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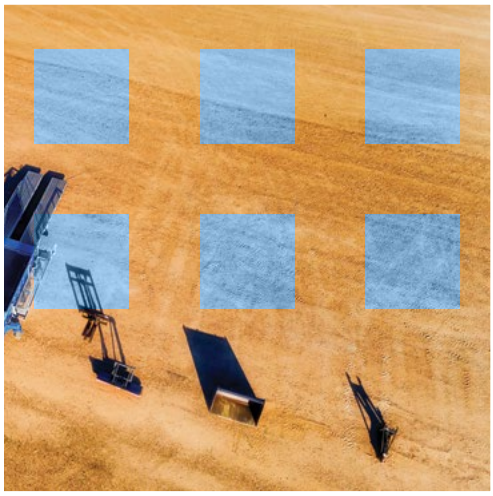
Australian Export Grains Innovation Centre

Bulk and containerised grain exports from Australia's main grain producing states

(supplementary report)

Ross Kingwell
AEGIC Chief Economist

Dipesh Maharjan
Research assistant



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GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

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Executive summary

Since 2011, Australia annually has produced on average about 41.5mmt of winter crops and 3.7mmt of summer crops. The grain from these crops flows to either domestic or export markets and most grain exported from Australia is in bulk form, rather than via containerisation. Nonetheless, around 30 per cent of all grain exported from Australia's eastern states, Victoria (VIC), New South Wales (NSW) and Queensland (QLD), is exported in containers.

The mix of crops exported via containerisation differs between Australian states. Wheat, lentils and faba beans dominate containerised grain exports from VIC, whereas wheat and chickpeas dominate exports from NSW and QLD. South Australia (SA) displays the most even mix of containerised grain exports, featuring lentils, faba beans, wheat, field peas and malt. Similarly, Western Australia (WA) exports a diverse range of grain exports, but mostly wheat, malt and processed oats. Each grain type, however, tends to be sent to a narrow range of destination countries. Pulses predominately are sent to South Asian and Middle East countries. Malt is exported to only a handful of countries. Sorghum is mostly sent to Japan and China, wheat is principally sent to China, Taiwan and a subset of South East Asian countries.

In contrast to containerisation, the bulk export of grains typically involves far fewer grain types and is dominated by wheat, barley and canola. WA is nationally unique in being almost entirely devoted to the bulk export of grain. WA regularly exports between 0.5mmt to 0.8mmt of containerised grain that comprises under 5 per cent of that state's annual grain exports, whereas containerised grain exports from VIC are regularly 1.2mmt to 1.8mmt and for NSW, 0.8mmt to 1.4mmt. Containerised grain exports from these two states often comprise around 30 per cent of their grain exports.

In contrast to containerisation, the bulk export of grains typically involves far fewer grain types and is dominated by wheat, barley and canola. WA dominates the export of bulk grain from Australia, regularly exporting in bulk between 12 to 16mmt of grain each year whereas most other states usually only export up to 5mmt of bulk grain annually. Nonetheless, bulk export of grain is by far the main source of grain exports in each Australian state.

Australia is renowned globally for the volatility of its grain production. This volatility translates into highly volatile grain exports, especially in eastern Australia. This volatility is liable to increase, mostly due to the interplay of increased drought frequency, greater growth in population is eastern states and technology progress that will temporally lift grain yields. This report briefly explores how the spatial nature of domestic demand for grain in Australia will exacerbate the volatility of Australia's grain exports, especially in Australia's eastern states.

Introduction

Grain is exported from Australia either in bulk or via containers. Grain containerisation is much more prevalent in Australia's eastern states of QLD, NSW and VIC; often forming around 30 per cent of all grain exports from these states. By contrast, the main state that dominates the export of bulk grain from Australia is WA. WA regularly exports in bulk between 12 to 16mmt of grain each year whereas most other states usually only export up to 5mmt of bulk grain annually.

The main grains exported and their destinations for each state's exports of containerised and bulk grain is shown in Table 1. There is often a marked difference in the types of grains exported in containers versus bulk. Many pulses, processed oats, malt and wheat are exported in containers. By contrast wheat, barley, canola and sorghum are the principal grains exported in bulk.

The destinations for most pulses exported in containers are countries such as India, Bangladesh, Egypt and Pakistan. Malt and processed oats go to a range of countries including China, Vietnam, South Korea and Malaysia.

The principal destinations for wheat exported in bulk are countries such as Indonesia, Vietnam, China and the Philippines. Barley, historically, has often been exported to China; but after China's imposition of prohibitive tariffs most barley now is exported to Saudi Arabia and Japan. Canola mostly is exported to countries in the European Union. Containerised sorghum has been sent to Japan, whereas bulk sorghum mostly is exported to China.

The next section shows in greater detail via a series of charts the export history of containerised grain exports from each state since 2011.

Table 1: Main grains exported and main destinations for each state's exports of containerised and bulk grain

State	Containerised exports		Bulk exports	
	Top 3 or 4 destinations	Main grains exported	Top 3 or 4 destinations	Main grains exported
WA	Vietnam, Philippines, South Korea, China	malt, processed oats, wheat	China, Japan, Indonesia, South Korea	wheat, barley, canola
NSW	Vietnam, Taiwan, China, India	wheat, chick peas, malt, faba beans	China, Indonesia, Vietnam	wheat, canola, sorghum
VIC	Vietnam, Malaysia, Taiwan, China	wheat, lentils, faba beans, malt	China, Indonesia, Japan, Vietnam	wheat, canola, barley
SA	Egypt, Bangladesh, India, Vietnam	lentils, faba beans, malt, wheat	Indonesia, China, Vietnam	wheat, barley, canola
QLD	India, Bangladesh, Japan, Pakistan	chick peas, wheat, sorghum	China, Vietnam, Indonesia, Japan	sorghum, wheat

Containerised grain exports

Victoria

VIC is Australia's main and most consistent source of containerised grain exports, regularly exporting over 1.2mmt of a variety of grains; principally wheat and lentils, but complemented by a range of other commodities; canola oil, malt and other pulses. The main destinations for these exports are a range of South East Asian countries; but some grains, like lentils and faba beans, flow to specific markets such as Egypt and sub-continent countries.

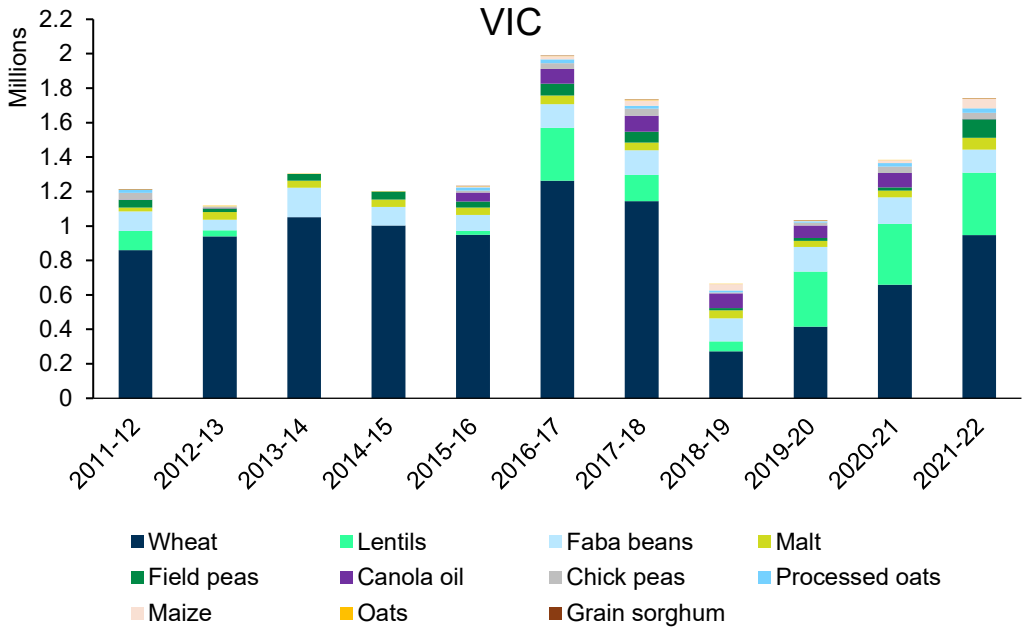

Figure 1. Containerised grain exports from Victoria each financial year from 2011/12 to 2021/22 (mmt)

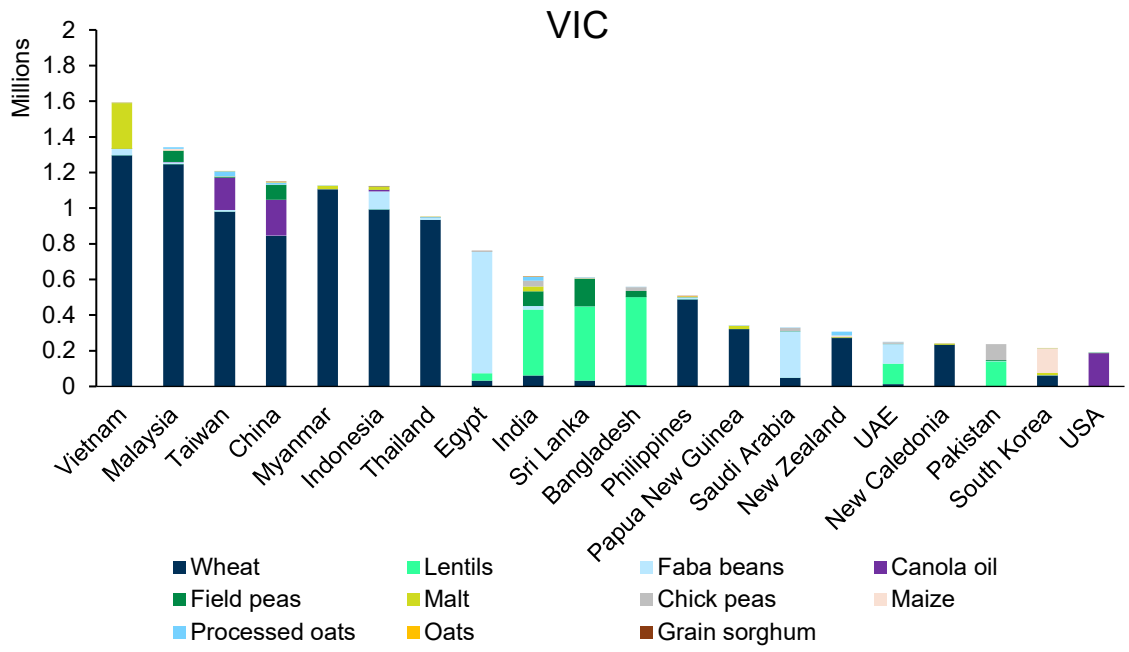

Figure 2. Top 20 markets for containerised grain exported from Victoria; total tonnage exported from 2011/12 to 2021/22 (mmt)

New South Wales

After VIC, NSW is the nation's next most important source of containerised grain exports. Wheat is the principal containerised grain exported from NSW. Of next importance are chick peas, malt and faba bean exports. The export of containerised grain is volatile due to seasonal impacts, especially periods of drought that curtail available supplies and drive up local prices of grains that ordinarily would be exported. Wheat in containers is principally exported to several South East Asian countries.

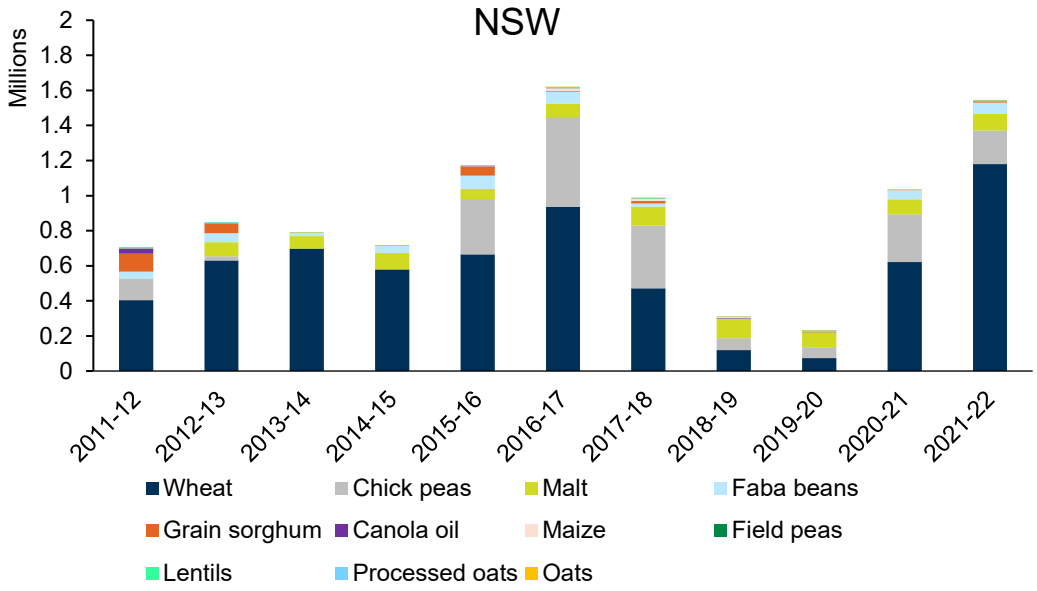

Figure 3. Containerised grain exports from New South Wales each financial year from 2011/12 to 2021/22 (mmt)

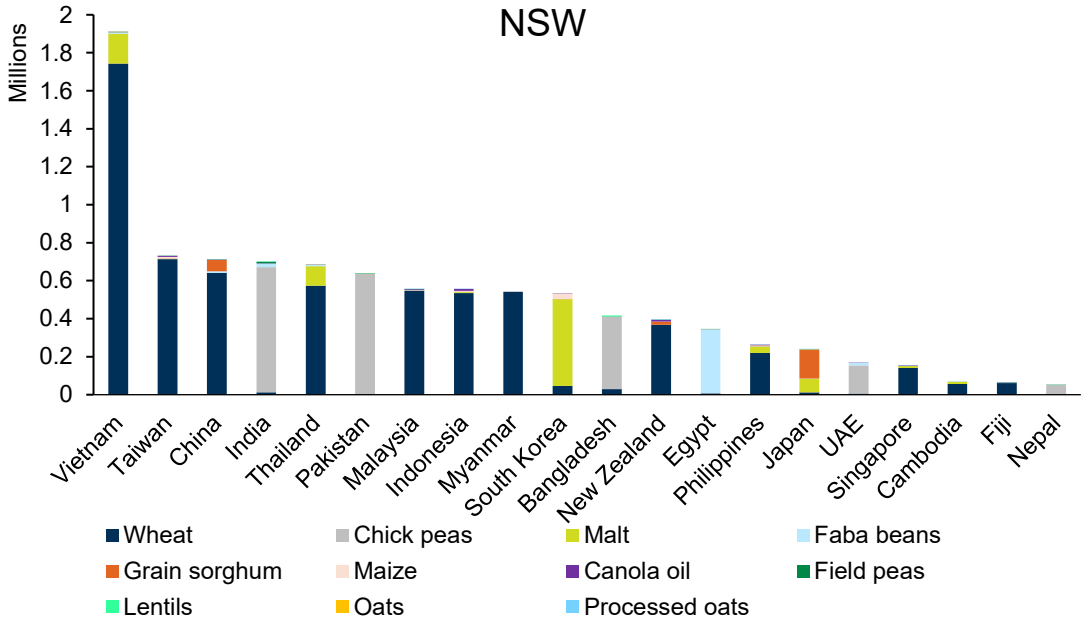

Figure 4. Top 20 markets for containerised grain exported from New South Wales; total tonnage exported from 2011/12 to 2021/22 (mmt)

Queensland

QLD's containerised grain exports are highly variable and show no consistent pattern of growth. Chick peas, wheat, faba beans and sorghum are the dominant grains exported in containers. In favourable production years greater volumes of these grains are exported, but in years of low production, exports are minimal. Chick peas exported to the sub-continent are especially important. A smaller more consistent volume of faba beans is also exported to a handful of countries like Egypt, China and Vietnam. Grain sorghum continues to be mainly sent to Japan, but in lesser volumes.

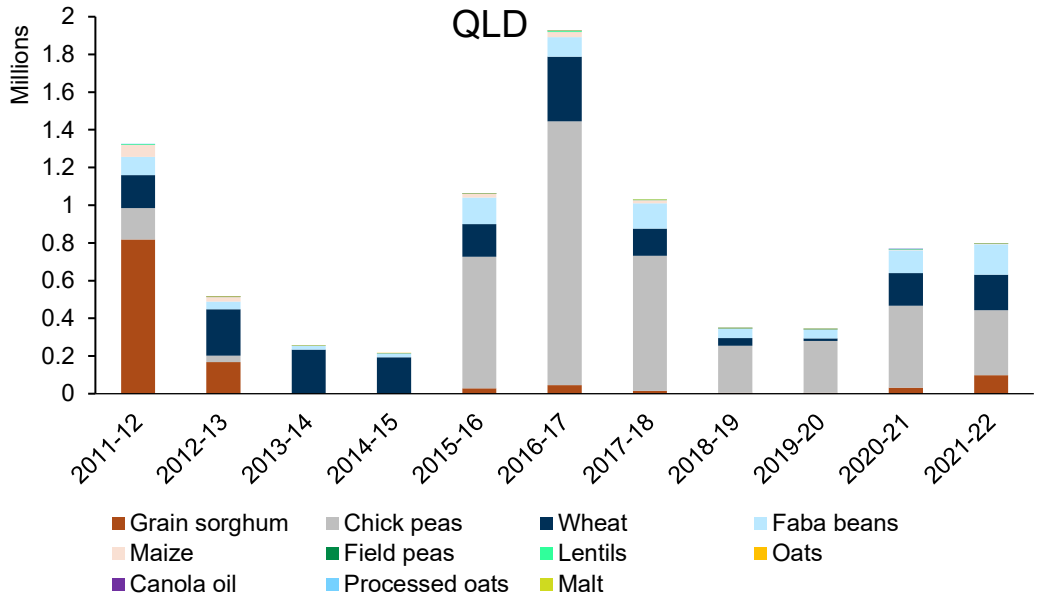

Figure 5: Containerised grain exports from Queensland each financial year from 2011/12 to 2021/22 (mmt)

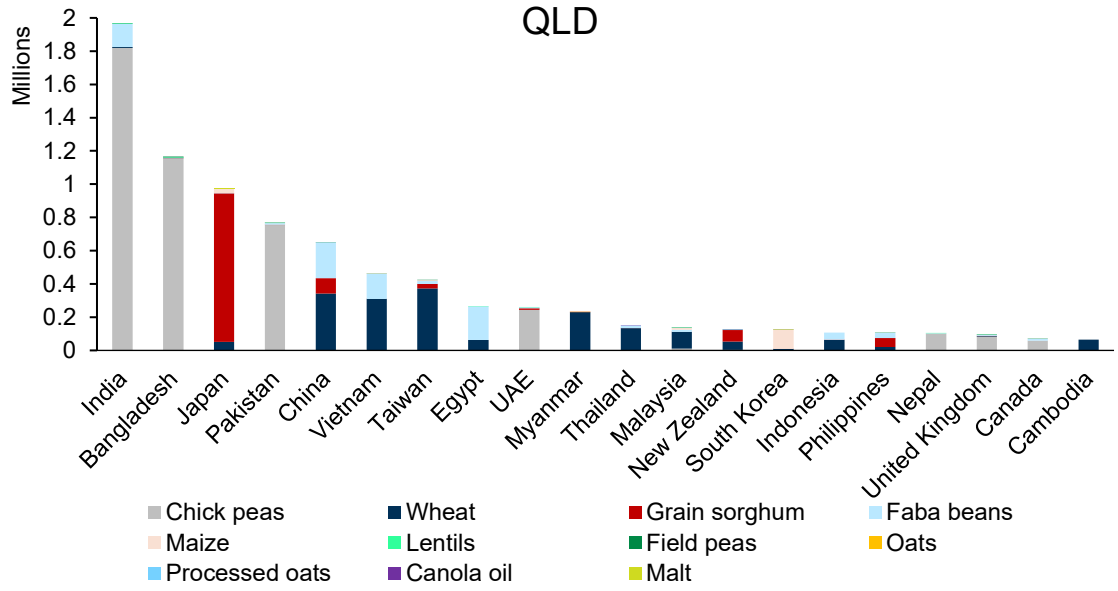

Figure 6. Top 20 markets for containerised grain exported from Queensland; total tonnage exported from 2011/12 to 2021/22 (mmt)

South Australia

SA is a stable exporter of a diverse suite of grains. Lentils, faba beans, malt and wheat form a balanced portfolio of grains exported in containers. The challenge for SA exporters of these grains is that the main destinations for these grains are in South Asia and Egypt. Disruption to container shipping resulting from the COVID pandemic greatly affected the cost and availability of container shipping routes to these countries and thereby affected the ease and profitability of the containerised exports of these grains from SA. Nonetheless since 2018/19 SA has increased its exports of containerised grain.

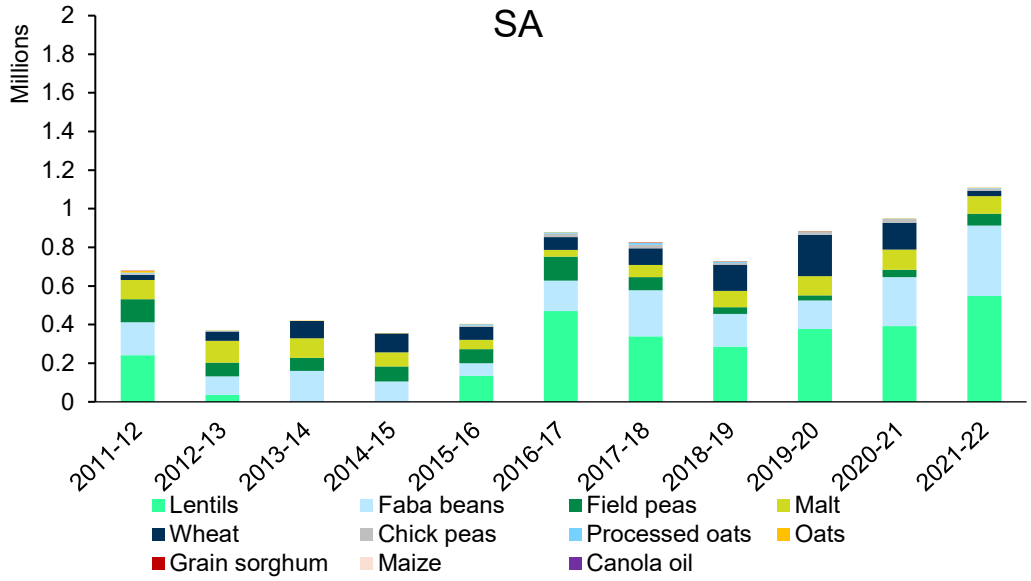

Figure 7. Containerised grain exports from South Australia each financial year from 2011/12 to 2021/22 (mmt)

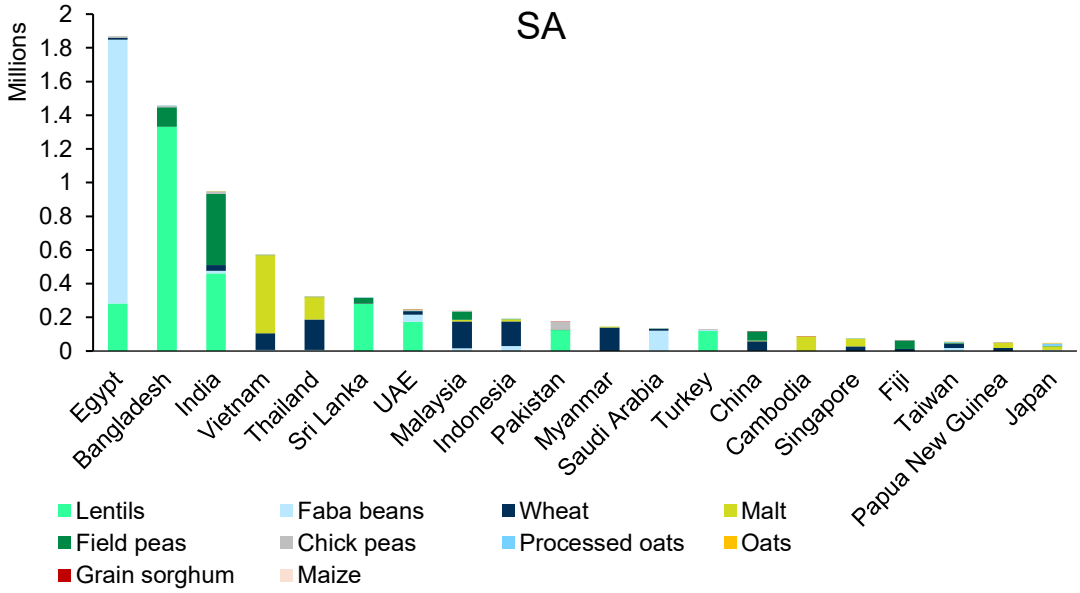

Figure 8. Top 20 markets for containerised grain exported from South Australia; total tonnage exported from 2011/12 to 2021/22 (mmt)

Western Australia

Like SA, WA maintains a diverse set of containerised grain exports, including malt, processed oats, and wheat. However, compared to the eastern states, WA exports much smaller volumes of containerised grain; around 0.6mmt each year.

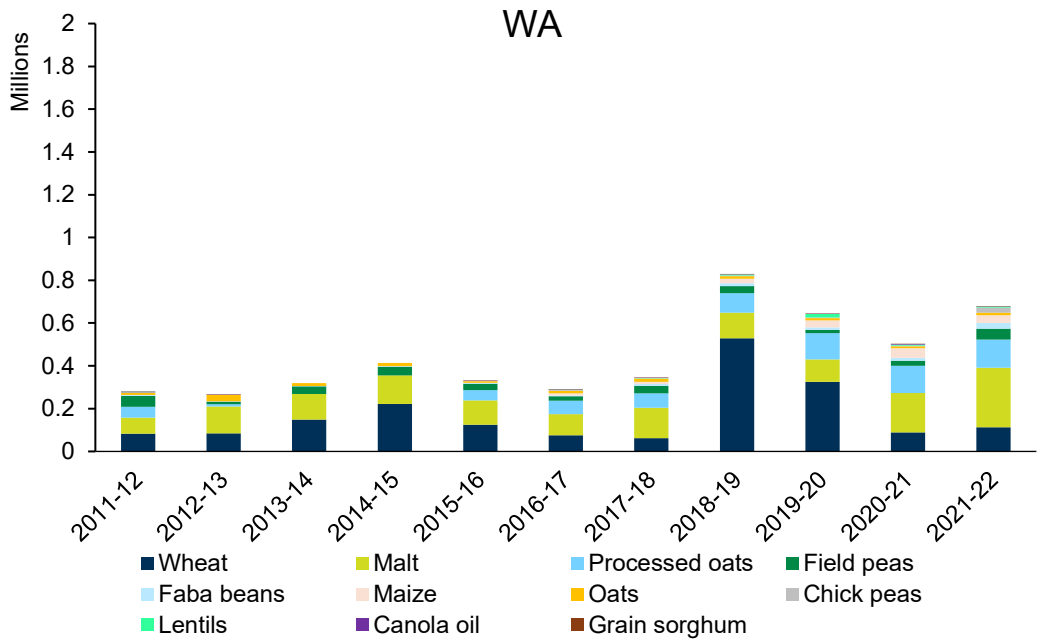

Figure 9. Containerised grain exports from Western Australia each financial year from 2011/12 to 2021/22 (mmt)

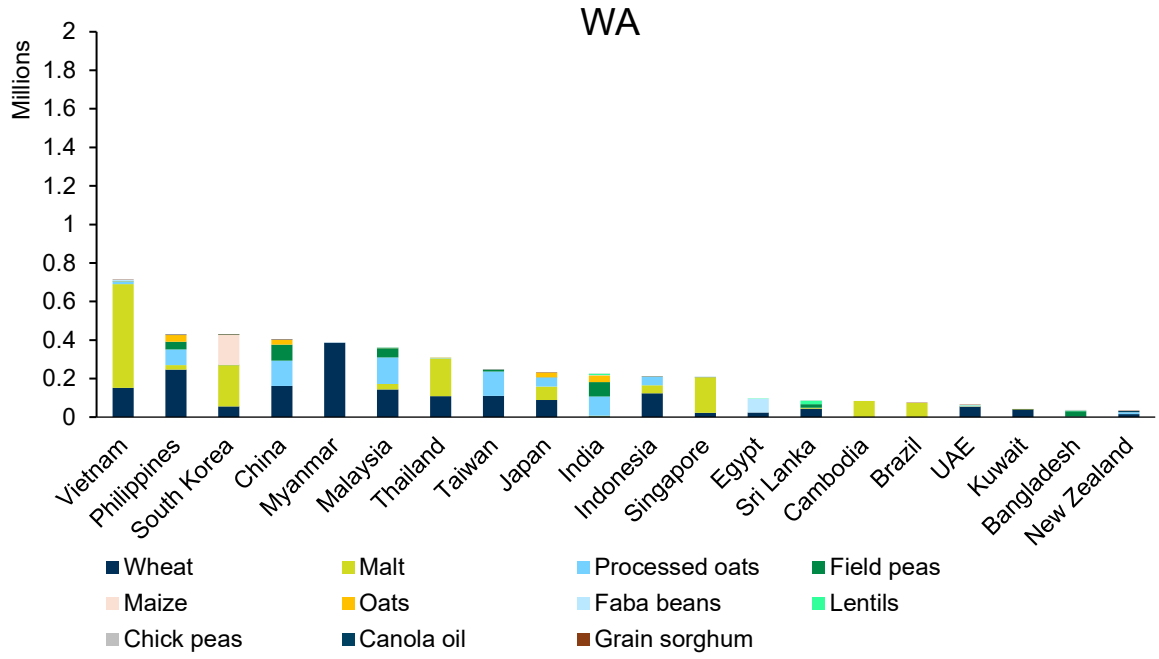

Figure 10. Top 20 markets for containerised grain exported from Western Australia; total tonnage exported from 2011/12 to 2021/22 (mmt)

Bulk Grain Exports

Western Australia

By far, Australia's main source of exports of bulk grain is WA. The state regularly exports between 13 to 16mmt of grain; mostly wheat, barley and canola.

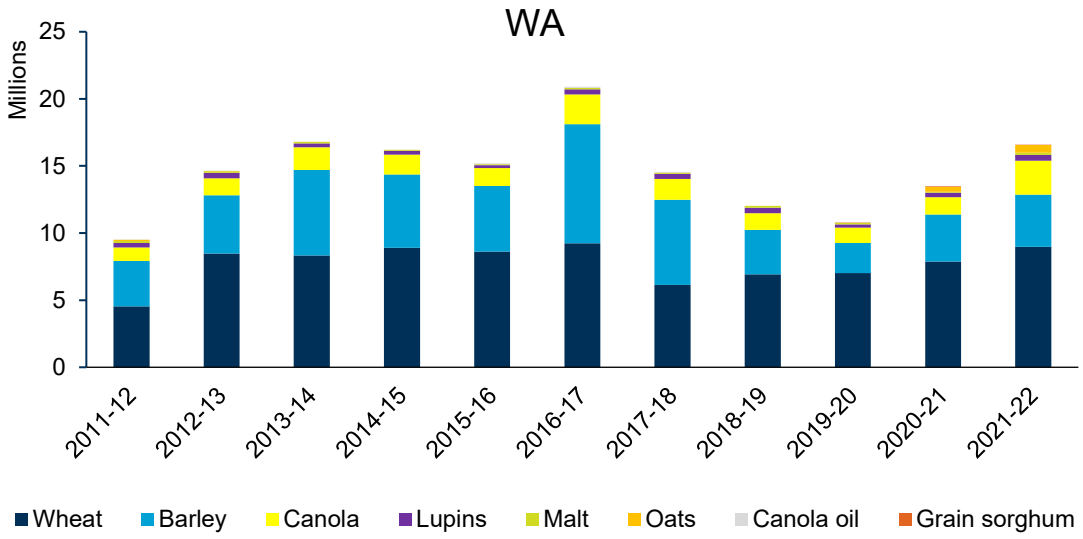

Figure 11. Bulk grain exports from Western Australia each financial year from 2011/12 to 2021/22 (mmt)

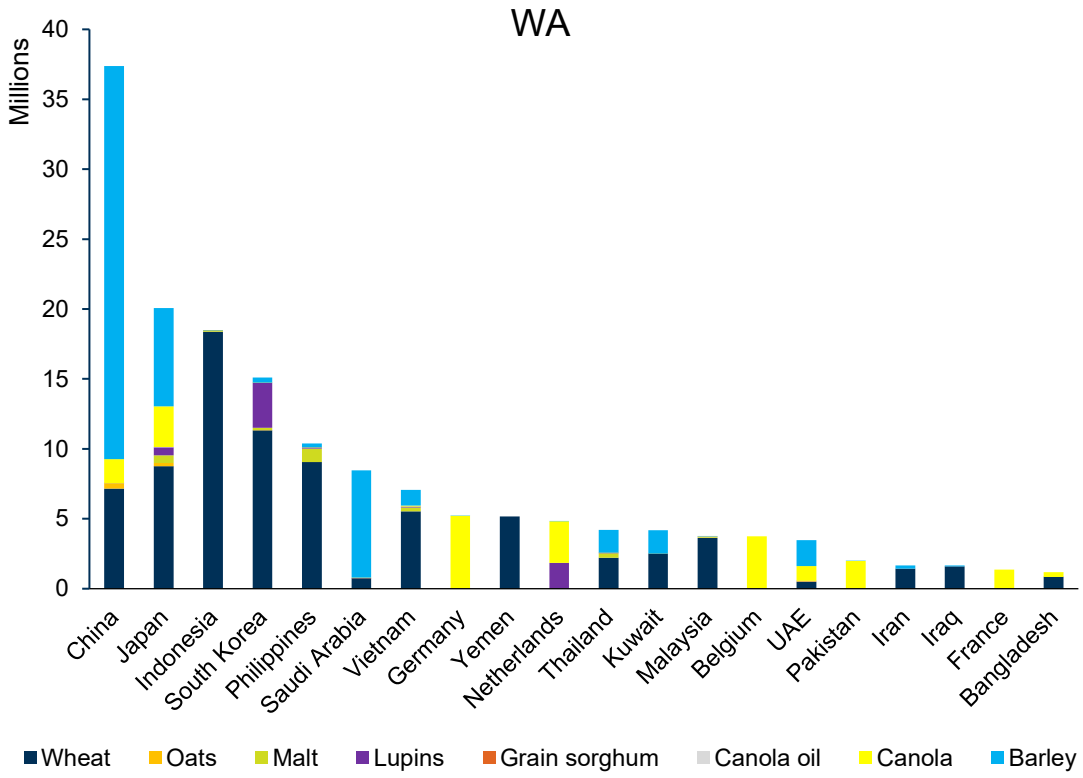

Figure 12. Top 20 markets for bulk grain exports from Western Australia; total tonnage exported from 2011/12 to 2021/22 (mmt)

New South Wales

Bulk exports of grain from NSW are subject to marked volatility. In periods of severe drought, as occurred in 2018-19 and 2019-20, bulk exports almost cease. By contrast, bumper years as occurred in 2020-21 and 2021-22 unleash annual bulk wheat exports of over 4mmt. The other bulk export crops of far lesser importance are canola and sorghum.

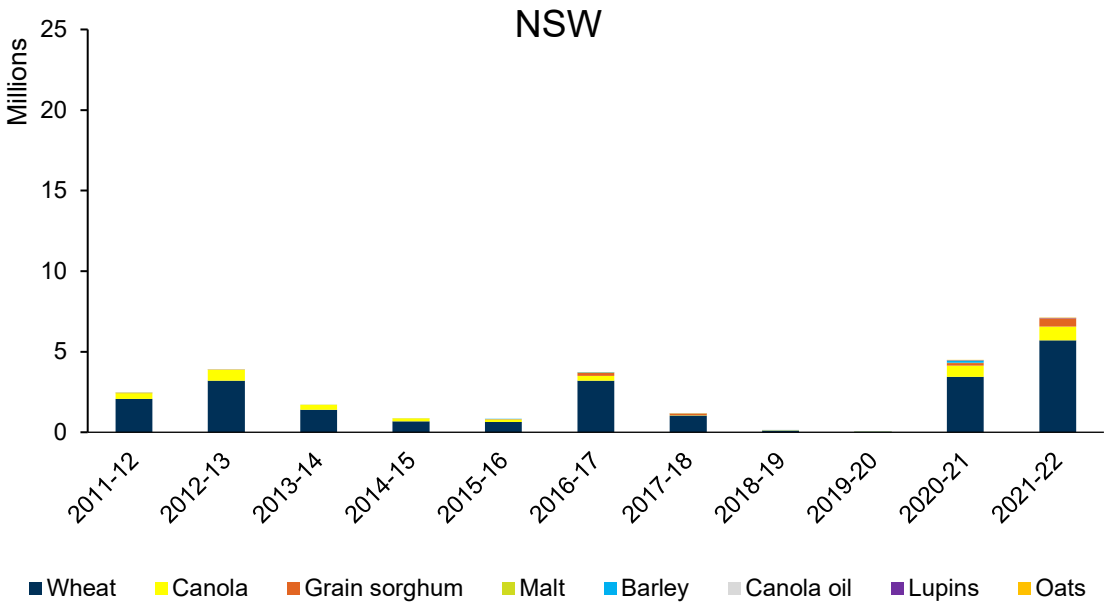

Figure 13. Bulk grain exports from New South Wales each financial year from 2011/12 to 2021/22 (mmt)

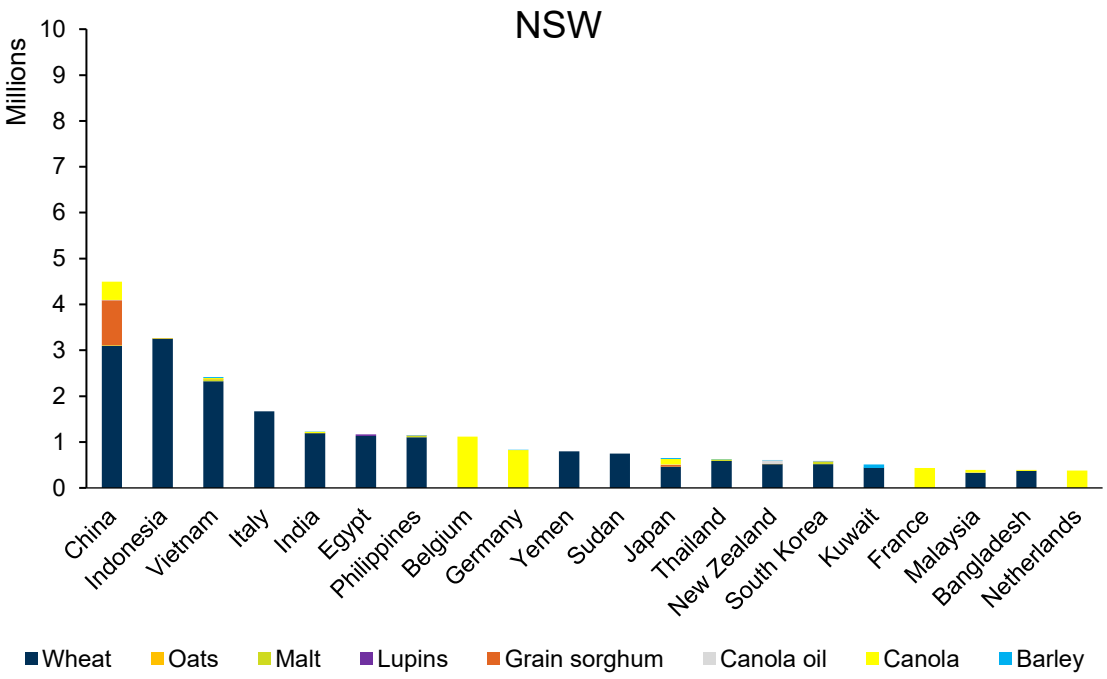

Figure 14. Top 20 markets for bulk grain exports from New South Wales; total tonnage exported from 2011/12 to 2021/22 (mmt)

South Australia

SA mostly is a reliable exporter of bulk grains; mostly wheat, barley and canola. The state regularly annually exports over 4mmt.

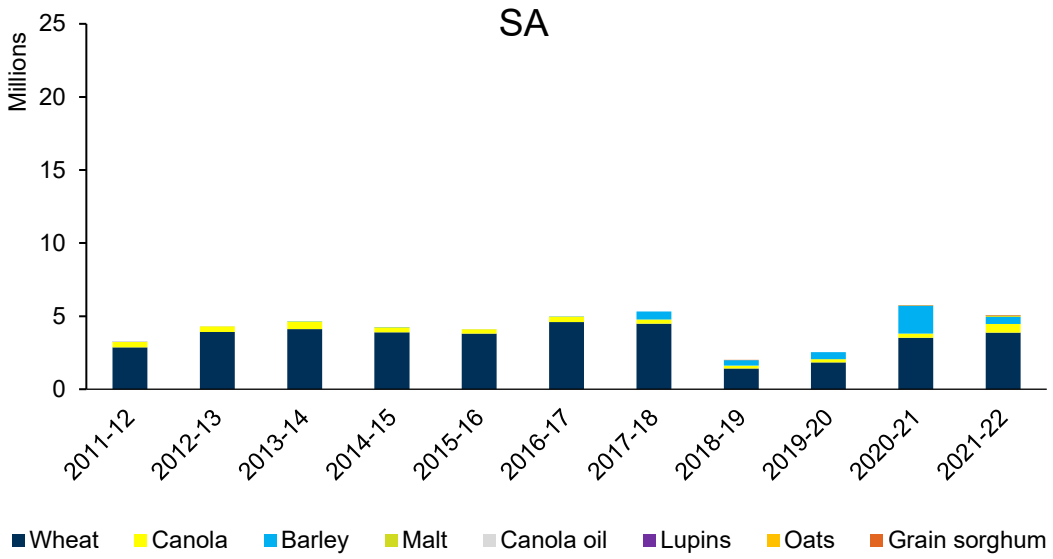

Figure 15. Bulk grain exports from South Australia each financial year from 2011/12 to 2021/22 (mmt)

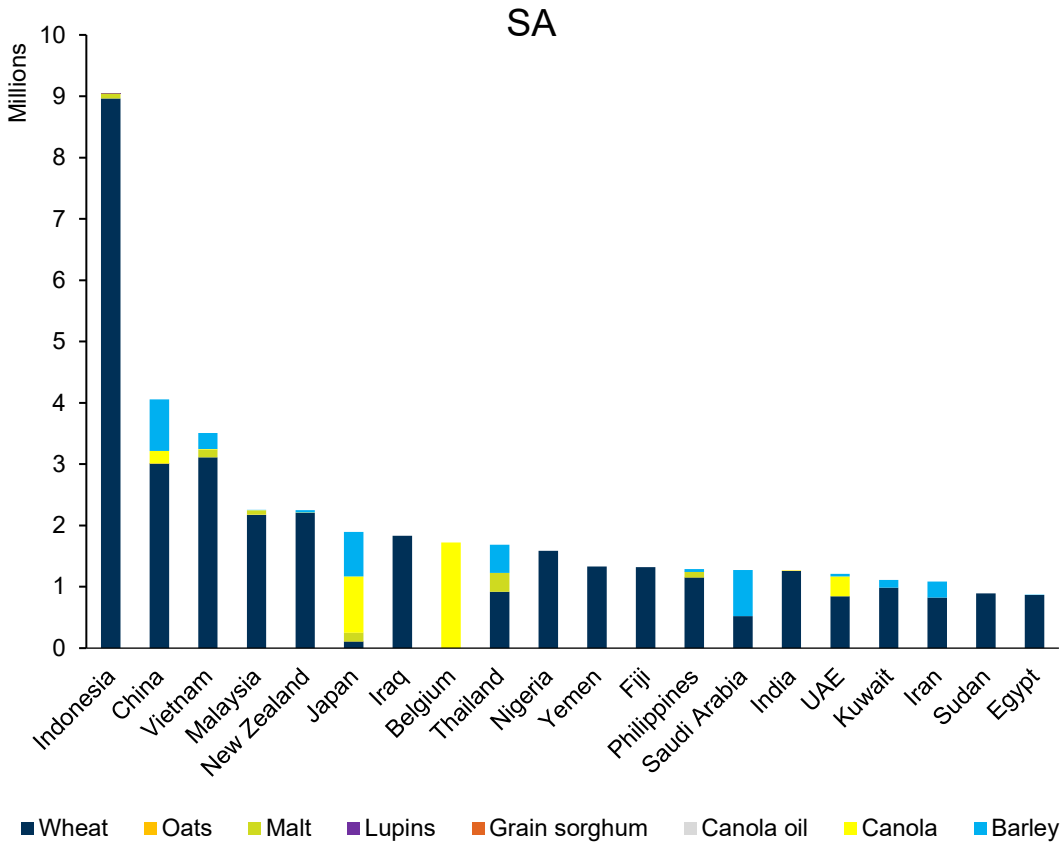

Figure 16. Top 20 markets for bulk grain exports from South Australia; total tonnage exported from 2011/12 to 2021/22 (mmt)

Victoria

Bulk exports of grain from VIC, like the volumes from QLD and NSW, are subject to marked volatility. In periods of severe drought, as occurred in 2018-19 and 2019-20, bulk exports greatly reduce. The portfolio of bulk grains exported from VIC is much more diverse and balanced in comparison to the portfolio of bulk export crops that emanate from NSW or QLD. Barley and canola, to a lesser extent, enjoy larger shares in the export crop mix in VIC, compared to the other states where wheat is by far the principal export grain.

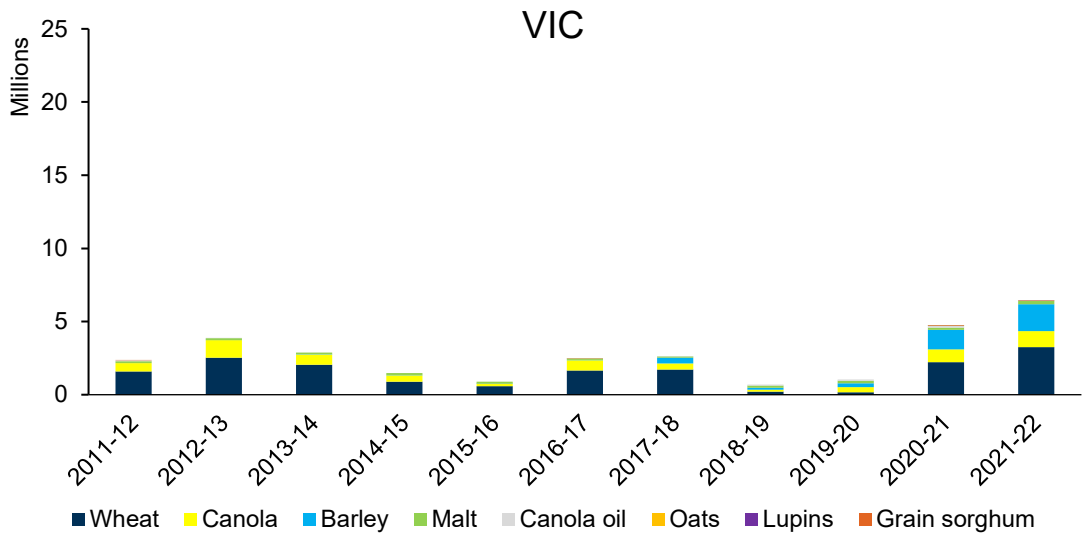

Figure 17. Bulk grain exports from Victoria each financial year from 2011/12 to 2021/22 (mmt)

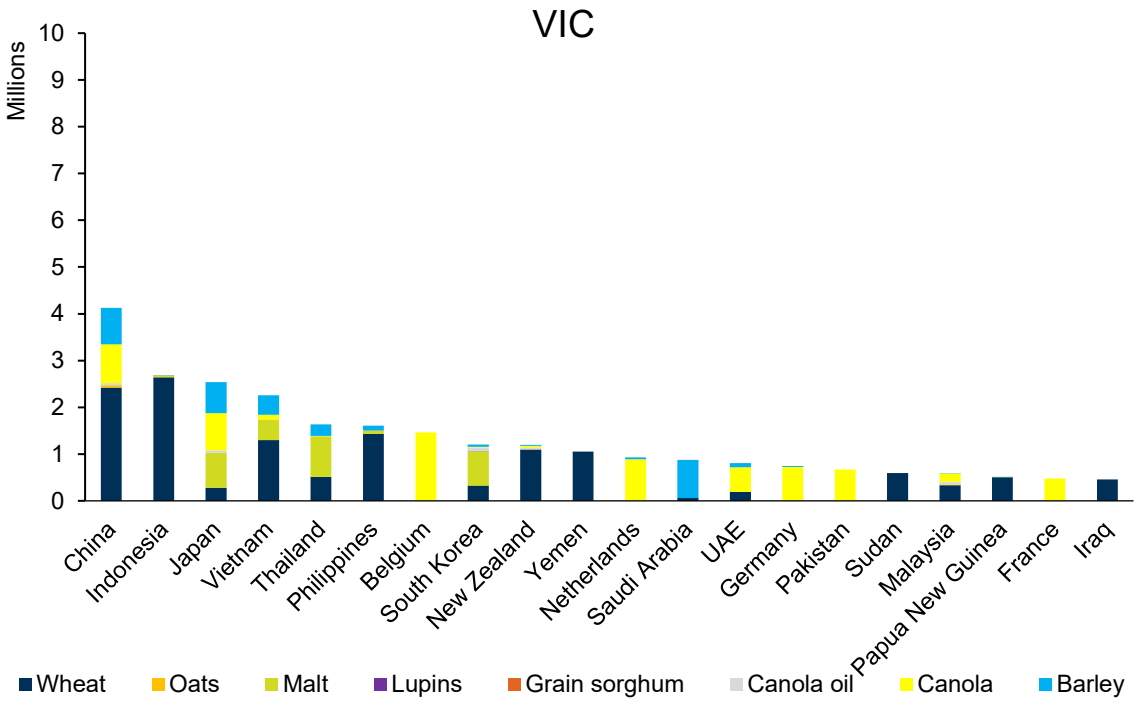

Figure 18. Top 20 markets for bulk grain exports from Victoria; total tonnage exported from 2011/12 to 2021/22 (mmt)

Queensland

The mix of bulk grains exported over the two decades from QLD has changed with wheat and sorghum emerging to be, by far, the key bulk grains exported. However, compared to other states, only small volumes of bulk grains emanate from QLD and are subject to variation arising from production volatility.

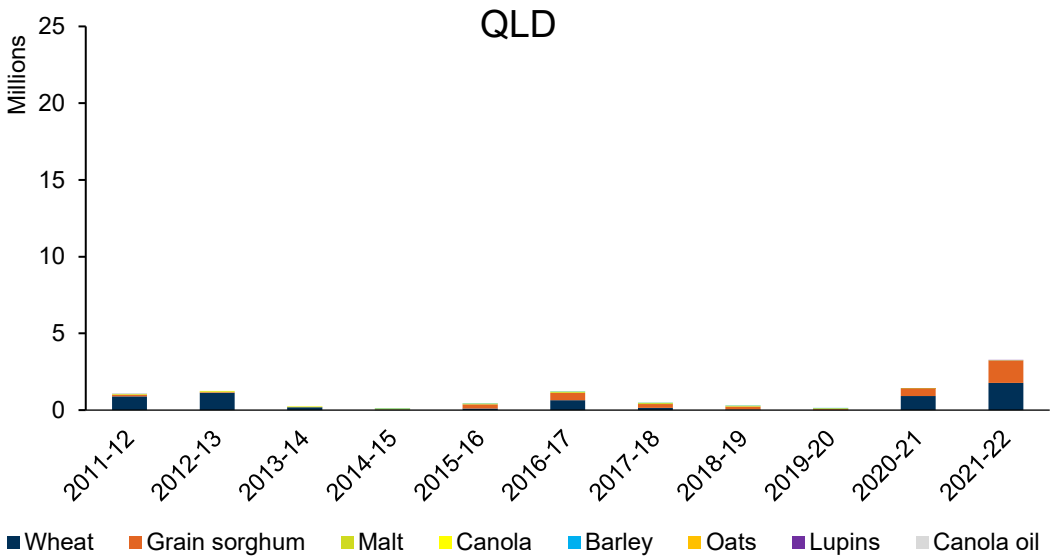

Figure 19. Bulk grain exports from Queensland each financial year from 2011/12 to 2021/22 (mmt)

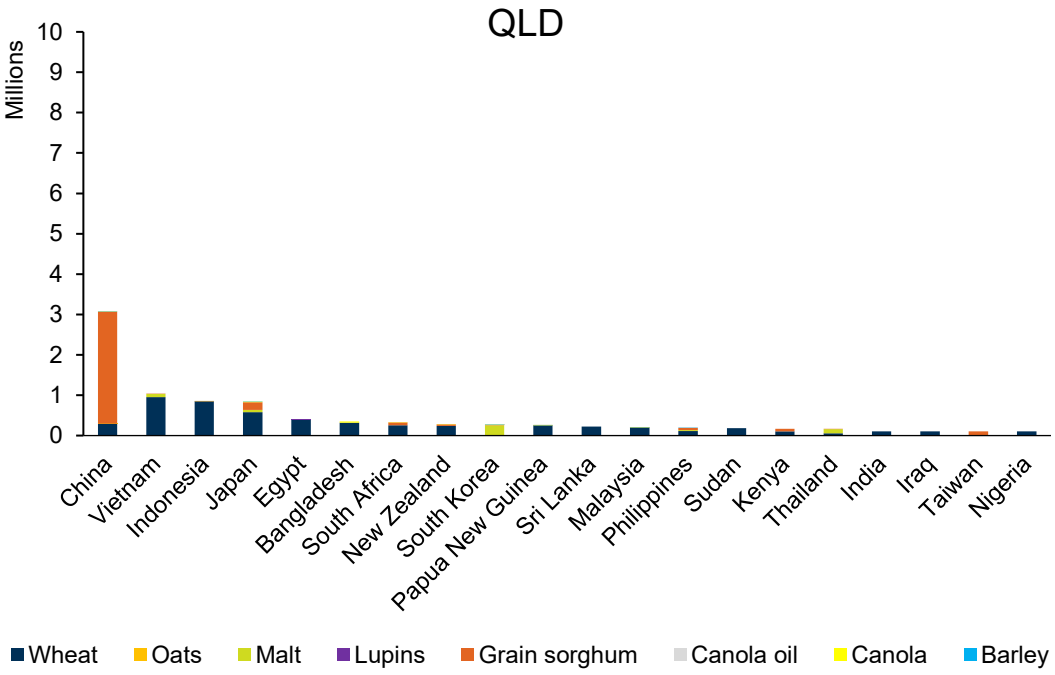

Figure 20. Top 20 markets for bulk grain exports from Queensland; total tonnage exported from 2011/12 to 2021/22 (mmt)

A deeper dive into the volatility of Australian grain exports

The previous charts reveal a marked temporal variation in the export of grains, particularly from Australia's eastern states. The variation in these states is mostly due to the impact of seasonal variation in production.

Generally in Australia, the export of grain is a residual activity where grain that is produced, after subtracting seed retention and on-farm use, then flows to domestic or export markets. Simplistically, the quantity of grain available for export from grain produced in any year is the grain produced (net of on-farm requirements) less the amount consumed domestically; noting that domestic buyers typically can afford higher prices than overseas consumers.

The availability of grain for export can be illustrated mathematically as follows. Let Q_s be the grain produced in any year, net of on-farm use, and let Q_d be the grain sold domestically. The surplus then available for export is $Q_e = Q_s - Q_d$.

Q_s is subject to volatility, mostly due to seasonal influences (e.g. bumper seasons or droughts) whereas Q_d is more stable and is mostly a function of domestic population growth and changes in per capita consumption. Hence, across a range of years the expected Q_e (i.e. $E[Q_e]$) is equal to $E[Q_s] – E[Q_d]$.

However, importantly, the volatility or variance in Q_e is not simply the difference in variances of Q_s and Q_d but rather, mathematically, is:

$$Var [Q_e] = Var [Q_s - Q_d] = Var [Q_s] + Var [Q_d] – 2Cov [Q_s,Q_d]$$

In words, this indicates that the variance in Q_e is the sum of the individual variances of Q_s and Q_d less a covariance term and the covariance of Q_s and Q_d is:

$$Cov [Q_s,Q_d] = \rho_{Qs,Qd} . \sigma_{Qs} \sigma_{Qd}$$

$\rho_{Qs,Qd}$ is the correlation between Q_s and Q_d and σ_{Qs} and σ_{Qd} are the respective standard deviations of Q_s and Q_d.

To illustrate how volatility in Q_s and Q_d affects the volatility or variance in Q_e we draw on a dataset of Australian grain production since 1995 to 2010. Complementing this dataset is other data on Australian population growth over that period and imputed domestic per capita consumption of grain over that period (noting that per capita consumption has increased particularly due to increased consumption of grain-based meats and whenever drought occurs).

Drawing on these datasets (with their measurement unit being mmt);

$\rho_{Qs,Qd} = -0.0397$

$\sigma_{Qs} = 9.413$

$\sigma_{Qd} = 2.837$

$Cov [Q_s,Q_d] = -1.060$

$Var [Q_e] = Var [Q_s - Q_d] = 95.059$

$E[Q_e] = E[Q_s - Q_d] = 22.655$

and the coefficient of variation of Q_e expressed in percentage terms is 43.0% is calculated as σ_{Qe} divided by $E[Q_e]$.

The large coefficient of variation of Q_e reveals the marked volatility in the export of Australian grains; mostly due to the volatility of grain production (Q_s) in Australia. However, the nature of domestic demand for grain slightly exacerbates export volatility, as domestic consumption of grains increases in low production years. This is because Australia's large animal grazing industries (cattle, sheep and dairying) increase their demand for feed grains during drought periods. Their impact is revealed in the slight negative covariance between Q_s - Q_d. In short, in low production years, domestic consumption of grains is higher than in bumper years. This negative covariance mathematically causes a slight enlargement in the magnitude of the variance of Q_e, the surplus of grain available for export.

Figure 21 shows the dataset for Q_s and Q_d. The chart's fitted linear equation displays the negative association between Q_s and Q_d. Figure 21 also shows how the relationship between Q_s and Q_d. is constantly changing insofar as Q_s and Q_d both are increasing through time as new technologies permit higher levels of production, yet continuing population growth fuels an increase in the domestic demand for grain. The direction of change is illustrated by the black arrow. The orange dots are the first 5 years (1995 to 1999) in the dataset while the red dots are the most recent 5 years (2016 to 2020).

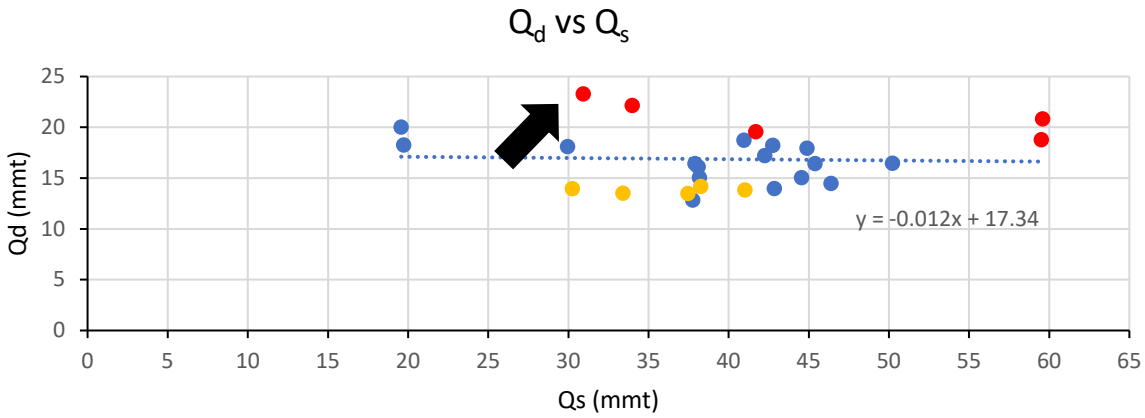

Figure 21: Relationship between Q_s and Q_d: 1995 to 2020

Comparing the orange and red dots reveals that, despite the march of time and technology, when drought ensues, very low production occurs, physically limiting grain production. However, in climatically favourable years, the benefits of biotechnology and new crop management techniques are more fully realised, resulting in very high yields and levels of production being achieved. The two red dots in the far right of Figure 21 indicate how much grain Australia can now produce, due to modern technologies, when favourable climatic conditions arise.

However, the introduction and embrace of new technologies inevitably cause an increase in yield and production variance; especially where the frequency of drought increases, as is projected for further adverse climate change. A greater frequency of drought combined with technologies that enable grain yields to continue to temporally trend upwards, will cause an the variance of Australia's grain production (Q_s) to increase. The upshot is that Australia's reliability as a grain exporter of consistent export volumes will worsen, mostly in regions where the domestic demand for grain continues to grow substantially.

Explaining further; the domestic demand for grain in Australia is not spatially uniform. Although substantial quantities of grain are produced in each of Australia's several states, QLD, NSW, VIC, SA and WA, importantly there are marked differences in those states' domestic demand for grain. Moreover, the growth prospects for grain demand in each state are also very different. Over the next two decades VIC and QLD are each projected to increase their population by 2.44 and 1.63 million persons respectively. NSW is expecting its population to increase by 2.27 million over the same period. However, the population increase projected for SA and WA is only 0.24 and 0.91 million persons respectively over the same period.

Domestic demand for grain will grow little in SA and WA yet their temporal trends of increasing grain production indicate that these states will continue to be main reliable sources of grain exports. However, the population growth in QLD, NSW and VIC will cause their grain production, especially in poor production years, to principally flow to their enlarged domestic markets, worsening their ability to be reliable suppliers of large quantities of exported grains.

In QLD, NSW and VIC where prolonged periods of drought are a feature of their climates, these drought periods will not only lessen the quantity of grain able to be exported but importantly will also raise the cost of their grain to exporters, especially as domestic customers will bid up the price of grain during drought. A further detrimental impact of prolonged drought will be that supply chain infrastructure (e.g. grain export port terminals) geared to deliver grain to export customers will remain greatly underutilised in these periods of low production; diminishing the returns to these assets and weakening their attractiveness as investments.

The marked volatility in the export volumes of Australian grain, particularly from eastern Australia, indicates that a downside risk cost will apply to any investment in export grain infrastructure. This risk cost will be passed along the supply chain to customers but also back to growers in the form of reduced offer prices.

Particularly in eastern Australia, lessening wherever possible the impacts of supply volatility will create multiplicative benefits to Australia's domestic consumers of grain, and to those involved in the export of Australian grains. Investments in grain storage and investments in reducing the cost of grain transport (rail, road and shipping services) will allow more grain to be made available more cheaply and readily in regions of grain deficit where local demand for grain exceeds the local production of grain in that particular year.

Acknowledgements

We would like to thank Luke Monahan for assembling the ABS datasets of containerised and bulk grain exports from Australian states. Dipesh Maharjan created the charts for this report.