On Farm Storage and the Grain Supply Chain

Unravelling the Logistics and Marketing Puzzle

A report for

NUFFIELD AUSTRALIA FARMING SCHOLARS

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Executive Summary

It is likely that Australian growers will continue to increase overall On Farm Storage (OFS) capacity and improve the quality and sophistication of existing infrastructure. This trend is currently being driven by:

- Harvest logistics and increased harvester capacities,
- Rationalisation of the upcountry grain storage network.
- The increased area sown to pulse and specialty crops.
- Government incentives to invest.
- Increases in overall grain production.
- Greater willingness of growers to have more control of their grain path to market following strong recent returns from selling grain ex-farm rather than through the Bulk-Handler system.

Growers considering investment in OFS should establish clear objectives, consider future needs and plan with potential expansion in mind. Long-term, the growth trajectory of OFS investment will be driven by the service offering from the commercial bulk handlers and also by the growth in domestic grain production and consumer needs. Managing relationships with supply chain partners is critical if growers are to effectively take on a greater role in the supply chain.

Australia's lack of an effective freight 'system' feeding main line rail in Eastern Australia is a constraint on productivity for the grains industry. Australian East-coast below rail assets do not currently meet the needs of a modern grain supply chain. State and Federal Governments have a challenge to ensure policy settings exist to encourage efficient investment in the grain supply chain, including alternative funding sources to facilitate and fast track investment. The long-term future of grain logistics in Eastern Australia will be heavily influenced by the construction of a Melbourne–Brisbane inland rail freight link. Sub section construction timelines will be an important component of this project. Governments also need to consider market led road upgrades that safely enable longer road combinations and enhanced productivity on strategically important grain road routes.

The grains industry relies on fumigation with phosphine gas to kill stored grain pests with few commercial alternatives available. The future management of grain in store will depend on alternatives to phosphine gas for maintaining grain in a saleable condition. The industry needs to maintain focus on fumigating in gas tight storage that meets Australian standard AS2628 to maximise the longevity of phosphine as a fumigant. The best alternative strategy to fumigation is to:

- limit the incursion of stored grain pests and by using good hygiene practices;
- adequate monitoring and cooling grain using automated aeration systems, and
- the use of grain protectants, subject to market requirements.

Systems enabling the use of C02 and nitrogen gas for fumigation will likely play a greater role in the future.

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Foreword

As a farmer with a background in the grains industry, I have always a keen interest in grain markets and the supply chain. The Australian grains industry has undergone unprecedented structural change over the past 25 years. Further change is likely and given the long working life of grain storage infrastructure, effective decisions to invest require an understanding of future storage needs. Australian grain growers are currently increasing their OFS capacity and carrying grain on farm for longer periods of time than in the past. This report attempts looks current grain supply chains and considers how this environment may change over the life of storage assets built today.

Governments need to provide the appropriate policy settings to facilitate the necessary investment that meets the needs of a modern grains industry. This is critical for all stakeholders including:

- grain producers;
- grains consumers; and
- companies that manage and operate the grain supply chain.

There is a balance between driving supply chain efficiencies whilst also having flexibility to cope with the variability in Australia's production system. The great challenge facing the grains sector today is a business model that balances the need to reduce supply chain costs and improve productivity, generate adequate return on assets for investors and be flexible enough to cope with Australia's production variability.

The decision to invest in OFS should be treated like any other business decision. Uncertainty over future grain storage requirements and supply chain needs can make this decision more difficult. What has worked in the past is no guarantee of what will work in the future.

Acknowledgments

I would first like to thank my family for all their support and the work they have done to keep our farm business running smoothly whilst I have been away. Thank you to the Grains Research & Development Corporation (GRDC) for their investment and support which has allowed me this game changing opportunity. Human capacity building and knowledge sharing is so critical to drive productivity in the grains sector and the GRDC's support of the Nuffield program goes a long way to achieving this end. I would also like to acknowledge Grain Growers Limited for opening the door to me to consider this scholarship program through the Australian Grain Farm Leaders Program.

I am very grateful to all the people who have opened their office doors for meetings and generously shared their time. I have learnt a tremendous amount from some fantastic people and innovative businesses. The Nuffield experience would not have been the same without you. To the Brazil Global Focus Program team, many a 'world problem' solved and personal obstacle overcome in six weeks of my life I will always look back on fondly. I hope to be able to repay the hospitality in the future. Enjoy!

Abbreviations

Above Rail: Locomotives rolling stock

AUD: Australian Dollars

Below rail: Rail track infrastructure

BNSF – Burlington North and Santa Fe

bu: bushel

CAD: Canadian Dollars

CME: Chicago Mercantile Exchange

CN – Canadian National

CP: Canadian Pacific

East Coast (Australia): States of Victoria, New South Wales & Queensland.

FXE: Ferromex

GBP: British Pound

GRDC: Grains Research and Development Corporation (Australia)

HRW: Hard Red Winter

Inland Rail: Melbourne to Brisbane freight link via Parkes and Narrabri

Kbu: thousand bushels

Kmt: thousand metric tonnes

Mbu: million bushels

Mmt: million metric tonnes

mt: metric tonne

Off The Header: Grain recently harvested

OFS: On Farm Storage

PNW: Pacific North West

SRW: Soft Red Winter

UP: Union Pacific

UK: United Kingdom

US: United States of America

USD: US Dollars

VM: Vomatoxin

WH&S: Work Place Health and Safety

Objectives

To investigate the current and future role of OFS as a component of an efficient Australian eastern seaboard grain supply chain. The scope is to consider potential changes that will impact the use of grain storage infrastructure built today during its useful working life.

The primary aims of this study are to investigate:

- Current storage, marketing, and logistics for the grower and upcountry bulk handlers.
- Managing grain in store including alternatives to Phosphine.
- Management of a grains business, innovation, partnerships, and customer relationships.
- The future role of the grower and OFS in the grain supply chain including better integration of OFS with bulk handler export channels.
- Future end user needs and potential supply chain changes.

Introduction: The Australian Market

Australia is a major exporter of wheat, pulses, and oilseeds; and is an important player in coarse grains. The competitiveness of Australian grain producers relies on an efficient supply chain to move grain into domestic and export markets. The East Coast of Australia is now a large consumer of feed grains and has significant domestic malt barley and milling wheat processing industries. There has also been significant growth in non-traditional export channels such us upcountry packing of grains in containers, particularly for pulses and cereals into south and south-east Asia. Figure 1 shows the volatility of grain production by state which can be a challenge for grain storage and supply chain asset utilisation.

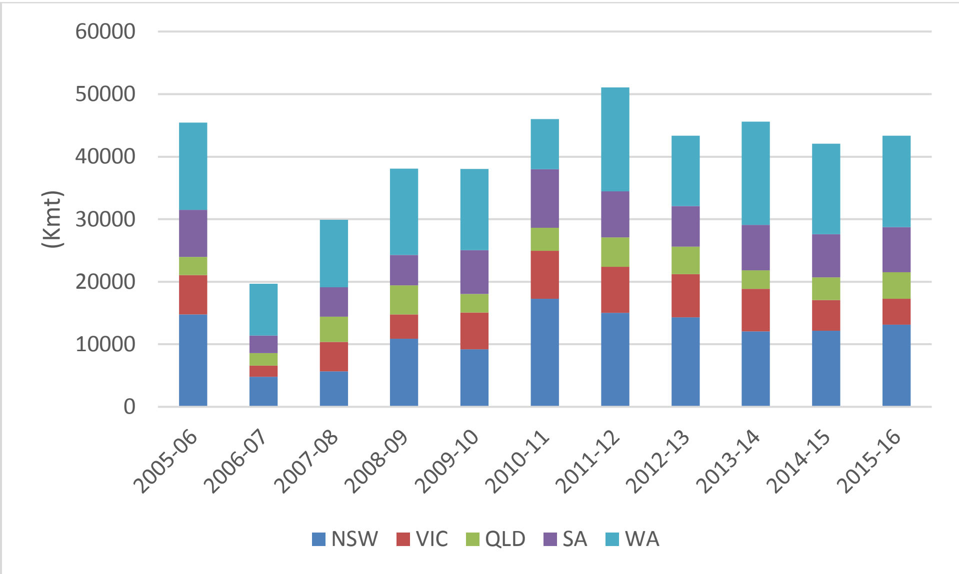


Figure 1: Australian All crop production by State

Data Source: ABARES (2016) Includes: Wheat, Barley, Canola, Pulses and Sorghum

The Australian grains industry has undergone unprecedented structural change over the past 25 years (*Figure 2*). Major international grain trading houses have bought into the Australian market place through acquisitions of upcountry grain accumulation businesses. Merger and acquisition activity among storage and marketing companies has been strong and has seen consolidation in the sector to form fewer and larger integrated businesses. Australian grain growers are also significantly increasing their OFS capacity and carrying grain on farm for longer periods of time then in the past (Botta 2016). Grain storage infrastructure is a long-term investment, and accordingly, growers need to consider potential needs in the future, not just their experience of the past or the current situation.

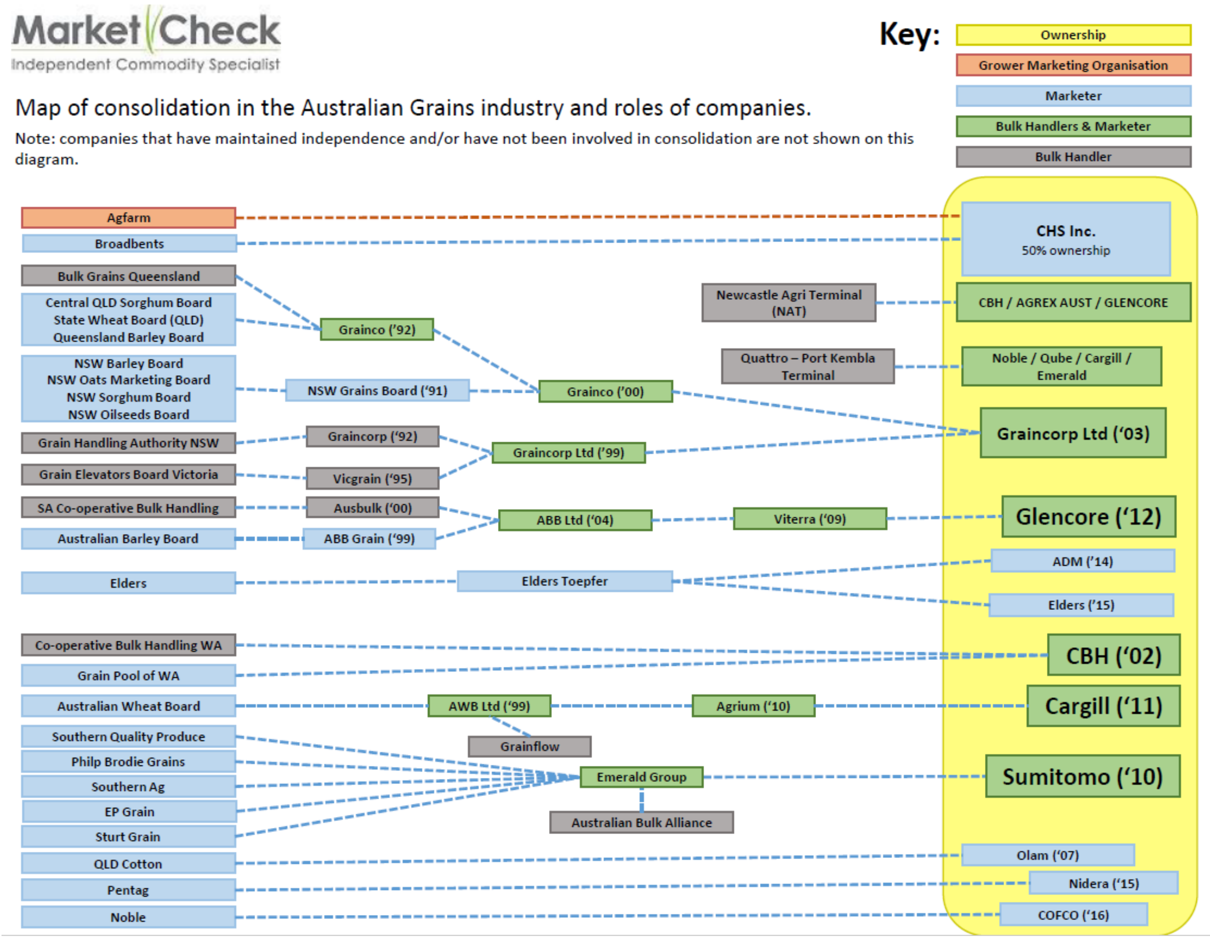


Figure 2: Australian Grains Industry Consolidation over the Past 25 Years

Source: Market Check Analysis (2016)

Industry players have noted a significant increase in OFS during the last ten years driven by:

- increases in production,
- deregulation of wheat export marketing arrangements,
- rationalisation of the up-country storage network,
- growth in non-traditional export channels,
- market premiums achieved by preserving the identity of niche grain parcels,
- the need to manage increased header capacity and grain volumes at harvest time, and
- benefits from greater control of marketing and the flexibility in the 'path to market'.

Chong, G. (2015) estimates current Australian OFS capacity at 15 million tonnes which according to ABARES (2016) figures represents 35% of 2015-16 Australian summer and winter crop production. Recent changes to depreciation treatment for grain and fodder storage assets in the 2015 Federal budget allows such investments to be written off over three years; and concessional loans are also making OFS investment more attractive for growers.

	Bulk Handlers (mmt)	OFS (mmt)	OFS % share of total	Total (mmt)
WA	15	2.6	15%	17.6
SA	10	1.2	11%	11.2
NSW	30	6.4	28%	41.8
VIC		3.5		
QLD		1.9		
Total	55	15.6	22%	70.6

Figure 3: OFS (on-farm) vs Bulk Handler (off-farm) Storage in Australia

Date Source: AEGIC (2014), Graincorp (2015)

Accurate statistics for OFS trend capacity and quality are not readily available. However, it is widely acknowledged by industry that OFS capacity and share of total storage has grown significantly over the past decade. ***Figure 3*** depicts current storage capacities by state.

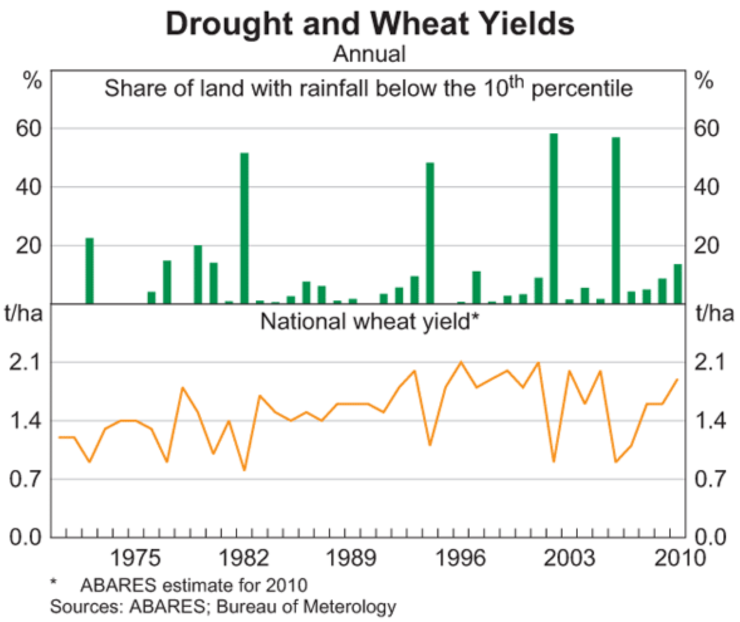


Figure 4 Drought and Australian Wheat Yields

Source: ABARES, Bureau of Meteorology

Drought is a reality of the Australian production system and a challenge for grain logistics on the East Coast. Drought also occurs on the west coast of Australia but the market structure there is different. A far smaller domestic grain consumption industry in the west means even in a drought grain still needs to move to the port into export markets. The correlation between drought and low wheat yield shown in *Figure 4* above impacts through to the export figures shown in *Figure 5* below. The millennium drought including the 2002, 2006 and 2007 drought years resulted in exports ceasing out of NSW ports. The storage and logistics network needs to be flexible to have spare capacity to cope with large production years and generate enough return for supply chain operators to cover years of low asset utilisation. Volatility of production and consistency of trade flows to port are an obstacle to investment that improves supply chain efficiency. The lack of efficiency gains made over the past decade is due in no small part to the millennium drought period, the impact of which is clearly evident in *Figure 5*.

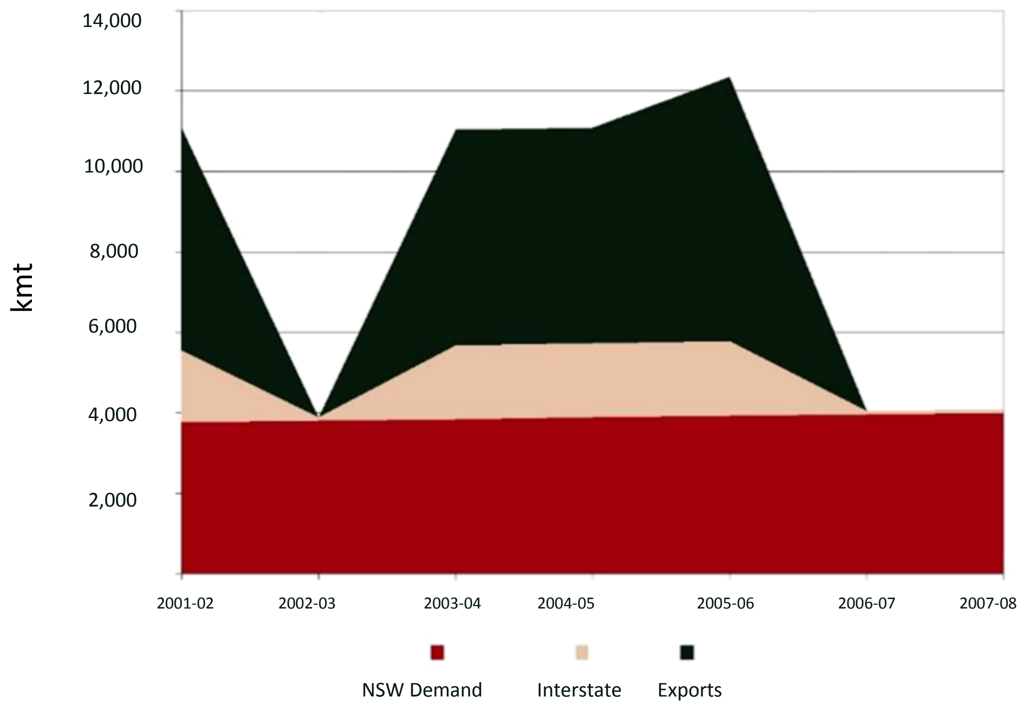


Figure 5: NSW Wheat Exports, Interstate trade and domestic use 2001/2 – 2007/8

Source: 2009 NSW Freight Task Review

The majority of grain destined for NSW domestic stockfeed markets is moved via road. By contrast, 90% of NSW domestic milling wheat; mostly purchased by Manildra Mills, Weston Mills and Allied Mills, are moved by rail. Movement of grain to port is a mixture of road and rail. Road freight whilst more expensive, has the advantage of being more flexible than rail;

and road freight capacity can be quickly scaled up or redeployed to other industries during drought years.

	NSW	QLD	SA	VIC	WA
Average rail line access cost (c/mt/km)	0.7	0.78	1.1	1.1	2.88
Median bin distance to port (km)	412	303	130	273	207
Modal share - rail to port (%)	85	46	50	53	60
Modal share - road to port (%)	15	54	50	47	40

Figure 6: Grain freight infrastructure costs and road/rail market share for bulk grain exports

Source: Stretch et al. (2014)

Fraser, L. (2014) suggests *'Australia's grains industry is the world's most efficient in terms of production, but poor freight outcomes continue to act as a significant handicap on the sector. Severely outdated road, rail and port infrastructure assets, government monopoly planning, spending and access policies act as major barriers to market investment and greater farmer profits.'* ***Figure 7*** shows the difference in freight cost across selected markets in Australia and Canada. There is opportunity to reduce supply chain costs in eastern Australia through investment in mainline rail efficiency. The Canadian National (CN) rail network is in the vicinity of $20/mt cheaper over the same distance the current east coast grain shipments. Another way of looking at this is that a 1000km journey for grain on rail on CN is the equivalent cost of a 400km journey in Australia. We may not be able to achieve the efficiencies in the Canadian supply chain due in large part due to supply volatility outlined in *Figure 4* and *Figure 5*. ***Figure 7*** paints a clear picture that there is significant room for improvement in the eastern Australian supply chain.

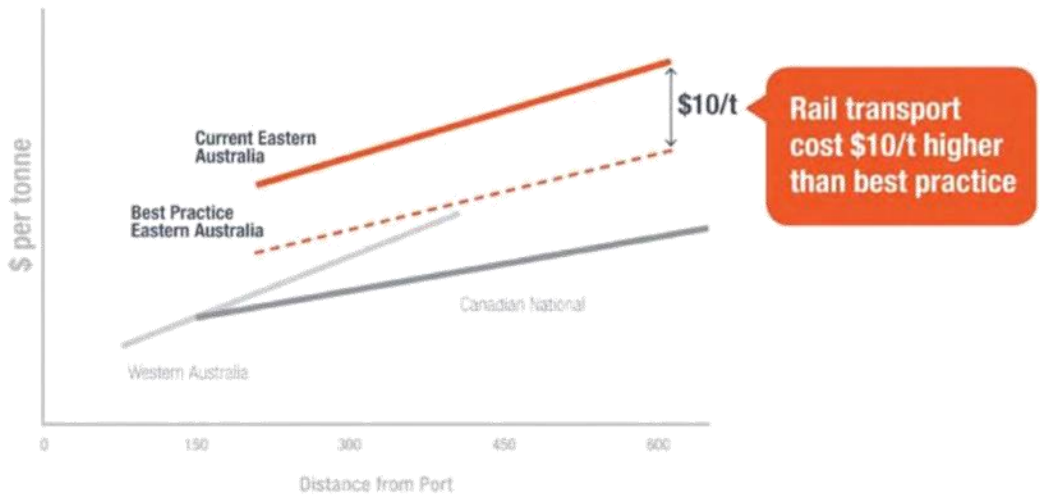


Figure 7: Rail Costs - Canada vs Western Australia vs Eastern Australia

Source: Graincorp Analysis (2015)

Commercial rail arrangements now see grain companies entering long-term take or pay agreements. If the grain company engages a rail operator on a take or pay agreement and has no grain to move on rail, it must pay a penalty to the rail operator. This transfers the risk and cost of variable volumes from the rail provider to the grain owner or purchaser of the rail services. Similar take or pay arrangements also govern ports promoting efficiency in the way the way grain is moved balancing port and rail utilisation with the traditional surge in grain exports that occurs in the first six months of the year. There is often a trade-off between flexibility and utilisation of rail rolling stock.

Powell (2009) assessed above rail assets (trains) as adequate and below rail assets (track infrastructure) as poor. Planning and co-ordination are also highlighted as inadequate with no long-term planning for ‘whole of chain’ industry wide efficiency improvements. Powell (2009) highlighted the risk of a ‘break out’ in road costs if rail branch lines are closed as local roads are not designed to cope with large increases in freight traffic.

Figure 8: NSW Rail branchline network

Source: Fraser (2014)

Much of the East Coast branch line network is in the vicinity of 100 years old. The Victoria, New South Wales and Queensland branch line networks largely remain three separated unconnected gauges.

Grain Trade Australia (GTA) commissioned the Fraser (2014) submission to the Federal Government Agricultural Competitiveness White Paper which highlighted that:

- Efficient mainline rail lies at the heart of more efficient grain freight.
- Australia's grain branch lines are far behind global best practice.
- Grain port efficiency and access competition is driven by mainline rail.
- Government grain transport projects should be measured on price per tonne impact.
- Wider financing sources must be found to augment scarce taxpayer revenue – this should begin with the Inland Rail project.

Joyce, B. (2014) identified Federal Government priorities for the East Coast grain market including:

- linking multiple port options with mainline rail;
- grain infrastructure piggy backing off mining and general freight supply chains;
- the need to drive efficiency but maintain flexibility in the upcountry storage network;
- The construction of Inland rail which will allow more ports to be accessed with greater efficiency.

There is work underway to improve efficiencies in the Australian rail network. In 2014, Graincorp announced 'Project Regeneration' which will spend 200 million AUD upgrading rail loading facilities (long rail balloon loops that allow rail wagons to reduce loading / unloading times as they do not need to split and shunt) at key sites to improve train cycle times and reduce supply chain costs.

In 2015, Agrex ran a large train by Australian standards from North West New South Wales into the port of Newcastle. The train mentioned below is long by Australian standards, but small compared to North American trains that regularly haul 110 wagons carrying 11,000mt of grain due to mainline rail, heavy axle weights and incentives for elevators to build fast out-turn facilities.

"The mega train measuring 1.25km (73 wagons) and carrying over 5000 tonnes of wheat from Northern New South Wales bound for south-east Asian markets, is nearly two and a half times the tonnage transported by regular grain trains in New South Wales."
Carter identifies "As well as upgrades to strategic sections of regional track, road infrastructure and access improvements are needed to streamline the connectivity from farm gate to major rail interchanges."
"Bigger trains mean increased efficiency and lower costs, which equals better returns for growers. It also frees up capacity for other users of the rail network."
For example, ARTC worked with us to increase the axle load from 20 to 23 tonnes for this train. This may sound small but this translates into a real saving of over $1.30 per tonne. The inland rail upgrade will further increase this to 25 tonnes. This then justifies investment in new, more productive grain wagons which leads to further cost savings."
Source NAT (2015)

The Powell (2009) report highlighted *'many country receivals are old, with limited storage capacity and low out-loading rates to both road and rail. On closer examination, the bottleneck in the supply chain has stemmed from train paths and rolling stock limitations.'* Investments in port facilities in NSW such as Newcastle Agri-Terminal and QUBE have been driven in large part by companies wishing to have greater control of their supply chain. Grain companies with financial stakes in port and upcountry grain handling facilities (See Figure2) have incentive to procure grain though supply chains in which they have a financial interest. It can be observed that through such investments that some grain companies wish to control their own destiny in the grain supply chain rather than rely on third party providers.

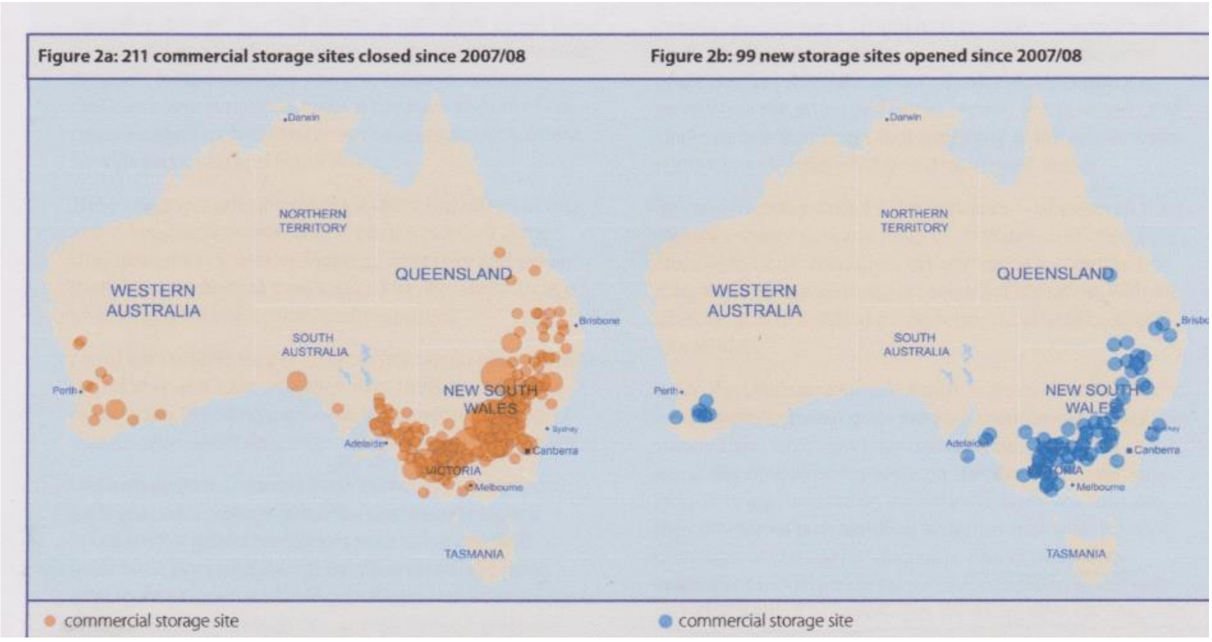


Figure 9: Bulk Handler Site Closures and Openings since 2007/08

Source: Chong, G. (2015)

Powell (2009) suggested *'efficient grain logistics requires a shared vision of the future development of the system by those in a position to influence its development; and shared information about how the system is currently performing. Neither of these things currently exists'*. There is a trend that some growers are using the bulk handlers as a store of last resort. Chong, G. (2015) suggested that bulk handlers may offer multi-year storage incentives to encourage growers to use a particular provider.

Chapter 1: Grain Supply Chains

Comparing Supply Chains

Fraser (2014) suggests that the benchmark for grain supply chains is the North American market. An extensive general rail freight network provides grain freight with access to low cost main line rail services. The US also has a significant barge network which plays an important part in the grain export task. Over half of soybean and corn exports and over a third of wheat exports are moved by barge in a typical year.

	Rail	Barge	Road
Corn			
Total	32%	15%	53%
Export	33%	64%	4%
Domestic	32%	2%	66%
Wheat			
Total	60%	19%	21%
Export	65%	35%	0%
Domestic	55%	2%	44%
Soybeans			
Total	23%	24%	54%
Export	34%	56%	10%
Domestic	16%	4%	81%

Figure 10: 2004 US Freight Modal Shares for Corn, Wheat and Soybeans

Data Source: Envision Freight http://www.envisionfreight.com/value/pdf/Grain.pdf

U.S. Rail Network

The US rail freight mainline network is designed primarily to move freight with heavy axle loads including double stacked containers and there are also incentives for long train sets. Rail companies in North America own both below rail (track) and above rail (train) infrastructure. BNSF and UP are the dominant rail providers for the grains industry in the US, and CP and CN in Canada.

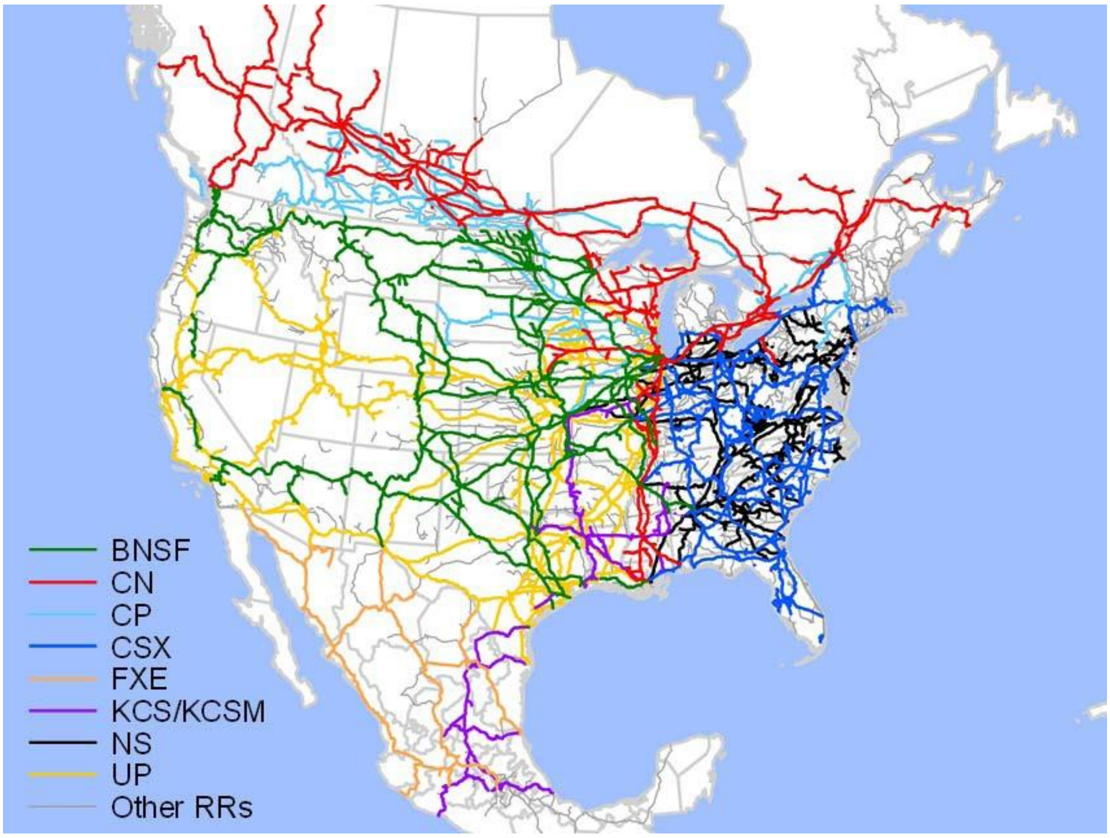


Figure 11: North American Rail Network Map

Source: http://canadians.org/

Rail reforms in the US have provided incentive for elevators to improve rail loading facilities to accommodate larger trains. 110 car unit trains capable of carrying 11,000mt now make up a majority of soybean and corn shipments and a major component of wheat shipments. *Figure 12* shows the change in rail shipment size for corn and the impact of shuttle and unit train loading facilities. From 1998 to 2008 there was an increase from 20% to over 50% of corn shipments with 75+ railcars. Longer trains improve productivity and reduce cost of grain movements and provide incentive for elevators to upgrade facilities to load longer trains efficiently.

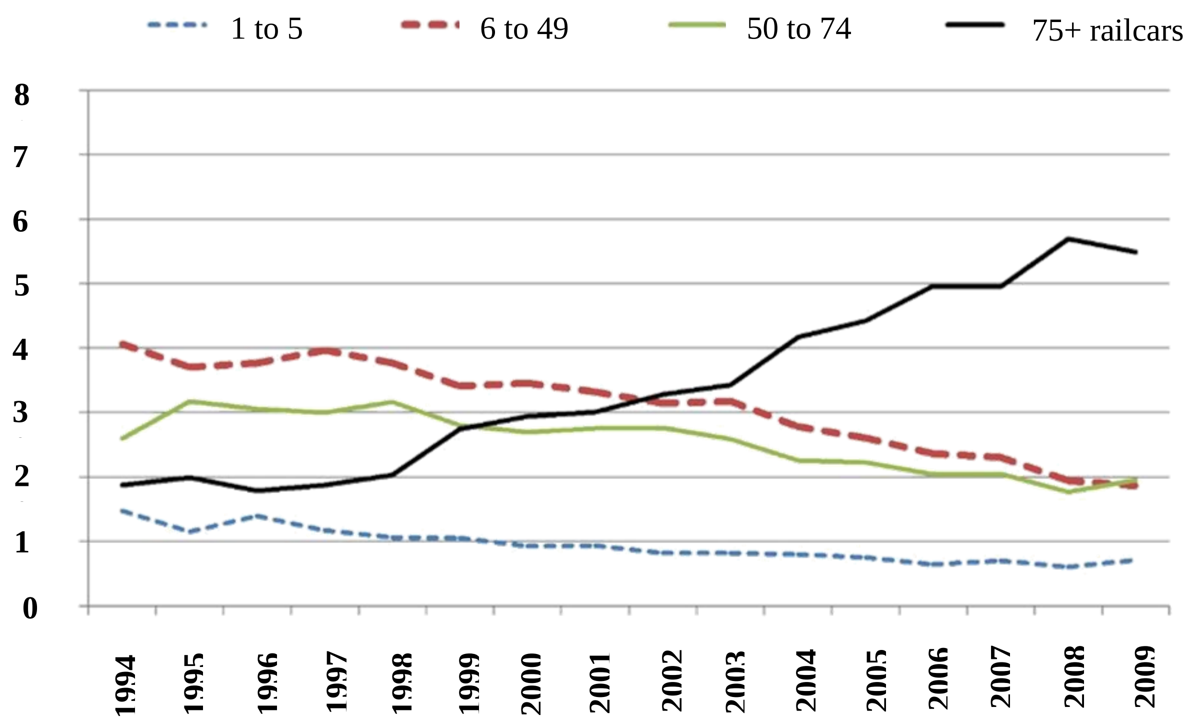


Figure 12: Percentage of U.S. Corn by Rail Shipment Size

Source: Prater, M. and Sparger, A. (2013)

Sarmiento, C. and Wilson, W. (2005) found that the cost of upgrading to a shuttle-loading facility was between $5 to $10 million US across nine US States in 2001. Vachal, K. et al (1999) found that elevators handling hard red spring wheat in the US Northern plains needed to handle in excess of 10 Mbu (275kmt) to justify upgrading to a 100-car unit train loading facility.

Shuttle trains carry grain only, and often cycle between two defined locations for a period of time. Shuttle trains operate at lowest cost for hauling grain but are also the least flexible. Unit trains in North America can carry grain and other mixed cargo. To maximise efficiency with unit trains, elevators still need rail loops long enough to accommodate a unit train regardless of the number of non-grain carriages to save splitting and shunting.

A look to the future of elevators could be observed at a facility under construction in Indiana, see *Figure 13* below. The joint venture between Cargill and the Truepoint grower co-operative at Milford, Indiana has been planned with future growth in mind. For example, the planned rail balloon loop is 3.2km long and will be capable of loading trains with up to 160 cars. The Truepoint facility is strategically located at the junction of UP and BNSF rail services so this will add flexibility and provide competition in rail services. It could be observed that grain elevators typically only have access to one rail freight provider.

Figure 13: Truepoint Co-Operative / Cargill Joint Venture site under construction

In 2014, increased oil traffic on the BNSF rail network increased grain freight costs leaving elevators on BNSF only track at a disadvantage to their competitors with access to the UP rail network. This example shows that elevators with access to only one rail provider are at risk of losing volumes if their rail provider becomes relatively more expensive.

The major export locations for US wheat are out of the gulf, great lakes and Pacific North West (PNW). Rail freight in the US has to compete with barge freight (see Figure 14) up and down the Mississippi and in the major tributaries that feed into the Mississippi river its tributaries and the great lakes system. The barge network creates competition with rail and limits to some extent the market power of the rail providers. The barge market is capable of executing large volumes of grain cost effectively and forces rail to compete on price to attract business.

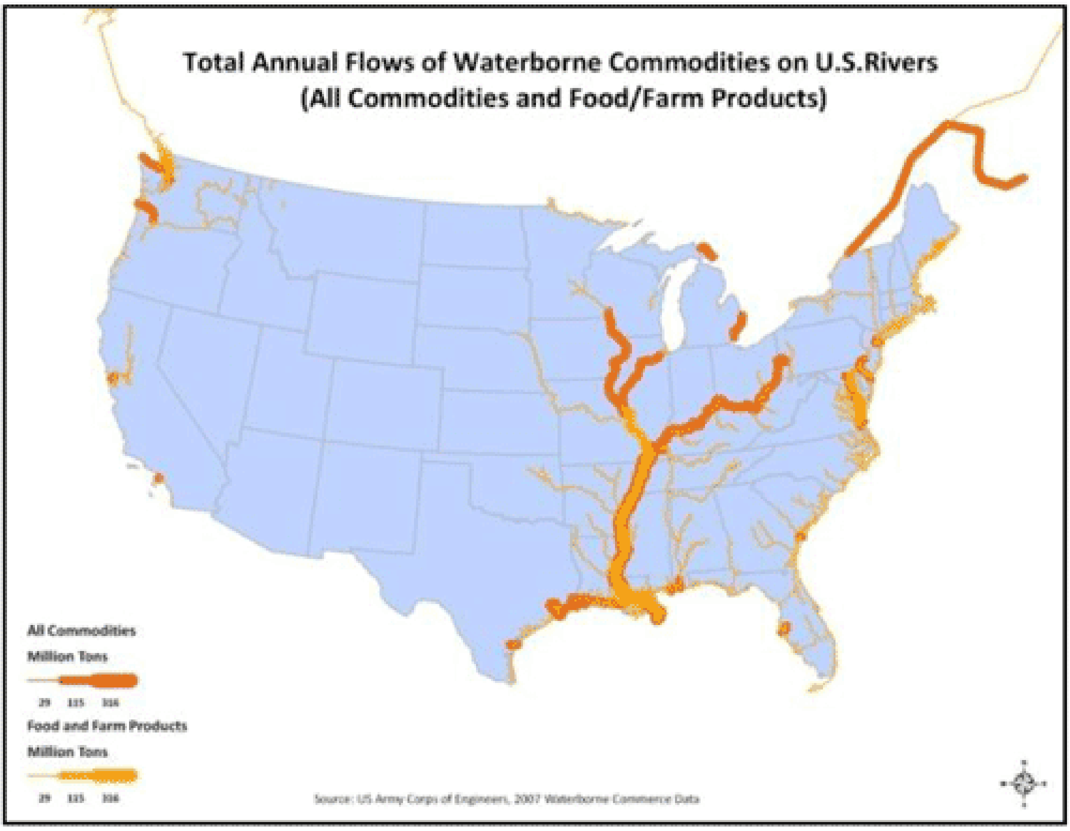


Figure 14: US Barge Network

Source: Casavant, K. (2010)

U.S. Grain Storage

Total grain storage capacity has increased over the past two decades following declines in the 1980s and early 1990s. The OFS share of total grain storage capacity has ranged between 55 – 60%. Elevator (off-farm) storage growth has marginally outpaced OFS Storage capacity growth since 2005.

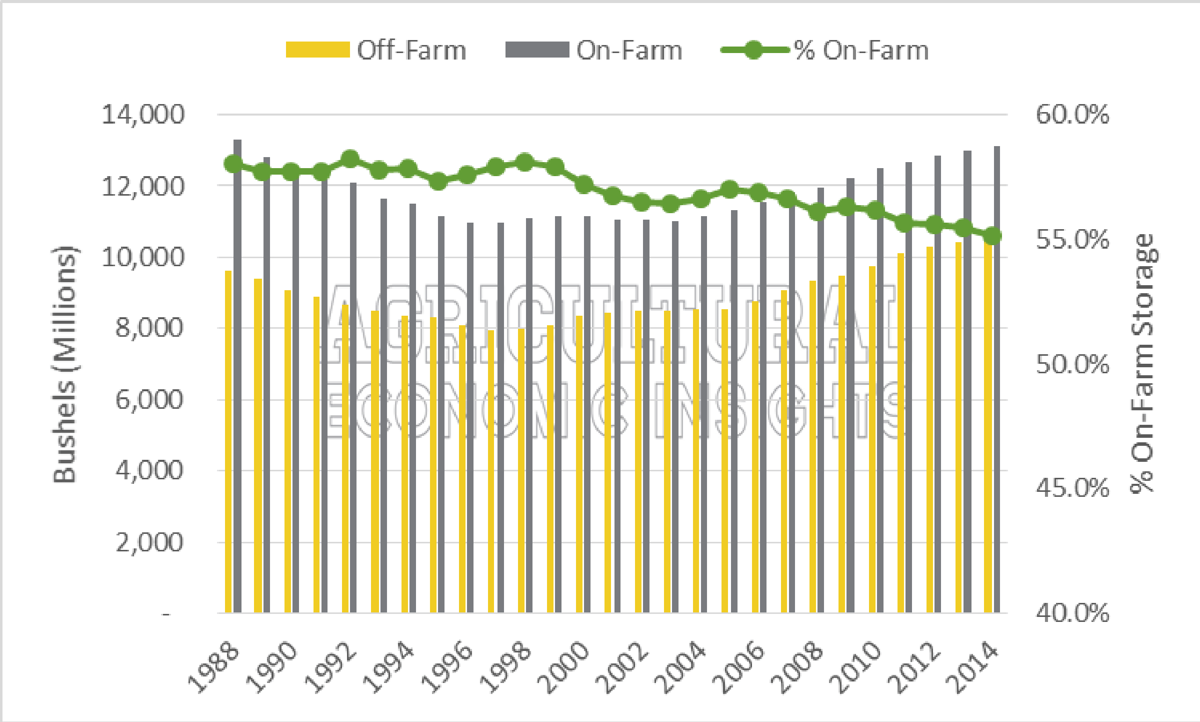


Figure 15: U.S. OFS (On Farm) and Off Farm Storage (1988 – 2014)

Data Source: USDA NASS (Agricultural Economic Insights)

Growth in OFS and off-farm (elevator) storage capacity (*Figure 15*) have mirrored increases in production (*Figure 16* and ***Figure 17***). Yields have been increasing over time with a 2.03bu/acre/year yield gain achieved nationally in corn (1.2% annual trend growth) and a 0.39bu/acre/year gain achieved nationally in winter wheat (0.9% annual trend growth). Strong relative prices for corn compared to soybeans have also increased the demand for grain storage as corn typically out yields soybeans by a factor between three to four times.

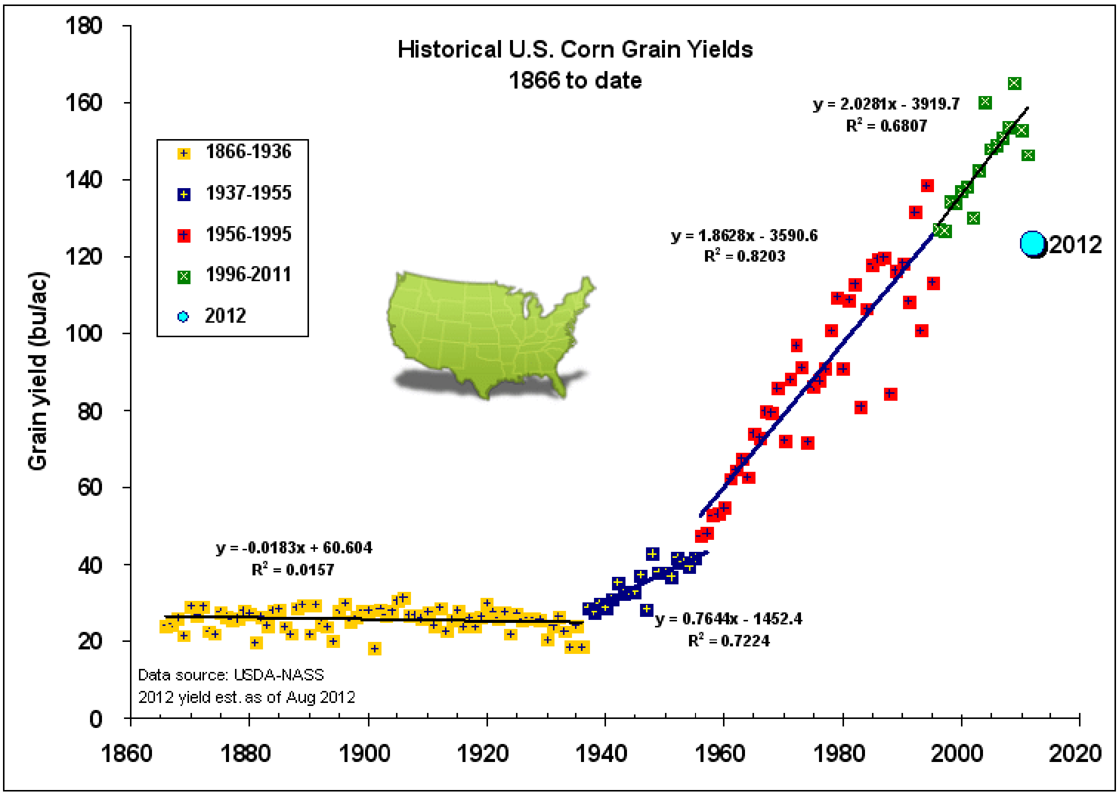


Figure 16: US Corn Yields 1866 - 2012

Source: https://www.agry.purdue.edu/ext/corn/news/timeless/yieldtrends.html

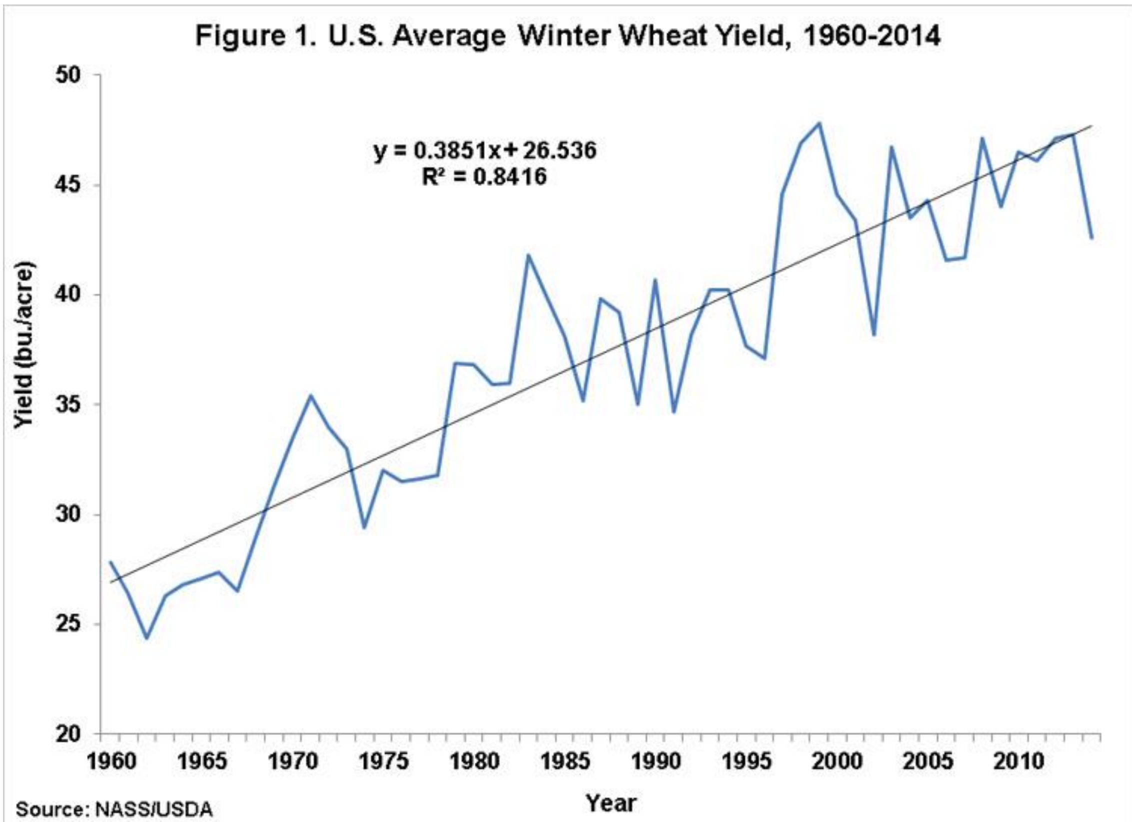


Figure 17: US Winter Wheat yields

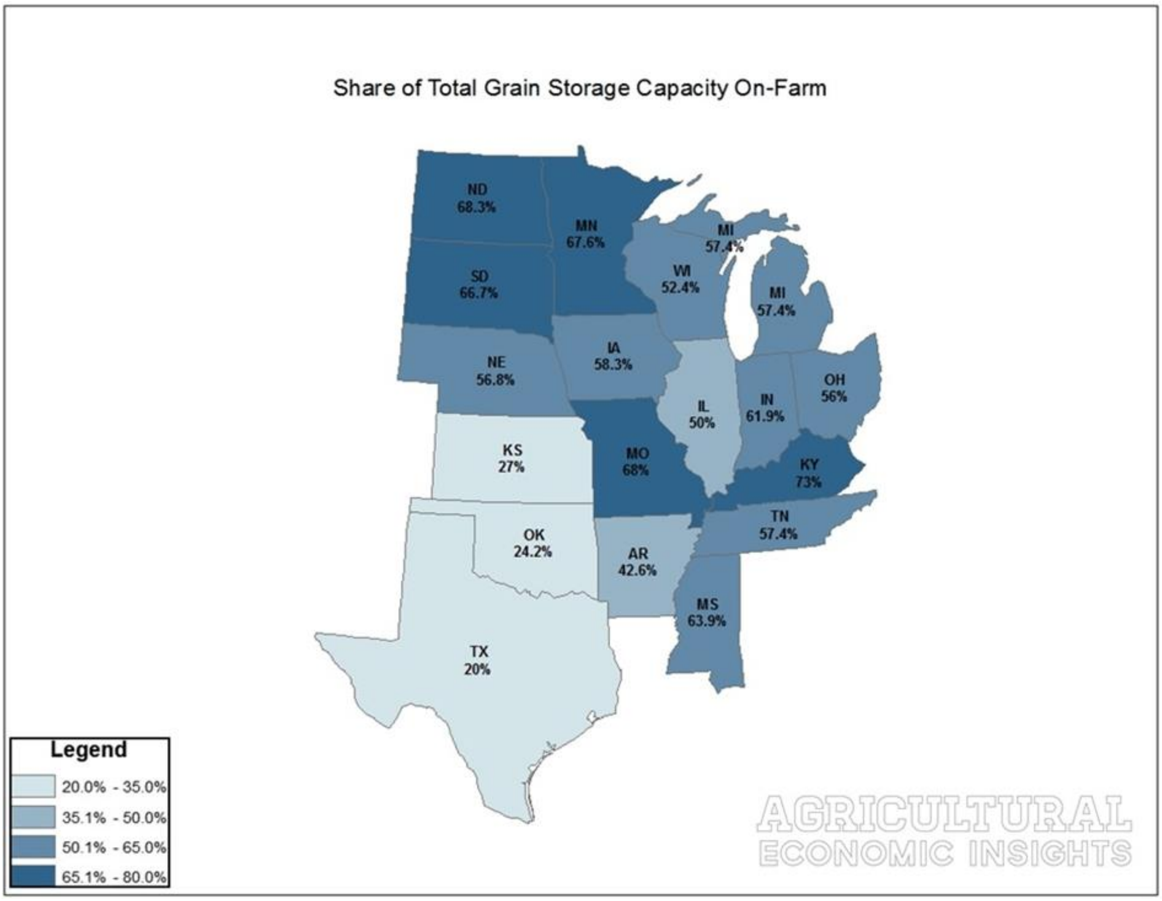


Figure 18 U.S. Share of Total Grain Storage Capacity On-Farm by Select States, 2014

Source: Widmar, D. (2015)

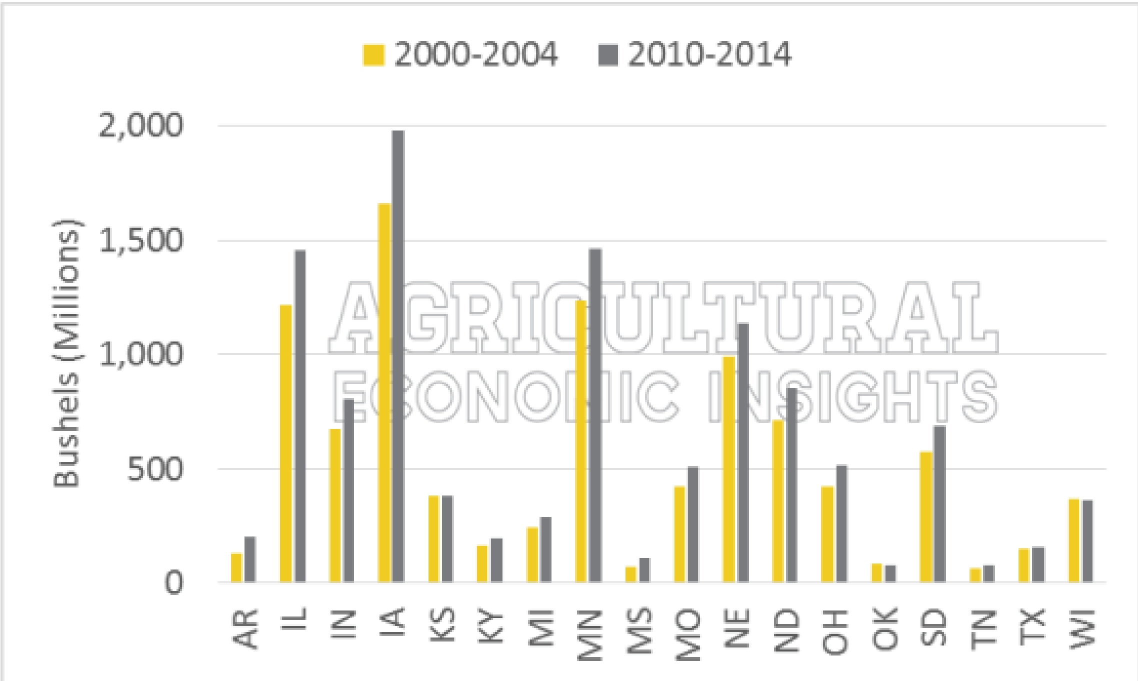


Figure 19 U.S. OFS Growth (2000-2004) Average vs (2010-2014) Average by State

Source: Widmar, D. (2015)

The largest increases in storage capacity (see *Figure 19*) can be observed in the mid-west and the northern plains. The mid-west is a large producer of corn and beans whilst the northern plains also grow spring wheat and other speciality crops including durum and pulses. Growth in Soybean and Corn production would appear to be a major driver behind overall and OFS capacity growth in the U.S. Widmar (2015) states that average total corn production increased by 28% from the 2000-2004 period versus the 2010-2014 period. Total OFS has increased by 17.6% and the combination of elevator and OFS increased by 20% over that period.

US Winter Wheat Storage and logistics

Hard red winter wheat (HRW) growing states such as Kansas have historically relied on elevators for the majority of grain storage storage requirements and as a result OFS makes up a far smaller percentage of overall storage capacity Dhuyvetter et al. (2007). Much of the HRW belt grain network was built in the 1950s and 1960s. These old facilities can be difficult to fumigate and as such, Phosphine resistance has developed as a significant issue Mason, L (2015).

In the long run, economic profits (profits in excess of risk adjusted return on capital target) from grain storage are close to zero in a competitive market. Economic profits however can be made where a storage provider, on-farm or off-farm can operate with a lower marginal cost that the market average.

Dhuyvetter, K. et al. (2007) used seasonal price trends from 1976/77 – 2005/06 to demonstrate that returns from an OFS investment in Kansas, designed to carry grain post-harvest, were positive for soybeans, negative for corn and sorghum and slightly negative for winter wheat. The analysis also indicated that profitability was positively correlated to size of the OFS facility.

There is the beginning of a shift under way in the HRW wheat belt towards more OFS following a historical reliance on large commercial elevator storage. Cooper, D. (2015) suggested, *"Smart growers are investing in storage because the economics of it works. Grain production now is very much a business and US growers are investing in storage because they can see that there is a return in it. (The) trend is only going to continue, more on farm storage."*

Cooper, D. (2015) also indicated that there is enough rail capacity to execute the entire US HRW wheat crop to export ports in as little as 1 month using shuttle trains if market conditions dictated.

Flory, C. (2015) has observed an increase in grain stocks held on farm and for longer periods of time was having a noticeable impact on US grain markets. Traditionally, traders would compete aggressively for grain at harvest, bidding up basis to secure grain supply then basis would soften post-harvest.

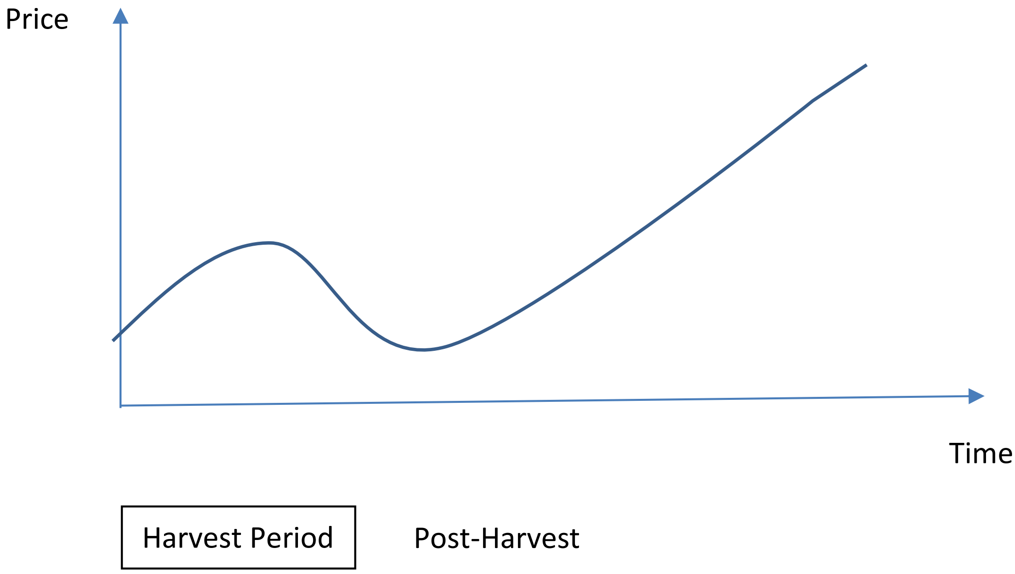


Figure 20: Typical Corn Harvest Upcountry Cash Carry Corn Pre Ethanol and OFS Expansion

Increases in OFS capacity and the development of the ethanol sector has resulted in market structures encouraging growers to carry grain on farm. Grain in OFS tends to be more tightly held meaning traders and consumers need to bid up to secure grain. The use of OFS has also changed the way grain moves to market, providing flexibility for growers in their choice of path to market based on price. The price offered for Corn from OFS now typically reflects the cost of storage and finance (carry).

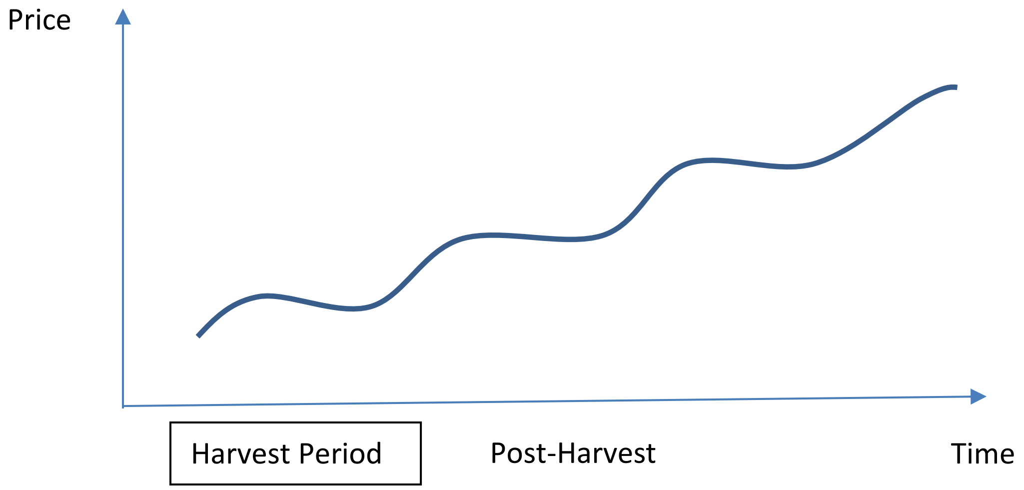


Figure 21: Typical Corn Harvest Upcountry Cash Carry Corn Post Ethanol and Increased OFS

Canada

There are similarities in rail operations in Canada and the US. This includes the private ownership of infrastructure, vertically integrated with rail operations (where railway companies CN and CP own the physical infrastructure and provide services to shippers). Operational similarities in the US and Canada also provide for industry-level cooperation, such as agreements between Canadian and United States railways that allow for the sharing of assets. It was observed that competition for traffic and resources among these railways is evident. Carter (2009) identified that this also creates grater resale in the marketplace in the second-hand rolling stock market compared to Australia.

Emmerson, D. (2015) identified a major pressure point in the Canadian system is the reliance in OFS. The combined commercial elevator capacity in Canada (including port and inland) can store no more than 20 percent of our average annual production. The US by contrast, can store over 50 percent of the crop in off-farm commercial storage; and Australia has bulk handler capacity for 175 percent. Canada relies on “just-in-time” delivery from farm to port to meet export demand.

A just-in-time approach relies on a co-ordinated approach in executing grain from farm to the upcountry elevator. Efficient co-ordination of grain movements requires buyers and sellers know exactly what is available in on-farm bins. Emmerson, D. (2015) also suggested that better reporting of grain stocks on farm in Canada are needed to improve the efficiency of grain movements.

The number of licensed primary elevators in Western Canada has declined from 1,004 facilities in 1999–00 to 371 facilities in 2013–14, a decline of over 63 percent according to Emmerson, D. (2015). Many of these remaining 371 facilities have been rebuilt over the past 20 years and these facilities are capable of high rail out-turn to unit and shuttle trains. The geography of Canada requires grain to be moved long distances (1000km+) to port along an inter-continental class 1 heavy rail line with the majority of grain exported through the Pacific North West (PNW) ports. This need is driving upgrades to rail loading facilities to further increase the productivity of main line operations, which are the backbone of the Canadian transport system.

This means that for the Canadian freight system to work efficiently, grain needs to move from farm via road or branch line rail to link with mainline rail before moving to port. Reliance on mainline rail results in Canadian grain exports being more evenly spread over 12 months in contrast to Australia where exports are typically front loaded over the first six months of the marketing year (immediately post-harvest).

Canadian grain shipments can be executed more cheaply than similar distances (See Figure 7) but the system has less spare capacity than the Australian market to deal with large crops as was evidenced in Canada during 2014. The grain logistics challenge of the 2014 crop year was exacerbated by increased oil shipments via rail out of the Canadian prairies to a point where interior cash grain basis values fall to a point where it was viable to truck grain from Alberta over the Rocky Mountains to flour mills in British Columbia which was virtually unheard of before, Meyer, S. (2014). The Canadian grain supply chain is far less flexible than in Australia or the U.S. but can execute at a lower cost per road mile. It could be observed that much of the Canadian elevator network has been rebuilt over the past 20 years.

Typically, Canadian farmers have enough OFS for 90% of average production according to Koshman, T. (2015). Logistically, growers are forced to store because of the long distances to port to execute via rail and capacity constraints.

Figure 22: Panoramic View of Lethbridge Viterra Shuttle Loader

This Lethbridge site (*Figure 22*) was built in 2008 by a 200-member grower co-operative, Lethbridge Inland Terminal (LIT) at a cost of 23 million CAD in 2008 and subsequently sold to Viterra in 2014. This site can load a 110-car unit train in 16 hours, the fastest sites in Canada are capable of loading a unit train in 10 hours. The facility has a storage capacity of 40kmt; the site was turned over 8.5 times during 2015 handling 340kmt, Koshman, T (2015).

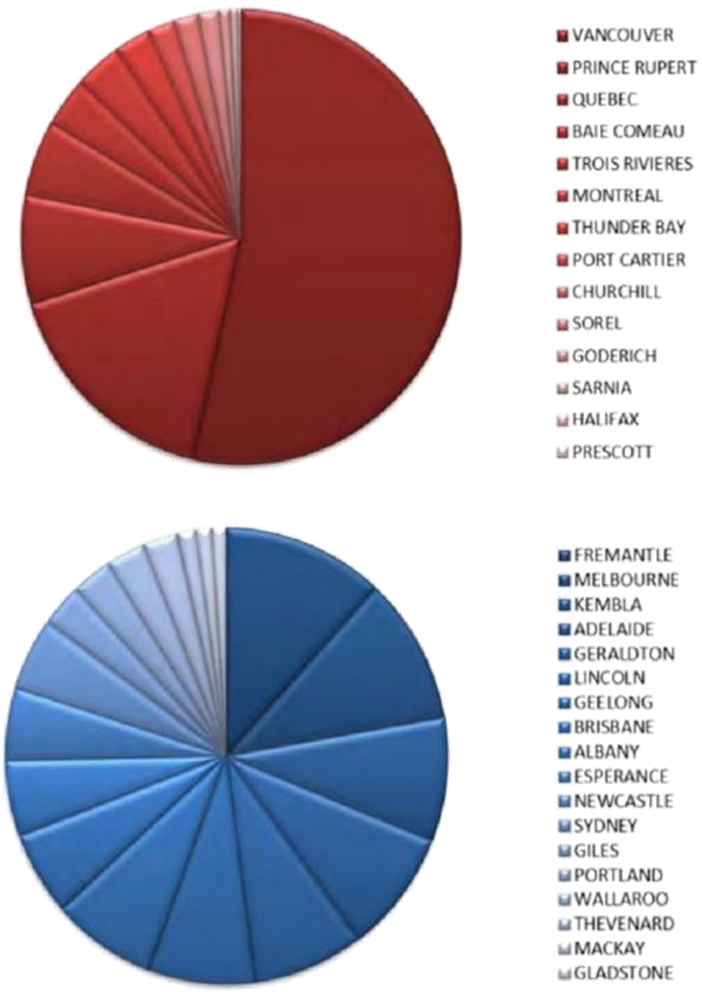


Figure 23: Port Market Share Canada vs Australia

Source: Fraser (2015)

Canadian ports have sufficient competition to not require regulation and can generate higher levels of return than comparable Australian ports, Fraser (2014). Thanks to greater tonnages received at lower unit cost via mainline rail, Canadian ports can offer greater economies of scale and competition to the grain industry. The largest of these, Port Metro Vancouver, has six commercial grain terminals. Relying on this innate competition offers a more efficient competition mechanism than regulatory interventions.

A benefit of an intercontinental rail line in Canada is that over 75% of grain is in shipped out of three ports, Vancouver and Prince Rupert in PNW and out of Quebec in the East. Vancouver for example has six port operators which provides competition for port services but also good returns to port operators due to economics of scale (see Figure 22).

By contrast, Australian ports lack scale with the top three ports in Australian only handling approximately one third of the Australian export task. Up until recently, Australian ports have been monopoly assets and required Australian Competition and Consumer Commission to monitor third party access to ensure competition.

United Kingdom

The UK wheat market can be compared to the Australian east coast domestic feed market as both are serviced predominantly by road. The UK only exports 10-20% of total production, the balance enters the domestic market; of which 100% is transported via road; and is typically stored for up to 12 months. Milling wheat and feed wheat demand are similar in the UK, with feed demand more variable depending on the availability of other feed stocks. Years of high production, for example 2015/16, result in stock carried over into the next marketing year.

UK Cereals Production (kmt)	2012/13	2013/14	2014/15	2015/16
Barley	5,522	7,092	6,911	7,281
Wheat	13 261	11, 921	16,606	16,129
Milling Wheat Demand	6,581	6,403	6,801	

Figure 24: UK Wheat Production and Milling Wheat Demand

Source: UK Department for Environment, Food and Rural Affairs

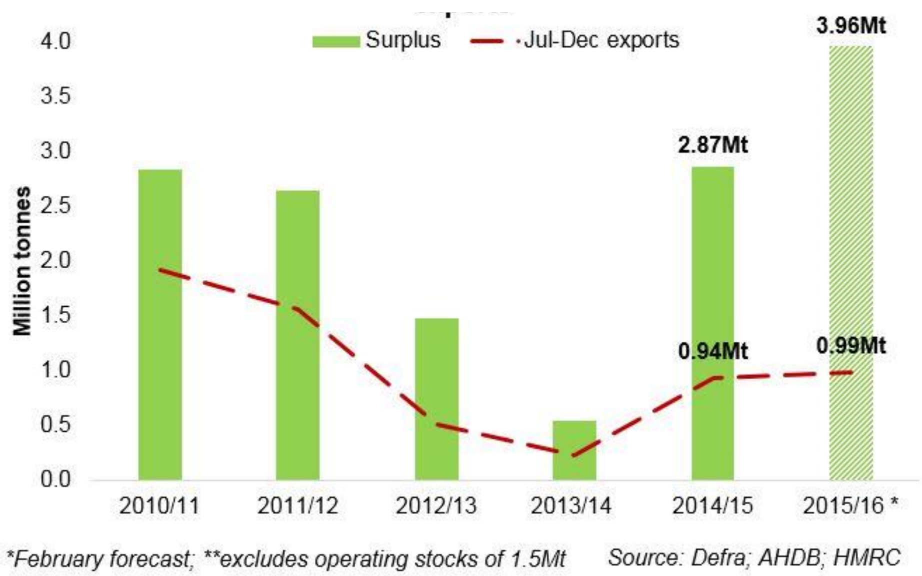


Figure 25: UK Wheat surplus available for export of inter year carry

Source: http://www.farminguk.com

It was observed that UK growers typically fill OFS first, with a bias to store dry grain on farm and send high moisture into grain co-operatives for drying or as a store of last resort. Collins, J. (2015) commented on grower decisions on where to store grain *'if your moisture is fine store on farm, but if moisture is high then look to use (grain store) drying facilities.'*

It was observed that the use of drying facilities was commonplace. Growers will harvest grain at higher than 15% moisture if required and use hot air drying facilities to reduce moisture to safe levels for storage. Down, R. (2015) commented that many UK growers don't understand how to manage grain at 16% moisture. He suggested growers would be better avoiding drying fees by not going into drying facilities and either selling grain at a small discount off the header or to blend with lower moisture grain and use aeration to manage quality. Peck, J. (2015) pointed out the importance of blending to reduce unnecessary drying costs by managing grain moisture content efficiently.

Typical Receival Charges

Weighbridge charge/mt	0.30 GBP
Handling charge/mt	7.00 GBP
Storage charge/mt/day	0.04 GBP
Shrink	1%

Moisture	Price (GBP)	Deduction for deadweight loss
15.1 – 16%	1.50	4%
16.1 – 17%	3.00	5%
17.1 – 18%	4.50	6%
18.1 – 19%	6.00	7%
19.1 – 20%	7.50	8.25%
24.1 – 25%	15.90	14.5%
29.1 – 30%	24.90	20.75%

Figure 26: Typical Drying Charges

Source: Down, R. (2015)

Black Grass (Alopecurus myosuroides) is a major problem for the UK grain industry and could be observed to be one of the major contributors to poor grain yield at an individual paddock level in the UK. Down, R. (2015) made the point that he would be reluctant to store grain on behalf of neighbours, due to the risk of contamination from resistant strains of black grass. This is an important consideration for Australian growers given the range of resistant weed problems in Australian farming systems.

PX Farms, Multiple Use Farm Sheds and Industrial Units

UK growers rely heavily on sheds for grain storage however the sheds are often designed for multiple use. It is common place for growers to store grain over the summer in a shed then empty it out and house livestock in the winter. It was observed that sheds in suitable locations could be converted for industrial storage if they were close to a major urban centre.

Significant demand for industrial units exists in the UK and it was observed that many farm sheds have been converted into industrial units. Building an agricultural shed then applying to convert it to industrial use is often an easier way to construct an industrial shed, Tremain, I. (2015). These external market forces are a driver of shed construction for grain storage in the UK. Peck, J. (2015) made the point that potential industrial value should influence choice of grain shed location and consideration given to a location that is useful for a major centre with demand for industrial units. PX farms grain storage sheds are located within 15 minutes of Cambridge, a major UK city.

PX Farms

- 60kmt storage (3 x 20kmt sheds)
- Store PX Farms production and local growers 40kmt and one 20kmt shed is managed by PX farms and leased to FenGrain.
- Close proximity to Cambridge with potential to convert to industrial units in the future.

UK Grain Storage Co-operatives

Many of the co-operative grain storage business formed due to demand from growers to pool resources to achieve economies of scale to store grain, in particular high moisture grain that was difficult for growers to justify building and managing individually. It was observed that many of the grain storage co-operatives were formed in the 1970s, there has been a trend towards consolidation over the past decade.

Westcountry Grain and Cannington Grain Store, Somerset

www.westcountrygrain.co.uk; www.openfield.co.uk

West Country Network Storage (total 150kmt capacity) / Openfield Marketing

Cornish; Cannington; Devon; Tamar; Scats

- Westcountry has 500 grower members.

Cannington Grain Store

- Established 1977
- 40kmt Storage Capacity
- Drying Facilities 5 Dryers Ranging from 30mt – 80mt/ hour capacity (200mt/hr Total)
- Peak Harvest Receival 3kmt per day
- Intake Pit 300mt / hour

Somerset has significant Dairy, Beef Cattle, Poultry and Pig Operations, the majority of feed wheat is sold to local feed mills. Cannington also handle milling wheat, malt barley, canola and pulses. Openfield operate the marketing out of Westcountry sites. 90% of grower grain is pooled and marketed by Openfield. The use of pools is encouraged to maximise the operations of the store year round. This is achieved by offering storage rebates to growers with shares in the store, Eastwood, I (2015).

FenGrain, Cambridgeshire

www.fengrain.co.uk

- Storage capacity of 150kt;
- Three phases of construction; 70s, 80s and 90s.
- Grower shareholders currently have requirement for 175kt of storage,
- 25kt shortfall is leased from other storage providers including PX farms.
- Moving towards inventory management
- Grown from 20 original farmer members to 900.

Fengrain currently have a waiting list for new members and existing members who want to increase their storage rights. Fengrain have a growth philosophy of only building new storage infrastructure if 50% presold. i.e. if looking to build an additional storage of 50kt there would need to be 25kt pre-sold. When the amount of grower storage space purchased by growers exceeds physically storage assets, third party storage assets can be leased to manage this.

Fengrain have approached expansion opportunities differently to other storage businesses in the UK. Fengrain have built partnerships with end users to build storage at the location of the consumer which Fengrain finance and manage. Fengrain accumulate grain into these facilities either directly of the header or throughout the year, this practice is not common practice in the UK, Munro, R. (2015). Many of the independent flour mills are family owned and these businesses lend themselves well to this partnership approach. The malt industry in the UK is also mature and these businesses are looking for storage and marketing partnerships which this approach also suits.

The UK market does not currently have significant inventory capacity at consumption points. The nature of the road only UK market, the growth in grain production and modern truck fleets are now making it feasible for more grain in south-east of the UK directly to the consumption point for storage. Fengrain are facilitating this investment by providing capital, management expertise and logistics capacity to drive efficiencies in the supply chain. Fengrain also have a meaningful trading operation and export cargoes from Norfolk and Great Rightborough to European ports.

Camgrain, Cambridge

www.camgrain.co.uk

- Largest Grain Co-operative in the UK at 430kmt total storage at four sites
- Differentiate through second stage food processing (pre-processing)
- Value add for Milling wheat sector using Z-sorter technology

Pre-processing allows dust, ergot, foreign seeds and foreign materials to be removed from the grain. The Zortex Z+ Optical sorter uses infrared and visible light to check grain for colour and transparency with capability to scan up to 120K individual grains per second (20mt/hr) using air to eject individual grains. The pre-processing of specific grades of grain is a value add proposition allowing certain grades to meet human consumption standards that would otherwise be only suitable for stockfeed or industrial use.

Growers can currently purchase storage rights for 110 GBP/mt, the real cost can be as low as 85 GBP when allowing for financing and taxation treatment. According to King (2015), for growers to purchase wet grain storage with drying capacity, the cost can be in excess of 200 GBP/mt. Camgrain have positioned themselves in the business of not only storing grain but in pre-processing grain and focusing on providing quality grain to the human consumption market. Camgrain were able to fund expansion in part through government grants to stimulate regional communities and to improve UK food quality.

Grower cooperative models for grain storage have faced some issues. Tremain, I. (2015) and Down, R. (2015) agreed that there can be challenges for grower shareholders to access capital, particularly when co-operatives are experiencing poor trading conditions. In addition, private ownership of grain storage is more likely to make hard decisions to rationalise storage infrastructure. Cooperative businesses may be less inclined to rationalise storage infrastructure due to the politics of favouring some growers and not others. There is also a risk to the grower community if monopoly assets once held in a co-operative structure are privatised that the private operator can exert market power over the grower in the absence of sufficient controls and regulation, potentially skewing profit share towards the private infrastructure operator at the expense of the grower. If the grower has other options to store and market grain then this risk can be reduced. For further discussion see Noel J, D et al. (2002).

Chapter 2: Managing Grain in Store

Australian growers are storing greater quantities of grain on farm, for longer periods of time, requiring a greater level of management to maintain grain in saleable condition. Fumigation with Phosphine is the only commercially available option for controlling grain insects in stored grain under Australian conditions, Botta (2016).

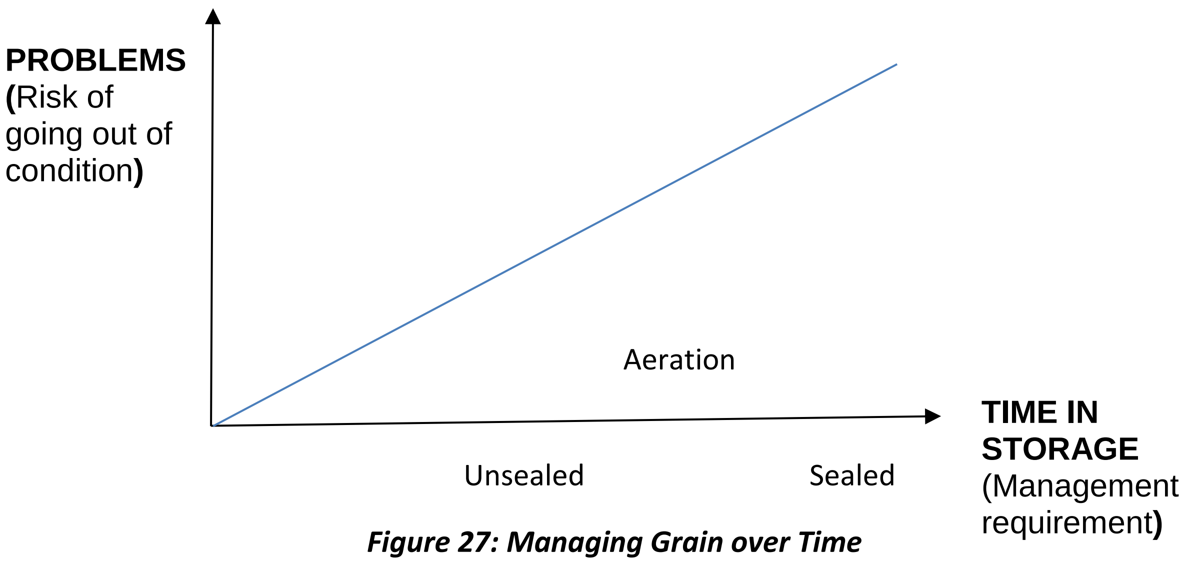


Figure 27: Managing Grain over Time

Adapted from Botta (2016)

Fumigation to Control Stored Grain Pests

When considering purchasing gas tight silos, build quality and the ability of the silo to maintain structural integrity in the long term are important. The Australian standard for gas tight silos AS2628 stipulates new silos must meet five-minute half-life and existing silos must meet three-minute half-life for fumigation. Botta (2016) estimates that up to 80% of phosphine use in Australia does not meet this standard. Botta (2016) suggested an initial minimum target for growers to have enough gas tight storage to meet maximum out-turn requirements for one month, allowing sufficient time for fumigation with phosphine and out-turn for market.

The industry faces challenges to manage grain in storage. Phosphine Resistance in Australia is a significant issue. The use of Phosphine in conditions which fail to meet AS2628 guidelines will exacerbate this problem.

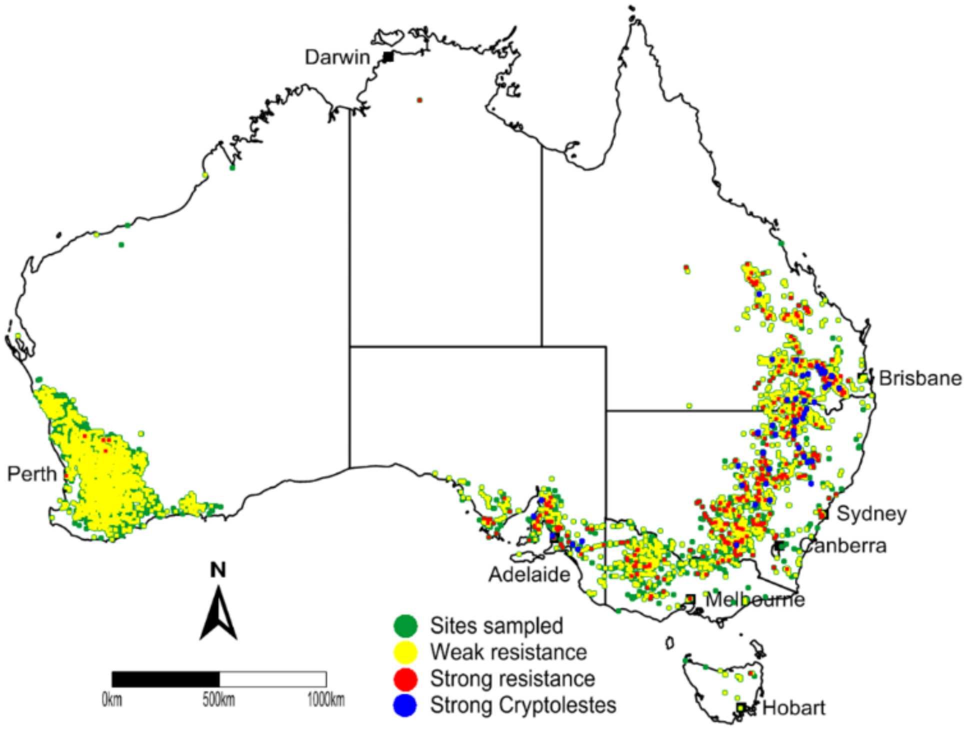


Figure 28: Phosphine Resistance in Australia (1986 – 2014)

Source: https://www.agric.wa.gov.au/exporting-western-australia/stored-grain-insect-resistance-monitoring-and-management

Phosphine gas as a fumigant in grain storage is currently under review for its impact on worker safety and toxicology, APVMA (2015). There is a risk that Phosphine gas could be removed or restricted for use in the future. It is possible that some export destinations may require grain to be absolutely chemical residue free, this would change the requirements for grain storage to access these markets. Phosphine does leave a small residue (Botta 2016), future infrastructure requirements will need to consider how grain can be cost effectively stored for these markets.

Risks to the reliance on phosphine include:

1) deregistration by regulators of the use of phosphine gas to control grain storage pests;

2) the efficacy of phosphine will diminish due to the development of resistance; and

3) more markets may demand grain stored with zero chemical residues. Future alternatives will include fumigation in gas tight storage using carbon dioxide and Nitrogen but are more expensive and require a higher level of management than phosphine.

Aeration and Automation

The objective of aeration is to maintain the quality of bulk grain in storage. Cooling grain is the primary objective of grain aeration (in relation to pest suppression). Stored grain insects are of tropical or subtropical origin and require fairly high temperatures, typically 24°C - 32°C for development. Grain infesting insects are sensitive to low temperatures. Stored product insect development is generally stopped below 16°C. Grain temperatures of 16° to 21°C are considered "safe" for insect management, because feeding and breeding are slow. Complete life cycles at these temperatures take three months or more, so insect population growth remains insignificant. Insect damage caused under these low temperature conditions is minimal, Hagstrum, D et al (2012).

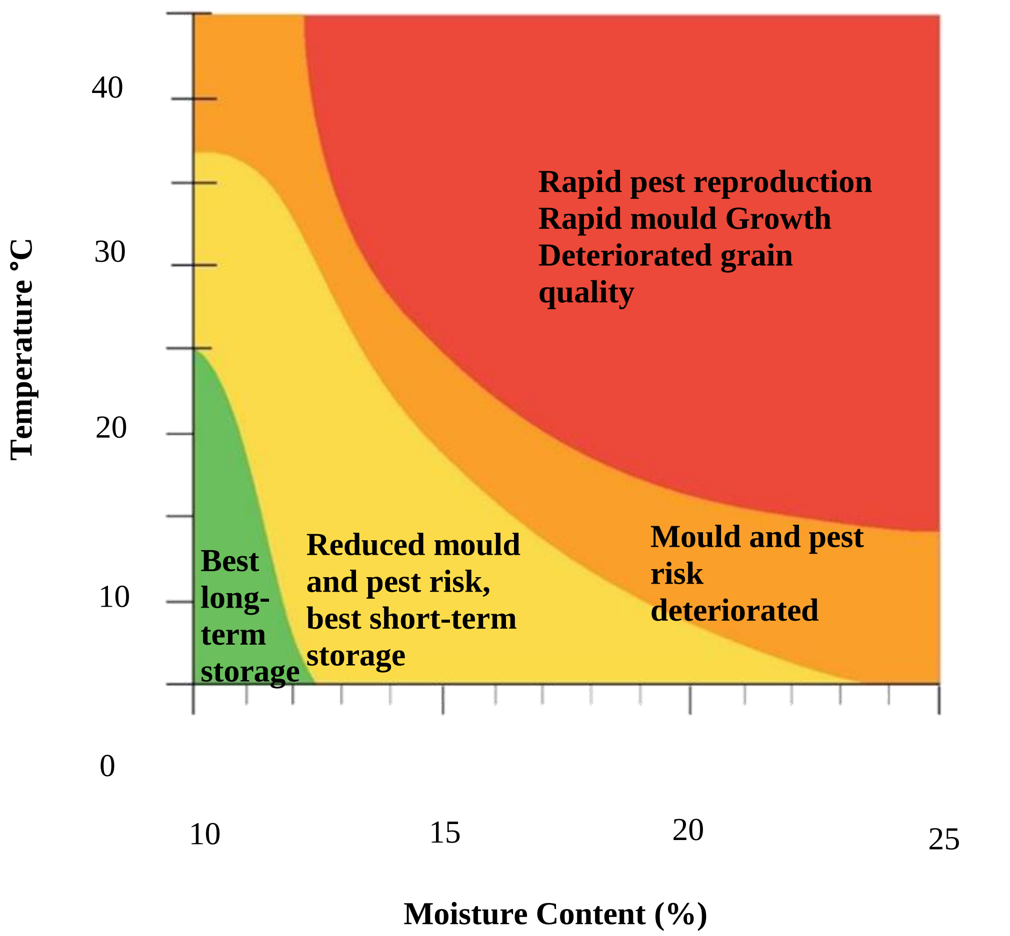


Figure 29: Effects of temperature and moisture on stored grain

Source: CSIRO

Problems with grain condition are more likely to occur in bins without automation. Field (2015) identified that automated controllers are a must for growers with aeration. Without automation, growers forget to turn fans on and/or leave fans on when weather conditions outside the silo are not suitable. Field (2015) suggested *'if grain can be kept in condition it solves a lot of problems down the track'*. This is supported by Hagstrum, D et al (2012) *'As long as grain temperature control is the primary objective, a simple low-cost electromechanical aeration controller may suffice to control all the fans at one installation. The payback on such a low-cost (500USD to 1,500USD) aeration controller is usually less than one year.'*

Workplace Health and Safety (WH&S)

Inside the Silo from the U.S.

It was observed that North American farmers commonly store grain at relatively high moisture content, and utilise hot air drying to bring down moisture to manageable levels. Storing grain at high moisture can pose greater risk of bin burnt grain. Not only does this pose a problem from a quality standpoint, it also increases the risk of blockages upon grain out-turn. The best solution is to use aeration and dry the grain down to manageable levels to prevent bin burnt grain from occurring.

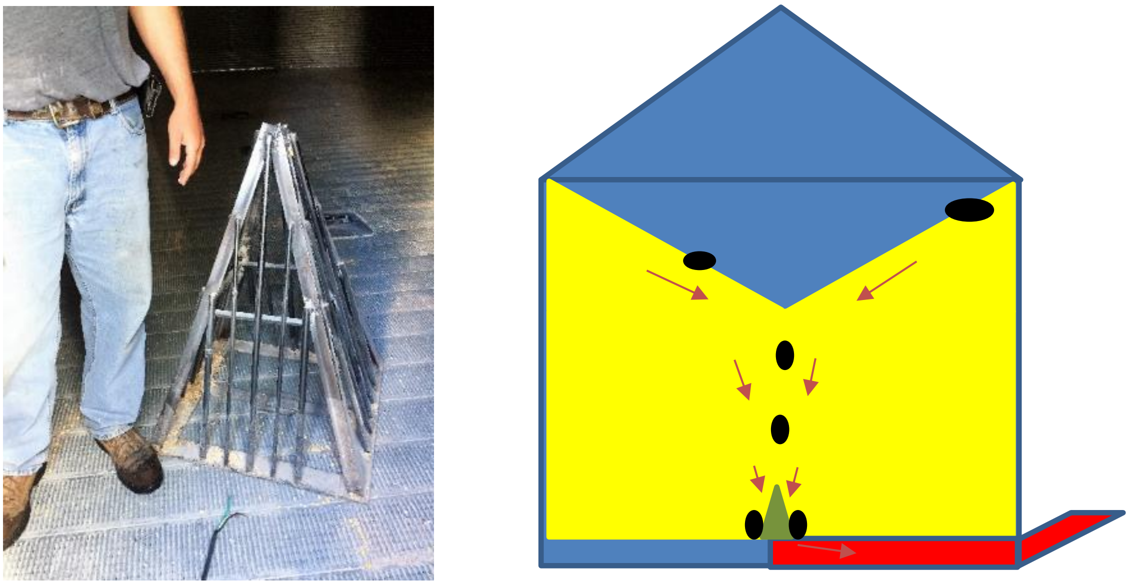


Figure 30: Grain Pyramid at Rich Farms, Indiana

The Grain Pyramid is a safety measure in the event of bin burnt grain forming. ***Figure 30*** shows a grain Pyramid designed for corn, it is important to note that different grain size alters the optimal design for the pyramid. The Grain Pyramid prevents clumps of wet (bin burnt) grain from blocking the hole that feeds the out-take chute. Rich, R. (2015) stated *'I would not put grain in a bin without one of the grain pyramids.'* This practice has been adopted as a result of past experience with bin burnt grain, the grain pyramids are now standard practice in the Rich on-farm grain storage operation.

Field (2015) identified that serious injury and deaths in grain storage facilities can be minimized by removing the need to enter the silo in the first place. Maintaining grain in condition is important from a worker safety standpoint and for the quality of grain on out-turn.

Another piece of equipment that reduces the need for bin entry is a sweep wheel developed by Hutchison-Mayrath with an internal planetary gear box. The sweep was designed in conjunction with rice producers in Louisiana to more effectively drive the auger sweep into the grain stack in challenging conditions. The sweep drive wheel turns more slowly than the sweep auger so the wheel can be designed with more aggressive tread that typical sweep wheels. The design means the sweep moves through wet or dusty grain more effectively than traditional sweep wheels. The design minimises stoppages and is better for safety due to reduced need for staff to enter the grain bin.

Chapter 3: Business of Grain Storage and Marketing

Management Resources and Expertise

Growers considering a greater role in the supply chain need to understand the additional management resources and service level expectation from customers. Hurt (2015) explained that a new enterprise will require management resources, potentially drawing away management resources from existing enterprises. Growers considering servicing consumers directly should question if their business is geared up to meet the needs of customers. Including:

- 365 day a year task to meet the needs of end users.
- Wet weather access.
- Fast loading.
- Room to load large combination trucks including B-Doubles, road trains and B-triples.

Growers looking to deal with end-users directly need to understand they are now providing a retail service to meet customer needs. Storage and marketing done well can add value to your business but this comes from good management. It is important for growers to understand the strengths and weaknesses of their businesses, seek advice, develop partnerships and/or outsource where required. Many growers build OFS without the necessary knowledge of the investment they are making, time spent in research at planning stage will save money in the long term Botta, P. (2015).

Grain Storage Asset Utilisation

An important consideration for type of storage is the trade-off between cost, ease of management, ease to keep grain in condition and need to ensure gas tight storage for fumigation. Individual growers have different needs and preferences for what they want to achieve from OFS. There is merit in considering a mix of storage types that reflect the probability of yield outcomes and implied utilisation rates and the return on investment generated. Below is a graph of storage cost and storage use, in this simple example assuming return generated from the asset is the same as the cost of storage increases, utilisation needs to increase to generate sufficient return on investment.

A grower who is restricted to storing their own production must manage their own production risks considering OFS and the utilisation of Bulk handlers. There is risk that OFS will see growers over capitalise and not generate enough return to pay for the asset. Growers should consider a range of storage options based on their own production variability, attitude to storing grain and length of time in storage.

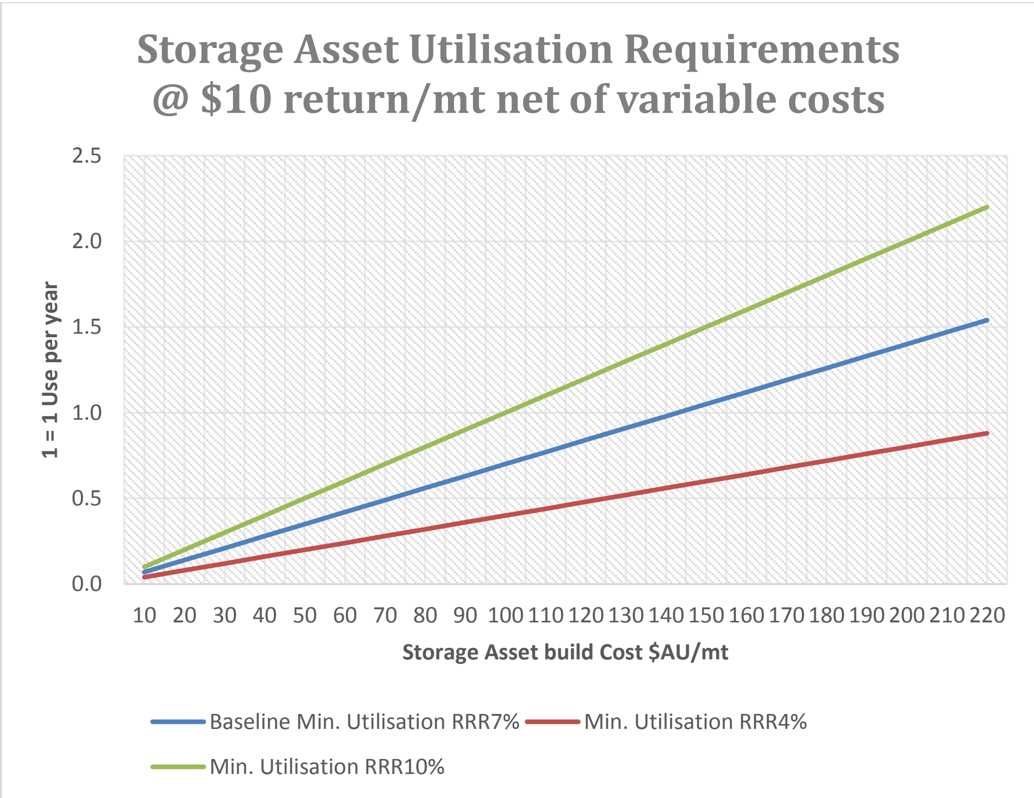


Figure 31: Asset Utilisation usage requirements vs cost of storage

Figure 31 shows the trade-off between the cost of the storage asset and the frequency of use required for it to be economic. Put simply, the more expensive a storage is to build the more it needs to be used to pay its way. This is important in the Australian context for growers or supply chain participants given the volatility of production Australian growers face (see figures 1,4 and 5.)

Relationships and Supply Chain Partners

Grain storage and marketing is a relationship business. A key to being a successful link in the supply chain is managing relationships with stakeholders. A common theme that emerged during my Nuffield travels was that successful independent grain storage providers have been able to find a niche in the market. This may include working with other storage providers, consumers and growers to provide value and service. Building storage capacity does not build a relationship, for a venture to be successful both of these aspects need to be managed well. The combination of getting grain storage and marketing right can be achieved using in-house resources or outsourcing where skill gaps exist with trusted business partners and advisors.

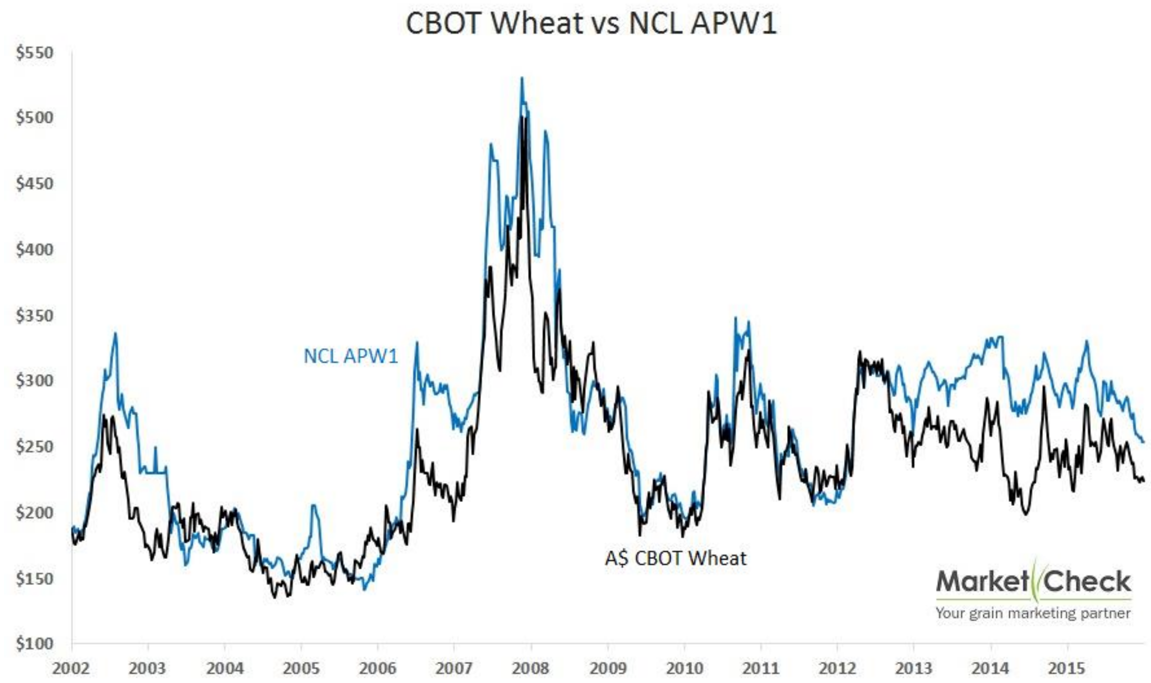
Chong, G. (2015) Suggested there are opportunities in Australia for a co-investment model between growers and grain trading companies which can lock in accumulation volume for the exporter in exchange for the provision of capital to invest in on-farm storage for the grower. For growers with smaller scale, this may present opportunities to work with other growers in order to lift market power. Long term agreements for up-country storage facilities (similar to port access agreements) would also ensure that existing infrastructure owners can have more certainty over asset utilisation, and therefore earnings.

Grain Marketing and Price Risk Management

Sound price risk management practices are critical to the running of a grain trading operation, can reduce risk and add value when managed well. Issues to consider include:

- The structure of the market including carry, basis and regional supply and demand;
- Possible and probable pathways to market;
- Planning for and responding to pricing opportunities;
- Business risks; and
- Executing physical trade and back office functions.

East Coast Australian markets are typically priced off export parity, however drought years can severely reduce export volumes and can lead to transhipment from SA or WA or imports of feed grains into metropolitan consumption markets. To justify the cost of transhipment or imports, East Coast basis must lift relative to export market pricing.



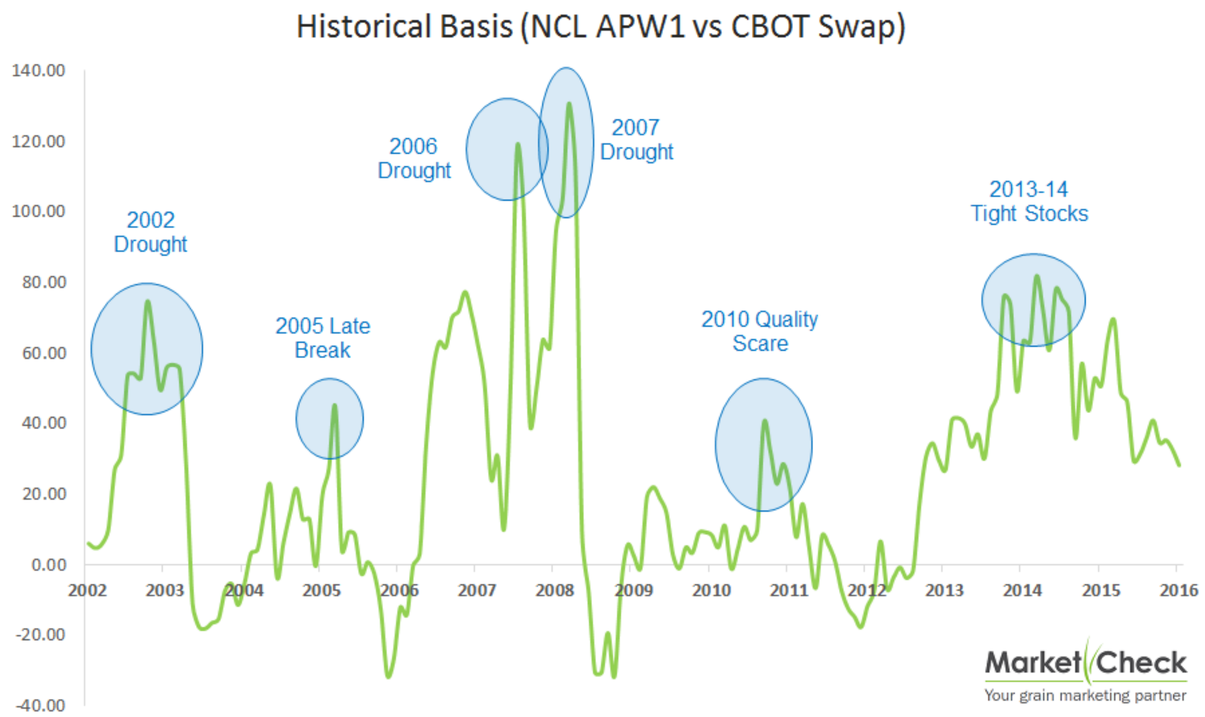


Figure 32: Newcastle APW Milling wheat vs CME SRW Wheat in AUD/mt (2002 – 2016)

Source: MarketCheck Analysis (2016)

Figure 32 shows relative pricing of APW milling wheat track Newcastle versus the nearby AUD equivalent CME SRW wheat contract. The important take home message from this graph is the basis relationship. Basis in commonly defined as the difference between a futures market price for a commodity and its local cash (or street) price. In this case the futures market is 'CME SRW' contract and the cash price is 'Newcastle track APW'.

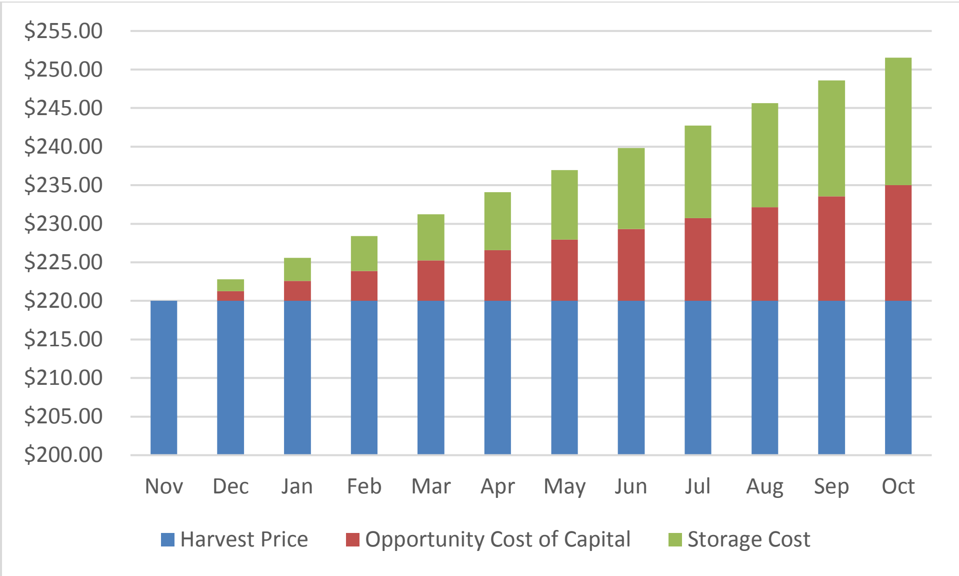


Figure 33: Cost of Carry Example

<u>Assumptions</u>

Harvest Price $220; Cost of Capital 7%; Storage Fees $1.50/mt/month.

Storing grain unpriced or unhedged can be inherently risky. The analysis in Figure 32 shows a simple example of the cost of carrying grain post-harvest. A marketing plan with an understanding of price risk management can add value and reduce risk in a grain growing operation. '*Storing grain for storing's sake is a risky business if you don't know what you are doing. You don't make money until you sell the grain'* Gold, M. (2015).

A Look at US Derivative markets

The U.S. derivatives market is the leader for agricultural commodity price risk management. The CME wheat contract is used globally as proxy for export wheat pricing and provides unrivalled pricing liquidity and is one of the few wheat markets where participant can consistently manage intra-year and inter-year 'carry markets'. The CME SRW and HRW wheat contracts are an important hedging mechanism for the Australian grain industry. Australian grain growers use tools such as SWAPs and options over SRW and HRW to manage price risk.

The use of offshore hedging contracts can reduce production risk by leaving Australian growers exposed to domestic basis.

Seamon, F. (2015) addressed two key issues that are currently of concern to commercial participants in the CME wheat contracts.

1. **Roll of Micro traders and excess volatility** reducing correlations to physical wheat values. Concerns from within the US industry that this increases volatility. The CME have a conflict in that the earn revenue based on turn over volume. Micro traders increase the volume of contracts that get traded and hence provide more revenue for the CME. The problem is that the micro traders in CME and many other derivative markets can increase volatility and reduce the correlation between the derivative and the underlying physical contract. Seamon, F. (2015) suggested the CME said it was monitoring this and it wasn't a problem. The risk here for the exchange is that if the CME wheat contract becomes less correlated, particularly short-term industry participants will rely on the contract less for the price risk management reducing liquidity and in particular reducing the relevance of the contract as a hedging mechanism that assists in physical grain trade.

2. **Vomitoxin (VM) tolerance**. Vomitoxin is a type of mycotoxin that can affect cereal grain crops (Caused by fusarium head blight in wheat). There is concern from some industry participants regarding Vomitoxin delivery specification changes. The CME SRW wheat contract allows for tolerance of up to 2ppm to be delivered against the contract and up to 3ppm at a discount of 20USc/bu. Many livestock industries and human consumption markets will not accept grain at greater than 2ppm.

The US Food and Drug Administration guidelines identify max safe VM levels as follows.

- Humans 1ppm in finished product (manufacturing process can reduce VM content of unprocessed grain),
- 5ppm for chickens and beef cattle at 40% of ration; and
- 5ppm for pigs at max 20% of diet (pigs are more sensitive).

Source: US Food and Drug Administration.

This guidance was updated in 2010 and saw increased safe allowable levels. The argument raised by the Seamon, F. (2015) regarding the increase in allowable VM up to 3ppm limit for the futures contract for deliverable wheat stocks to sit in the middle of the quality range between what the growers and warehouseman want to store and want the buyers want to buy. The onus is on the buyer to specify when contracting physical grain if they have specific requirements that they need met. Some industry participants would argue that wheat with less than 2ppm VM is not a specific requirement but a general industry requirement. The advantage of allowing wheat of up to 3ppm VM at a discount is that it expands the pool of deliverable stock that can be delivered against the SRW wheat contract, reducing the risk of a short squeeze event where the volume of deliverable stock could be adversely affected in this case by weather damage at harvest time.

Managing Production Variability and drought Risk

Storing grain, in particular feed grain can be an effective drought risk management tool for producers of grain and for mixed cropping and livestock producers in Eastern Australia. Figure 26 shows that during drought in Eastern Australia, cash wheat basis CME SRW wheat increases and in severe drought 2002, 06 and 07 can approach import parity. This allows a long East Coast cash basis an effective drought hedge and important risk mitigation tool. Hedging with CME compared to forward selling physical wheat can also act as a lower risk management tool for growers. OFS has and will continue to pay a roll in mixed farming operations to store feed grain for livestock consumption. If managed correctly, it can provide an alternative to production risk insurance products that are currently entering the Australian market place.

End User and Trade Procurement

Feed users of grain typically purchase grain on a 12-month basis on a just in time basis. Grain milling companies and maltsters as a rule of thumb tend to purchase forward a large share of the requirements to ensure supply. The major difference is that feed users can substitute inputs where millers are limited in what they can do. Understanding this difference is important when considering a plan for various types of grain produced on farm then stored and moved to market when required.

Co-operative Business Models and Scale

It can be observed that the formation of a co-operatives is typically due to a gap in the market place, benefits due to economies of scale from growers working together or due to grower concerns over market power. The UK grain co-operatives outlined on pages 37-39 of this report are a good example of this. A gap could be a service or a need that a grower needs that is not being solved by the private sector and/or to increase market power by growers working together. It can be observed that the roll of the grain co-operative in North American and European markets has changed over time. Trends toward consolidation driven by the need for economies of scale in both storage and marketing. A challenge in the past raised by Tremain, I. (2015) and Down, R. (2015) for the co-operative model is for growers to be able to exit the co-operative and get their capital returned. This problem can be exacerbated during difficult trading conditions. For further discussion of the advantages and disadvantages of co-operative and private ownership structures of grain infrastructure assets, refer to Noel J, et al. (2002).

Conclusions

It is reasonable that OFS as a share of overall grain storage capacity in the Australian marketplace could approach US levels of over 50% market share. It is unlikely to reach the 80-90% levels in Canada. Canada's long haul rail freight task that operates on a 12 month export program compared to Australia's front loaded 6 month export program and higher production volatility are key differences between the two markets. Australia's production will need to maintain flexibility to cope with volatility in the Australian crop production, bunker storage will remain a feature of the Australian bulk handling system provided quality can be maintained and customer needs are met.

A well thought out grower OFS system, attention to good management and a marketing plan can add significant value and compliment grain production enterprise. Well run grower OFS can compete with bulk handlers on cost of storage and in the feed grain sector will maintain an economic advantage over the bulk handlers in road delivery markets. Bulk handlers are likely to maintain focus where they have comparative advantage. This occurs where scale, specific management requirements and capital access are important. This includes: below and above rail operations; site rail loading capacity; segregating milling wheat; intake capacity at harvest time; relationships with large domestic customers; trade finance; accumulation of large parcels of grain for export shipments and international trade.

The delivery of Inland Rail is the potential 'game changer' for East Coast grain freight and has the potential to deliver on average \$10+/mt in rail freight savings. Combined with Bulk-Handler upgrades such as Graincorp's 'Project Regeneration' have the potential to save a further \$5/mt in supply chain costs. The combined uplift to growers from these supply chain savings could be in the order of \$15+/mt compared to current supply chain costs. Current Federal government commitments see the Coalition planning Inland Rail completion in 2026 and Labor sometime in the late 2020s. If delivered, this will accelerate the need for better integration of OFS and post-harvest deliveries into the Bulk Handler network to meet bulk rail shipments. The relative improvement in rail freight costs vs road could see the need to accredit OFS so grain can move directly from OFS to upcountry rail loading facilities and meet the required quality standards.

The optimal mix of OFS infrastructure is influenced by:

- Commodities produced.
- Cashflow.
- Quality and grade of products produced.
- Market Demand.
- Reliability of Supply.
- Local Path’s to market and the supply chain access.
- Service offering from nearby bulk handlers
- Regulatory Framework, Investment environment and Access to Capital.

There is no single formula for the optimal mix of OFS. There is typically a trade off when making OFS investment decisions between build quality; cost; ease of management; segregation requirements; and minimum utilisation to generate sufficient ROI. Growers need to do their own research including the use of grain storage professionals to ensure an OFS investment will meet their needs. Fumigation in gas tight storage that meets AS2628 is required to kill insect infestations and is the only way to guarantee cereals are insect free in Australian conditions. Growers should target as a minimum enough gas tight storage capacity that meets meet their maximum monthly out-turn requirements according to Botta (2016). Good hygiene and automated aeration are the best alternatives to maintain grain in condition for long term storage.

Recommendations

1. Government to review the grain supply chain as a whole system and establish a long term strategic plan to better target future grain supply chain investment.
2. Strategic upgrade of grain roads to safely enable larger truck combinations to enhance road productivity.
3. Government must include the price per tonne impact on grain exports and supply chain savings in considering the viability of and timeline to completion of an inland rail link.
4. Alternative financing options to fast track the Melbourne - Brisbane inland rail link.
5. Investigate better integration of OFS with the export supply chain including the potential to accredit OFS infrastructure to meet export requirements.
6. Annual reporting of OFS storage infrastructure quality and quantity and quarterly reporting of grain stocks on farm to improve the co-ordination grain movements.
7. Continued grower education on the need for gas tight storage to kill stored grain pests.
8. Further development of alternatives to phosphine gas as a fumigant.

Update

In the May 2017 budget, the Australian commonwealth government outlined a funding commitment for the Melbourne to Brisbane Inland rail line. This has significant implications for the future of the Australian East Coast grain supply chain and the roll of On Farm Storage.

'The Government has committed to finance the Melbourne to Brisbane Inland Rail project by a combination of an additional $8.4 billion equity investment in the Australian Rail Track Corporation and a public private partnership for the most complex elements of the project. Inland Rail will provide a high-capacity freight link between Melbourne and Brisbane through regional Australia to better connect our products to domestic and international markets.'

'the Commonwealth's biggest rail project in 100 years, that will build a dedicated high productivity rail freight corridor'

Source:http://minister.infrastructure.gov.au/chester/releases/2017/may/budget-infra_03-2017.aspx

This is a potential 'game changer' for the grain supply chain on the eastern seaboard of Australia. Efficient mainline rail operations are the key to lowering the cost of grain movements from the farm gate to export markets. Opportunity now exists for grain producers to explore investment in storage and handling infrastructure that compliments government investment in mainline rail assets including the Melbourne – Brisbane Inland Rail project. This investment will reduce the cost of moving grain to domestic and export markets and if implemented effectively can provide higher farm gate returns for grain producers. Good governance and partnerships will be critical for growers to gain benefit from a more productive grain supply chain and achieve higher farm gate returns.

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Plain English Compendium Summary

Project Title:	**On Farm Storage and the Grain Supply Chain**
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Objectives	**Investigate current trends in on farm storage and consider future investment needs in the context of the Australian grain supply chain.**
Background	There has been a surge in grower interest in On Farm Storage investment over recent years. Grain storage assets can have an operating life in excess of 30 years; this means storage infrastructure built today, needs to consider current and future supply chain needs.
Research	Investigate the roll of storing grain on farm and how this will be influenced by the grain supply chain now and over the life of grain storage assets. Lifetimes for these assets can be in excess of 30 years. Research was conducted in France, The Netherlands, Germany, The United Kingdom, Canada, United States, Mexico, Brazil and New Zealand using a combination of face to face visits, phone interviews and my own research.
Outcomes	• The lack of an effective freight 'system' is a constraint on grain farm productivity in Australian East Coast Grain Markets. The construction of an Inland Rail link from Brisbane to Melbourne is critical to improving East Coast grain freight productivity. • On Farm Storage when managed well can add value to a grain growing operation. Time spent in planning and developing management expertise is required for this to be realised. It is feasible that On Farm Storage will continue to gain total market share of grain produced in Australia. • Supply chain relationships are critical for growers to invest in storage and handling infrastructure that can increase their farm gate price. • A combination of good hygiene practices as a minimum and preferably the use of gas tight storage that meets AS2628 to guarantee grain is insect free when it leaves On Farm Storage. Opportunity exists for grain producers to explore investment in storage and handling infrastructure that compliments government investment in mainline rail assets. Partnerships will be critical for growers to fully realise this opportunity.
Publications	Nuffield Australia National Conference Presentation, Adelaide (2016)