southern Queensland. Although Australia produces only 3 per cent of the world's cotton, Australia is the fourth largest exporter of cotton, behind China, India and the United States.

Livestock

Australia produced 3.6 million cattle and sheep as livestock in 2015. Almost 68 per cent of the 115,000 farms in Australia are involved in livestock production, with beef cattle farms the most common followed by chicken, sheep and goat farms. Sheep production tends to occur in the southern states, beef production occurs in every state and territory, and the more intensive livestock industries such as pork, dairy and poultry are concentrated in regions that are either proximate to major metropolitan areas or the coastline.

Supply Chains

Agriculture is predominantly a bulk freight task. The supply chain includes intermediate links ie. storage sites or intermediate processing. The distributed nature of farms nationwide means that road transportation is heavily relied on. Rail is relied on where possible as it is more cost efficient than road, however, the use of rail is challenged by the fragmented nature of production. Most of the agriculture supply chains are export-oriented, ie farm to port to ship.

Supply chain costs

Supply chain costs are driven by mode, the standard of infrastructure used and the crop/commodity being transported. It is difficult to compare the supply chain costs for each commodity due to the differences in measurement. For example, the cost per kilometre for transporting livestock on rail is measured in dollar per kilometre per deck, whereas the equivalent cost for grain is measured in dollars per tonne per kilometre. Publically available information on supply chain costs is generally limited due to their commercially sensitive nature.

Supply chain user needs and bottlenecks

Current supply chains have evolved in response to the specific issues driven by the user needs of participants and stakeholders in each agriculture sector. User needs for the various agricultural supply chains can be categorised into the following four categories:

- cost - the additional complexity of Australia's export supply chain results in transport costs being a larger component of total cost of production in the agriculture sector than it is for many international competitors. Therefore supply chain efficiency in the agricultural supply chain – and particularly cost minimisation – is a critical element of the overall global competiveness for Australia's agricultural sector;
- reliability - reliability is an important consideration for users and is driven by a need:
  - to achieve the required paddock to customer timelines to take advantage of key marketing windows;
  - to ensure that additional storage costs and penalties are not incurred through missing shipping or port windows;
  - for supply chains to respond to the variability of production volumes – particularly during peak demand periods and bumper yield seasons; and
  - to provide adequate service frequencies and minimising unscheduled service disruption and associated recovery time
- capacity - All users seek network capacity that is fit for the freight task undertaken in the individual supply chain; and
- control - cost competiveness, responsiveness and flexibility can be achieved though supply chain control.

There are three key types of bottlenecks that occur in agricultural sector supply chains. These are:

- capacity – this includes inadequate road network standards, road network congestion, lack of rail network coverage, variable network quality, the need to share sections of the rail network with other users and limited above rail competition.
- regulatory - the efficiency of these supply chains is impacted by road network management, performance based standards systems which permit the deployment of high productivity vehicles and a the approach to regulation of rail assets.
- approvals – a lack of regional oversight in the approvals process could result in excessive infrastructure investment which results in low volumes to the point that some or all investments become unviable.

The impact of technology on the supply chain

In response to supply chain efficiency bottlenecks, agriculture companies have continued to focus on improving productivity and reducing costs through the use of new technologies. New technologies, which have been implemented or are currently being considered within the agriculture sector globally, include:

- technology that can track and trace agricultural products along the supply chain;

- robotics for the automation of the supply chain; and
- data driven software and devices designed to optimise the movement of agricultural cargo.

Contents

1 Introduction

PricewaterhouseCoopers Consulting (Australia) Pty Limited and Ranbury Pty Ltd (Ranbury) have analysed the agricultural sector supply chain on behalf of the Department of Infrastructure and Regional Development (the Department) as part of the Inquiry into National Freight and Supply Chain Priorities (the Inquiry). This work is intended to assist the Inquiry in informing the forthcoming National Freight and Supply Chain Strategy to ensure:

- the cost of freighting Australia's agricultural and resource commodities and general freight to destination markets does not undermine the global competiveness of these industry sectors; and
- the cost of freighting imported goods domestically does not result in increased costs to Australians and ultimately undermine our standard of living.

1.1 Study objective

This study is an input to the Inquiry process and is intended to identify, at a high level, critical issues in supply chains for the agriculture sector. The study analyses:

- the infrastructure underpinning typical supply chains for each industry;
- supply chain costs;
- user needs and bottlenecks impacting the supply chain; and
- technology, innovation and changing business practices impacting supply chains in the future, particularly in relation to infrastructure, service requirements and cost.

Data in this study is drawn from the following sources:

- ABARES (2016), Annual commodity statistics: cotton
- ABARES (2016), Annual commodity statistics: meat - general
- ACCC (2016), Issues paper: Cattle and beef markets;
- Australian Export Grains Innovation Centre (2014), The cost of Australia's bulk grain export supply chains: An information paper;
- Australian Livestock Exporters Council (2014), Submission by the Australian Livestock Exporters' Council to the Green Paper on Developing Northern Australia;
- BITRE (2016), Why short haul intermodal rail services succeed;
- Commonwealth of Australia (2015), Agricultural competitiveness white paper;
- CSIRO (2013), Livestock Industry Logistics: Optimising Industry Capital Investment and Operations;
- DIRD (2009), Independent Review of the Grain Infrastructure Group's Freight Network Review;

- GrainCorp (2014), Victorian Port Terminals: Exemption from Port Terminal Access (Bulk Wheat) Regulation;
- GrainGrowers (2016), State of the Australian Grain Industry;
- International Trade Centre (2007), Cotton Exporter's Guide;
- Meat and Livestock Australia (2016), Fast Facts: Australia's beef industry;
- Meat and Livestock Australia (2016), Fast Facts: Australia's sheep industry;
- Meat and Livestock Australia (2016), Fast Facts: Australia's goat meat industry;
- Productivity Commission (2016), Inquiry Report: Regulation of Australian Agriculture;
- QTLC (2013), Supply Chain Perspectives: Cotton;
- Submissions to the National Freight Inquiry;
- various industry body websites; and
- stakeholder consultation with John Holland as the operator of the Country Regional Network in NSW – other organisations, including producers, were contacted but were not available for consultation.

1.2 Commodities analysed in this study

This working paper analyses three key agriculture commodities including:

- grain;
- cotton; and
- livestock.

1.3 Report Structure

Following this introduction, the report is structured as follows:

Section 2: Grain

This section provides a high level summary of the freight task and a description of key grain supply chains including a description of predominant transport mode, participants, infrastructure capacity, supply chain costs and relevant regulatory regimes.

Section 3: Cotton

This section provides a high level summary of the freight task and a description of the NSW and QLD cotton supply chains.

Section 4: Livestock

This section provides a high level summary of the freight task and a description of the livestock (national) supply chain.

Section 5: Technology and innovation

This section provides a summary of the key technological advances in the supply chain and the impact of these changes.

Section 6: User needs

This section provides an analysis of the user needs for each supply chain.

Section 7: Bottlenecks

This section provides an analysis of bottlenecks in the supply chains.

2 Grain

2.1 Freight Task

2.1.1 Production regions and volumes

Australia produced an average of 45 million tonnes of grain and oilseed per annum between 2010 and 2015.[1] This includes wheat, barley, oats, triticale, lupins, field peas, canola, faba beans and chickpeas. Grain production accounts for more than a quarter of the value of Australian agricultural production. Western Australia and NSW account for the majority of grain production as shown in Table 1 below.

Table 1: Grain production estimates by jurisdiction (2015)

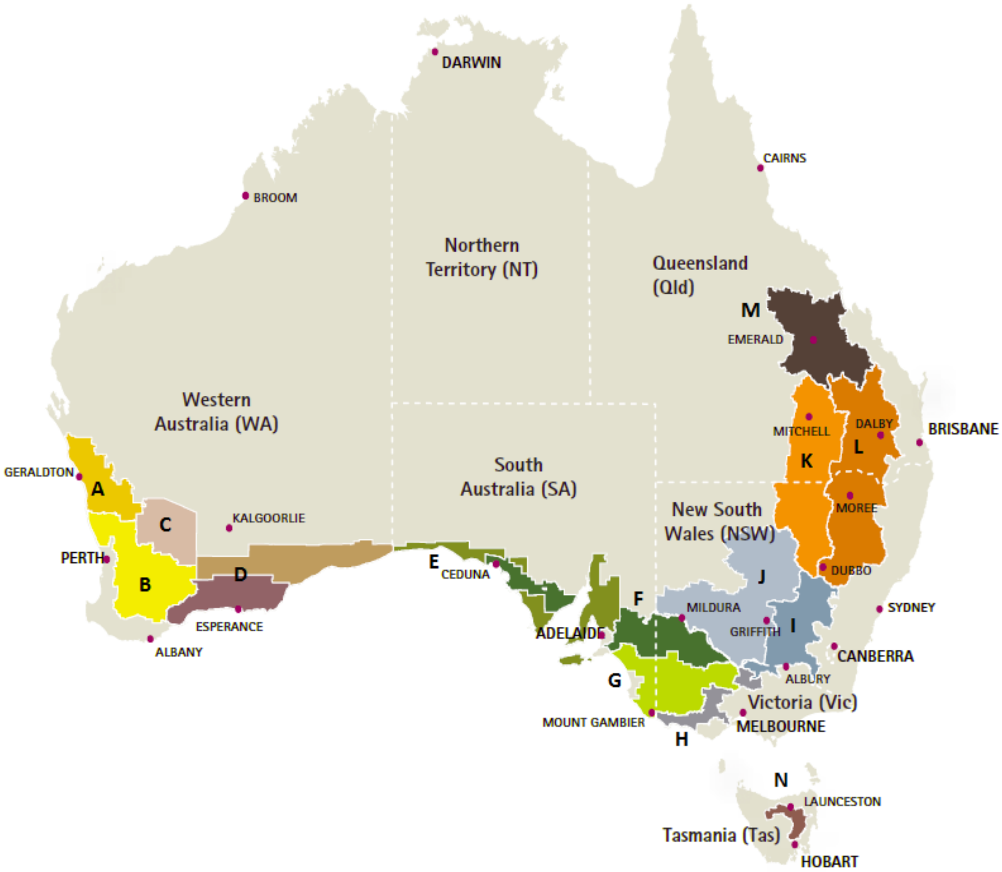
NSW	Vic	QLD	SA	WA	Tas
12 mt	6 mt	3 mt	7 mt	13 mt	0.1 mt

Source: ABARES (2016), includes wheat, coarse grains (ex rice), oilseeds and pulses

Grain production is seasonal and generally occurs along the eastern seaboards and through southern Australia (central and western) as shown in Figure 1 and described in Table 2 below.

[1] Grain Growers Limited (2016)

Figure 1: Grain production regions



Source: GrainGrowers (2016), State of the Australian Grain Industry 2016

Table 2: Grain grown in agro ecological zones

	Agro ecological zone	Season	Dominant crops grown
A	*WA Northern*	Winter	Wheat, barley, oats, triticale, lupins, field peas, canola, faba beans, chickpeas
B	*WA central*	Winter	Wheat, barley, oats, triticale, cereal rye, lupins, field peas, canola, faba beans, chickpeas
C	*WA eastern*	Winter	Wheat, barley, oats, triticale, lupins, field peas, canola, faba beans, chickpeas
D	*WA Sandplain and Mallee*	Winter	Wheat, barley, oats, triticale, lupins, field peas, canola, faba beans, chickpeas
E	*SA Mid-north – Lower Yorke, Eyre*	Winter	Wheat, barley, oats, triticale, lupins, field peas, canola, chickpeas, faba beans, vetch, safflower
F	*SA - Victoria Mallee*	Winter	Wheat, barley, oats, triticale, cereal rye, lupins, vetch, canola, field peas, chickpeas, faba beans, safflower
G	*SA - Victoria Border –Wimmera*	Winter	Wheat, barley, oats, triticale, lupins, field peas, canola, chickpeas, faba beans, vetch, lentils, safflower
H	*Victoria High Rainfall*	Winter	Wheat, barley, oats, triticale, lupins, field peas, canola

I	*NSW - Victoria Slopes*	Winter	Wheat, barley, oats, triticale, lupins, field peas, canola
J	*NSW Central*	Winter	Wheat, barley, oats, chickpeas, triticale, faba beans, lupins, field peas, canola, safflower
		Summer	Sorghum, sunflowers, maize, mung beans, soybeans, cotton
K	*NSW North West – Qld South West*	Winter	Wheat, barley, oats, chickpeas, triticale, faba beans
		Summer	Sorghum, sunflowers, maize, mung beans, soybeans, cotton
L	*NSW North East – Qld South East*	Winter	Wheat, barley, oats, chickpeas, triticale, faba beans, millet/panicum, safflower, linseed
		Summer	Sorghum, sunflowers, maize, mung beans, soybeans, peanuts, cotton
M	*Qld Central*	Winter	Wheat, barley, oats, chickpeas
		Summer	Sorghum, sunflowers, maize, mung beans, soybeans, cotton
N	*Tasmania*	Winter	Wheat, barley, oats, triticale, lupins, field peas, canola

Source: Grain Growers Limited (2016)

2.1.2 Nature of freight task

Export based commodity

Grain is an export based commodity with approximately 65 per cent of production exported. Grain accounted for approximately 35 per cent of Australian agricultural exports between 2010 and 2015.[2]

The grain freight task in WA and SA is export oriented with approximately 85-95 per cent of production destined for international markets. The freight task for east coast grain is more domestic oriented in comparison with approximately 50 per cent of production consumed domestically.

Inconsistency of freight task

The grain freight task is inconsistent within a year and also across years as a result of:

- seasonal production, as shown in Table 2 above;
- variation in volumes driven by weather conditions such as drought; and
- fluctuations in demand driven by global grain prices.

The supply chain has therefore built in significant storage capacity to cater for peak demand.

Trend towards containerisation

Grain products have traditionally been transported as bulk commodities, however, containerisation is emerging as a preferred freight type for grain. It is estimated that between 12 and 15 per cent of Australia's grain exports to Asia are now shipped in containers. The shift towards containerisation has been driven by:

- the degradation in legacy bulk transport infrastructure which results in reduced payloads, lost efficiency and increased cost;

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2 Grain Growers Limited (2016)

- the increased flexibility afforded by containerisation/intermodal transportation – the inconsistent nature of the grain freight task means infrastructure designed for containerised grain can be used for other goods in low seasons which reduces the average cost;
- demand for smaller quantities of grain from key Asian markets – containerised grain allows end users to purchase and transport smaller quantities;
- cost efficiencies arising from the ability to re-hire empty containers commensurate to volume, as opposed to the potential trading of bulk infrastructure assets in low production seasons; and
- increased demand for higher grades of grain which require containerised transportation

2.1.3 Market Structure

This grain market is currently undergoing transition from the traditional model, which is characterised by large bulk handlers, to an emerging model which relies on smaller on-farm storage.

Traditional model – bulk handling

The traditional model is characterised by a small number of large grain handlers buying, processing, transporting and selling grains produced by farmers. This model emerged as a result of regulation of the grain market after the great depression and allowed for the development of large scale supply chain infrastructure (handling facilities, rail) which was not viable for individual producers to develop. The dominant bulk handlers currently include:

- Cooperative Bulk Handling (CBH) in WA;
- Viterra (Glencore Agricultural) in SA; and
- GrainCorp in eastern Australia.

These companies own integrated supply chains, including storage sites, rolling stock, ports, and exporting and marketing businesses. While the bulk handling market participation is consolidated, there is intense competition between handlers in export markets, with 50 – 70 per cent of grain exported by up to 23 marketers in any season.

The volumes handled by the bulk handlers and their market shares in the jurisdictions where they operate are provided in Table 3 below.

Table 3: Volumes handled by the dominant bulk handlers

	CBH (WA)	Viterra (SA)	GrainCorp (QLD, NSW, Vic)
Average annual harvest (MMT)	10.2	6.0	20.0
Approximate domestic consumption (MMT)	1	1.2	9.5
% of harvest exported	92	90	50
Market share – up-country	~90% WA's grain	80% market share of SA up-country grain storage	Handles ~ 75% of east coast grain

Source: Australian Export Grains Innovation Centre (2014)

Emerging model – on-farm storage

On-farm storage capacity has grown significantly in recent years and is now estimated to be in excess of 15 million tonnes.[3] The increased reliance on-farm storage model has been driven by:

- government tax incentives – these incentives have made farm storage infrastructure more affordable;
- the producer's desire for increased control of supply and ability to adjust to seasonal variability and market prices – on-farm storage allows individual producers to store supply from bumper harvests and sell them when prices increase; and
- the need for a model which is more suited to the domestic grain task by road – on-farm storage better supports direct delivery of grains to end users.

2.1.4 Key corridors

Export

Key export markets include Indonesia, China, Vietnam, Japan, Vietnam, South Korea and Malaysia. The key export corridors in the sector include:

- Eyre Peninsula grain exported via Thevenard, Port Lincoln, Wallaroo, Port Giles and Port Adelaide (including the Inner and Outer Harbour terminals);
- NSW grain exported via Port Kembla and the Port of Newcastle;
- QLD grain exported via Mackay, Gladstone and Brisbane; and
- WA grain exported via Geraldton, Kwinana, Bunbury, Albany and Esperance.

Domestic

The domestic grain task can be described as a distributed system (as opposed to point to point) where grain can be transported from any origin to any domestic end user. Under the emerging on farm storage model, the domestic grain corridor involves the transportation of grain from farms to feedlots and mills.

While demand is nationwide, the domestic market is predominantly supplied by grain from the east coast (QLD, NSW and Vic).

2.2 Supply chains – General

2.2.1 Process

Grain is transported from the farm to bins via road. From the bin, grain that is transported as bulk freight is loaded on bulk grain trailers and transported to port for export markets or alternatively distributed to domestic markets. Grain is also transported in bulk from bins at receival sites via rail grain hoppers to port for export markets. Small amounts of gain are transported as bulk rail freight to domestic markets in NSW (e.g. Allied Mills Manildra).

Containerised grain is transported from bins to intermodal containerisation facilities. From the intermodal terminal, containerised grain is transported via rail wagons to container grain handling terminals. The grain is unloaded from the wagons and stored before being loaded onto container vessels for export.

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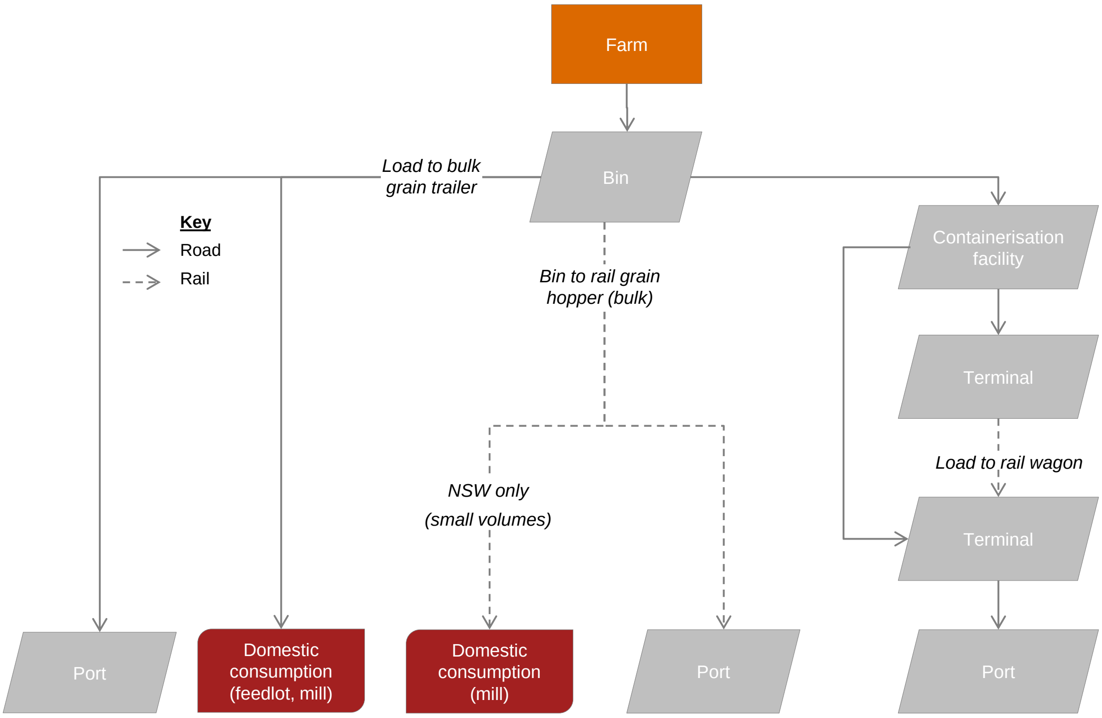
[3] Australian Export Grains Innovation Centre (2014)

A schematic representation of the grain supply chain is shown in Figure 2 below.

Figure 2: General grain supply chain



Source: PwC analysis

2.3 Supply Chains – Eyre Peninsula (SA)

2.3.1 Mode(s)

The Eyre Peninsula grain supply chain is predominantly an export based supply chain. It consists of road and rail based supply chains. The transportation of grain from farms to bulk handling sites relies almost entirely on road transportation. Grain volumes transported on the leg between bin and port are split almost evenly between road and rail.[4]

Approximately 5.5 million tonnes of grain is exported annually as bulk dry cargoes compared to 300,000 tonnes in containerised form.[5]

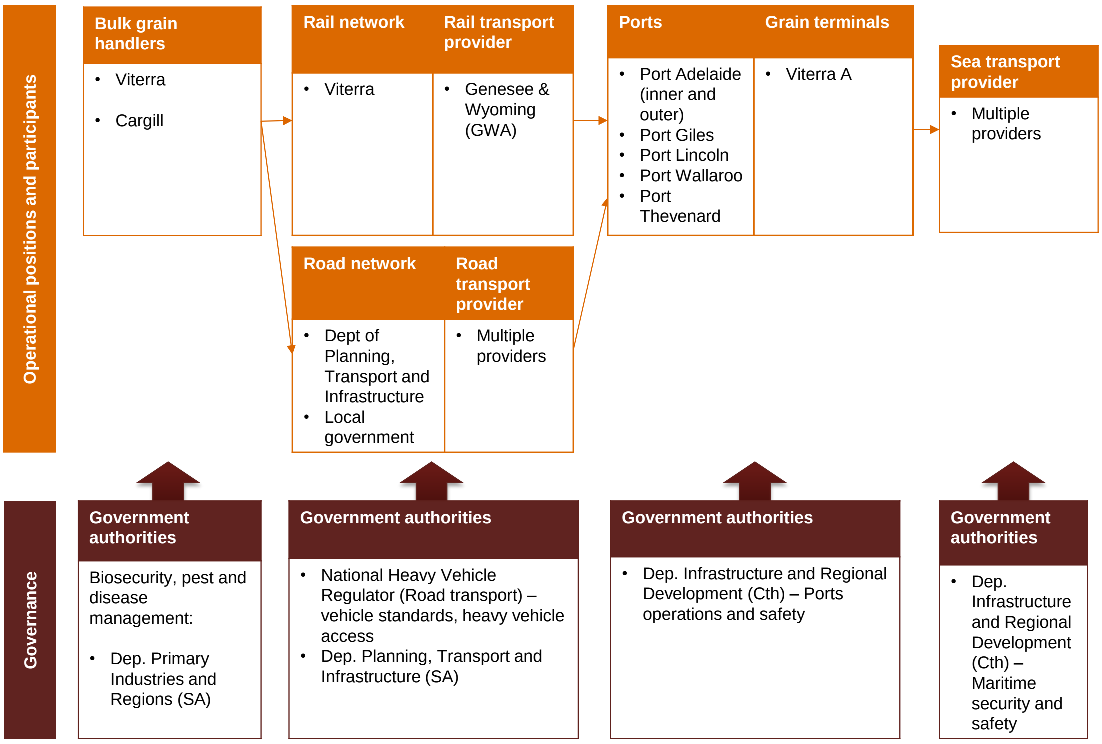
2.3.2 Participants & operation

The key positions and participants in the Eyre Peninsula grain supply chain are shown in Figure 3 below.

4 Australian Export Grains Innovation Centre (2014)

5 Government of South Australia (2017).

Figure 3: Key participants in the Eyre Peninsula grain supply chain



Source: PwC Analysis

2.3.3 *Infrastructure capacity*

Bulk handling and storage

Viterra is the predominant bulk handler in this grain supply chain consisting of 92 receival sites with a total storage capacity of 10 million tonnes. On farm grain storage was estimated at 1 million tonnes.

Ports

The Eyre Peninsula grain supply chain consists of 6 terminals (Thevenard, Port Lincoln, Wallaroo, Port Giles and Port Adelaide (including the Inner and Outer Harbour terminals) with a total throughput capacity of approximately 7 million tonnes per annum.[6] The terminal facilities have load out rates of between 600 and 2,000 tonnes per hour and can handle vessels of up to 60,000 dead weight tonnes (dwt).[7]

2.3.4 *Costs*

Grain supply chain costs are estimated at $72 per tonne, for Eyre Peninsula grain producers traveling an average of 200km from farm to port.

2.4 *Supply Chains – NSW*

2.4.1 *Mode(s)*

The NSW grain supply chain is designed to transport grain to the port for export and also to transport grain for domestic consumption. The transportation of grain from farms to bulk

6 ACCC (2016), Bulk wheat ports monitoring report

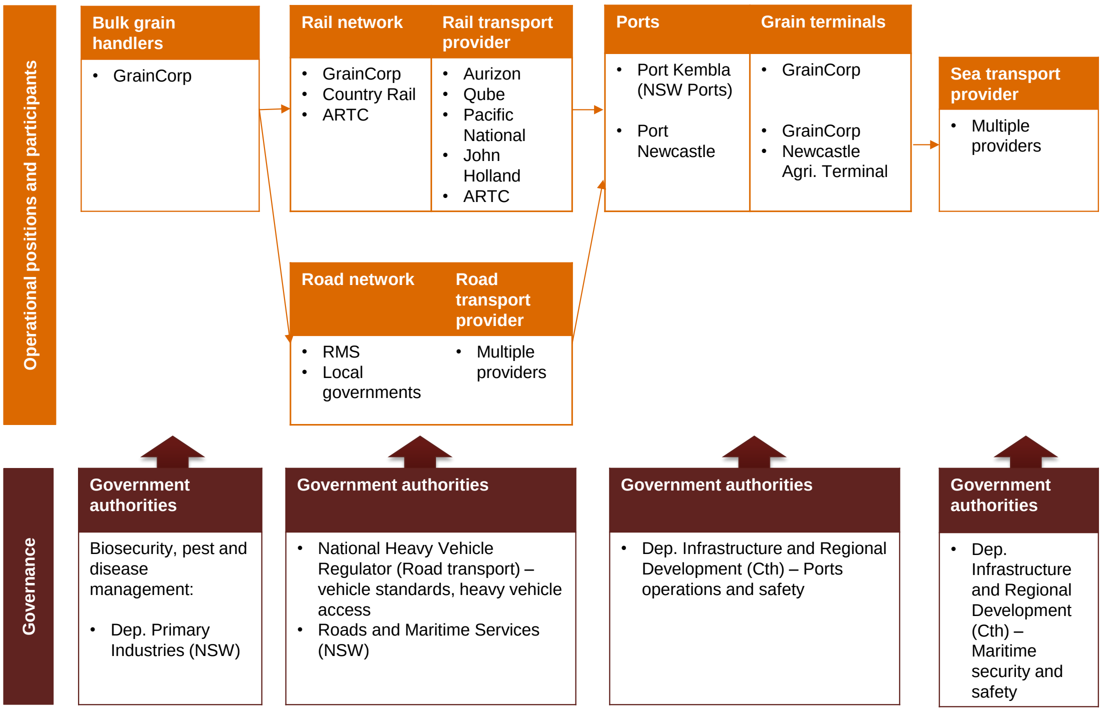
7 Australian Export Grains Innovation Centre (2014)

handling sites relies almost entirely on road transportation. Freight to port relies more heavily on rail which accounts for 85 per cent of total mode share.[8]

2.4.2 *Participants & operation*

The key positions and participants in the New South Wales grain supply chain are shown in Figure 4 below.

Figure 4: Key participants in the NSW grain supply chain



Source: PwC Analysis

2.4.3 *Infrastructure and capacity*

Bulk handling and storage

Grain Corp operates 50 country silos in Central and Southern NSW with a total capacity of 5 million tonnes. On farm grain storage was estimated at 6.4 million tonnes.[9]

Rail

The NSW grain supply chain uses both the Country Rail Network, which is operated by John Holland, and the ARTC network. The section of the Country Rail Network which is used for grain transportation is 996km in length and has an average TAL of 21 and a maximum speed of 80km/h. Most of the ARTC network supports loads of 30 tonnes per axle (120 tonnes per wagon), however the North Coast Line section is limited to 25 tonne axle load.

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[8] Australian Export Grains Innovation Centre (2014)

[9] Australian Export Grains Innovation Centre (2014)

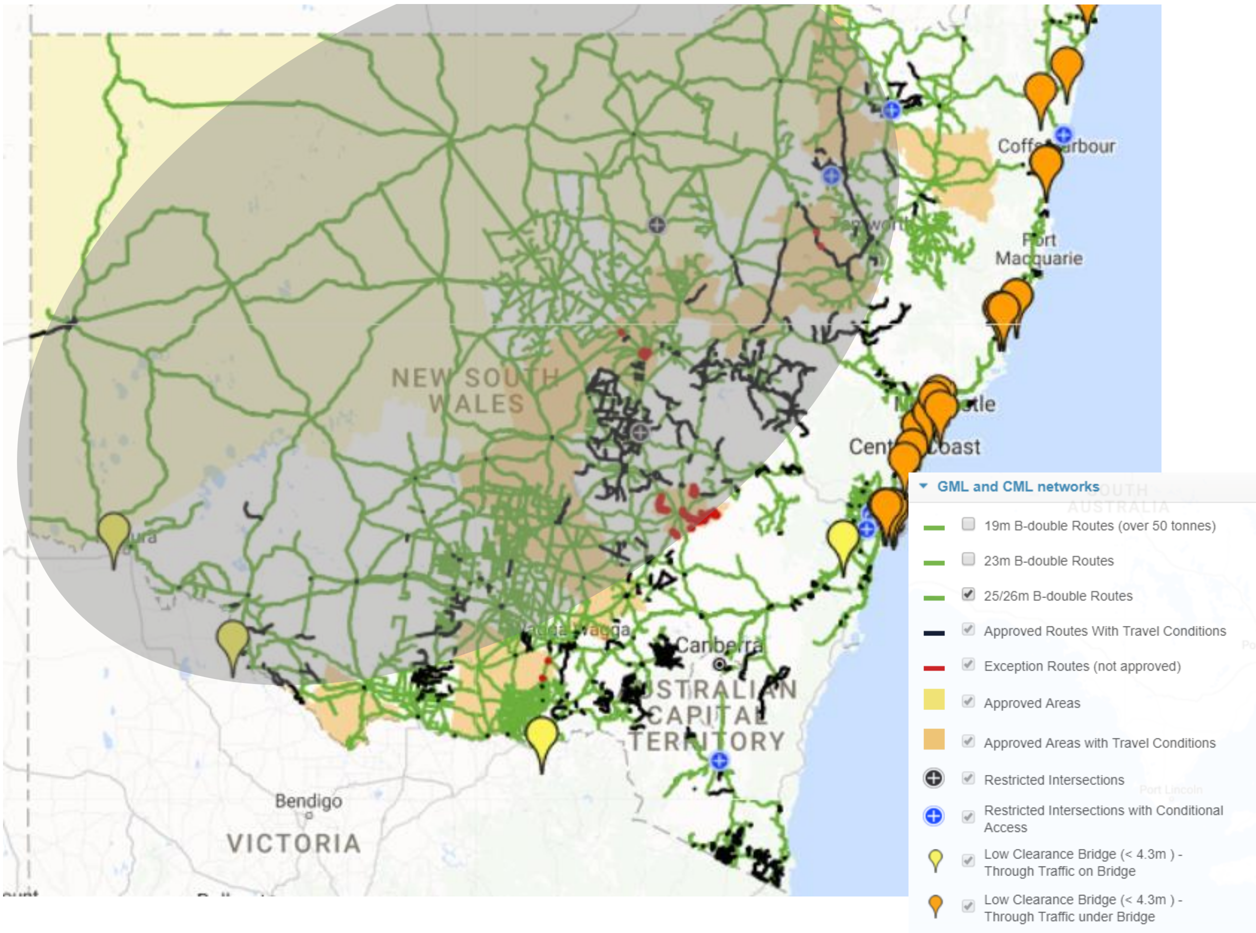
The NSW grain supply chain rail network uses 48 Class x 2 locomotives that carry payloads of 2,200 tonnes with a maximum length of 650m (up to 40 wagons). The grain is transported in GGVF SG wagons.

Road

The road network used by the NSW grains supply chain consists of both local and state governed roads. As shown in Figure 5 below, the road network is comprised of a series of routes which are approved for 25/26m B-double vehicles (green routes and yellow areas), some of which are approved with travel conditions (black routes and orange areas).

GrainCorp operate a fleet of approximatley 100 diferent grain truck and trailer combinations with payloads ranging between 15 tonnes for a rigid truck to 102.5 tonnes for an AB triple with tri dolly.[10] The HML capacity of the AB triple with tri dolly is 113 tonnes, however, the rate of deployment of HML capacities is unknown and the HML enabled network is relatively limted.

Figure 5: NSW GML and CML networks (grain region shaded in grey)



Source: Roads and Maratime Services (2016), valid as of 6/10/17

Ports

The NSW grain supply chain consists of 2 terminals (Port Kembla and the Port of Newcastle) with a total throughput capacity of 10 million tonnes per annum.[11] The terminal facilities

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10 GrainCorp (date unknown)

11 ACCC (2016), Bulk wheat ports monitoring report

have load out rates of between 4,000 and 5,000 tonnes per hour and can handle vessels of up to 120,000 dwt.[12]

The Port Kembla terminal is considered a fast-loading terminal by international standards. These load out speeds compare favourably with Canadian ports which have maximum loading capacities of 3,400 tonnes per hour. Fast load rates are critical to increasing turnaround time and reducing vessel charter costs.

2.4.4 Costs

Grain supply chain costs are an estimated $69 per tonne, for NSW grain producers traveling an average of 200km from farm to port.

2.5 Supply Chains – QLD

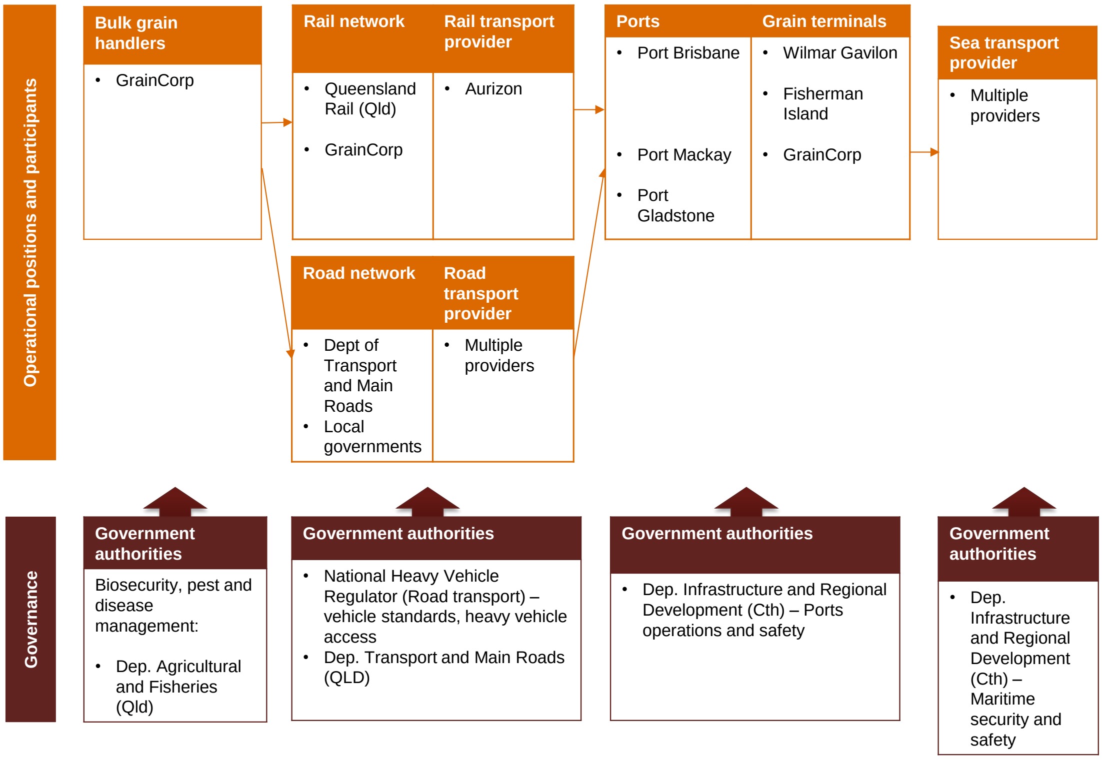
2.5.1 Mode(s)

The QLD grain supply chain is designed to transport grain for domestic consumption. The transportation of grain from farms to bulk handling sites relies almost entirely on road transportation. Road also accounts for 54 per cent of mode share for the freight to port movement.[13]

2.5.2 Participants & operation

The key positions and participants in the QLD grain supply chain are shown in Figure 6 below.

Figure 6: Key participants in the QLD grain supply chain



Source: PwC Analysis

[12] Australian Export Grains Innovation Centre (2014)

[13] Australian Export Grains Innovation Centre (2014)

2.5.3 Infrastructure and capacity

Bulk handling and storage

GrainCorp operate 23 receival sites with an unknown total storage capacity. On-farm grain storage was estimated at 2 million tonnes.[14]

Rail

The QLD grain supply chain uses various systems within the Queensland Rail network including the following:

- Western Line;
- Glenmorgan Branch;
- South Western Line;
- Millmerran Branch;
- Clermont-Emerald; and
- Mt McLaren.

This network is typically restricted to axle loads of between 15.75 and 18 tonnes.

The QLD grain supply chain rail network uses 2,300 Class x 2 locomotives that carry payloads of 1,800 tonnes with a maximum length of 650m (up to 40 wagons). The grain is transported in VGH Narrow gauge grain hopper wagons.

Road

GrainCorp operate a fleet of approximatley 100 diferent grain truck and trailer combinations with payloads ranging between 15 tonnes for a rigid truck to 102.5 tonnes for an AB triple with tri dolly.[15] The HML capacity of the AB triple with tri dolly is 113 tonnes, however, the deployment of HML capacities is not applicable in Queensland given road access.[16]

Ports

The QLD grain supply chain consists of 4 terminals with a total throughput capacity of approximately 4 million tonnes per annum (Mackay, Gladstone and Fisherman's Island, Brisbane).[17] The terminal facilities have load out rates of between 900 and 5,200 tonnes per hour and can handle vessels of up to 70,000 dwt.[18]

2.5.4 Costs

Grain supply chain costs are an estimated $73 per tonne, for QLD grain producers traveling an average of 200km from farm to port.

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[14] Australian Export Grains Innovation Centre (2014)

[15] GrainCorp (date unknown)

[16] AgForece Queensland (2017)

[17] ACCC (2016), Bulk wheat ports monitoring report

[18] Australian Export Grains Innovation Centre (2014)

2.6 Supply Chains – CBH (WA)

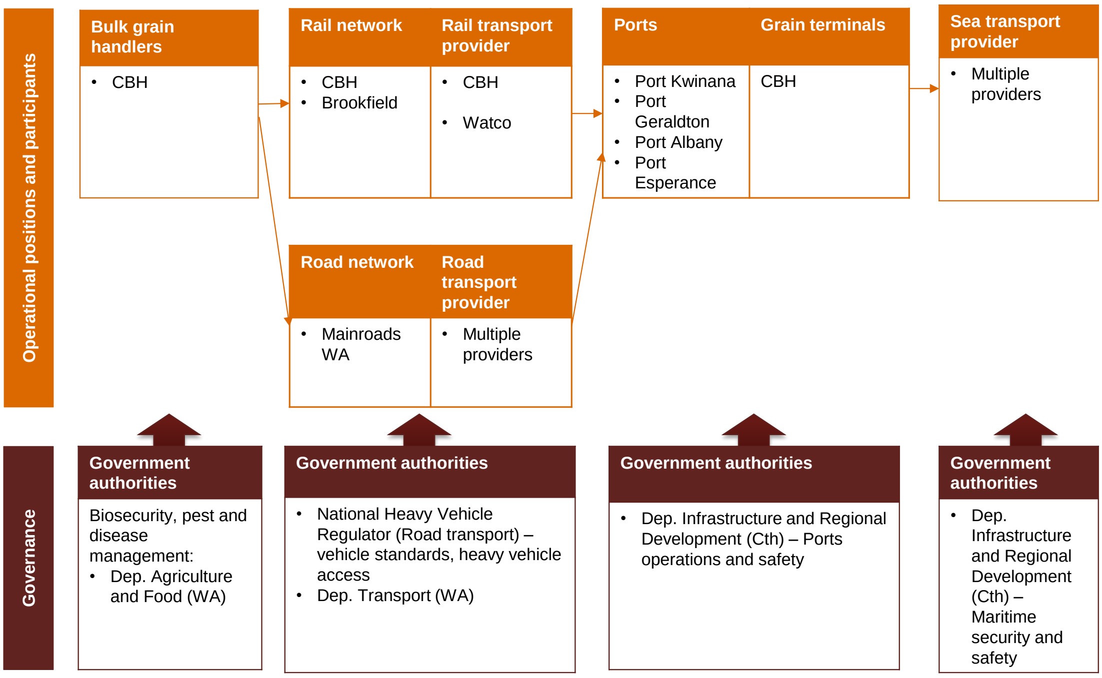
2.6.1 Mode(s)

The WA grain supply chain is predominantly designed to transport grain to the port for export. The transportation of grain from farms to bulk handling sites relies almost entirely on road transportation. Road also accounts for 40 per cent of mode share for the freight to port movement with the remaining 60 per cent transported by rail.[19]

2.6.2 Participants & operation

The key positions and participants in the WA grain supply chain are shown in Figure 7 below.

Figure 7: Key participants in the CBH grain supply chain



Source: PwC Analysis

2.6.3 Infrastructure capacity

Bulk handling and storage

The WA grain supply chain consists of 197 receival sites with a total storage capacity of 20 million tonnes. On farm grain storage was estimated at 2.6 million tonnes.[20]

Rail

The CBH grain supply chain uses the Brookfield operated rail network in the south-west of Western Australia. This network is 5,500km in length and is typically restricted to axle loads of between 16 and 24 tonnes. The network is organised into three tiers following a government review conducted in 2009. Tier 1 and 2 lines were considered essential to the grain freight network, while tier 3 lines were shut after they were deemed unsafe and commercially unviable.

[19] Australian Export Grains Innovation Centre (2014)

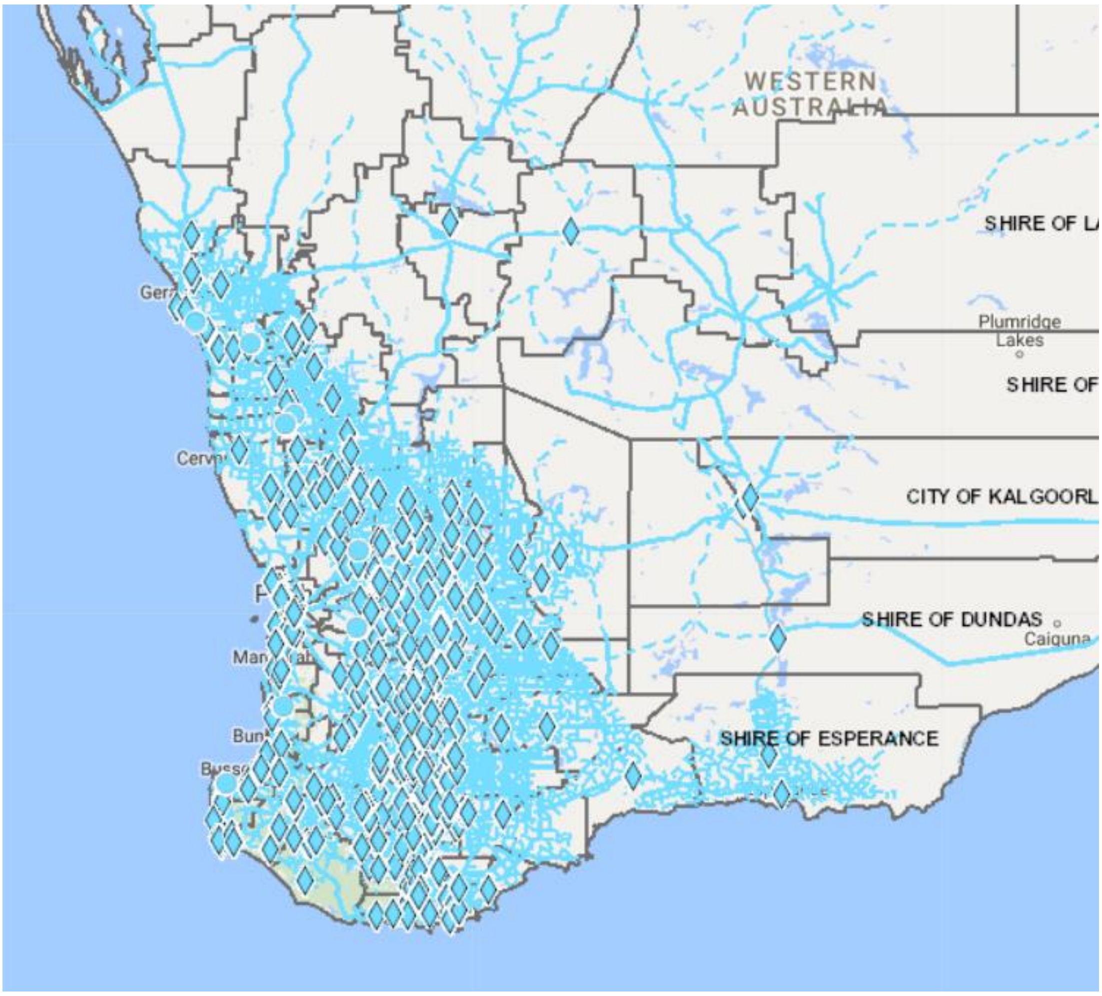
[20] Australian Export Grains Innovation Centre (2014)

Grain is hauled by CBH Class x 2 locomotives that carry payloads of 1,800 tonnes with a maximum length of 650m (up to 40 wagons). The grain is transported in CBHN Narrow gauge grain hopper wagons.

Road

A typical vehicle combination for grain freight bulk grain transportation in the WA grain supply chain is a RAV3 network vehicle with a maximum length of 27.5m and a maximum mass of 82 tonnes. This vehicle type is currently able to access a large network of roads in WA's wheat belt as shown in Figure 8 below.

Figure 8: Tandem Drive Level 3* enabled road network (Restricted Access Vehicle 3)



Source: Main Roads WA (2017)
*Tandem drive level 3 inlcudes (A) & (C) TRUCK TOWING A 5 OR 6 AXLE DOG TRAILER < 25.0M, (A) TRUCK TOWING 2 X 5 OR 6 AXLE DOG TRAILERS

Ports

The WA grain supply chain consists of 5 terminals (Geraldton, Kwinana, Bunbury, Albany and Esperance) with a total throughput capacity of 16.5 million tonnes.[21] The terminal

[21] ACCC (2016), Bulk wheat ports monitoring report

facilities have load out rates of between 1,000 and 5,000 tonnes per hour and can handle vessels of up to 120,000 dwt.[22]

The Kwinana terminal is considered a fast-loading terminal by international standards with capacities of 5,000 tonnes per hour. These load out speeds compare favourably with other Australian and international facilities.

2.6.4 Costs

Grain supply chain costs are an estimated $58 per tonne, for WA grain producers traveling an average of 200km from farm to port.

2.7 Regulation

Ports in each of the grain supply chains are subject to the Port Terminal Access (Bulk Wheat) Code of Conduct which requires port terminal service providers to ensure that exporters of bulk wheat have fair and transparent access to port terminal services. The Code is enforced by the ACCC.

Terminal operators can be exempt from parts 3 to 6 of the Code (access, loading protocols) if it can be demonstrated to the ACCC that there is sufficient competition in the port zone. The following terminals are currently exempt:

- Adelaide terminal;
- Port Kembla - all terminals;
- Port of Newcastle - all terminals;
- Port of Brisbane - all terminals; and
- Bunbury.

2.8 International Case Study – Canada grain supply chain

2.8.1 Description

Canada is the 8th largest producer and the 4th largest exporter of grain products. While Canada produces 7 per cent or less of any one product, it is a significant exporter of wheat, canola and pulses. Canada is a small producer of grain on a global scale, however the small domestic demand relative to production makes the grain producer a significant exporter to global markets.

2.8.2 Supply Chains

Mode(s)

Rail is the major mode of transport used for the large scale transport of 11,000 tonne grain loads from regional inland depot facilities to export port terminals. The round trip cycle times generally take 12 to 14 days per service reflecting one way haul distances of 1,300 to 1,800 km.

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[22] Australian Export Grains Innovation Centre (2014)

Participants & operation

The rail task is dominated by major Canadian Class 1 rail operators Canadian Pacific (CP) Railway and Canadian National (CN) Railway, who provide integrated services through owning 85 % of the network and delivering 96% of the rail task.

Infrastructure and capacity

The main CP and CN networks have standards aligned to the USA networks to allow the switching and interchange of wagons between operators across country borders.

The major rail companies when providing integrated rail transport services to customers, have a dual commercial challenge of matching both track and operating capacity to customer requirements.

The networks developed by the rail companies also reflect the capacities required in individual regions for specific customer demand and products. While the majority of the network is single line track with passing loops, sections of the network have been expanded and augmented over time to meet capacity requirements.

Regulation

The Canadian grain industry has a regulatory framework that protects the interests of supply chain participants. Economic and safety regulation is applied to companies through the Canadian Transport Act by the Canadian Transport Agency and Transport Canada.

2.8.3 Lessons Learned

Key lessons from the Canadian grain supply chain include:

- The haul distances from Western Canada to export ports are too long for road to be a viable mode option, resulting in the rail companies having significant market power.
- Shortline Operations that have taken over abandoned network components and handover wagons to CN/CP for line haul on main corridors, only own/operate only 15% of the network and transport 4% of rail haulage task.
- There has been a 38% reduction in the supply chain transport and handling time over the last 15 years due to efficiencies extracted from the supply chain as various operations have been rationalised subsequent to transfer from Government ownership and privatisation.
- Issues have arisen when rail capacity has been rationalised and grain harvest peaks result in demand outstripping capacity of grain export supply chains from Western Canada.
- This has resulted in a number of regulatory interventions that seek to rectify perceived or real market imbalances. These include:
  - interchange/interswitching obligations for shortline operators;
  - the MRE revenue cap for the major rail companies;
  - guaranteed rail service obligations when commercial negotiations fail;
  - the provision of guaranteed capacity levels by rail operators; and
  - the forced sale of abandoned rail network sections.
- The market power of the major companies in the supply chain and market imperfections and distortions has been the catalyst for government intervention and regulation of Canadian Export Grain supply chains.

- While Australian supply chains are also subject to regulation, the competition between the road and rail modes in Australia for grain export volumes appears to result in more market driven outcomes.

- The multi product rail networks in Canada ensure that critical trunk network infrastructure can be maintained at a high standard and is remunerated by the density of traffics using the networks.

- The lightly trafficked grain lines in Australia are typically relying on seasonal grain volumes to support and maintain the network infrastructure.

- In addition, Australia separates the financial accountability for network infrastructure and rail operations, unlike Canada. The vertically integrated model adopted in Canada may create surety of investment in network capacity but may require significant regulatory oversight as it is likely to reduce contestability.

- With the degradation of regional grain networks over time in Australia, Government funding support for rail branch lines that are limited to light grain traffic is typically required to ensure they remain open.

- Integrated above and below rail operations delivering customer rail solutions are more likely to ensure that rail industry stakeholder interests are aligned and industry is more responsive to customer requirements.

3 Cotton

3.1 Freight Task

3.1.1 Production regions and volumes

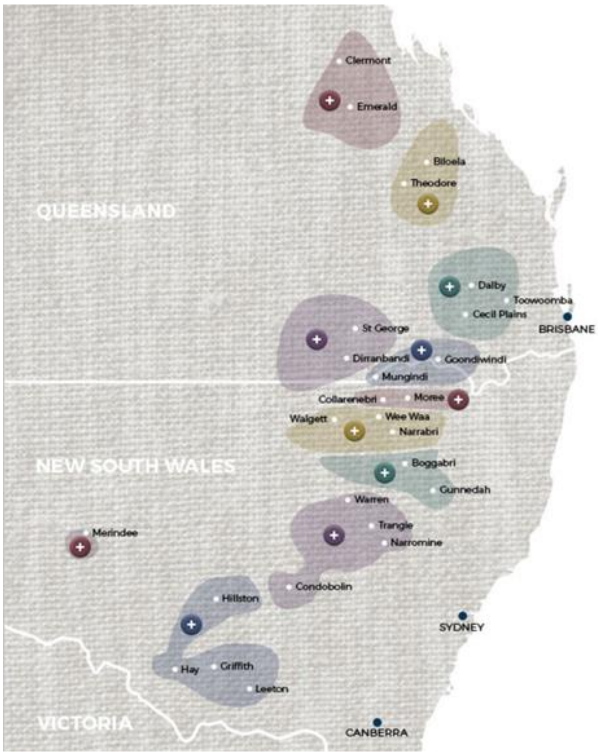
Australia produced 626.2 kilotonnes of cotton lint and 885.5 kilotonnes of cottonseed, which can be processed into oils and meal, in 2016. The key production regions include the:

- area surrounding the Barwon and Darling rivers in western NSW and the Lachlan and Murrumbidgee rivers in southern NSW which collectively account for approximately 60 per cent of volumes; and the

- Darling Downs, St George, Dirranbandi and Macintyre Valley regions in southern Queensland, which accounts for approximately 40 per cent of total volumes.[23]

Australia's cotton production region is show in Figure 9 below.

Figure 9: Cotton producing regions in Queensland and New South Wales



Source: Cotton Australia (2017)

3.1.2 Nature of freight task

Export based commodity

Cotton lint is an export based commodity with approximately 99 percent of production exported. Key export markets include China, Indonesia and Thailand. Domestic

[23] ABARES (2016)

consumption of cotton lint has declined significantly in line with the contraction of Australia's textiles industry.

Inconsistency of freight task

The freight task for cotton is seasonal reflecting the growing and harvesting patterns of the crop. Australia's cotton growing season lasts approximately six months, starting in September/October (planting) and ending in March/April (picking).

The freight task also varies depending on weather conditions (ie drought) which impact volumes.

Impact of upcountry facilities on mode choice

The choice of mode depends on whether there are up country containerisation facilities. If facilities are available the cotton is likely to be containerised at the terminal before being railed to warehouse in the metropolitan area and sent to the Port for export. If facilities are not available then cotton is likely to be transported by road to a warehouse in the metropolitan area before it is containerised and sent on to the Port for export.

Backhaul

The cotton lint freight task involves significant backhaul operations. Trucks are often loaded with diesel and fertiliser for transportation from the port to producers after the cotton product is unloaded for export.

3.1.3 Market Structure

The overall cotton market is characterised by two distinct operating models including the:

- vertically integrated corporate model - this involves large vertically integrated operations who undertake ginning, warehousing, marketing and trade of cotton ie. Namoi, Cargill, Olam, Auscott; and

- individual growers model – this model involves cotton growers selling crop directly to a gin or to a marketing intermediary who on sells the crop to a gin. The Australian cotton industry operates under an unregulated market system which allows for this model.

Cotton farming

The cotton farm sector itself is highly fragmented with approximately 1,250 cotton farms in operation. The majority of agricultural operators in the sector are family-run farms and businesses. The four largest companies in the sector were estimated to account for less than 20 per cent of industry revenue in the 2016-17 period. CS Agriculture Pty Ltd is a major cotton operator, with a market share of 8.5 per cent.[24]

Farms are generally organised into cooperatives that arrange machinery purchases, provide seed, advise on pest control and undertake processing and marketing. Such cooperatives include Namoi Cotton Cooperative, which is also one of Australia's largest ginners.

Cotton ginning

The cotton ginning is moderately concentrated with the industry's four largest players accounting for an estimated 54 per cent market share.[25] The four largest players are Namoi Cotton, Olam Investments Australia (Queensland Cotton), LDC Enterprises Australia (Louis Dreyfus) and Auscott Limited.

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[24] IBISWorld (2017)

[25] IBISWorld (2016)

3.1.4 Key corridors

Export

The key export corridors for cotton export include:

- cotton lint and cottonseed from Central Queensland, Darling Downs, St George/Dirranbandi, Border Rivers and some volumes from Gwydir Valley transported to the Port of Brisbane for export;
- cotton lint and cottonseed from Namoi Valley, Macquarie Valley and some volumes from Gwydir Valley transported to the Port of Botany for export; and
- cotton lint and cottonseed from the Riverina, Bourke/Tandou and some volumes from Namoi Valley and Macquarie Valley transport to the Port of Melbourne for export.

Cotton exports are predominantly bound for end markets in China and India.

Table 4 below shows the key ports from which cotton is exported from.

Table 4: Key ports for cotton exports

	Port Botany	Port of Brisbane	Port of Melbourne
% of cotton lint exports	35%	43%	22%
% of cottonseed exports	37%	57%	7%

Source: Queensland Transport and Logistics Council (2014), rounding errors present

Domestic

Domestic consumption of cotton lint is negligible given the size of Australia's textile manufacturing industry. However, cottonseed, is transported to processing plants located across NSW and QLD for transformation into meal and oils for the domestic market.

3.2 Supply chain – General

3.2.1 Mode(s)

Both the NSW and QLD cotton supply chains are predominantly road based. In QLD, only 5 per cent of containerised cotton bales and 3 per cent of cottonseed is transported via rail to the Port of Brisbane (2013).[26] Small volumes of cotton lint produced in northern NSW may also rely rail for transportation to port for export.

Farm to gin

Picked cotton is pressed on farm into large, rectangular, truck-sized blocks called modules, or large round bales. The cotton modules are transported either directly to ginning facilities or via a warehouse by road where cotton lint is separated from cottonseed. The cotton lint is pressed into bales and transported to the port for export.

Gin to port

Bales may be packed into containers on site and transported by road to a terminal for loading onto a train and railed to the port for export. Bales may also be transported by road from the gin to a containerisation facility for packing into containers. From there the containers are transported to a terminal and then a port for export.

[26] Queensland Transport and Logistics Council (2014)

Rail transportation is used sparingly as very few gins have direct access to rail sidings. Many gins also do not have sufficient onsite storage capacity (eg one or two week's production capacity) meaning an infrequent rail service would not be suitable.[27]

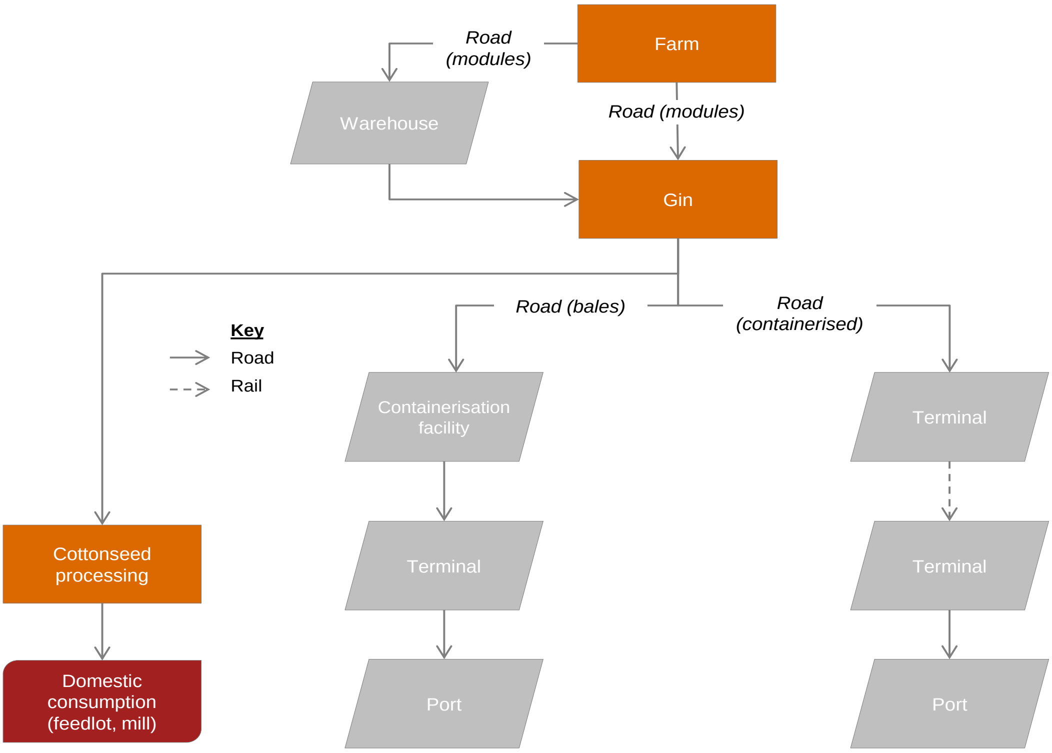
Gin to domestic markets

Cottonseed from the gin is transported to processing plants by road for transformation into livestock feed and oils. These products are predominantly transported to domestic market via road.

A schematic of the cotton supply chain is shown in Figure 10.

Regional variations

Figure 10: Cotton supply chain



Source: Queensland Transport and Logistics Council (2014)

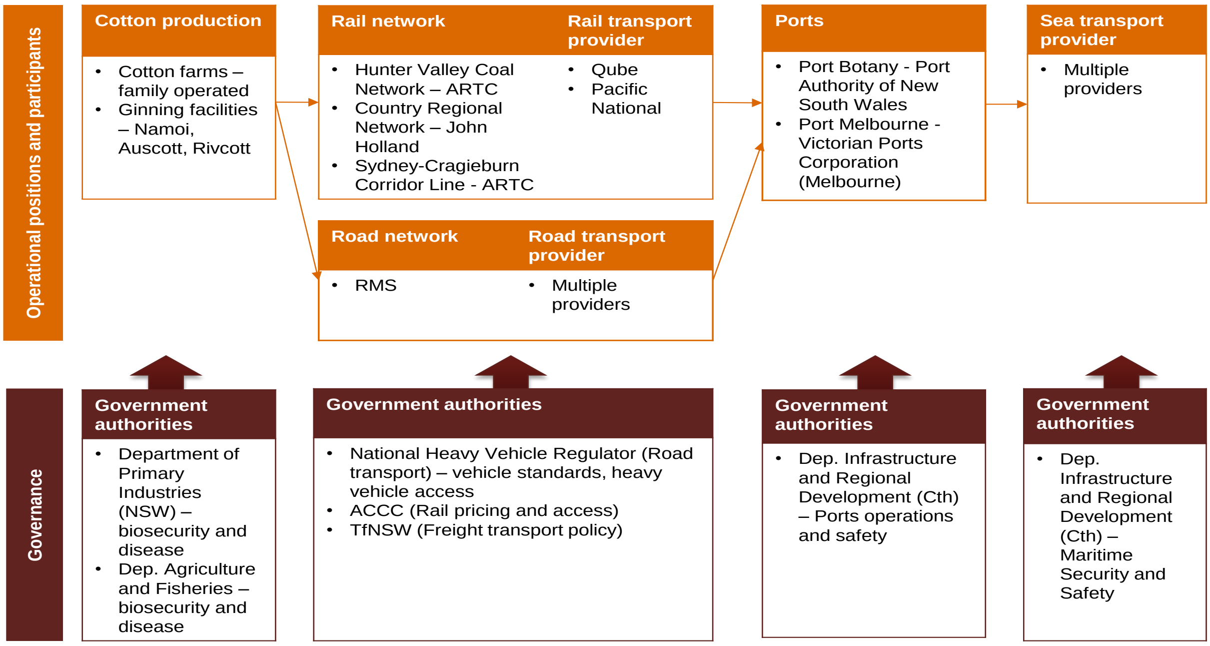
3.3 Supply Chains - NSW

3.3.1 Participants & operation

The NSW cotton supply chain consists of a number of key supply chain positions, and participants operating within each position. The key positions and participants in this corridor are show in Figure 11 below.

[27] Queensland Transport and Logistics Council (2014)

Figure 11: Key participants in the NSW cotton supply chain



Source: PwC Analysis

3.3.2 Infrastructure and capacity

Road

Cotton is predominantly transported by long distance road hauliers, using articulated semi-trailer, B-Double or A-Double road vehicles. The transportation of cotton modules from farm-to-gin is almost entirely undertaken by road transportation. Cotton from the farm to the gin is delivered by long distance road haulers using 14-18 tonne modules on flat top semi-trailers, chain-bed loaded module trucks or B- Double road vehicles. B-Double, semi-trailer and road trains transport bales from gins to warehouses for sorting, consolidation and shipping.[28]

Rail

Cotton from the northern areas of Wee Waa and Narrabri is transported to Port Botany by rail on the Hunter Valley Coal Network. This network is managed by ARTC and operates a maximum TAL of 30 tonnes.

Cotton is also transported on the Country Regional Network from the North West of Sydney. The Country Regional Network is owned by Transport for NSW and is operated by John Holland under a 10-year lease ending in 2020. The relevant track starts in Warren, has a maximum capacity of 22 TAL and a maximum speed of 80km/h.

Ports

NSW cotton, which has been pressed into bales and containerised, is exported through Port Botany, the Port of Melbourne and the Port of Brisbane. Each of these ports have multiple container berths with modern loading facilities. It is noted that the Port of Brisbane and Melbourne receive cotton transported predominantly by road while the Port of Botany is receives a relatively higher proportion of cotton by rail.

Table 5 below shows the key ports from which NSW cotton is exported from.

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[28] Queensland Transport and Logistics Council (2014)

Table 5: Key ports for NSW cotton exports

	Port Botany	Port of Brisbane	Port of Melbourne
% of cotton lint exports	50%	18%	32%

Source: Queensland Transport and Logistics Council (2014), rounding errors present

3.3.3 Costs

The cost of road transportation was not available based on publically available information.

The cost to transport cotton on the ARTC's Hunter Valley Coal Chain Network is made up of a fixed and a variable component. The cost for using the network between Maitland and Muswellbrook are outlined in Table 6 below.

It is noted that the Maitland to Muswellbrook corridor only represents a portion of the track from Wee Waa/Narribri to Port Botany. It is possible that the costs to travel from the more remote cotton production regions is more expensive.

Table 6: Cost for cotton transport on the Hunter Valley Coal Network

	Cost ($)
Variable price per '000 GTK	4.005
Flag fall price per train km	0.507

Source: ARTC (2017)

3.3.4 Regulation

Vehicles carrying cotton abide by most of the regulations of the National Heavy Vehicle Regulator, but do have some state-based exemptions.

In recognition of the expansion of bales once they are loaded, cotton-carrying vehicles have exemption to exceed the statutory width limit of 2.5 metres by 0.2 metres, so long as the height is less than 4.6 metres and the load does not protrude more than 100mm from the trailer.

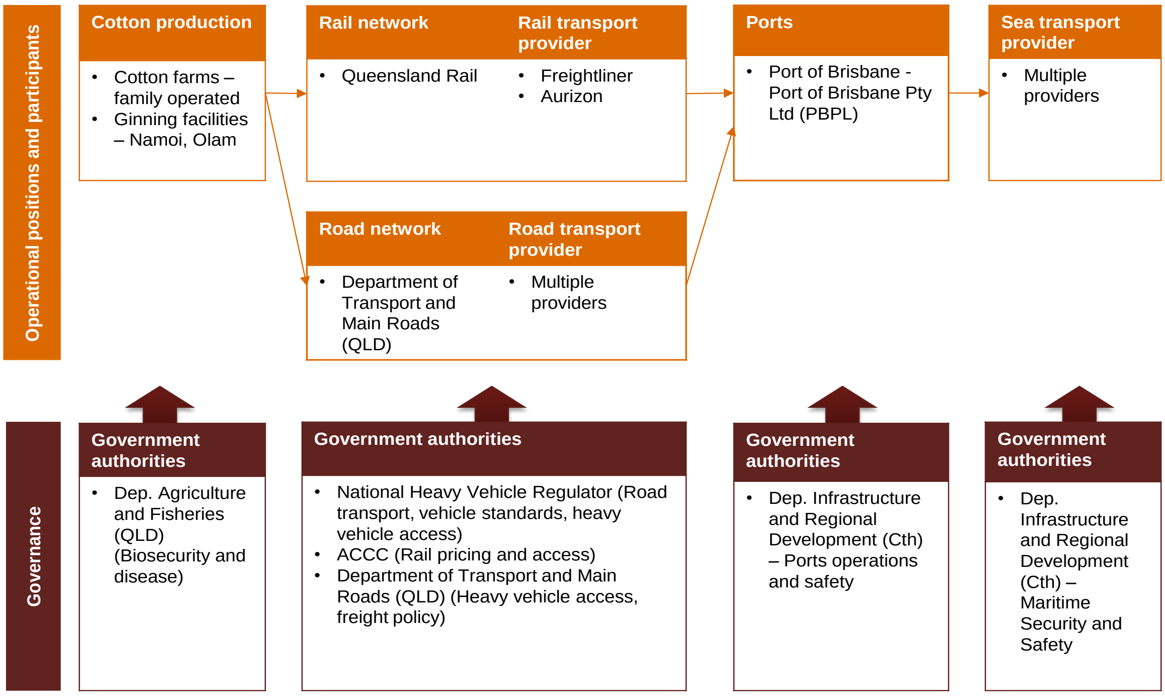
Both vehicles with a height between 4.3 and 4.6 metres and vehicles with width between 2.6 and 2.7 metres are restricted in the roads they can travel.

3.4 Supply Chains - QLD

3.4.1 Participants & operation

The Queensland cotton supply chain consists of a number of key supply chain positions, and participants operating within each position. The key positions and participants in this corridor are show in Figure 12 below.

Figure 12: Key participants in the QLD cotton supply chain



Source: PwC analysis

3.4.2 Infrastructure and capacity

Road

The QLD cotton supply chain adopts similar vehicles to NSW. Cotton is predominantly transported by long distance road hauliers, using articulated semi-trailer, B-Double or A-Double road vehicles. The transportation of cotton modules from farm-to-gin is almost entirely undertaken by road transportation. Cotton from the farm to the gin is delivered by long distance road haulers using 14-18 tonne modules on flat top semi-trailers, chain-bed loaded module trucks or B- Double road vehicles. B-Double, semi-trailer and road trains transport bales from gins to warehouses for sorting, consolidation and shipping.[29]

Rail

Key rail lines used in the QLD cotton supply chain include:

- South Western System – this system is operated by QR and is limited to 15.75 tonne axle loads and diesel hauled trains of 655 metres. Container wagons are restricted in payload (due to axle load limit) and can only fit sub-standard 2.75 metre high containers, compared to contemporary industry standards of 2.9 up to 3.2 metres;

- The diesel locomotives in use are 1970s vintage. Compared to current generation locomotives, these old locomotives are poorly powered, have higher fuel consumption, are more expensive to maintain and are less reliable; and

- the West Moreton system – this system is operated by QR and is limited to 15.75 tonne axle load, and diesel hauled trains of 655 metres, with a nominal payload of 1,940 tonnes. The system includes steep grades, sharp curves and 11 tunnels with clearance limitations which limits the overall capacity of the system which does not permit use of the preferred

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[29] Queensland Transport and Logistics Council (2014)

9 foot 6 inch containers. This limits the viability of transporting cotton by inland rail and makes road the more competitive and viable option.

Ports

QLD cotton, which has been pressed into bales and containerised, is exported exclusively through the Port of Brisbane which has 9 container berths fitted with modern loading facilities.[30]

3.4.3 Costs

The cost of transporting cotton in the QLD cotton supply chain is not available based on the lack of publically available information.

3.4.4 Regulation

Vehicles carrying cotton abide by most of the regulations of the National Heavy Vehicle Regulator, but do have some state-based exemptions.

Cotton-carrying vehicle combinations in Queensland must meet all the requirements of the National Class 2 Road Authorisation notice for operation in Queensland, except for the requirement to have a maximum height of 4.3 metres high. Like New South Wales, Queensland cotton trucks are permitted to have height of 4.6 metres.

[30] Port of Brisbane (2017)

4 Livestock

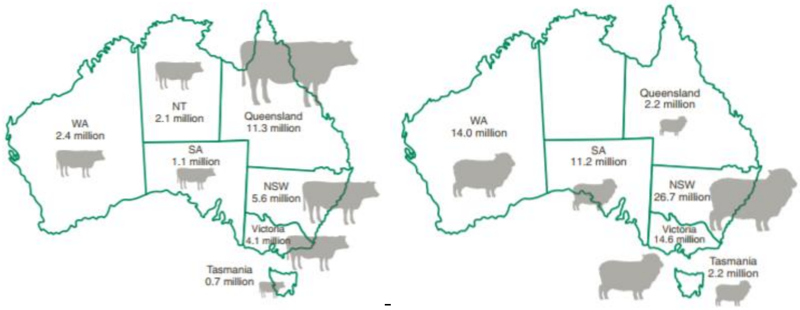
4.1 Freight Task

4.1.1 Market Overview

Australia produced 3.6 million cattle and sheep as livestock in 2015. Livestock forms a large proportion of Australia's agricultural sector with almost 68 per cent of farms involved in livestock production. The most common livestock include beef cattle, chicken, sheep and goat.

Australian livestock production is nationwide, with variations in the livestock farmed in each state. Sheep production tends to be more prevalent in the southern states, beef production occurs in every state and territory with a critical mass on the east coast, and the more intensive livestock industries such as pork, dairy and poultry concentrated in regions that are either proximate to major metropolitan areas or the coastline. Figure 13 outlines the dispersion of Australian cattle and sheep.

Figure 13: Locations of Australian cattle and sheep



Source: Meat and Livestock Australia (2016)

Market Structure

The two defining features of the livestock market structure are fragmentation and regional stock specialisation.

Fragmentation

Livestock production is highly fragmented. For example, approximately 67 per cent of cattle farms run less than 400 head of cattle and only a small portion of farms operate herds of 800 or more.

Regional Stock Specialisation by region

Stock produced varies regionally throughout Australia. For example, live cattle exports dominate in the Northern Territory and northern Western Australia, whereas sheep farming is the dominant livestock production in NSW.

4.1.2 End Markets

The Australian market for livestock products is predominantly export-driven, with the exception of poultry.

Cattle

Approximately three quarters of beef and veal production, and 1.2 million head of live cattle were exported in 2015/2016.

Sheep

Australia exported over 55 per cent of total lamb production and over 90 per cent of total mutton production in 2015/16. Australia is the third largest exporter of live sheep.

Goat

Australia is a small producer of goat meat globally, yet is the world's largest exporter.

Poultry

Only around 4 per cent of Australia's poultry is exported.

4.1.3 Key corridors

Export

Key export markets include:

- live cattle to Indonesia, which accounts for approximately 50 per cent of Australia's live cattle exports;
- processed beef products to the United States and Japan. Australia was the world's largest beef exporter in 2015, shipping 1.17 million tonnes to 84 countries;
- sheep to markets in the Middle East including Kuwait (37 per cent of exports) and Qatar (25 per cent). Australia is the third largest live sheep exporter, with 1.86 million head exported in 2015;
- mutton products from Victoria to the Middle East, South East Asia and China. Lamb is also predominantly sent to the Middle East, with a significant portion (22 per cent) going to the United States; and
- goat products are exported to Malaysia and the United States.

Domestic

There is a limited flow of livestock between states. Supply is generally met within each state. Interstate flows generally occur in response to seasonal fluctuations in supply.

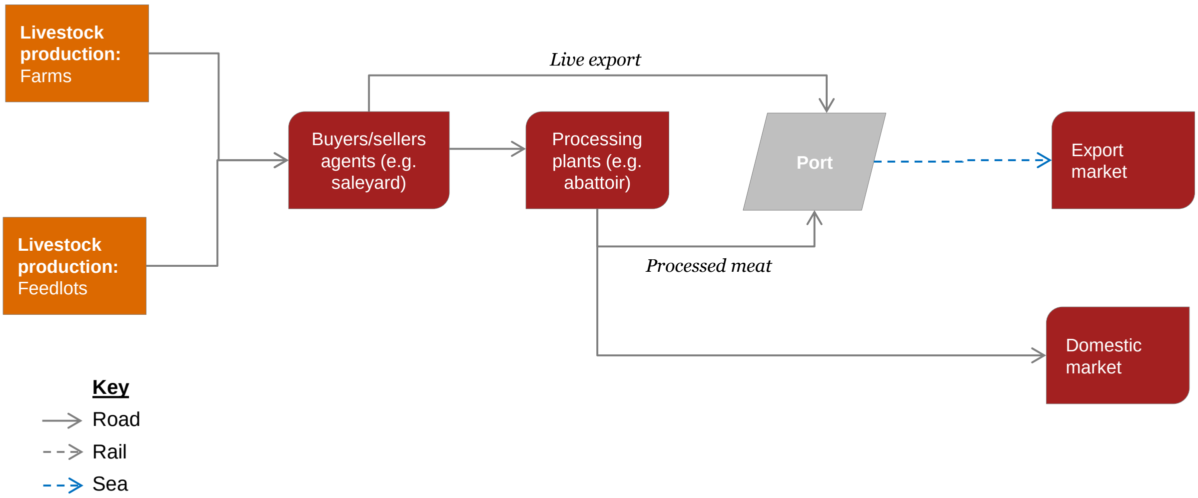
4.2 Supply Chains - National

4.2.1 Mode(s)

Livestock is collected from farms and transported, typically by road, to processing plants or end users. The livestock supply chain includes all modes, infrastructure of varying quality and is characterised by long distances. Cattle for example, can travel an average of 1,000km from farms to abattoirs on the east coast – some of these trips from cattle properties in North West Queensland to abattoirs in Brisbane can span up to 2,500km.

The livestock supply chain is summarised in Figure 14 below.

Figure 14: Livestock supply chain

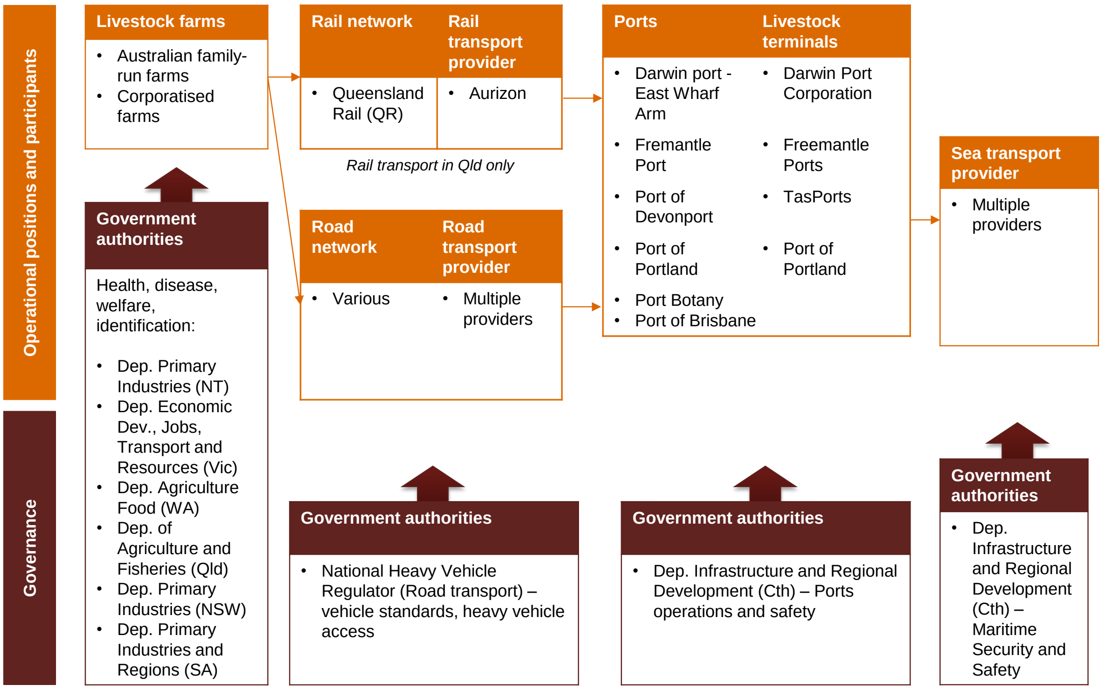


Source: PwC Analysis

4.2.2 *Participants & operation*

The transportation of Australian livestock involves a number of key supply chain positions and participants operating within each position. The key positions and participants in this corridor are show in Figure 15 below.

Figure 15: Key positions and participants in the livestock supply chain



Source: PwC Analysis

Rail

Queensland is the only state that transports livestock by rail (predominantly via the Queensland Rail regional networks).

Trains loading live cattle from the south west, central west and north west Queensland locations transport cattle to Queensland abattoirs at Brisbane, Rockhampton and Mackay. Cattle transported by rail equates to approximately 16 per cent of containerised export meat.

The rail services in Queensland are subsidised by Government under the livestock transport services contract that is structured to enable up to 325 rail cattle train services per annum from Cloncurry, Longreach and Charleville.

Road

Road is the primary form of transport for Australian livestock in both Queensland and the rest of Australia due to their ability to transport truckloads of cattle from a diverse number of remote farm origins to nominated abattoirs for processing. Live cattle movements are also undertaken by road to export ports such as Townsville and Darwin.

Sea

Meat products and to a lesser degree live animals are exported from ports in each state, given the abundance of Australian livestock.

4.2.3 Infrastructure and capacity

Rail

Livestock rail routes are lighter (15.75 TAL) on south west and central west lines and 20 TAL on Mount Isa and North Coast Lines as shown in Figure 16.

Livestock is typically hauled to loading points at various locations on Type 1 or 2 road trains with specified prime movers able to haul trailers with up to six decks. Road Trains need appropriate drive trains, running gear and suspensions to handle the first part of the journey which is often in remote and dry conditions, in harsh terrain.

Figure 16: Queensland livestock rail network

Source:: Aurizon (2016)

There are restrictions in terms of train length permitted and the axle load capacity on some branch lines which limits the type of locomotives able to be used on some the Queensland Rail network upon which livestock rail services operate.

Height

For meat products being transported to ports for export, a standard 8’6” export refrigerated container is required that can be connected to shore power on rail services and at the Port. Domestic reefer containers are not used for export products.

Length

The maximum train length on most systems in Queensland is 650 metres except for the Mount Isa Line which can handle a 1,000m train services. This is shorter than interstate standard gauge services. However, a longer 1,500 or 1,800 metre train service would be difficult to handle in terms of both origin loading and destinations unload given the number of cattle to be hauled would double.

Capacity

The regional network systems are limited in terms of absolute capacity by number of passing loops on the single-track Queensland Rail network systems. This does not limit capacity however given the limited number of services on most regional systems including the North Coast Line where more passenger and intermodal services operate. There is some limited competition with coal services between Gladstone and Rockhampton and Emerald and Rockhampton as well as between Townsville and Mount Isa with minerals haulage services. However, no detrimental impacts occur given the spare network capacity on most of these networks and the priority afforded to Cattle services to ensure animal welfare is maintained.

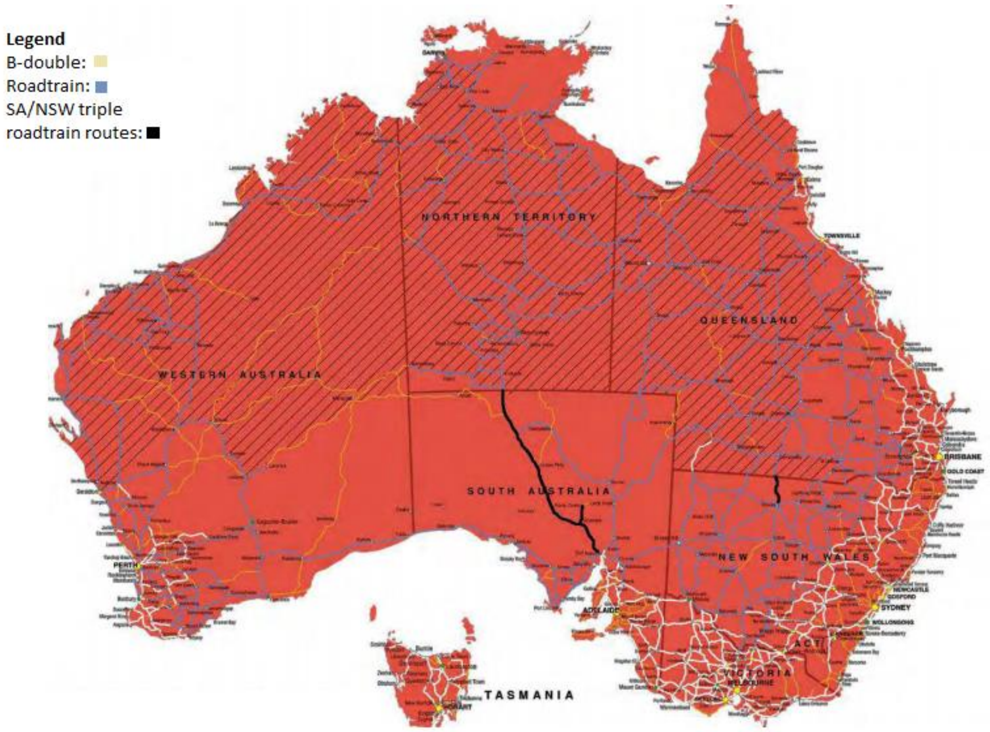
Road

Road is the primary form of transport for Australian livestock due to the flexibility of road transport to be able to take direct routes and leave immediately when loaded. Road preference is also driven by constrained access to rail given dispersed nature of farms.

Articulated trucks move approximately two-thirds of the food and livestock transported by road. These trucks are load-carrying vehicles consisting of a prime mover with articulated trailers, and are B-double, road train or single semi-trailer truck configurations depending on the origin, destination and available access to heavy vehicle truck routes.

B-Double and road train routes are the preferential road infrastructure for transporting livestock. - The Australian B-double and road train networks are shown in Figure 17

Figure 17: Major Australian highways and roads



Source: Meat and Livestock Australia (2010)

The major national B-Double and road train highways used to transport livestock are listed in the Table 7 below.

Table 7: Queensland livestock rail specifications

State	Major highway (highway number)	State	Major highway (highway number)
QLD	Bruce (1) Warrego (A2) Capricorn (A4) Flinders (A6) Landsborough (A2)	***SA***	Western (A8) Dukes (A8) Sturt (20) Princes (A1) Stuart (A87)
NSW	Newell (39) New England (15) Sturt (20)	***TAS***	Booker (1) Midland (1) Bass (1)
VIC	Hume (31) Western (A8) Dukes (A8)	***WA***	Eyre (1) Great Eastern (94) Great Northern (95) Victoria (1)
NT	Stuart (87) Barkly (66)		

Source: Meat and Livestock Australia (2010

Sea

The key ports in each state are outlined in Table 8.

Table 8: Summary of key livestock ports

	Port of Brisbane (Qld)	Devonport (Tas)	Port Adelaide (SA)	Port of Portland (Vic)	Darwin Port (NT)	Fremantle Port (WA)
Storage	1.5ha	1.2ha	Unknown	50ha	4,000m²	Unknown
Ship loading	Unknown	3.4 t/m²	Unknown	1 x 3.5 t/m² 1 x 5.0 t/m²	3 - 6 t/m²	Unknown
Berths	2 common user, livestock berths	1 common user, livestock berth	1 common user, livestock berth	2 common user livestock berths	4 common user, livestock berths	4 common user, livestock berths
Channel Depth	11.5m	9.5m	10.0m	11.7m	12.2m	11.0m
Reference vessel (LOA)	Unknown	205	206	230	246	265

Source: : Port of Brisbane Shipping Handbook 2013/2014, Tasports Port Information: Port of Devonport (2014), Marine Operations Port Adelaide Port Rules, Port of Portland (2017), Port of Darwin Port Handbook, Port of Freemantle (2011),

4.2.4 Costs

Rail

Indicative transport costs on the Queensland livestock rail network are listed in Table 9.

Table 9: QLD Rail transport costs ($/km/deck)

From	To					
	Stuart	Dinmore	Holmview	Lakes Creek	Fields Siding	Banks Pocket
Mirri		0.97				
Malbon		0.97				
Cloncurry	1.31	0.96	0.97	1.02	1.04	0.98
Julia Creek	1.32	0.96	0.97	1.04	1.06	0.98
Nelia		0.97				
Richmond	1.60	0.97	0.99	1.03		0.99
Hughenden	1.76	1.00	1.01	1.04		1.02

Source: CSIRO (2013)

Road

Road costs

Indicative costs for transport by road in Northern Australia are outlined in Table 10.

Table 10: Road transport costs per vehicle ($/km for a given km/day)

Type	1,200 km/day	1,000 km/day	800km/day	600km/day	400km/day	Idle cost ($/hr)
B-Double	2.16	2.35	2.64	3.13	4.10	141
Type 1	3.01	3.24	3.59	4.17	5.33	169
Type 2	3.19	3.43	3.78	4.36	5.52	177

Source: CSIRO (2013)

Sea

Export meat is transported internationally at standard reefer container rates that vary by origin and destination ports.

4.2.5 Regulation

The National Heavy Vehicle Regulator specifies the following dimensions for typical livestock carriers:

- B-double: The two semi-trailers must not have more than 18.8 metres of their combined length to carry livestock; and

- Trailers built to carry livestock: There must not be more than 12.5 metres of length available to carry livestock on two or more partly or completely overhanging decks.

5 Technology and innovation

Farmers, agricultural researchers, industry groups, and transport and logistics companies continue to focus on improving productivity and reducing costs through the use of new technologies. New technologies which have been implemented or are currently being considered within the agricultural supply chain include:

- technology that can track and trace agricultural products along the supply chain;
- robotics for the automation of the supply chain; and
- data driven software and devices designed to optimise the movement of agricultural cargo.

This section focusses on the current and upcoming technologies which impact the transportation of commodities from their source to end users. Supply chain technologies represent potential solutions to alleviating the bottlenecks and logistics related issued identified in Section 7.

The potential impacts of these technologies on the supply chains and infrastructure requirements is based on results from existing implementations where available. The impact of these technologies within the Australian context should be verified via stakeholder consultations with industry and government.

5.1 Tracking & traceability systems

Tracking systems involve technology that is able to transmit information about the location of goods along the logistics chain. RFID, Blockchain and GPS technology can be used as supply chain tracking systems, which can connect and communicate with suppliers and producers. GPS is primarily used as a vehicle locator device as it requires the use of the vehicle battery as a reliable power source. RFID tags are relatively inexpensive, and are most used for tracking assets at a certain location. Blockchain technology serves as the decentralised platform which collects and stores data submitted manually by users and automatically by integrated systems. The security of this data is facilitated by its decentralised and disaggregated functionality which breaks up data which is encrypted. Tables 18 and 19 describe the RFID, GPS and Blockchain technology and how it is currently implemented in Australian and International supply chains.

Table 11: Blockchain

Description	Blockchain technology is a decentralised distribution ledger that can hold and record transactions between contracting parties and operates on a user-to-user basis. The technology captures this information and transactions using sensor and signaling inputs along a transaction chain or, more specifically for the Agriculture sector, along a supply chain. These signals and sensor technologies enable traceability to source origin, integrity of product quality through the supply chain and mitigate against counterfeiting. Blockchain technology is largely being built by users with a need for the decentralized distribution ledger.
Commodities impacted	All agriculture products with specific uses. Cases identified for pork, mangoes, grain (oats), tomatoes, tuna, chickens, beef, food products (general), fresh milk
Take Up	From an agriculture perspective, Blockchain technology is mostly in proof of concept or pilot phase with a number of pilots taking place through partnerships between agri businesses and technology solution providers to test the applicability of the technology. Some technology is in small production and this is largely due to the nature of the supply

	chain of that sector or developer.
Likely impact on supply chain and infrastructure requirements	Specific to the Agriculture sector, Blockchain enables verification and certainty around the movement of goods and compliance with contractual obligations as they relate to commercial transactions. Specifically to the agriculture sector, the strong motivators for use of this technology has been driven by: <u>Provenance</u> Blockchain can provide absolute and accurate verification for consumers of the source origin of goods and the contents of the ingredients. For many consumers today this is a key factor in their purchasing decision, whether it wanting full confidence that the produce comes from the farm advertised/promoted to understanding the ingredients and other elements utilised in the production of agriculture goods. <u>Improve quality/integrity and reduced wastage</u> Blockchain will help enable both retailers and consumers verify that the safety and quality requirements of the goods have been maintained through the various nodes of the supply chain through the maintenance of accurate and fully verified recording of the movements in the supply chain network. Examples would include the recording of temperature throughout the voyage of fresh/perishable items (ie fresh milk) that can verify that it has been kept at or below the required temperature throughout transit. This information can also help identify parts of the supply chain where quality and integrity has failed, enable action to mitigate the breakdown and reduce ongoing wastage of perishable items. <u>Counterfeit</u> Agriculture goods are particularly exposed to counterfeit, especially in export markets such as China. Utilsiing blockchain, retailers and consumers are able to detect counterfeit goods by determining provenance and tracking their movement throughout the supply chain.
Use case example(s)	<u>IBM & Walmart</u> IBM and Walmart are in the pilot stage of testing blockchain capabilities for pork and mangoes. Its purpose is to provide visibility over the end to end supply chain and enable verification of provenance, security and contractual obligations across the supply chain. <u>OwlChain</u> This Taiwanese e-commerce platform is using Ethereum blockchain technology to address consumer concerns around food quality and safety and easily determine food provenance. <u>Grass Roots & Provenance:</u> US-based cooperative, Grass Roots has established a blockchain traceability platform using QR codes. It enables consumers to trace their chicken produce from shop to the farm verifying provenance such as ‘free range’ and origin. <u>PwC, Blackmores, Alibaba & Australia Post</u> Alibaba Group, PwC, Blackmores and Australia Post are undertaking a proof of concept to explore the use of blockchain technology to curb the rise in counterfeit food being sold across China. From the proof of concept, Alibaba is looking to develop a “Food Trust Framework” that will help in improving traceability on its global supply chains. They have chosen Australia to be the test bed of this new framework. <u>CBH Group & AgriDigital:</u> Australian grain exporter CBH is piloting a blockchain system that would protect the grain supply chains and involved parties. In particular, CBH is testing the oats supply chain, testing origin and quality documentation as well as matching title transfer and payment. <u>Ripe.Io & The Cornucopia Project , Analog Devices Inc:</u> Ripe Io has developed a software and technology system including blockchain and IoT devices to identify, trace, establish quality and taste tomatoes. Using sensor technology, Cornucopia farmers are able to pull data to assess the tomatoes’ taste and quality attributes as well as track the tomatoes and monitor food safety later in the supply chain. <u>BeefLedger</u> A blockchain platform initiative, Beefledger intends to integrate its supply chain to establish provenance, counterfeit detection, smart contracting and allow for testing of

	supply chain efficiency and performance. Provenance A London based blockchain platform, Provenance is using Ethereum technology to verify the origin of Indonesian tuna, served in Japan. Using sensors of RFID technology, Provenance is able to track, record and provide this information in the blockchain platform via a user to user access system.

Table 12: Radio Frequency Identification Tags

Description	RFID tags contain microchips that can identify and respond to radio frequencies. These microchips are applied to product packaging to validate products from the point of packaging. RFID tags can be passive or active, whereby active tags are connected to a battery and can transmit its identity to a reader every couple milliseconds. Passive tags require a reader to send a radio frequency signal first. Passive RFID tags can be read hundreds of feet away and multiple tags can be read at once while in motion. This is unlike traditional barcodes which have to be manually scanned.
Commodities impacted	Cotton and livestock
Take Up	RFID track and trace technology has been established in the agriculture industry for some time, however, due to growing interest in validating the authenticity of Australian agricultural products in export markets, the technology has a renewed role in the agricultural supply chain.
Likely impact on supply chain and infrastructure requirements	RFID track and trace technology ensures stakeholders in the supply chain have accurate records of the source of each individual product. This improves supply chain management and reduce waste in the supply chain. Track and trace technology, through the validation of product attributes, also enhances end user trust and confidence with the agricultural produce. The extent to which RFID technology can validate production practices, origin and ingredients will depend on the chain of custody in place.
Use case example(s)	National Livestock Identification System (NLIS) Currently, track and trace technology is implemented in the cotton industry, with RFID tagging of individual cotton bales for transportation between the ginning facility and spinning mill. Traceability of cotton is required due to the manufacturers having different product specifications. The National Livestock Identification System (NLIS) requires cattle, sheep and goats to be traced with an ear tag that contains RFID technology.

Source: http://www.pwc.com.au/assurance/assets/business-risk/food-trust-mar15.pdf, Rural Industries Research and Development Corporation, Agricultural Product Validation Needs analysis and technology evaluation

Table 13: QR code

Description	A Quick Response Code (QR code) is a two-dimensional barcode that is readable by smartphones. It allows to encode over 4,000 characters in a two dimensional barcode. QR Codes may be used to display text to the user, to open a URL, save a contact to the address book or to compose text messages. Reading a QR Codes utilising a smartphone, requires the installation of appropriate software. QR codes are commonly used in agriculture to provide consumers information of the product, including its source origin and content.
Commodities impacted	All packaged agriculture products
Take Up	QR code based track and trace technology has been established in the agriculture industry for some time and is most commonly used to provide product information to the end consumer as it is a low cost approach to providing visibility. With the growing interest in validating the authenticity of Australian agricultural products in export markets we can expect even greater use of QR codes, however more advanced technologies that enable item level tracking (such RFID) and real time validation of product integrity (ie Blockchain) have the potential to slow the use of QR codes as they mature

Likely impact on supply chain and infrastructure requirements	Like RFID, QR code track and trace technology ensures stakeholders in the supply chain have accurate records of the source of each individual product. This improves supply chain management and reduces waste in the supply chain.
Use case example(s)	John West John West has implemented a web-based traceability platform where customers can enter code on a lid of tuna can to trace the produce back to its source origin

Table 14: Global Positioning System

Description	Global Positioning System (GPS) is a supply chain tracking system which can connect and communicate with suppliers and producers. A GPS tracking system uses the Global Navigation Satellite System (GNSS) network. This network incorporates a range of satellites that use microwave signals that are transmitted to GPS devices to give information on location, speed, time and direction of the vehicle a GPS device is attached to. Through the use of GPS, road transport providers have been able to optimise routes, increase truck utilisation, reduce travel time and improve load building and backloading.
Commodities impacted	All agricultural commodities
Take Up	GPS is a mature technology which has been deployed for a number of decades. Originally established for use by the defence industry, the technology has been commercialised for use across a number of industries including agriculture.
Likely impact on supply chain and infrastructure requirements	The proliferation of GPS technology in trucks and locomotives will enable advancement in the area of supply chain tracking. End users will be able to track produce from the farm, to processing facilities, to the port or to their warehouse. This will increase visibility with freight transportation, ensuring end users can better plan for the arrival of the produce. Tracking systems can also inform supply chain reform that leads to more timely transportation and reduces wastage. This is important with short shelf life agricultural products where transportation is time critical. Tracking systems could result in more efficient asset utilisation along the supply chain and more targeted infrastructure investment in road and rail transportation.
Use case example(s)	Qube Freight transport company Qube uses GPS technology to enable web-based 24/7 real-time tracking. Freight is tracked through the use of Geofence technology that allows status messages to be sent to the online system without driver activation. When the freight carrying the mobile device comes into contact with the Geofence virtual geographic boundary, the software triggers a status message response. Australian Rail Track Corporation (ARTC) Not all locomotives carry GPS technology, however, the rail infrastructure manager of the interstate rail network, ARTC uses GPS as part of its primary communication system. ARTC is using GPS to implement a situational awareness system that incorporates safe travelling distance technology and real-time locomotive tracking. Currently the use of GPS in locomotives has been for the purpose of rail safe working and communication with train control centres.

NOTE: ARTC's situational awareness system is called Advanced Train Management System. Source: Australian Logistics Council – Using information and Communications Technology to Increase Productivity in the Australian Transport and Logistics Industry July-2010, http://www.qube.com.au/logistics/technology, https://www.artc.com.au/customers/operations/nib/

5.2 Supply chain automation

5.2.1 Port automation

Table 15: Automated port systems

Description	Automated port technology involves the use of robotics to control and manage port operations. These include driverless automated container carriers to move containers around the port and automated stacking cranes for the loading of containers on to the vessel
Commodities impacted	All agricultural commodities
Take Up	Port automation is relatively mature in Australia, as many port terminals around Australia have automated stacking cranes A number of terminals have undergone and/or are undergoing automation programs over the last 5 years, such as Patrick's terminal at Botany Bay that completed the installation of automated straddles and machines in 2015.
Likely impact on supply chain and infrastructure requirements	Automated port systems is a more efficient way of delivering terminal services. This may reduce supply chains costs as it provides additional capacity required to meet increasing production. The technology will also improve the safety and reliability of terminal operations. It maximises performance and safety, while reducing the impact of external factors such as weather conditions and human error.
Use case example(s)	Patrick's Botany Bay Automated stacking cranes are operated from a remote control station in the terminal office area. The remote control station is a duplicate of the trolley-mounted operator cabin, except with the addition of monitors for the camera images of the actual crane's position and movement. Victorian International Container Terminal The Victorian International Container Terminal also uses remotely operated quay cranes and driverless automated container carriers. Automated container carriers move containers from where vessels are moored to the container yard. These remotely operated cranes and carriers are also operated from a remote control station in the terminal office area.

Sources: http://www.ictsi.com/operations/victoria-international-container-terminal-vict-melbourne-australia/

http://www.smh.com.au/nsw/sydneys-patrick-terminal-goes-automated-with-fewer-staff-but-dancing-robots-20150617-ghqc24.html

5.2.1 Digitised supply chain planning

Table 16: Supply chain planning

Description	A digital, real-time and wireless-enabled networking system across the entire supply chain which facilitates tracking, re-supply and control over the movement of goods. It allows for efficient planning and allocation of resources within supply chains and helps to improve security around movement and provenance of goods.
Commodities impacted	All agricultural commodities: • security around the provenance of agricultural produce will be significantly improved; and • lag times between demand for additional stock and re-stock should also improve with the analytics technology and data traceability of end to end processes
Take Up	The Internet of Things (IoT) and other models of end-to end traceability solutions are

	still in conceptual testing phases. Connecting transportation, home and office networks. The theory is that IoT will dramatically increase efficiency and reduce waste of time and resources. There are broader visions of IoT capabilities with the end goal being a "smart city" in which transport, homes, roads, utilities, and other urban systems are all inter-connected and are able to interact to function symbiotically. Currently, technology is at the forefront of agricultural progress by means of data analytics systems. Using these systems, farmers are better able to allocate crops to certain areas of land based on an analysis of temperature, soil moisture, nutrients and other determinants. This sensor-based technology is also being used in the wine industry with vignerons now able to assess the environment ahead of important time-line and weather dependent decisions must be made (ie time to harvest) and are therefore better able to control their produce and vines. IoT technology is able to dramatically reduce the level of risk and uncertainty for farmers and is therefore able to provide for more consistent performance and economic stability in regions where the physical environment has historically made achieving this stability, quite challenging.
Likely impact on supply chain and infrastructure requirements	Supply chain systems will require a technological overhaul to allow for wireless-based tracking capabilities. With the deployment of the IoT (sensors, wireless and connected devices across the value chain and logistics ecosystems on goods, trucks, containers etc), all components along the supply chain will have to be fitted with IoT enabling technology. The long-term impacts on supply chains will have significant benefits on profit-margins (reduced lag times, reduced wastage of transport and logistics, fresh produce (assuming an agricultural supply chain)) and increased supply and business capabilities (from 'smart' systems ability to reorder stock when supplies become low). Additionally, the use of data transfer and analytics technologies would help components of the supply chain to better their service capacity and better allocate their resources where most efficient (eg transport providers). In particular, an industry survey recently revealed that eighty per cent of ports surveyed experience significant downtime between busy periods. IoT could be instrumental in increasing port usage year-round and optimise performance at the port end of the supply chain. There would need to be significant investment in the infrastructure of IoT to facilitate a successful implementation of IoT between businesses. For example, without the sensors, wireless and fibre cables network, agricultural producers are not able to fully utilise the IoT system to trace their goods to the end destination. This may have economic ramifications in terms of produce wastage, lost capacity in transport facilities and greater road and rail network usage than needed. An added benefit to both the supply chain aspect and infrastructure, is the ability for IoT to monitor asset loads (truck, container, train etc) to schedule and alert for maintenance requirements. This further improves efficiency costs as only well-maintained transport will be operational on the roads/rail/sea. This should consequently result in less break-downs, greater mobility of transport networks and stronger commerce. The greatest impact of Agricultural IoT technology is its ability to help foster regional development. As shown above, by providing data analytics capabilities for farmers and vignerons, IoT enables these producers to be more informed and make decisions based on environmental conditions that help to sustain their crop production and harvests. Longer term, this should have a lasting impact on farmers economic stability because they are less susceptible to uncontrollable weather conditions impacting their ability to market their produce.
Use case example(s)	Not provided in consultations

Source: https://www.forbes.com/sites/jacobmorgan/2014/05/13/simple-explanation-internet-things-that-anyone-can-understand/#250539e1d091, http://www.theland.com.au/story/4018057/embrace-real-time-data/?cs=4941

5.3 Use of online portals and cloud technology

5.3.1 Port systems

Table 17: Terminal booking systems

Description	Online tools and software that streamline port booking systems and container movements. This section looks at 1-stop, which involves the use of online tools and software to reduce port congestion. 1-stop allows for the exchanging of supply chain information where users

	can directly access vessel schedules, track their containers, lodge Customs documentation, and book times to pick up or drop off containers. It includes a Vehicle Booking System (VBS) that manages terminal capacity with electronic data entry and validation without manually keying in data. The VBS uses a PIN code system to signal each truck arrivals at the port and to alert port workers to collect and deliver the correct container.
Commodities impacted	All agricultural commodities
Take Up	Globally there are many online portals and software that manages port bookings and container movements. 1-stop is currently implemented at all eight DP WORLD and Patrick terminals in Australia and at the Victoria International Container Terminal.
Likely impact on supply chain and infrastructure requirements	Online tools and software that streamline port booking systems, such as 1-stop, could result in: • a reduction in truck queues and turnaround times; • increased reliability and certainty of freight and container movement for freight originators and end users; and • transparent information flow and more efficient allocation and utilisation of port equipment. More efficient asset utilisation could result in a decreased need for infrastructure investment at the Port.
Use case example(s)	DP World and Patrick terminals in Australia and at the Victoria International Container Terminal.

Source: https://www.1-stop.biz/

5.4 Autonomous vehicles

Table 18: Autonomous vehicles

Description	Autonomous transport vehicles which do not require a human operator to function. This includes road freight trains, rail trains, drones as well as passenger vehicles. Using sensor and radar technology these vehicles are able to navigate the surrounding environment without any human input.
Commodities impacted	Agriculture – especially fresh produce (reduced transport times (no maximum hours on driver shifts) and reduced wastage)
Uptake	Autonomous vehicles for point to point transportation are still in conceptual testing phases. The use of autonomous vehicle is largely closed operational environments, such as mining operations and distribution centers. In October 2016, a driverless truck successfully transported goods 'short-haul' autonomously across the USA. However, the technology required the truck to be on the highway before it could safely be engaged to drive autonomously. The trip therefore necessitated the use of a human driver. However, the transport company, Otto is developing the technology such that it is programmed capable for any and every possible traffic condition. As an interim step, it is likely that we will see road trains manned with one driver at the front of the fleet with automated trucks following behind (heavy vehicle platooning). Fully autonomous vehicles are projected to be operational between 2020-2030. From an infrastructure perspective, in the USA the first steps have been made towards investing in the infrastructure (the Smart Mobility Corridor) capable of facilitating automated transportation and connected-vehicles or road freight trains and drones. In Ohio, the state government is investing $15 million (USD) to install highway technology including sensors and fibre-optic cables which will increase capabilities for tracking and controlling automated vehicles, traffic conditions, and traffic mobility solutions. Additionally, if the drones' wireless concept is successful, this will further relieve the road/rail usage and infrastructure needs of relative government departments and resources.

Current or future technology	**Current and future** Finally, autonomous air transport has begun conceptually with the use of drones. Amazon Air Prime is a delivery service which uses small drones to deliver small parcels. This concept is however still in its testing phases in the USA and has not yet been commercialised. The original drones concept relied on an operator however in January 2017, the use of wireless technology was being tested as a means for creating an entirely autonomous delivery service.
Likely impact on supply chain and infrastructure requirements	Autonomous road and rail trains will mean that regulation surrounding driver responsibility (fatigue management, licensing) will significantly reduce. In terms of impact on supply chain, automation should dramatically cut transport time and costs associated with wastage, delay, recertification, and compliance. However, given these reductions are significant for the transport stage of the supply chain, there are likely to be increases in verification processes and costs for supply chain participants either side of the supply chain. For example, there may be increased costs for wheat producers who use aluminium phosphide as an insecticide in the treatment of weevils. In this scenario, producers would save costs involved in obtaining protective equipment for drivers and educating and equipping farm workers on the work health and safety procedures for dangerous goods. At the Port or end of the domestic supply chain, automation would greatly improve productivity and optimisation of end-supply chain utilisation. Theoretically, inbound transport consignments could be categorised and scheduled resourcefully to their respective ships and vessels based on variables such as weight, container size, destination, etc. In terms of the impact on infrastructure, the decrease in agricultural produce wastage attributed to increased transport capabilities (no fatigue management laws and limits on hours spent driving) should result in less road/rail usage that would usually arise from return trips for undamaged goods. This should reduce time and volume of infrastructure use over the longer term. From an infrastructure perspective, investments would be required to facilitate the automated transportation and connected-vehicles or road freight trains and drones. Additionally, if the drones wireless concept is successful, this will further relieve the road/rail usage and infrastructure needs of relative government departments and resources.
Use case example(s)	Amazon Prime Amazon Air Prime is a delivery service which uses small drones to deliver small parcels. This concept is however still in its testing phases in the USA and has not yet been commercialised. The original drones concept relied on an operator however in January 2017, the use of wireless technology was being tested as a means for creating an entirely autonomous delivery service.

Source: DIRD (2017), Social Impact of Automation in Transport

5.5 Intermodal freight terminals

Table 19: Intermodal freight terminals

Description	Intermodal freight terminals are facilities situated at strategic supply chain nodes where intermodal movement allows the efficient transfer of goods from one mode of transport to another.
Commodities impacted	All freight being imported and exported from Australia via an Intermodal Freight Terminal. Given agricultural commodities are typically produced in regional or inland areas, and intermodal freight terminals are intended to very quickly connect inland areas with Australia's urban supply chain networks and ports. Agricultural goods may be positively impacted through intermodal development.
Update	While not a new supply chain innovation per se, the operationalisation of a number of significant new intermodal developments in Australia is changing the face of domestic import and export supply chains. Application of technologies such as digitised supply chain planning and autonomous vehicles, amongst others, stand to improve the operating efficiency of intermodal hubs in a similar fashion to Australia's ports and other container terminals.

Likely impact on supply chain and infrastructure requirements	Developments at Enfield, Moorebank and Somerton have and will continue to shift greater freight capacity from road on to rail and provide Agricultural exporters with a cheaper means of transporting their goods to market. The deployment of dedicated rail shuttles between the Enfield Intermodal and Port Botany should incrementally increase through-put. Moreover, greater use of rail shuttles for 'wharf cartage' rather than road transport operators will see less congestion on urban road networks.
Use case example(s)	Not provided in consultations

5.6 Trade modernisation

Table 20: Trade modernisation

Description	A suite of measures under consideration or in development by the Australian government to re-engineer international trade business process and streamline border regulatory frameworks and leveraging new and emerging technologies such as cloud, artificial intelligence and distributed ledger (or 'Blockchain'). These include 'Secure Trade Lanes' and a 'Single Window for Trade, which the United Nations Economic Commission for Europe defines as a one-stop-shop for exchange of information between traders and government agencies.
Commodities impacted	• all freight either imported or exported from Australia, but particularly freight made up of regulated goods at the border and which requires permission from an Australian government regulator to be exported or imported (for example, agricultural commodities); and • trans-Tasman freight including agricultural commodities.
Uptake	Efforts to modernise the trade environment in Australia are in the proof of concept and pilot stage. The Australian government is exploring the implementation of a Single Window for Trade. Examples of Single Window systems can be found in many countries, with New Zealand's 'Joint Border Management System' being a recent and relevant implementation of a Single Window for Trade. As significant assets where clearance from government to undertake the import or export of goods is granted, Single Window systems represent critical ICT infrastructure which can streamline the flow of freight across the border. Where these systems experience issues, such as during the deployment of the Integrated Cargo System in Australia in 2005, they can also inhibit the movement of freight and cause bottlenecks. A move to replace the Integrated Cargo System with a new Single Window for Trade in Australia would likely incorporate the use of innovative ICT architecture and hardware, and may look to incorporate artificial intelligence or leverage industry-led Blockchain initiatives. For example, the recently deployed Barbados Single Window employs advanced artificial intelligence in the classification of goods, demonstrating that this technology is becoming more prevalent and cost effective. Governments are also forming partnerships to share data and intelligence on traders in order to better facilitate low risk trade and intervene in high or unknown risk activities. One technological innovation being explored by the Australian and New Zealand governments is a 'Secure Trade Lane' which is designed to "expedite trade and reduce border clearance costs for selected participants." While detailed information on the technical elements of the Secure Trade Lane are not in the public domain, based on our understanding of similar project the technology would involve advanced data sharing between the Customs authorities of Australia and New Zealand and require trusted entities to provide the respective governments with less information less often.
Likely impact on supply chain and infrastructure requirements	Any move by the Australian Government to implement a Single Window for Trade would likely yield significant improvements in terms of border clearance for international traders through the streamlining of business processes and regulatory frameworks. Moreover, the deployment of artificial intelligence would likely disrupt traditional freight supply chain intermediaries such as Customs Brokers and Freight Forwarders where some of the activities previously performed by these entities on behalf of international traders is now automated. In tandem, these types of measures would yield significant increases in the velocity of freight across Australia's border and through Cargo Terminals, Ports and Airports. Conversely, if the implementation of a new system is not carefully managed, it may also lead to the creation of bottlenecks where implementation issues are

	addressed in a live environment. The faster freight moves from Cargo Terminals, Ports and Airports through to the end user, the high the capacity of these key supply chain nodes as high container dwell times are cited by Container Terminal Operators as a significant capacity constraint on their facilities. The deployment of a Secure Trade Lane between Australia and New Zealand is likely to impact the flow of freight through the trans-Tasman supply chain. Depending on the number of international traders and volume of freight moving across the Tasman to support their operations, this technological innovation could improve the through-put of Australia's key freight supply chain nodes as well. However, as the Secure Trade Lane is a discretionary supply chain where only certain 'trusted traders' are eligible to ship their freight, the overall impact on the infrastructure and supply chain is expected to be limited.
Use case example(s)	Not provided in consultations

Source: Australian National Audit Office, Customs' Cargo Management Re-Engineering Project, [accessed 7 September 2017], https://www.anao.gov.au/sites/g/files/net3241/f/ANAO_Report_2006-2007_24

6 User needs

Current supply chains have evolved in response to the specific issues driven by participants and stakeholders in each agriculture sector. This includes the impacts of individual user scale of operations and geographic dispersal, their customer base, practicalities of product aggregation to achieve "train load" scale, service quality parameters and costs. The flexibility and responsiveness of road transport has driven this transport mode as the default land transport mode, with only a few exceptions where rail has maintained its position in the supply chain. The retention of rail's role in the supply chain is generally limited to bulk grain, and some intermodal/containerised freights, and a share of the livestock supply chain in Queensland.

User needs for the various agricultural supply chains can be summarised as being covered by parameters of:

- cost;
- reliability;
- capacity; and
- control.

Features of each and examples are described in the following sections.

6.1 Cost

End users in the agriculture sector typically face global as well as domestic competition. In Australia, this creates additional supply chain complexity relative to international competitors due to:

- additional positions in the export chain; and
- Australia's remoteness.

The export supply chain is significantly more complex in Australia compared to domestic supply chains given the requirement for either a maritime or aviation leg to connect with markets. Conversely, some global competitors in commodities are able to rely solely on a landside supply chain solution.

The additional complexity of Australia's export supply chain results in transport costs being a larger component of total cost of production in the agriculture sector than it is for many international competitors. Therefore supply chain efficiency in the agricultural supply chain – and particularly cost minimisation – is a critical element of the overall global competiveness for Australia's agricultural sector.

The overall cost of the rail based supply chain is a function of the aggregate unit costs per container incurred across each position within the rail based supply chain. The performance and costs of any one participant in the supply chain will impact and potentially flow through to participants in other positions of the chain given its interdependent nature and as a result may have to be absorbed as part of the total supply cost.

The competitiveness of the rail based supply chain and the associated freight traffic is optimised by efficient interaction and interface between all positions within the rail based supply chain. The individual efficiency and capacity of any position within the supply chain is generally insufficient to drive the overall suitability of the chain if the interdependent components are not also functioning at optimal efficiency and capacity.

Key cost considerations for end users in agriculture, which affect Australia's global competiveness, include:

- distance to markets;
- quality and functionality of infrastructure;
- impact of scale of production and aggregation of transport requirements;
- geographic dispersion of production and demand;
- seasonality impacts and seasonal variability;
- asset utilisation and cycle times;
- labour productivity and cost of labour (relative to other countries);
- energy efficiency and cost;
- underlying quality/productivity of the transport mode;
- specialist equipment required;
- terminal costs;
- product storage costs; and
- congestion costs (road) or rail curfew/delay costs.

6.2 Reliability

Reliability is an important consideration for users. This is driven by a need to:

- achieve the required paddock to customer timelines to take advantage of key marketing windows;
- ensure that additional storage costs and penalties are not incurred through missing shipping or port windows;
- improve the ability of supply chains to respond to the variability of production volumes – particularly during peak demand periods and bumper yield seasons; and
- provide adequate service frequencies and minimising unscheduled service disruption and associated recovery time.

Reliability is becoming increasingly important to users as bulk storage capacity for agricultural products is declining due to:

- bulk handling agencies seeking to improve supply chain efficiency by rationalising low utilisation assets eg GrainCorps Project Regeneration; and
- displacement or restricted operation of down country facilities through urban encroachment such as warehousing and cold stores proximate to port, placing upward pressure on costs to users.

Agricultural supply chains are typically multi position and multi service provider chains which are reliant upon optimal operations and capacity across all positions to drive the overall reliability of the chain. The impact of unreliability in the supply chain is more profound in comparison to resources supply chains.

6.3 Control

Cost competiveness, responsiveness and flexibility can be achieved though supply chain control. Therefore users seek to supply their individual supply chain to the extent they can. There are a number of transformations within agricultural supply chains that provide greater supply chain control to end users. These include:

- abolition of single desk entities such as the AWB, and the ability for more direct involvement in the market by individual producers;
- increasing size of production units and achieving better economies of scale;
- meeting customer requirements (scale, quality and more niche products), through product differentiation, through greater containerisation in the supply chain; and
- more extensive use of on-farm storage to permit optimising time to market and gaining advantage of market price variations.

6.4 Capacity

All users seek network capacity that is fit for the freight task undertaken in the individual supply chain. For example:

- users of the road based supply chains seek additional capacity both in terms of increased capacity on the road network (volume) and improved mass limits and vehicle lengths to enable the capture of productivity gains from High Productivity Vehicles; and
- users of the rail network seek sufficient capacity to respond to volume variation throughout the season while simultaneously minimising the cost to the end user of latent capacity resulting from network investment.

Some of the key capacity considerations for end users in agricultural supply chains include

- geographic distribution of producers, depots, infrastructure and customers;
- size of depots and individual customer demands (eg meeting shipping schedules);
- peak seasonal demands, including contingency arrangements for handling abnormal season production;
- availability and effective deployment of supply chain assets (trucks, rollingstock, storage facilities);
- quality and capability of the rail network infrastructure and line haul (train lengths, axle loads, train speeds, terminal facilities, cycle times, availability of train paths); and
- quality and capability of road line haul and first/last mile road legs (route heavy vehicle classification, road condition, cycle times, road congestion impacts, terminal queuing).

7 Bottlenecks

This section provides a high level discussion of potential bottlenecks that can occur in the agricultural sector supply chain. There are three key types of bottlenecks that occur in agricultural sector supply chains. These are:

- capacity;
- regulatory; and
- approvals.

7.1 Capacity bottlenecks

7.1.1 Road based supply chains

Road based supply chains exhibit considerable flexibility. They have:

- low barriers to entry;
- a multitude of suppliers operating in a highly competitive environment;
- short lead times to increase fleet capacity; and
- ability to respond to changed circumstances, such as peak demands, and unplanned outages.

One of the key challenges for road based supply chains is to capture the productivity savings generated through the use of High Productivity Vehicles. Road network capacity is a significant bottleneck (either real or potential) to maximising the use of High Productivity Vehicles in the agricultural supply chain. Capacity bottlenecks can result from:

- road network standards; and
- network congestion and service levels.

Road network standards

State and local governments set road standards, and regulate the heavy vehicles and permitted heavy vehicle routes. This includes limits on vehicle length and gross vehicle mass, and driving hours. These standards effectively regulate vehicle payload which significantly influences the cost of the road based supply chain. Standards are not consistent network wide. Individual network segments have variable standards and permissible vehicle configurations and payloads. Users and operators potentially face a decision to choose:

- a sub optimal route which maximises payload volume but increases travel distance, time and cost; or
- an optimal route in terms of direct distance which minimises travel distance and time but may decrease the gross vehicle mass and payload.

Variability in the following road elements impacts the approval of heavy vehicle routes and route selection:

- bridge standards (axle loads and width);
- lane widths and turning radius;

- pavement standards (axle loads, length and height); and
- intersection features (length and height).

Network congestion

Network congestion results in the following in the road based supply chain:

- increased travel time and vehicle operating costs; and
- reduced reliability and ability to meet receival windows – primarily at port or intermediary facilities such as feedlot, abattoir or warehouse.

These issues are particularly relevant to containerised agricultural cargo such as grain on route to metropolitan container ports or bulk cotton bales on route to metropolitan warehousing and containerisation facilities. However, they can also be localised when the local road network serving regional intermediary facilities such as feedlots, abattoirs and intermodal terminals (Pick up and delivery (PUD) leg).

The causes of road congestion are numerous. A selection of causes that are relevant to the agricultural supply chain include:

- lane carrying capacity;
- non-commercial vehicle volumes (particularly where freight is traversing the network in am and pm peaks); and
- poorly managed vehicle booking and arrival/departure windows at receival points such as ports and warehouses.

Road congestion around Port Botany is the most critical current road bottleneck for containerised agricultural exports in NSW, but Melbourne, Brisbane and Perth also experience road network congestion issues for freight.

7.1.2 Rail based supply chains

Unlike road, rail based supply chains are considerably more complex. Rail is a multi-party supply chain with a range of parties involved. There are significant infrastructure constraints on different networks resulting in operational inefficiencies arising from infrastructure limitations, and the need to share sections of the rail network with other users. The bottlenecks for rail for key agricultural commodities include:

- service catchment;
- network standards;
- access and pathing; and
- metro terminals.

Network coverage and service catchment

The national rail freight network and component parts serving regional Australia was established as the core transport network to underpin regional economic development. The rail network was established prior to the emergence of high capacity multi-combination vehicles that transformed the ability of larger vehicle combinations to make road based supply chains very competitive.

The freight rail network serving the agricultural sector (such as the legacy grain lines):

- covers a substantial area with extensive branch line infrastructure;

- requires a longer travel distance to destinations to capture a broader growing area in order to maximise customer coverage; and
- generally has low quality legacy rail infrastructure that is fit for purpose with constrained line haul speeds and axle loads that is sub-optimal relative to mainline networks and a higher potential capacity associated with modern rolling stock.

Branch line closures over recent decades (and most recently with the Tier 3 lines in Western Australia) and the rationalising of rail grain receival depots in a number of regions, has contributed to a lessening of the geographic coverage of the regional grain rail network and resulted in mode shift and increased use of road transport. Furthermore, the retention of land assets by bulk handlers and restriction of access to rail sidings (such as those in regional NSW) has inhibited the potential use of rail by other rail providers as well as diversification of use of the network for other agricultural freight commodities.

The comparative disadvantage of travel distance across the rail network relative to road transport results in a reduction of rail competiveness relative to more direct road freight routes. This is particularly the case for grain transport in the eastern Darling Downs, where road links from the Darling Downs region are significantly quicker than using rail to Port of Brisbane.

Variable rail network quality

Regional feeder branch lines in agricultural production networks can generally be characterised as fit for purpose minimum standard, with low axle loads and short crossing loops, limiting access for higher performance locomotives and wagons, and train payloads.

The track condition, including old light weight rail, timber sleepers and a legacy ballast profile, also restrict train speeds, and the achieving of efficient train cycle times. There has been as a consequence, a decline in rail usage and extended under-investment in the regional grain belt branch lines in most jurisdictions.

In south west Queensland, the rail network is currently constrained by low axle load (15.75 tonnes) throughout, and low vertical clearances in the tunnels between Rosewood and Toowoomba. This has limited the ability for rail to compete for the haulage of containerised grain (ie only one loaded 20 foot box per wagon), and constrained carrying of the high-cube containers used for cotton. Lowering track in the tunnels is planned to address the latter constraint. The completion of Inland Rail will partly address the problem of low axle load on the main trunk route, but not on the feeder lines.

The mix of rail gauges, axle loads and low and uncertain volumes, make it unattractive to new rail entrants, entrenching a lack of competition in the rail supply chain. This has been partly offset with pricing based on older, essentially life expired, rollingstock, but with downsides in terms of rollingstock maintenance costs and rail performance reliability.

Grain rail supply chains can be successful. CBH in Western Australia has taken control of its above rail grain supply chain, with an investment of $175m in 2012, acquiring 22 new locomotives and 574 grain wagons. CBH achieved a record monthly grain railing of 964,832 tonnes in March 2017 and has contracted Watco WA Rail, an experienced US short line rail operator, to operate these grain trains.

Current investment by the Commonwealth and Victorian Governments converting the broad gauge Murray Basin branch lines to standard gauge, including major track and axle load upgrades, is an example of what is needed to drive rail efficiencies for the bulk grain and other freight traffics on these lines.

Investment hurdles to network upgrades

The previous privatising of regional grain branch lines in Victoria, South Australia and currently in Western Australia, have demonstrated the difficulties in private sector investment in grain branch line upgrades, even where rail operating efficiencies can be demonstrated.

The lack of volume scale, and seasonal variability in production volumes, contribute to not achieving commercial investment hurdles for both the below-rail infrastructure and rollingstock. Unlike the resources industries, the grain industry has limited ability to enter into substantive Take-or-Pay contracting arrangements that would underpin investment in rail networks, and similarly for third party above - rail operators. CBH in Western Australia has acquired its own train sets to achieve its objectives, and take a greater control of its grain supply chain and internalise its rail haulage business risks, rather than relying on the previous incumbent Rail Operator.

There have been recent moves to invest in new or upgrading existing grain receival terminals in some jurisdictions, and this should address some legacy problems with catering only for short trains, with slow loading rates and resultant poor rail asset utilisation.

Shared rail network sections

The rail based agriculture supply chains generally include some level of sharing with other freight traffics, and/or with passenger services. This is particularly so for the major supply chains accessing the capital city ports, as well as the major multi-commodity ports.

Passenger priority provisions in most jurisdictions involve freight train curfews on shared track sections around the passenger peak periods, and agriculture product trains may have a lower priority in gaining track access paths and day-of-operation train scheduling compared to other freight services.

This increases train cycle times, reducing supply chain capacity and increasing costs.

Limited above rail competition

Track gauge and axle load limitations have both contributed to the lack of effective competition in providing rail services for the agriculture industry. This has been exacerbated by relatively low volumes (compared to the major resource industries (coal/iron ore), and the seasonality and seasonal volume variability.

The grain branch lines with limitations in particular, have a heavy reliance on utilising older locomotives and wagons, with insufficient volume to support new entrants, or re-capitalising the bulk grain rollingstock fleets. CBH in Western Australia has been a recent major exception to this, but as a grower cooperative controls the major share of the Western Australian grain export market, compared to the growing regions in the eastern states. South Australia grain is handled by GWA who operate an integrated model control above and below rail operations.

7.1.3 Terminals

Terminals for both road and rail based supply chains can be bottlenecks for some supply chains. This can include inadequate storage capacity to meet bumper season production, and in-loading and out-loading capacity constraints. For a number of the rail-based grain supply country depots, investment has failed to keep pace with user needs, with limitations on maximum train lengths and slow train loading rates common constraints.

The trend to more differentiation in products has exacerbated the issues with some bulk terminals. Containerisation of agricultural products is increasing as a consequence, requiring an alternate rail operation to the cycling of bulk grain trains. This has contributed to a growing requirement to provide effective regional intermodal terminals, where the consolidation of container volumes can provide the economy of scale to operate regional intermodal services, with a service frequency and cost structure attractive to users.

7.2 Regulatory Constraints

7.2.1 Road based supply chains

Road Network Management, Operation and Financing

The road network serving the agricultural road based supply chains, including road links to the rail terminals, comprises the bulk of the regional road network and State and National Highway networks. All three levels of Government are involved to varying extents, including responsibility for planning, building new road links and upgrading existing roads, and in road maintenance.

However, there is differing capacity within each tier of Government to capture revenue to fund road capital projects and operations and maintenance.

Currently the Australian Government has significant ability to capture revenue to fund road infrastructure both through general taxation and fuel excise and approvals revenue from NHVR as a road specific revenue source. State Governments have regulatory mechanisms such as licensing, registration and GST allocations from Australian Government.

Local governments have few options to raise revenue beyond registration charges and therefore few incentives to maximise permissible mass limits given their inability to raise revenue for operations and maintenance required for heavy vehicle traffic. This creates significant connectivity issues – particularly from farm to bin and bin to feedlot/warehouse/ abattoir. This is both a regional and metropolitan bottleneck.

Performance Based Standards System

The Performance Based Standards (PBS) Scheme permits the deployment of vehicles of greater length and greater capacity (eg higher mass) than standard vehicle combinations, to access designated routes. This includes deployment of B-Doubles, A- Doubles and various road train vehicle types. On previously designated routes, application to deploy approved vehicle types is straight forward. Extension of these routes and the first/last mile links require more detailed consideration by the road authority, and non-approval or delay in approval may be a roadblock.

7.2.2 Rail based supply chains

A one size fits all approach to regulation

Almost every below rail manager controls a diverse range of lines that have different demand-side characteristics. These can be classified as:

- commercial lines, which are profitable at the full economic cost;
- economic lines, which only cover the costs of providing access to those lines; and
- legacy lines, which are loss making and generally subsidised by the government.

Managers of networks with legacy and economic lines report that, due to demand-side factors, they are unable to set prices that recover capital costs. As the manager does not have significant market power on these lines, the benefit of heavy handed regulation could be very low relative to the cost of compliance, but some regulators do not differentiate. This is particularly relevant in states such as Queensland, NSW and Western Australia that have substantive commercial resource and agricultural networks as well as legacy agricultural networks.

7.3 Approvals Constraints

7.3.1 Rail Based Supply Chains

Lack of Regional Oversight

In regions such as the Riverina, which are characterised by the production of multiple railable agricultural products, there is an emerging trend for producers to build, own and operate their own intermodal and bulk terminals which are scalable to variable volume. In the Riverina there are up to 5 proposals for intermodal terminals located in different local government jurisdictions that have either received planning and building approvals or are seeking approval. These terminal proposals are all contingent on consolidating throughput from the same producers to achieve the scale required to operate viably. The region has insufficient throughput to support all proposed terminals.

This lack of regional oversight could potentially result in all 5 terminals entering operation and effectively cannibalising volumes to the point that some or all which become unviable. This would seriously destabilise rail freight in the region as the service operators would react to perceived increase of risk through contracting terms.

Appendices

Appendix A Riverina Case Study

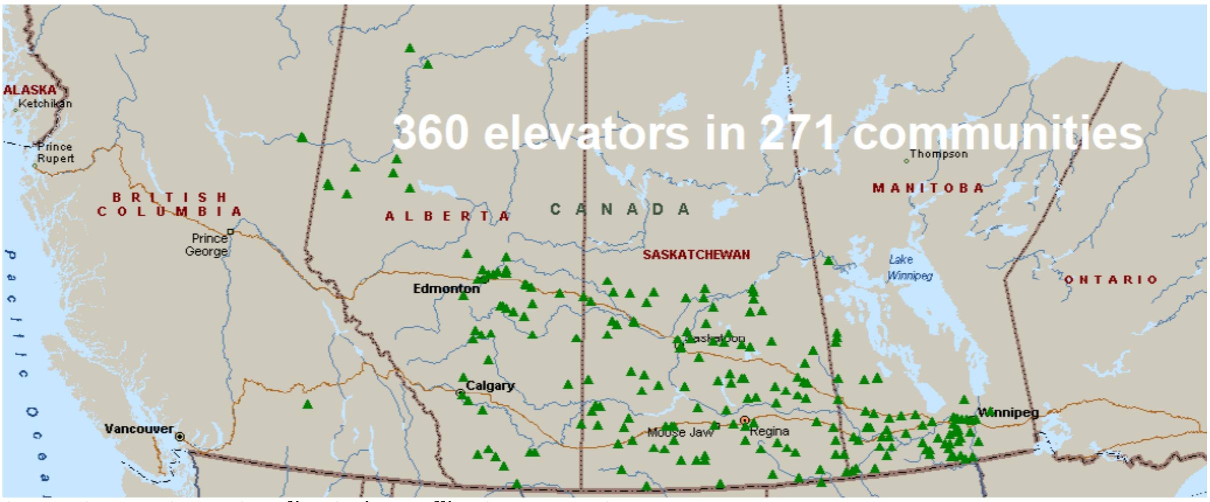
[Attached with this report]

Appendix B Western Canadian Grain Export Supply Chain

1 Demand and Production

In Canada, the central plains area is the major grain production area and is referred to as the Western Canada Grain area. It covers a total area of 150 million ha with approximately 18% of the land or 27 million ha under cultivation (Statistics Canada 2010-11).

Figure 18: Canadian Elevator (Silo) Storage and Transfer Facilities 2011



Source: Quorum Corp – Canadian Grain Handling & Transport System – 2012.

Grain production in Canada averaged a total of 73 million tonnes p.a. over 2009 to 2013 (Aegic 2015). This excludes the 2013-4 record season of 90 Mt which was 25% above average. A breakdown of the grain products in terms of production and export volumes are outlined in Table 21.

Table 21: Canadian Grain Production and Export (5 Year Ave to 2012-13)

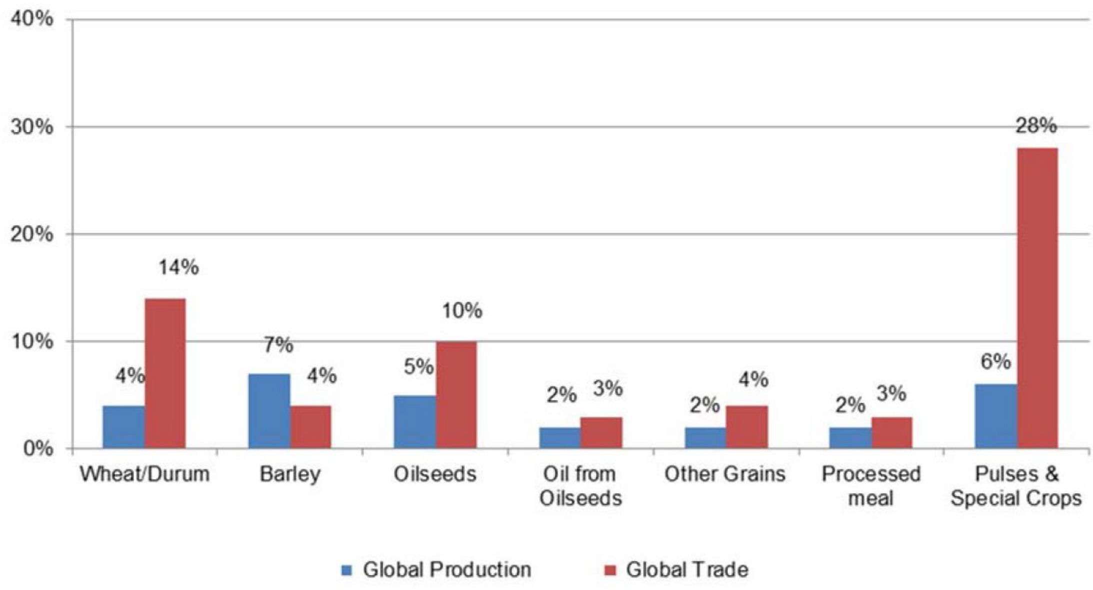
Grain Product	Production (M tonnes)	Exported (M tonnes)
Wheat	26.3	18.2
Canola	13.4	7.6
Barley	9.0	1.3
Oats	3.1	1.6
Pulses	5.3	4.7
Corn	11.4	0.9
Other crops	4.5	2.9
Total	**72.9**	**37.2**

Source: Aegic – Canada challenges Australian grain supply chains – 2015.

The total international grain market with production from 161 countries is estimated at 2.2 billion tonnes p.a. of which approximately 20% or 440 Mt is traded globally (Quorum 2014). The Canadian production and export levels outlined in Table 21, make it the 8th largest producer and the 4th largest exporter of grain products. While Canada produces 7% or less of any one product, it is a significant exporter of wheat, canola and pulses.

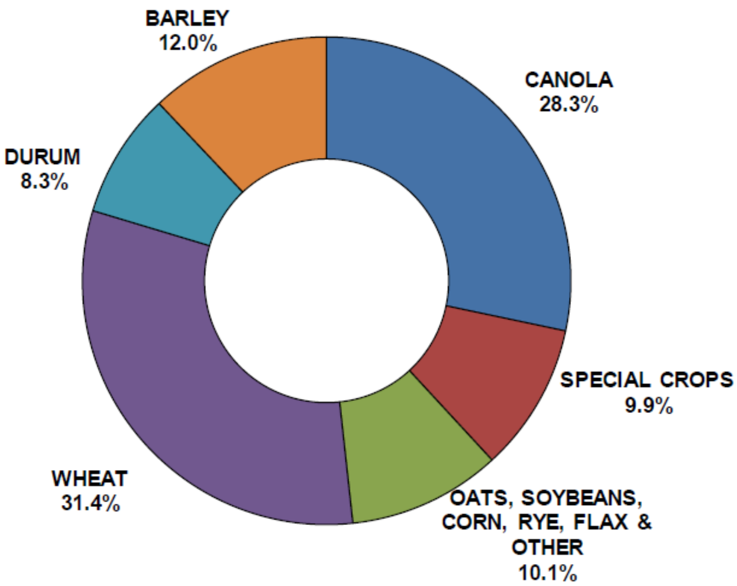
Spring is the main growing season in Canada with crops sown in in late April or early May after the winter snow has melted. Crops are rain fed and grow throughout summer and mature into the autumn period with the crop life cycle completed within 4 to 5 months. Crop growth is curtailed by mid-September by autumn frosts. Some winter cropping also occurs where crops are sown in September to enable seedlings to emerge before winter and survive under the snow. They grow and are able to be harvested early before the spring crops. Crops are harvested from mid-August to mid-October and stored and/or transported for export before winter.

Figure 19: Canadian Share of Global Production and Trade 2006 to 2010.



Source: Quorum Corp – Grain Supply Chain Study 2014.

Figure 20: Canadian Grain Production Share 2015-16.



Source: Quorum Corp – Canadian Grain Handling & Transport System - Annual Report 2015-16.

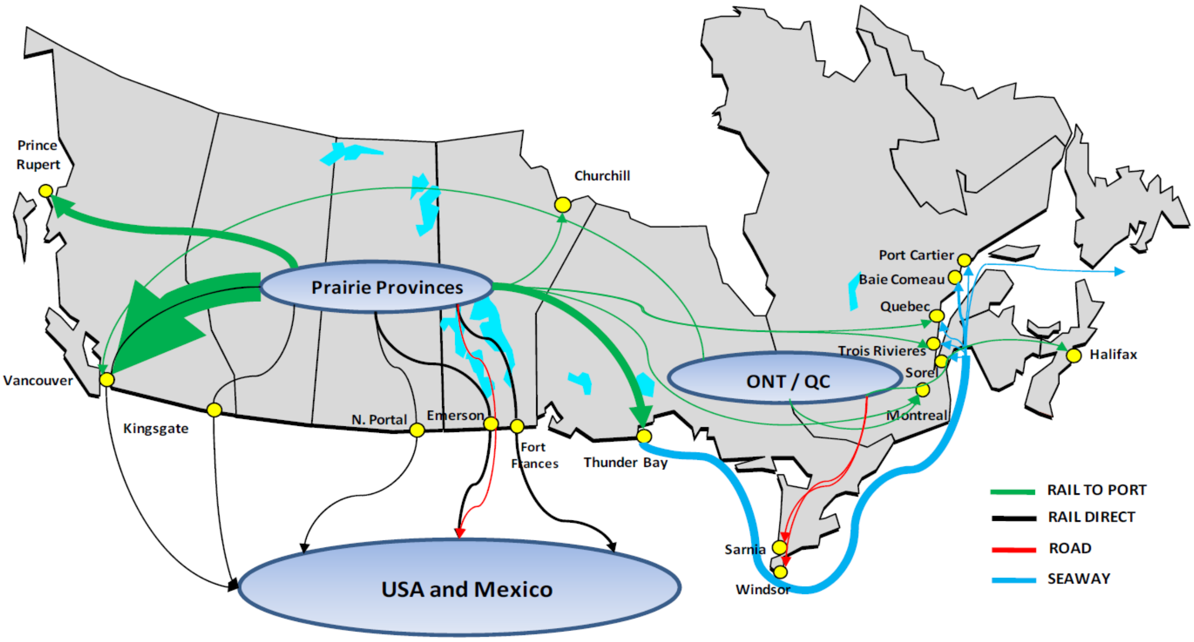
As outlined in Table 21, approximately 50% of the grain produced in Canada is exported. The key supply chains for both export and domestic grain in Canada are as follows.

- Wheat – Exported to European, North America and Asia/Pacific markets.
- Pulse and Special Crops – Exported to the Indian sub-continent and western Asia.
- Other Grains – Oats to US and Flax for Europe and Asia
- Wheat and Barley – Domestic milling and malting markets.

Major Canadian export grain markets in 2012-13 were identified as (CGC 2014):

- China – 5.4 Mt
- Japan - 4.7 Mt
- USA – 4.1 Mt
- Mexico – 2.1 Mt

Figure 21: Key Modal Freight Flows – Canadian Grain Exports 2011

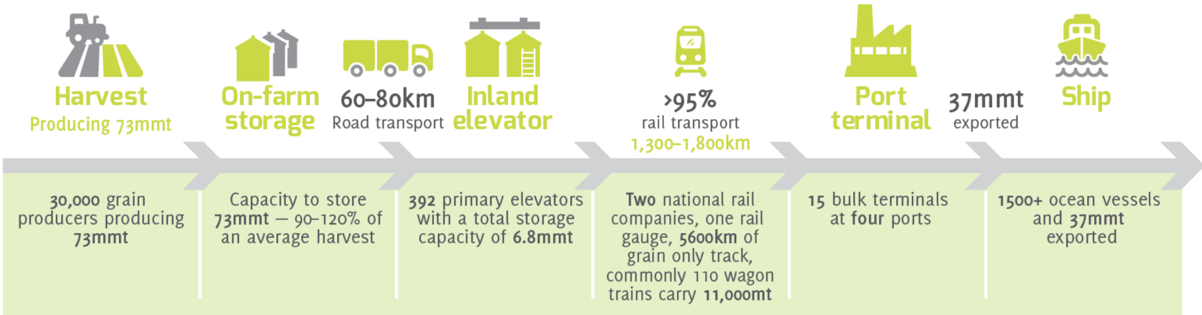


Source: Quorum Corp – Grain Supply Chain Study 2014.

2 *Transport in the Canadian Grain Industry.*

There are multiple stages in the export grain supply chain. These are outlined in Figure 22. The transport of grain in Canada for export is primarily undertaken by rail from the central Prairie Provinces to key ports (77%) or direct rail (17%) to US and Mexican markets (Quorum 2014). This leaves approximately 5% that is transported by road to its destination in the US.

Figure 22: Overview of Canadian Grain Export Supply Chain



Source: Aegic – Canada challenges Australian grain supply chains – 2015.

The supply chain in Canada is structured around a pull delivery system. Most of the grain is stored on farm after harvest rather than in regional facilities. The grain remains at the farm and is only trucked to a rail "elevator" receival site for loading on rail services and transport to a designated Port to meet the specific vessel arrival. This "pull system" effectively operates as a just in time system driven by the optimisation of the Port facilities. This is driven by the need for certainty in terms of matching the rail delivery capacity with the Port storage and ship loading capacity.

3 *Grain Bulk Exports by Sea*

For the Canadian bulk grain exports that are shipped to overseas customers, there are only four export Ports with 15 terminals used for approximately 37 Mt of bulk grain export products. The large grain companies own most of the port capacity with Viterra, Richardsons and Cargill accounting for approximately 75 % of the export grain task (Aegic 2015).

The two major export Ports are on the west coast and handle 79% of the export task in Canada compared to 20 terminals at 18 ports in Australia for circa 28 Mt of bulk grain exports. The western ports of Prince Rupert and Vancouver have excellent connectivity with, and access to the Asian Pacific and Middle East markets. These ports handle 77% of the export seaborne task through 45% of the storage capacity, resulting in an intensive utilisation of facilities and high stock turns. Seaborne exports using the Thunder Bay Port will be targeting the European and Middle East markets but have to travel through the Great Lakes and the St Lawrence Seaway to access the Atlantic Ocean. The Canadian Export Ports are outlined in Table 22.

Table 22: Canadian Grain Export Terminal Capacity and Throughput (2011-12)

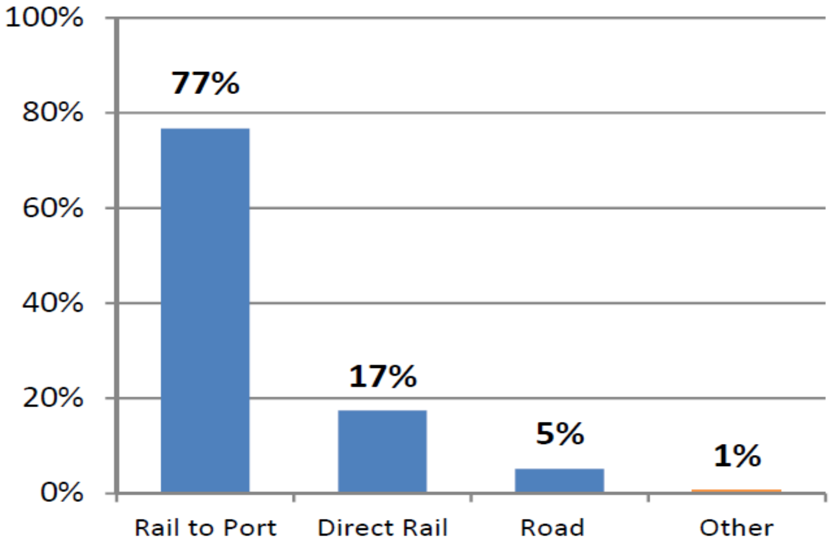
Grain Port Location	No. of Terminals	Storage Capacity (Tonnes)	%	Grain Product Throughput (Million Tonnes)	%	Stock Turns p.a.
Prince Rupert	1	209,000	8%	6.3	17%	30
Vancouver	6	954,290	37%	23.1	62%	24
Thunder Bay	7	1,230,000	49%	7.2	19%	6
Churchill	1	140,000	5%	0.4	1%	3
TOTAL	**15**	**2,553,290**	**100%**	**37.0**	**100%**	**14**

Source: Aegic – Canada challenges Australian grain supply chains – 2015/ Quorum Corp – CGHT System – 2017.

4 *Bulk Grain Export Transport by Rail*

Rail is the predominant land transport mode for exports by sea and exports into the USA and Mexico. Rail transports 77% of product to port facilities for loading onto bulk vessels and 17% of product is transported to southern destinations directly by rail line haul. This makes rail the prime haulage mode for 94% of all grain exports. The balance of the product (2.3 Mt) is primarily transported to the USA by road transport.

Figure 23: Modal Distribution of Canadian Grain Exports - 2011

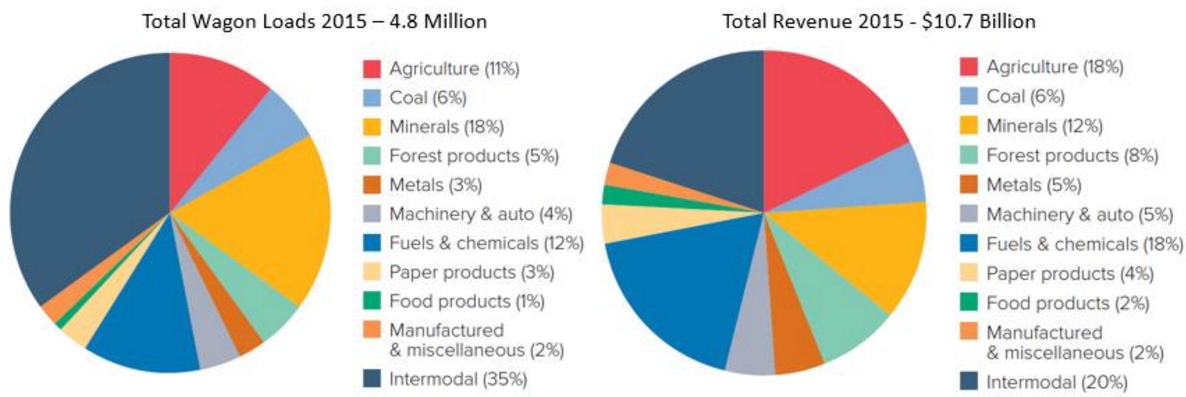


Source: Quorum Corp – Grain Supply Chain Study 2014.

5 Rail Grain Operations

The Canadian rail freight industry is dominated by the major Class 1 rail companies. There are two major Class 1 companies in Canada. These are Canadian National (CN) and Canadian Pacific (CP). Rail operations in Canada provide important transport linkages across the nation and haulage of a broad range of products. While agriculture that is dominated by grain haulage is an important market sector for the rail freight industry, it has a diversified base. CN and CP provide an integrated rail service for customers through management of both the above rail train operations and below rail network infrastructure. Each has a network that it effectively manages as its core franchise and have to establish interchange commercial agreements to use or access network beyond their respective territories.

Figure 24: Canadian Rail Freight Industry Loadings & Revenue 2015



Source: Railway Association of Canada – Rail Trends 2016.

In the Western Canada grain region, the rail network in 2013 consists of circa 27,820 km of track of which only 5,400 km or less than 20%, are grain only lines (Quorum 2017). The two major rail companies own 85% of the network (23,600 km) and transport 96% of the grain export task. CN focus on their network in the north and CP on the southern region (Figure 25).

Figure 25: Western Canada Rail Network

Source: Railway Association of Canada – Rail Trends 2016.

Shortline/regional rail operators own the balance of the network (4,220 km) and connect with the Class 1 networks. The viability of the shortline branch lines are directly related to the number of regional receival facilities (country elevators) that undertake rail loading and the volume of grain transported on these lines. The rationalisation of grain receival sites over the past 15 years (1000 + to circa 380) and branch lines serving the region has contributed to a 38% percent reduction in the transit time across the supply chain from the time of receival of product at inland sites to loading onto vessels (Quorum 2017). This has been driven by enabling the loading of longer rakes of wagon (i.e. 110 wagons), enabling quicker loading, and reduced shunting. However, the “pull system” and country depot storage capacity limitations of 6.8 Mt has resulted in an increase in the distance of the inbound road delivery leg from farm to depot from 20 km to 80 km (Aegic 2015).

Figure 26: Canadian Grain Export Supply Chain Transit Time - Days

Year	Country Depot Storage	Rail Linehaul to Port	Port Storage & Loading	Transit Time Depot-Vessel
1999-00	41.7	7.8	18.6	68.1
2012-13	26.5	5.4	14.3	46.2
2013-14	26.9	5.3	8.9	41.1
2014-15	25.5	5.8	10.7	42.0
2015-16	26.1	4.8	10.9	41.8

Source: Quorum Corp – Annual Report 2015/16 - Canadian Grain Handling & Transport System – 2017.

The rail haul task from country depot to port terminal is much longer than grain hauls in Australia generally covering distances from 1300 km to 1800 km compared to distances of 100 to 400 km in Australia (Aegic 2015). To make the haul task as efficient as possible, the rail operators seek to run the largest train configuration possible on the network and port infrastructure. The standard train configuration is generally a diesel hauled standard gauge service hauling a minimum of 100 wagons. This train configuration can achieve a train payload of 11,000 tonnes of grain.

Generally, the Canadian/US networks can accommodate a much larger structure gauge (train envelope) than Australia that enables the deployment of larger locomotives and wagons. The train length for a 110 wagon train would be in the order of 2 km long and is likely to require up to 4 locomotives for a train of this length and weight. The motive power required would be determined by the trailing load (payload plus wagon tare) and the ruling grades on the various routes.

CP has trialled longer train configurations up to 138 wagons in recent years (Aegic 2015). Extending train lengths are limited by infrastructure constraints (e.g. passing loops). Even with track infrastructure able to accommodate longer services, loading or discharge facilities will be designed to a standard (e.g. 100 wagons). This can make the assembly or breaking of long train configurations more difficult.

CN has indicated that they are now running 200 wagon (circa 4 km) train services (CN 2017). This is based on loading separate 100 wagon services at different depots that have a proximate origin so they can be combined for line haul and broken into 100 wagon consists at the port for unloading. CN are able to undertake these step change options relatively quickly because they control both their below rail and above rail operations and can pursue integrated synergies.

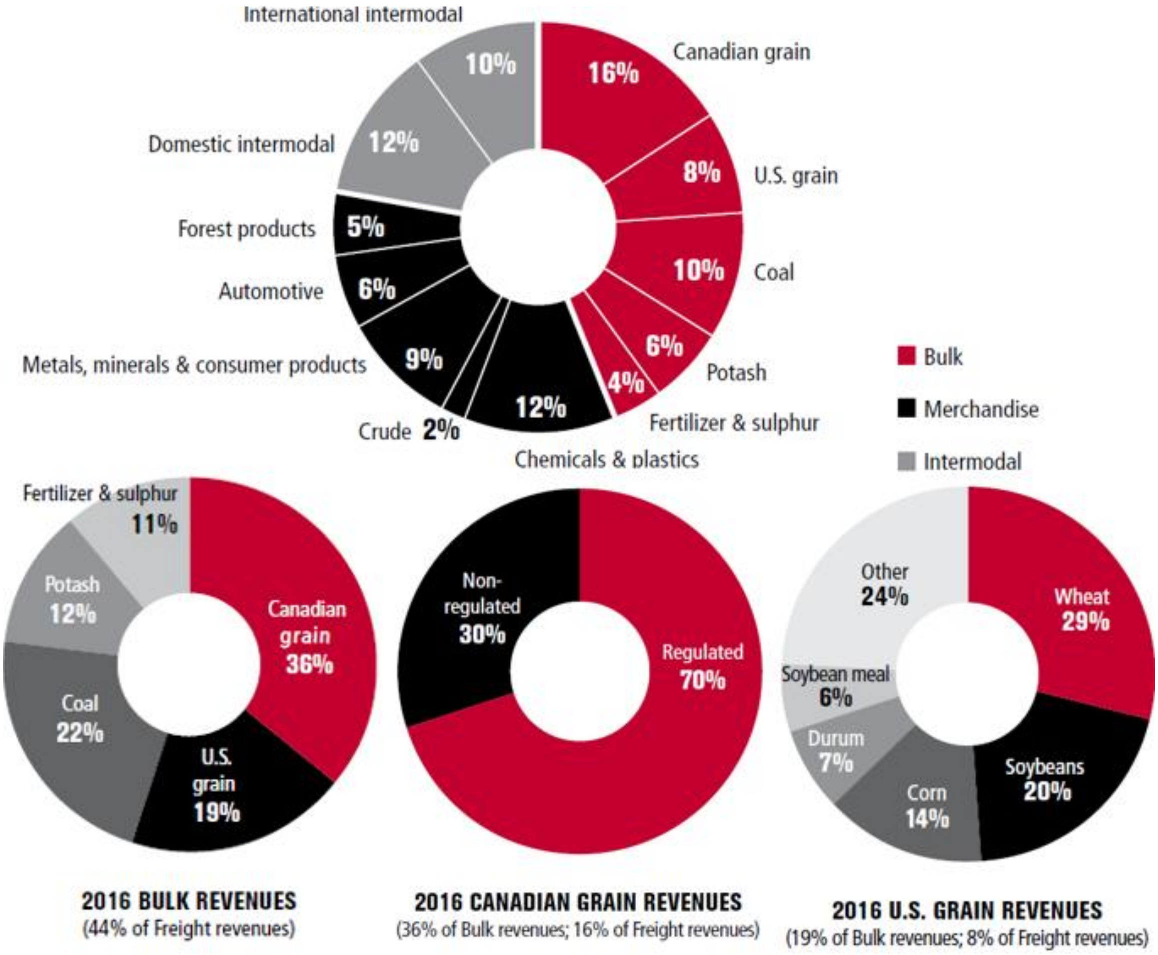
The efficiency of train operations are also impacted by loading and unloading rates. Train loading at high efficiency / throughput depots can load a 100 wagon consist in less than 24 hours (CP 2014).

While cycle times vary according to origin destination routes, the round trip duration for export grain services from western Canada to the export ports are likely to take 12 to 14 days covering loading, discharge and line haul compared to 1 to 1.5 days in Australia (Aegic 2015). The distance and the scale of the haul task is the reason that road transport cannot compete with rail effectively in Canada. As a result, the major rail operators are the only viable options for the long grain haulage task to ports for export in Canada. In contrast, the short haul distances and cycle times in Australia results in road being the default mode operation in Australia for many routes, and this ensures that transport costs are competitive given road and rail can be substitute modes for each other in the grain transport market.

Unlike Australia, the grain haulage tasks make up a large proportion of the CN and CP rail businesses. Grain is the largest market segment for CP comprising $1.48 billion or 24% of the $6.06 billion of freight revenue in 2016 (CP 2017). This is equivalent to 432,000 wagon loads p.a. The Canadian rail component generates $962 million of revenue. CN has a larger overall freight business at $11.3 billion of which grain haulage is $1.68 billion or 15% of the freight task (CN 2017). This equates to an estimated 480,000 wagon loads p.a.

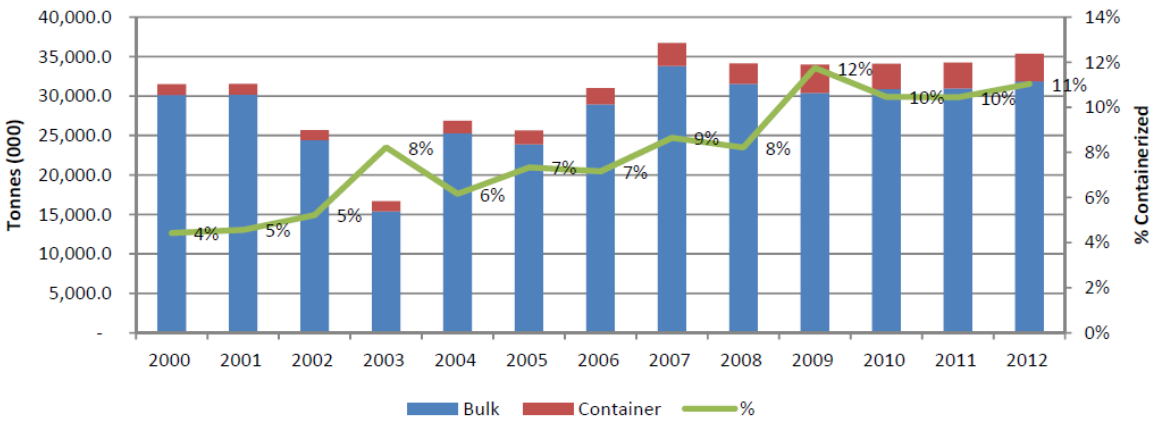
Increasingly, the transport of export grain has included containerised options. The grain container traffic moves through the intermodal supply chain, accommodating customers who do not have access to bulk grain handling facilities at either the origin or destination of the supply chain. In addition, the segregation of specific grain varieties enables producers to differentiate products on quality dimension. Containerisation of pulses and legumes makes up the majority of containerised grains.

Figure 27: CP Rail Revenue Profile Breakdown 2016



Source: CP Annual Report 2016.

Figure 28: Comparative Bulk v Container Export Grain Task



Source: Quorum Corp – Grain Supply Chain Study 2014.

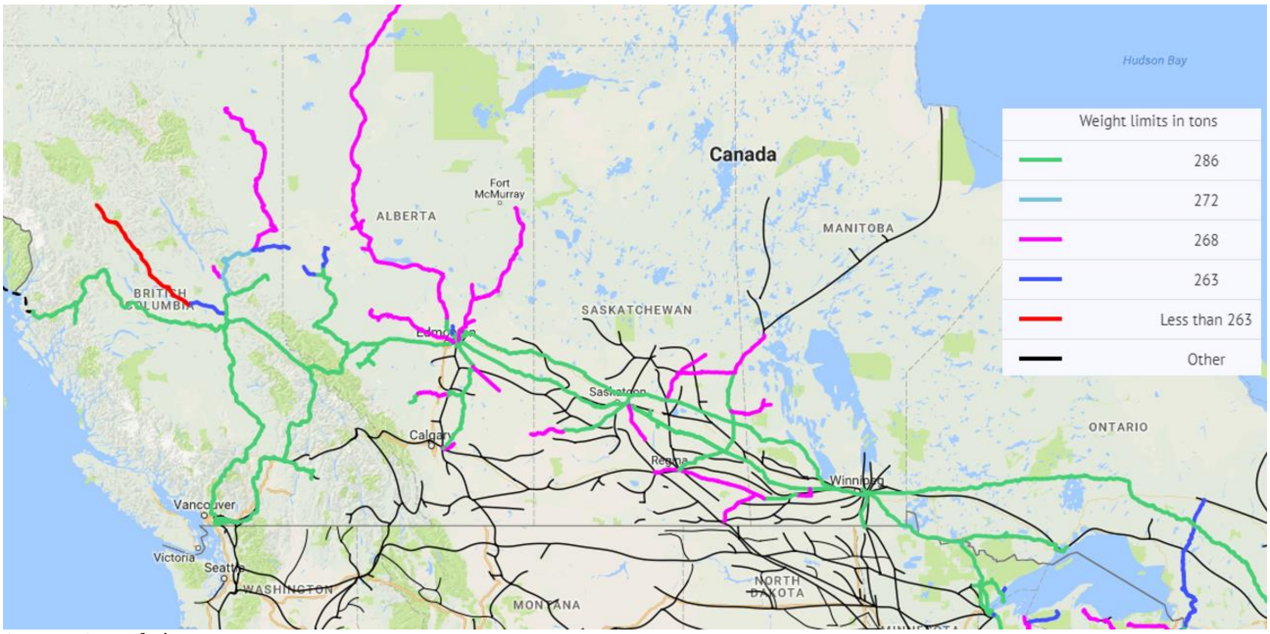
6 Rail Network Infrastructure

The major rail companies when providing integrated rail transport services to customers, have a dual commercial challenge of matching both track and operating capacity to customer requirements. Revenue generated from customers must cover operating costs including a margin and a ROIC for all of network, rollingstock fleet and support facilities. Many Australian grain rail networks are not multi product corridors like Canada. The relatively close proximity of the Canadian oil and minerals fields to the western grain region results in the networks being more heavily trafficked and generating a total revenue that provides a sustainable return on network assets. Only 29% of the grain exported from Western Canada was sourced from grain only branch lines (Aegic 2015). Shortline operators who provide services on their networks are generally grain only lines as well. Only 3.8% of grain is sourced from receival sites on shortline branch lines (Quorum 2013).

Increasingly, the rail operators are offering customers guaranteed car supply ("take or pay") rail contracts that include an allocation of rail capacity that is secured in advance of the grain season (CN 2016). This is beneficial to the rail companies who lock in customer capacity, plan capacity and communicate discretionary availability for residual spot capacity.

The rail companies must also undertake continual network investment to optimise operational efficiency and to connect or extend the network to new depot locations which are the aggregation and collection points for grain volumes. The main CP and CN networks have standards aligned to the USA networks to allow the switching and interchange of wagons between operators across country borders. The axle loads operating on the major networks have progressively expanded to accommodate the larger, more efficient rollingstock essential for long distance hauls. The CP and CN wagon load capacities on the major grain corridors to the Port are the same as the US 286,000 lb gross vehicle weight ("286k GVW") equal to 32 TAL in Australia. More remote branch lines and shortline branch operations that connect to the major networks, may have a lesser TAL track standard.

Figure 29: CN Network TAL Limitations West and Northern Regions



Source: CN website.

The networks developed by the rail companies also reflect the capacities required in individual regions for specific customer demand and products. While the majority of the network is single line track with passing loops, sections of the network has been expanded and augmented over time to meet capacity requirements. Exchange agreements exist between different rail operators to facilitate the transport of rail freight across the networks of competitor operators as required.

7 Capital Investment

Maintenance of these large network systems combined with the upgrades, capacity expansion and adoption of new technology requires significant ongoing investment. The total Canadian network comprises 44,000 km of which 28,700 km is in the Western Canada grain region. CN and CP own and operate 84% of this network with grain only lines comprising only 20% of the network (Quorum 2013). To maintain their networks, CN and CP are investing approximately $1 billion p.a. each.

The Capital Programs for CN and CP are significant. CN are planning to spend $2.5 billion in 2017 of which $1.6 billion will be invested in track infrastructure upgrades and improvements (CN 2017). CP also has a significant capital investment program. They expected to spend $1.25 billion on capital programs in 2017 after investment of $1.2 billion in 2016 of which over $900 million was invested in track infrastructure improvements and new projects (CP 2016).

8 Regulation

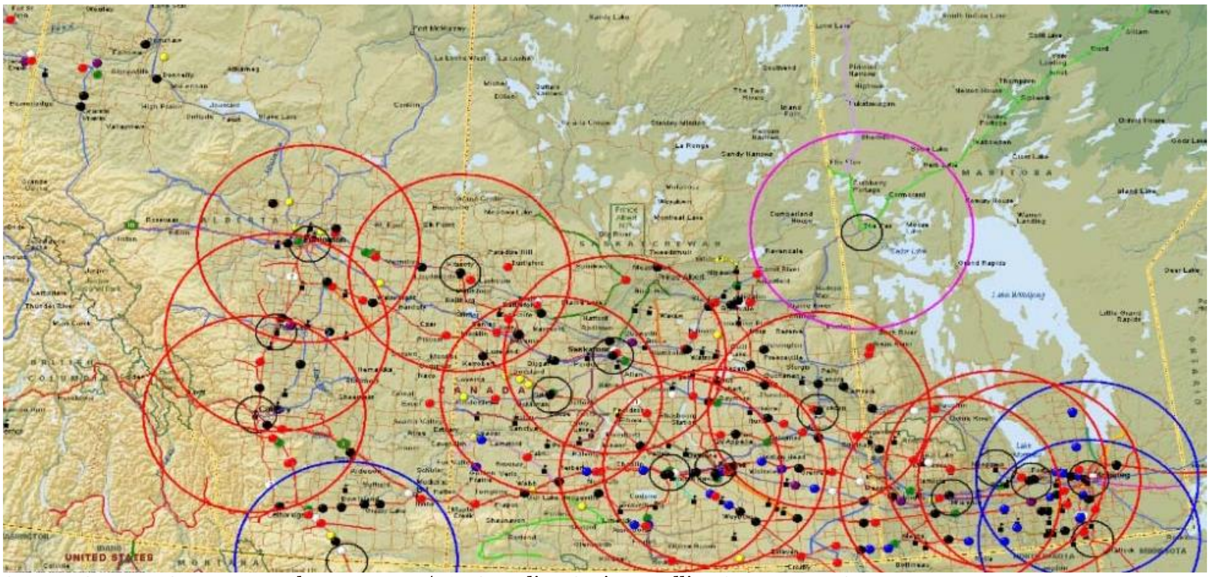
The Canadian grain industry has a regulatory framework that protects the interests of supply chain participants. Economic and safety regulation is applied to companies through the Canadian Transport Act by the Canadian Transport Agency and Transport Canada. Rail regulation includes rail operators being obligated under common carrier legislation to provide services for the freight tasks sought from customers.

In addition, regulated interswitching occurs in the rail industry in Canada. This ensures that a customer who has access to one rail provider (e.g. shortline operator) who provides wagon collection, cannot be prevented from having that loading handed off to another mainline operator (Cairns 2014). This only impacts 3% to 5% of loading. In 2014, the Federal Government extended the switching zone from 30 km to 160 km to increase competition between rail companies and enable additional rail capacity access. It was identified that only 4% of potential users of extended interswitching used the option and only 24% were applied to domestic rail traffic (Quorum 2017). The major of interswitching accessed was to use a US carrier (e.g. BNSF) to haul grain to export destinations in the US (Quorum 2017).

Similar to Australia, a number of government agencies in the industry have been privatised and a market framework put in place. The Canadian Wheat Board had its monopoly of the sale of wheat and barley removed in 2011 and was transitioned to private ownership. Grain quality and safety were regulated through a series of federal legislation that included the establishment of the Canadian Grain Commission (CGC) to act as the regulator of the grain industry (Quorum 2014).

With the elimination of direct government transportation subsidies in 1995, the Canadian Government introduced the Canadian Transportation Act (CTA) in 1996, which established a mileage based set of freight rates to be paid directly by farmers. Amendments to the CTA in 2000 replaced the maximum rate scale with an annual ceiling on revenues that CN and CP could earn from the movement of “regulated” grain product that resulted in a revenue cap or maximum grain revenue entitlement (MRE).

Figure 30: Western Canada Switching and Interchange Zones



Source: Quorum Corp – Annual Report 2015/16 - Canadian Grain Handling & Transport System – 2017.

The MRE is calculated annually by the CTA and adjusts the MRE for industry tonnages, haul task distances, price inputs, capital investments, rail operating costs, etc. Rail companies can set differential pricing and market based freight rates to incentivise shippers on configurations, routes and OD pairs as long as revenue does not exceed the MRE cap. It also allows the rail companies to retain the benefits of productivity improvements from technology, improved processes, etc. (Quorum 2014).

In 2010, a Rail Freight Service Review sought to change the system from a regulatory to a commercial approach to address problems raised by stakeholders. The recommendations adopted by government (Quorum 2014) included:

- Establishment of a template service agreement and a commercial dispute resolution procedure.
- Legislation to give shippers a right to a "service agreement" with rail companies if commercial negotiations fail.
- Establishment of a commodity supply chain table to address logistics issues through published performance metrics.
- Undertaking a detailed grain supply chain study.

Additional areas of regulation have arisen from the bumper grain crop in 2013-14 which was circa 25% larger than normal at 90 million tonnes. This highlighted the extent of rationalisation of rollingstock, branch lines and regional storage sites. The Fair Rail for Grain Farmers Act was enacted to require the rail companies to ship a minimum number of wagons per week to avoid penalties (Aegic 2015).

CP and CN have also been forced to lease or sell abandoned branch lines to shortline operators by government (Aegic 2015). The shortline operators provide lower cost operations that have a modified lighter regulatory regime through provincial governments compared to national operators regulated by the Federal Government.

Road transport provides no alternative line haul mode option for the Western Canadian grain industry beyond PUD tasks and short cross border haulage tasks. As a result, CN and CP dominate Western Canadian rail supply chains and have potential market power arising from providing integrated services. The federal government in Canada is very conscious of potential market failures and consequences for customers and the economy. This has resulted in a range of ongoing regulatory interventions and overlays to manage and control impacts where possible.

To try and address these matters, the rail companies are undertaking expanded commercial offering that allow shippers to lock in future haulage capacity. If customer demand exceeds supply, a pre-determined published methodology (CN 2017) is applied on a weekly basis addressing in order:

1. Commercial capacity contract commitments.
2. Allotments for Shortline operators / producer cars (farmer loaded wagons)
3. Allocation across remaining spot orders.

9 Key Facts and Relevant Issues

- The Western Canadian grain industry serves significant domestic and export markets.
- Rail is the major mode of transport used for the large scale transport of 11,000 tonne grain loads from regional inland depot facilities to export port terminals. The round trip cycle times generally take 12 to 14 days per service reflecting one way haul distances of 1300 to 1800 km.
- The rail task is dominated by major Canadian Class 1 rail operators CP and CN, who provide integrated services through owning 85 % of the network and delivering 96% of the rail task.
- The haul distances from Western Canada to export ports are too long for road to be a viable mode option, resulting in the rail companies having significant market power.
- Shortline Operations that have taken over abandoned network components and handover wagons to CN/CP for line haul on main corridors, only own/operate only 15% of the network and transport 4% of rail haulage task.
- There has been a 38% reduction in the supply chain transport and handling time over the last 15 years due to efficiencies extracted from the supply chain as various operations have been rationalised subsequent to transfer from Government ownership and privatisation.
- Issues have arisen however when rail capacity has been rationalised and grain harvest peaks result in demand outstripping capacity of in grain export supply chains from Western Canada.
- This has resulted in a number of regulatory interventions that seek to rectify perceived or real market imbalances. These include:
  - Interchange/interswitching obligations for shortline operators,
  - The MRE revenue cap for the major rail companies,
  - Guaranteed rail service obligations when commercial negotiations fail,
  - The provision of guaranteed capacity levels by rail operators,
  - The forced sale of abandoned rail network sections.
- The market power of the major companies in the supply chain and market imperfections and distortions has been the catalyst for government intervention and regulation of Canadian Export Grain supply chains.

- While Australian supply chains are also subject to regulation, the competition between the road and rail modes in Australia for grain export volumes appears to result in more market driven outcomes.
- The multi product rail networks in Canada ensure that critical trunk network infrastructure can be maintained at a high standard and is remunerated by the density of traffics using the networks.
- The lightly trafficked grain lines in Australia are typically relying on seasonal grain volumes to support and maintain the network infrastructure.
- In addition, Australia separates the financial accountability for network infrastructure and rail operations unlike Canada.
- With the degradation of regional grain networks over time in Australia, Government funding support for rail branch lines that are limited to light grain traffic, is typically required to ensure they remain open.
- Integrated above and below rail operations delivering integrated customer rail solutions are more likely to ensure that rail industry stakeholder interests are aligned and industry is more responsive to customer requirements.

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