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Transport Infrastructure for Australia's Agricultural Needs

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Australian Government

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Development Corporation**

Transport Infrastructure for Australia's Agricultural Needs

by Catherine Tulloh and David Pearce

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Foreword

Planning for transport infrastructure involves four key steps:

1. Understanding current freight flows.
2. Understanding how and why these may change.
3. Examining deficiencies in existing infrastructure.
4. Identifying priorities not being addressed in the current policy framework.

The purpose of the policy research reported here is to assist in working through the first two (and to a lesser extent the third) of these steps.

Transport is a fundamental ‘finishing component’ of agricultural production. Inefficient or insufficient transport infrastructure reduces the ability of producers to meet consumer demands and to achieve a fair return for their product. Efficient transport infrastructure planning — that both recognises the unique nature of agricultural production and that can respond to emerging changes within agriculture — is therefore essential to the effective functioning of agricultural markets.

The immediate target of this research is policy planners and policy makers — particularly those working in transport infrastructure. To the extent that this leads to better infrastructure outcomes, then the ultimate beneficiaries will be agricultural producers and consumers.

There are three key findings from the research.

1. The existing information base for infrastructure planning is limited, both in terms of current transport flows and in terms of a comprehensive view of bottlenecks.
2. Existing transport task forecasting methods do not account for potential structural changes within agriculture — rather, they tend to be based around aggregate agricultural production.
3. It is possible to construct a framework that can systematically work through potential drivers for structure change in agriculture. Fully integrating this with transport planning, however, requires an improved information base.

A key recommendation from this research is that policy makers working in the field of infrastructure planning should first, actively seek a better information base on which to build infrastructure decisions and second, seek to incorporate scenarios for structural change within agriculture in transport task forecasting and planning.

This report is an addition to RIRDC’s diverse range of over 2000 research publications and it forms part of our Global Challenges R&D program, which aims to collectively address challenges, whether impediments or opportunities, to improve the profitability and sustainability of Australian agriculture.

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Executive Summary

What the report is about

The purpose of this policy research report is to assist in understanding current freight flows and how and why these may change.

Who is the report targeted at?

The immediate target of this research is policy planners and policy makers — particularly those working in transport infrastructure. To the extent that this leads to better infrastructure outcomes, then the ultimate beneficiaries will be agricultural producers and consumers.

Background

In 2006–07 over 2500 million tonnes of freight was transported domestically. The freight task has increased at an annual average rate of 3.4 per cent between 1983 and 2003 and is expected to continue to grow over the period to 2020 but at a lower rate.

In 2001 freight of food and livestock in Australia was about 30 per cent of the national freight task.

Most transport of agricultural goods in Australia is conducted via road, with grains the only significant agricultural user of rail transport.

The latest available data on road freight movements dates back to 2001. This data does not provide detail of the types of agricultural products being transported between regions with food and live animals grouped together. This data does show that most road freight moves goods within a particular region or state, with limited movements between states.

Aims/objectives

The objectives of the project were to identify:

- priority gaps or weaknesses that exist or may emerge in Australia's transport infrastructure network relevant to the transport of agricultural freight;
- opportunities to improve the efficiency and productivity of Australia's transport infrastructure network relevant to the transport of agricultural freight.

Methods used

Seven qualitative scenarios have been developed based on varying assumptions around population growth, water availability, climate change, productivity growth and biofuel policy. These scenarios provide a framework in which the potential transport infrastructure requirements of the agriculture sector can be assessed.

Under the business-as-usual scenario agricultural production and exports are expected to continue to increase along historical lines as populations increase and productivity improves. The other scenarios can be compared against business-as-usual.

Implications for relevant stakeholders

Current infrastructure arrangements present some challenges for the agriculture sector. The introduction and use of B-double and larger trucks in agriculture has been limited because roads have not been upgraded to a state suitable for use by B-doubles. NSW authorities limited the weight of

livestock transport vehicles so that degraded roads were not further damaged. These poor road conditions affect agricultural productivity, even if only part of the journey is affected.

Other challenges include road congestion and inconsistencies in transport regulations between the states.

The problems with current transport infrastructure are symptoms of poor governance of the national transport infrastructure network. Responsibilities for transport infrastructure are spread across 3 levels of government and involve numerous agencies. The state of infrastructure has suffered from inadequate funding, poor maintenance programs, piecemeal planning and limited reporting.

The planning, monitoring and maintenance processes for providing transport infrastructure should be improved so that it can easily and quickly adapt and respond as the transport needs change.

Demand for agricultural transport services and infrastructure is derived from the supply and demand of agricultural products. Therefore, understanding the potential changes in transport of agricultural products requires analysis of possible states of agricultural markets in the future.

Some of the more important elements of the future agricultural sector will be changes in the:

- location of production;
- location of destination markets and processing centres;
- volume of production;
- volume of exports (particularly relative to export demand); and
- nature of the products produced.

Developments in international markets, such as income and population growth are likely to affect demand for Australian agricultural products – particularly driving greater demand for meat and dairy products as incomes overseas increase.

In Australia, projected increases in population will reduce the volume of agricultural produce that is exported and increase the transport of produce to capital cities. As well as increasing demand for products, domestic population growth may cause water and land shortages for the agriculture sector.

Biofuel policy, development of GM crops and the impacts of climate change are all likely to affect the volume, location and pattern of agricultural production in Australia but there is still insufficient information and projections in each of the areas to create a clear picture of the combined implications for agriculture and agricultural transport requirements.

The most significant projected change in agricultural production patterns is an increase in agricultural production in northern Australia. This would require development of the road infrastructure in the region and possible development of ports able to deal with different product types.

The literature summarised does not present any clear trends in the volume or location of agricultural production in Australia. However, two key regions where change might be significant can be identified:

- The value of irrigated agricultural production in the Murray Darling Basin could fall by 49 per cent by 2050 and 92 per cent by 2100 under an extreme climate change scenario.
- Northern Australia has been identified as a region that could be developed for agriculture. Any significant increase in agricultural production would require supporting transport infrastructure.

In general, even with adverse effects of climate change, it is projected that agricultural production and exports will continue to increase over the coming decades.

Recommendations

There is limited data available on freight movements, particularly detailed data on the products being transported and origin and destination of the products. More comprehensive and recent data collection on freight movements would help in understanding transport requirements for the agriculture sector and the broader freight task.

In the absence of improved or additional data, steps can be taken to improve the current regulatory and maintenance frameworks. Measures might include improving maintenance programs, upgrading roads and addressing regulation issues (including across jurisdictions). A number of initiatives have commenced and are likely to help this process, such as the Establishment of the National Heavy Vehicle Regulator, the National Land Freight Network, the National Ports Strategy and the COAG Road Reform Plan.

Information gaps are a key constraint on understanding and planning for the national freight task. This lack of data means that there is not a clear picture about the future needs of freight and how the freight task might grow. Producing forecasts or possible scenarios about the future cannot be done without solid data on the current freight activities and problems.

Existing transport task forecasting methods do not account for potential structural changes within agriculture — rather, they tend to be based around aggregate agricultural production. To help respond to potential structural changes in the agriculture sector, forecasts should incorporate potential changes in drivers of agricultural production. This report presents a framework of how these drivers can be analysed.

Multiple levels of forecasts are likely to be needed to understand potential transport requirements. Firstly, demands for transport by individual sectors will need to be understood by forecasting the production and consumption patterns within each sector. Secondly, the entire freight task should be forecast considering all sectors and modes of transport.

Agriculture is one of many sectors that require transport infrastructure. Planning of infrastructure investments needs to consider the entire Australian freight task and the likely volume and patterns of demand for transport services.

Introduction

Goods are not finished until they are in the hands of their ultimate users, and they have no value unless they can get there. And unless goods can be moved reasonable distances to satisfy dispersed demands, producers can serve only small regional markets, which makes specialised production — a key source of economic progress — impossible. (*Building for the Job*: National Transport Planning Taskforce, January 1995)

This report seeks to discuss the freight infrastructure needs of the Australian agriculture sector and how these needs can be met in the future as Australian agriculture develops and adapts to changing conditions — both economic and physical. Transport infrastructure is a key element of the agricultural supply chain and can significantly affect the productivity of the industry. Providing and maintaining the infrastructure needed to transport agricultural products and inputs will ensure the productivity of agriculture is maximised.

Planning for transport infrastructure can be seen as involving four key steps:

1. Understanding current freight flows.
2. Understanding how and why these flows may change in the near, medium and long term.
3. Examining deficiencies in existing infrastructure.
4. Identifying priorities not being addressed in the current policy and planning framework, particularly relating to understanding how flows may change in the future.

This report is particularly concerned with the first and second (and to a lesser extent the third) of these key points. It proposes a framework for considering likely future structural changes in agriculture as they related to transport infrastructure needs.

There is some evidence that current transport infrastructure has some gaps and lacks consistent maintenance. These gaps may be amplified as agricultural production increases or shifts over time. In this report some of the potential changes to agricultural production are explored by drawing on literature and developing a series of potential scenarios. The possible transport infrastructure requirements of the Australian agriculture sector will be driven by the volume and composition of production, the location of production and the markets into which this production is sold (export or domestic).

Agriculture is one of many sectors that require transport infrastructure. Planning of infrastructure investments needs to consider the entire Australian freight task and the likely volume and patterns of demand for transport services. However, agriculture has some unique characteristics that need to be considered in the infrastructure planning process:

- Agricultural transport relies on rural road systems.
- There is large and unpredictable seasonal variability in production volumes.
- The transport of livestock and fresh produce requires efficient systems that minimise delay to ensure transport does not result in the damage or loss of product.
- Agriculture is a major export sector and so requires passage from rural areas to ports.
- The mining sector shares some of the rural roads and is a competitor for some transport resources such as port capacity.

The remainder of this report is structured as follows:

- In chapter 1 current freight flows and trends are discussed.
- Chapters 2 and 3 set out a framework for thinking about how agriculture may change in the coming decades and use available information to discuss the implications for this framework.
- Potential scenarios for the future of agriculture in Australia are set out in chapter 4 for use in analysing potential transport requirements.
- Chapter 5 explores some of the limitations of the current infrastructure system and planning framework.
- In chapter 6 some recommendations are made as to how infrastructure investment and planning could be improved.

Objectives

An assessment of potential future supply scenarios and their implications for agricultural transport infrastructure needs is required to better inform governments and industries on gaps and priorities.

The need for an assessment of strategic transport infrastructure priorities is driven by a number of factors which themselves will contribute to the likely future structure of Australian agriculture, including greenhouse gas emissions, rising fuel prices, decline in existing infrastructure quality and the need to meet the changing transport demands of agricultural industries.

For a variety of reasons, it is likely that Australian agriculture will change significantly (in terms of location, products, markets serviced, etc.) in the coming decades. Australian population growth (including the expected population of 35 million by 2050), climate change (including changes in water availability and water markets), productivity enhancements and changing international demands will combine to change the picture of Australian agriculture. The purpose of this project is to establish a number of scenarios for possible futures for Australian agriculture that can form a basis for transport infrastructure planning for the sector.

Methodology

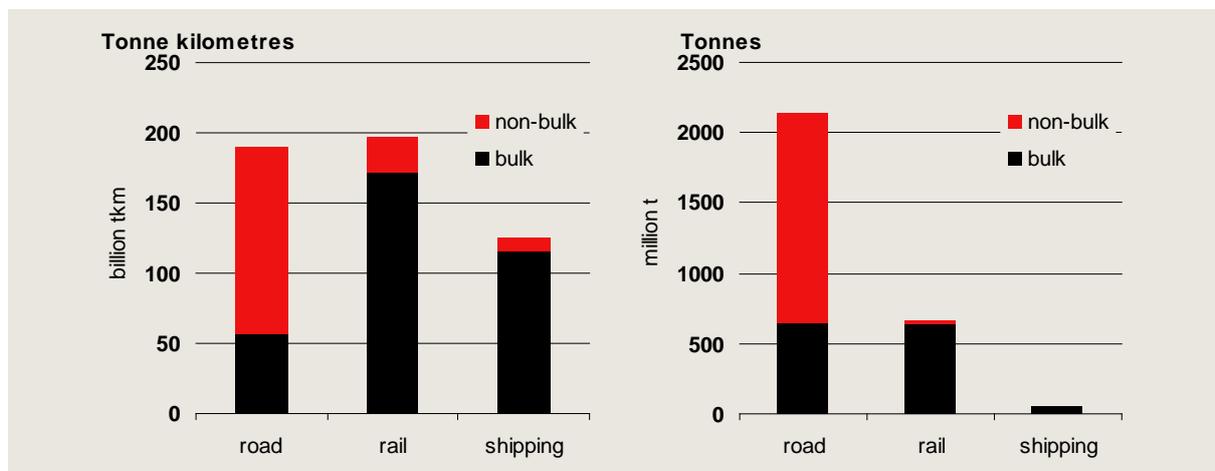
The methodology for this project involved:

- A detailed review of literature covering potential future developments in the structure of Australian agriculture.
- A review of current transport patterns and the information base available to assess them.
- Discussions with industry stakeholders concerning transport infrastructure needs.
- A review of current transport planning initiatives.

1. Agricultural transport in Australia

Australian freight task

In 2006–07 over 2500 million tonnes of freight was transported in Australia by road rail or coastal shipping (Infrastructure Australia 2011, see also Figure 1.1). Over 2000 billion tonne kilometres was transported by road. Rail and shipping have a greater share of the long distance freight task, with rail carrying 200 billion tonne kilometres, road around 180 billion tonne kilometres and shipping around 125 billion tonne kilometres (Infrastructure Australia 2011). Many goods have multiple leg journeys where they will be transported by more than one mode. Rail and shipping are used mostly for bulk commodities, they often depend on road networks to pick up and deliver goods from terminals. Road transport dominates the non-bulk freight market and transport in urban areas.



Note: Road freight in tonnes uses 2006-07 figures as 2007-08 was not available.
Data source: based on BITRE 2011.

Figure 1.1 Split of domestic freight task between modes, 2007–08.

Total international sea freight to or from Australia was 789.6 million tonnes in 2007-08, of which 95 per cent was bulk freight (BITRE 2011). Cargo loaded at Australian ports amounted to 766.4 million tonnes, and 144.47 million tonnes was unloaded (this includes imports, exports and domestic shipping volumes).

Australian sea freight exports were valued at \$153 billion in 2007–08 and were predominately exports of crude materials (iron ore and concentrates) and mineral fuels, lubricants and related materials (mostly coal, coke and briquettes). Food and live animals account for 12 per cent of sea freight exports by volume (Allen Consulting Group 2010).

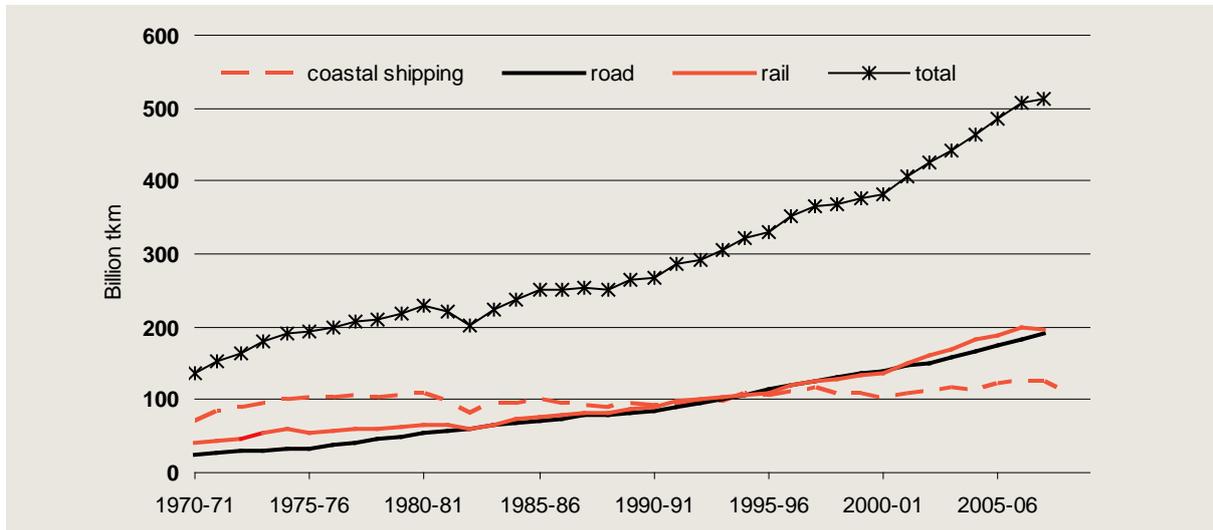
Growth of the Australian freight task

The domestic freight task has increased at an annual average rate of 3.4 per cent between 1983 and 2003 (Allen Consulting Group 2010). Each transport mode has exhibited growth; however the growth in coastal shipping has been slower than road and rail freight (see Figure 1.2).

In the past coastal shipping dominated the domestic freight task, carrying 52 per cent of total freight in 1970–71 in tonne kilometre terms (Allen Consulting Group 2010). In 2006–07 road and rail were

responsible for 36 and 39 per cent of the total freight task respectively (Allen Consulting Group 2010).

Freight is expected to continue to grow over the period to 2020 but at a lower rate than was observed between 1983 and 2003. The projected growth rate is 2.8 per cent a year, with non-bulk freight projected to grow at an average rate of 3.6 per cent a year (Allen Consulting Group 2010). The highest growth rate is expected from road transport (Allen Consulting Group 2010).

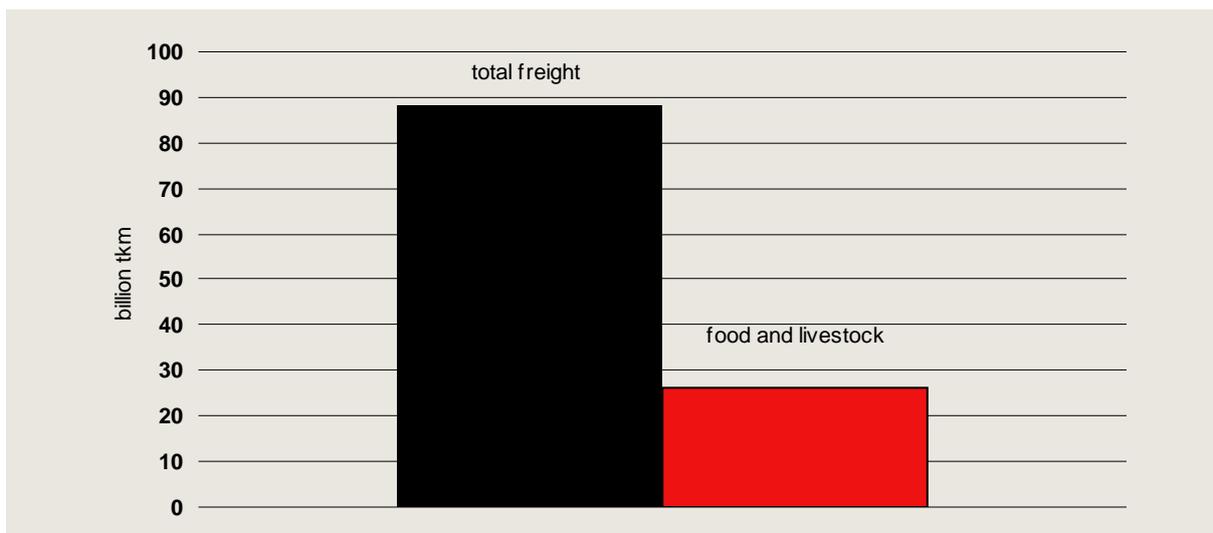


Data source: BITRE 2011.

Figure 1.2 Total domestic freight by transport mode, 1970–2007.

Agriculture share of freight

In 2001 total freight of food and livestock in Australia amounted to 26 billion tonne kilometres, 30 per cent of the national freight task that year (ABS 2002).



Data source: ABS 2002.

Figure 1.3 Food and livestock freight relative to total domestic freight, 2001.

Mode of transport — agriculture

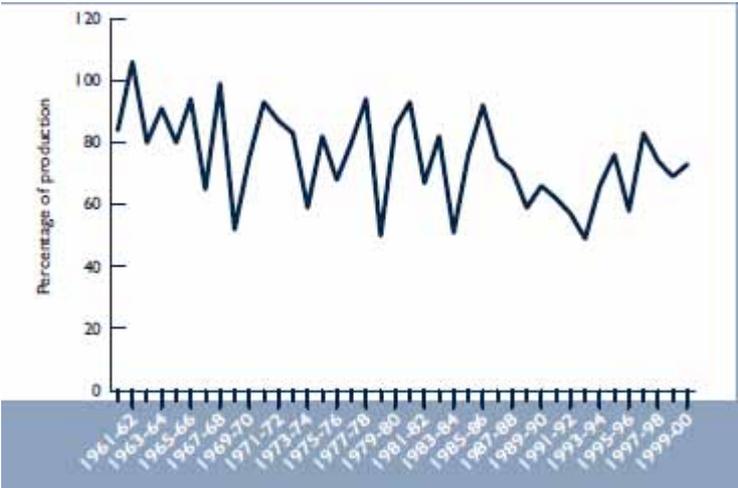
Per dollar value of goods produced, the expenditure on road transport is much greater than on rail transport (ABS 2009). For example, for each dollar value of grains produced in Australia, the grains industry spends \$0.19 on road transport and \$0.02 on rail transport. Table 1.1 shows these values for each agricultural commodity and product. The most transport intensive products are grains, beef cattle and the broad category ‘other agriculture’, which mostly covers horticulture.

Table 1.1 Transport use coefficients for agricultural commodities, 2005–06.

| | <i>Road</i> | <i>Rail</i> |
|--------------------------------------|--|--|
| | \$ expenditure on transport per \$ produced | \$ expenditure on transport per \$ produced |
| Sheep | 0.09 | 0.01 |
| Grains | 0.19 | 0.02 |
| Beef cattle | 0.12 | 0.00 |
| Dairy cattle | 0.05 | 0.00 |
| Pigs | 0.10 | 0.00 |
| Poultry | 0.06 | 0.00 |
| Other agriculture | 0.17 | 0.01 |
| Meat and meat products | 0.04 | 0.00 |
| Dairy products | 0.04 | 0.00 |
| Fruit and vegetable products | 0.09 | 0.00 |
| Oils and fats | 0.05 | 0.00 |
| Flour mill products and cereal foods | 0.04 | 0.00 |
| Bakery products | 0.00 | 0.00 |
| Confectionery | 0.05 | 0.00 |
| Other food products | 0.06 | 0.00 |

Source: based on ABS 2009.

Data from the Bureau of Infrastructure, Transport and Regional Economics (BTRE) (2006a) shows that, despite the low expenditure on rail transport, some agricultural commodities are transported by rail, in particular grains. The data shows the share of rail in the transport of grains was around 67 per cent in 1999–2000 and has declined slightly since 1961. Most of the rail transport takes the grains from the grain producing regions to the ports within the same state (Figure 1.4).



Data source: BTRE 2006a.

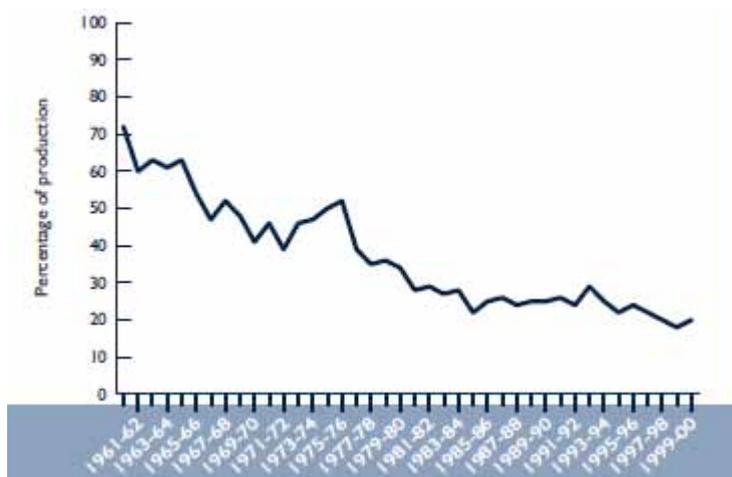
Figure 1.4 Share of rail in grains freight.



Data source: BTRE 2006a.

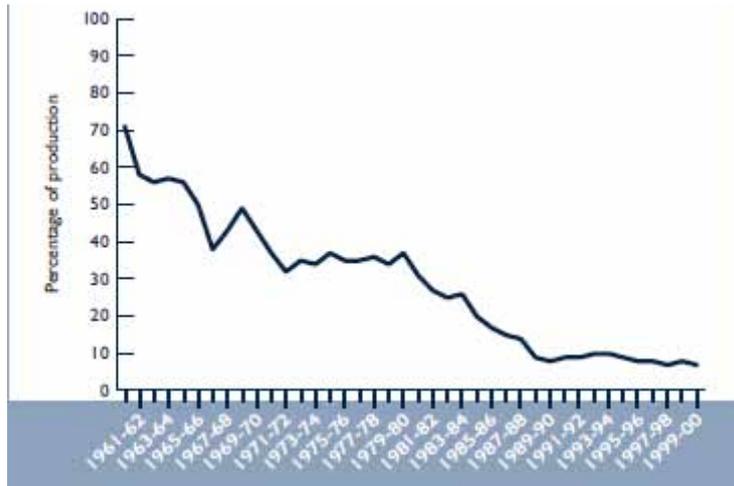
Figure 1.5 Interregional rail freight flow for grains, 1998–99.

The use of rail in the transport of other agricultural products is much less significant. Other agriculture (which includes wool, fruit and vegetables) has a rail share of less than 20 per cent and the share of rail in the transport of livestock is below 10 per cent (Figures 1.6 and 1.7). The use of rail for these products has fallen significantly since 1961. The remaining use of rail for these goods is mostly in Queensland.



Data source: BTRE 2006a.

Figure 1.6 Share of rail in other agriculture freight.

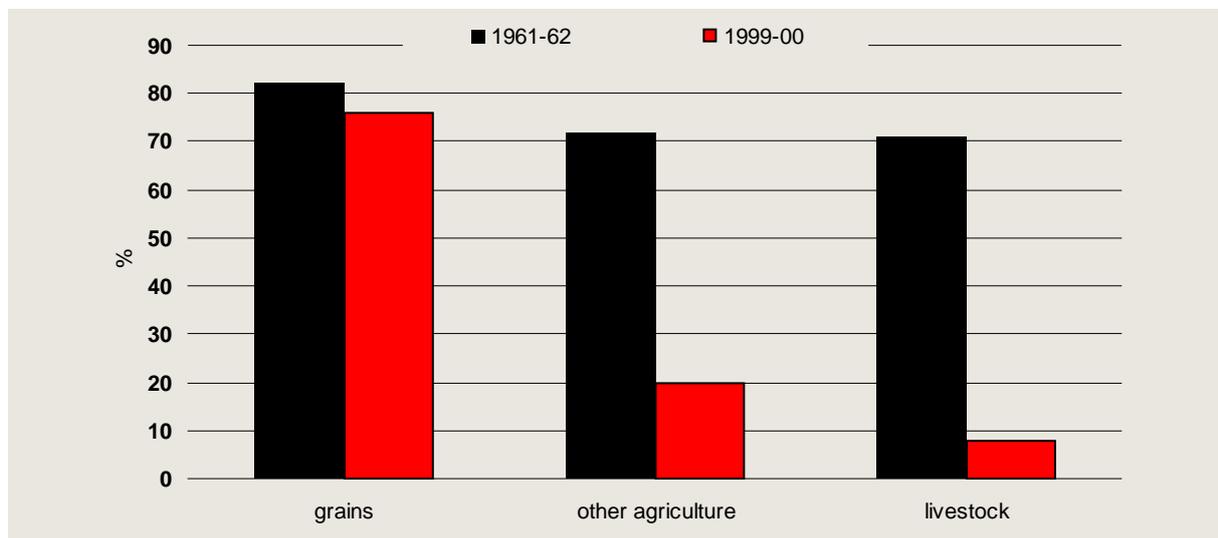


Data source: BTRE 2006a.

Figure 1.7 Australian rail share of livestock.

It appears, however, that the estimated share of rail for the transport of these products is based on the total volume produced and the total volume transported by rail. It does not appear to account for the fact that these products are likely to be transported by road as well as rail. For this reason, these estimates are likely to be an overestimate of the proportion of the freight task carried by rail as opposed to road.

Figure 1.8 summarises the change in the use of rail for the transport of grain, other agriculture and livestock. This figure clearly shows how the use of rail has significantly diminished over time for other agriculture and livestock.



Data source: based on BTRE 2006a.

Figure 1.8 Rail share for different commodities, 1961-62 and 1999-2000.

Agricultural transport origin and destination patterns

The latest available data from the ABS (2002) detailing road freight movements in Australia by commodity group suggests that the bulk of road freight for agricultural products (food and live animals) is intrastate and even intra-region (defined on the basis of statistical division). As well as the original region, capital cities were the other major destination for the agricultural products. Tables 1.2 and 1.3 show the distribution of the freight task for each state across different destinations: within the same statistical division, the state capital city, other regions of the state and interstate.

These trends are more pronounced when measuring the freight task in tonnes (rather than tonne kilometres). For example, the major destinations for freight originating in the Far West region of NSW, by tonne kilometres, are Eyre (SA) (24 per cent), North Western NSW (21 per cent) and Mallee (Vic) (21 per cent). The proportion of freight destined within the region was 3 per cent when measured in tonne kilometres, however, by tonnes transported, within the region was the largest destination (35 per cent). This is driven by the large distances travelled to reach other states and regions from the Far West.

Table 1.2 Destinations of food and live animals freight task for each state (in tonne kilometres).

| <i>Origin State</i> | <i>Origin and destination in the same region</i> | <i>Destination is the capital city of the origin state</i> | <i>Destination is another region within the origin state</i> | <i>Interstate destination</i> |
|---------------------|--|--|--|-------------------------------|
| | % | % | % | % |
| NSW | 11 | 13 | 20 | 55 |
| Victoria | 15 | 14 | 20 | 51 |
| Queensland | 13 | 14 | 26 | 47 |
| SA | 11 | 9 | 10 | 70 |
| WA | 24 | 26 | 32 | 18 |
| Tasmania | 36 | 23 | 41 | 0 |
| NT | 17 | 34 | 5 | 44 |
| Australia | 14 | 15 | 22 | 49 |

Source: ABS 2002.

Table 1.3 Destinations of food and live animals freight task for each state (in tonnes).

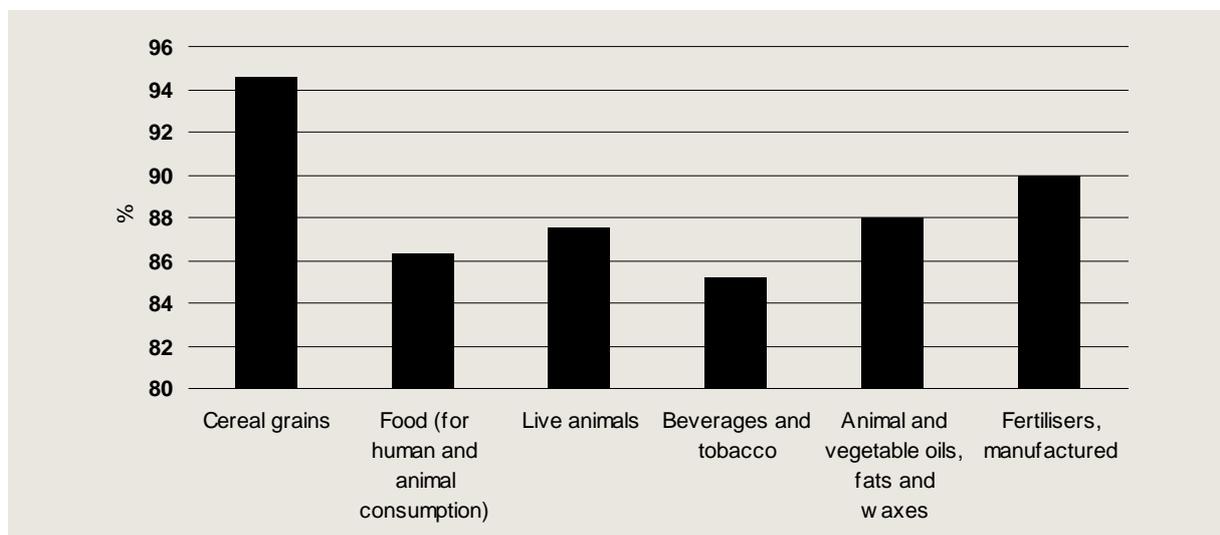
| <i>Origin State</i> | <i>Origin and destination in the same region</i> | <i>Destination the capital city of the origin state</i> | <i>Destination other regions within the origin state</i> | <i>Interstate destination</i> |
|---------------------|--|---|--|-------------------------------|
| | % | % | % | % |
| NSW | 58 | 8 | 15 | 19 |
| Victoria | 64 | 10 | 16 | 10 |
| Queensland | 69 | 9 | 14 | 8 |
| SA | 63 | 11 | 9 | 17 |
| WA | 73 | 15 | 11 | 1 |
| Tasmania | 68 | 10 | 22 | 0 |
| NT | 61 | 20 | 7 | 12 |
| Australia | 65 | 10 | 14 | 11 |

Source: ABS 2002.

Some exceptions to the broad trends observed include:

- Agricultural freight from the Murray and Far West regions of NSW destined for Victoria rather than NSW destinations.
- Agricultural freight from the Barwon region of Victoria has major destinations in other regions of the state rather than Melbourne or within Barwon.
- Freight from South West Queensland to the Darling Downs area of Queensland and from Central West Queensland to the South West region rather than to Brisbane or within the same region.

Of the commodity groups, grains are mostly transported within the state of origin where as a larger share of transport of food and live animals is interstate (Figure 1.9). The ABS data does not provide a breakdown of transport between regions for the separate commodities so it is difficult to determine how much of this transport is between different points in the supply chain or transport to the final consumer.



Data source: based on ABS 2002.

Figure 1.9 Share of road freight where destination is within the state of origin, measured in tonnes.

2. How agricultural transport needs might change?

Demand for agricultural transport services and infrastructure is derived from the supply and demand of agricultural products. Therefore, understanding the potential changes in transport of agricultural products requires analysis of possible states of agricultural markets in the future.

What might change?

Some of the more important elements of the future agricultural sector will be changes in:

- the location of production:
 - this could be affected either by the current location of production becoming unsuitable through climate change, salinity or competition for land resources from other sectors; or by expanding into new agricultural areas.
- the location of destination markets and processing centres:
 - this will be affected by changes in Australian population numbers, the location of the Australian population, the level of agricultural export and the location of international ports for exports.
- the volume of production:
 - a significant increase in the volume of production, without necessarily changing the location of production or consumption may require upgrades to existing infrastructure to manage increased volumes.
- the volume of exports:
 - an increase in the volume of exports would affect the required capacity of ports and related export facilities.
- the nature of the products produced:
 - for example a shift in production from grains to horticulture would require different transport facilities.

What are the drivers?

Changes in these characteristics may be affected by a number of different drivers. These could include changes in populations and location of populations, economic growth, climate change, salinity, technological developments and biofuel policies.

In chapter 3 a detailed discussion of the potential developments in each of the areas is provided. Table 2.1 provides a summary of the key findings from the literature review.

Implications of the drivers

From the literature summarised, the following conclusions related to transport infrastructure requirements of the agriculture sector can be drawn:

- The clearest suggested change in location of Australian agriculture canvassed in the literature was an increase in agriculture in northern Australia. Development of irrigated agriculture in northern Australia would probably be in the cotton, sugar, rice, horticulture and vegetable industries. Some scenarios suggest that the area developed could be 1 Mha, but the study by the Northern Australia Land and Water Taskforce found that the additional irrigated agricultural area would be 20 000 to 40 000 ha. One scenario also proposed further development of dryland cropping in northern Australia.
- Climate change, water availability or salinity could result in some agricultural areas becoming unsuitable for the agricultural activities they are currently used for, or could significantly reduce productivity in these areas. Climate change could lead to cotton, sugar and subtropical fruit crops being produced in areas further south than current production areas. Cool variety grapes, stone- and pome- fruits are expected to be produced in fewer areas as temperatures increase.
- Most of the literature assumes a continuation of current consumption patterns, with most of Australian agricultural production being exported. This, however, may be affected by increasing the use of crops for biofuel production or as stock feed, or a significant increase in the Australian population.
- Many of the scenarios considered project agricultural production and exports to continue to steadily increase, predominantly through continued productivity improvements. The greater production volumes will meet the projected increasing demand, primarily from developing countries, driven by higher populations and incomes.
- Some scenarios indicated that production could shift away from traditional agricultural products towards high value irrigated agriculture such as horticulture. Others suggest a shift towards conservation with decreased agricultural production.
- Biofuel policy, development of GM crops and the impacts of climate change are all likely to affect the volume, location and pattern of agricultural production in Australia.

The literature summarised does not present any clear trends in the volume or location of agricultural production in Australia. However, two key regions where change might be significant can be identified:

- The Murray Darling Basin (MDB) is the source of around 40 per cent of Australia's total gross value of agricultural production (Garnaut 2008). Higher temperatures and lower rainfall projected under climate change could threaten the future of agriculture in the Basin. Under one extreme scenario, Garnaut (2008) projects the value of irrigated agricultural production could fall by 49 per cent by 2050 and 92 per cent by 2100.
- Northern Australia has been identified as a region that could be developed for agriculture, particularly if water availability became problematic in the MDB. Assessments of the potential for development vary from 20 000ha to 1 Mha, however, any significant increase in agricultural production would require some supporting transport infrastructure.

Table 2.1 Summary of drivers of agricultural production.

| <i>Driver</i> | <i>Projected changes</i> | <i>Potential affects on future Australian agriculture</i> |
|--|--|--|
| Australian population | Australian population projected to increase, particularly in Queensland and Western Australia with greater growth in capital cities and coastal areas. The extent of population increase is uncertain. | Increased demand for agricultural produce in Australia, particularly urban areas. Possibility of urban encroachment on agricultural land. |
| Global population | Global population projected to increase, particularly in Asia and Africa. The extent of population increase is uncertain. | Increased demand for agricultural exports, particularly grain staples consumed in Asia and Africa. |
| Economic growth | Growth projected to be strongest in Asia. The rate of economic growth is uncertain. | Increased demand for agricultural exports to Asia, and increased demand for meat and dairy products. |
| Biofuels demand | Depends heavily on policy, biofuels could potentially increase 10 fold by 2050 and account for 6 per cent of transport fuels. | High demand could significantly increase demand for sugar, grains and oilseeds and push up prices of these commodities. Uptake of second generation biofuels would lessen the effect on these commodities. |
| Climate change in Australia | Still very uncertain. General projections are that temperatures will increase and rainfall will decrease in the major agricultural areas. | Agricultural productivity could decrease by between 12 and 41 per cent depending on the region. Irrigated agricultural production in the Murray Darling Basin could decline by up to 49 per cent by 2050. |
| Global impacts of climate change | Overall increased temperatures globally, change in rainfall patterns, extreme weather conditions could increase in frequency. Agriculture in some countries (eg Europe and Canada) could benefit from higher temperatures, other countries will suffer. | By considering potential changes to agricultural productivity in major agricultural countries, Australian production and exports are projected to decline relative to business-as-usual but increase relative to current levels. |
| Development of northern Australian agriculture | Development of between 0.02 and 1 Mha of irrigated agricultural land in northern Australia. | Increased production of cotton, sugar, rice, horticulture and/or vegetables in northern Australia. |
| Salinity | Projected that the area of agricultural land affected by salinity could double by 2050, expected to be a problem for NSW, Victoria and Queensland in particular. | Reduced agricultural production in salinity affected areas. |
| GM crops | GM crops could increase maize, cotton, soybean, wheat and rice yields by around 10 per cent. | An increase in production of crops if GM strains are adopted. Declines in production, exports and prices for crops if GM strains are not adopted in Australia but are elsewhere. |

Uncertainty

From the literature review, it is clear that there are many different factors likely to affect agricultural production in the future. Often these factors act in opposing directions, for example:

- Climate change is expected to decrease agricultural productivity while technological developments and adoption of GM crops could increase productivity.
- Larger and richer populations overseas create heightened demand for exports while higher domestic populations would drive increased domestic consumption.

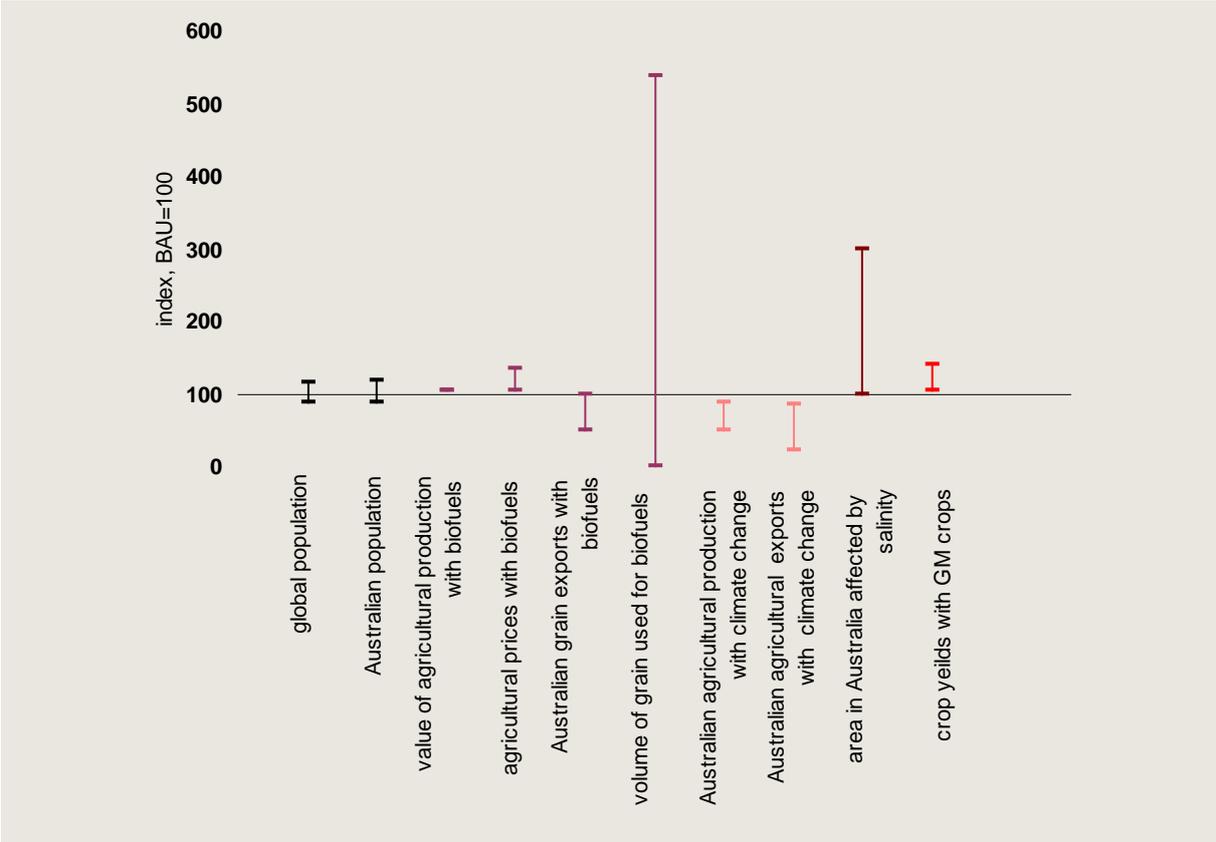
- Under ambitious biofuel policies in Australia grain exports would fall significantly, however, international biofuel policies will increase the demand for grain exports.
- High projected temperatures in northern Australia under climate change assumptions are expected to decrease agricultural productivity in the north. However, development of irrigated agricultural land in the north could greatly increase agricultural production from the area.

In an attempt to deal with some of these opposing drivers, seven descriptive scenarios have been developed and explained in chapter 4. In these scenarios the drivers discussed above are combined in an internally consistent manner to form a framework in which the transport infrastructure requirements of agriculture can be discussed and assessed.

There is also significant uncertainty around each of these drivers individually. Alternative projections of the potential size of each of the drivers can differ vastly, reflecting uncertainty or alternative opinions of how each of the drivers may change in the future. Figure 2.1 illustrates the range of projections for a number of different measures of the scale of agricultural production and its drivers. The figure demonstrates the uncertainty around individual drivers in the future which is magnified when the drivers are combined to paint a complete picture of agriculture in the future.

In the literature there is a range of potential projected outcomes for each of the various drivers that have been identified. In figure 2.1 this range is illustrated relative to the projected business as usual level for each driver, that is, for each identified driver, the projected business as usual value at 2050 was set to equal 100 and the alternative projections were scaled accordingly. For example, under a business as usual, or moderate, scenario, global population is projected to be 9150 million in 2050. Under a high growth scenario the population is projected to be 10461 million and under a low growth scenario 7959 million. In figure 2.1 this is represented by setting the medium variant at an index value of 100, which would make the high and low values 114 and 87 respectively, represented by the first vertical bar in the figure. The variation in projections for other drivers is significantly greater, for example the volume of grain used for biofuels. The projections range from zero to an increase of over five times business as usual – represented by the sixth vertical bar stretching from zero to 537.

Figure 2.1 Range of projections for selected drivers of agricultural production.



3. Review of literature on the future of Australian agriculture

The future of Australian agriculture will depend on a wide range of factors, both domestic and international. The pattern of production in Australia will be affected by supply and demand factors. The supply of agricultural products will depend on physical elements such as climate, the quality of soils and the quality and quantity of available water in different regions of Australia as well as market based issues such as the availability of labour and land, the price of inputs, the uptake of new technologies and policy driven costs of production (for example, the introduction of carbon pricing). The demand for agricultural products will be driven by domestic factors such as Australian population, income, preferences and the development of new products that demand agricultural inputs, as well as international demand and supply conditions that drive the international market which is important for the Australian, export driven, agriculture sector.

The literature canvassed in this chapter covers:

- general projections of agricultural production:
 - assuming a continuation of current conditions;
 - assuming changes such as widespread uptake of biofuels or climate change impacts;
- more specific drivers of agricultural production such as salinity, climate change, population and GM crops; and
- specific elements of agricultural production such as the grains industry or agricultural transport requirements.

Australia is a major exporter of agricultural products and is a small economy, and the agriculture sector is strongly tied to global developments. Any examination of the future of Australian agriculture needs to include some discussion of global developments. Three key studies of global agricultural production are discussed here: the FAO's *World Agriculture Towards 2030/2050* released in 2006 (and revised in 2009), FAPRI's *US and World Agricultural Outlook* (2010) and OECD-FAO *Agricultural Outlook 2010–2019*.

Population and income projections

Key drivers of the demand for agricultural products are population and income. Projections of these drivers can provide some indication of the quantity of agricultural products that may be demanded and also where the demand is likely to be.

Global population projections are produced by the UN Population Division. The UN World Population Prospects: 2008 Revision provides projections of the global population, by country, to 2050. The data is based on national population censuses and surveys and assumptions about fertility, mortality and international migration rates. The assumptions differ between countries and the variants reflect differing assumptions about fertility rates.

Table 3.1 Current and projected global population, 2005 and 2050 and per cent increase compared to 2005.

| | 2005 | 2050 High variant | | 2050 Medium variant | | 2050 Low variant | |
|---------------------------------|---------|----------------------|-----|------------------------|-----|---------------------|-----|
| | Million | Million | % | Million | % | Million | % |
| World | 6 512 | 10 461 | 61 | 9 150 | 41 | 7 959 | 22 |
| Africa | 921 | 2 267 | 146 | 1 998 | 117 | 1 748 | 90 |
| Asia | 3 937 | 6 003 | 52 | 5 231 | 33 | 4 533 | 15 |
| Europe | 729 | 782 | 7% | 691 | -5 | 609 | -16 |
| Latin America and the Caribbean | 557 | 845 | 52 | 729 | 31 | 626 | 12 |
| Northern America | 335 | 505 | 51 | 448 | 34 | 397 | 19 |
| Oceania | 34 | 58 | 71 | 51 | 50 | 45 | 323 |
| Australia | 20 | 32 | 60 | 29 | 45 | 26 | 30 |

Source: UN Population Division 2009.

Australian population projections were produced by the ABS based on recent fertility, life expectancy and migration trends. Series B reflects current trends, Series A is based on high fertility, life expectancy and migration assumptions and Series C is based on low assumptions. Table 3.2 shows the projected Australian population in 2050 and also the expected population of the capital cities.

Table 3.2 Current and projected population, Australia, 2007 and 2050, and per cent increase compared to 2007.

| | 2007 | 2050 Series A | | 2050 Series B | | 2050 series C | |
|----------------|--------|------------------|-----|------------------|-----|------------------|----|
| | '000 | '000 | % | '000 | % | '000 | % |
| Australia | 21 015 | 39 608 | 88 | 33 959 | 62 | 30 179 | 44 |
| NSW | 6 888 | 11 145 | 62 | 9 894 | 44 | 9 077 | 32 |
| Vic | 5 205 | 9 235 | 77 | 8 199 | 58 | 7 640 | 47 |
| Qld | 4 181 | 9 992 | 139 | 8 225 | 97 | 6 966 | 67 |
| SA | 1 584 | 2 418 | 53 | 2 151 | 36 | 2 011 | 27 |
| WA | 2 106 | 4 920 | 134 | 4 047 | 92 | 3 397 | 61 |
| Tas | 493 | 743 | 51 | 571 | 16 | 448 | -9 |
| NT | 215 | 516 | 140 | 377 | 75 | 261 | 21 |
| ACT | 340 | 636 | 87 | 492 | 45 | 377 | 11 |
| Sydney | 4 334 | 7 187 | 66 | 6 685 | 54 | 6 368 | 47 |
| Melbourne | 3 806 | 7 398 | 94 | 6 460 | 70 | 5 899 | 55 |
| Brisbane | 1 857 | 4 507 | 143 | 3 721 | 100 | 3 102 | 67 |
| Adelaide | 1 158 | 1 758 | 52 | 1 605 | 39 | 1 590 | 37 |
| Perth | 1 554 | 3 796 | 144 | 3 146 | 102 | 2 693 | 73 |
| Greater Hobart | 207 | 346 | 67 | 274 | 32 | 227 | 10 |
| Darwin | 117 | 302 | 158 | 226 | 93 | 164 | 40 |

Source: ABS 2008.

A report recently commissioned by the Department of Immigration and Citizenship (Sobels et al. 2010) described the long term implications of net overseas migration for the natural and built physical environments in Australia. The report raised a number of potential impacts higher populations, driven by migration, may have on agricultural production:

- Increased pressure on agriculture to produce food to feed the larger population;

- Increased pressure on agriculture to export products to help maintain Balance of Payments when larger populations import more products;
- Less water availability as populations increase with a greater proportion of the water used domestically; and
- Urban expansion threatening agriculture on the fringes of Sydney, Melbourne and Perth.

The study concluded that:

- Australia remains a net exporter of most food commodities under all the migration scenarios analysed;
- Australia is most likely to become a net importer of products where current production and consumption are nearly equal, such as fruit and nuts. This is expected to occur earlier under higher migration rates;
- At high migration rates Australia could be expected to become a net importer of oil crops and pig meat as well as fruit and nuts. At very high migration rates Australia may need to import vegetables, dairy and lamb;
- A transition to healthier diets in the general population may lead to imports of fruit and vegetables earlier than otherwise expected;
- The cost of agricultural production could be increased and food security threatened if agricultural inputs (for example fertiliser) becomes more difficult to obtain; and
- The supply of fresh food to Sydney could be threatened by urban expansion overtaking agricultural land.

Table 3.3 shows the projected GDP growth rates for different regions used in the agricultural projections by FAO (2006). Income growth helps to determine both the overall quantities of products that might be demanded and also the types of agricultural products that would be demanded. For example, high income countries tend to consume more meat and dairy products.

Table 3.3 Per cent per annum global GDP growth rates.

| | <i>Total GDP at market prices</i> | | <i>Per capita GDP at market prices</i> | |
|---------------------------------|-----------------------------------|------------------|--|------------------|
| | <i>2000-2030</i> | <i>2030-2050</i> | <i>2000-2030</i> | <i>2030-2050</i> |
| | % | % | % | % |
| World | 3.1 | 3.2 | 2.1 | 2.7 |
| Developing countries | 4.8 | 4.6 | 3.6 | 4 |
| Sub-Saharan Africa | 3.8 | 4.3 | 1.6 | 2.8 |
| Near East/North Africa | 4.1 | 4.1 | 2.4 | 3.1 |
| Latin America and the Caribbean | 3.4 | 3.5 | 2.3 | 3.1 |
| South Asia | 6 | 5.5 | 4.7 | 4.9 |
| East Asia and Pacific | 6 | 5 | 5.3 | 5 |
| Industrial countries | 2.5 | 2.5 | 2.2 | 2.4 |
| Transition countries | 4.3 | 3.8 | 4.5 | 4.3 |

Source: FAO 2006

Global agricultural projections

Global agriculture projections by the FAO, FAPRI and OECD-FAO indicate that demand for Australian agricultural products, in particular cereal crops, will be maintained and steadily increase to 2050 as developing countries import agricultural products to meet the demand of growing populations. The projections assume continuation of current policies and conditions and a slight slow down in global population and income growth rates. It is also assumed that there is continued productivity growth and no impacts of climate change.

These projections indicate that the transport requirements for Australian agriculture will not change significantly over the projection period. Transport infrastructure will need to be maintained to ensure products can reach export and domestic markets, and there will be a gradual increase in the capacity required as output, populations and incomes grow steadily.

Australian agricultural projections

Foran and Poldy (2002) used scenario analysis to examine possible futures for Australian agriculture. They proposed three alternative scenarios:

- **Baseline scenario:** assumes future development of the agriculture sector reflects past developments.
 - Assumes modest increases in the area of land devoted to crops (some from grazing, some newly cleared land) and some conversion of agricultural land to forestry as the land degrades.
 - Small increases in crop yields are assumed. Some new crops and cropping systems are assumed to be adopted (for example industrial quality oilseeds, agroforestry and alley cropping) and some improvements in water use efficiency are assumed. Overall production gains are not significant and areas of production remain the same.
- **Landscape integrity scenario:** assumes there is an enhanced focus on the environment resulting in reduced production but improved conservation, driven by demand for organic and clean, green food and fibre.
 - Assumes reduced use of energy and material inputs and a restoration of the hydrological and chemical balances on the land. Reduced land degradation, reduced salinity and improved biodiversity.
 - 30 per cent of arable cropland is retired and woody vegetation is projected to increase.
 - Total crop production is maintained at current levels to 2050 and there is increased production of legumes, animal feed (hay and silage) and deep rotted perennial vegetation.
- **Technology advance scenario:** crop technologies and farming systems are assumed to improve the hydrological and chemical balances on the land.
 - An increase in the area of land devoted to crops, and some agricultural land converted to plantation is assumed.
 - Production is of high value crops such as vegetables, fruit and oilseeds and overall crop production increases.
 - Increase in the use of fertiliser and irrigation is assumed and salinity is reduced by planting woody vegetation and pumping water.

The baseline scenario examined by Foran and Poldy assumes an increase in irrigated agriculture in northern Australia as limited water availability in southern Australia constrains production. In order to maintain required production levels, around 1 million hectares (Mha) of land in northern Australia would be developed into irrigated agricultural land, producing all of Australia's new cotton, sugar and rice and some horticulture and vegetables. The area would require around 10 000 GL of water a year by 2050, which is about 25 per cent of the available water source in the northern region. The scenario also assumed that increased agricultural production under limited water availability would be achieved through technological progress. For example, the water efficiency of the dairy industry would improve to be equal to the performance of the top 10 per cent of the current producers.

With a shift of agricultural production to northern Australia (northern WA and NT) transport infrastructure would need to be developed in the region to ensure the output reaches markets, either export or domestic.

Foran and Poldy (2002) also examined scenarios of different population growth rates. The different populations were assumed to be driven by alternative immigration policies. The study showed that the different population growth rates would affect Australia's agricultural exports, but Australia would maintain a positive net food balance.

Dunlop et al. (2004) developed three scenarios around the future of Australian agriculture, with a particular focus on the grains industry:

- **Water, water everywhere: dryland agriculture** — this scenario sees investment in dryland cropping, increasing productivity through new varieties, increased inputs, better management and retirement of less productive land. Expansion of dryland crops and intensive pastures in northern Australia (9 Mha) replaces retired low productivity land in southern Australia (11 Mha). Environmental water flows improve as irrigation is reduced by 40 per cent and water use efficiency increases, which help to alleviate the impacts of dryland salinity. The scenario assumes strong growth in yields and productivity can be maintained.
- **Give and take: irrigation** — assumes a continuation of the current shift from low value and variable dryland agriculture to high value irrigation. The scenario assumes there is a significant shift in land use, with 40 per cent of dryland crops and sown pastures converted to low intensity grazing on perennial pastures, forestry and native vegetation, and a doubling of the area under irrigation (from 2 to 4 Mha) of which about 1 Mha is in northern Australia. The scenario would see a substantial increase in exports of horticultural products.
- **Brave new regions: post agriculture** — this scenario assumes the area of agricultural land almost halves, with 19 Mha converted to forestry or conservation areas. The remaining agricultural land is better managed to account for the prevailing soil and climate conditions resulting in less land degradation and improved yields. There will be an increase in perennials, more varied rotations, an increase in cultivation of native plants and animals and an increase in the link between production and domestic markets. Agricultural output will exceed domestic demand, with at least half of production exported. Regional communities will be sustained by new non-agricultural industries.

The discussion in the report highlights the need for efficient transport systems to support the future development of agriculture. It noted that transport infrastructure should be improved significantly to meet current demands, let alone future requirements.

The Northern Australia Land and Water Taskforce (2009) provided the federal government with a report on the potential opportunities for economic development in northern Australia based on water resource availability. The taskforce found that groundwater resources could support new uses of water, such as mosaic agriculture. The area of additional land that could be supported under irrigated, mosaic agriculture was estimated at 20 000 to 40 000 ha (note that this is significantly less than the

1 Mha that had been proposed in other scenarios, such as Dunlop et al. (2004) and Foran and Poldy (2002)). This assessment considers water availability as well as availability of suitable agricultural soils. The taskforce also identified beef cattle as an industry that could expand significantly in northern Australia with improved access to land and water resources.

Biofuels demand

Some global agriculture studies have examined the effect biofuel demand may have on agricultural markets. First generation biofuels use either grains or sugar to produce bioethanol, or oilseeds to produce biodiesel. Significant demand for biofuels can affect the global agricultural markets by significantly increasing the demand for, and therefore price of, grains, sugar and oilseeds. Biofuels closely link agricultural prices and demand to energy prices and energy policies. Development and deployment of second generation biofuels will reduce the impact on agricultural markets because they use crop residues, woody biomass or grasses rather than grains to produce bioethanol and algae to produce biodiesel.

Fischer (2009) examined the impact of two different biofuel scenarios on global agricultural markets. The first scenario assumed biofuel expansion consistent with projections in the IEA's *World Energy Outlook 2008* in which biofuel consumption in developed economies reaches 124 Mtoes in 2050 and total global biofuel consumption reaches 212 Mtoes (or 6 per cent of total transport fuel use). Biofuel consumption in 2008 was around 39 Mtoes (Carriquiry et al 2010). The second scenario assumes global biofuel consumption increases rapidly to meet announced biofuel mandates and targets, and reaches 424 Mtoes in 2050. Sensitivity analysis was also conducted around the proportion of biofuels produced using first generation technologies.

Under each of the biofuel scenarios prices for agricultural products were projected to be between 4 and 35 per cent higher than under the base case. The projected impact on prices increased with the demand for biofuels and the proportion of biofuels produced from first generation technologies. Cereal production is also higher under the biofuel scenarios but the increase in production does not fully cover the demand from biofuels (Tables 3.4 and 3.5). Therefore the use of cereals for food and feed is lower than in the base case.

Table 3.4 Change in agricultural value added due to biofuel production relative to the reference scenario.

| | Scenario WEO-V1 | | | Scenario WEO-V2 | | | Scenario TAR-V3 | | |
|---------------------------|-----------------|------|------|-----------------|------|------|-----------------|------|------|
| | 2020 | 2030 | 2050 | 2020 | 2030 | 2050 | 2020 | 2030 | 2050 |
| | % | % | % | % | % | % | % | % | % |
| North America | 8.5 | 11.2 | 8.6 | 8.7 | 13.2 | 12.8 | 11.6 | 14.1 | 8.6 |
| Europe and Russia | 1.8 | 3.5 | 4.6 | 1.7 | 4.1 | 5.3 | 1.9 | 6.1 | 7.3 |
| Pacific OECD | 0.8 | 1.6 | 1.7 | 0.8 | 1.4 | 1.6 | 1.7 | 3 | 2.8 |
| Africa, sub-Saharan | 2.4 | 2.4 | 2.9 | 2.4 | 2.6 | 3.4 | 4.2 | 4.8 | 4.5 |
| Latin America | 3.1 | 3.5 | 5.2 | 3.1 | 3.8 | 6.4 | 4.9 | 5.7 | 7.8 |
| Middle East and N. Africa | 1.9 | 2.1 | 2.7 | 2 | 2.2 | 2.9 | 3.4 | 3.9 | 3.6 |
| Asia, East | 0.9 | 1.1 | 1.2 | 0.9 | 1.2 | 1.4 | 1.3 | 1.5 | 1.7 |
| Asia, South/Southeast | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.5 | 2.6 | 2.8 | 2.3 |
| Rest of World | 1.2 | 1.2 | 1.1 | 1.3 | 1.4 | 0.5 | 2.6 | 3 | 2.4 |
| Developed | 4.3 | 6.3 | 5.8 | 4.4 | 7.4 | 7.8 | 5.7 | 8.9 | 7.3 |
| Developing | 1.8 | 1.9 | 2.4 | 1.8 | 2.1 | 2.9 | 2.9 | 3.3 | 3.7 |
| Rest of World | 1.2 | 1.2 | 1.1 | 1.3 | 1.4 | 0.5 | 2.6 | 3 | 2.4 |
| World | 2.5 | 3.1 | 3.2 | 2.5 | 3.5 | 4 | 3.7 | 4.9 | 4.5 |

Note: Scenarios: WEO-V1–biofuel use as projected by IEA in WEO reference scenario with second generation biofuels from 2015; WEO-V2–as for WEO-V1 but assuming second generation biofuels from 2030; TAR-V3–assumes that announced biofuel targets will be implemented and development of second generation biofuels is accelerated.

Source: Fischer 2009.

Table 3.5 Change in global production and use of cereals in different biofuel scenarios compared to reference case.

| | 2020 | | | 2030 | | | 2050 | | |
|--------|--------------------|-------------------|-------------------|--------------------|-------------------|-------------------|--------------------|-------------------|-------------------|
| | <i>Biofuel use</i> | <i>Production</i> | <i>Food /feed</i> | <i>Biofuel use</i> | <i>Production</i> | <i>Food /feed</i> | <i>Biofuel use</i> | <i>Production</i> | <i>Food /feed</i> |
| | Million tons | Million tons | Million tons | Million tons | Million tons | Million tons | Million tons | Million tons | Million tons |
| REF-01 | 83 | 64 | -19 | 83 | 66 | -17 | 83 | 68 | -15 |
| WEO-V1 | 181 | 134 | -46 | 206 | 167 | -45 | 246 | 180 | -62 |
| WEO-V2 | 192 | 140 | -48 | 258 | 194 | -68 | 376 | 271 | -102 |
| TAR-V1 | 327 | 229 | -96 | 437 | 308 | -133 | 446 | 313 | -127 |
| TAR-V3 | 238 | 174 | -59 | 272 | 201 | -69 | 262 | 198 | -62 |

Note: Scenarios: REF-01–assumes biofuel feedstock constant at 2008 levels; WEO-V1–biofuel use as projected by IEA in WEO reference scenario with second generation biofuels from 2015; WEO-V2–as for WEO-V1 but assuming second generation biofuels from 2030; TAR-V1–as for WEO-V1 but assumes that announced biofuel targets will be implemented; TAR-V3–as for TAR-V1 but with accelerated development of second generation biofuels.

Source: based on Fischer 2009

The IEA (2010) developed a different scenario (BLUE Map Scenario) which projects biofuels would supply 25 per cent of the required transport fuels in 2050. This would require 612 Mtoes of biofuels (121 Mtoe of bioethanol and 491 biodiesel). If these biofuels were produced using first generation the impact on agricultural markets would be substantial. The IEA, however, suggests that the biofuels would be produced from second generation technology, using significantly less agricultural output. It is assumed that biofuels produced from oilseeds and grains would be completely phased out by 2050. The result is that around 160 million hectares of land would be needed to produce the 612 Mtoes of second generation biofuels.

The studies did not specifically analyse the impact of biofuels on Australian agricultural production, however, an overall increase in the demand and prices of cereals would imply an increase in demand for Australian crops and an increase in exports.

CSIRO (2008) conducted a study into alternative biofuel scenarios for Australia. The scenarios examined all assumed emissions trading would be introduced in Australia. Four scenarios were considered, each assumed emission targets of either 60 or 95 per cent below 2000 levels by 2050 and either high or low oil prices. A number of sensitivity cases were also explored by altering technology, policy and social preference assumptions. The uptake of biofuels is similar across the alternative core scenarios. In these scenarios Australian demand for ethanol peaks in 2035 at 107PJ a year (13 per cent of road transport energy requirements).

The projections indicate that if first generation biofuels are used, the use of grain for bioethanol will affect the quantity of grain exports, but total production and domestic consumption (other than for biofuels) would remain unaffected by an increase in biofuel production. The study also concludes that if second generation biofuels are used, the feedstock for ethanol production would be derived from crop residues and expansion of biofuel production would not affect total production or exports of grains. The core scenarios assume uptake of lingo-cellulosic (second generation) ethanol production between 2015 and 2020 and agricultural production continues as under the base case. It is assumed that historical increases in yields continue into the future. The result is that exports of grains decrease compared to the base case in the period to 2020 before second generation biofuels are fully adopted, but total production volumes are unaffected. If only first generation biofuels were used, around 50 per cent of wheat exports in 2035 would be diverted to biofuel production. Using second generation technology, there would be no change to exports or production but around 38 per cent of the wheat crop residue would be required for biofuels.

The implication for transport infrastructure in Australia is that, where there is significant domestic production of biofuels using grains, export infrastructure requirements would be lower but infrastructure would be required to transport grains from production areas to biofuel processing centres, and further transport would be required to take the biofuel to the markets (mostly in the capital cities).

Climate change

Cline (2007) provides a comprehensive study of the potential impacts of climate change on agricultural productivity in 116 countries and regions. As the study provides global coverage and consistent methodology, it has been used in a number of studies (for example Gunasekera et al. (2007), Zhai and Zhuang (2009) and van der Mensbrugge et al. (2009)). Cline found that climate change (assuming the IPCC SRES A2 scenario which projects emissions of 17.4GtC by 2050 and 29.1GtC by 2100) would lead to an increase in global average land temperatures of 4.5°C by 2070-99 (compared to 1961-90) and an increase in precipitation of 5.9 per cent. These results differ significantly between specific regions. In Australia, the increase in temperature ranges from 4.14°C in central west Australia to 3.4°C in south west Australia. Changes in precipitation are also projected differ between regions with a projected 1 per cent increase in precipitation in the central east and a 22 per cent decrease in the south west.

The effect of climate change on agricultural productivity is projected to differ between regions accordingly. The impact on agricultural productivity is driven by the changes in climate and also the initial climatic condition. According to Cline, Mendelsohn et al. identified a climatic turning point, beyond which additional warming has negative impacts. All of the regions of Australia currently have temperatures above the optimum so increased temperatures are projected to lead to declines in productivity. Other industrialised countries (apart from some areas of the US) are below the optimal temperature so initial warming would benefit agriculture in these countries. Cline projects that agriculture in Australia would experience declines in productivity of 15.6 to 26.6 per cent by the

2080s depending on the strength of the carbon fertilisation effect. The impact varies from an increase of 0.9 per cent in south east Australia assuming carbon fertilisation to a decrease of 41.4 per cent in northern Australia assuming no carbon fertilisation (Table 3.6).

Table 3.6 Projected impact of climate change on Australian agricultural productivity by the 2080s.

| | <i>Without carbon fertilisation</i> | <i>With carbon fertilisation</i> |
|--------------|-------------------------------------|----------------------------------|
| | % | % |
| Australia | -26.6 | -15.6 |
| Southeast | -12.2 | 0.9 |
| Southwest | -13.5 | -0.5 |
| Central East | -23.4 | -11.9 |
| Central West | -35.1 | -25.4 |
| North | -41.4 | -32.6 |

Source: Cline 2007

Gunasekera et al. (2007) estimated the impact of climate change on Australian agricultural production and exports in 2050 using the productivity estimates produced by Cline (2007). Gunasekera et al. found that under climate change (assuming no carbon fertilisation), Australian production and exports of the major commodities (wheat, beef, dairy, sugar and sheep meat) would decline relative to a reference case scenario without climate change but would still increase relative to current levels.

Table 3.7 Projected change in agricultural production and exports in 2050 due to climate change relative to the reference case.

| | <i>Wheat</i> | <i>Sheep meat</i> | <i>Beef</i> | <i>Dairy</i> | <i>Sugar</i> |
|--------------------|--------------|-------------------|-------------|--------------|--------------|
| | % | % | % | % | % |
| Production | | | | | |
| New South Wales | -12 | -13 | -3 | -12 | - |
| Victoria | -13 | -12 | -6 | -10 | - |
| Queensland | - | - | -34 | - | -17 |
| South Australia | -12 | -12 | - | -6 | - |
| Western Australia | -13 | -13 | -6 | - | - |
| Tasmania | - | - | - | -12 | - |
| Northern Territory | - | - | -34 | - | - |
| Australia | -13 | -14 | -19 | -18 | -14 |
| Exports | | | | | |
| Australia | -15 | -21 | -33 | -27 | -79 |

Source: Gunasekera et al. 2007

Fischer (2009) also examined the impact climate change may have on global agricultural production to 2050 assuming the SRES A2 scenario (but using different climate and agriculture models). He found that crop production potential in the Oceania and Polynesia region (which includes Australia) would increase, in particular if carbon fertilisation was observed, compared to the baseline scenario. Projected production levels are also higher for the Pacific OECD region (which includes Australia) compared with the baseline scenario.

One factor contributing to the difference between the results of the Gunasekera et al and Fischer studies may be the level of aggregation. The Fischer study aggregated Australia in with Oceania and Polynesia (for the physical estimates) and Pacific OECD (for the economic estimates). These include New Zealand, among other countries, which are projected to experience benefits from climate change. It is clear, however, that there is still great uncertainty as to what extent agriculture will be affected by climate change.

Garnaut (2008) estimates that climate change, if not addressed, would reduce irrigated agricultural output in the Murray Darling Basin by 49 per cent by 2050 compared to a scenario without climate change. The industries affected would be dairy, fruit, vegetables and grains. The reduced production would reduce agricultural exports and may result in a reliance on food imports. With mitigation, the impact is projected to be lower, around 6 per cent. Agriculture in other areas of the country would also be affected by climate change due to higher temperatures, lower rainfall, lower water availability and the spread of pests and diseases.

If climate change does occur, then it is likely agricultural production will be affected, either through changes in production levels or the location of production. Stokes and Howden (2008) looked at the potential impacts of climate change on Australian agricultural industries and identified options for adaptation. Some adaptation identified involved shifting of industries to areas projected to have more suitable climates. They found that summer grain and pulse crops (such as sorghum) could be grown in more temperate zones than they currently are; cotton could be produced further south and could expand in the Ord and Burdekin irrigation areas, dryland cropping is likely to decline and could be replaced with increased livestock, production of sugar could shift south, the areas suitable for producing cool variety wine grapes and stone- and pome- fruits would decline but the areas suitable for the production of subtropical fruits would increase as previously unsuitable areas experience less frost.

Climate change in the cold wet regions of Australia (south west Tasmania and around the Kosciusko Plateau) could lead to agricultural production in the area benefit from climate change with an increase in growing seasons and therefore increased crop growth. This could result in an increase in Dry areas (inland Australia), however, are likely to suffer from even lower water availability and therefore declining crop yields and pasture growth.

Despite the research efforts outlined above, climate models are unable to reliably predict the likely climate in a particular area under climate change. This is noted in the NSW Grain Freight Review (Department of Infrastructure, Transport, Regional Development and Local Government 2009):

“... if there was certainty on the likely pace and extent of future climate changes in grain-growing regions—which there is not—predicting the precise impact of these changes would be extremely difficult. No reliable, detailed modelling of future rainfall patterns currently exists. Moreover, while higher temperatures will tend to increase yields, increased variability in rainfall will tend to decrease them. Lower and more variable rainfall may push some marginal areas out of grain production, at the same time higher water prices could induce switching of some land from the production of irrigated crops such as rice and cotton to grain. Finally, over the medium term there is considerable scope to accommodate changes in temperature and rainfall—through the development of different crop varieties, greater diversity in crops grown and other advances in farming management practices.”

Salinity

One of the more serious issues for agriculture during the 1990s was salinity. Drought conditions that prevailed through much of the 2000s reduced much of the concern about salinity but after the drought passes salinity may again become a problem for agriculture (Webb 2011).

Salinity has been projected to worsen in some areas of Australia, affecting agricultural yields and production. The Australian Dryland Salinity Assessment 2000 sought to identify the potential impacts of dryland salinity. The assessment included estimates of the area of land and infrastructure that would be affected by salinity by 2050. The results of the assessment are summarised below (Table 3.8). If the area of land estimated below is affected, either agricultural production would need to shift to other areas or the level of production would decline. Either of these situations would require a change in transport infrastructure.

Table 3.8 Assets estimated to be affected by salinity in 2050.

| | <i>Area of land currently affected</i> | <i>Area of land expected to be affected in 2050</i> | <i>Area of agricultural land expected to be affected in 2050</i> | <i>Estimated proportion of agricultural land affected</i> | <i>Length of highways expected to be affected in 2050</i> | <i>Length of railways expected to be affected in 2050</i> |
|------------------------------|--|---|--|---|---|---|
| | '000 ha | '000 ha | '000 ha | % | km | km |
| New South Wales | 181 | 1 300 | 1156 | - | 1 235 | 416 |
| Victoria | 670 | 3 110 | 2 800 | 18 | 3 597 | 952 |
| Queensland | 48 | 3 100 | 2 600 | - | 12 000 | - |
| South Australia | 390 | 600 | 521 | 40 | 1 710 | 46 |
| south west Western Australia | 4 363 | 8 800 | 6490 | - | 1 500 | 2 180 |
| Tasmania | 54 | 90 | 90 | 5 | - | - |
| Australia | 5 658 | 17 000 | 12 615 | | | |

Source: ANRA 2000.

GM crops and agricultural technology

The use of genetically modified crops is increasing around the world. GM crops have the potential to increase productivity through decreasing inputs and increasing yields. GM crops could potentially lead to significant changes in cropping industries and also livestock through the use of GM products in feedgrains or GM pastures. The advantages of GM crops include yield improvements (for example 10 per cent increase in maize yields; 10–40 per cent in cotton yields) and allows for the adoption of some other productivity improving practices such as no-till and double cropping systems and reduced pesticide and herbicide use (Nossal et al. 2008).

Nossal et al. (2008) looked at a scenario where Australia adopted GM canola and wheat and compared it to a scenario without Australian adoption of GM crops, but assumed GM oilseeds and wheat were used in Argentina, Brazil, China and India. GM crops were assumed to have higher yields than the conventional crops. The assumed yield improvements from GM adoption were 10 per cent for canola in Australia, India and China; 3 per cent for soybeans in all 5 countries; and 9 per cent for wheat in all five countries.

The results show that if Australia does not adopt GM crops, Australia will experience declines in the prices received for crops (improved productivity in other countries increases supply and dampens world prices) and reduced market share from lower production and exports. Australia may benefit from the production of conventional crops if a specific market remains for non-GM crops, for example import restrictions or labelling requirements differentiate the products. If Australia adopts GM crops, exports could expand and productivity is projected to improve. In 2018, the value of Australian exports of oilseeds and wheats would be \$918m higher if GM crops are adopted compared to if they aren't adopted. Exports of agricultural products would be \$747m higher as the GM crops lead to a shift in production towards GM crops and away from other agricultural products. The estimated increase in exports would be lower if the EU restricted imports of GM crops (Table 3.9).

Table 3.9 Impact of adoption of GM crops in Australia compared to the reference case where Australia does not adopt GM crops.

| | <i>Assuming unrestricted access for GM crops</i> | <i>Assuming access for GM crops is restricted in the EU</i> |
|-------------------------------|--|---|
| | \$ million (Australian 2007 \$) | \$ million (Australian 2007 \$) |
| GNP | 912 | 732 |
| Exports of oilseeds and wheat | 918 | 682 |
| Total agricultural exports | 747 | 558 |

Source: Nossal et al. 2008.

Acworth et al. (2008) analysed the expected economic benefits of adopting GM canola in Australia and of adopting GM canola, soybeans, maize, wheat and rice in Australia. Scenarios with full adoption of these GM crops were compared with a scenario where the only GM crop adopted in Australia was cotton. The analysis found that the adoption of GM canola would yield the greatest benefits in NSW but would also generate economic benefits for WA, Victoria and SA. The benefits would be larger if all of the GM crops were to be adopted. The expected benefits would be the result of both improvements in yields and reductions in the cost of material and labour inputs required. The assumed changes in yield and input costs as a result of adopting GM crops are outlined here (Table 3.10).

Table 3.10 Assumed changes in yields and input costs from the adoption of GM crops.

| | <i>Yield</i> | <i>Material cost</i> | <i>Labour cost</i> |
|---------|--------------|----------------------|--------------------|
| Canola | 10 | -2.4 | -3.8 |
| Soybean | - | -13 | -11 |
| Maize | 6.5 | 13 | - |
| Wheat | 9 | - | - |
| Rice | 5 | - | - |

Note: a positive number in the change of material costs indicates an increase in costs because the additional cost of GM seed is greater than the other input savings

Source: Acworth et al. 2008.

Increased productivity in cropping resulting from the adoption of GM crops could lead to an increase in production from existing cropping areas and also an expansion of croplands as production of the crops becomes more profitable.

ACIL Tasman (2008) discussed the possibility of third generation of GM crops which refers to the development of crops for non-food, industrial or pharmaceutical processes or products. The development of these crops would create a new market and potentially greater returns on agricultural land and resources. Some applications are being researched in Australia for lettuce, sugarcane, tobacco, wheat and poppies. Third generation GM also has potential in livestock industries.

As these technologies are in the early stages of development, still over 10 years from commercial production, there is not much information available on the potential location and volumes of future production. However, an increase in the returns to agricultural land would be expected to expand the area devoted to crops, and the new uses for crops may require the agricultural output to be transported to new destinations.

These technology developments are examples of how agricultural productivity may improve in the future. ABARE estimates that total factor productivity growth averaged 1.5 per cent per year between 1978 and 2007 for broadacre agriculture (Table 3.11). The growth rate varied over the period, influenced by a number of different factors including investment in public R&D, climatic conditions and adoption of new technologies.

Table 3.11 Growth rate of total factor productivity for broadacre agriculture, 1978 to 2007.

| | <i>All broadacre</i> | <i>Cropping</i> | <i>Mixed crop -livestock</i> | <i>Sheep</i> | <i>Beef</i> |
|--------------|----------------------|-----------------|----------------------------------|--------------|-------------|
| | % | % | % | % | % |
| 1980 to 1989 | 2.2 | 4.8 | 2.9 | 0.4 | -0.9 |
| 1985 to 1994 | 1.8 | 4.7 | 3.2 | -1.7 | 3.1 |
| 1989 to 1998 | 2.0 | 1.9 | 1.4 | -1.2 | 1.6 |
| 1994 to 2003 | 0.7 | -1.2 | 0 | 3.4 | 1.0 |
| 1998 to 2007 | -1.4 | -2.1 | -1.9 | 0.5 | 2.8 |
| 1978 to 2007 | 1.5 | 2.1 | 1.5 | 0.3 | 1.5 |

Source: Sheng et al. 2010.

Projected freight requirements

Two studies have examined the expected future freight volumes at ports in Australia. BTRE (2006b) forecasts the container and ship movements through Australian ports between 2004–05 and 2024–25. The forecasts are based on the current pattern of imports and exports, increasing in line with projected population and incomes. The forecast annual average growth rate for containerised trade through Australian ports for the period 2004–05 to 2024–25 is 5.4 per cent. Non-containerised trade is projected to increase by 3.8 per cent annually. The fastest growth in containerised trade is expected through the Brisbane port (7.4 per cent a year) and the greatest growth rate in non-containerised trade is projected from ports other than the five capital cities (3.9 per cent a year).

Meyrick and Associates (2007) also forecast trade from Australian ports to 2020 using a different methodology for the Australian Transport Council. The Meyrick study took a more disaggregated approach using forecast production and exports of individual commodities such as grains and coal to forecast the trade in bulk commodities. Forecasts of containerised trade, however, were conducted in a similar way using macroeconomic growth projections and resulted in similar projected volumes as the BTRE study.

In estimating the freight requirements of the grains industry, Meyrick assumed the structure of the grains industry would be constant to 2020. The report highlighted a number of issues related to grain exports: grain exports are very volatile, affected by climatic conditions and competition between ports; farmers are increasingly able to store grain on the farm and control when the grain is available for export; and trends indicate that the proportion of production exported will decline as more grain is used as animal feed and as inputs into the biofuels industry. The report concludes that projected growth in grain exports is unlikely to affect the shipping industry because of the existing high variability in grain exports.

Overall, the report found that there will be a significant increase in international trade that will require new port capacity but that plans to increase port capacities will cater for the increased freight volumes. There are, however, concerns that the planned infrastructure development will be delayed by regulatory requirements.

In a report by BITRE (2010) estimates of past, and forecasts of future, road freight requirements were made. These were based on population and economic growth projections and on trends in road freight use. The estimates include information on the volume of freight that is transported interstate, in capital cities and in the rest of the state for the period to 2030. The report found that growth in road freight is expected to be similar to the expected average rate of GDP growth over the same period, 2.7 per cent a year.

As the forecasts are based on historical relationships between non-agricultural GDP and interstate freight flows, and the observed trend towards a saturation point in per person non-bulk freight, the projections implicitly assume a continuation of historical production and consumption patterns.

These projections of potential freight requirements are limited in scope and are unlikely to be useful in helping with infrastructure planning that takes into account potential structural changes in the agriculture sector. Key limitations of these projections are:

- To a large extent they do not account for the unique of the agriculture sector and its transport requirements
- They do not take into account the potentially large structural changes that may occur, in particular in the agriculture sector
- They are largely based on historical growth patterns
- There is limited regional specific information
- The estimates do not incorporate any projected developments or requirements for specific sectors of the economy. There is also no discussion of transport requirements of the different sectors.

4. Scenario Descriptions

Of the literature reviewed and summarised in the previous chapter, there were few studies that presented alternative futures for the Australian agriculture industry taking into account the full range of drivers and the structural change in the agriculture sector they could possibly cause. Furthermore, none of the scenarios looked specifically at the implications of alternative agriculture scenarios for transport requirements.

This chapter presents a number of scenarios in an attempt to fill the identified gap. These descriptive scenarios have been designed to represent alternative potential futures of how agriculture in Australia may develop over the coming decades. A summary of the scenarios is provided in table 4.1 which shows the main assumptions for each scenario. Based on these scenarios, initial implications for future transport needs of Australian agriculture are set out.

Scenario 1: Business as usual

This scenario aims to represent a continuation of current policies and growth patterns.

- Under this scenario it is assumed that Australian and global population and income growth continues modestly.
 - Australian population grows along the lines of the ABS population projections (series B), reaching 33 million by 2050.
 - Global population growth follows the UN population projections (medium variant) which results in a global population of 9.1 billion in 2050.
 - Consistent with business as usual projections from the literature (for example, FAO 2006), global income growth is assumed to be 2.7 per cent per capita. With higher growth projected in East Asian countries.
- Consumption patterns are also assumed to be consistent with projections by FAO (2006) with growth in food consumption projected to follow population growth. Developing countries will continue to import cereals and demand will shift towards meat, dairy and oilcrop products as incomes increase.
- In this scenario it is assumed that there is no climate change, climatic conditions and water availability return to historical levels.
- Productivity growth is assumed to continue at approximately the same rate as observed in the past. ABARE estimate total factor productivity growth averaged 1.5 per cent in broadacre agriculture between 1978 and 2007 (Sheng et al. 2010).
- It is assumed that there is no change in Australian policy towards biofuels, climate change and no expansion of agriculture in northern Australia.

Scenario 2: SDLs

In this scenario, it is assumed that sustainable diversion limits (SDLs) are introduced to the Murray Darling Basin which results in water allocations being 30 per cent lower than current diversion limits. Other policy and growth assumptions are the same as in scenario 1.

Scenario 3: Water shortage

This scenario aims to represent a situation where water shortages in southern Australia, particularly in the Murray Darling Basin, persist long term. These assumed water shortages are represented by a continuation of the drought conditions that have been observed in the past decade. It is assumed that Australian agricultural production levels reflect the production achieved in the past 10 years. Reacting to this water shortage, it is assumed that agriculture in northern Australia expands by around 40 000ha as explored by the Northern Australia Land and Water Taskforce (2009). Other variables are assumed to be the same as in scenario 1.

Scenario 4: Climate change

In scenario 3 it is assumed that climate change is realised, affecting global agricultural productivity. Cline (2007) provides estimates of the impact climate change may have on agricultural productivity and Gunasekera et al (2007) provides some analysis of what this may mean for Australian agriculture and trade. As one of the impacts of climate change, water availability is projected to be low, with rainfall similar to the patterns observed over the past 10 years. Other growth and policy settings are assumed to be the same as in scenario 1. No climate change mitigation policy is assumed.

Scenario 5: Big Australia

Under the Big Australia scenario the Australian population is assumed to grow faster to reach around 40 million by 2050. This is consistent with the high growth scenario in the ABS population projections (Series A). It is also assumed that the proportion of the population in the capital cities would increase. Other assumptions remain the same as in scenario 1.

Scenario 6: Productivity advances

ABARE estimates that total factor productivity growth averaged 1.5 per cent per year between 1978 and 2007 for broadacre agriculture. The growth rate varied over the period, influenced by a number of different factors including investment in public R&D, climatic conditions and adoption of new technologies. ABARE shows that productivity growth has slowed over time. In this scenario, it is assumed that agricultural productivity growth returns to the higher levels observed in the 1980s of around 2.2 per cent. One key area that may lead to these productivity improvements is the adoption of GM crops. GM crops have the potential to increase yields by up to 10 per cent and decrease labour and material costs.

In this scenario it is assumed that productivity is high but the remaining growth and policy assumptions are the same as under scenario 1.

Scenario 7: Global food crisis

This scenario seeks to replicate the circumstances that arose during 2008 when global food prices increased significantly. The price hikes were a result of high fuel prices, poor seasonal conditions in a number of countries and biofuel policies. Together these factors increased the cost of agricultural production, restricted supply and diverted some supply of agricultural products from food industries to biofuels.

Therefore, for this scenario, it is assumed that global population growth is high, water availability is low, climate change is realised and biofuel policies are introduced. Productivity growth is assumed to remain at the same rate as in scenario 1. Overall, these circumstances are likely to place significant pressure on agriculture with high demand but conditions constraining supply. The biofuel scenarios

examined by CSIRO (2008) found that, as demand for crops increased for biofuel use, agricultural production in Australia remained the same but some of the production was diverted from export to domestic use.

Table 4.1 Summary of scenarios.

| | Scenario 1 'Business as usual' (BAU) | Scenario 2 SDLs | Scenario 3 Water shortages | Scenario 4 Climate change | Scenario 5 Big Australia | Scenario 6 Productivity advances | Scenario 7 Global food crisis |
|---------------------------------|---|--|---------------------------------------|--------------------------------------|-------------------------------------|---|--|
| Australian population growth | Moderate | Moderate | Moderate | Moderate | High | Moderate | Moderate |
| Global population growth | Moderate | Moderate | Moderate | Moderate | Moderate | Moderate | High |
| Water availability | Historical rainfall | SDLs decrease water allocations by 30 per cent | Last 10 years rainfall | Last 10 years rainfall | Historical rainfall | Historical rainfall | Last 10 years rainfall |
| Climate change | No | No | No | Yes | No | No | Yes |
| High productivity growth | No | No | No | No | No | Yes | No |
| Biofuel policy | No | No | No | No | No | No | Yes |
| Northern Australian agriculture | No | No | Yes | No | No | No | No |
| Other shocks/situations | – | – | – | – | – | – | High fuel prices, poor seasonal conditions o/s leading to high food prices (as in 2007-08) |

Source: CIE.

Implications of scenarios for transport infrastructure

The scenarios are likely to change some of the characteristics of Australian agriculture that will result in changes in the transport task. These characteristics include the share of production exported, the commodity mix, the transport distance and the volume of product to be transported.

An increase in the export share is likely to mean transport corridors to the main ports will have increased usage and ports may require further development to cope with the increased export volumes. Different commodities have different transport requirements, therefore a significant change in the mix of commodities produced will have implications for the transport requirements. For example, an increase in the production of dairy products may require improved road networks around dairy processing facilities and requires different export facilities compared to grains for example. A change in the distance products are to be transported, for example because of an expansion of agriculture in northern Australia, will affect the transport task and required infrastructure. Finally, increased volumes of production will involve a larger freight task and require the associated transport infrastructure.

An initial assessment of how these drivers may be affected by the assumptions in the various scenarios is provided in Table 4.2.

Table 4.2 Change in key indicators relative to ‘business as usual’.

| | Scenario 2 SDLs | Scenario 3 Water shortages | Scenario 4 Climate change | Scenario 5 Big Australia | Scenario 6 Productivity advances | Scenario 7 Global food crisis |
|---------------------------|--|--|--|-------------------------------------|---|--|
| Volume produced (tonnage) | Decrease | Decrease | Decrease | Increase | Increase | Decrease |
| Export share | Decrease | Decrease | Decrease | Decrease | Increase | Decrease |
| Commodity mix | Shift to higher value products (eg horticulture) | Shift away from cereals | Slight shift away from beef and dairy | - | Depends on the nature of the productivity improvement | Increase in grains and oilseed crops for biofuel production Decrease in grain fed livestock |
| Transport distance | - | Increase (expansion of northern agriculture) | - | - | - | - |

Source: CIE.

Scenario 2: SDLs

The SDLs proposed for the Murray Darling Basin are projected to lead to reductions in irrigated agricultural output from the region and also an increase in non-irrigated agricultural output (ABARE-BRS 2010). Overall, the volume of agricultural production is expected to decline relative to if the SDLs are not implemented. A decline in agricultural production, without a shock to domestic demand, would lead to a decline in exports, and therefore a decrease in the export share. The available water is expected to be used in high value irrigated agricultural output, vegetables, fruit and nuts and grapes. The greatest decline in irrigated production is expected from hay, cereals and other broadacre. Some increase in non-irrigated agricultural production is expected in the MDB, for example cotton and dairy. Assuming no expansion of agriculture in northern Australia, the change in the transport distance would be minimal.

Scenario 3: Water shortage

Similar to the SDL scenario, ongoing water shortages would be expected to reduce production and exports. Evidence from the 2002–03 drought indicates that reduced production was greatest for cereal crops (PC 2005). It could be expected that water shortages would impact cereal production the most due to its dependence on rainwater, leading to a shift of agricultural production away from cereals. In this scenario it is assumed that agriculture expands in northern Australia in response to continued dry conditions in southern Australia. Current agriculture activities in northern Australia include beef cattle, sugar and horticulture. With increased production in the remote areas of northern Australia, the transport distances will be greater.

Scenario 4: Climate change

Climate change is expected to impact negatively on Australian agricultural production. Estimates by Gunasekera et al. (2007) are that Australian production of agricultural products would decline by up to 19 per cent by 2050 compared to if there was no climate change, depending on the commodity. The export share is expected to decline as domestic consumption remains relatively unchanged with the decrease in production volumes. The beef and dairy sectors are projected to be the most affected commodities, wheat, sheep meat and sugar slightly less affected. It is unclear what impact this scenario may have on transport distances. Northern Australia is expected to be the most affected by climate change as temperatures rise beyond those suitable for agriculture, however, water availability is expected to be better in the north.

Scenario 5: Big Australia

Larger populations in Australia are expected to increase domestic demand for agricultural products. Under this scenario production volumes would remain relatively unaffected but the export share would decrease as a greater proportion of the production would be required domestically. Due to the large export share for most agricultural products, meeting domestic demand is unlikely to require a change in commodity mix. The commodity with the lowest export share is probably vegetables, at 11 per cent. An increase in domestic demand may require increased production, or imports, of vegetables. With most of Australia's population concentrated in the capital and other large cities, there is unlikely to be a significant change in the transport distance required.

Scenario 6: Productivity advances

Productivity advances are likely to increase agricultural production above business as usual, and increase the share of production exported. Any change in the commodity mix is likely to be driven by the nature of the productivity advances. One of the potential productivity improvements may come from the adoption of GM crops. If GM crops are widely adopted in Australia it is likely that production of crops such as cotton, soy bean, maize, canola, wheat and rice would increase. Productivity improvements would probably have limited impact on the transport distance. However, some improvements may enable production to take place in previously unsuitable areas which would change transport distances.

Scenario 7: Global food crisis

In this scenario, low rainfall, climate change and high fuel prices are expected to limit the volume agricultural production. At the same time, high population growth and demand for biofuel feed stocks will increase the demand for agricultural products. It could be expected that agricultural production and exports would be lower due to the physical constraints. There would be a shift in production toward biofuel feed stocks (grains, oilseeds, sugar). Grain fed livestock may decline because of high grain prices. Transport distance is unlikely to change significantly.

5. Issues with existing transport infrastructure and institutional arrangements

Current state of transport infrastructure

Poor road conditions

The Australian Rural Road Group, in its report *Going Nowhere* (ARRG 2010), provides some detail on the current poor state of local rural roads:

- The introduction and use of B-double and larger trucks in agriculture has been limited because roads have not been upgraded to a state suitable for use by B-doubles.
- NSW authorities limited the weight of livestock transport vehicles so that degraded roads were not further damaged.

It is this situation of poor road conditions that affect agricultural productivity. Even if part of the journey is affected by poor roads, freight will either be transported on smaller, less efficient vehicles, or be double handled.

A case study presented by the Australian Livestock Transporters Association (ALTA 2006) demonstrates the impact of restrictions to larger and more efficient vehicles accessing key agricultural sites. The case study examined the transport of sheep and lambs to Fletcher International Pty Ltd, an abattoir in Dubbo. Key conclusions from the study were:

- There is a cost advantage in transporting sheep in multi combination vehicles (such as B- doubles, B-triples and road trains) compared to traditional 6-axle semi trailers.
- Routes to the facility are not suitable for multi combination vehicles because:
 - Turning areas off major highways are not long enough
 - Bridges are too low to be passed by stock crates
 - Entrances and exits to major highways are built too close to rises and crests to be negotiated safely
 - Farm gates are not large enough and loading ramps not high enough for the larger vehicles.
- If the public road infrastructure were improved, there would be fewer truck movements, savings to the cost of transport would be around 5 per cent for Fletcher International and other businesses would also benefit from road upgrades.
- The volume of exports from Fletcher International could be 12 per cent higher were they able to benefit from productivity gains from improved roads.

It was estimated that a 5 per cent transport saving achieved through removing these types of infrastructure bottlenecks would have net present value to livestock transport of around \$373m (in 2004-05 prices) (ALTA 2006).

Congestion

Road congestion is recognised as a problem in the major cities, Infrastructure Australia (2010a) states that ‘addressing transport congestion presents the greatest opportunity to improve national productivity’. Congestion affects transport of agricultural goods into urban markets and metropolitan ports. Infrastructure Australia (2010a) also notes that severe congestion and delays are being experienced on both the land and sea side of some ports. Land side problems are notable in metropolitan ports and sea side congestion in bulk commodity ports. Increasingly, the agriculture sector is competing with the growing mining sector for port capacity.

Interstate inconsistency

Inconsistencies in transport regulations between the states make interstate transport costly.

- A truck loaded with livestock to a legal limit in Victoria and Queensland is illegal in NSW (Catanzariti 2007).
- Grain trucks are allowed to be overloaded by 5 per cent in Queensland and WA but not in Victoria or NSW (Catanzariti 2007).

These inconsistent regulations mean that effectively the lowest loading limit is applied to interstate freight movements to ensure compliance in each state. This can mean significantly greater number of truck movements are required to complete the freight task, adding to costs.

Rail freight also faces interstate transport problems with three different rail gauges operating across the country. Different rail gauges limits the use of rail freight in some areas.

Institutional arrangements

The problems described briefly above could be thought of as the symptoms of poor governance of the national transport infrastructure network. Responsibilities for transport infrastructure are spread across 3 levels of government and involve numerous agencies. The state of infrastructure has suffered from inadequate funding, poor maintenance programs, piecemeal planning and limited reporting.

Jurisdiction responsibilities and funding

There are multiple agencies at each level of government involved in the provision and regulation of transport infrastructure:

- State and Territory governments, along with local governments, are responsible for the road network (CRRP 2011). State government departments and road agencies are responsible for the planning and management of arterial roads, improving road safety and registrations. Local governments own and manage roads (CRRP 2011). Some state governments are increasing the responsibilities of local governments with regard to roads (ARRG 2010).
- The Australian Transport Council (ATC) has responsibility and political oversight for the road transport sector. The council is comprised of Federal and State/Territory Ministers, but will be replaced by a Standing Council on Transport and Infrastructure from July 2011 (CRRP 2011). ATC is supported by the National Transport Commission (NTC) which submits reform recommendations and monitors and coordinates the implementation of reforms.
- The Federal Department of Infrastructure and Transport provides advice and analysis on infrastructure planning and coordination, transport safety and security and major project facilitation among other things.

- Infrastructure Australia advises governments, investors and infrastructure owners on infrastructure needs, financing arrangements and policy, pricing and regulation impacts on infrastructure use.

Road charging and funding arrangements also involve multiple agencies and do not have strong links between road usage, road charges and road maintenance funding. Without strong links between revenues and road usage the incentives to maintain roads by state and local governments is lost because the local (or state) government does not receive increased funding from having well maintained, and therefore useful and productive, roads.

Heavy vehicle charges are set nationally under an Inter-governmental agreement based on historical road construction and maintenance costs (CRRP 2011). Charges are collected through the fuel excise by the Federal Government and form part of the Commonwealth's general revenue (CRRP 2011). State and Territories collect heavy vehicle registration charges which are also added to general revenue (CRRP 2011). Local governments receive a share of the heavy vehicle revenue indirectly through financial assistance grants and the Nation Building Program payments but over half of expenditure on local roads is self funded by local governments (CRRP 2011).

The ARRG (2010) emphasises that funding for local roads is inadequate and declining. This is supported by estimates from Federal government, The Australian Local Government Association and the Institute of Public Works Engineering Australia. Each of these groups found that there is a shortfall in funding of local roads nationally (ARRG 2010). Government funding for road infrastructure fluctuates over short time frames. Major infrastructure programs, however, require long term funding streams (Infrastructure Australia 2011). Spending on the maintenance of roads is often sacrificed for the sake of other competing political priorities (ARRG 2010, CRRP 2011).

Grants provided to local governments through the Financial Assistance Grants program are provided on an equity basis to ensure all councils receive funds, with greater funding going to disadvantaged councils. The allocations do not take into account the productivity of a road or area, the grants are not well targeted to achieve productivity improvements (ARRG 2010).

Jurisdictional arrangements for railways and ports are more straight forward with commercial ownership arrangements and some funding from State and Federal Governments.

Planning

In the past there have been numerous attempts at creating national transport plans (Infrastructure Australia 2011), including:

- Auslink/Nation Building
- National Highways scheme
- Designated Interstate Rail Network
- Australian Rail Track Corporation network

Despite these plans and initiatives the Review of the NTC (NTC Review Steering Committee 2009) found that "strategic planning and prioritisation at a national level to achieve that vision has been relatively ad hoc". The OECD also found that "infrastructure spending decisions are frequently taken with no regard for national priorities" (Infrastructure Australia 2011). The ARRG (2010) concluded that the current management approach for road infrastructure is neither national nor strategic.

Planning and strategy documents often are limited to a particular mode, industry or State. Current planning documents or initiatives include:

- Development of a National Land Freight Strategy;
- A National Port Strategy;
- Strategic Infrastructure Plan for South Australia 2004–05 — 2014–15;
- Freight Futures — Victorian Freight Network Strategy.

An ad hoc and inconsistent approach to managing road infrastructure has implications for other parts of the economy. Investments in storage, rail and ports need to be made in the context of the capacity, or future capacity of roads (ARRG 2010). Without certainty around the availability of suitable road infrastructure it is not possible to make efficient investment decisions in other areas.

Reporting and data

There is limited data available on freight movements, particularly detailed data on the products being transported and origin and destination of the products. The latest data set published by the ABS (2002) refers to the year ending March 2001 (Freight Movements Australia). The data provides detail on either the goods transported or the destination and origin of the freight, it does not provide detail on both, nor does it provide detail on the types of vehicles transporting each type of product. Most of the information available through the ABS refers to road transport, there is even less detail available for rail freight.

Road and rail freight data sets are produced by BITRE using models and partial indicators (BITRE 2009). The freight statistics published by BITRE (2009) are limited in detail to bulk and non-bulk freight by road, rail and sea, and by state. The time series data published by BITRE is incomplete and also is inconsistent with ABS data. For example, total freight carried by road in the year ending March 2001 according to ABS was 88 billion tonne kilometres (ABS 2002). For the financial year 2000–01, BITRE estimates the total freight carried by road to be 98 billion tonne kilometres (BITRE 2009).

There is limited reporting on the condition of the national road infrastructure network. There is no requirement for detailed reporting on road assets to the Commonwealth, the only reporting published on the state of roads is at a homogenised state level. The lack of detail and depth of information means the poor state of some roads is overlooked (ARRG 2010).

Infrastructure Australia (2011) found that information gaps were a key constraint on the national freight task. It found that current data collection is inadequate or descriptive rather than analytical. Some data is held by state governments but is not publically released (Infrastructure Australia 2011). This lack of data means that there is not a clear picture about the future needs of freight and how the freight task might grow. Producing forecasts or possible scenarios about the future cannot be done without solid data on the current freight activities and problems.

6. Recommendations for infrastructure planning

Broadly speaking, there are 4 steps or stages that can be taken to improve transport infrastructure planning for the agriculture sector:

1. Take steps to improve the current regulatory and maintenance frameworks in the absence of improved or additional data
2. Improve data collection
3. Develop forecasts of agricultural freight requirements
4. Incorporate agricultural scenarios into infrastructure planning

Improve current frameworks

Currently available data does not enable accurate forecasting, so rather than seek a precise prediction of the freight tasks that will be required in the future, the planning, monitoring and maintenance processes for providing transport infrastructure should be improved so that it can easily and quickly adapt and respond as the transport needs change while at the same time being informed by potential drivers and trends.

The shortcomings of the current systems were discussed in the previous chapter. Improving maintenance programs, upgrading roads and addressing regulation issues (including across jurisdictions) are some steps that could be taken immediately to improve transport of agricultural goods.

A number of initiatives that have been started are likely to help this process if they are followed through.

- Establishment of the National Heavy Vehicle Regulator which will help standardise transport regulations across states making interstate freight more efficient.
- Development of the National Land Freight Network which will consider the freight needs across all sectors and transport modes.
- The National Ports Strategy will seek to address both land side and sea side congestion at ports.
- Reforms to heavy vehicles charges are being considered through the COAG Road Reform Plan to better align road prices with the costs that heavy vehicles impose on road infrastructure.

The ARRG (2010) suggested a number of reforms to help with the maintenance of local roads. These included mandatory asset plans, establishment of a national road portfolio manager and establishment of a national rural local road productivity fund. Together these reforms aim to ensure a consistent approach to the maintenance of local roads and ensure adequate funding is provided for the task. Local roads are an important feature of the agricultural freight task but lie outside the scope of the other reform processes underway including the National Land Freight Network.

Incorporating agricultural scenarios into infrastructure planning

There is a strong likelihood that the nature and location of agricultural production will change in the medium to long term. This report sets out a framework for considering the drivers of such changes and also indicates how information from a variety of sources can be used to implement such a framework.

It should be noted, however, that providing a definitive account of how, where and when agricultural production will take place in Australia is a very difficult task. There are many different factors that can influence the agriculture sector in the future. Combining the uncertainty around each of these drivers, results in a very wide range of possibilities for agricultural production in Australia.

Furthermore, the statistical data available on current transport patterns is not very detailed or timely. Improved regular data collection and the development scenarios that incorporate a range of possible futures are required before detailed agricultural scenarios can be incorporated into infrastructure planning.

Data collection

An important initial underpinning for planning transport infrastructure is data. As discussed in the previous chapter, detailed and timely data on freight movements is not currently available. It is difficult to ensure transport infrastructure is adequate without complete information about how it is currently being used. Furthermore, monitoring changes in transport use will be an essential element in understanding how transport requirements are likely to develop in the future (particularly when combined with structural scenarios as noted above).

Policy planners in this area should actively seek to commission and obtain timely data including:

- updated information on current freight demands; and
- comprehensive (rather than anecdotal) evidence on bottlenecks within the transport system.

Information on transport patterns for different product types will be useful in analysing transport infrastructure requirements. This information may include:

- type of product being transported;
- type of vehicle being used;
- destination;
- transport loads at peak times during the year (as opposed to annual volumes); and
- what delays/barriers were faced.

Having regular data collection will enable any changes in transport patterns to be identified faster.

For sectors such as agriculture where production volumes, and therefore transport demands, vary greatly based on seasonal conditions, having information on peak demand is important. This means that data collections should account for seasonality. In this sense, average annual data may be misleading, so the choice of timing for data collection will be crucial.

Data and droughts

A particular characteristic of production of agricultural goods, and therefore demand for transport of agricultural products, is the high variability in production volumes, not just within a year but also between years. Droughts can have significant impacts on production volumes for a number of consecutive years. When collecting data it will be important to identify whether the activities in the relevant region have been affected by drought at the time. Identifying statistics affected by drought will be important for two uses of the data – informing forecasting and ongoing monitoring of the sector.

Forecasts are a long term planning tool and so results of forecasts are designed to provide indications of long term average production in typical years. The in any one scenario, projections will not be able to reflect the occurrence of drought years. It is important that the data underlying forecasts are of typical, rather than drought years, so that the forecasts do not project ongoing drought year conditions.

Understanding what data is associated with drought conditions will also be important for general ongoing monitoring of agricultural and transport demand where forecasts are not being used. It is important to understand if an observed decline in production is associated with a significant and permanent structural change or whether the change is caused by drought and therefore is temporary.

Using data without accurate forecasts

While detailed data collection is an important input into developing quantitative demand forecasts, improved data will also help with improving infrastructure planning in the absence of forecasts.

Even without formal projections or forecasts, monitoring changes in the key drivers of agricultural production, and monitoring changes in production and transport patterns will help infrastructure planners to identify likely changes in demand for infrastructure as they develop so planning can start before problems intensify. Changes in agricultural production are likely to be gradual, giving opportunities to respond as changes occur. Without the event of significant changes in the identified drivers, agricultural production is likely to continue along business as usual lines. Infrastructure planners could start with an assumption that production patterns will continue along historical lines, and plans can be adjusted as changes are identified through regular monitoring.

Forecasts

As was highlighted in chapter 3, the published literature falls short of providing detailed projections of the demand for transport infrastructure under alternative scenarios that divert from business as usual. In particular, current forecasts do not incorporate potential structural shifts in agricultural production.

Improved data will enable the development of these more useful demand forecasts. In Infrastructure Australia's recent *National Ports Strategy* (Infrastructure Australia 2010b) it is recommended that:

The Bureau of Infrastructure, Transport and Regional Economics and the Australian Bureau of Agriculture and Resource Economics (ABARE) should publish forecasts of trade including by commodity, activity and corridor usage that are usable for the purposes of planning.
(Recommendation 1.9)

And:

The Commonwealth should lead a project to improve the evidence and forecasting basis for exports and growth in services, and develop scenarios for the impact of changes such as demography, climate and energy for planning consideration. (Recommendation 1.10)

Implementing these recommendations with greater detail so that the information can be of use for the entire freight sector, rather than just ports, would be a significant step toward enhancing the understanding of transport infrastructure requirements.

Multiple levels of forecasts are likely to be needed to understand potential transport requirements.

Firstly, demands for transport by individual sectors will need to be understood by forecasting the production and consumption patterns within each sector. This is likely to be a very complex task. In the case of agriculture, the forecasts should consider developments in the drivers that were identified and discussed in this report. As previously discussed, developing long term forecasts of agricultural production is very difficult. Multiple scenarios, such as those proposed in chapter 4, can help in canvassing alternative possible patterns of change. Ongoing monitoring of the developments in each of the drivers as well as production and consumption of agricultural products will help to develop and update these forecasts.

Secondly, the entire freight task should be forecast considering all sectors and modes of transport. Transport modelling is used to project freight forecasts. BITRE (2010) conducted a study on road freight estimates but did not differentiate between sectors of the economy. With more comprehensive data, as outlined above, it would be possible to undertake a more detailed analysis of the freight task.

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Transport Infrastructure for Australia's Agricultural Needs

by Catherine Tulloh and David Pearce

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Transport is a fundamental 'finishing component' of agricultural production. Inefficient or insufficient transport infrastructure reduces the ability of producers to meet consumer demands and to achieve a fair return for their product. Efficient transport infrastructure planning that both recognises the unique nature of agricultural production and that can respond to emerging changes within agriculture is therefore essential to the effective functioning of agricultural markets.

The purpose of the policy research reported here is to assist in understanding current freight flows, how and why these may change and examining deficiencies in existing infrastructure.

The immediate target of this research is policy planners and policy makers — particularly those working in transport infrastructure.

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