Department of Agriculture and Food, WA

Economic analysis of irrigated agriculture development options for the Pilbara

Report

November 2015

WATER | ENERGY & RESOURCES | ENVIRONMENT | PROPERTY & BUILDINGS | TRANSPORTATION

Executive summary

The Department of Agriculture and Food, Western Australia (DAFWA) engaged GHD to undertake a preliminary economic analysis of options for developing irrigated agriculture in the Pilbara of Western Australia.

The report investigates the viability of a range of irrigated crop options, including crops grown for livestock fodder (grain and hay), fibre (cotton), human food (mungbeans, peanuts, tomatoes, capsicums) and industrial use (guar). Crops were mainly assessed for export potential based on exports from Port Hedland, however investigations of value add options for grain/hay use in cattle feedlots and as biofuel feedstock were also completed. Note it was beyond the scope of this report to assess the viability of individual crops in relation to soil types, temperatures, evaporation and water availability. It was also beyond the scope of the report to consider more intensive greenhouse production systems.

Economic analysis was on the basis of irrigation water being available from mine dewatering, and that such water was available at zero cost for agricultural use. It was assumed that costs for pumping this water to irrigation sites and then applying via centre pivot irrigators was included in the economic analysis. It was assumed that water quality was suitable for irrigation purposes without treatment, and that land with suitable soil structure was also available. Based on current estimates, the analysis assumed water will be available to irrigate a total area of 8,000 hectares, for a period of 30 years. The ongoing availability of water will however depend on the ongoing viability and operation of iron ore mining in the region.

This study considers the data provided via CSIRO's Northern Australia: Food and Fibre Supply Chains Study Project Report (CSIRO 2014) and DAFWA's Enterprise Assessment Tool (EAT). These resources provide insight into potential economic returns from individual crops and for scenarios that included crop rotations, however do not provide a consistent basis for comparing irrigated cropping opportunities, or evaluate the substantial land and irrigation infrastructure development costs, or early-stage processing costs required for some crops.

GHD used gross margins of the various crops based on information from the CSIRO and EAT reports as well as other sources. In addition, development budgets were constructed over a 30 year timespan and Net Present Value (NPV) of the different crops was calculated. NPVs were then used as the basis for comparing crops and developing potential scenarios for irrigation development on the 8,000 hectares.

The NPVs are sensitive to a range of assumptions, particularly for those crops that require some form of processing in the Pilbara (cotton, peanuts, tomatoes and capsicums). The cost of establishing processing plants is sensitive to the area of the respective crops, with economies of scale being significant. For this reason, care should be exercised in the interpretation of this preliminary economic analysis.

NPVs were calculated for crops based on two values for land and irrigation development costs: $10,000 per hectare and $27,000 per hectare). The former closely resembles costs assumed in the CSIRO report while the latter is taken from the EAT model. GHD considers the higher cost is likely to be more realistic in the case of a greenfield, mine dewatering development. It should be noted that costs to establish processing plants and a 10,000 head cattle feedlot are in addition to the above land and irrigation development costs.

Because of the different bases used for calculations, GHD compared crops and other enterprises (cattle feedlot and biofuels) based on three groups: (i) broadacre crops; (ii) vegetables; and (iii) value add (cattle feedlot, biofuels).

Broadacre crops

Comparisons for all broadacre crops were on the basis of 8,000 hectares of irrigated production. Note that this approach would be unlikely to occur in practice as crops areas would change because of crop rotations, whether as a crop disease control purpose or for product marketing purposes. However, at this preliminary analysis stage this approach provides a comparative analysis that genuinely compares economic performance between crops.

For the $10,000 per hectare development costs, NPVs were positive for six crops: lucerne hay, Rhodes grass hay, cotton, peanuts, sweet potato and canning tomatoes. For the $27,000 per hectare development costs, NPVs were negative for all crop types except canning tomatoes. The table below indicates the breakeven yield and price for each alternative, and the modelled percentage increase (or decrease) compared to the accepted averages. A decrease in breakeven yield or price indicates a profit, while an increase indicates a loss.

Crop	Break even for $10,000/ha development costs				Break even for $27,000/ha development costs			
	Yield (t/ha)[1]	(%)	Price ($/t)	(%)	Yield (t/ha)	(%)	Price ($/t)	(%)
Maize	13.01	9%	$ 298	6%	20.15	69%	$ 414	48%
Sorghum	16.39	15%	$ 263	9%	25.38	78%	$ 359	50%
Lucerne	10.90	-27%	$ 220	-19%	18.42	23%	$ 312	16%
Lablab	21.33	113%	$ 287	59%	36.07	261%	$ 425	136%
Rhodes grass	21.33	-29%	$ 153	-15%	36.07	20%	$ 199	11%
Guar	2.57	29%	$ 780	25%	5.14	157%	$ 1,472	136%
Cotton	1.49	-26%	$ 1,661	-25%	2.14	7%	$ 2,353	7%
Peanuts	4.42	-12%	$ 762	-10%	6.24	25%	$ 1,039	22%
Sweet potato	5.24	-13%	$ 622	-11%	7.49	25%	$ 853	22%
Pulses/lentils (bulk grain)	7.54	116%	$ 547	82%	14.01	300%	$ 943	214%
Canning tomato	45.38	-9%	$ 1,250	-7%	46.66	-7%	$ 1,278	-5%
Canning capsicum	38.02	9%	$ 1,117	6%	39.79	14%	$ 1,157	10%

Vegetables

Mechanically harvested tomatoes and capsicums that were processed into cans at a newly constructed plant in the Pilbara were considered. These crops are generally high producing (more than 35 tonnes/ha) and require more detailed management than broadacre crops. A $35,000 ha development cost was consequently adopted for these crops.

The analysis showed that a breakeven price or yield had to increase - compared to the initial adopted price - to $0.67 per can for tomatoes and $0.72 for capsicums. These prices are 8% and 16% above the initial prices adopted ($0.58 per can for tomatoes and $0.59 for capsicums). For completeness, NPV values remained negative when land development costs are lowered to $10,000 per hectare at the assumed starting yields and can prices. Can prices had to increase from $0.58 to $0.65.

Crop	Break even for $35,000/ha development costs			
	Yield (t/ha)	(%)	Price ($/can)	(%)
Canning tomato	54	8%	$0.67	8%
Canning capsicum	40.5	16%	$0.72	16%

[1] All yield figures in report reflect undried weight.

Processing and value adding

The table below provides an indicative minimum scale for a range of potential processing or value adding facilities in the Pilbara, with the corresponding production area required to meet this level of input. Note this information is indicative only and viable scale will vary based on facility design, production efficiencies and profit margins.

Facility	Minimum scale of viable facility	Minimum production area required	Reference
Cotton Gin	4 stand gin ~70,000 t/annum	~8,000Ha	CSIRO 2014
Peanut processing plant	~20,000 t/annum	~4,000Ha	CSIRO 2014
Feedlot	~1,000 head capacity ~3,000 head per annum if 120 day feeding cycle	~300Ha grain/fodder production in addition to cattle breeding for 3,000 head per annum.	ALFA / MLA Feedlot Surveys
Abattoir	~10,000 head per annum	~1,000Ha for feedlot (see above)	Industry consultation
Biofuel plant	Highly dependent on prices. Dalby ethanol plant has a capacity of ~200,000T sorghum producing 80M litres per annum	~15,000Ha	CSIRO 2014
Tomato/capsicum processing plant	Australia's smallest tomato processing plant (Billabong Produce, Jerilderie) processes ~25,000 tonnes	~500Ha	NSW Parliamentary Research Service (2013

A 10,000 head cattle feedlot and a nine million litre capacity ethanol plant were considered. Based on relatively conservative input assumptions, the feedlot provided an NPV of $57 million over 30 years.

Calculations for the ethanol plant showed that a breakeven price of $1.18 per litre was required before consideration of any additional engine conversion costs.

Conclusions

GHD considered that decisions on the adoption of different crops and value add options could be categorised into three generations of development, with those of least risk and higher potential for economic return to be prioritised. As such, the three generations are:

First generation (years 1-5)

Fodder crops (grain and hay for export)

Second generation (years 6-10)

Cattle feedlot. In addition, ongoing development of first generation crop production systems (expansion of area, lifting yields, specialisation, further development of export or niche markets, further on-farm processing (e.g. stockfeed pellets), further development of supply chain infrastructure.

Third generation (years 11+)

Cotton, peanuts, pulses, canning tomatoes and capsicums and biofuel (ethanol).

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1. Introduction

1.1 Purpose of this report

The Department of Agriculture and Food, Western Australia (DAFWA) engaged GHD to undertake a preliminary economic analysis of options for developing irrigated agriculture in the Pilbara of Western Australia.

The report investigates the viability of a range of irrigated crop options, including crops grown for fodder, industrial use, biofuel feedstock, fibre and food.

The report includes the following:

- A consolidated summary and background of information currently available on the economic viability of irrigated agriculture in the Pilbara
- Market analysis of crops, including existence or otherwise of supply chains to market (domestic and export)
- Economic analysis of crops including gross margins, net present value and sensitivities
- Risk assessment and development of potential scenarios, which combine different crop rotations, processing and marketing options.

This report should be read as a preliminary analysis which consolidates and builds on findings from previous projects, and identifies key issues, risks and information gaps associated with certain crops and development options.

1.1.1 Scope and limitations

This report: has been prepared by GHD for Department of Agriculture and Food, WA as part of the Royalties for Regions Pilbara Hinterland Agricultural Development Initiative and *may only be used and relied on by Department of Agriculture and Food for the purpose agreed between GHD and the Department of Agriculture and Food as set out section 1.1 of this report.*

GHD otherwise disclaims responsibility to any person other than Department of Agriculture and Food arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (Sections 1 through 8) GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Department of Agriculture and Food and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

1.1.2 Assumptions

This report relies heavily on the information and analysis of previous reports, particularly the CSIRO's Northern Australia: Food and Fibre Supply Chains Study Project Report. It has been assumed that all the crops and enterprises discussed would be viable based on climatic and environmental conditions. It was not within the scope of this report to assess the viability of crops in relation to soil types, temperatures, evaporation and water availability. All economic analysis has been conducted over a 30 year time horizon.

2. Background

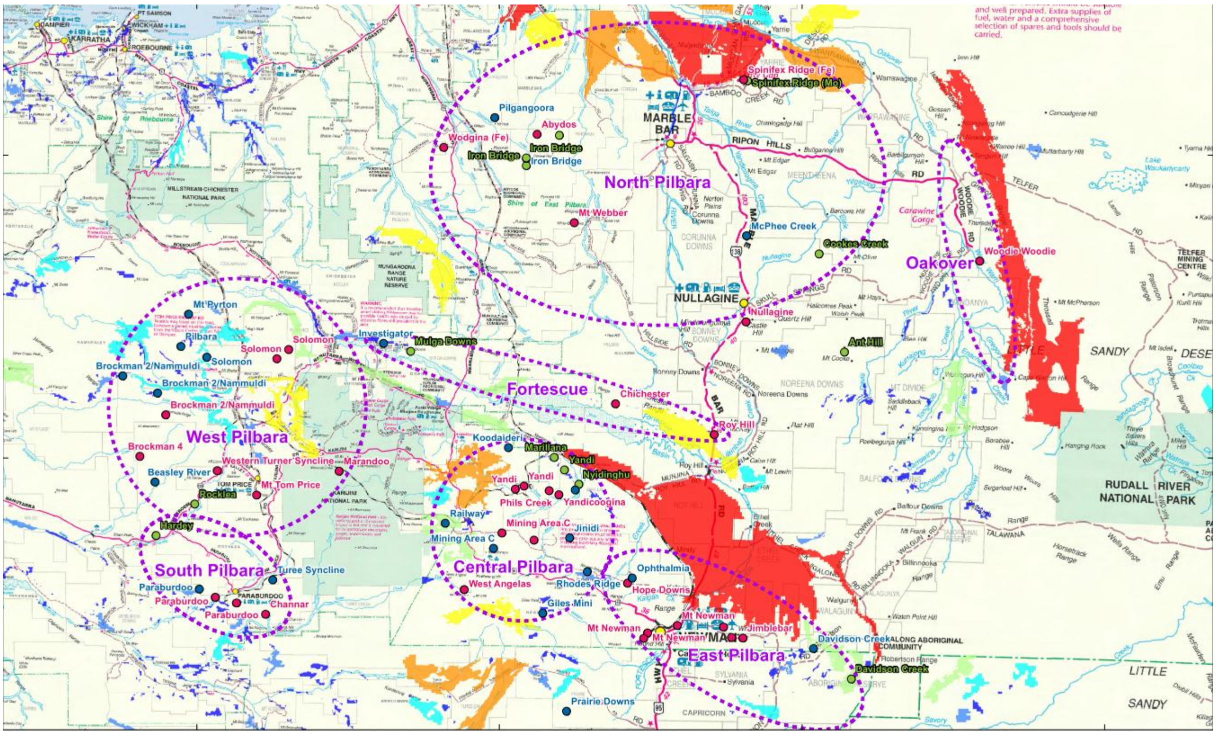
The Pilbara district is situated in northwest Western Australia, and is comprised of the local government areas of Ashburton, East Pilbara, Karratha and Port Hedland (see Figure 1).

The Pilbara region covers an area of 507,896 km². It has a population of approximately 60,000, most of whom live in the western third of the region in towns such as Port Hedland, Karratha, Wickham, Newman and Marble Bar.

Irrigated agriculture has been identified at all levels of government as a potential growth area as a result of the increasing global demand for agriculture products and the potential access to surplus water from mining operations. It has been estimated that there is a potential for 200 to 300 GL/year of water to be available for irrigation from dewatering operations. Section 2.1, discusses the available dam sites within the Pilbara region that can be used for extraction.

Agriculture in the Pilbara has been dominated by pastoralism based on extensive grazing of sheep and cattle since the late 1800s. The rainfall in the region is too low and variable to support any form of dryland cropping and, historically, water resources have been too scarce or inaccessible for irrigated agriculture. However, the climate allows most summer crops to be grown year-round if irrigation is available.

Figure 1 Pilbara agriculture and mining areas



The Pilbara Hinterland Agricultural Development Initiative (PHADI) has been established under the Royalties to Regions program of the Western Australian Government. This initiative is a partnership between the Western Australian Department of Agriculture and Food, the Pilbara

Development Commission, the Department of Regional Development, community groups, the mining industry, agribusiness and industry. There are three projects:

- Pathways to Pilbara Irrigation Development Project, which is developing the underpinning knowledge to support development of an irrigated agricultural industry in the Pilbara
- Woodie Woodie pilot project, which involves a 38-ha irrigated pilot site to evaluate the fodder production potential for cattle and as a biomass source for biofuel
- Yandicoogina pilot project, which is exploring a range of food and fodder crops, which has been discontinued.

In terms of developing agricultural opportunities in the region, the Shire of East Pilbara sees the main opportunities applying to larger-scale corporate agriculture rather than family farms (Shire of East Pilbara, 2012). This view stems from the need to scale-up quickly to take advantage of the rapidly expanding mine dewatering resource and, possibly, the medium-term nature of the water resource (i.e. the life of individual mines and their water available for agriculture will be about 20 years).

Australia Bureau of Statistics (ABS) data below shows that current agricultural production in the area is predominantly from cattle production with other forms of production being insignificant from a reporting perspective (Table 1).

Table 1 Pilbara – Total (livestock) value cattle and calves ($m/2012-13)

Pilbara		Ashburton (S)		East Pilbara (S)		Port Hedland (T)		Roebourne (S)	
Gross value	**Local value**	Gross value	Local value	Gross value	Local value	Gross value	Local value	Gross value	Local value
61.0	**54.8**	23.7	21.2	25.7	23.1	5.4	4.9	6.2	5.6

2.1 Potential irrigation sites

Four irrigation sites in the Pilbara have been identified as supporting irrigated agricultural production. Below is a preliminary summary of each site (information provided by DAFWA). Two other sites are Pardoo and Minderoo; many other potential sites could exist and it is a project aim of PHADI to inform the identification of further sites.

Wallal Station

Wallal station is located 250 km north east of Port Hedland and is currently a pastoral station. Access to the site is via the Great Northern Highway. One GL of water is currently licensed for extraction and more water (up to 20 GL/yr) is potentially available from the aquifer. Water is drawn from the aquifer under pressure from the West Canning basin aquifer so no power is required for pumping to the storage dam. Diesel generators are required to power the irrigation systems.

Marandoo – Hamersley Agricultural Project (HAP)

The Marandoo dam site is located approximately 45 km east of Tom Price. The site is fully owned and operated by Rio Tinto Iron Ore. Water sourced from the mine is stored in a 3 GL dam and then pumped to the irrigation systems.

Opthamalia Dam

Opthamalia Dam is located south west of the Fortescue Marsh, approximately 36 km north of Newman. Water is sourced from mine dewatering at BHP sites and is pumped into Opthamalia

Dam with a capacity of 33 GL. The water can then either be pumped directly out of the dam or drawn from the alluvium downstream of the dam.

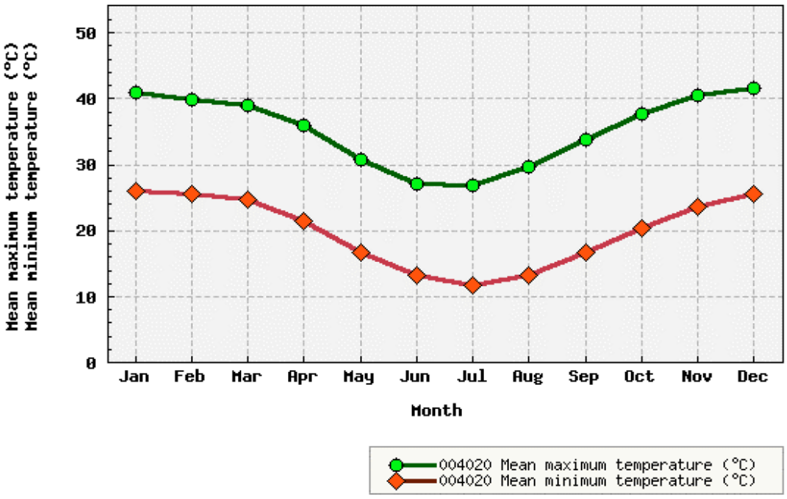
Woodie Woodie

The Woodie-Woodie dam site is located approximately 170 km east of Marble Bar. Currently the dam is supplied by mine dewatering at 60 GL/yr. Water is drawn from Oakover Creek with irrigation systems currently being developed as part of the PHADI project.

2.2 Climate

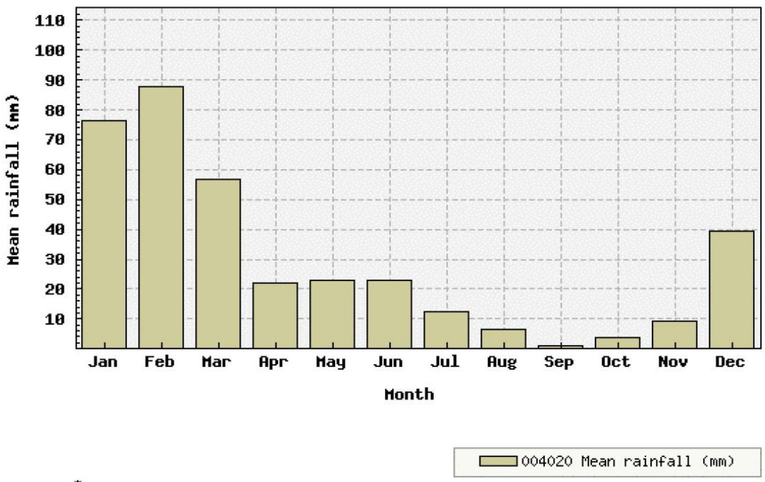
The region experiences some of the hottest temperatures in Australia. Climate data for Marble Bar has been used as an indicator, and shows mean maximum temperatures ranging from 28°C in winter to 41°C in summer (Figure 2). Average annual rainfall is 402 mm with a marked summer dominance (Figure 3).

Figure 2 Temperature



Australian Government
Bureau of Meteorology

Figure 3 Rainfall



Australian Government
Bureau of Meteorology

2.3 Soils

Soil suitability investigations for irrigated agriculture in the Pilbara region are currently being conducted by DAFWA (N Schoknecht 2014, pers. comm.) as part of the PHADI project, with the results of intensive surveys expected to provide a detailed assessment of limitations and agricultural suitability at the different sites. In addition, information on soil suitability is available in section 8.5 *Land suitability for cropping* (CSIRO, 2014).

For the purpose of this report, GHD has not considered soil limitations but detailed investigations will be essential as part of future feasibility assessments.

2.4 Existing reports and data on irrigated agriculture

A number of relatively recent reports on the economics of irrigated agriculture in the Pilbara have been published. These reports consider a range of potential crop and livestock opportunities and calculate economic returns based on yield and gross margin assumptions. While the reports address a range of limitations (e.g. lack of processing facilities; transport costs) they do not consider on-farm development costs and potential market opportunities for the respective enterprises.

Following is a brief summary of the outputs from these reports. GHD then explores market issues in section 3 and provides a more comprehensive economic analysis in section 5.

2.4.1 CSIRO Pilbara Regional Analysis

The report established indicative gross margins for a range of crops (Table 2) and investigated two development scenarios based on local processing and use of crops/forages (scenario 1) and an industrial crop focus with cotton (Table 3). The two scenarios were based on having sufficient irrigation water for 8,000 hectares of irrigated crops.

Table 2 CSIRO crop gross margin analysis

Crop	Yield (t/ha)	Price ($/t)	Total Variable Costs ($/ha)	GM/ha ($)
Maize	11.9	280	2,781	551
Peanut*	5.2	850	3,554	866
Mungbean	2	900	1,304	496
Watermelon	55	900	40,740	8,760
Cotton (per bale for yield and price)*	8.9	500	3,101	1,349
Guar	2	625	753	497
Forage sorghum	30	130	3,361	539
Lablab	10	180	1,291	509

*Gross margins are based on local processing facilities being established. GHD has altered original CSIRO variable costs per hectare to suit.

Table 3 CSIRO scenario analysis

	Area (ha)	Location for marketing and processing	Assumptions for regional scenario
Scenario 1 – local processing and use of crops/forages			
Peanut	4000	Pilbara and Perth	Dried and shelled in the Pilbara region and then trucked to Perth
Maize (rotation with peanuts)	4000	Pilbara	Integrated into intensive beef-feeding systems within the Pilbara region
Forage sorghum	4000	Pilbara	Used in pastoral enterprises, intensive beef feeding and, possibly, as a biofuel crop to reduce dependency on diesel in mining operations that are off-grid
Net value of production per year (8,000 ha)			**$12.05 mill**
Scenario 2 – Industrial crop focus: cotton			
Cotton	8000	Pilbara	Cotton gin built in association with grid power in the region
Lablab (rotation with cotton)	2000	Pilbara	Used in the beef industry locally and could be compressed and trucked elsewhere
Guar (rotation with cotton)	2000	Perth	Processed in Perth
Mungbean (rotation with cotton)	4000	Perth	Processed in Perth
Net value of production per year (8,000 ha)			**$9.92 mill**

The scenarios resulted in a net annual value of production of $12.05 million and $9.92 million for scenario 1 and scenario 2 respectively.

2.4.2 Enterprise Assessment Tool

DAFWA developed the Enterprise Assessment Tool (EAT) to assist with analysing conceptual scenarios for irrigated agriculture in the West Kimberley and Pilbara. The tool is basically an interactive user driven spreadsheet that describes investing in a farming unit in a Greenfield location up to a scale of 2000 ha. This scale was chosen as it was considered the working limit of one set of machinery as described in the model; beyond this scale additional machinery would be required. The versions of the EAT as referenced in this report were produced to support the initial mine dewatering concepts at a very conceptual stage of mine dewatering proposals and at a scale of 600 to 800 ha. The model includes gross margins for cotton, maize, peanuts and fodder production options. These crops chosen were selected as indicators of typical of field crop options; fibre, legume, fodder and grain crop options in other locations and should not be construed as a recommendation of crop type in this location. The tool also compared two different irrigation systems, drip and centre pivot irrigation costs and allowed the user to select yield and price ranges to calculate the breakeven points and impacts of changing prices and yields.

Table 4 EAT cropping calculation

Crop	Yield (t/ha)	Price ($/t)	Variable costs ($/ha)	GM ($/ha)	NPV**
Cotton*	8	650	3,839	1,361	–
Maize	12	280	2,396	964	–
Peanuts	4	850	2,668	732	–
Fodder (Rhodes grass or similar)	30	300	3,097	5,903	$9.2 mill

* Yield and price for cotton is on a per bale basis

** Net Present Value (NPV) based on a 15 year development budget with inclusion of up-front capital development costs

Both of the above reports provide important information on potential economic returns from irrigated agriculture, however the results are not presented in a consistent manner thus making comparisons difficult. In the following sections, GHD has prepared economic analyses for crops using a consistent methodology that aids the comparative analysis, by using both the lower CSRIO and high EAT's development costs and adopting a 30 year timeframe.

Before completing the economic analysis, GHD provides a brief overview of the market opportunities for the chosen crops and scenarios.

2.5 Minimum scale of processing and value-adding facilities

Processing and value-adding facilities will generally need to be of a certain scale or capacity in order to be viable. Drawing on the findings of the CSIRO report and other references, Table 5 below provides an indicative minimum scale for a range of potential processing or value adding facilities in the Pilbara. Also provided is the estimated corresponding production area required to meet this level of input. Note this information is indicative only and viable scale will vary based on facility design, production efficiencies and profit margins.

Table 5 Estimated minimum scale of processing and value-adding facilities

Facility	Minimum scale of viable facility	Minimum production area required	Reference
Cotton Gin	4 stand gin ~70,000 t/annum	~8,000Ha	CSIRO 2014
Peanut processing plant	~20,000 t/annum	~4,000Ha	CSIRO 2014
Feedlot	~1,000 head capacity ~3,000 head per annum if 120 day feeding cycle	~300Ha grain/fodder production in addition to cattle breeding for 3,000 head per annum.	ALFA / MLA Feedlot Surveys
Abattoir	~10,000 head per annum	~1,000Ha for feedlot (see above)	Industry consultation
Biofuel plant	Highly dependent on prices. Dalby ethanol plant has a capacity of ~200,000T sorghum producing 80M litres per annum	~15,000Ha	CSIRO 2014
Tomato/capsicum processing plant	Australia's smallest tomato processing plant (Billabong Produce, Jerilderie) processes ~25,000 tonnes, while Australia's largest plant (Kagome, Echuca) processes in excess of 200,000 tonnes	~500Ha (25,000 tonnes @ 50 tonnes / hectare)	NSW Parliamentary Research Service (2013

4. Market Analysis

GHD completed a desktop overview of market opportunities for different irrigated agriculture enterprises, and also considered supply chain logistics and processing requirements for the relevant markets. For some products, supply chains are relatively simple and there is potential for existing logistical infrastructure to be augmented with some relatively minor additions to accommodate the product. Others (e.g. cotton, peanuts and canning vegetables) require investment in processing facilities in the Pilbara and this cost has an obvious impact on the economic viability of these enterprises.

Following is a summary of the key market opportunities (export or domestic), transport and processing requirements used as assumptions in the economic analysis of different crops. A more complete overview of markets is provided in Appendix A.

Note that GHD has used a simplifying assumption in the economic analyses that all exports are via Port Hedland, and that appropriate port infrastructure is available for that purpose. In reality, improvements to the port infrastructure may be required to ensure efficient loading and dispatch of the products.

4.1 Livestock fodder

A range of grain and forage (hay) crops can be grown as livestock fodder, and are suitable for both export and domestic use (in feedlots or as supplementary fodder during pasture shortages). These crops can also be used for the production of biofuels (ethanol).

Table 6 Market analysis – livestock fodder

Crop	Key export markets	Nearest port	Domestic market
Maize (grain)	Japan, Korea, China	Port Hedland	Local pastoral companies, feedlots, biofuel
Sorghum (grain)	Japan, China		
Lucerne (hay)	Japan, South Korea and Taiwan		
Lab-lab (hay)	Potential		
Rhodes grass (hay)			

4.3 Fibre and industrial use crops

4.3.1 Cotton

The majority (95%) of Australian cotton lint is exported to international markets, mainly Asia. China has emerged as the largest importer of Australian cotton, taking around 70% of exports in 2012-13. Other important markets are Indonesia, Thailand and the Republic of Korea.

Demand is likely to increase from countries like Cambodia and Vietnam as wage inflation in China has led to Chinese manufactures and global textile companies moving to other low cost nations. Other potential markets that could be developed are Bangladesh, Pakistan, Taiwan and Hong Kong.

Harvested cotton requires ginning to produce the cotton lint suitable for export. The CSIRO report found that the closest gin to Pilbara is located in Menindee, NSW, and that transport costs to Menindee result in a negative gross margin.

Table 7 Market analysis - cotton

Issue	Assumptions
Key export markets	Asian markets for ginned cotton lint.
Nearest Port	Port Hedland (containers from the gin)
Domestic market	Nil

4.3.2 Guar

The world guar market is relatively mature and is increasing steadily (> 2% per year) with a wide range of end uses including: food processing (vegetable gum, thickener); personal care (bath/shower gels, cosmetics); agriculture (stockfeed); paper; textiles; pharmaceuticals; energy (hydraulic fracturing, drilling); and mining (nickel sulphide flotation). No domestic capacity currently exists at a commercial level to process the bean to guar gum for input into these uses.

Guar is generally processed in Asia before being exported as guar gum. The USA is the largest consumer of guar gum with an annual consumption of 45,000 tonnes which represents 25% of world trade. Germany & Japan consume another 23% between them with the UK, Denmark and the Netherlands combining take further 22% of world trade.

Table 8 Market analysis - guar

Issue	Assumptions
Export markets	Unprocessed guar exported in bulk to Asian markets.
Nearest Port	Port Hedland
Domestic market	Nil.

4.5 Human food crops

While there is an increasing demand for food products worldwide, Australian producers are increasingly required to contend with competition from cheaper imports. The relative abundance of land for grain production and mechanisation of production means that Australia can readily compete in the global grain trade, however Australia is less competitive for crops with high labour requirements such as vegetables.

GHD has chosen peanuts, mungbeans and sweet potatoes as potential broadacre food crops for bulk export to Asian markets. Australia produces about 40,000 tonnes of peanuts annually with more than 90% grown in Queensland. The size of the domestic market for peanuts is about 50,000 tonnes annually, and Australia imports both processed and unprocessed peanuts to meet the shortfall. GHD's analysis of peanut production includes a requirement for the establishment of a processing plant in the Pilbara to dry and shell the nuts.

There is a high level of global self-sufficiency in vegetables and some Asian markets that have traditionally imported Australian vegetables are becoming net exporters. The opening up of trade barriers will further intensify competition. This will be particularly challenging for Australian growers, given high input costs and limited investment capital in the industry. As such, the production of fresh vegetables in the Pilbara has not been included in this analysis, however an economic assessment of mechanically harvested and canning tomatoes and capsicums is provided.

Table 9 Market analysis – human food crops

Crop	Key export markets	Nearest port	Domestic market
Tomato (canning)	Virtually no exports at present, however potential to supply Asian markets. All require some form of processing prior to export.	Port Hedland	Perth
Capsicum (canning)			
Peanuts			
Sweet potato			
Mungbeans	Indian sub-continent and Middle East		

4.6 Livestock – lot-feeding cattle

The live export trade is the main outlet for cattle from the Pilbara, and production of irrigated grain and hay can be used as a supplement for feeder steers during adverse seasonal periods or when cattle are fed at assembly depots.

However, this analysis considers the economics of establishing a feedlot with the major feed inputs (maize, sorghum and hay) assumed to be grown on irrigated land in the Pilbara. There is a high demand for Australian grain fed beef for export (Japan, Korea, and the United States) and for the domestic market.

The analysis assumes the construction of a 10,000 head feedlot, the purchase of local cattle fed for 90 days and then trucked to Perth to an abattoir for processing. Processed product is then available for domestic and export markets.

Table 10 Market analysis – lot feeding cattle

Issue	Assumptions
Markets	Boxed beef for domestic and export trade
Transport	Cattle purchased locally and trucked to the feedlot. Finished cattle trucked to Perth for processing.

4.7 Biofuels

Energy is in major demand in the Pilbara for mining and other industries. It is understood that the main source of energy is diesel. The cost of diesel is high because of distances required to transport from the port.

Due to the high cost of energy, it is worth considering if irrigated crops could be used to produce biofuels for local use. Maize and sorghum grain could then be used as seedstock for ethanol production. Biodiesel based on the use of oilcrops is also possible but has not been considered by GHD.

Table 11 Market analysis - biofuels

Issue	Assumptions
Domestic market	Local pastoral companies, mining companies and local domestic use.

6. Production

The economics of irrigated agricultural production will depend on the following factors (note that purchase price of the land is not included in the calculations):

- Land preparation and irrigation development costs
- Machinery capital costs (cultivation, planting, pest & weed control, harvesting)
- Crop gross margins, including transport to port
- Crop processing and storage costs.

Each of these is discussed below.

6.1 Land preparation and irrigation development costs

Land preparation and development costs are based on the establishment of a 'mosaic' irrigation farm unit whereby irrigation layout and crop choice will depend on local soils and topography. It is likely that irrigation blocks will not necessarily be contiguous, but interspersed with non-irrigated land.

Land preparation will include clearing vegetation, levelling and providing access tracks. In addition, each 'farm' will require buildings for storage of equipment and housing of office facilities. Irrigation development costs include centre pivots and associated pumps, power units and piping. For this study, GHD has not considered the cost of constructing primary water storages (dams) as these are assumed to be a mining enterprise cost (i.e. storage required for dewatering).

The CSIRO economic analyses is based on establishment costs included in the report titled *Mosaic irrigation for the northern Australian beef industry, an assessment of sustainability and potential* (CSIRO 2013). Capital costs per ha range from about $7,000 per ha to about $11,000 per ha. GHD considers that this cost does not take account of all land preparation and irrigation development costs. Table 12 provides a list of items required to establish an irrigation farm.

Table 12 Land and irrigation development costs

Project Characteristic	Requirements
Land preparation and development	• Land clearing • Land levelling • Network of roads and access tracks
Power supply	• Diesel generators for office, sheds and workshops. • Local diesel generators, one for each centre pivot.
Irrigation supply	• Irrigation areas will use a centre pivot irrigation system (32 ha/pivot) • Fertigation unit for each pivot • The maximum irrigation rate is expected to be approximately 13 mm/day • 3GL water storage dam • Reticulation of water from storage dam to each pivot.
Other facilities and infrastructure development	• Office buildings, ablutions, fuel and storage, machinery wash down area and contractors machinery shed. • Fencing around groups of pivots within the Proposal area to restrict the ingress of livestock. • On-farm product storage
Machinery	• Tractors, cultivation, planting equipment • Harvesters, including haymaking equipment • On-farm transport

The EAT model bases its economic analysis on irrigation development costs required for 1,000 hectares of pivot irrigation (see Table 13). Costs are approximately $26 million for 1,000 hectares or $26,000 per hectare.

For this analysis, GHD has adopted a low establishment cost assumption and a high establishment cost assumption ($10,000 and $27,000 per hectare). Any costs for processing plants are additional to these land and irrigation development costs.

Table 13 Irrigation establishment costs (1,000 hectares)

Item	No.	Unit cost	Total
Transfer pump set	1	$2,340,000	$2,340,000
Transfer pipeline system (from source to delivery pipe)	1	$4,150,000	$4,150,000
Road or creek crossing	1	$83,000	$83,000
Storage tank (set of tanks to re-pressurise lines)	2	$280,000	$560,000
Irrigation pump set (re-pressurise)	1	$2,340,000	$2,340,000
Irrigation pipeline (after 2nd pump)	1	$11,614,558	$11,614,558
Pivot base - concrete foundation and motor mounts	20	$2,000	$40,000
Pivot irrigators (50 ha per unit)	20	$197,500	$3,950,000
Fertilizer mixing tank	10	$7,000	$70,000
Fertilizer pump	10	$1,600	$16,000
Remote	20	$8,000	$160,000
Genset	20	$18,000	$360,000
Fertigation Control	10	$30,000	$300,000
TOTAL			**$25,983,558**

6.2 Methodology for economic analysis

GHD completed the economic analysis based on two key parameters: gross margins and net present values (NPVs).

6.2.1 Gross margins

Gross margins consider gross income from crops (yield in tonnes per hectare multiplied by price per tonne at Port Hedland) less costs of production (including freight costs). GHD has adopted gross margin assumptions based on data from the CSIRO reports, EAT and other sources. The gross margins for the respective crops are shown in Table 14. Gross margins do not consider land and irrigation development costs or costs for processing plants. For this reason they are not a good indicator of economic performance for projects that include up-front development or other capital costs.

Table 14 Gross margin – Expenses, yield and price

Crop	Point of sale/export	Yield (t/ha)	Price ($/t)	Operating costs	Freight costs[2]	Gross Margin ($/ha)
Livestock fodder (grain)						
Maize	Port Hedland	11.9	280	1,710	1023	599
Sorghum	Port Hedland	14.3	240	1,710	1230	492
Livestock fodder (hay)						
Lucerne	Port Hedland	15	270	1,191	1290	1,569
Lablab	Port Hedland	10	180	1,191	860	-251
Rhodes grass	Port Hedland	30	180	1,191	2,580	1,629
Fibre or industrial use crops						
Guar	Port Hedland	2	625	573	172	505
Cotton	Port Hedland	2	2,200	2,335	172	1,893
Human food crops						
Peanuts	Port Hedland	5	850	2,566	430	1,254
Sweet potato	Port Hedland	6	700	2400	516	1,284
Pulses/lentils (bulk grain)	Port Hedland	3.5	300	800	301	-51
Canning tomato	Perth	50	1,350	48,147	13,550	5,803
Canning capsicum	Perth	35	1,050	28,800	9,485	-1,535

[2] Calculated based on an indicative cost of $86 per tonne freight Port Hedland, and $271 per tonne to Perth, as applied in the CSIRO report.

6.2.2 Net present value (NPV)

NPVs consider annual cashflows from a development project over a given timeframe (GHD has adopted a 30 year timeframe for this analysis). Cashflows consider capital start-up costs in the early years in combination with gross margin incomes in future years. The values in later years are converted to present day values based on a discount rate (GHD has adopted a 7% per year discount rate).

Note that for broadacre crops, for this preliminary economic analysis, GHD has compared NPVs on the basis of all crops being planted on 8,000 hectares. This is due to the complexity of comparing results between crops on a simple per hectare basis when some require the establishment of processing plants. The impact on NPVs of the capital costs of these plants is very sensitive to the area of land and volume of production the plants service. For a preliminary comparative analysis it is thus reasonable to assume a common area of land for all crops.

6.3 Results

6.3.1 Broadacre crops

Table 15 shows the NPVs for each broadacre crop given the base case assumptions for gross margins from Table 14. The capital costs adopted for establishing a cotton ginning plant is $25 million, and for a peanut drying and shelling plant is $4 million.

Based on these assumptions, six crops show a positive NPV based on the low cost scenario for land and irrigation development (lucerne hay, Rhodes grass hay, cotton, peanuts, sweet potato and canning tomatoes). Canning tomatoes was the only crop to shows positive return at the higher development cost scenario.

Table 15 Broadacre crops NPV analysis (8,000 hectares)

Crop	Gross Margin base case assumptions		NPV for $10,000/ha development costs	NPV for $27,000/ha development costs
	Yield (t/ha)	Price ($/t)	NPV ($)	NPV ($)
Livestock fodder (grain)				
Maize	11.9	280	-$21,204,674	-$157,204,674
Sorghum	14.3	240	-$31,655,431	-$167,655,431
Livestock fodder (hay)				
Lucerne	15	270	$74,109,365	-$61,890,635
Lablab	10	180	-$104,653,570	-$240,653,570
Rhodes grass	30	180	$80,002,648	-$55,997,352
Fibre or industrial use crops				
Guar	2	625	-$30,398,197	-$166,398,197
Cotton (per bale for yield and price)	8.9	500	$105,933,096	-$30,066,904
Human food crops				
Peanuts	5	850	$43,169,626	-$92,830,374
Sweet potato	6	700	$46,116,268	-$89,883,732
Pulses/lentils (bulk grain)	3.5	300	-$85,009,291	-$221,009,291
Canning tomato	50	1,350	$489,978,741	$353,978,741
Canning capsicum	35	1,050	-$230,769,838	-$366,769,838

Table 16 below shows the breakeven yield (t/ha with price constant) and price ($/t with yield constant) for each crop. The percentage increase for yield/price is also shown. Note that the crops that show a negative percentage increase are those that have a positive NPV in Table 16.

Some crops indicate that a relatively modest percentage increase in yield or price is required to achieve a breakeven NPV for the low development cost scenario (eg maize, sorghum). However all crops require a substantial increase in yield or price at the high development cost scenario to break-even.

Table 16 Broadacre crops break-even NPV analysis (8,000 hectares)

Crop	Break even for $10,000/ha development costs				Break even for $27,000/ha development costs			
	Yield (t/ha)	(%)	Price ($/t)	(%)	Yield (t/ha)	(%)	Price ($/t)	(%)
Livestock fodder (grain)								
Maize	13.01	9	298	6	20.15	69	414	48
Sorghum	16.39	15	263	9	25.38	78	359	50
Livestock fodder (hay)								
Lucerne	10.90	-27	220	-19	18.42	23	312	16
Lablab	21.33	113	287	59	36.07	261	425	136
Rhodes grass	21.33	-29	153	-15	36.07	20	199	11
Fibre or industrial use crops								
Guar	2.57	29	780	25	5.14	157	1,472	136
Cotton	1.49	-26%	$ 1,661	-25%	2.14	7%	$ 2,353	7%
Human food crops								
Peanuts	4.42	-12	762	-10	6.24	25	1,039	22
Sweet potato	5.24	-13	622	-11	7.49	25	853	22
Pulses/lentils (bulk grain)	7.54	116	547	82	14.01	300	943	214
Canning tomato	45.38	-9%	$ 1,250	-7%	46.66	-7%	$ 1,278	-5%
Canning capsicum	38.02	9%	$ 1,117	6%	39.79	14%	$ 1,157	10%

6.3.2 Processed tomato and capsicum analysis

The analyses for processed tomatoes and capsicums is based on establishing a canning factory in the Pilbara to process mechanically harvested produce. For this preliminary analysis, it is assumed that a canning plant(s) can be established in the Pilbara and that essential services required to operate the plant are available. These services include water, electricity, gas and staff.

Discussions with industry indicate that processing plant establishment costs are of the order of $100 million and GHD has assumed that this cost includes connection to services (electricity and gas). GHD has adopted annual operating costs for a processing plant at 20% of capital cost, ie $20 million per year.

Table 17 and Table 18 provide a summary of the assumptions and outputs for tomatoes and capsicums respectively. In both cases, irrigation development costs are assumed to be $35,000/ha for drip irrigation and associated piping and pumping equipment.

Table 17 Assumptions, NPV and break-even for canning tomatoes

Item	Outputs
Area (Ha)	1,000
Yield (t/ha)	50
Total yield (tonnes)	50,000
Total costs ($/ha)	72,447
Income ($/ha) ($0.62 per 400g can)	77,500
Gross margin ($/ha)	5,053
NPV ($)	- $72,297,115
Break-even price ($/can)	$0.67
Break-even Yield (t/ha)	53.8

For tomatoes, the NPV based on a gross margin of $5,053/ha is negative. To achieve a break-even NPV, the price per can would need to increase to $0.67 (8% increase), assuming a constant yield. Alternatively, yield would need to increase by 8% to 54 t/ha with price being constant.

Table 18 Assumptions, NPV and break-even for canning capsicums

Item	Outputs
Area (Ha)	1,000
Yield (t/ha)	35
Total yield (tonnes)	35,000
Total costs ($/ha)	51,810
Income ($/ha) ($0.62 per 400g can)	54,250
Gross margin ($/ha)	2,440
NPV ($)	-$105,042,475
Break-even price ($/can)	0.72
Break-even Yield (t/ha)	40.5

For capsicums, the NPV based on a gross margin of $2,440/ha is negative. To achieve a break-even NPV, the price per can would need to increase to $0.72 (16% increase), assuming a constant yield. Alternatively, yield would need to increase by 16% to 40 t/ha with price being constant.

6.3.3 Lot fed cattle analysis

An alternative to selling grain or hay for export is to establish a cattle feedlot and feed the produce to the cattle. GHD has assumed the establishment of a 10,000 head feedlot in the Pilbara for this purpose. Cattle would be sourced locally, and finished cattle would be transported by road to Perth for processing.

GHD has adopted establishment costs for the feedlot of $15 million ($1,500 per head for 10,000 head capacity) and cattle remain on feed for 100 days. Feed is assumed to be purchased from the irrigated property at breakeven cost (average $160/tonne for sorghum and lucerne) factoring in the freight savings.

Table 19 provides key assumptions and outputs for the cattle feedlot enterprise.

Table 19 Cattle feedlot assumptions and NPV

Item	Value
Number of head fed per year	30,000
Average purchase weight (kg LW)	480
Purchases price ($ per kg LW)	$2.50
Freight-in cost ($ per head)	$7.00
Daily weight gain (kg per day)	2.50
Feed requirement (% LW)	2.30%
Days on feed (days)	100
Cost of feed ($ per tonne mixed)	$160
Growth promotants ($ per head)	$3.70
Vet costs ($ per head)	$6.00
Stock loss (%)	1.00%
Casual labour costs ($ per year)	$200,000
Repairs & maintenance ($ per year)	$50,000
Interest rate on stock purchases (%)	6.00%
Freight to market ($ per head)	$105
Transaction levy ($)	$5.20
Gross margin per head	$236.06
NPV ($) (30 years)	$71,949,383
Tonnes of feed required per year	41,760
Crop area (ha)	2,886

The NPV is based on a gross margin per head of $236.06 and assumes an initial development cost of $15 million. In addition, a further 10% of the initial capital cost (i.e. $1.5 million/year) is assumed for energy and other costs for fodder preparation (e.g. roller milling etc.).

The area of irrigated crop (predominantly maize and sorghum with some lucerne hay) to supply the feedlot is calculated at 2,886 hectares per year.

6.3.4 Abattoir analysis

Rather than being transported to Perth for processing, finished cattle from the feedlot could be slaughtered on-site at a purpose built abattoir. Labour availability in the region is likely to make full processing difficult; however carcases could be partially processed into quarters before being transported in refrigerated containers to Port Hedland for export or alternatively transported to Perth to a boning room for the export and / or domestic market.

The scenario modelled below is based on an abattoir with a maximum processing capacity of 30,000 head per annum (matching the annual output from the feedlot). Cattle are assumed to be purchased from the feedlot at breakeven cost ($2.10 per kg live weight) factoring in the freight savings.

This analysis, including cost assumptions has been adapted from the *Central Highlands Meat Processing Plant Feasibility Study* (GHD 2015)[3].

Table 20 below provides an overview of the operational and throughput assumptions used in the analysis.

Table 20 Abattoir operations and throughput assumptions

Operations and Throughput	Estimate
Days in operation per year	240
Shifts per day	1
Hours per shift	7.6
Head/hour	16
Cattle processed per day	122
Throughput per annum (head)	29,184
Average live weight (Kg)	730
Purchase price from feedlot ($/kg LW)	2.30
Dressing percentage	53%
Average Dressed Carcase Weight	387
Output (t/week)	217
20' container capacity (t)	21
Containers per week	10.34
Freight cost to Port Hedland ($/t)	$100

Table 21 below provides an analysis of estimated staffing requirements.

Table 21 Estimated staffing requirements

	FTE
Slaughter & Offal	18
Maintenance	2
Administration	3
Total	23

[3] http://www.centralhighlands.qld.gov.au/meat-processing-plant-feasibility-study

Table 22 below outlines the assumed facilities, site services and materials used (adapted from GHD 2015).

Table 22 Abattoir facilities, site services and materials

	Details
Facilities	• Stock receiving and unloading • Cattle holding pens • Cattle Ante Mortem yards • Slaughter and offal processing • Carcass chillers and chiller freezers • Carcase loadout • Offal handling, chilling and freezing facilities • Services and utilities • Amenities and administration • Truck access and roads • Private vehicle and visitor parking • Quartering room with amenities • Carton handling, chilling and freezing facilities • Cold store
Site Services	• Refrigeration plant – Two stage Ammonia or Cascade CO2/Ammonia • Evaporative air cooled ventilation to slaughter floor • Steam generation and reticulation • Water chlorination system (inclusion dependent on AQIS requirements) • Wastewater pre-treatment (screens, DAF, etc.) • Stormwater collection and drainage
Construction materials	• Concrete structural and wearing slabs • Non-slip epoxy resin hi-build floor sealants • Galvanised structural steel frame • In-ground or under slab HDPE drainage • Colourbond roofing and weather fascia's • Impervious Insulated panel ceilings and walls • low energy lighting up to 1000 lux • Hot Dipped Galvanised carcase overhead conveying systems • Hygienic, Stainless steel pipe, metalwork, fittings and equipment within process area • Electrical and automation installation suitable for intensive wash-down

Table 23 provides a financial analysis of the abattoir including:

- Establishment costs (CAPEX):
- Operational costs (OPEX):
- Projected revenue
- Gross margins, NPV and breakeven prices

The estimated costs per head from the Central Highlands feasibility study (GHD 2014) were reduced by 20% to reflect the reduced processing required.

Table 23 Abattoir financial analysis

Item	Amount	Details and assumptions
CAPEX	**$16,426,667**	As per Table 22
Cattle purchase cost	**$44,739,072**	29,184 cattle purchased at $2.10 per kg live weight
Labour	$4,028,326	Based on per head estimate from Central Highlands Feasibility Study (GHD 2015) minus 20% to reflect reduced processing requirements
Consumables	$204,288	
Electricity	$476,283	
Water	$93,389	
Gas	$176,563	
Maintenance Parts	$233,472	
Insurances etc	$307,599	
Depreciation Building	$202,537	
Depreciation Services	$202,537	
Depreciation Equipment	$472,781	
Freight to port	$1,086,520	$100 per tonne refrigerated transport to Port Hedland
Interest	$985,600	6%
Total OPEX	**8,469,895**	
Quartered carcass price (FOB) ($/kg)	5.07	Average annual FOB price received for boneless chilled beef exports to Japan and North Korea from 2014-2013 (724c/kg) with a 30% price discount for semi-processed (bone in) product.
Co-product price ($/head ex abattoir)	$100	Assumes $50 skin, $50 for remaining offal and co-products
Annual revenue (quartered carcasses)	$55,086,580	
Annual revenue (co-products)	$2,918,400	
TOTAL Revenue	$58,004,980	
Gross Margin	$4,796,013	
NPV	$39,679,643	
Breakeven sale price ($/kg DW FOB)	$4.76	

The analysis suggests the annual gross margins on an abattoir would be approximately $4.8M, which represents a 29% return on investment. However margins are particularly susceptible to variations in operating costs and prices, as is usually the case with meat processing facilities.

Over a 30 year period, the facility would return a positive NPV under the above assumptions. An average sale price of $4.76 per kg dressed weight would be needed to achieve a break-even NPV.

Operational risks and issues

There would be some key operational risks and issues associated with establishing and operating an abattoir in the Pilbara region, these include:

- Achieving consistent throughput over the course of the year and minimising the wet-season closure.
- Sourcing cattle of a consistent size and quality to ensure streamlined processing and the supply of a consistent export product. The analysis above is based on the abattoir receiving all cattle from the abattoir at a consistent live weight of 730 kg after 100 days on feed, in reality this may be optimistic.
- Labour supply, cost and accommodation: May require the use of overseas workers under 457 visa or labour agreements.
- Potable water supply and waste water disposal.
- Reliable and affordable power supply and natural gas if available.

6.3.5 Biofuel (ethanol) analysis

In addition to the use of grains in cattle feedlots, an alternative use is for the production of biofuels, namely ethanol. GHD has considered the economic returns from the establishment of a 9 million litre ethanol plant based on a combination of corn and sorghum as the feedstock.

Table 24 provides a summary of the assumptions and outputs for consideration. The establishment cost for an ethanol plant is assumed to be $1.50 per litre of capacity, or $13.5 million. In addition to the purchase price of the feedstock, GHD has allowed annual operating costs of 20% of upfront capital cost (ie $2.7 million per year).

Based on these assumptions, the breakeven price for ethanol is $1.18 per litre, and a total crop irrigated area of 1,800 hectares per year would be required to supply the feedstock.

GHD assumes that most energy in the Pilbara is from diesel power. The calculations do not take into account the ability for ethanol to substitute for diesel apart from providing the cost per litre of the ethanol alternative. Any conversion of engines to enable use of ethanol or ethanol mixes has not been considered.

Table 24 Ethanol break even analysis for $1.50/per litre development costs

Item	Assumption, result
Capacity (litres)	$9,000,000
Capital cost (@ $1.50/litre capacity)	$13,500,000
Yield of ethanol – corn (l/tonne)	424
Yield of ethanol – sorghum (l/tonne)	370
Average cost of feedstock ($/tonne)	$260
Annual operating costs	$2,700,000
Freight cost ($/litre)	$0.10
Breakeven price ($/per litre)	**$1.178**
Total annual feedstock (tonnes)	22,640
Area required for feedstock (ha)	1,743 ha

6.4 Summary

6.4.1 Broadacre crops

Based on the above analysis, only lucerne, rhodes grass, cotton, peanuts and sweet potato return a positive NPV over 30 years for the low development cost scenario. For the high development cost scenario, only Rhodes grass returns a positive NPV (see Table 25).

Table 25 Summary of economic modelling results (broadacre crops)

	Gross Margins	NPV (low development cost scenario)	NPV (high development cost scenario)
Livestock fodder (grain)			
Maize	+	-	-
Sorghum	+	-	-
Lucerne	+	+	-
Livestock fodder (forage)			
Lablab	-	-	-
Rhodes grass	+	+	-
Fibre or industrial us crops			
Guar	+	-	-
Cotton	+	+	-
Human food crops			
Peanuts	+	+	-
Sweet potato	+	+	-
Pulses/lentils	-	-	-
Canning tomato	+	+	+
Canning capcicum	-	-	-

6.4.2 Vegetables and value add options

Of the vegetable and value add options, GHD considers the following order indicates the relative attractiveness of each option:

- Cattle feedlot
- Canning tomatoes
- Canning capsicums
- Ethanol

7. Scenario Development

7.1 Risk analysis

After considering the range of crops and development options, GHD believe the most appropriate approach to developing agriculture in the Pilbara region, is to adopt a staged, approach which minimises risk, encourages diversity in production and marketing options and allows for adaptive learning.

This approach will avoid the need for initial investments which are higher risk due to:

- Production risk (e.g. due to pest and disease)
- Labour requirements
- Capital outlays
- Reliance on yet to be developed processing/value adding capacity
- Reliance on yet to be developed supply chain/transport infrastructure
- Reliance on single or specialised markets

Consistent with the risk-return relationship, opting initially for lower risk investment options will probably result in lower gross margin returns. However over time, as agricultural production becomes established in the Pilbara, more sophisticated production systems could be implemented including more established processing and value adding capacity, leading to higher returns.

7.2 Three generations of production and development

GHD has grouped the analysed crop types and development options into three generations outlined below.

7.2.1 First generation (years 1-5)

Focus

The aim of the first generation of development will be to establish the sound foundations of agricultural production in the Pilbara. Irrigation infrastructure (most likely pivot irrigation) will be developed to support a range of potential crop types.

Some of the key challenges faced during the initial stages of development include:

- Pests and disease
- Reliability of irrigation water (due to new infrastructure)
- Reliability of energy
- Reliability of labour
- Access to input and support services

Possible crops or development options

Fodder crops offer a lower risk option for initial development

7.2.2 Second generation (years 6-10)

Focus

During the second generation of development, producers will seek to produce higher value crops and/or pursue value adding opportunities.

Possible crops or development options

- Guar
- Cattle lot-feeding
- Ongoing development of first generation crop production systems (expansion of area, lifting yields, specialisation, further development of export or niche markets, further on-farm processing (e.g. stockfeed pellets), further development of supply chain infrastructure.

7.2.3 Third generation (years 11+)

Focus

During the third generation of development,

Possible crops or development options

- Cotton
- Vegetable crops (canning tomatoes and capsicums)
- Biofuels

Table 26 Relative advantage of opportunities

Generation	Crops	Production risk	Labour intensity	Setup costs	Reliance on processing and value adding	Established markets	Supply chain infrastructure	Relative advantage
1	Forage and grain crops	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	15
2	Guar	✓✓	✓✓✓	✓✓	✓✓	✓	✓✓	12
	Cattle feeding	✓✓	✓	✓	✓✓	✓✓✓	✓✓✓	12
3	Cotton	✓✓	✓✓	✓✓	✓	✓✓✓	✓	11
	Peanuts, pulses	✓✓	✓✓	✓✓	✓	✓✓	✓	10
	Vegetables	✓	✓	✓	✓	✓	✓	6
	Ethanol	✓	✓	✓	✓	✓	✓	6

8. References

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Appendices

Appendix A – Market Analysis

Maize

Export

Australia's two most important export markets for maize are Japan and Korea however Australian product comprises less than 1% of their respective imports. Our major competitors are the US, Argentina and Brazil. Asia is expected to be the driver of world maize consumption, largely as a result of increased demand for feed grain.

Australia status as a non-GM producer provides marketing opportunities to access high value niche markets. Increasing demand for Non-GM products in Asia means that Australian exporters can command a higher premium above the world price.

Since 1996, growers around the world have adopted GM hybrids to control pests and weeds, which Australia is free from. Ninety per cent of the maize produced in the United States, one of the biggest exporters, is now GM. Many countries have strict regulations on importing and selling GM goods. South Korea and Japan both restrict GM maize imports for food consumption. The growing demand for non-GM maize in Asian markets gives Australian growers an advantage over other big exporters.

The two major export opportunities for maize are due to production in Australia being counter-seasonal to the production in the northern hemisphere, Australian maize is available when Europe or North America has limited supplies and that Australia does not yet have access to China's market for Maize.

Domestic

Within Australia, livestock feeding of maize accounts for approximately 54 per cent of total domestic consumption while food and industrial consumption accounts for the remaining 46 per cent. Maize is only a minor component of the feed complex, but over 90 per cent of feed maize is consumed by pigs or poultry.

Domestic marketing opportunities will depend largely on poultry and pig numbers. Over the medium term, pig and poultry numbers are projected to rise, supporting domestic demand for Maize.

Figure 1 and Figure 2 summarise the worldwide and Australian maize markets.

Figure 1 World maize production

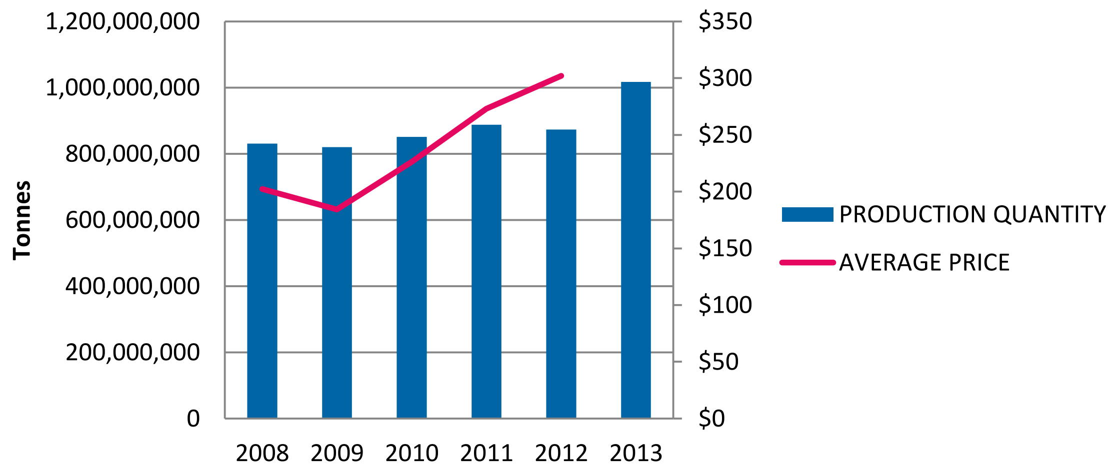
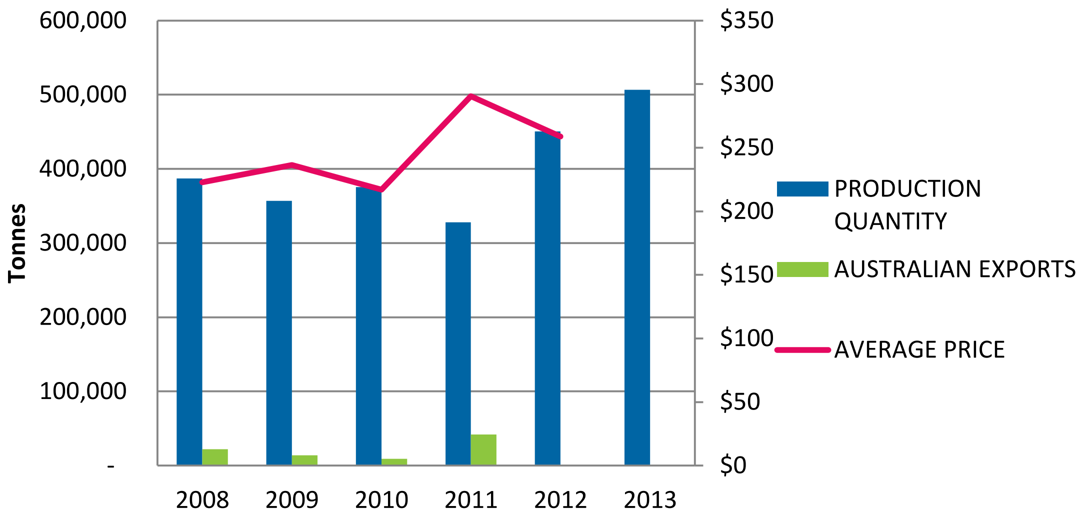


Figure 2 Australian maize production



Gross margins

	EAT ($)	CSIRO ($)	GRDC (2013)	FGARA
Maize (Domestic)	964	1028		1132
Maize (Export)		254		

Sorghum

Export

There's a substantial export market for sorghum, especially to Japan and China. Increased Chinese demand was making sorghum more and more attractive for growers across the globe. Australia has a chance to extract even further premiums from the sorghum boom, as it is well positioned in the relatively small human consumption sorghum market. In 2012-13 China bought 700,000 tonnes relatively out of the blue to make the spirit baijiu.

Domestic

Despite export opportunities, the large majority of Australian sorghum is used domestically for cattle, pigs and poultry stockfeed (2.2 Mt).

Figure 3 and Figure 4 summarise the worldwide and Australian sorghum market.

Figure 3 World sorghum production

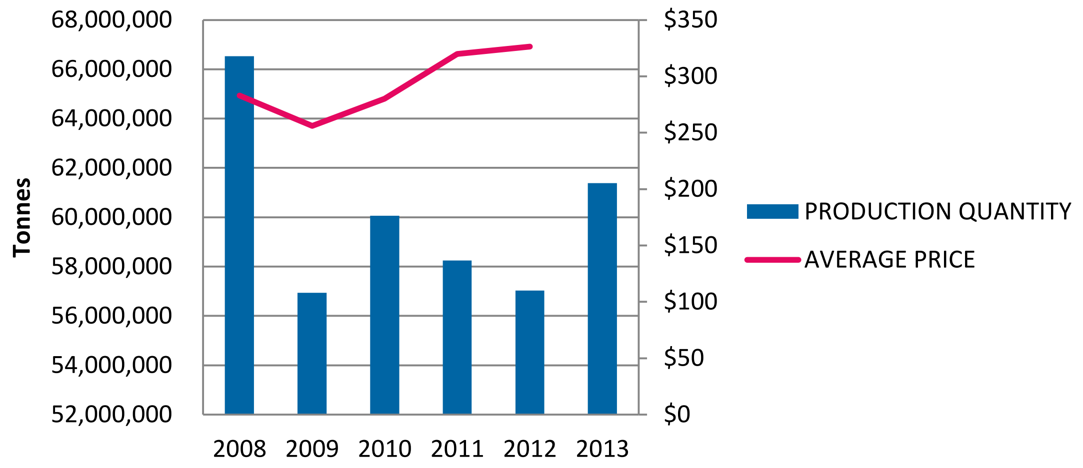
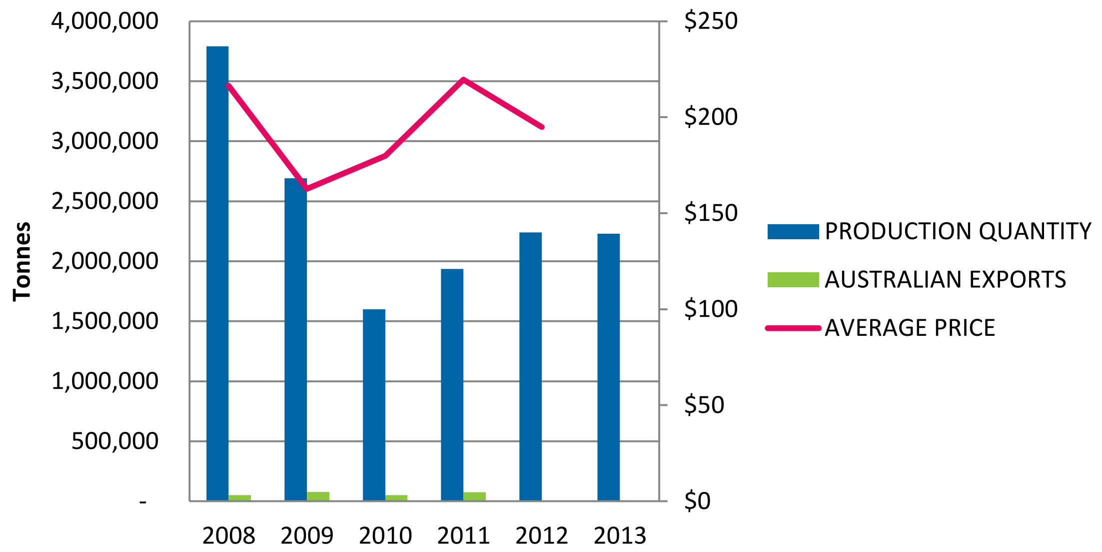


Figure 4 Australian sorghum production



Gross margins

	EAT ($)	CSIRO ($)	GRDC (2013)	FGARA
Sorghum	N/A	539		371

Oaten hay and lucerne

Export

Western Australia (WA) exports on average 48% of Australia's oaten hay, exporting around 300 000 tonnes worth over A$88 million in 2012/13. The WA hay industry is well established but still has potential to expand further to meet global demand.

WA oaten hay is exported to more than 13 markets, with the largest markets being Japan, South Korea and Taiwan. China presents a huge opportunity with Chinese imports doubling in the last 12 months from 35,000 tonnes to 60,000 tonnes as the local dairy numbers push beyond 12.5 million head.

Cereal hay and chaff is the largest single feed product exported. In 2008-09, 385,285 tonnes of cereal hay and chaff worth A$138 million dollars was exported from Western Australia. This represented 91% of total animal feed exports. Cereal straw and husks were the next largest product exported with 11,331 tonnes, worth A$2.96 million dollars (representing 3% of total exports), exported last year. Worked grains of oats (3%), feed supplements (1%) and lucerne meal and pellets (<1%) are the other animal feed export products of note (Source: ABS).

Gross margins

	EAT ($)	CSIRO ($)	GRDC (2013)	FGARA
Oaten hay (Export)	172		263	
Lucerne				

Lablab

Gross margins

	EAT ($)	CSIRO ($)	GRDC (2013)	FGARA
Lablab	N/A	509		622 (@$160t)

Rhodes grass

Gross margins

	EAT ($)	CSIRO ($)	GRDC (2013)	FGARA
Rhodes grass	6,107			

Guar

India is the largest producer of Guar seed in the world, constitute about 80% of the total production. Pakistan, USA, South Africa, Malawi, Zaire and Sudan are other major producing countries. World market for guar gum is estimated to be around 150000 tons/year, 70% of which is produced by India and Pakistan. The USA is the largest consumer of guar gum with an annual consumption of 45,000 tones which represents 25% of world trade. Germany & Japan consume another 23% between them with the UK, Denmark and the Netherlands combining take further 22% of world trade. The world guar market is a mature one and increasing steadily (> 2% per year). The area of growth is in Asia and South America as standards of living increase resulting in the increased consumption of processed food.

The processing plants process the guar seed to obtain the refined split (guar gum), and during process Churi and Korma are obtained as by-products of guar split. The refined split is directly sold to respective industrial users. The high protein by-products are used for poultry and animal feeds with in the country.

Guar is traditionally used as a thickening agent in food processing but has more recently been used in the oil and gas industry as a hydraulic fracturing agent. Guar gum is currently being imported into Australia from India and Pakistan.

High recent prices have forced the oil and gas companies to find cheaper alternatives however demand is expected to remain strong due to the availability of alternatives.

Extensive end uses exist for guar including: food processors and manufacturers (vegetable gum, thickener); personal care (bath/shower gels, cosmetics); agriculture (stockfeed); paper; textiles; pharmaceuticals; energy (hydraulic fracturing, drilling); and mining (nickel sulphide flotation). No domestic capacity currently exists at a commercial level to process the bean to guar gum for input into these uses

Exports

India currently dominates world production of guar producing approximately 80% with Pakistan and the US other large producers. The US and Germany are the two largest importers of Guar. 50% of guar production is used by the oil and gas industry.

Significant demand originates from the US energy industry. Other demand sources come from Japan, Germany, UK, Denmark and the Netherlands for a variety of end uses. It is anticipated that markets within Asia will also become prominent as demand increases for more processed food products.

Domestic

Domestic production is still in the very early stages with only 650 tonnes of guar produced in 2012-13. There is an estimated 10,000 ha planted in northern Australia 2013-14 with an approximate yield of 10-15,000 tonnes.

Gross margins

	$/t	EAT ($)	CSIRO ($)	GRDC
Guar	625		497	

Cotton

Figure 5 World cotton (lint) production

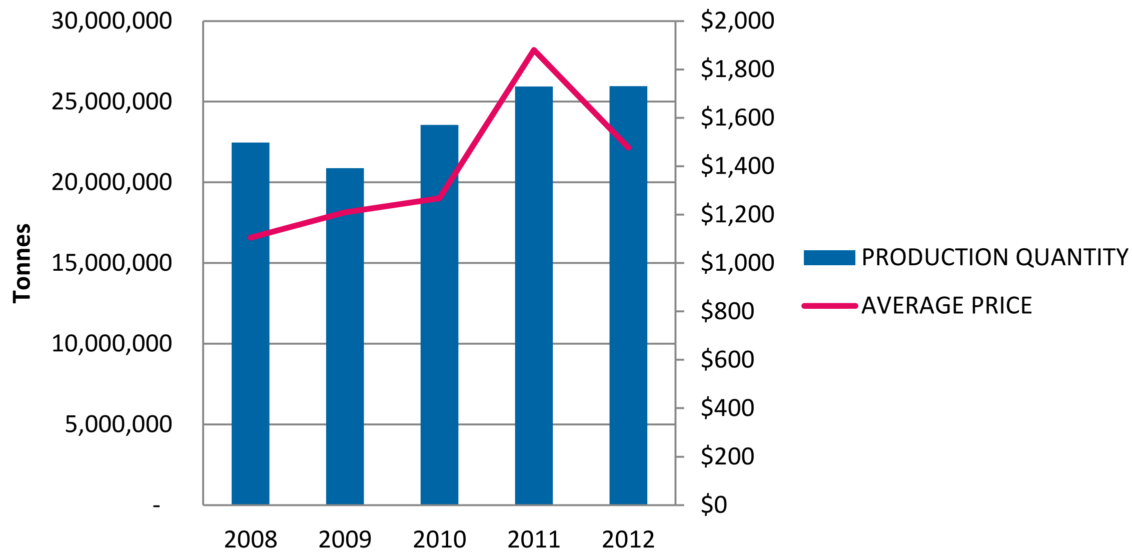
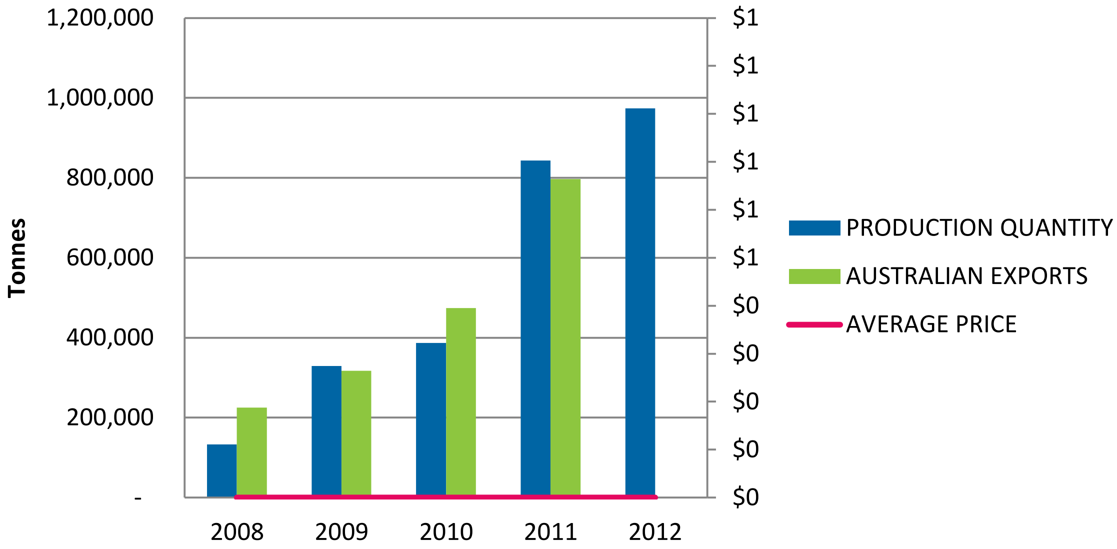


Figure 6 Australian cotton (lint) production



Export

95% of Australian cotton lint is exported to international markets, mainly Asia. China has now emerged as the largest importer of Australian cotton, taking around 70% of exports in 2012-13. Other important markets are Indonesia, Thailand and the Republic of Korea.

Demand is likely to increase from countries like Cambodia and Vietnam as wage inflation in China has led to Chinese manufactures and global textile companies moving to other low cost nations.

Other potential markets that could be developed are Bangladesh, Pakistan, Taiwan and Hong Kong.

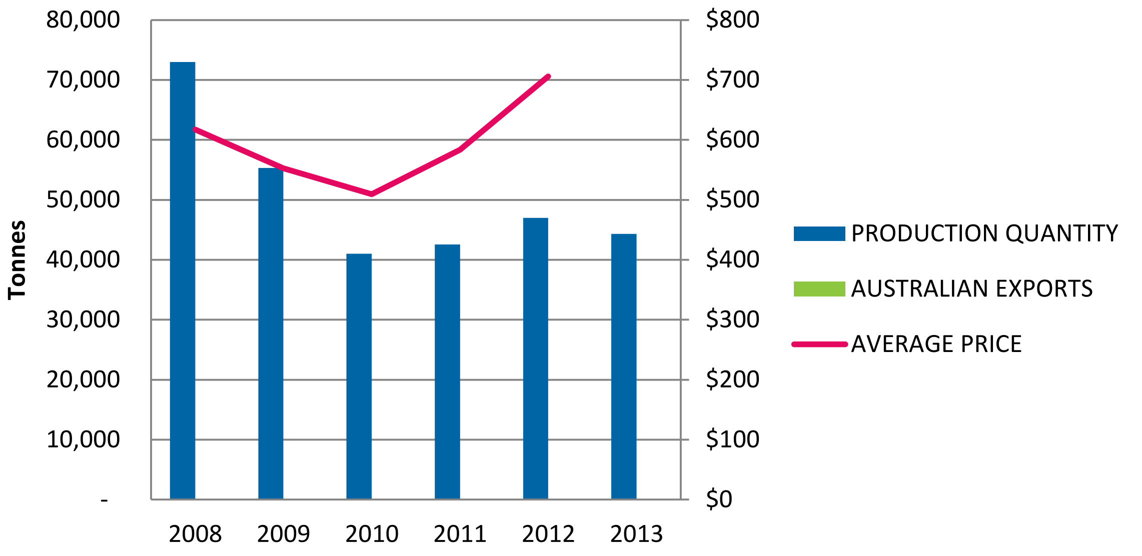
Domestic

A large proportion of cotton seed is consumed domestically. Domestic cotton mills only mill approximately 3% of Australian cotton. It is unlikely that demand for ginned cotton will be treated domestically as labour costs are much cheaper overseas.

Gross margins

	$/bale	EAT ($)	CSIRO ($)	GRDC ($)	FGARA
Cotton	650	1658	1349 (@$500)		2165 (@$450)

Figure 7 Australian sunflower production



Tomatoes

Figure 8 World tomato production

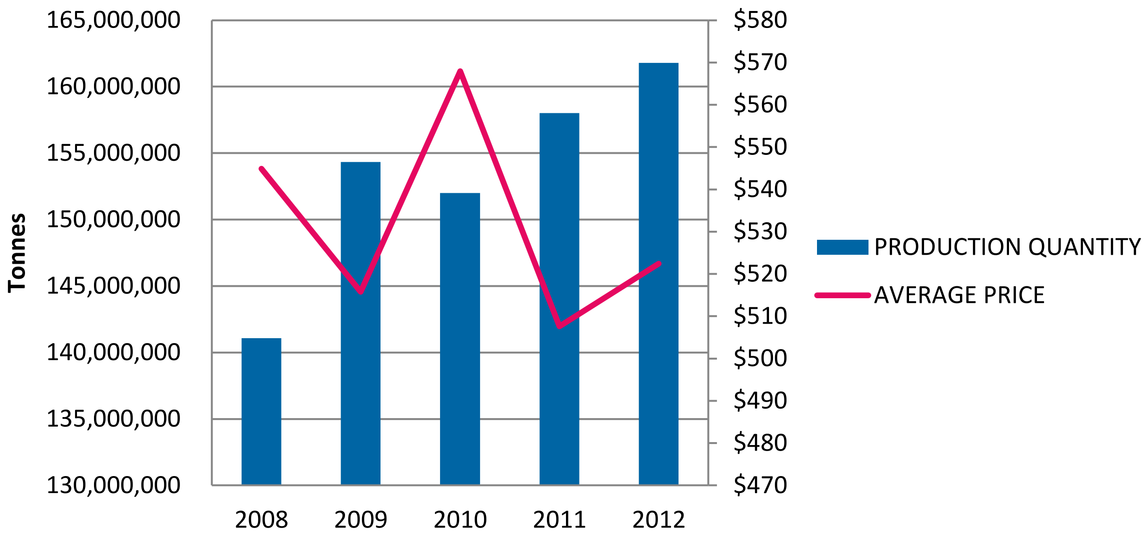
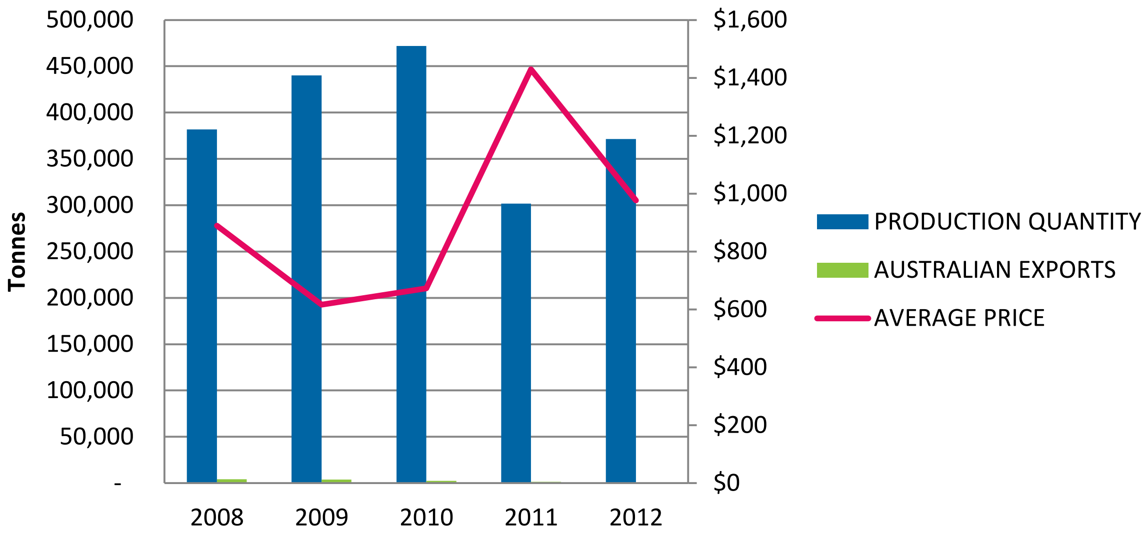


Figure 9 Australian tomato production



Export

From 1992 until 2002, Australia fought the dumping of cheap Italian tomatoes by charging the importers duties. But in 2002, an importer legally challenged the federal government over the measures and won. Then came the high dollar, rising by a third against the euro, making it even cheaper to ship to Australia. Since 2007, imports of tomatoes have grown by 40 per cent.

Importers can buy cans from 32¢ for lower quality, to 60¢ for premium quality. It then costs between 12¢ and 17¢ a can for shipping. Australia has seen many food manufacturing closures in the last few years. Heinz Australia and Rozella also closed its tomato sauce factories in. Coca-Cola Amatil's subsidiary cannery operation SPC Ardmona in Victoria's Goulburn Valley is currently being reorganised after a restructuring that saw many jobs being lost.

In mid-2011, Heinz's move of its Golden Circle beetroot and fruit processing facility in Queensland's Lockyer Valley was shut down as its business was partly shifted from Australia to New Zealand.

Gross margins

	$/t	EAT ($)	CSIRO ($)	GRDC ($)	FGARA	NSW DPI (2013)
Tomatoes (Fresh)	1350					$19,353
Tomatoes (processing)	1300					$2,286

Capsicum

Figure 10 World Capsicum (Chillies and peppers, green) production

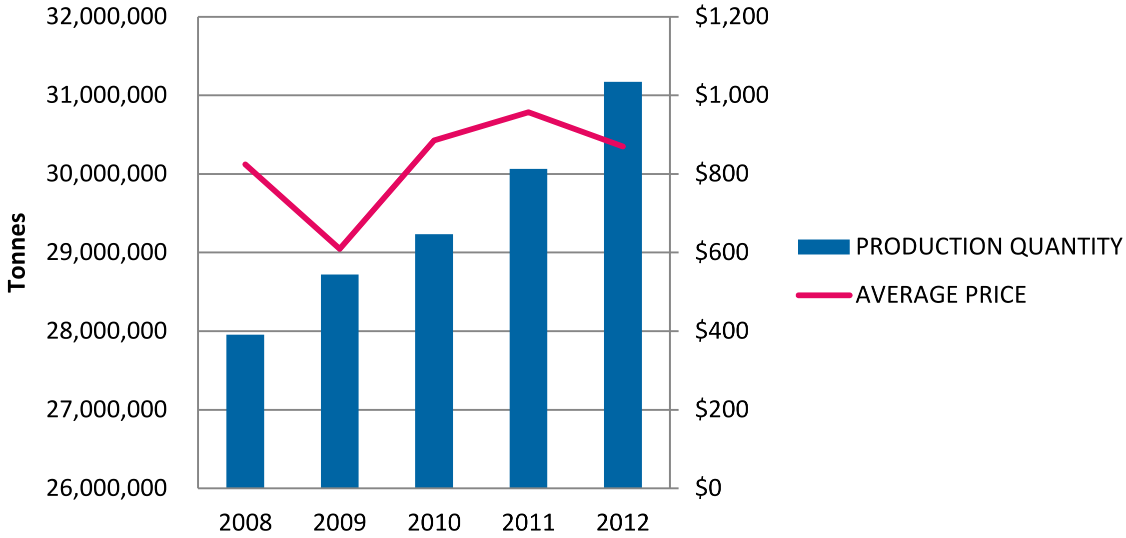
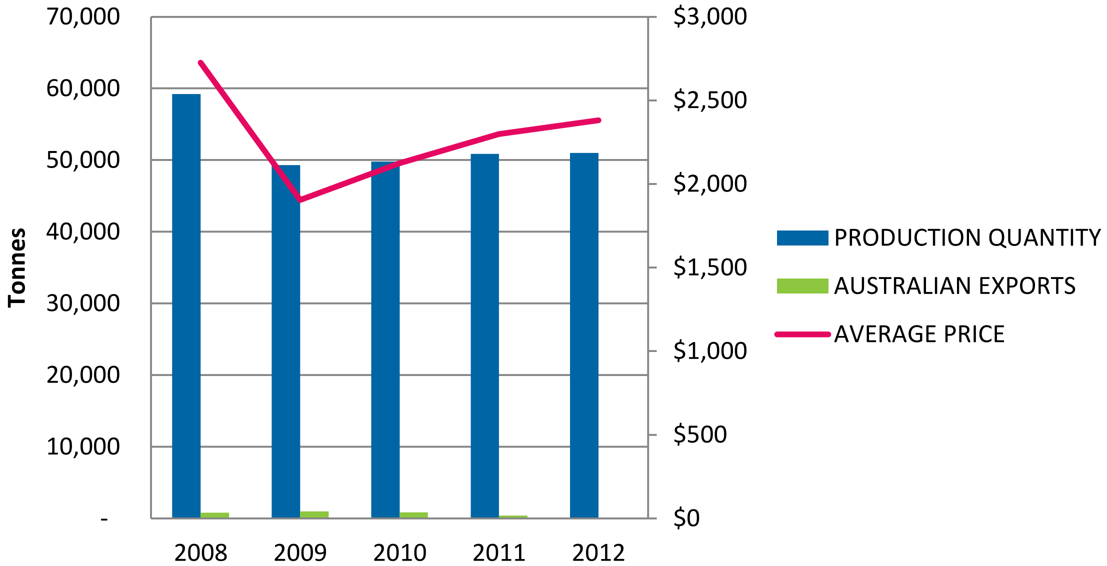


Figure 11 Australian Capsicum (Chillies and peppers, green) production



Gross margins

	$/t	EAT ($)	CSIRO ($)	GRDC ($)	FGARA	NSW DPI (2013)
Capsicums	1050					2,693

Peanuts

Figure 12 World peanuts with shell production

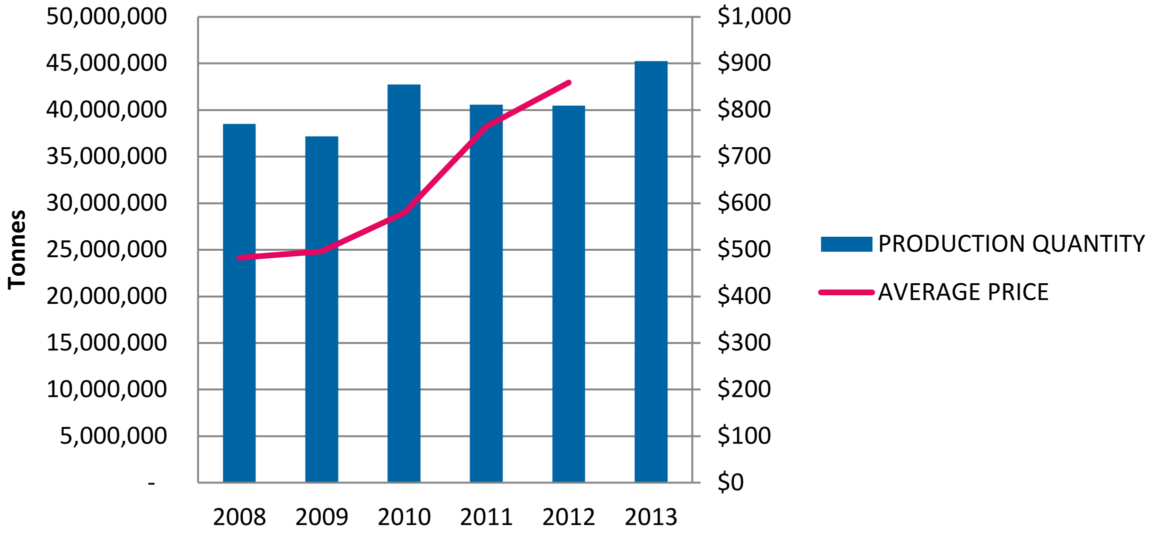
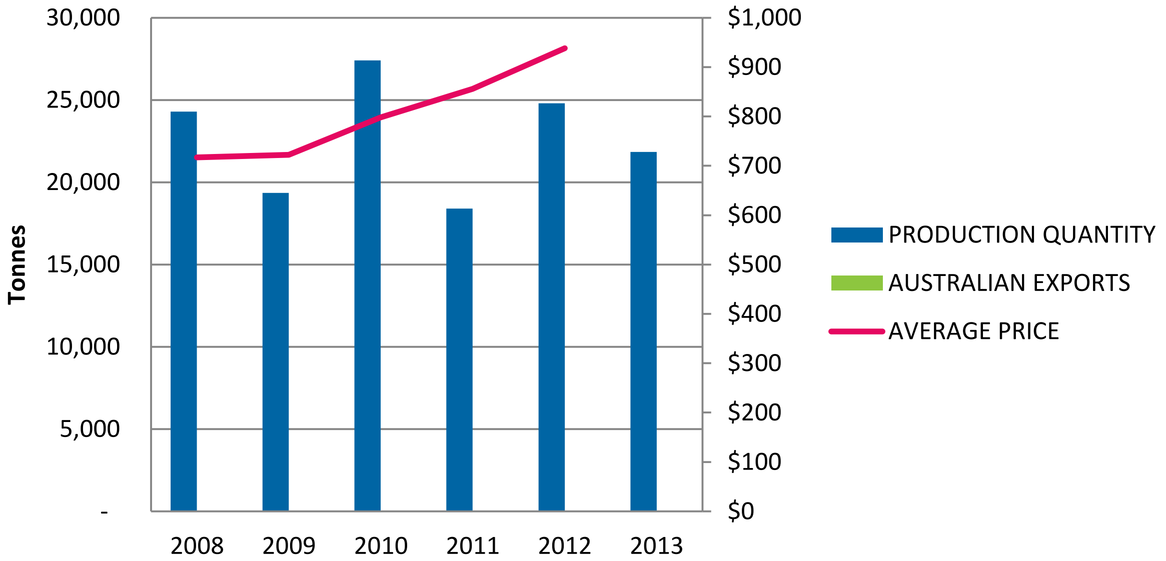


Figure 13 Australian peanuts with shell production



Exports

China and India are the largest crushers of peanuts and consumers of peanut meal and oil. China was once the primary supplier in international markets, however growing domestic consumption has reduced exports.

Should production expand, there is potential for some import substitution of peanuts for food use and also peanut meal for intensive livestock production. Any expansion in production could also be shipped to current export markets, particularly Japan and Korea. The major supplier of these markets is China but, with their own domestic consumption increasing there is an opportunity for Australian exporters to expand in these markets.

An opportunity has also been identified in supplying high oleic peanut oil to the world market. To capitalise on this opportunity would require large scale supply of high oleic peanuts and export market development.

Domestic

Australia produces about 40,000 tonnes of farmer stock peanuts annually which represents only about 0.2% of the world's peanut production. More than 90% of Australia's peanuts are grown in the state of Queensland. The industry is based on the large-seeded Virginia varieties and medium seeded Runner varieties. Plantings are approximately 1/3 Virginia varieties to 2/3 Runner types. Some ultra-early varieties with runner type kernel are also planted.

The size of the domestic market for peanuts is about 50,000 tonnes annually. Australia is one of the few peanut producing countries where imports are freely permitted. The price that growers receive for their crop is therefore significantly influenced by world prices. Australia imports both processed and unprocessed peanuts. Argentina is our largest supplier with over 80% followed by China and Nicaragua.

The area planted annually is about 15,000 hectares and this produces about 40,000 tonnes of farmers' stock peanuts. Tonnages have varied in recent times from less than 15,000 tonnes to more than 50,000 tonnes. One third of production is from rain grown areas and two thirds from irrigated production. Rain grown crops average approximately 2.5t/ha yield in South Qld and 4t/ha in North Qld.

In contrast the irrigated areas regularly produce yields of five tonnes per hectare with some exceptional yields of over seven tonnes per hectare. There is a growing movement towards irrigated peanuts to ensure reliable supply for both our domestic and export customers.

Gross margins

	$/t	EAT ($)	CSIRO ($)	GRDC ($)	FGARA	NSW DPI (2013)
Peanuts	850	732	866		885	

Sweet potatoes

Figure 14 World sweet potato production

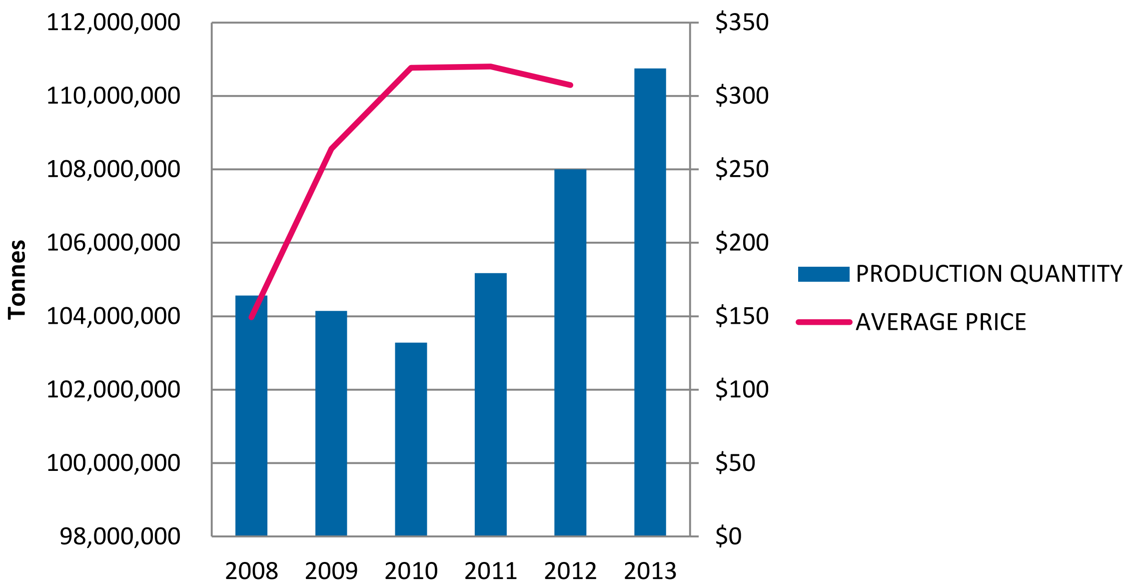
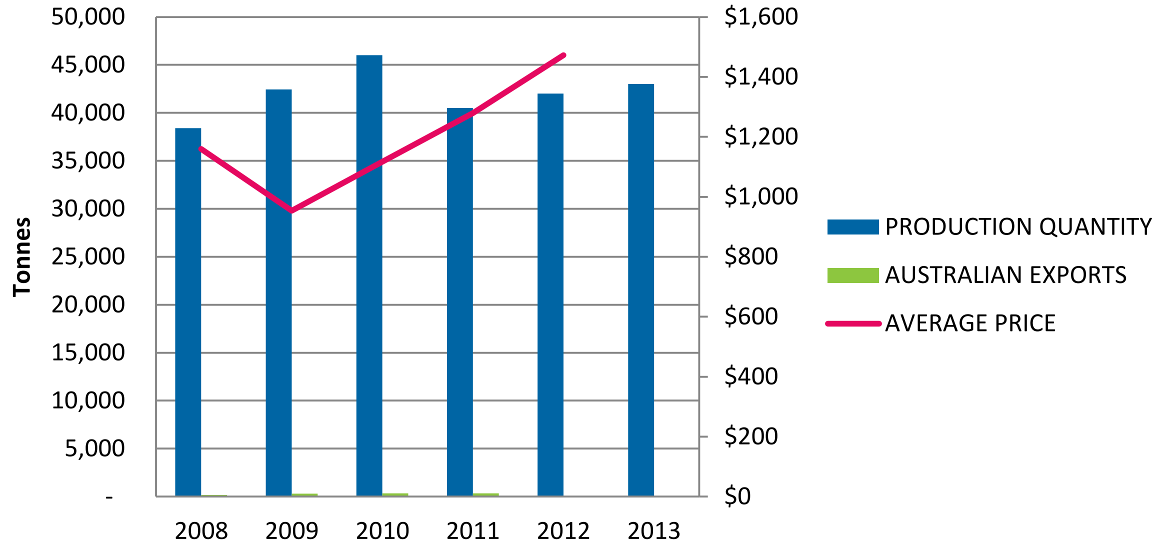


Figure 15 Australian sweet potato production



Domestic

Industry estimates for 2012 are that approximately 2000 ha produced approximately 100,000 t of sweetpotatoes in Australia worth around $100 million at the farm gate, with about 78% of this produced in Queensland (Australian Sweetpotato Growers Inc.)

Gross margins

	$/t	EAT ($)	CSIRO ($)	GRDC ($)	FGARA	NSW DPI (2013)
Sweet potatoes	700					1800

Pulses

Figure 16 World chick pea production

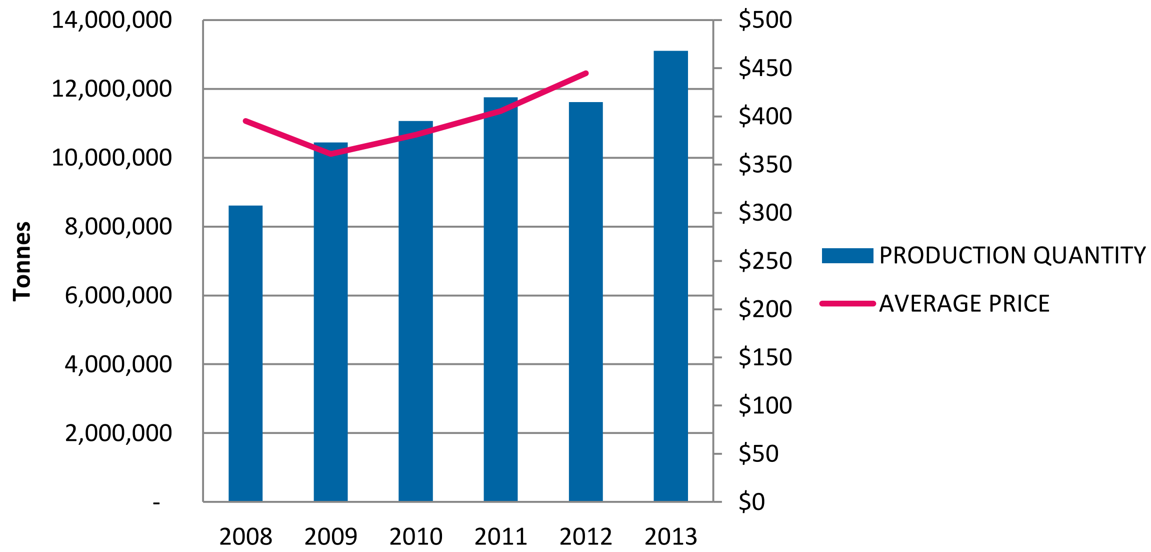
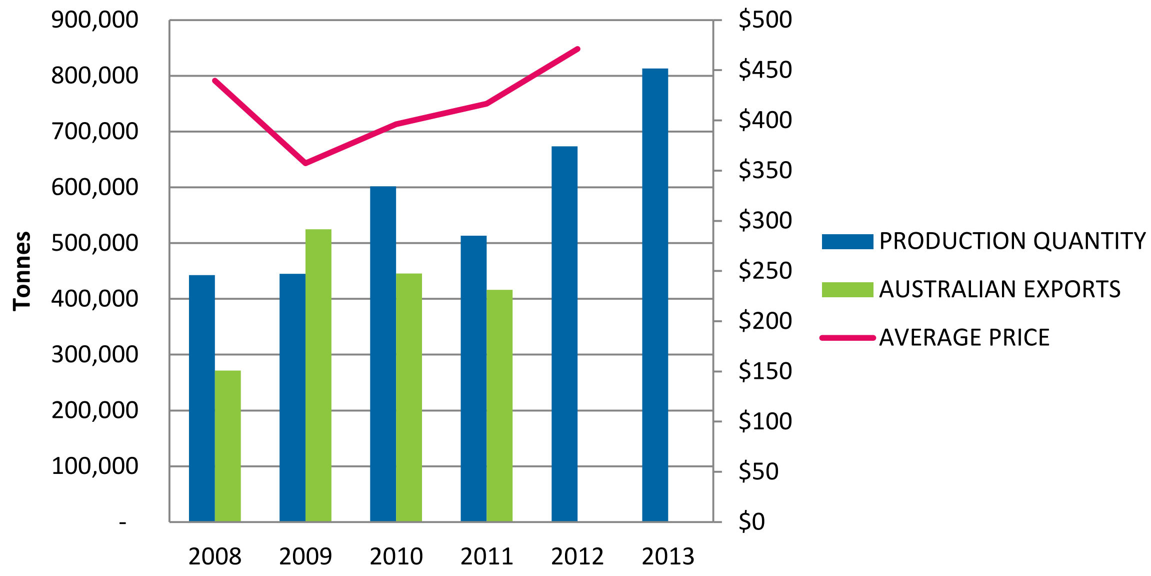


Figure 17 Australian chick pea production



Gross margins

	$/t	EAT ($)	CSIRO ($)	GRDC ($)	FGARA	NSW DPI (2013)
Pulses	260			157		

Lentils

Figure 18 World lentil production

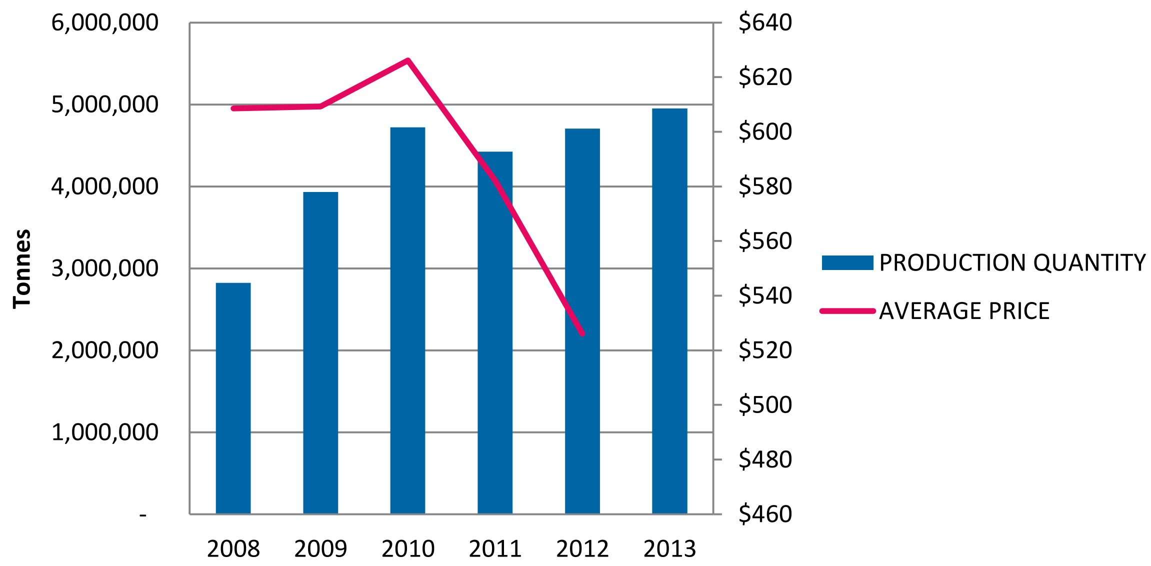
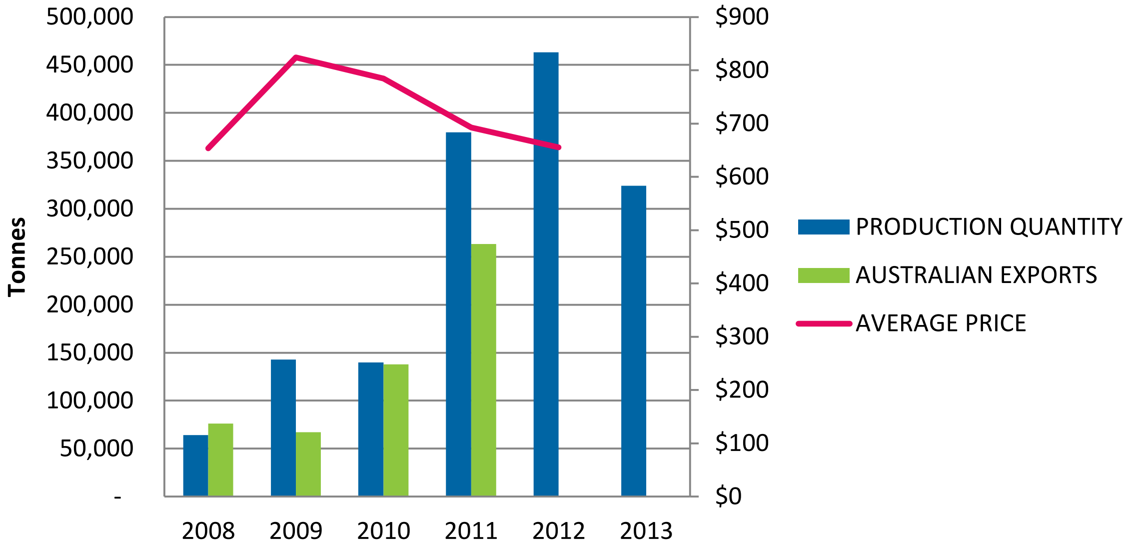


Figure 19 Australian lentil production



Gross margins

	$/t	EAT ($)	CSIRO ($)	GRDC ($)	FGARA	NSW DPI (2013)
Lentils	480			318	256 (@$500)	

Lot feeding

The major issues of concern to the sector are on-going access to international parity price grain, market access, animal welfare, climate change, exotic disease, legislative burden and land use planning (among others). The industry is particularly concerned about the possibility of increased Government support for grain derived ethanol production given its distortionary impact on grain and food prices.

The distribution of export and processing facilities is such that, for most enterprises, long-distance road transport of cattle is required. The road network away from main highways is generally not sealed and therefore prone to road closures in the wet. Long distance road transport is expensive and animals can lose condition, and so market value. Proximity to abattoirs or port facilities is a potentially important issue and close proximity can greatly reduce costs in some cases.

Export

Over the medium term, the lot fed cattle industry is likely to continue to feel pressure from US competition in the important grain fed beef markets of Japan and the Republic of Korea. Reduced tariffs under the Korea-Australia Free Trade Agreement and the Japan-Australia Economic Partnership Agreement improve those prospects.

The value of box beef exports is up by 39% in the period from January to May 2013 compared to the same period in 2012. This increase reflects a 7% increase in average price and a 29% increase in volume. Japan (17%), Indonesia (16%) and the Republic of Korea (13%) remain the main markets. From a relatively low base, Saudi Arabia and China have increased their imports of boxed beef by four times and ten times respectively.

While the total number of cattle exported live is almost unchanged, the industry is more diversified with an increased number of markets being serviced. In 2012-13, cattle exported from northern ports in Western Australia were mainly shared between Indonesia (56%), Egypt (19%), Malaysia (14%) and Libya (8%) whereas in 2009-10, all cattle were exported to Indonesia. Southern ports have also seen a reduced reliance on Indonesia.

In 2012-13, live cattle exports have been shared between Israel (43%), Turkey (23%), Indonesia (9%), Jordan (8%) and Malaysia (8%). The feedlot sector has seen an increase in turn off, however utilisation remains around a third of capacity.

The complementary nature of Western Australia's northern cattle industry and the Indonesian feedlot/processing industry makes it the most profitable option for northern producers. Any support that builds volume will assist WA producers and Indonesian consumers.

The rise in exports of boxed beef to China combined with the recent devaluation of the Australian dollar are positive signs for the production and processing sectors. These positive signs have not gone unnoticed with growing interest from foreign investors in the Australian beef industry

Ethanol

Feedstock

Corn, sorghum, sugar beets sugar cane, sweet potatoes, coconut, cassava, milo, cellulose, miscanthus, prairie grass, switchgrass

Grains (sorghum and maize)

Ethanol prices are projected to increase in line with the inflation rates and crude oil prices over the next decade. Biodiesel prices are also expected to increase but their growth should be slower, mostly driven by the expected growth in vegetable oil prices and to a lesser extent by the growth in crude oil prices.

Ethanol use in the United States will be limited by the ethanol blend wall and should only grow marginally in the latter years of the projection period, leaving additional biodiesel use necessary to meet the advanced and total mandates. The policy driven imports of sugarcane based ethanol to fill the advanced gap are also expected to flatten at the end of the next decade to reach 10 Bln Lby 2023. It is assumed that by 2023 only 12% of the US cellulosic mandate will be implemented.

Biodiesel

Feedstock

Coconut oil, oil palm, castor beans, jatropha, pongamia pinnata rapeseed, soy beans, sunflower seed algae, waste vegetable oil, Halophytes (Saltwater plants).

Biomass (Rhodes grass, sorghum, grain crop stubble)

Increasing domestic demand in key exporting countries is expected to raise biodiesel prices in 2016 and 2017. This trend is in line with the assumptions in this Outlook on the continuation of biofuel policies.

For the European Union, the Outlook assumes that the fulfilment percentage of the RED coming from biofuels should reach 8.5% in 2020. Biodiesel use is expected to increase in the first part of the projection period and then to stay at a plateau of 19 Bln L from 2020 onwards. The increase in production of second generation biofuel will remain very limited. Imports will be necessary to satisfy the RED target.

Oilseed brassicas (canola, cotton seed, soybean and sunflower)

Exports

While Australia is a relatively small producer of oilseeds by international standards, it is widely regarded for its high quality exports and has developed some significant international markets for its canola and cottonseed exports. Currently, the UE, Japan, Pakistan and Bangladesh are important markets for Australian canola; with Japan and the US being the major cottonseed destinations.

Domestic

Australia usually produces between 2 to 3 million tonnes of oilseed crops each year, with canola and cottonseed accounting for over 90 per cent of total oilseed production, with soybeans and sunflower comprising a further 3 and 4 per cent respectively. Canola production is now the largest oilseed crop representing well over half of Australian oilseed production over the past 5 years, while cottonseed comprises around a third.

Figure 20 World cottonseed production

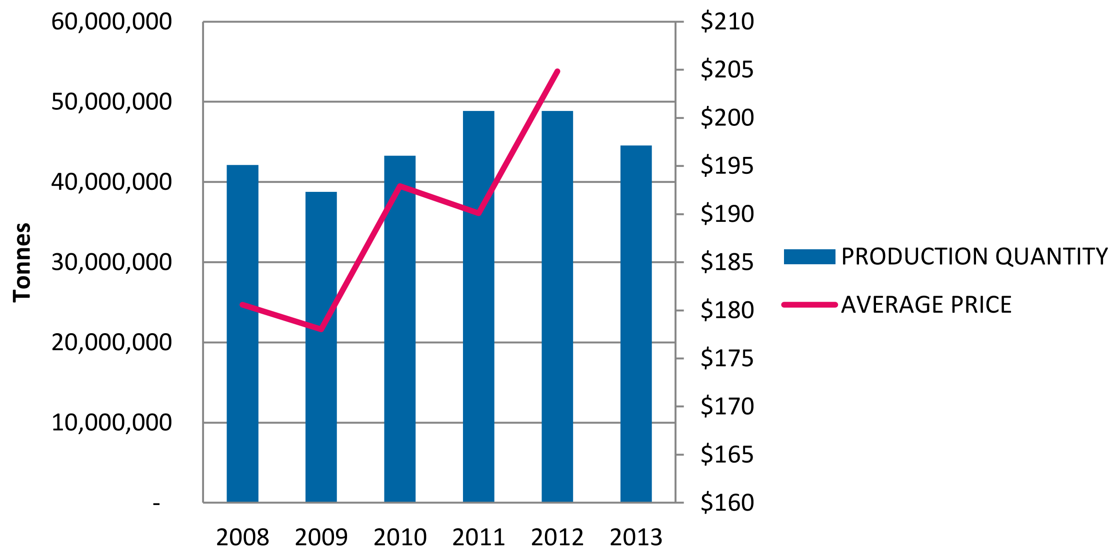


Figure 21 Australian cottonseed production

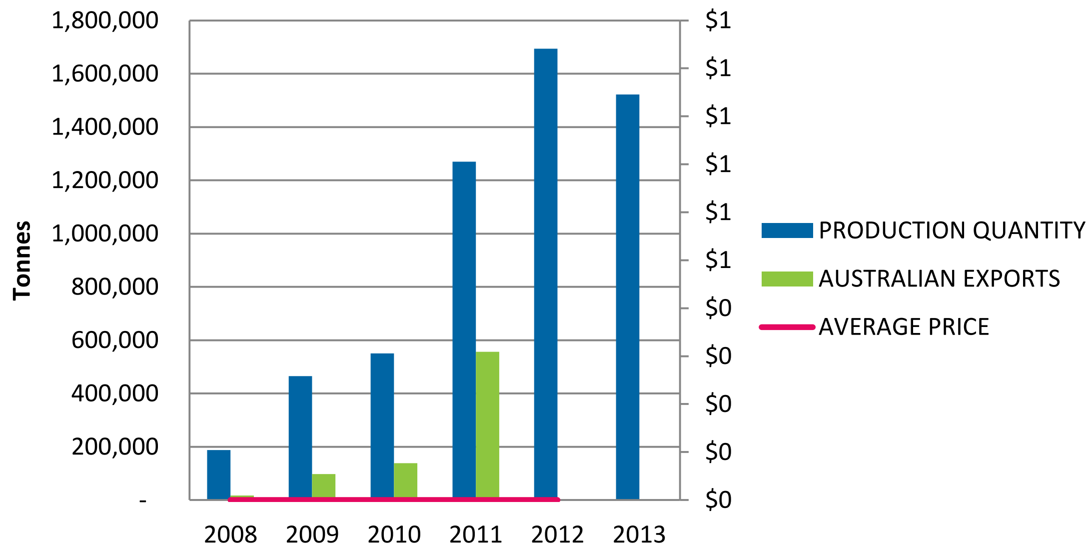


Figure 22 World soybean production

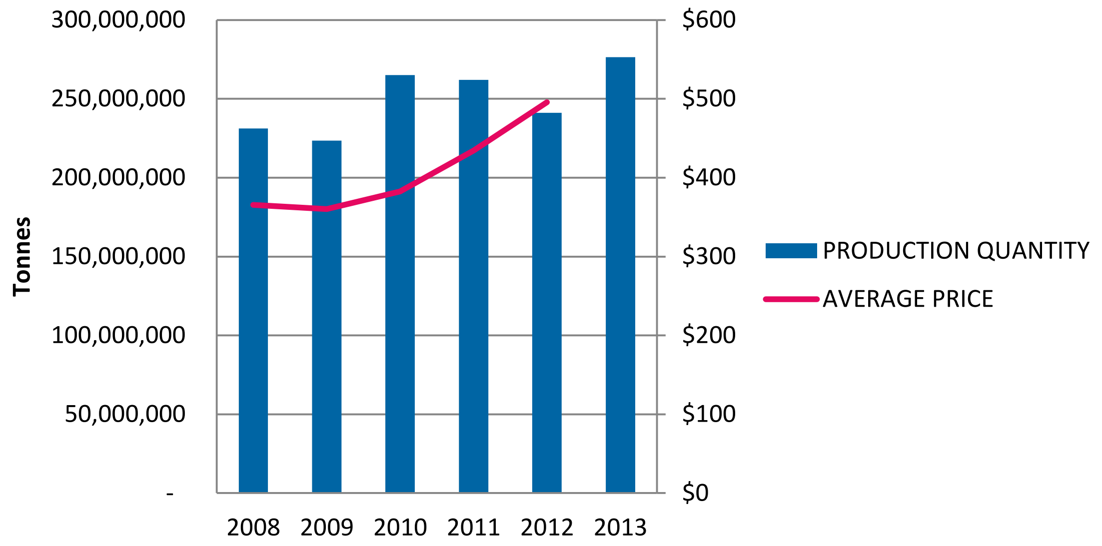


Figure 23 Australian soybean production

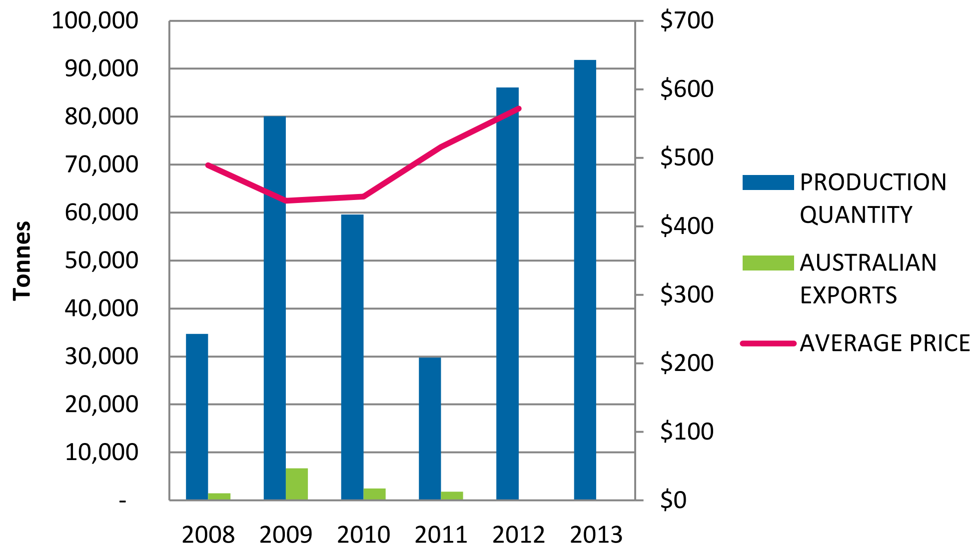
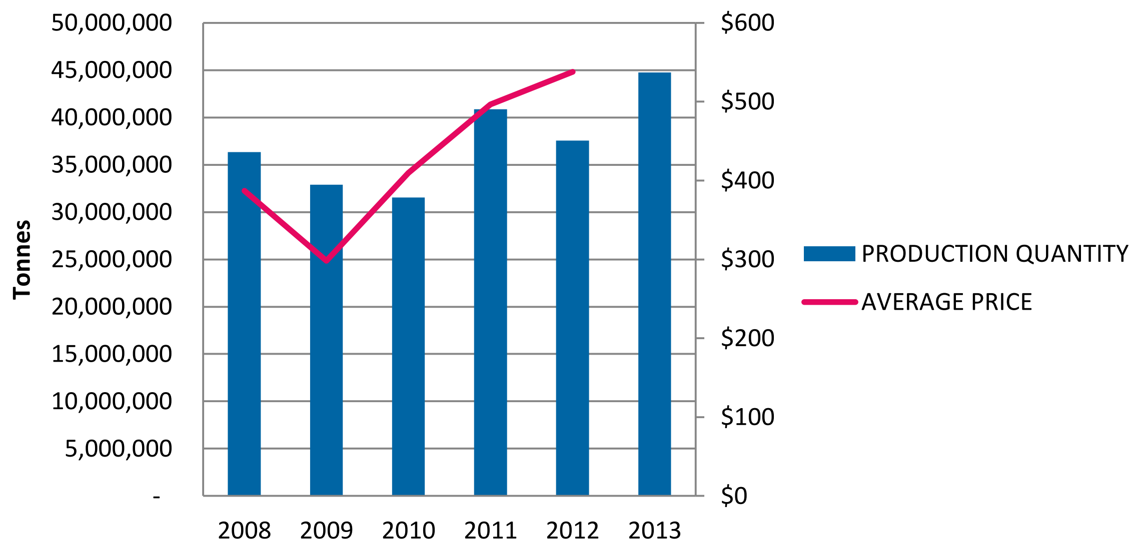


Figure 24 World sunflower production



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