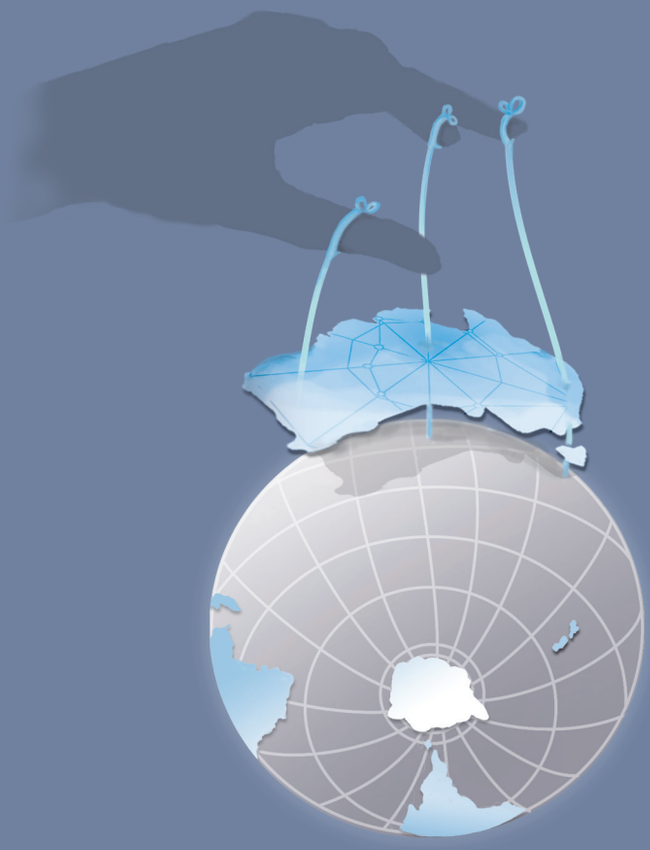

Balancing Act

A TRIPLE BOTTOM LINE ANALYSIS

OF THE AUSTRALIAN ECONOMY

VOLUME 2

The University of Sydney

CSIRO

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Contents

Sector 0101: Sheep and Shorn Wool (Wo)

Sheep, lambs, shorn wool and dead wool

Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions and water use are about seven times the average, while land disturbance is 50 times the average. The social indicators show that employment generation is 50% greater than average, income is 45% below average, and government revenue is 35% below average. The financial indicators show that operating surplus is 60% greater than average, export penetration is four times the average, and import penetration is 50% below average. While the historical importance of wool to the Australia economy appears to be waning, considerable effort is being devoted to improving its fractured supply chain, and gaining access to synthetic garment markets fro m which it has been excluded. This analysis highlights environmental impacts in relation to financial returns.

Sector Description

Wool production in 2003 was nearly 500 000 tonnes shorn from 118 million sheep which graze in the wheat sheep zone (55%), the high rainfall zone (33%), and the pastoral zone (12%). The flock is composed of Merino (85%), crossbred (10%), and other (5%) breeds. One third of the wool clip is now the more valuable fine grades that are less than 19 microns in diameter. China is the top wool export destination (33%) followed by Italy (15%), Korea (7%), Taiwan (5%) and India (5%). Sheep meat is grown in this sector, but delivered through the ‘meat products’ sector. Meat production is about 640 000 tonnes annually from 32 million animals, with half exported and half consumed domestically. Six million live sheep are exported mainly to the Middle East. In constant dollar terms, the turnover of wool growing has halved over the last 30 years, while sheep and lambs have decreased by one fifth. Turnover in 2002 was about $4 billion and involved over 11 000 enterprises.

Place of Industry in the Economy

The sheep and shorn wool sector ranks 44t^{h} out of 135 sectors in terms of value adding in the economy, and contributes 0.46% of GDP in this analysis. It is similar in value adding to the meat products and plastic products sectors. It is a moderate employer with 31 000 employment years directly embodied in final demand, and another 11 000 years in the sector’s suppliers, giving a total of 42 000 employment years. In addition, the sector supplies 24 000 employment years to the final demand of downstream industries such as processed wool, meat products, and clothing. The sector has relatively large resource requirements in absolute terms, with over 20% of national land disturbance, 2.7% of water use, 2.8% of greenhouse emissions, and 0.3% of energy use. In financial terms, exports are nearly 20 times the level of imports.

Strategic Overview

The spider diagram portrays the sheep and wool sector with a number of pronounced outliers for the environmental indicators of land disturbance, water use and greenhouse emissions. The financial indicators, as well as the social indicator of employment generation, are well above average. The environmental indicators reflect the physical realities of the production process, which are indexed against a market price currently struggling to maintain an appropriate exchange value that reflects the complexity of the production chain. Downstream issues include animal welfare, the live sheep trade, landscape health and biodiversity loss. Although there is much media comment on the demise of the wool industry, the sector is still important for the rural economy and provides an important underpinning for many rural communities, and for efficient and viable farm production systems.

TBL Account #1

The financial indicator of operating surplus is 45% above average, with a direct sector effect of 75% and a long chain of 1% contributors such as shearing, hay growing, machinery repairs, wholesale trade and banking. The social indicator of employment generation is 30% above average, with a direct effect of 74%, and a composition similar to the surplus indicator. The environmental indicator of greenhouse emissions is six times the average, and is discussed in more detail below.

TBL Accounts #2 and #3

The second TBL account shows an export propensity four times the average, an income indicator 50% below average and a water use indicator nearly six times the average. The third TBL account shows import penetration 60% below average, government revenue 20% below average, and land disturbance 45 times the average. Water use and land disturbance are discussed below.

Structural Path Analysis and Linkages

The environmental indicators of greenhouse emissions, water use, and land disturbance are all substantially above average. In all cases the direct sector effect dominates, with 94% of the greenhouse emissions, 78% of water use, and 100% of land disturbance indicating improvement should be within sector. Fuel use produces only 2% of greenhouse emissions. Most (97%) are due to methane from the digestion processes in sheep, with higher levels of emissions from sheep grazing poor quality pastures. Water use is due to irrigated pasture and crop that is used primarily to fatten lambs and to accelerate live weight gain (flushing) in ewes to stimulate ovulation and subsequent pregnancy. Much of the market success of lamb meats in the past decade has been due to the ability of the production system to provide high quality tasty meat in most months of the year. While production zones are matched where possible to the highest likelihood of seasonally green pasture, the inherent variability of Australian animal production systems means that irrigated pasture provides the essential buffer. Feedlotting of sheep is being used to grow lambs out, but there may be a fine balance in consumer acceptance between ‘lambs from grass’ and ‘lambs from lots’. The land use indicator is an integration of intensively managed land that can carry more than 20 sheep per hectare, and extensive pastoral land that requires more than 20 hectares per sheep. If the land disturbance account used in the study was complemented by measurements of biodiversity loss, it is possible that the land disturbance underlying sheep and wool production might be reduced. Some methods of environmental accounting would suggest the moderate prices paid for the products do not adequately reflect the full suite of environmental services embodied in them.

The sector’s stimulus to its upstream suppliers is 25% below average and impacts on services to agriculture (shearing), wholesale trade, accounting and marketing, road transport, and property services. The linkages to downstream industries are 20% below average mainly because of the large export of product. The linkages to downstream industries suggest that any expansion in wool and sheep should be led by expansion in processed wool and fabrics, meat products, and clothing.

Future Trends in Sector

The base case scenario of the *Future Dilemmas* study anticipates that production of both wool and sheep meats doubles by 2050, driven by a new affluent vision for wool fabrics, and a worldwide demand for sheep meats from both affluent (lamb) and basic (mutton) markets.

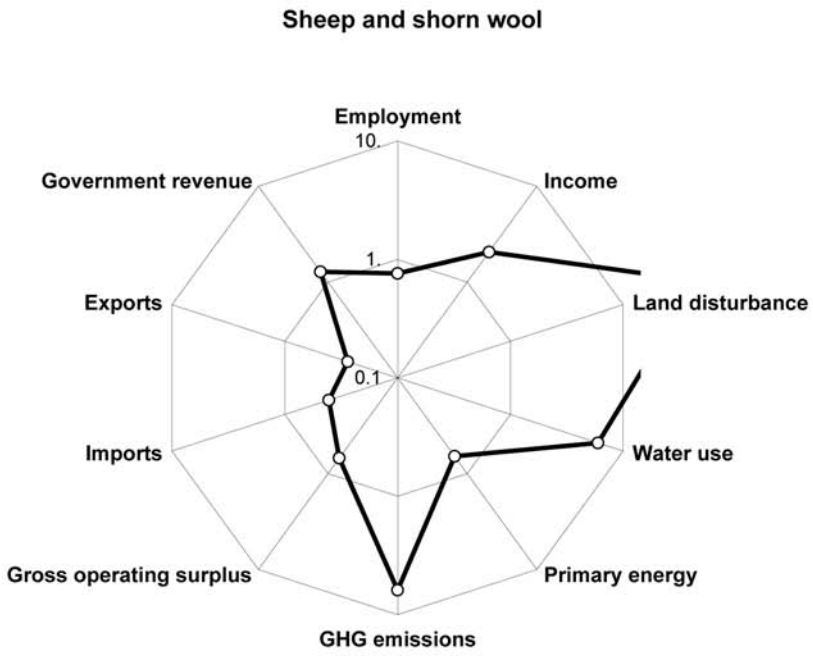
Innovation and Technical Opportunities

Wool has lost many opportunities for innovative uses over the last five decades. It is currently hampered by a highly fragmented production chain and difficulty in delivering container sized lots of agreed specification on demand. Simplifying the production chain may help craft its future.

Sector **Sheep and shorn wool** **(Wo)**

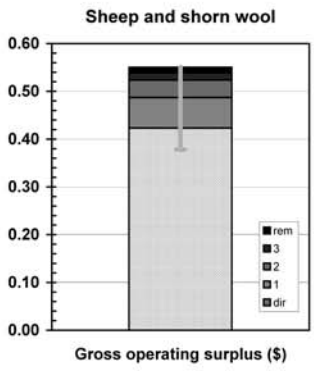
Sheep, lambs and shorn wool

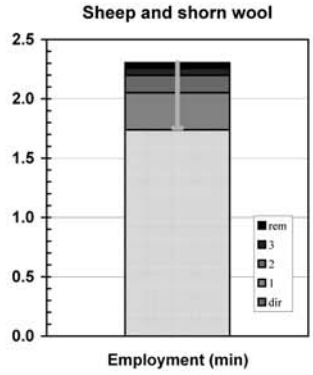
Spider diagram

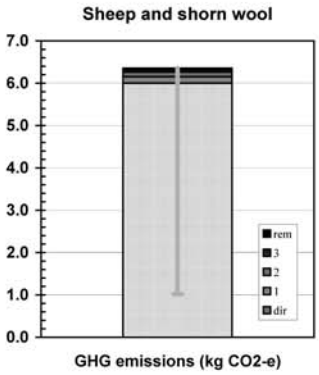


Bar graphs

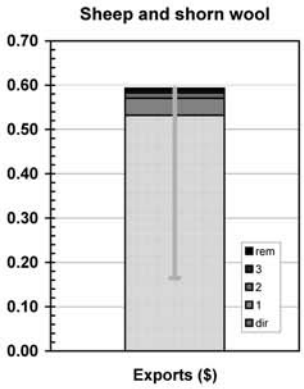
Account #1

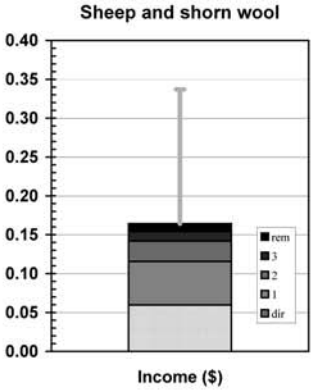


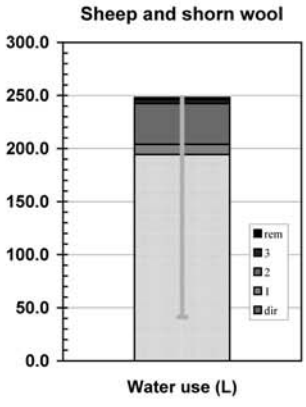




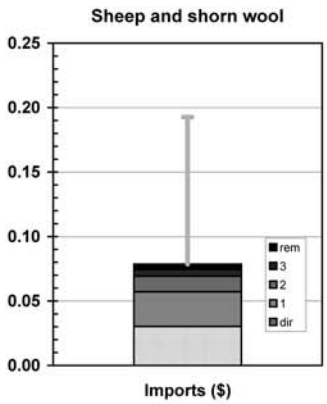
Account #2

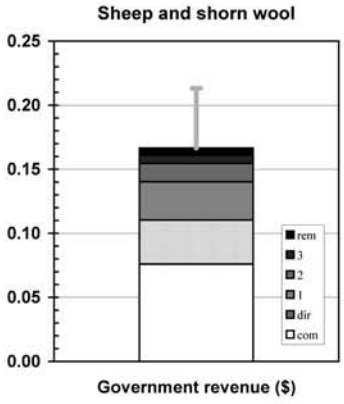


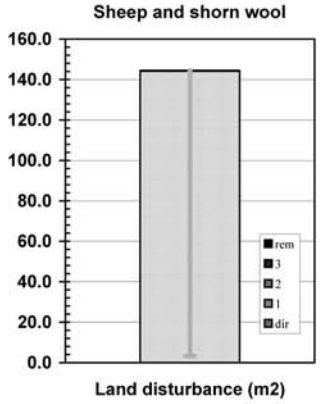




Account #3







National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 14.1	(0.01% of total)	($m 14.1 domestically produced)
Government final consumption	$m 0.0		
Gross fixed capital expenditure	$m 129.1	(0.12% of total)	($m 129.1 domestically produced)
Net changes in stocks	-$m 325.7	-(18.42% of total)	
Sectoral GNE	**-$m 182.4**	**(0.04% of GNE)**	
Exports	$m 2,117.9	(2.54% of total)	($m 2,117.9 domestically produced)
Final demand	**$m 1,935.4**	**(0.36% of GNT)**	**($m 1,935.4 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 237.3	(0.14% of total)	
Gross operating surplus	$m 1,685.5	(0.88% of total)	
Taxes less subsidies	$m 137.3	(0.16% of total)	
Sectoral GDP*	**$m 2,060.1**	**(0.46% of GDP)**	
Imports	$m 120.2	(0.12% of total)	
Primary inputs	**$m 2,180.3**	**(0.40% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 1,685.5	(0.88%)	$m 956.9	(0.50%)	$m 1,245.0	(0.65%)
Exports ($m)	$m 2,117.9	(2.54%)	$m 1,202.4	(1.44%)	$m 1,341.4	(1.61%)
Imports ($m)	$m 120.2	(0.12%)	$m 68.2	(0.07%)	$m 177.8	(0.18%)
Employment (e-y)	55,465 e-y	(0.78%)	31,490 e-y	(0.44%)	41,758 e-y	(0.59%)
Income ($m)*	$m 237.3	(0.14%)	$m 134.7	(0.08%)	$m 371.4	(0.22%)
Government revenue ($m)†	$m 308.9	(0.29%)	$m 249.5	(0.23%)	$m 376.4	(0.35%)
GHG emissions (kt CO_2-e)	23,899 kt	(4.61%)	13,568 kt	(2.62%)	14,373 kt	(2.77%)
Water use (ML)	773,641 ML	(3.69%)	439,229 ML	(2.10%)	560,695 ML	(2.68%)
Land disturbance (kha)	57,392 kha	(35.52%)	32,584 kha	(20.03%)	32,677 kha	(20.08%)
Primary energy (TJ)	9,247 TJ	(0.24%)	5,250 TJ	(0.14%)	11,409 TJ	(0.29%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.42	0.55	0.38
Exports ($)	0.53	0.59	0.16
Imports ($)	0.03	0.08	0.19
Employment (min)	1.74	2.30	1.75
Income ($)	0.06	0.16	0.34
Government revenue ($)	0.11	0.17	0.21
GHG emissions (kg CO_2-e)	6.00	6.36	1.02
Water use (L)	194.26	247.98	41.32
Land disturbance (m^2)	144.11	144.52	3.21
Primary energy (MJ)	2.32	5.05	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Wo	0.423	(0; 77.%)	Wo	1.74	(0; 75.%)	Wo	6.0	(0; 94.%)
Cg Wo	0.00962	(1; 1.7%)	Cg Wo	0.0634	(1; 2.7%)	Fr Wo	0.0392	(1; 0.62%)
Vf Wo	0.00708	(1; 1.3%)	Wt Wo	0.0416	(1; 1.8%)	Sc Cg Wo	0.0347	(2; 0.55%)
Sc Cg Wo	0.00705	(2; 1.3%)	Vf Wo	0.0351	(1; 1.5%)	El Wo	0.0218	(1; 0.34%)
Rv Wo	0.00603	(1; 1.1%)	Sc Cg Wo	0.035	(2; 1.5%)	Ch Wo	0.0191	(1; 0.3%)
Wt Wo	0.00578	(1; 1.1%)	Rd Wo	0.0204	(1; 0.89%)	Fo Wo	0.0177	(1; 0.28%)
Bk Wo	0.00386	(1; 0.7%)	Ms Wo	0.0172	(1; 0.75%)	Vf Wo	0.0137	(1; 0.22%)
Ms Wo	0.00384	(1; 0.7%)	Rv Wo	0.0161	(1; 0.7%)	Fr Vf Wo	0.00819	(2; 0.13%)
Rd Wo	0.00347	(1; 0.63%)	Bk Wo	0.0153	(1; 0.66%)	Fr Sc Cg Wo	0.00816	(3; 0.13%)
Cm Wo	0.00304	(1; 0.55%)	Nb Wo	0.0126	(1; 0.54%)	Fe Wo	0.00602	(1; 0.095%)
Oi Fo Wo	0.00252	(2; 0.46%)	Ho Wo	0.00974	(1; 0.42%)	Wt Wo	0.00577	(1; 0.091%)
Wh Wo	0.00195	(1; 0.35%)	Wh Wo	0.00962	(1; 0.42%)	Rd Wo	0.00551	(1; 0.087%)
St Wo	0.00186	(1; 0.34%)	Cm Wo	0.0084	(1; 0.36%)	Oi Fo Wo	0.00533	(2; 0.084%)
Ch Wo	0.0016	(1; 0.29%)	Rh Wo	0.00656	(1; 0.28%)	Wh Wo	0.00411	(1; 0.065%)
Ac Wo	0.00141	(1; 0.26%)	Ac Wo	0.00507	(1; 0.22%)	Cg Wo	0.00301	(1; 0.047%)
Sf Bk Wo	0.00135	(2; 0.24%)	Ts Wo	0.00497	(1; 0.22%)	Fd Wo	0.00294	(1; 0.046%)
Nb Wo	0.00123	(1; 0.22%)	Fn Wo	0.00489	(1; 0.21%)	El Ch Wo	0.00288	(2; 0.045%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Wo	0.532	(0; 90.%)	Wo	0.0596	(0; 36.%)	Wo	194.3	(0; 78.%)
Cg Wo	0.0169	(1; 2.9%)	Cg Wo	0.0109	(1; 6.6%)	Sc Cg Wo	36.3	(2; 15.%)
Wt Wo	0.00473	(1; 0.8%)	Wt Wo	0.00894	(1; 5.4%)	Vf Wo	7.32	(1; 3.%)
Wh Wo	0.0025	(1; 0.42%)	Ms Wo	0.004	(1; 2.4%)	Wh Wo	0.994	(1; 0.4%)
Ch Wo	0.00223	(1; 0.38%)	Bk Wo	0.00378	(1; 2.3%)	Sc Cg Vf Wo	0.76	(3; 0.31%)
Vf Wo	0.00214	(1; 0.36%)	Rd Wo	0.00351	(1; 2.1%)	Sc Cg Sc Cg \	0.756	(4; 0.31%)
Oi Fo Wo	0.00172	(2; 0.29%)	Vf Wo	0.00289	(1; 1.8%)	Wa Wo	0.71	(1; 0.29%)
Rd Wo	0.00121	(1; 0.2%)	Sc Cg Wo	0.00287	(2; 1.8%)	Su Fd Wo	0.356	(2; 0.14%)
Ac Wo	0.000993	(1; 0.17%)	Rv Wo	0.0026	(1; 1.6%)	Ri Fc Wo	0.333	(2; 0.13%)
Rf Wo	0.00081	(1; 0.14%)	Cm Wo	0.00191	(1; 1.2%)	Ba Wo	0.132	(1; 0.053%)
Fd Wo	0.000809	(1; 0.14%)	Nb Wo	0.00187	(1; 1.1%)	El Wo	0.121	(1; 0.049%)
Fo Wo	0.000719	(1; 0.12%)	Ho Wo	0.00142	(1; 0.86%)	Wa Ms Wo	0.0987	(2; 0.04%)
Ms Wo	0.000594	(1; 0.1%)	Ac Wo	0.00129	(1; 0.79%)	Ws Wo	0.0948	(1; 0.038%)
Ho Wo	0.000542	(1; 0.091%)	Ts Wo	0.00116	(1; 0.71%)	Wa Cg Wo	0.0731	(2; 0.029%)
At Wo	0.000519	(1; 0.087%)	In Wo	0.00112	(1; 0.68%)	Ws Ho Wo	0.071	(2; 0.029%)
St Wo	0.00046	(1; 0.077%)	Rf Wo	0.00111	(1; 0.68%)	Su Fd Cg Wo	0.0612	(3; 0.025%)
Cm Wo	0.000405	(1; 0.068%)	Ch Wo	0.000989	(1; 0.6%)	Sc Cg Wh Wo	0.0587	(3; 0.024%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Wo	0.0302	(0; 38.%)	Wo	0.0345	(0; 38.%)	Wo	144.1	(0; 100.%)
Fo Wo	0.0058	(1; 7.4%)	Cg Wo	0.00571	(1; 6.3%)	Wh Wo	0.145	(1; 0.1%)
Cg Wo	0.0027	(1; 3.4%)	Wt Wo	0.00418	(1; 4.6%)	Sc Cg Wo	0.0477	(2; 0.033%)
Ac Wo	0.00267	(1; 3.4%)	Rd Wo	0.00249	(1; 2.7%)	Ba Wo	0.0156	(1; 0.011%)
Ch Wo	0.00223	(1; 2.8%)	Bk Wo	0.00209	(1; 2.3%)	Bc Mp Ho Wo	0.014	(3; 0.0097%)
Vf Wo	0.00174	(1; 2.2%)	Ms Wo	0.0019	(1; 2.1%)	Fr Wo	0.0126	(1; 0.0087%)
Sc Cg Wo	0.00174	(2; 2.2%)	Vf Wo	0.00177	(1; 2.%)	Bc Mp Ch Wo	0.00761	(3; 0.0053%)
Wt Wo	0.00134	(1; 1.7%)	Sc Cg Wo	0.00177	(2; 1.9%)	Bc Mp Wo	0.00728	(2; 0.005%)
Rd Wo	0.00088	(1; 1.1%)	Rv Wo	0.0016	(1; 1.8%)	Vf Wo	0.00691	(1; 0.0048%)
Ms Wo	0.000873	(1; 1.1%)	In Wo	0.0012	(1; 1.3%)	Bc Mp Fd Wo	0.00639	(3; 0.0044%)
Rv Wo	0.000782	(1; 0.99%)	Cm Wo	0.000912	(1; 1.%)	Wh Ac Wo	0.00406	(2; 0.0028%)
Ap Wo	0.000745	(1; 0.95%)	Nb Wo	0.000788	(1; 0.87%)	Bc Ch Wo	0.00383	(2; 0.0026%)
Fe Wo	0.000734	(1; 0.93%)	Ho Wo	0.000748	(1; 0.83%)	Wh Fc Wo	0.00288	(2; 0.002%)
Pc Wo	0.000635	(1; 0.81%)	Ts Wo	0.000573	(1; 0.63%)	Wo Tx Ac Wo	0.00285	(3; 0.002%)
Rh Wo	0.000554	(1; 0.7%)	Rf Wo	0.00051	(1; 0.56%)	Wh Fd Wo	0.00279	(2; 0.0019%)
Cm Wo	0.00052	(1; 0.66%)	Ch Wo	0.000493	(1; 0.54%)	Fr Vf Wo	0.00263	(2; 0.0018%)
Ac Cg Wo	0.000479	(2; 0.61%)	Fn Wo	0.000448	(1; 0.49%)	Fr Sc Cg Wo	0.00262	(3; 0.0018%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.726 ±0.011	(±1.5%)
Downstream	0.822 ±0.034	(±4.1%)

Sector 1210020: Barley (Ba)

Unmilled barley

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is over two times the average, water use is over seven times the average, and land disturbance is over ten times the average. The social indicators reveal that employment generation is 60% above average, income is 40% below average, and government revenue is 70% below average. The financial indicators show that the operating surplus is 60% above average, export propensity is three times the average, and import penetration is 40% below average. The sector faces a reasonably optimistic future if its malting barley products can consistently meet the stringent requirements for individual beer varieties at home and abroad. The analysis highlights land, water and greenhouse issues in the production systems, which are mostly direct effects and so open to sector management.

Sector Description

Barley production averages around six million tonnes per year, from three million hectares of planted land, at a yield of about two tonnes per hectare. Two million tonnes are consumed domestically for animal feed and food (including malt for beer) and four million tonnes are exported, of which 500 000 tonnes are in a pre-processed malt form for brewers in Japan, the Philippines, Korea and China. South Australia and Victoria together account for about two thirds of national production. Exports are composed of feed barley (50%), malting barley (30%) and processed malt (20%). In constant dollar terms, the turnover of the barley growing sector is at the same level as it was 30 years ago, although year to year fluctuations due to climatic variation have been high. Financial turnover is about $1 billion per annum.

Place of Industry in the Economy

The barley growing sector ranks 120th out of 135 in terms of value adding in the economy and contributes 0.06% of GDP in this analysis. It is similar in value adding to railway equipment manufacturing, and silver and zinc ore mining. It has small employment generation with 3 000 employment years directly embodied in final demand, and a further 1 000 years in the sector's suppliers, giving a total of 4 000 employment years. In addition, the sector supplies over 5 000 employment years to the final demand of downstream industries such as beer and malt, accommodation cafes and restaurants, animal foods, and meat products. The sector's absolute resource requirements are small with less than one tenth of one percent of national energy use and greenhouse emissions, and three tenths and four tenths of one percent respectively of water use and land disturbance. In financial terms, exports are ten times the level of imports.

Strategic Overview

The spider diagram portrays above average financial indicators, mixed social indicators, and three outliers for the environmental indicators of land disturbance, water use and greenhouse emissions. A major issue for barley and other grain crops is the moderate yield of about two tonnes per ha, versus a potential yield of more than six tonnes per ha. The solution is not as simple as increasing nitrogen fertiliser which, if incorrectly applied, will increase greenhouse emissions through release of nitrous oxides. Downstream issues for barley growing and other cereals include yearly soil erosion rates of 2.7 tonnes per ha (or more than one tonne of soil lost per tonne of production), its part in fragmentation of landscapes and biodiversity loss (in the absence of tree plantings), and the challenges of dryland salinity, soil acidification and soil compaction in agricultural landscapes.

TBL Account #1

The financial indicator of operating surplus is 40% greater than average, with a direct sector effect of 66% and contributions from wholesale trade (2%), forwarding and storage (1%), road transport (1%), and banking (1%). The social indicator of employment is 45% greater than average and two thirds of this is a direct sector effect with the remaining contributions similar to the surplus indicator. The environmental indicator of greenhouse emissions is two and a half times the average and composed of a direct effect of 78% with contributions from electricity production (1%), manufacture of basic chemicals (1%) and diesel refining (1%). Combustion of fuels from machinery use produce 6% of total emissions and methane 4%. The majority (90%) are due to nitrous oxides from nitrogen volatilisation. Lowering nitrous oxide emissions will require a parsimonious and knowledge intensive approach to nitrogen fertiliser application. For malting barley with a protein goal of around 11%, nitrogen is best applied early in the season. For feed barley, nitrogen application is best later in the season, when soil moisture conditions are known. Inhibitors which restrict nitrogen volatilisation and allow a steady release in line with growth are being investigated in field trials. Inhibitors can be applied directly to the soil or incorporated with the fertiliser.

TBL Accounts #2 and #3

The second TBL account shows that export propensity is three times the average, income is 45% below average, and water use is nearly seven times the average. The third TBL account shows that import penetration is 50% below average, government revenue is 50% below average, and land disturbance is more than ten times the average.

Structural Path Analysis and Linkages

The structural path analyses for the water use and land disturbance indicators reveal that the direct sector effect is 82% for water and 87% for land disturbance, reflecting the large proportion of raw barley that reaches final demand. Like other agricultural commodities, barley does not generate substantial value adding until it enters the processing streams of malting for beer and malt, or prepared animal feed for pigs and feedlot cattle. The physical requirements in land and water are thus divided by a smaller final demand (lower dollar returns). Increased prices for basic grains or improved yields could help improve these indicators, although the economic laws of supply and demand exert strong constraints on these linked parameters.

The sector's stimulus to its upstream suppliers is average and impacts on wholesale trade, road transport, accounting and marketing and property services. The linkages to downstream sectors are 60% stronger than average and suggest that sector expansion must be led by expansion of sectors such as beer and malt, accommodation cafes and restaurants, animal foods, and meat products.

Future Trends in Sector

While the base case scenario of the *Future Dilemmas* study viewed barley as part of a grouped grains commodity, industry anticipates that barley production could grow by 60% to nearly 10 million tonnes per annum by 2050. This future will be driven by improved grain varieties, and better management of fertilisers and soil water, rather than increased planting areas in Southern Australia.

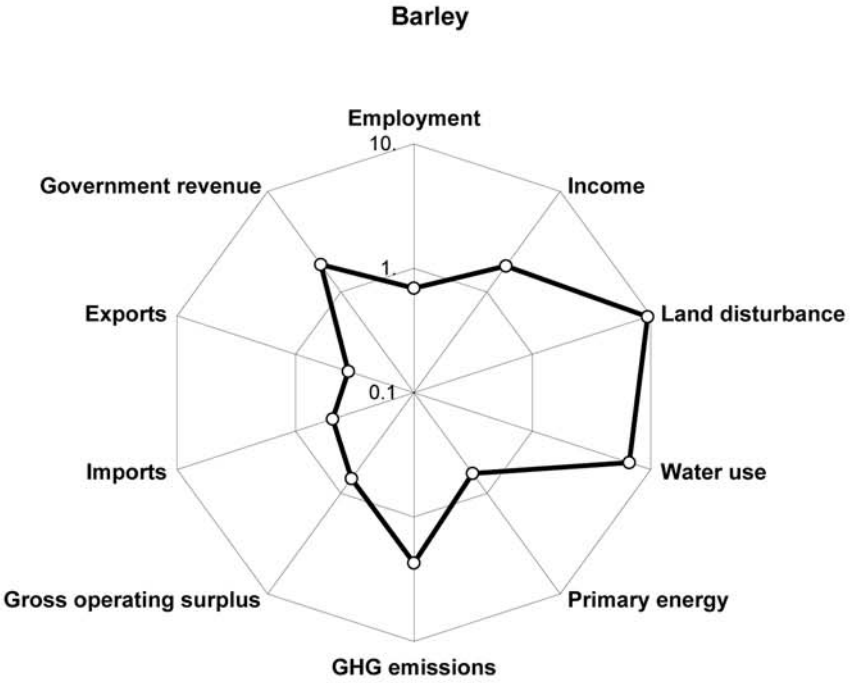
Innovation and Technical Opportunities

A tension exists between the specific production requirements for malting barley and the volume orientated production systems for barley used in animal feeding. With the expectation that the Asian brewing market will be buoyant for the next five decades, varieties are being purpose bred for diastatic power (enzymes to convert grain starch to fermentable sugars), protein levels and grain size. Malting requirements are highly specific and vary markedly for domestic and overseas beers.

Sector **Barley** **(Ba)**

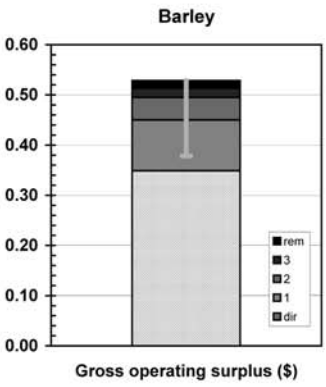
Barley, unmilled

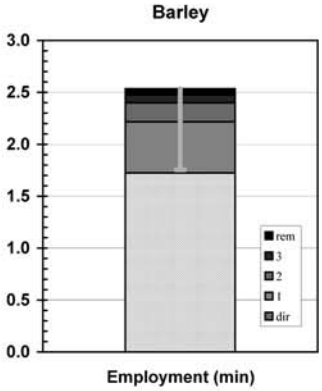
Spider diagram

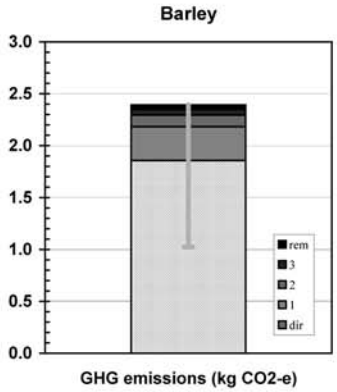


Bar graphs

Account #1







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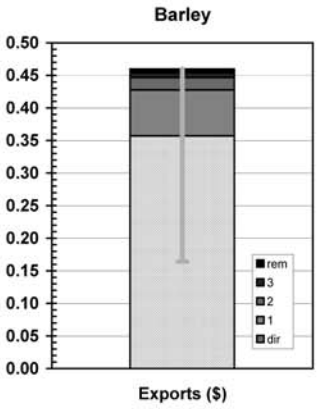

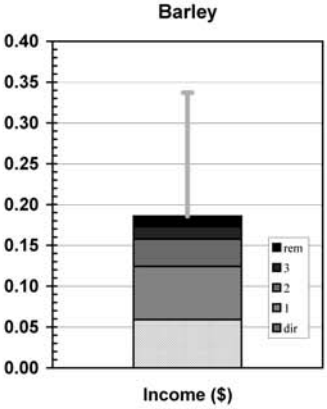

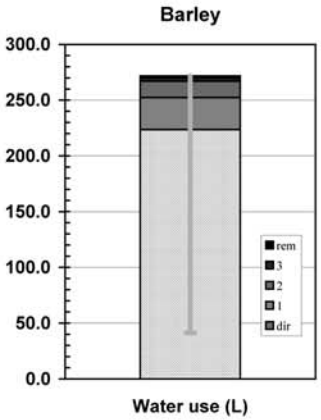

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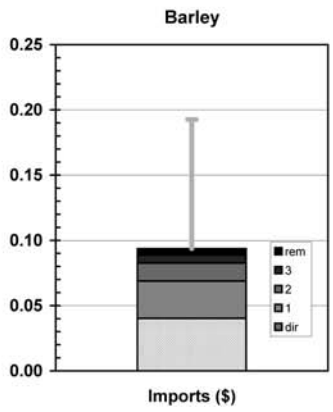
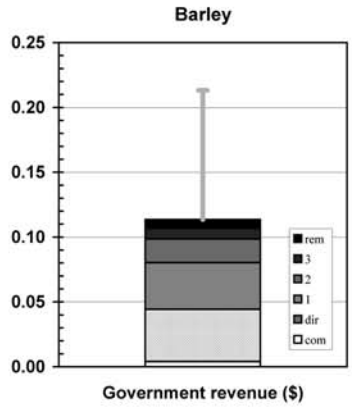
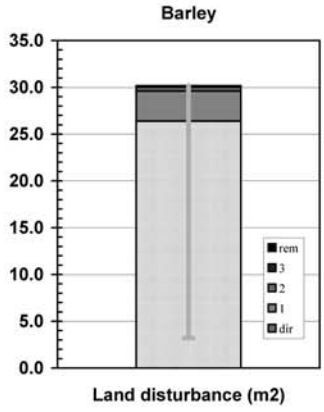






National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 0.0		
Government final consumption	$m 0.0		
Gross fixed capital expenditure	$m 0.0		
Net changes in stocks	-$m 18.4	-(1.04% of total)	
Sectoral GNE	**-$m 18.4**	**(0.00% of GNE)**	
Exports	$m 203.3	(0.24% of total)	($m 203.3 domestically produced)
Final demand	**$m 184.9**	**(0.03% of GNT)**	**($m 185.6 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 33.7	(0.02% of total)	
Gross operating surplus	$m 198.7	(0.10% of total)	
Taxes less subsidies	$m 23.0	(0.03% of total)	
Sectoral GDP*	**$m 255.3**	**(0.06% of GDP)**	
Imports	$m 22.9	(0.02% of total)	
Primary inputs	**$m 278.2**	**(0.05% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 198.7	(0.10%)	$m 70.9	(0.04%)	$m 107.5	(0.06%)
Exports ($m)	$m 203.3	(0.24%)	$m 72.6	(0.09%)	$m 93.5	(0.11%)
Imports ($m)	$m 22.9	(0.02%)	$m 8.2	(0.01%)	$m 19.1	(0.02%)
Employment (e-y)	7,869 e-y	(0.11%)	2,810 e-y	(0.04%)	4,130 e-y	(0.06%)
Income ($m)*	$m 33.7	(0.02%)	$m 12.0	(0.01%)	$m 37.8	(0.02%)
Government revenue ($m)†	$m 23.8	(0.02%)	$m 9.0	(0.01%)	$m 23.1	(0.02%)
GHG emissions (kt CO_2-e)	1,058 kt	(0.20%)	378 kt	(0.07%)	487 kt	(0.09%)
Water use (ML)	127,255 ML	(0.61%)	45,435 ML	(0.22%)	55,264 ML	(0.26%)
Land disturbance (kha)	1,502 kha	(0.93%)	536 kha	(0.33%)	614 kha	(0.38%)
Primary energy (TJ)	923 TJ	(0.02%)	330 TJ	(0.01%)	987 TJ	(0.03%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.35	0.53	0.38
Exports ($)	0.36	0.46	0.16
Imports ($)	0.04	0.09	0.19
Employment (min)	1.72	2.53	1.75
Income ($)	0.06	0.19	0.34
Government revenue ($)	0.04	0.11	0.21
GHG emissions (kg CO_2-e)	1.86	2.39	1.02
Water use (L)	223.46	271.79	41.32
Land disturbance (m^2)	26.38	30.18	3.21
Primary energy (MJ)	1.62	4.85	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Ba	0.349	(0; 66.%)	Ba	1.72	(0; 68.%)	Ba	1.86	(0; 78.%)
Wt Ba	0.0094	(1; 1.8%)	Wt Ba	0.0677	(1; 2.7%)	El Ba	0.0251	(1; 1.1%)
St Ba	0.00667	(1; 1.3%)	Rd Ba	0.0339	(1; 1.3%)	Ch Ba	0.0186	(1; 0.78%)
Rd Ba	0.00576	(1; 1.1%)	Bk Ba	0.02	(1; 0.79%)	Fo Ba	0.0122	(1; 0.51%)
Bk Ba	0.00503	(1; 0.95%)	Cg Ba	0.0183	(1; 0.72%)	Sc Cg Ba	0.01	(2; 0.42%)
Rv Ba	0.0049	(1; 0.93%)	Rh Ba	0.0156	(1; 0.62%)	Fe Ba	0.00992	(1; 0.41%)
Ms Ba	0.00307	(1; 0.58%)	Rf Ba	0.0143	(1; 0.57%)	Wt Ba	0.00938	(1; 0.39%)
Cg Ba	0.00278	(1; 0.53%)	Ms Ba	0.0137	(1; 0.54%)	Rd Ba	0.00915	(1; 0.38%)
Rh Ba	0.00256	(1; 0.48%)	Rv Ba	0.0131	(1; 0.52%)	El Rf Ba	0.00522	(2; 0.22%)
Sc Cg Ba	0.00204	(2; 0.39%)	St Ba	0.0109	(1; 0.43%)	Rf Ba	0.0052	(1; 0.22%)
Rf Ba	0.00179	(1; 0.34%)	Sc Cg Ba	0.0101	(2; 0.4%)	Oi Fo Ba	0.00368	(2; 0.15%)
St Wt Ba	0.00179	(2; 0.34%)	Nb Ba	0.00999	(1; 0.39%)	El Wt Ba	0.00282	(2; 0.12%)
Sf Bk Ba	0.00176	(2; 0.33%)	Ho Ba	0.00877	(1; 0.35%)	El Ch Ba	0.0028	(2; 0.12%)
Oi Fo Ba	0.00174	(2; 0.33%)	Ts Ba	0.00718	(1; 0.28%)	El St Ba	0.00278	(2; 0.12%)
Ts Ba	0.00159	(1; 0.3%)	Ma Ba	0.00628	(1; 0.25%)	Fr Sc Cg Ba	0.00236	(3; 0.099%)
Ch Ba	0.00155	(1; 0.29%)	Ms Wt Ba	0.00611	(2; 0.24%)	Ap Ba	0.00177	(1; 0.074%)
Wa Ba	0.00144	(1; 0.27%)	Fn Ba	0.00466	(1; 0.18%)	Bc Mp Ho Ba	0.00174	(3; 0.073%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Ba	0.357	(0; 78.%)	Ba	0.0591	(0; 32.%)	Ba	223.5	(0; 82.%)
Wt Ba	0.00768	(1; 1.7%)	Wt Ba	0.0145	(1; 7.8%)	Sc Cg Ba	10.5	(2; 3.9%)
Cg Ba	0.0049	(1; 1.1%)	Rd Ba	0.00582	(1; 3.1%)	Wa Ba	1.06	(1; 0.39%)
Rf Ba	0.00294	(1; 0.64%)	Bk Ba	0.00493	(1; 2.7%)	Sc Cg Sc Cg I	0.219	(4; 0.08%)
Ch Ba	0.00216	(1; 0.47%)	Rf Ba	0.00402	(1; 2.2%)	El Ba	0.139	(1; 0.051%)
Rd Ba	0.002	(1; 0.44%)	Ms Ba	0.0032	(1; 1.7%)	Wa Ms Ba	0.0788	(2; 0.029%)
St Ba	0.00165	(1; 0.36%)	Cg Ba	0.00315	(1; 1.7%)	Ws Ho Ba	0.0639	(2; 0.024%)
Oi Fo Ba	0.00119	(2; 0.26%)	St Ba	0.00278	(1; 1.5%)	Ch Ba	0.0568	(1; 0.021%)
Ma Ba	0.000922	(1; 0.2%)	Rv Ba	0.00211	(1; 1.1%)	Bc Mp Ho Ba	0.0458	(3; 0.017%)
Ac Ba	0.000758	(1; 0.16%)	In Ba	0.00177	(1; 0.96%)	Dc Dp Ho Ba	0.038	(3; 0.014%)
Fo Ba	0.000496	(1; 0.11%)	Rh Ba	0.00171	(1; 0.92%)	Wt Ba	0.0379	(1; 0.014%)
Ho Ba	0.000488	(1; 0.11%)	Ts Ba	0.00168	(1; 0.9%)	Wa Ms Wt Ba	0.035	(3; 0.013%)
Ms Ba	0.000475	(1; 0.1%)	Nb Ba	0.00149	(1; 0.8%)	Fe Ba	0.0317	(1; 0.012%)
St Wt Ba	0.000444	(2; 0.097%)	Ms Wt Ba	0.00142	(2; 0.76%)	Ri Fc Ho Ba	0.0295	(3; 0.011%)
Bk Ba	0.000392	(1; 0.085%)	Ho Ba	0.00128	(1; 0.69%)	Wa Pd Wt Ba	0.0295	(3; 0.011%)
At Wt Ba	0.000364	(2; 0.079%)	Ma Ba	0.00118	(1; 0.63%)	El Rf Ba	0.0289	(2; 0.011%)
In Ba	0.000344	(1; 0.075%)	Ac Ba	0.000985	(1; 0.53%)	St Ba	0.0288	(1; 0.011%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Ba	0.0402	(0; 43.%)	Ba	0.0403	(0; 37.%)	Ba	26.4	(0; 87.%)
Fo Ba	0.004	(1; 4.3%)	Wt Ba	0.00679	(1; 6.2%)	Sc Cg Ba	0.0138	(2; 0.046%)
Wt Ba	0.00218	(1; 2.3%)	Rd Ba	0.00413	(1; 3.8%)	Bc Mp Ho Ba	0.0126	(3; 0.042%)
Ch Ba	0.00217	(1; 2.3%)	Bk Ba	0.00272	(1; 2.5%)	Bc Mp Ch Ba	0.00739	(3; 0.025%)
Ac Ba	0.00204	(1; 2.2%)	In Ba	0.00191	(1; 1.7%)	Bc Mp Fe Ba	0.00413	(3; 0.014%)
Rd Ba	0.00146	(1; 1.6%)	Rf Ba	0.00185	(1; 1.7%)	Bc Ch Ba	0.00372	(2; 0.012%)
Rh Ba	0.00132	(1; 1.4%)	Cg Ba	0.00165	(1; 1.5%)	Wh Ac Ba	0.0031	(2; 0.01%)
Fe Ba	0.00121	(1; 1.3%)	Ms Ba	0.00152	(1; 1.4%)	Wo Tx Wt Ba	0.00241	(3; 0.008%)
Ma Ba	0.00109	(1; 1.2%)	St Ba	0.00148	(1; 1.4%)	Wo Tx Ac Ba	0.00217	(3; 0.0072%)
Ap Ba	0.000999	(1; 1.1%)	Rv Ba	0.0013	(1; 1.2%)	Bc Fe Ba	0.00208	(2; 0.0069%)
Cg Ba	0.00078	(1; 0.83%)	Ts Ba	0.000828	(1; 0.76%)	Rf Ba	0.00202	(1; 0.0067%)
Ms Ba	0.000697	(1; 0.74%)	Rh Ba	0.000785	(1; 0.72%)	Wo Tx Tp Ba	0.00184	(3; 0.0061%)
Rv Ba	0.000634	(1; 0.68%)	Ms Wt Ba	0.000675	(2; 0.62%)	Bc Mp Of Ba	0.00167	(3; 0.0055%)
St Ba	0.000604	(1; 0.64%)	Ho Ba	0.000673	(1; 0.61%)	Wo Mp Ho Ba	0.00143	(3; 0.0047%)
Sc Cg Ba	0.000502	(2; 0.54%)	Pd Wt Ba	0.000638	(2; 0.58%)	Bc Mp Ho Wt	0.00139	(4; 0.0046%)
Bk Ba	0.000487	(1; 0.52%)	Nb Ba	0.000627	(1; 0.57%)	Wo Tx Ba	0.00108	(2; 0.0036%)
Rf Ba	0.000463	(1; 0.49%)	Ma Ba	0.000568	(1; 0.52%)	Ba Bm Ho Ba	0.00103	(3; 0.0034%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.923 ±0.017	(±1.8%)
Downstream	1.627 ±0.064	(±3.9%)

Sector 1210040: Rice (Ri)

Rice in the husk

Short Summary

Rice growing is the primary sector which delivers paddy rice to the milling sector from which dietary rice and export products are obtained. The water intensity of production is over 200 times the average or 8400 litres per dollar of final consumption. The greenhouse intensity is over four times the average and due to methane production as well as fossil energy use. Land disturbance is 40% above average. Employment generation is 50% above average and most of this is located in regional areas. However income and government revenue are respectively 45% and 50% below average. For the financial indicators, operating surplus is 40% above average while export propensity and import penetration are 60% and 50% below average respectively. Rice in the husk or paddy rice is exported after processing in the milling sector and thus the export indicator is less relevant here. The sector shows strong downstream linkages to the sectors of milling, bakery products, wine and spirits, and accommodation and cafes. Increases in consumer demand provide an average upstream stimulus to suppliers including wholesale trade, road and railway freight, banking, property services and marketing. Increasing consumer prices to reflect the water and greenhouse emissions embodied per unit of product may be beneficial in environmental terms. However there could be complex interactions as domestic price increases may decrease exports and increase imports, and then impact on regional viability.

Sector Description

Around 150 000 hectares are sown to rice each year producing 1.3 million tonnes at a yield of 8-9 tonnes per hectare and a total crop value of $800 million. The rice industry is located around the Murrumbidgee and Murray Rivers in south eastern Australia and has been under development since the 1920s. About 2 500 farms produce rice and in any one year, only one third of the ‘rice area’ is planted, allowing a crop rotation system that breaks disease cycles and helps improve soil health. While Australian production is a small proportion of the total global production of 600 million tonnes per year, the industry exports 85% of production as branded and value added product. This represents 4% of world trade giving $500 million in trade receipts. Technological advances in the last decade have reduced water use by 30% per hectare and increased yield by 60% per megalitre (10^6 L) of irrigation water used.

Place of Industry in the Economy

The rice growing sector is a small part of the value adding part of the economy, ranking 132nd out of 135 and contributing 0.02% of GDP in this analysis. Because it requires processing in the flour and rice milling sector before it effectively becomes part of final demand, many of the embodied effects are shown in downstream products and services, rather than in this primary sector. It contributes 3 000 employment years to downstream sectors such as cereal foods and bakery products.

Strategic Overview

The integrated overview in the spider diagram shows major outliers for two social, and three environmental indicators. The issues highlighted are due to both production technologies and the relatively low farm gate product prices paid per unit of environmental input. Farm gate prices may need to increase by three to five times before technological mechanisms for reducing the greenhouse indicator are within reach. More advanced national water accounts which separate the water extracted and transpired from percolation back to stream flow could possibly improve the water intensity indicator.

TBL Account #1

The financial surplus is 40% above the economy wide average with two thirds of this a direct effect, and with smaller contributions from wholesale trade (2%) and road transport, storage, banking and machinery repairs (1% each). Employment generation is 50% above average with a composition similar to the financial surplus, emphasising the importance of the sector to this part of regional Australia. The greenhouse gas indicator is over four times the average with most of this being a direct within paddock effect.

TBL Accounts #2 and #3

The second TBL account shows an income indicator that is 45% below average and only one quarter of this reduced value is directly from the rice sector. The water indicator is the largest in this analysis at over 200 times the economy wide average, most of which is a direct within paddock effect of managed irrigation water. The export indicator is less relevant since exports are delivered from the milling sector. The third TBL account shows an import penetration 50% below average, government revenue 50% below average and land disturbance 40% above average.

Structural Path Analysis and Linkages

The structural chain for greenhouse emission shows that 82% of the total is a direct within paddock effect due mostly to methane production (in soils under water) with one tenth due to fuel combustion. Electricity production, fertiliser manufacture and diesel refining are minor parts of the greenhouse chain.

The downstream linkages are twice the average highlighting milling, accommodation and bakery products. Increased consumer demand give upstream suppliers a below average stimulus.

Future Trends in Sector

Both the CSIRO studies, *Future Dilemmas* and Decision Points, anticipate growth in rice production of 30-50% over the next 50 years driven by superior trade performance in affluent export markets, as well as focused industry expansion, management improvement and cultivar development. Both water and environmental issues may constrain industry activities over the next two decades if the public perception of Australia's water 'crisis' deepens. Consumer advice or product labelling initiatives that report the environmental resources and social returns embodied per physical unit of product may be part of the process required to engage Australian consumers in paying the whole-system production costs of all types of food and fibre consumption.

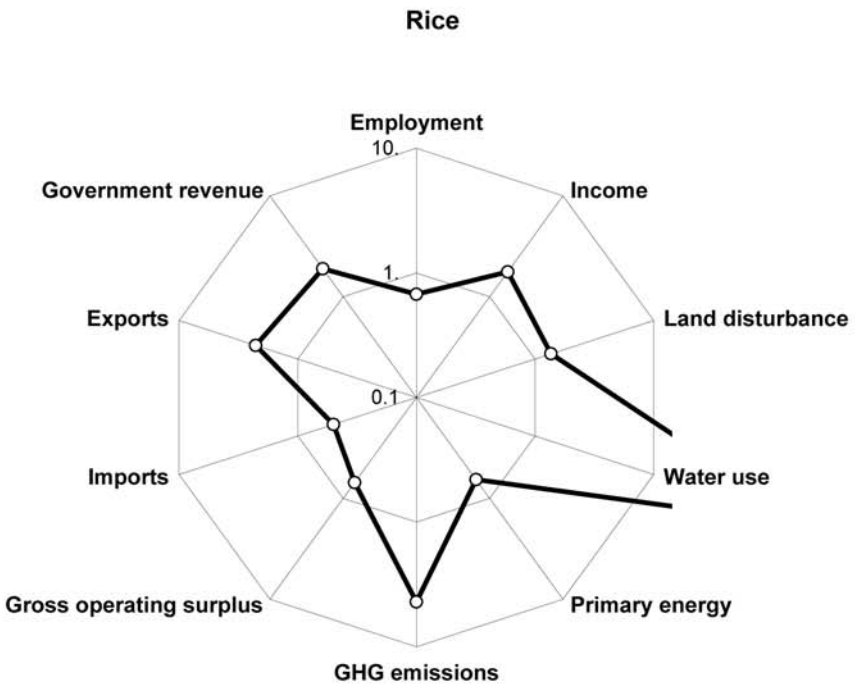
Innovation and Technical Opportunities

The most pressing issues for innovation are the water and greenhouse gas accounts. The interplay between choosing rice soils that have low groundwater recharge (soil surveys, electromagnetic surveying, assessment of soil sodicity) and crop rotation systems that keep the lower profile full, form an agronomic approach to constraining water use. Breeding perennial deep rooted rice cultivars is considered feasible if pursued vigorously at a global scale and may yield results in two to three decades. Dryland rice systems are available but may not meet the quality and productivity requirements of the Australian industry. However with development, they may offer a double return by decreasing water use, and methane production which makes up 90% of the greenhouse indicator. There may be two further avenues to reduce methane emissions. Different rice cultivars vary in methane production. Some soils also differ in methane metabolism depending on position in the soil profile and the periodicity of the wetting and drying cycle. A combination of new cultivars and altered management offers potential for managing methane production. It may also be possible to develop advantageous soil micro-organisms that neutralise the methane emitters.

Sector **Rice** **(Ri)**

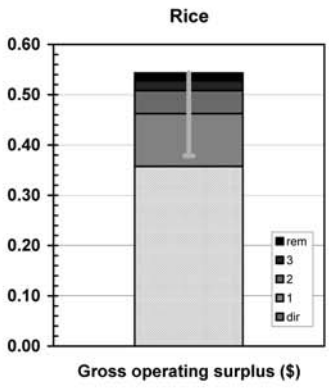
Rice, in the husk

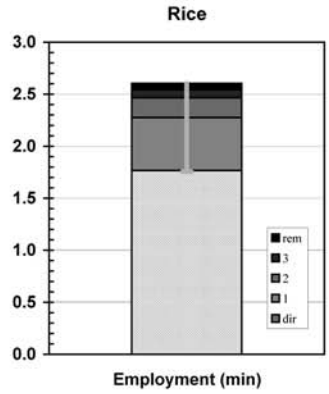
Spider diagram

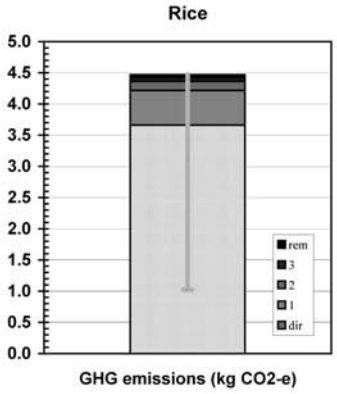


Bar graphs

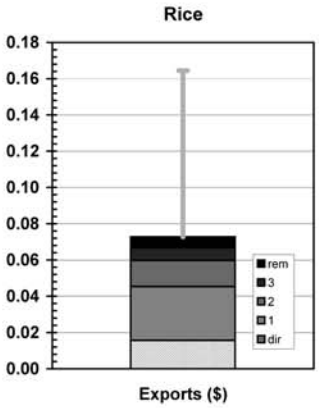
Account #1

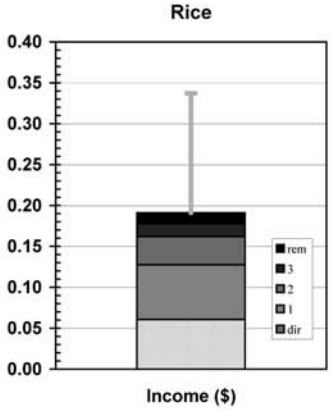


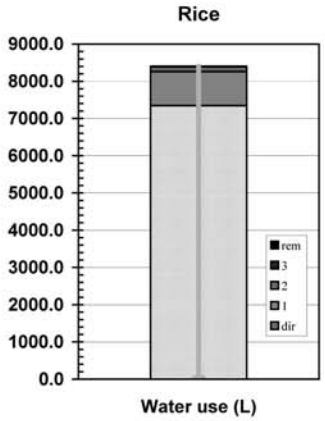




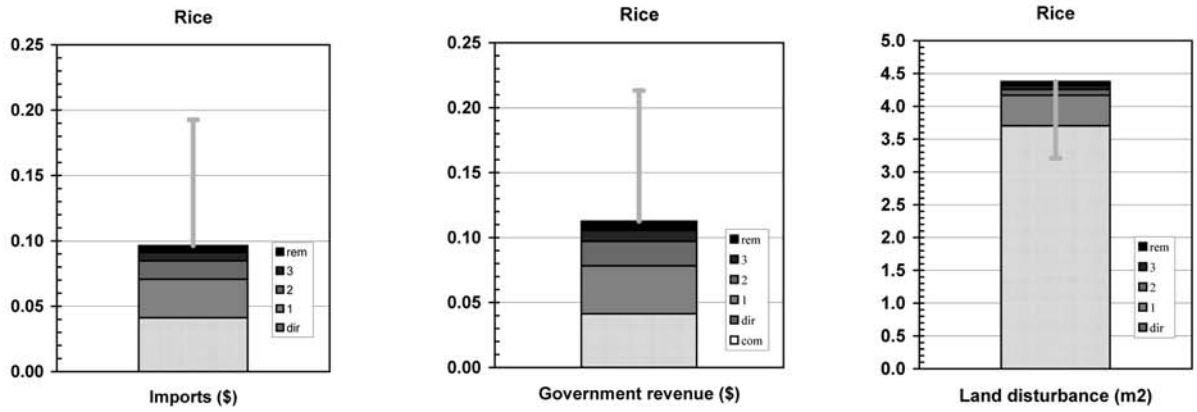
Account #2







Account #3



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Government final consumption	$m 0.0		
Gross fixed capital expenditure	$m 0.0		
Net changes in stocks	-$m 1.5	-(0.08% of total)	
Sectoral GNE	**-$m 1.5**	**(0.00% of GNE)**	
Exports	$m 3.1	(0.00% of total)	($m 3.1 domestically produced)
Final demand	**$m 1.6**	**(0.00% of GNT)**	**($m 1.6 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 11.8	(0.01% of total)	
Gross operating surplus	$m 69.9	(0.04% of total)	
Taxes less subsidies	$m 8.1	(0.01% of total)	
Sectoral GDP*	**$m 89.8**	**(0.02% of GDP)**	
Imports	$m 8.0	(0.01% of total)	
Primary inputs	**$m 97.9**	**(0.02% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 69.9	(0.04%)	$m 1.1	(0.00%)	$m 1.7	(0.00%)
Exports ($m)	$m 3.1	(0.00%)	$m 0.0	(0.00%)	$m 0.2	(0.00%)
Imports ($m)	$m 8.0	(0.01%)	$m 0.1	(0.00%)	$m 0.3	(0.00%)
Employment (e-y)	2,768 e-y	(0.04%)	43 e-y	(0.00%)	64 e-y	(0.00%)
Income ($m)*	$m 11.8	(0.01%)	$m 0.2	(0.00%)	$m 0.6	(0.00%)
Government revenue ($m)†	$m 8.1	(0.01%)	$m 0.1	(0.00%)	$m 0.3	(0.00%)
GHG emissions (kt CO_2-e)	716 kt	(0.14%)	11 kt	(0.00%)	14 kt	(0.00%)
Water use (ML)	1,436,105 ML	(6.85%)	22,484 ML	(0.11%)	25,745 ML	(0.12%)
Land disturbance (kha)	72 kha	(0.04%)	1 kha	(0.00%)	1 kha	(0.00%)
Primary energy (TJ)	325 TJ	(0.01%)	5 TJ	(0.00%)	15 TJ	(0.00%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.36	0.54	0.38
Exports ($)	0.02	0.07	0.16
Imports ($)	0.04	0.10	0.19
Employment (min)	1.77	2.61	1.75
Income ($)	0.06	0.19	0.34
Government revenue ($)	0.04	0.11	0.21
GHG emissions (kg CO_2-e)	3.66	4.47	1.02
Water use (L)	7342.56	8407.79	41.32
Land disturbance (m^2)	3.70	4.38	3.21
Primary energy (MJ)	1.66	4.99	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Ri	0.357	(0; 66.%)	Ri	1.77	(0; 68.%)	Ri	3.66	(0; 82.%)
Wt Ri	0.00963	(1; 1.8%)	Wt Ri	0.0693	(1; 2.7%)	El Ri	0.0258	(1; 0.58%)
St Ri	0.00684	(1; 1.3%)	Rd Ri	0.0347	(1; 1.3%)	Ch Ri	0.0191	(1; 0.43%)
Rd Ri	0.0059	(1; 1.1%)	Bk Ri	0.0205	(1; 0.79%)	Fo Ri	0.0125	(1; 0.28%)
Bk Ri	0.00516	(1; 0.95%)	Cg Ri	0.0188	(1; 0.72%)	Sc Cg Ri	0.0103	(2; 0.23%)
Rv Ri	0.00502	(1; 0.92%)	Rh Ri	0.016	(1; 0.61%)	Fe Ri	0.0102	(1; 0.23%)
Ms Ri	0.00314	(1; 0.58%)	Rf Ri	0.0147	(1; 0.56%)	Wt Ri	0.0096	(1; 0.21%)
Cg Ri	0.00285	(1; 0.52%)	Ms Ri	0.0141	(1; 0.54%)	Rd Ri	0.00937	(1; 0.21%)
Rh Ri	0.00262	(1; 0.48%)	Rv Ri	0.0134	(1; 0.51%)	El Rf Ri	0.00535	(2; 0.12%)
Sc Cg Ri	0.00209	(2; 0.38%)	St Ri	0.0112	(1; 0.43%)	Rf Ri	0.00532	(1; 0.12%)
Rf Ri	0.00184	(1; 0.34%)	Sc Cg Ri	0.0104	(2; 0.4%)	Oi Fo Ri	0.00377	(2; 0.084%)
St Wt Ri	0.00184	(2; 0.34%)	Nb Ri	0.0102	(1; 0.39%)	El Wt Ri	0.00289	(2; 0.065%)
Sf Bk Ri	0.0018	(2; 0.33%)	Ho Ri	0.00898	(1; 0.34%)	El Ch Ri	0.00287	(2; 0.064%)
Oi Fo Ri	0.00178	(2; 0.33%)	Ts Ri	0.00736	(1; 0.28%)	El St Ri	0.00285	(2; 0.064%)
Ts Ri	0.00163	(1; 0.3%)	Ma Ri	0.00643	(1; 0.25%)	Fr Sc Cg Ri	0.00242	(3; 0.054%)
Ch Ri	0.00159	(1; 0.29%)	Ms Wt Ri	0.00626	(2; 0.24%)	Ap Ri	0.00182	(1; 0.041%)
Wa Ri	0.00147	(1; 0.27%)	Fn Ri	0.00477	(1; 0.18%)	Bc Mp Ho Ri	0.00178	(3; 0.04%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Ri	0.0157	(0; 22.%)	Ri	0.0605	(0; 32.%)	Ri	7,342.6	(0; 87.%)
Wt Ri	0.00787	(1; 11.%)	Wt Ri	0.0149	(1; 7.8%)	Sc Cg Ri	10.8	(2; 0.13%)
Cg Ri	0.00502	(1; 6.9%)	Rd Ri	0.00596	(1; 3.1%)	Wa Ri	1.08	(1; 0.013%)
Rf Ri	0.00301	(1; 4.1%)	Bk Ri	0.00505	(1; 2.6%)	Sc Cg Sc Cg I	0.224	(4; 0.0027%)
Ch Ri	0.00222	(1; 3.%)	Rf Ri	0.00412	(1; 2.2%)	El Ri	0.142	(1; 0.0017%)
Rd Ri	0.00205	(1; 2.8%)	Ms Ri	0.00328	(1; 1.7%)	Wa Ms Ri	0.0808	(2; 0.00096%)
St Ri	0.00169	(1; 2.3%)	Cg Ri	0.00322	(1; 1.7%)	Ws Ho Ri	0.0655	(2; 0.00078%)
Oi Fo Ri	0.00122	(2; 1.7%)	St Ri	0.00285	(1; 1.5%)	Ch Ri	0.0582	(1; 0.00069%)
Ma Ri	0.000945	(1; 1.3%)	Rv Ri	0.00216	(1; 1.1%)	Bc Mp Ho Ri	0.047	(3; 0.00056%)
Ac Ri	0.000776	(1; 1.1%)	In Ri	0.00182	(1; 0.95%)	Dc Dp Ho Ri	0.0389	(3; 0.00046%)
Fo Ri	0.000508	(1; 0.7%)	Rh Ri	0.00175	(1; 0.92%)	Wt Ri	0.0388	(1; 0.00046%)
Ho Ri	0.0005	(1; 0.69%)	Ts Ri	0.00172	(1; 0.9%)	Wa Ms Wt Ri	0.0359	(3; 0.00043%)
Ms Ri	0.000486	(1; 0.67%)	Nb Ri	0.00153	(1; 0.8%)	Fe Ri	0.0325	(1; 0.00039%)
St Wt Ri	0.000455	(2; 0.63%)	Ms Wt Ri	0.00145	(2; 0.76%)	Ri Fc Ho Ri	0.0302	(3; 0.00036%)
Bk Ri	0.000401	(1; 0.55%)	Ho Ri	0.00131	(1; 0.69%)	Wa Pd Wt Ri	0.0302	(3; 0.00036%)
At Wt Ri	0.000373	(2; 0.51%)	Ma Ri	0.00121	(1; 0.63%)	El Rf Ri	0.0296	(2; 0.00035%)
In Ri	0.000352	(1; 0.48%)	Ac Ri	0.00101	(1; 0.53%)	St Ri	0.0295	(1; 0.00035%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Ri	0.0412	(0; 43.%)	Ri	0.0413	(0; 37.%)	Ri	3.7	(0; 85.%)
Fo Ri	0.0041	(1; 4.3%)	Wt Ri	0.00695	(1; 6.2%)	Sc Cg Ri	0.0141	(2; 0.32%)
Wt Ri	0.00224	(1; 2.3%)	Rd Ri	0.00423	(1; 3.8%)	Bc Mp Ho Ri	0.013	(3; 0.3%)
Ch Ri	0.00222	(1; 2.3%)	Bk Ri	0.00279	(1; 2.5%)	Bc Mp Ch Ri	0.00758	(3; 0.17%)
Ac Ri	0.00209	(1; 2.2%)	In Ri	0.00196	(1; 1.7%)	Bc Mp Fe Ri	0.00423	(3; 0.097%)
Rd Ri	0.0015	(1; 1.6%)	Rf Ri	0.00189	(1; 1.7%)	Bc Ch Ri	0.00381	(2; 0.087%)
Rh Ri	0.00135	(1; 1.4%)	Cg Ri	0.00169	(1; 1.5%)	Wh Ac Ri	0.00317	(2; 0.072%)
Fe Ri	0.00124	(1; 1.3%)	Ms Ri	0.00156	(1; 1.4%)	Wo Tx Wt Ri	0.00247	(3; 0.056%)
Ma Ri	0.00112	(1; 1.2%)	St Ri	0.00152	(1; 1.4%)	Wo Tx Ac Ri	0.00223	(3; 0.051%)
Ap Ri	0.00102	(1; 1.1%)	Rv Ri	0.00133	(1; 1.2%)	Bc Fe Ri	0.00213	(2; 0.049%)
Cg Ri	0.000799	(1; 0.83%)	Ts Ri	0.000848	(1; 0.75%)	Rf Ri	0.00207	(1; 0.047%)
Ms Ri	0.000714	(1; 0.74%)	Rh Ri	0.000804	(1; 0.71%)	Wo Tx Tp Ri	0.00188	(3; 0.043%)
Rv Ri	0.00065	(1; 0.67%)	Ms Wt Ri	0.000691	(2; 0.61%)	Bc Mp Of Ri	0.00171	(3; 0.039%)
St Ri	0.000619	(1; 0.64%)	Ho Ri	0.00069	(1; 0.61%)	Wo Mp Ho Ri	0.00146	(3; 0.033%)
Sc Cg Ri	0.000514	(2; 0.53%)	Pd Wt Ri	0.000653	(2; 0.58%)	Bc Mp Ho Wt	0.00142	(4; 0.033%)
Bk Ri	0.000499	(1; 0.52%)	Nb Ri	0.000642	(1; 0.57%)	Wo Tx Ri	0.00111	(2; 0.025%)
Rf Ri	0.000474	(1; 0.49%)	Ma Ri	0.000582	(1; 0.52%)	Ba Bm Ho Ri	0.00106	(3; 0.024%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.949 ±0.017	(±1.8%)
Downstream	2.086 ±0.101	(±4.8%)

Sector 0102: Wheat and Other Grains (Wh)

Wheat, legumes for grain, oilseeds, oats and other grains excluding rice

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is equal to average, while water use and land disturbance are respectively five times and eight times the average. By definition, this sector is a large user of land and could never equal the economy wide average. Nevertheless there is room for improvement particularly in balancing crop production with area sown, management applied and nutrient inputs. Leading edge management may allow a doubling of per hectare yields and a consequent halving of total area sown. The social indicators show that employment is 30% above average, much of it regional, while income and government revenue are 50% and 40% below average respectively. The financial indicators show an operating surplus 30% above average, export propensity over three times the average and import penetration 55% below average. The sector is expected to maintain its current grain production levels despite widespread landscape problems. Yet there remains a pressing need for a landuse revolution in Australia's farming lands that could potentially be initiated by the grains sector.

Sector Description

This sector produces approximately 34 million tonnes of grain per year (34 megatonnes or Mt) comprising wheat (22 Mt), oats and grain sorghum (4.5 Mt), oil seeds such as canola (3 Mt), pulses (2.4 Mt) and cottonseed (1 Mt). By way of comparison, France produces 36 Mt of wheat annually and Canada 25 Mt. The farm gate value is approximately $9 billion of which wheat makes up $6 billion. In world terms, Australia is a relatively small grain producer with approximately 3% of annual world production. However Australia accounts for at least 10-15% of world grain trade behind the United States, Canada and the European Union. The sector uses approximately 18 million ha of cropland. Australians consume about 96 kg of cereal products per capita each year.

Place of Industry in the Economy

The grains industry ranks 61st out of 135 in terms of value adding in the economy and contributes 0.28% of GDP in this analysis. By way of comparison, it is half the size of the beef cattle sector and about the same size as the dairy cattle and bakery products sectors. The sector has moderate employment generation with a direct requirement of 18 000 employment years and another 8 000 years for the sector's suppliers, giving a total of 26 000 employment years. In addition, it contributes 21 000 employment years to downstream industries such as flour milling and animal feeds. The sector has moderate resource requirements with over one percent of national water use and over two percent of national land disturbance. It has less than three tenths of one percent of energy use and greenhouse emissions. In financial terms, exports are ten times imports.

Strategic Overview

The integrated overview provided by the spider diagram shows a sector with strong financial indicators. The social indicators show strong employment generation but weaker indicators for income and government revenue. The environmental indicators are average for energy use and greenhouse emissions, but five to eight times the average for water use and land disturbance. The land disturbance indicator reflects the physical reality of Australia's variable climate and relatively poor soils (in a world context). The downstream impact of land use on regional biodiversity status is not shown in this analysis. The water indicator is due to a range of speciality wheats grown under irrigation and the flow through effect of reporting cottonseed production from irrigated cotton.

TBL Account #1

The grains sector provides a relatively good first TBL account. The financial indicator of operating surplus is 30% above the economy wide average with two thirds due to direct effects of the industry. Other contributors include wholesale trade (2%), travel, road transport, banking and equipment repairs (1% each). The social indicator of employment is 30% greater than average of which two thirds is a direct effect. The environmental indicator of greenhouse emissions is equal to the economy wide average. About two thirds of emissions are direct, with electricity generation (2%), energy used in manufacturing nitrogen fertilisers (2%), diesel refining (1%), cotton ginning (1%), mixed fertilisers (1%), wholesale trade (1%), and road transport (1%) also contributing. This account has particular regional significance since most of the employment and profits are located in grain growing areas and do not dissipate to city activities and firms.

TBL Accounts #2 and #3

The second TBL account shows an export propensity more than three times the average, income 50% below average and water use five times the average. The third TBL account shows an import propensity 55% below the average, government revenue 40% below average and land disturbance over eight times the average. The biodiversity implications of arable farming are not analysed.

Structural Path Analysis and Linkages

The below average income indicator (only one third of which is directly attributable) shows a broadly based structural chain. Given the sector's above average operating surplus, it may be possible to improve the income indicator by financial transfers within the sector. Other contributors to the income indicator include wholesale trade (8%), road freight and banking (3% each) and rail freight, accounting, cotton ginning and freight forwarding (2% each). Many of these sectors are strongly competitive with costs are cut to the margin, so a higher financial contribution to labour through the supply chain may not be feasible. The structural path for water shows that 80% is used directly and 5% is a flow through effect from the cotton crop to the cottonseed by-product. The remaining 15% of water use is spread across a large number of minor contributors.

Activity within the sector produces average stimuli for the associated upstream and downstream sectors. Increased investment in the sector means that the downstream sectors of flour and cereal foods, animal feed, accommodation and cafes, and meat and meat products must expand to dissipate increased production. Increases in consumer demand give an average upstream stimulus to wholesale trade and road transport.

Future Trends in Sector

The CSIRO *Future Dilemmas* study anticipates that current grain production levels will be maintained despite the loss of arable land due to dryland salinity and associated landscape problems. One scenario in the CSIRO Decision Points study anticipates growth in grain production to 50 million tonnes in 2050, based on high (rainfed) water use efficiency and advanced plant varieties.

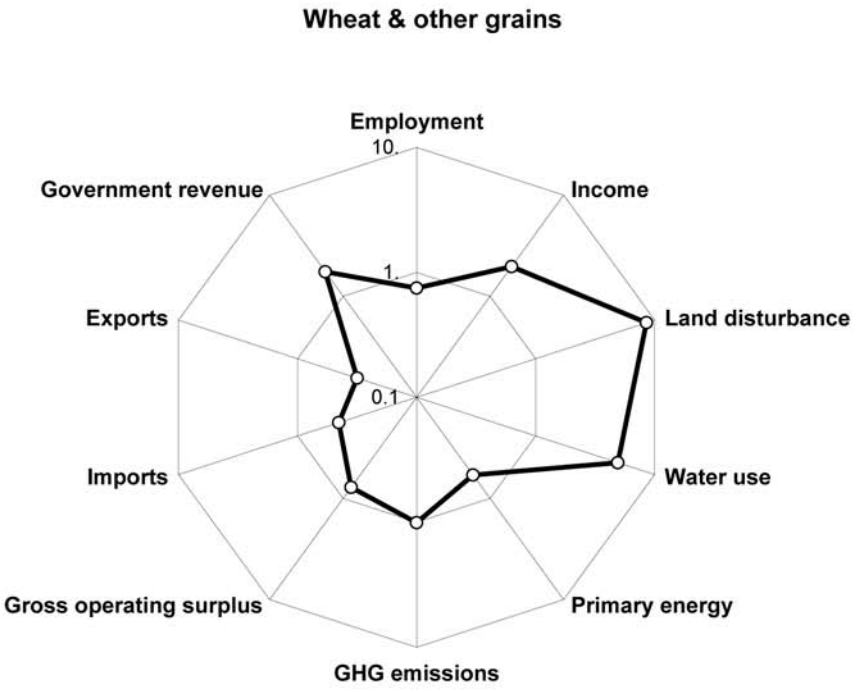
Innovation and Technical Opportunities

The environmental challenges faced by broadscale agriculture in Australia include soil toxification (dryland salinity and acidification), climate change and biodiversity decline. Blocks and corridors of native vegetation are being re-established, but coverage of 30-40% of the farming landscape will require several decades of aggressive effort. Technological complements to re-establishing biodiversity cover include perennial wheat varieties and new strains of nitrogen fixing bacteria that can directly transfer nitrogen to wheat plants' roots thereby lessening dependence on chemical nitrogen. Laboratory progress is well advanced but commercial applications may be 20 years away.

Sector **Wheat & other grains** **(Wh)**

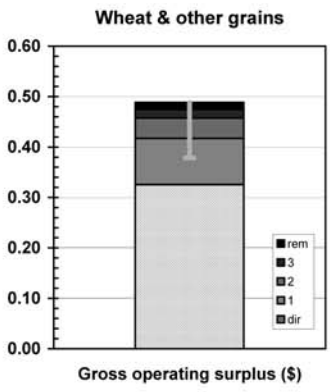
Wheat, legumes for grain, oilseeds, oats and other grains

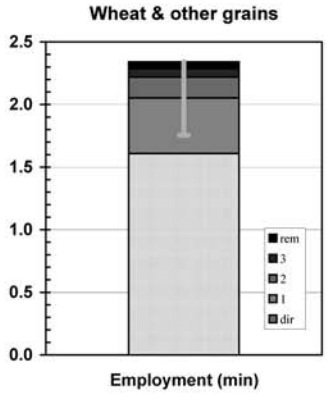
Spider diagram

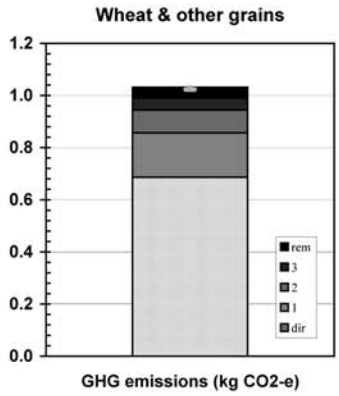


Bar graphs

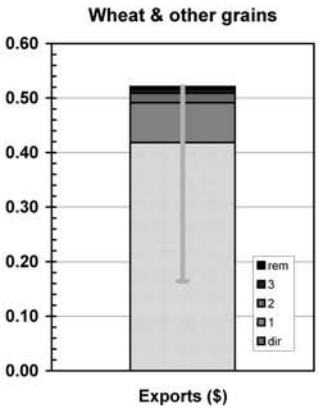
Account #1

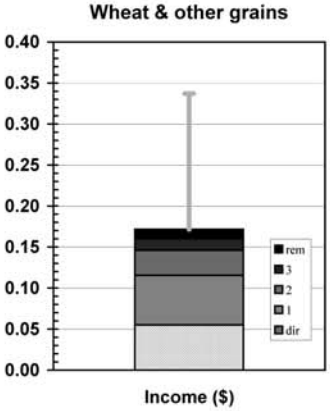


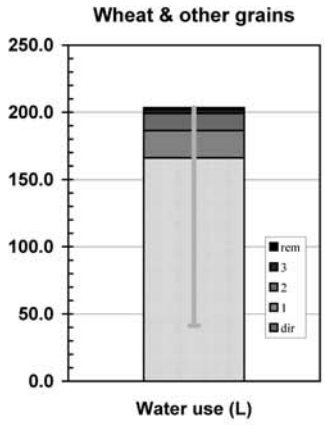




Account #2







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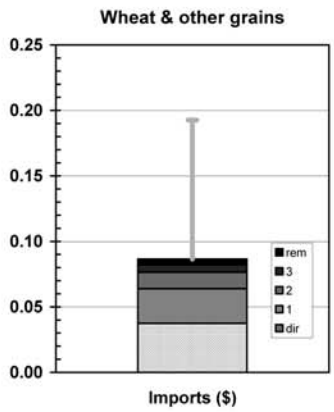
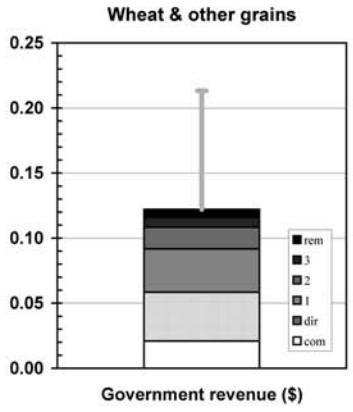
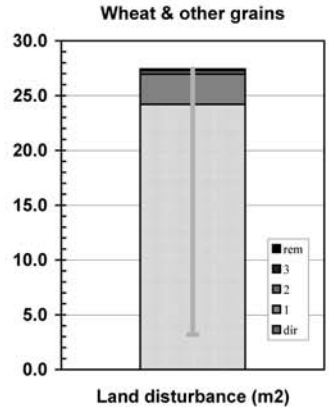






National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 100.4	(0.04% of total)	($m 98.3 domestically produced)
Government final consumption	$m 0.0		
Gross fixed capital expenditure	$m 0.0		
Net changes in stocks	-$m 286.1	-(16.18% of total)	
Sectoral GNE	**-$m 185.6**	**(0.04% of GNE)**	
Exports	$m 1,271.8	(1.53% of total)	($m 1,271.8 domestically produced)
Final demand	**$m 1,086.1**	**(0.20% of GNT)**	**($m 1,076.4 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 167.6	(0.10% of total)	
Gross operating surplus	$m 989.2	(0.52% of total)	
Taxes less subsidies	$m 114.3	(0.13% of total)	
Sectoral GDP*	**$m 1,271.1**	**(0.28% of GDP)**	
Imports	$m 113.9	(0.12% of total)	
Primary inputs	**$m 1,385.0**	**(0.25% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 989.2	(0.52%)	$m 445.7	(0.23%)	$m 669.2	(0.35%)
Exports ($m)	$m 1,271.8	(1.53%)	$m 573.0	(0.69%)	$m 714.0	(0.86%)
Imports ($m)	$m 113.9	(0.12%)	$m 51.3	(0.05%)	$m 118.6	(0.12%)
Employment (e-y)	39,178 e-y	(0.55%)	17,652 e-y	(0.25%)	25,706 e-y	(0.36%)
Income ($m)*	$m 167.6	(0.10%)	$m 75.5	(0.04%)	$m 235.2	(0.14%)
Government revenue ($m)†	$m 142.9	(0.13%)	$m 80.1	(0.07%)	$m 167.3	(0.15%)
GHG emissions (kt CO_2-e)	2,088 kt	(0.40%)	941 kt	(0.18%)	1,414 kt	(0.27%)
Water use (ML)	504,984 ML	(2.41%)	227,529 ML	(1.09%)	278,628 ML	(1.33%)
Land disturbance (kha)	7,358 kha	(4.55%)	3,315 kha	(2.04%)	3,759 kha	(2.31%)
Primary energy (TJ)	4,595 TJ	(0.12%)	2,070 TJ	(0.05%)	6,140 TJ	(0.16%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.33	0.49	0.38
Exports ($)	0.42	0.52	0.16
Imports ($)	0.04	0.09	0.19
Employment (min)	1.61	2.34	1.75
Income ($)	0.06	0.17	0.34
Government revenue ($)	0.06	0.12	0.21
GHG emissions (kg CO_2-e)	0.69	1.03	1.02
Water use (L)	166.07	203.37	41.32
Land disturbance (m^2)	24.20	27.43	3.21
Primary energy (MJ)	1.51	4.48	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Wh	0.325	(0; 67.%)	Wh	1.61	(0; 69.%)	Wh	0.687	(0; 67.%)
Wt Wh	0.00876	(1; 1.8%)	Wt Wh	0.0631	(1; 2.7%)	El Wh	0.0234	(1; 2.3%)
St Wh	0.00622	(1; 1.3%)	Rd Wh	0.0316	(1; 1.3%)	Ch Wh	0.0173	(1; 1.7%)
Rd Wh	0.00537	(1; 1.1%)	Bk Wh	0.0186	(1; 0.8%)	Fo Wh	0.0114	(1; 1.1%)
Bk Wh	0.00469	(1; 0.96%)	Cg Wh	0.0171	(1; 0.73%)	Sc Cg Wh	0.00936	(2; 0.91%)
Rv Wh	0.00457	(1; 0.93%)	Rh Wh	0.0146	(1; 0.62%)	Fe Wh	0.00925	(1; 0.9%)
Ms Wh	0.00286	(1; 0.59%)	Rf Wh	0.0134	(1; 0.57%)	Wt Wh	0.00874	(1; 0.85%)
Cg Wh	0.00259	(1; 0.53%)	Ms Wh	0.0128	(1; 0.55%)	Rd Wh	0.00853	(1; 0.83%)
Rh Wh	0.00238	(1; 0.49%)	Rv Wh	0.0122	(1; 0.52%)	El Rf Wh	0.00487	(2; 0.47%)
Sc Cg Wh	0.0019	(2; 0.39%)	St Wh	0.0102	(1; 0.43%)	Rf Wh	0.00485	(1; 0.47%)
Rf Wh	0.00167	(1; 0.34%)	Sc Cg Wh	0.00943	(2; 0.4%)	Oi Fo Wh	0.00343	(2; 0.33%)
St Wt Wh	0.00167	(2; 0.34%)	Nb Wh	0.00931	(1; 0.4%)	El Wt Wh	0.00263	(2; 0.25%)
Sf Bk Wh	0.00164	(2; 0.34%)	Ho Wh	0.00817	(1; 0.35%)	El Ch Wh	0.00261	(2; 0.25%)
Oi Fo Wh	0.00162	(2; 0.33%)	Ts Wh	0.0067	(1; 0.29%)	El St Wh	0.00259	(2; 0.25%)
Ts Wh	0.00149	(1; 0.3%)	Ma Wh	0.00585	(1; 0.25%)	Fr Sc Cg Wh	0.0022	(3; 0.21%)
Ch Wh	0.00145	(1; 0.3%)	Ms Wt Wh	0.00569	(2; 0.24%)	Ap Wh	0.00165	(1; 0.16%)
Wa Wh	0.00134	(1; 0.27%)	Fn Wh	0.00434	(1; 0.19%)	Bc Mp Ho Wh	0.00162	(3; 0.16%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Wh	0.418	(0; 80.%)	Wh	0.0551	(0; 32.%)	Wh	166.1	(0; 82.%)
Wt Wh	0.00716	(1; 1.4%)	Wt Wh	0.0135	(1; 7.9%)	Sc Cg Wh	9.8	(2; 4.8%)
Cg Wh	0.00457	(1; 0.88%)	Rd Wh	0.00543	(1; 3.2%)	Wa Wh	0.984	(1; 0.48%)
Rf Wh	0.00274	(1; 0.53%)	Bk Wh	0.0046	(1; 2.7%)	Sc Cg Sc Cg \	0.204	(4; 0.1%)
Ch Wh	0.00202	(1; 0.39%)	Rf Wh	0.00375	(1; 2.2%)	El Wh	0.13	(1; 0.064%)
Rd Wh	0.00187	(1; 0.36%)	Ms Wh	0.00298	(1; 1.7%)	Wa Ms Wh	0.0735	(2; 0.036%)
St Wh	0.00154	(1; 0.3%)	Cg Wh	0.00293	(1; 1.7%)	Ws Ho Wh	0.0596	(2; 0.029%)
Oi Fo Wh	0.00111	(2; 0.21%)	St Wh	0.00259	(1; 1.5%)	Ch Wh	0.0529	(1; 0.026%)
Ma Wh	0.00086	(1; 0.16%)	Rv Wh	0.00197	(1; 1.1%)	Bc Mp Ho Wh	0.0427	(3; 0.021%)
Ac Wh	0.000707	(1; 0.14%)	In Wh	0.00165	(1; 0.96%)	Dc Dp Ho Wh	0.0354	(3; 0.017%)
Fo Wh	0.000462	(1; 0.089%)	Rh Wh	0.00159	(1; 0.93%)	Wt Wh	0.0353	(1; 0.017%)
Ho Wh	0.000455	(1; 0.087%)	Ts Wh	0.00157	(1; 0.91%)	Wa Ms Wt Wh	0.0327	(3; 0.016%)
Ms Wh	0.000443	(1; 0.085%)	Nb Wh	0.00139	(1; 0.81%)	Fe Wh	0.0296	(1; 0.015%)
St Wt Wh	0.000414	(2; 0.079%)	Ms Wt Wh	0.00132	(2; 0.77%)	Ri Fc Ho Wh	0.0275	(3; 0.014%)
Bk Wh	0.000365	(1; 0.07%)	Ho Wh	0.00119	(1; 0.69%)	Wa Pd Wt Wh	0.0275	(3; 0.014%)
At Wt Wh	0.000339	(2; 0.065%)	Ma Wh	0.0011	(1; 0.64%)	El Rf Wh	0.0269	(2; 0.013%)
In Wh	0.000321	(1; 0.062%)	Ac Wh	0.000919	(1; 0.54%)	St Wh	0.0269	(1; 0.013%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Wh	0.0375	(0; 43.%)	Wh	0.0376	(0; 37.%)	Wh	24.2	(0; 88.%)
Fo Wh	0.00373	(1; 4.3%)	Wt Wh	0.00633	(1; 6.3%)	Sc Cg Wh	0.0129	(2; 0.047%)
Wt Wh	0.00204	(1; 2.4%)	Rd Wh	0.00385	(1; 3.8%)	Bc Mp Ho Wh	0.0118	(3; 0.043%)
Ch Wh	0.00202	(1; 2.3%)	Bk Wh	0.00254	(1; 2.5%)	Bc Mp Ch Wh	0.0069	(3; 0.025%)
Ac Wh	0.0019	(1; 2.2%)	In Wh	0.00178	(1; 1.8%)	Bc Mp Fe Wh	0.00385	(3; 0.014%)
Rd Wh	0.00136	(1; 1.6%)	Rf Wh	0.00172	(1; 1.7%)	Bc Ch Wh	0.00347	(2; 0.013%)
Rh Wh	0.00123	(1; 1.4%)	Cg Wh	0.00154	(1; 1.5%)	Wh Ac Wh	0.00289	(2; 0.011%)
Fe Wh	0.00113	(1; 1.3%)	Ms Wh	0.00142	(1; 1.4%)	Wo Tx Wt Wh	0.00225	(3; 0.0082%)
Ma Wh	0.00102	(1; 1.2%)	St Wh	0.00138	(1; 1.4%)	Wo Tx Ac Wh	0.00203	(3; 0.0074%)
Ap Wh	0.000932	(1; 1.1%)	Rv Wh	0.00121	(1; 1.2%)	Bc Fe Wh	0.00194	(2; 0.0071%)
Cg Wh	0.000727	(1; 0.84%)	Ts Wh	0.000772	(1; 0.76%)	Rf Wh	0.00188	(1; 0.0069%)
Ms Wh	0.00065	(1; 0.75%)	Rh Wh	0.000732	(1; 0.72%)	Wo Tx Tp Wh	0.00171	(3; 0.0063%)
Rv Wh	0.000591	(1; 0.68%)	Ms Wt Wh	0.000629	(2; 0.62%)	Bc Mp Of Wh	0.00156	(3; 0.0057%)
St Wh	0.000563	(1; 0.65%)	Ho Wh	0.000628	(1; 0.62%)	Wo Mp Ho Wh	0.00133	(3; 0.0049%)
Sc Cg Wh	0.000468	(2; 0.54%)	Pd Wt Wh	0.000594	(2; 0.59%)	Bc Mp Ho Wt '	0.0013	(4; 0.0047%)
Bk Wh	0.000454	(1; 0.52%)	Nb Wh	0.000585	(1; 0.58%)	Wo Tx Wh	0.00101	(2; 0.0037%)
Rf Wh	0.000431	(1; 0.5%)	Ma Wh	0.00053	(1; 0.52%)	Ba Bm Ho Wh	0.000963	(3; 0.0035%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.853 ±0.016	(±1.8%)
Downstream	0.964 ±0.027	(±2.8%)

Sector 0103: Beef (Bc)

Beef cattle and calves (before meat products)

Short Summary

The environmental indicators per dollar of final demand show greenhouse emissions are 26 times the economy wide average, water use 18 times, and land disturbance 58 times the average. The social indicators shows that employment generation is 50% above average while income and government revenue are 40% and 50% below average respectively. The financial indicator of surplus is 55% above average while export propensity and import penetration are 30% and 50% below average respectively. Over the next 50 years Australian beef production may double and this could further inflate environmental indicators. The combination of western diets, intensive production systems and globalised trade give strong demand for beef products, but market prices do not reflect the full environmental costs of production. The sector is critically important to many regional areas and national export income. There are regional opportunities to design and market beef production systems with lower environmental indicators.

Sector Description

The beef sector includes on farm production and domestic and international trade in live cattle. Meat products after slaughtering are shown in the meat products sector. Australia has approximately 28 million beef cattle, 8-9 million (30%) of which are slaughtered every year. Queensland is the premier beef state with 40% of the national herd. The farm gate value of production is $7 billion and exports are valued at $5 billion of which 8% is live cattle exports and the rest meat. Volumetric production is 2 million tonnes annually of which one third is consumed domestically and the remainder exported. Australia has 2% of the world's herd but over 20% by volume of world trade. Finishing in feedlot systems is underpinned by 800 000 ha of agricultural land producing the 1.5 million tonnes of grain and 815 000 tonnes of roughage consumed annually. Australians consume 113 kg of animal protein per capita per year including 35 kg beef.

Place of Industry in the Economy

The beef sector ranks 38th out of 135 sectors in terms of value adding and contributes 0.57% of GDP in this analysis. By way of comparison it is 25% larger than the wool and sheep meat sector and 10% smaller than the vegetable and fruit growing sector. The sector is a moderate employment generator with direct requirements of 10 000 employment years with a further 4 000 years in the sector's suppliers giving a total of 14 000 employment years. In addition, the sector contributes 62 000 employment years to downstream sectors principally the meat products sector from which the sector's products are delivered to final demand. The beef sector is responsible for 2% of water use, nearly 4% of greenhouse emissions and 8% of national land disturbance.

Strategic Overview

The integrated view provided in the spider diagram shows strong financial indicators. Social indicators are mixed, with above average employment generation but below average income and government revenue. The environmental indicators are typical of most food production sectors with the indicators of greenhouse emissions, water use and land disturbance well above average. The land disturbance account for pastoral industries is large in gross area and although grazing is rated as having only a small to moderate impact, the product of this is still significant. The water indicator reflects the poor conversion pathway of water to pasture to meat to financial returns. The greenhouse emissions indicator mainly reflects CO_2 from burnt and decaying woody vegetation.

TBL Account #1

The financial indicator of gross operating surplus is 55% above the economy wide average, with three quarters a direct effect of the sector, with contributions from fodder production (3%) and the road transport, services to agriculture, machinery maintenance and communications sectors (1% each). The social indicator of employment generation is 50% above average and two thirds of this a direct effect. The greenhouse emissions indicator is 26 times the average, most of which is direct due to land development activities (67%) and methane emissions (30%). The greenhouse indicator is strongly affected by international greenhouse accounting conventions (which allocate emissions to the country of production rather than the country of consumption) as 70% of production is exported. Curtailing land development and clearing could reduce the emissions indicator.

TBL Accounts #2 and #3

The second TBL account shows income is 40% below average while water use is 17 times the average. Exports are mostly delivered through the meat processing sector making the export propensity indicator less relevant here. The third TBL account shows import penetration 50% below average, government revenue 50% below average and land disturbance 58 times the average.

Structural Path Analysis and Linkages

The structural path analysis shows that the environmental indicators are dominated by the direct within-sector effects which account for 96%, 93% and 99% of greenhouse emissions, water use and land disturbance respectively. Improvements must therefore be sought directly within the sector.

Investment in beef cattle requires a moderately strong expansion of exports as well as domestic downstream sectors such as meat products, retail trade and accommodation and cafes to dissipate the extra production. Increases in consumer demand give a weaker than average upstream stimulus to sectors such as hay making, wholesale trade, road transport and accounting.

Future Trends in Sector

The CSIRO *Future Dilemmas* study anticipates the beef cattle herd may expand to 50 million cattle, and meat production to 4 million tonnes per year by the year 2050. This is in response to an expanding demand for meat in Asian countries as population and per capita income grows. The feasibility of this depends on the dynamics and nature of changes in Australian land use. Substantial investment into forage supply systems and feedlots would be required to buffer the inherent climate variability which is anticipated to increase with global change. The intensification process suggested here may restrict opportunities to improve the environmental indicators. If consumer awareness of and responsiveness to embodied environmental impacts increased, then production locations, financial viability, consumer prices and per capita consumption could change.

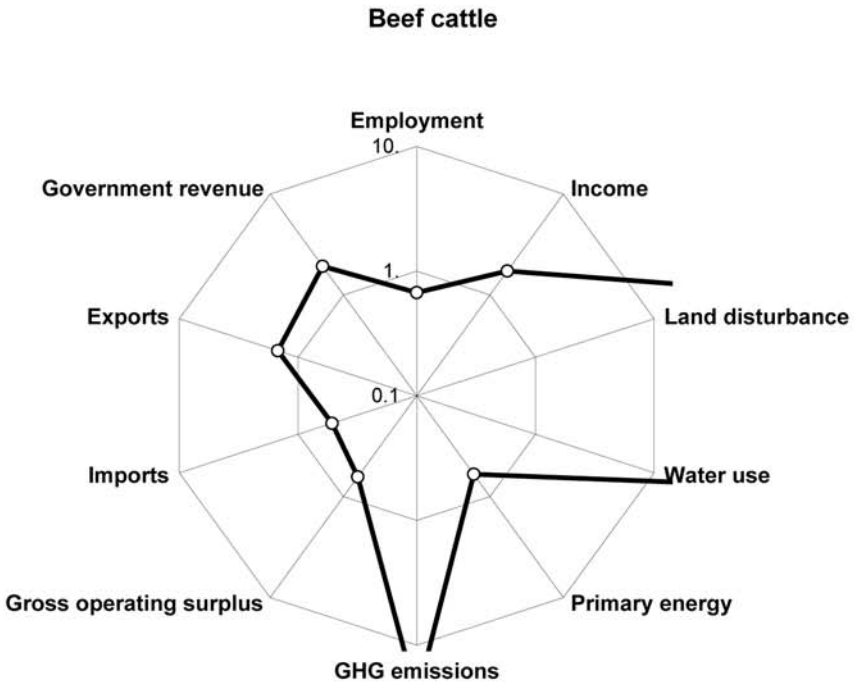
Innovation and Technical Opportunities

Given the size of the environmental indicators relative to economy wide averages (currently 20-60 times) substantial improvements may require revolutionary technical advances as well as substantial increases in consumer prices. Beef could become a boutique dietary item attracting high prices and sourced from environmentally certified farming systems (with TBL indicators closer to 5-10 times the economy wide average). In purely ecological terms it seems logical to maintain beef production systems mostly on grass and take advantage of ruminant's ability to process rough forage in the absence of alternative land uses. In purely energetic terms, finishing cattle with grain concentrates in feedlots may require further examination. There are obvious life cycle advantages in using agricultural and industrial by-products in value adding feedlots rather than sending them to landfill.

Sector **Beef cattle** **(Bc)**

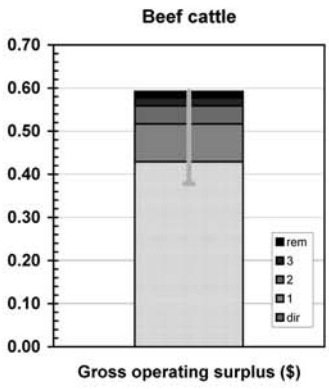
Beef cattle

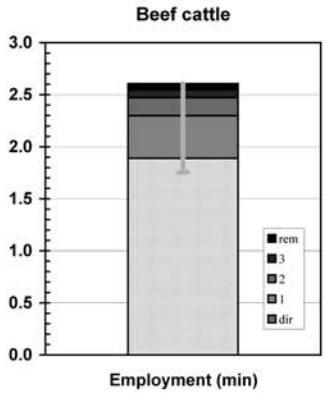
Spider diagram

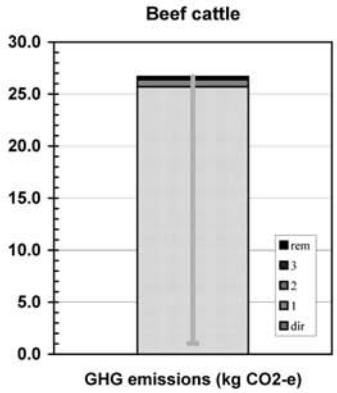


Bar graphs

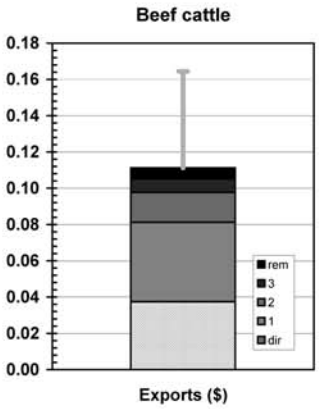
Account #1

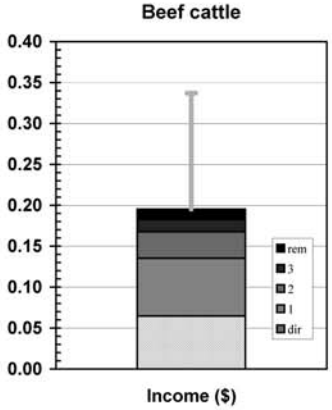


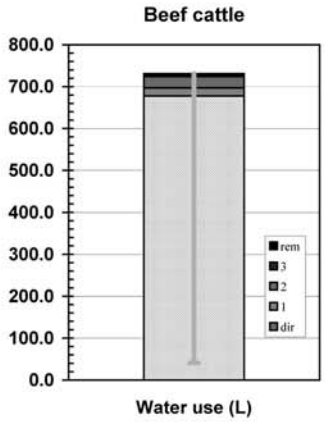




Account #2







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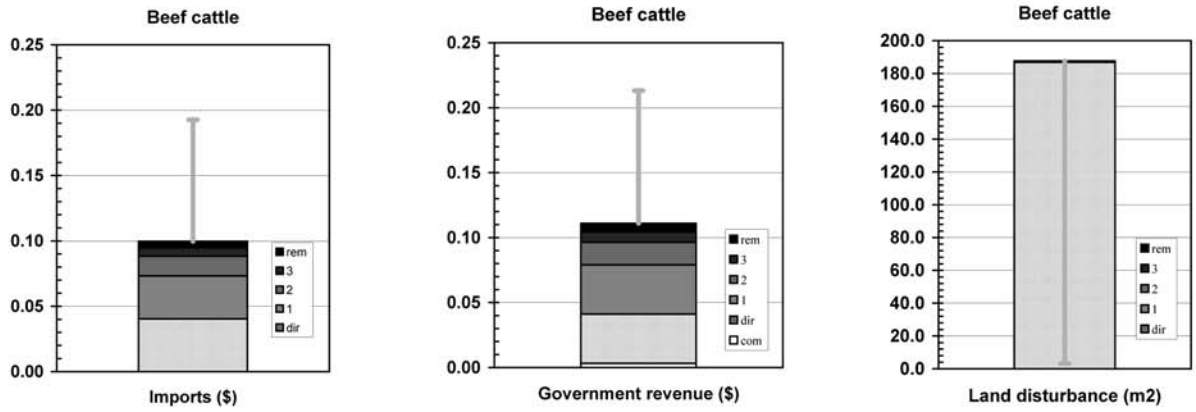


National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 41.9	(0.02% of total)	($m 41.9 domestically produced)
Government final consumption	$m 0.0		
Gross fixed capital expenditure	$m 345.8	(0.33% of total)	($m 345.8 domestically produced)
Net changes in stocks	$m 117.1	(6.62% of total)	($m 117.1 domestically produced)
Sectoral GNE	**$m 504.8**	**(0.11% of GNE)**	**($m 504.8 domestically produced)**
Exports	$m 178.5	(0.21% of total)	($m 178.5 domestically produced)
Final demand	**$m 683.3**	**(0.13% of GNT)**	**($m 683.3 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 308.6	(0.18% of total)	
Gross operating surplus	$m 2,045.2	(1.07% of total)	
Taxes less subsidies	$m 180.8	(0.21% of total)	
Sectoral GDP*	**$m 2,534.6**	**(0.57% of GDP)**	
Imports	$m 191.9	(0.20% of total)	
Primary inputs	**$m 2,726.6**	**(0.50% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 2,045.2	(1.07%)	$m 293.1	(0.15%)	$m 404.8	(0.21%)
Exports ($m)	$m 178.5	(0.21%)	$m 25.6	(0.03%)	$m 76.0	(0.09%)
Imports ($m)	$m 191.9	(0.20%)	$m 27.5	(0.03%)	$m 68.2	(0.07%)
Employment (e-y)	72,145 e-y	(1.01%)	10,340 e-y	(0.15%)	14,269 e-y	(0.20%)
Income ($m)*	$m 308.6	(0.18%)	$m 44.2	(0.03%)	$m 133.4	(0.08%)
Government revenue ($m)†	$m 183.0	(0.17%)	$m 28.1	(0.03%)	$m 75.9	(0.07%)
GHG emissions (kt CO_2-e)	122,527 kt	(23.63%)	17,561 kt	(3.39%)	18,234 kt	(3.52%)
Water use (ML)	3,229,335 ML	(15.41%)	462,838 ML	(2.21%)	499,572 ML	(2.38%)
Land disturbance (kha)	89,070 kha	(55.12%)	12,766 kha	(7.85%)	12,828 kha	(7.88%)
Primary energy (TJ)	2,826 TJ	(0.07%)	405 TJ	(0.01%)	3,140 TJ	(0.08%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.43	0.59	0.38
Exports ($)	0.04	0.11	0.16
Imports ($)	0.04	0.10	0.19
Employment (min)	1.89	2.61	1.75
Income ($)	0.06	0.20	0.34
Government revenue ($)	0.04	0.11	0.21
GHG emissions (kg CO_2-e)	25.70	26.68	1.02
Water use (L)	677.35	731.11	41.32
Land disturbance (m^2)	186.82	187.73	3.21
Primary energy (MJ)	0.59	4.60	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Bc	0.429	(0; 72.%)	Bc	1.89	(0; 72.%)	Bc	25.7	(0; 96.%)
Vf Bc	0.0152	(1; 2.6%)	Vf Bc	0.0752	(1; 2.9%)	Fr Bc	0.474	(1; 1.8%)
Rd Bc	0.00601	(1; 1.%)	Cg Bc	0.037	(1; 1.4%)	El Bc	0.0783	(1; 0.29%)
Cg Bc	0.00562	(1; 0.95%)	Rd Bc	0.0353	(1; 1.4%)	Ch Bc	0.0349	(1; 0.13%)
Rv Bc	0.00546	(1; 0.92%)	Wt Bc	0.0235	(1; 0.9%)	Vf Bc	0.0293	(1; 0.11%)
Ms Bc	0.00522	(1; 0.88%)	Ms Bc	0.0234	(1; 0.9%)	Sc Cg Bc	0.0203	(2; 0.076%)
Bk Bc	0.00515	(1; 0.87%)	Nb Bc	0.0221	(1; 0.85%)	Fr Vf Bc	0.0175	(2; 0.066%)
Cm Bc	0.00484	(1; 0.82%)	Bk Bc	0.0204	(1; 0.78%)	Fd Bc	0.0165	(1; 0.062%)
Sc Cg Bc	0.00412	(2; 0.69%)	Sc Cg Bc	0.0204	(2; 0.78%)	Bc Mp Bc	0.0151	(2; 0.057%)
Wh Bc	0.00336	(1; 0.57%)	Wh Bc	0.0166	(1; 0.64%)	Rd Bc	0.00954	(1; 0.036%)
Wt Bc	0.00327	(1; 0.55%)	Rv Bc	0.0146	(1; 0.56%)	Wh Bc	0.00708	(1; 0.027%)
El Bc	0.00317	(1; 0.53%)	Ts Bc	0.0136	(1; 0.52%)	Fe Bc	0.00542	(1; 0.02%)
Ts Bc	0.00303	(1; 0.51%)	Cm Bc	0.0134	(1; 0.51%)	El Ch Bc	0.00525	(2; 0.02%)
Ch Bc	0.00291	(1; 0.49%)	Hs Bc	0.0126	(1; 0.48%)	Bc Mp Fd Bc	0.00493	(3; 0.018%)
Fd Bc	0.0025	(1; 0.42%)	Rh Bc	0.0088	(1; 0.34%)	Fr Sc Cg Bc	0.00476	(3; 0.018%)
Ac Bc	0.00222	(1; 0.37%)	Ho Bc	0.00874	(1; 0.34%)	El Vf Bc	0.00377	(2; 0.014%)
Nb Bc	0.00217	(1; 0.37%)	Ch Bc	0.00849	(1; 0.33%)	Fo Bc	0.00336	(1; 0.013%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Bc	0.0374	(0; 34.%)	Bc	0.0647	(0; 33.%)	Bc	677.3	(0; 93.%)
Cg Bc	0.00989	(1; 8.9%)	Cg Bc	0.00635	(1; 3.3%)	Sc Cg Bc	21.2	(2; 2.9%)
Vf Bc	0.00458	(1; 4.1%)	Vf Bc	0.00618	(1; 3.2%)	Vf Bc	15.7	(1; 2.1%)
Fd Bc	0.00453	(1; 4.1%)	Rd Bc	0.00608	(1; 3.1%)	Su Fd Bc	1.99	(2; 0.27%)
Wh Bc	0.00432	(1; 3.9%)	Ms Bc	0.00544	(1; 2.8%)	Wh Bc	1.71	(1; 0.23%)
Ch Bc	0.00406	(1; 3.6%)	Wt Bc	0.00505	(1; 2.6%)	Sc Cg Vf Bc	1.63	(3; 0.22%)
Wt Bc	0.00267	(1; 2.4%)	Bk Bc	0.00504	(1; 2.6%)	Wa Bc	0.969	(1; 0.13%)
Rd Bc	0.00209	(1; 1.9%)	Nb Bc	0.0033	(1; 1.7%)	Ri Fc Bc	0.713	(2; 0.098%)
Ac Bc	0.00156	(1; 1.4%)	Ts Bc	0.00319	(1; 1.6%)	Sc Cg Sc Cg I	0.442	(4; 0.06%)
Ms Bc	0.000808	(1; 0.73%)	Hs Bc	0.00313	(1; 1.6%)	El Bc	0.433	(1; 0.059%)
Bl El Bc	0.000766	(2; 0.69%)	Cm Bc	0.00304	(1; 1.6%)	Bc Mp Bc	0.399	(2; 0.055%)
Cg Vf Bc	0.000758	(2; 0.68%)	Rv Bc	0.00235	(1; 1.2%)	Ba Bc	0.339	(1; 0.046%)
At Bc	0.000735	(1; 0.66%)	Ac Bc	0.00203	(1; 1.%)	Ws Bc	0.338	(1; 0.046%)
Cm Bc	0.000646	(1; 0.58%)	Ch Bc	0.0018	(1; 0.92%)	Vf Fd Bc	0.158	(2; 0.022%)
Ma Bc	0.000632	(1; 0.57%)	Sc Cg Bc	0.00168	(2; 0.86%)	Wa Ms Bc	0.134	(2; 0.018%)
Mp Bc	0.000588	(1; 0.53%)	In Bc	0.00135	(1; 0.69%)	Bc Mp Fd Bc	0.13	(3; 0.018%)
Rf Bc	0.000546	(1; 0.49%)	Fd Bc	0.00131	(1; 0.67%)	Dc Dp Bc	0.119	(2; 0.016%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Bc	0.0403	(0; 40.%)	Bc	0.0379	(0; 35.%)	Bc	186.8	(0; 100.%)
Ac Bc	0.0042	(1; 4.2%)	Rd Bc	0.00431	(1; 4.%)	Wh Bc	0.25	(1; 0.13%)
Ch Bc	0.00406	(1; 4.1%)	Vf Bc	0.00379	(1; 3.5%)	Fr Bc	0.153	(1; 0.081%)
Vf Bc	0.00373	(1; 3.7%)	Cg Bc	0.00333	(1; 3.1%)	Bc Mp Bc	0.11	(2; 0.059%)
Cg Bc	0.00157	(1; 1.6%)	Bk Bc	0.00279	(1; 2.6%)	Ba Bc	0.04	(1; 0.021%)
Rd Bc	0.00152	(1; 1.5%)	Ms Bc	0.00258	(1; 2.4%)	Bc Mp Fd Bc	0.0358	(3; 0.019%)
Ms Bc	0.00119	(1; 1.2%)	Wt Bc	0.00236	(1; 2.2%)	Sc Cg Bc	0.0279	(2; 0.015%)
Fo Bc	0.0011	(1; 1.1%)	Ts Bc	0.00157	(1; 1.5%)	Wh Fd Bc	0.0156	(2; 0.0083%)
Ap Bc	0.00106	(1; 1.1%)	In Bc	0.00145	(1; 1.3%)	Vf Bc	0.0148	(1; 0.0079%)
Sc Cg Bc	0.00101	(2; 1.%)	Cm Bc	0.00145	(1; 1.3%)	Bc Mp Ch Bc	0.0139	(3; 0.0074%)
Ts Bc	0.000869	(1; 0.87%)	Rv Bc	0.00145	(1; 1.3%)	Bc Mp Ho Bc	0.0126	(3; 0.0067%)
Pc Bc	0.000868	(1; 0.87%)	Nb Bc	0.00139	(1; 1.3%)	Wo Mp Bc	0.0124	(2; 0.0066%)
Cm Bc	0.000828	(1; 0.83%)	Hs Bc	0.00126	(1; 1.2%)	Bc Ch Bc	0.00697	(2; 0.0037%)
Wt Bc	0.000759	(1; 0.76%)	Sc Cg Bc	0.00103	(2; 0.96%)	Wh Ac Bc	0.00638	(2; 0.0034%)
Fd Bc	0.000753	(1; 0.76%)	Ch Bc	0.000898	(1; 0.83%)	Wh Fc Bc	0.00617	(2; 0.0033%)
Ma Bc	0.000747	(1; 0.75%)	Ho Bc	0.000671	(1; 0.62%)	Fr Vf Bc	0.00564	(2; 0.003%)
Rh Bc	0.000743	(1; 0.74%)	Fd Bc	0.000635	(1; 0.59%)	Wh Vf Bc	0.00452	(2; 0.0024%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.902 ±0.012	(±1.3%)
Downstream	1.179 ±0.076	(±6.4%)

Sector 0104: Dairy Cattle and Milk (Dc)

Dairy cattle and untreated whole milk

Short Summary

The environmental indicators per dollar of final consumption for the dairy cattle sector show land disturbance almost three times the average, greenhouse emissions four times the average and water use 35 times the average. The social indicators show employment generation is 35% above average while income is 40% below average and government revenue is 45% below average. The financial indicators show operating surplus is 45% above average, export propensity is 25% below average and import penetration is 40% below average. The indicators show reasonable financial outcomes, moderate social outcomes and below average environmental outcomes. Improving the environmental indicators could be attacked through the numerator (the gross flows of water etc.) or through the denominator (the prices paid). If farm gate prices are reduced by dairy industry deregulation, then denominator effects may offset any numerator improvements.

Sector Description

The dairy cattle sector produces nearly 11 billion litres of whole milk each year from 2.3 million cows on 12 000 farms with a farm gate value of $3 billion. Manufactured dairy products are reported in the Dp sector. Over 60% of the cows are located in Victoria and a typical farm has 150 cows producing 750 000 litres per year, although herds of 600 cows producing over 5 million litres per year are becoming more common. The industry has seen considerable change since 1950 when there were 82 000 farms with an average of 18 cows per farm producing 1 700 litres per cow. Today cows produce 4 500 litres per year on average and will produce 6 000 litres per cow by 2010. Some European dairy systems produce 8-10 000 litres per cow. Australians consume 100 litres of whole milk per year (19% of production) with the rest for manufacture for domestic use and exports.

Place of Industry in the Economy

The dairy cattle industry ranks 64th out of 135 in terms of value adding and contributes 0.25% of GDP in this analysis. By way of financial comparison, the beef cattle sector is twice the size and the dairy products sector (the manufacturing side) is the same size. The sector is a small employer with less that 3 000 employment years in direct and indirect requirements. However 31 000 employment years are passed on to downstream sectors, mainly the dairy products sector. The sector is responsible for one percent of national water use, about one tenth of one percent of greenhouse emissions and less than one tenth of one percent of national energy use and land disturbance. In a downstream sense, the overall diary industry is responsible for nearly 17% of national water use.

Strategic Overview

The strategic overview in the spider diagram shows a sector with outlying indicators in social and environmental areas. Upstream issues for the sector relate particularly to the water and greenhouse intensity of milk production systems and the degree to which irrigated pasture systems are threatened by irrigation salinity in some areas. Downstream issues include perceived dietary and health issues relating to the consumption of milk products (positive and negative), as well as effluent and pollution issues from intensive dairy systems. Higher than average employment multipliers are important for regional areas but the lower than average income multiplier may suggest an equity issue. Significantly higher than average environmental multipliers and lower than average government revenues suggest that direct environmental taxation such as best practice water pricing, based on user pays and full cost recovery principles, may warrant investigation.

TBL Account #1

The financial indicator of gross operating surplus is 45% above the economy wide average with two thirds of this being a direct effect. Other sectors contributing to the surplus include animal feeds (3%), hay making (2%), machinery repairs (2%), electricity generation (1%), water distribution (1%), wholesale trade (1%) and wheat (1%). The employment generation indicator is 35% above average with two thirds of the effect from within the sector. The greenhouse emissions indicator is over four times the economy wide average with four fifths of that a direct effect. Much of the greenhouse effect is due to gases such as methane and nitrous oxides rather than carbon dioxide emitted from fuel combustion. These gases are metabolism products from feed eaten and excreted by dairy cows.

TBL Accounts #2 and #3

In the second TBL account, exports are delivered through the dairy products sector so the export propensity indicator is less relevant in this case. The income indicator is 40% below average while the water indicator is 35 times the average. In the third TBL account, import penetration is 40% below average, government revenue is 45% below average and land disturbance is nearly three times the average. Thus the sector shows social and environmental indicators with room for improvement. If commodity prices fall, for example due to dairy deregulation policies or market competition, these indicators could be difficult to improve.

Structural Path Analysis and Linkages

A structural path analysis for greenhouse emissions shows that 78% of emissions are direct and include methane and nitrous oxides as well as carbon dioxide. Minor contributions are from electricity generation (4%), land development (3%), animal feeds (4%) and basic chemicals (1%). The water path also has a high direct component (95%) with contributions from cottonseed, molasses and hay (1% each). The land disturbance indicator has a high direct component (83%) and contributions from wholesale trade (6%), beef cattle (3%) and barley growing (1%). Investment into the dairy cattle sector provides reasonably strong downstream linkages to the dairy products sector and the accommodation and cafes sectors. Increases in consumer demand for dairy produce gives a slightly above average upstream stimulus to the supplying sectors such as animal feeds, wholesale trade, road transport and marketing.

Future Trends in Sector

The CSIRO *Future Dilemmas* study anticipates that whole milk production will double to 20 billion litres by 2035 on the basis of growing export demand, mostly from South East Asia. This is physically feasible provided that irrigated dairy systems halve the amount of irrigation water used in the production chain for each litre of milk (from approximately 1 000 to 500 litres/litre) and where irrigation water is not available, that grain concentrate feeding systems are used.

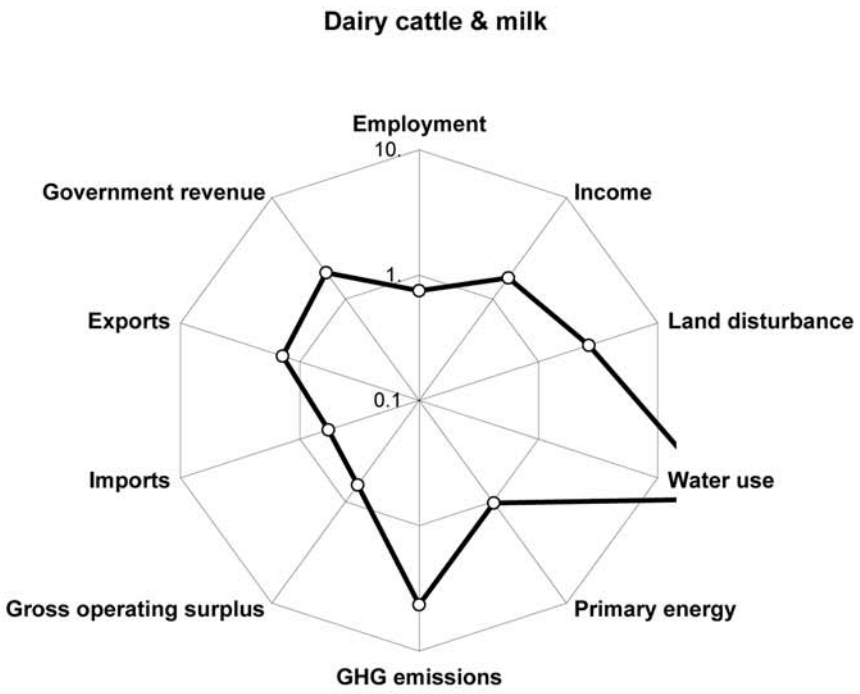
Innovation and Technical Opportunities

Genetically engineered cows and milk face consumer, processing and animal breeding constraints. However genetic markers now facilitate ‘neutraceutical’ or ‘designer milks’ using traditional or natural breeding techniques, and this trend will continue. Methane and nitrous oxide emissions from milk production systems will become important. Methane has a global warming potential 21 times that of carbon dioxide and dairy cows produce around 150 kg of methane per annum. Feeding high quality forages can decrease methane emissions by 10-40%. Research may seek rumen micro-organisms that transfer hydrogen to a rumen by-product other than methane. Intensification will mean more automation and microelectronics focusing on the individual cow as a unique biological factory unit. Milk systems may further diversify to include dairy sheep, goats and water buffalo.

Sector **Dairy cattle & milk** **(Dc)**

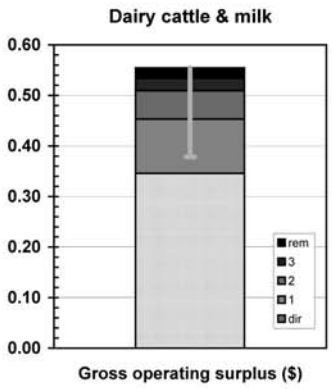
Dairy cattle and untreated whole milk

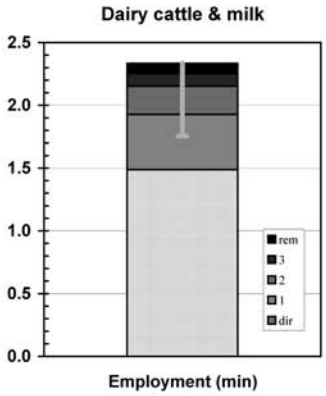
Spider diagram

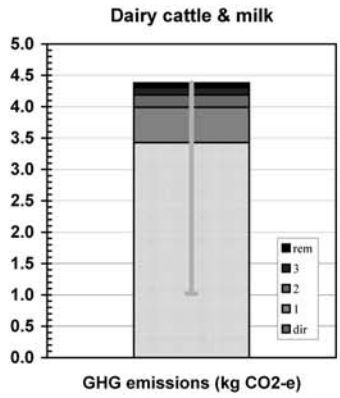


Bar graphs

Account #1







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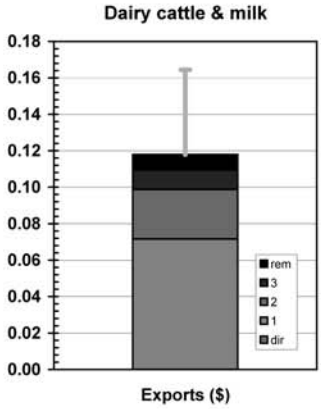

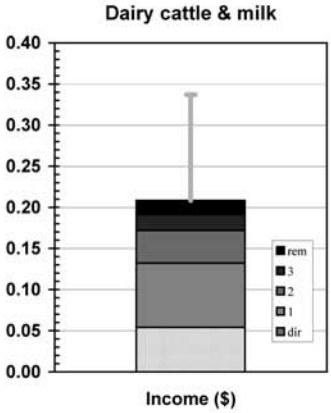

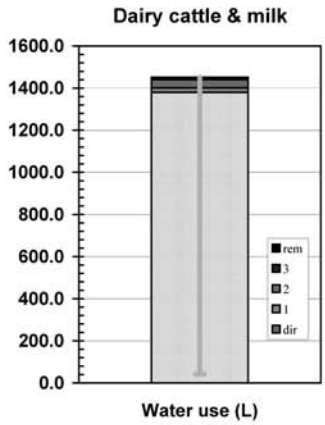

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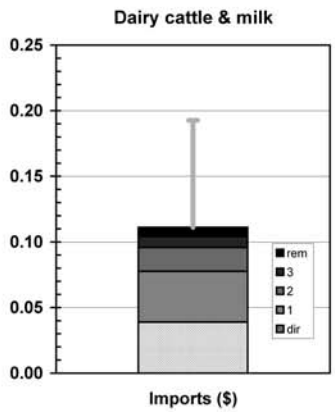
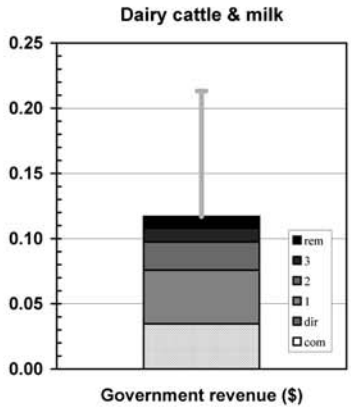
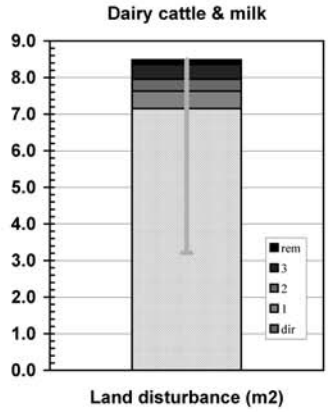






National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 1.2	(0.00% of total)	($m 1.2 domestically produced)
Government final consumption	$m 0.0		
Gross fixed capital expenditure	$m 142.0	(0.14% of total)	($m 142.0 domestically produced)
Net changes in stocks	-$m 2.9	-(0.16% of total)	
Sectoral GNE	**$m 140.3**	**(0.03% of GNE)**	**($m 140.3 domestically produced)**
Exports	$m 0.0		
Final demand	**$m 140.3**	**(0.03% of GNT)**	**($m 140.3 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 139.0	(0.08% of total)	
Gross operating surplus	$m 887.6	(0.46% of total)	
Taxes less subsidies	$m 88.8	(0.10% of total)	
Sectoral GDP*	**$m 1,115.4**	**(0.25% of GDP)**	
Imports	$m 99.8	(0.10% of total)	
Primary inputs	**$m 1,215.2**	**(0.22% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 887.6	(0.46%)	$m 49.5	(0.03%)	$m 79.4	(0.04%)
Exports ($m)	$m 0.0				$m 16.9	(0.02%)
Imports ($m)	$m 99.8	(0.10%)	$m 5.6	(0.01%)	$m 15.9	(0.02%)
Employment (e-y)	30,600 e-y	(0.43%)	1,706 e-y	(0.02%)	2,679 e-y	(0.04%)
Income ($m)*	$m 139.0	(0.08%)	$m 7.8	(0.00%)	$m 29.8	(0.02%)
Government revenue ($m)†	$m 88.8	(0.08%)	$m 5.0	(0.00%)	$m 16.7	(0.02%)
GHG emissions (kt CO_2-e)	8,801 kt	(1.70%)	491 kt	(0.09%)	627 kt	(0.12%)
Water use (ML)	3,542,391 ML	(16.91%)	197,550 ML	(0.94%)	207,951 ML	(0.99%)
Land disturbance (kha)	1,837 kha	(1.14%)	102 kha	(0.06%)	122 kha	(0.07%)
Primary energy (TJ)	4,952 TJ	(0.13%)	276 TJ	(0.01%)	1,128 TJ	(0.03%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.35	0.55	0.38
Exports ($)	0.00	0.12	0.16
Imports ($)	0.04	0.11	0.19
Employment (min)	1.49	2.33	1.75
Income ($)	0.05	0.21	0.34
Government revenue ($)	0.03	0.12	0.21
GHG emissions (kg CO_2-e)	3.43	4.38	1.02
Water use (L)	1379.49	1452.11	41.32
Land disturbance (m^2)	7.15	8.48	3.21
Primary energy (MJ)	1.93	7.87	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Dc	0.346	(0; 62.%)	Dc	1.49	(0; 64.%)	Dc	3.43	(0; 78.%)
Fd Dc	0.0177	(1; 3.2%)	Vf Dc	0.0579	(1; 2.5%)	El Dc	0.184	(1; 4.2%)
Vf Dc	0.0117	(1; 2.1%)	Wt Dc	0.0412	(1; 1.8%)	Fr Dc	0.144	(1; 3.3%)
Rv Dc	0.00816	(1; 1.5%)	Fd Dc	0.0395	(1; 1.7%)	Fd Dc	0.117	(1; 2.7%)
El Dc	0.00744	(1; 1.3%)	Cg Dc	0.0324	(1; 1.4%)	Bc Mp Fd Dc	0.0349	(3; 0.8%)
Wa Dc	0.00724	(1; 1.3%)	Rd Dc	0.0304	(1; 1.3%)	Ch Dc	0.0289	(1; 0.66%)
Wt Dc	0.00573	(1; 1.%)	Nb Dc	0.0296	(1; 1.3%)	Vf Dc	0.0226	(1; 0.52%)
Rd Dc	0.00517	(1; 0.93%)	Wh Dc	0.0232	(1; 0.99%)	Sc Cg Dc	0.0178	(2; 0.41%)
Cg Dc	0.00493	(1; 0.89%)	Rv Dc	0.0218	(1; 0.94%)	Fo Dc	0.0173	(1; 0.39%)
Wh Dc	0.00469	(1; 0.85%)	Hs Dc	0.0187	(1; 0.8%)	Fr Vf Dc	0.0135	(2; 0.31%)
Bk Dc	0.00425	(1; 0.77%)	Sc Cg Dc	0.0179	(2; 0.77%)	Wh Dc	0.00991	(1; 0.23%)
Sc Cg Dc	0.00361	(2; 0.65%)	Su Fd Dc	0.0178	(2; 0.76%)	Bc Mp Dc	0.00827	(2; 0.19%)
Su Fd Dc	0.00359	(2; 0.65%)	Bk Dc	0.0169	(1; 0.72%)	Rd Dc	0.0082	(1; 0.19%)
Ms Dc	0.00358	(1; 0.65%)	Ms Dc	0.0161	(1; 0.69%)	El Fd Dc	0.007	(2; 0.16%)
Cm Dc	0.0032	(1; 0.58%)	Ho Dc	0.014	(1; 0.6%)	Wt Dc	0.00571	(1; 0.13%)
Nb Dc	0.0029	(1; 0.52%)	Wa Dc	0.00921	(1; 0.39%)	Su Fd Dc	0.00529	(2; 0.12%)
Oi Fo Dc	0.00246	(2; 0.44%)	Cm Dc	0.00883	(1; 0.38%)	Oi Fo Dc	0.00521	(2; 0.12%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Fd Dc	0.0321	(1; 27.%)	Dc	0.0541	(0; 26.%)	Dc	1,379.5	(0; 95.%)
Cg Dc	0.00867	(1; 7.4%)	Fd Dc	0.00929	(1; 4.5%)	Sc Cg Dc	18.6	(2; 1.3%)
Wh Dc	0.00603	(1; 5.1%)	Wt Dc	0.00885	(1; 4.2%)	Su Fd Dc	14.1	(2; 0.97%)
Wt Dc	0.00468	(1; 4.%)	Cg Dc	0.00557	(1; 2.7%)	Vf Dc	12.1	(1; 0.83%)
Vf Dc	0.00353	(1; 3.%)	Rd Dc	0.00522	(1; 2.5%)	Wa Dc	5.32	(1; 0.37%)
Ch Dc	0.00336	(1; 2.9%)	Vf Dc	0.00476	(1; 2.3%)	Wh Dc	2.4	(1; 0.17%)
Wh Fd Dc	0.00191	(2; 1.6%)	Hs Dc	0.00466	(1; 2.2%)	Sc Cg Vf Dc	1.25	(3; 0.086%)
Bl El Dc	0.0018	(2; 1.5%)	Nb Dc	0.00442	(1; 2.1%)	Vf Fd Dc	1.12	(2; 0.077%)
Rd Dc	0.0018	(1; 1.5%)	Bk Dc	0.00416	(1; 2.%)	El Dc	1.02	(1; 0.07%)
Oi Fo Dc	0.00168	(2; 1.4%)	Ms Dc	0.00374	(1; 1.8%)	Bc Mp Fd Dc	0.92	(3; 0.063%)
Mp Fd Dc	0.00136	(2; 1.2%)	Rv Dc	0.00352	(1; 1.7%)	Ri Fc Dc	0.837	(2; 0.058%)
Ac Dc	0.00114	(1; 0.97%)	El Dc	0.00224	(1; 1.1%)	Wh Fd Dc	0.76	(2; 0.052%)
Ba Dc	0.000778	(1; 0.66%)	Wa Dc	0.00208	(1; 1.%)	Dc Dp Dc	0.686	(2; 0.047%)
Ho Dc	0.000776	(1; 0.66%)	Ho Dc	0.00204	(1; 0.98%)	Ba Dc	0.487	(1; 0.034%)
At Dc	0.000757	(1; 0.64%)	Cm Dc	0.00201	(1; 0.96%)	Sc Cg Sc Cg I	0.387	(4; 0.027%)
Fo Dc	0.000702	(1; 0.6%)	Ch Dc	0.00149	(1; 0.72%)	Dc Dp Fd Dc	0.345	(3; 0.024%)
Wt Fd Dc	0.000623	(2; 0.53%)	Ac Dc	0.00148	(1; 0.71%)	Ws Dc	0.251	(1; 0.017%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Dc	0.0389	(0; 35.%)	Dc	0.0346	(0; 30.%)	Dc	7.15	(0; 84.%)
Fo Dc	0.00566	(1; 5.1%)	Fd Dc	0.0045	(1; 3.8%)	Wh Dc	0.349	(1; 4.1%)
Fd Dc	0.00533	(1; 4.8%)	Wt Dc	0.00414	(1; 3.5%)	Bc Mp Fd Dc	0.254	(3; 3.%)
Ch Dc	0.00337	(1; 3.%)	Rd Dc	0.0037	(1; 3.2%)	Wh Fd Dc	0.111	(2; 1.3%)
Ac Dc	0.00307	(1; 2.8%)	Cg Dc	0.00293	(1; 2.5%)	Bc Mp Dc	0.0601	(2; 0.71%)
Vf Dc	0.00288	(1; 2.6%)	Vf Dc	0.00293	(1; 2.5%)	Ba Dc	0.0575	(1; 0.68%)
Cg Dc	0.00138	(1; 1.2%)	Bk Dc	0.0023	(1; 2.%)	Fr Dc	0.0462	(1; 0.54%)
Wt Dc	0.00133	(1; 1.2%)	Rv Dc	0.00217	(1; 1.9%)	Wo Mp Fd Dc	0.0287	(3; 0.34%)
Rd Dc	0.00131	(1; 1.2%)	Hs Dc	0.00188	(1; 1.6%)	Sc Cg Dc	0.0244	(2; 0.29%)
Wa Dc	0.0011	(1; 0.99%)	Nb Dc	0.00186	(1; 1.6%)	Su Fd Dc	0.0226	(2; 0.27%)
Rv Dc	0.00106	(1; 0.95%)	Ms Dc	0.00178	(1; 1.5%)	Bc Mp Ho Dc	0.0201	(3; 0.24%)
Pc Dc	0.00104	(1; 0.93%)	Wa Dc	0.00156	(1; 1.3%)	Ba Fd Dc	0.0152	(2; 0.18%)
Nb Dc	0.000985	(1; 0.89%)	El Dc	0.0014	(1; 1.2%)	Bc Mp Ch Dc	0.0115	(3; 0.14%)
Sc Cg Dc	0.000889	(2; 0.8%)	Ho Dc	0.00107	(1; 0.92%)	Vf Dc	0.0114	(1; 0.13%)
Su Fd Dc	0.000883	(2; 0.79%)	Cm Dc	0.000958	(1; 0.82%)	Wh Fc Dc	0.00724	(2; 0.085%)
Ms Dc	0.000815	(1; 0.73%)	Sc Cg Dc	0.000904	(2; 0.77%)	Wo Mp Dc	0.00679	(2; 0.08%)
Rh Dc	0.000694	(1; 0.62%)	Su Fd Dc	0.000898	(2; 0.77%)	Bc Ch Dc	0.00578	(2; 0.068%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	1.146 ±0.016	(±1.4%)
Downstream	1.341 ±0.091	(±6.8%)

Sector 0105: Pigs (Pg)

Pig farming

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is more than three times the average, while water use is four times the average, and land disturbance is equal to average. The social indicators reveal that employment generation is 20% above average, income is 20% lower than average, and government revenue is 25% below average. The financial indicators show that operating surplus is 10% above average, export propensity is 10% above average, and import penetration is 25% below average. Pig farming management will maintain its rapid technological pace and will need to balance the overall nutritional quality of the product with production chain issues of pig feed and effluent disposal.

Sector Description

Yearly production of pig meat is currently around 407 000 tonnes which, with a feed conversion ratio of 4 kg of ration to one kg of liveweight, and a dressing percentage of 70%, suggests a yearly feed budget of about 2.3 million tonnes. At any one time, pig numbers are about 3 million, with 350 000 breeding sows generating 5.6 million slaughtered animals each year. A live pig of 100 kg gives a market carcass weight of about 70kg, and takes five to six months to grow in commercial situations. Australians consume about 21 kg of pig meat per year, an almost threefold increase since the 1940s. About half of this is bacon and ham. Imports and exports are currently equal at 90 000 tonnes per year. Australia supplies nearly half of Singapore's requirements for fresh pork and 300 to 400 tonnes is airfreighted weekly as 'Air Pork'. Japan is also an important market. In constant dollar terms, the turnover of the sector has been relatively constant for the past 30 years, and in 2002 was about $900 million and involved nearly 1 000 enterprises.

Place of Industry in the Economy

The pig growing sector ranks 130th out of 135 sectors in terms of value adding in the economy, and contributes 0.04% of GDP in this analysis. It is similar in value adding to the prefabricated buildings, and aviation jet fuel sectors. It is a relatively small employer in direct and indirect terms. However, it contributes nearly 5 000 employment years to the final demand of downstream industries such as meat products (where pigs are turned into pork, ham and bacon), retail trade, and accommodation cafes and restaurants. It has small absolute resource requirements with less than one tenth of one percent of national land disturbance, water use, energy use and greenhouse emissions.

Strategic Overview

The spider diagram reveals a reasonable TBL account for pig growing with two obvious outliers for the environmental indicators of greenhouse emissions and water use. Downstream issues with intensive pig production include odours and effluent. In more densely populated areas, odours can cause offence and are best solved by high levels of cleanliness and regular flushing into well managed effluent ponds. While poor management of effluent ponds can lead to increased methane emissions, better management allows energy production from biogas digesters. Effluent requires careful management to prevent leakage to waterways or overland flow. Effluent can be used as a biological fertiliser but needs careful management to limit nitrate leaching into groundwater, or high levels of nitrification and further greenhouse emissions. Traditional management allowing pigs to range in pasture can lead to over-foraging and soil disturbance. Contaminated food (swill feeding) can catalyse precursor conditions for the promotion and spread of dangerous pig diseases.

TBL Account #1

The financial indicator of operating surplus is 10% above average with a direct effect of 35% and contributions from animal foods (4%), dairy cows (3%), vegetable and fruit growing (3%), flour mill products 3%), dairy products (3%) and wholesale trade (2%). The social indicator of employment generation is 20% above average with a direct effect of 47% and a composition similar to the surplus indicator. The environmental indicator of greenhouse emissions is more than three times the average, and is discussed in more detail below.

TBL Accounts #2 and #3

The second TBL account shows that export propensity is 10% above average, income is 20% below average, and water use is more than four times the average. The third TBL account shows that import penetration is 25% below average, government revenue is 25% below average and land disturbance is equal to average.

Structural Path Analysis and Linkages

The indicators of water use and greenhouse emissions are well above average. Examining the structural path for water use shows that the direct sector effect is less than one percent. The main contributions to water use are the production chains of feed ration components such as ‘dairy cows-dairy products-pigs’ (33%), ‘rice growing-flour mill products-pigs’ (18%), vegetable and fruit growing (9%), ‘sugar cane-animal feeds-pigs’ (8%), ‘seed cotton-cotton ginning-pigs’ (3%), wheat growing (3%), and barley growing (1%). The greenhouse chain is dominated by methane emissions (70%) with minor contributions from dairy cows (4%), animal feeds (4%), electricity production (3%), and beef cattle (1%). Improving the water indicator may be difficult as pigs utilise by-products rather than primary products. These include dairy (whey), cotton (cottonseed), sugar (molasses), rice (bran and pollard), and fruit growing (fruit pulp). Changing a feed purchasing policy, apart from avoiding contaminants, may deny a disposal option. The greenhouse indicator could be improved by converting pig manure effluent into biogas for heating and power.

The sector’s stimulus to its upstream suppliers is 60% greater than average and impacts on sectors such as wholesale trade, animal feeds, dairy products, flourmill and cereal products, and road transport. The linkages to downstream industries are 35% above average and suggest that any sector expansion must be led by expansion in sectors such as meat products, retail trade, and accommodation cafes and restaurants.

Future Trends in Sector

The base case scenario of the *Future Dilemmas* study anticipates pig meat production increases of 50% by the year 2050, driven by population growth, inbound international tourism and some exports. Uncertainties include the potential effect of world trade issues, such as the effect of large scale production in North America on Australian profitability, more humane rearing standards in the European Union, and the possible spread of swine disease with greater international trade.

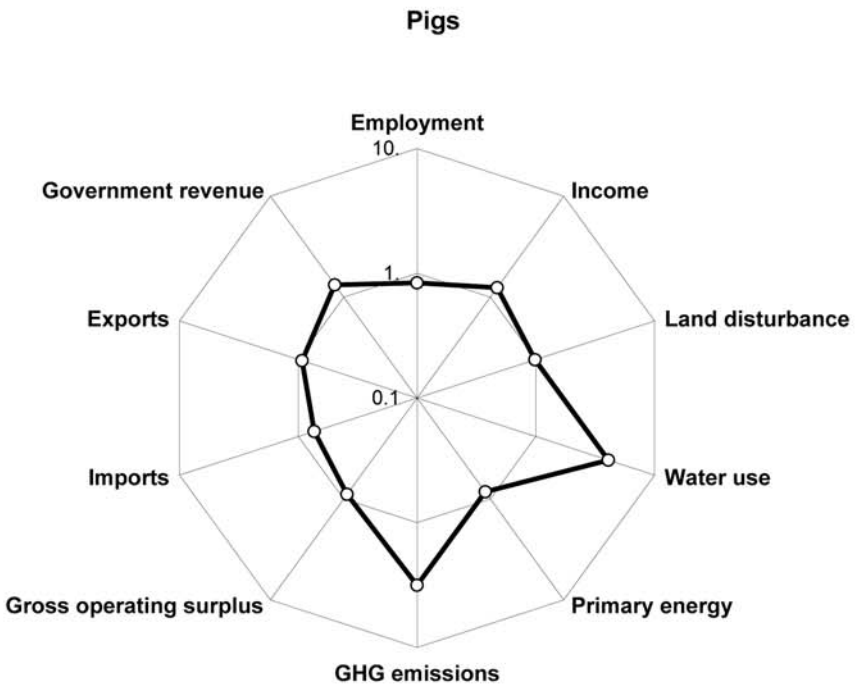
Innovation and Technical Opportunities

The science literature notes four areas of active innovation. With the mapping of the pig genome, geneticists are using marker assisted selection to rapidly advance disease resistance, meat leanness and feed conversion. Organic and/or humane production systems are receiving considerable attention in Europe and this may see the development of a boutique pork market and a downgrading of the bulk consumer product. It may be possible to batch-produce different meat compositions from the same herd with combinations of feeding and management. Finally branding of the product may be driven by bio-ethical and philosophical considerations, as much as by its production economics.

Sector **Pigs** **(Pg)**

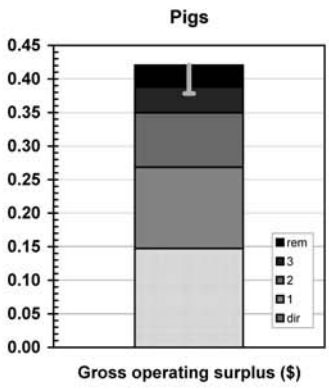
Pigs

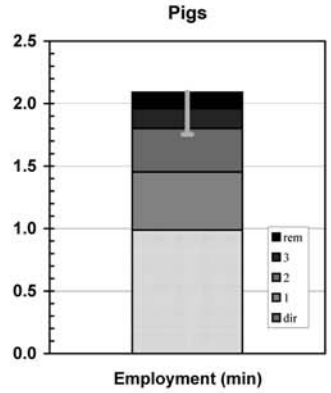
Spider diagram

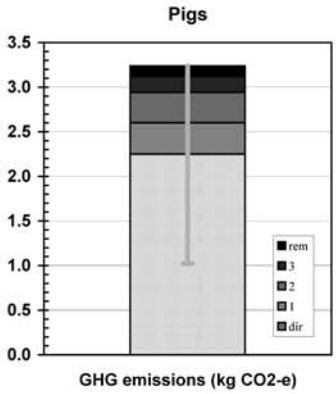


Bar graphs

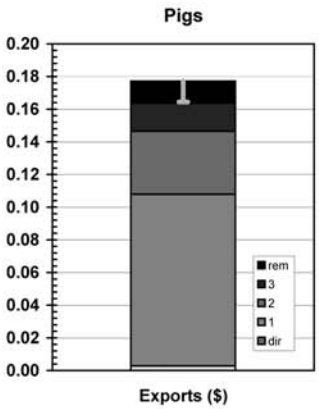
Account #1

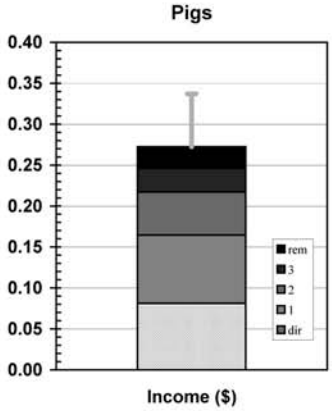


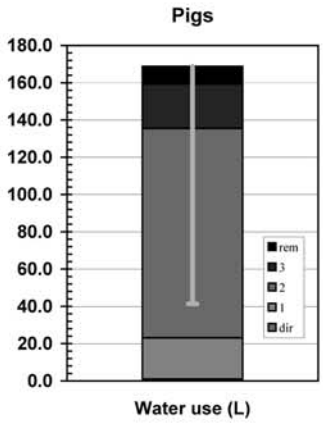




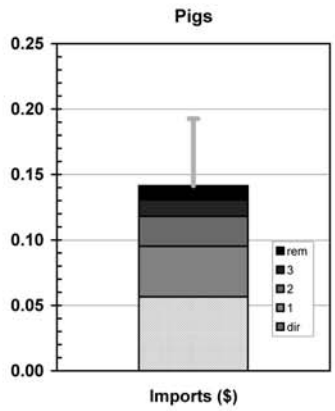
Account #2

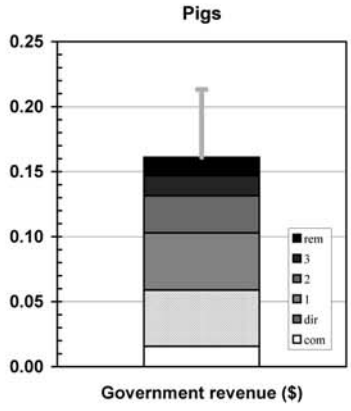


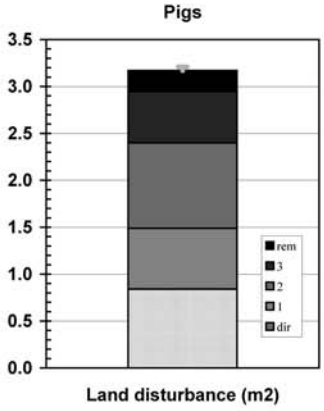




Account #3







National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 3.8	(0.00% of total)	($m 3.8 domestically produced)
Government final consumption	$m 0.0		
Gross fixed capital expenditure	$m 0.0		
Net changes in stocks	-$m 2.7	-(0.15% of total)	
Sectoral GNE	**$m 1.1**	**(0.00% of GNE)**	**($m 1.1 domestically produced)**
Exports	$m 1.6	(0.00% of total)	($m 1.6 domestically produced)
Final demand	**$m 2.7**	**(0.00% of GNT)**	**($m 2.7 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 47.0	(0.03% of total)	
Gross operating surplus	$m 85.3	(0.04% of total)	
Taxes less subsidies	$m 25.1	(0.03% of total)	
Sectoral GDP*	**$m 157.4**	**(0.04% of GDP)**	
Imports	$m 32.7	(0.03% of total)	
Primary inputs	**$m 190.1**	**(0.03% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 85.3	(0.04%)	$m 0.8	(0.00%)	$m 2.3	(0.00%)
Exports ($m)	$m 1.6	(0.00%)	$m 0.0	(0.00%)	$m 1.0	(0.00%)
Imports ($m)	$m 32.7	(0.03%)	$m 0.3	(0.00%)	$m 0.8	(0.00%)
Employment (e-y)	4,581 e-y	(0.06%)	42 e-y	(0.00%)	90 e-y	(0.00%)
Income ($m)*	$m 47.0	(0.03%)	$m 0.4	(0.00%)	$m 1.5	(0.00%)
Government revenue ($m)†	$m 25.2	(0.02%)	$m 0.3	(0.00%)	$m 0.9	(0.00%)
GHG emissions (kt CO_2-e)	1,302 kt	(0.25%)	12 kt	(0.00%)	17 kt	(0.00%)
Water use (ML)	559 ML	(0.00%)	5 ML	(0.00%)	906 ML	(0.00%)
Land disturbance (kha)	49 kha	(0.03%)	0 kha	(0.00%)	2 kha	(0.00%)
Primary energy (TJ)	481 TJ	(0.01%)	4 TJ	(0.00%)	35 TJ	(0.00%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.15	0.42	0.38
Exports ($)	0.00	0.18	0.16
Imports ($)	0.06	0.14	0.19
Employment (min)	0.99	2.09	1.75
Income ($)	0.08	0.27	0.34
Government revenue ($)	0.06	0.16	0.21
GHG emissions (kg CO_2-e)	2.25	3.24	1.02
Water use (L)	0.97	168.82	41.32
Land disturbance (m^2)	0.84	3.17	3.21
Primary energy (MJ)	0.83	6.51	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Pg	0.147	(0; 35.%)	Pg	0.987	(0; 47.%)	Pg	2.25	(0; 69.%)
Fd Pg	0.0178	(1; 4.2%)	Vf Pg	0.0689	(1; 3.3%)	Dc Dp Pg	0.138	(2; 4.3%)
Dc Dp Pg	0.0139	(2; 3.3%)	Dc Dp Pg	0.06	(2; 2.9%)	Fd Pg	0.117	(1; 3.6%)
Vf Pg	0.0139	(1; 3.3%)	Wt Pg	0.0595	(1; 2.8%)	El Pg	0.107	(1; 3.3%)
Fc Pg	0.0108	(1; 2.6%)	Fd Pg	0.0396	(1; 1.9%)	Bc Mp Fd Pg	0.035	(3; 1.1%)
Dp Pg	0.0107	(1; 2.5%)	Rd Pg	0.035	(1; 1.7%)	Vf Pg	0.0269	(1; 0.83%)
Wt Pg	0.00827	(1; 2.%)	Dp Pg	0.0301	(1; 1.4%)	Fr Vf Pg	0.0161	(2; 0.5%)
Rd Pg	0.00595	(1; 1.4%)	Wh Pg	0.0277	(1; 1.3%)	Ri Fc Pg	0.0154	(2; 0.48%)
Cm Pg	0.00581	(1; 1.4%)	Fc Pg	0.0267	(1; 1.3%)	Ba Pg	0.0148	(1; 0.46%)
Wh Pg	0.0056	(1; 1.3%)	Nb Pg	0.0249	(1; 1.2%)	Wh Pg	0.0118	(1; 0.37%)
Rv Pg	0.00517	(1; 1.2%)	Ms Pg	0.0189	(1; 0.9%)	Dp Pg	0.00998	(1; 0.31%)
El Pg	0.00432	(1; 1.%)	Su Fd Pg	0.0178	(2; 0.85%)	Rd Pg	0.00945	(1; 0.29%)
Ms Pg	0.00422	(1; 1.%)	Wh Fc Pg	0.0178	(2; 0.85%)	El Fc Pg	0.0094	(2; 0.29%)
Su Fd Pg	0.0036	(2; 0.86%)	Cm Pg	0.0161	(1; 0.77%)	Bc Mp Pg	0.00878	(2; 0.27%)
Wh Fc Pg	0.00359	(2; 0.85%)	Rv Pg	0.0138	(1; 0.66%)	Fc Pg	0.00863	(1; 0.27%)
Ba Pg	0.00278	(1; 0.66%)	Ba Pg	0.0137	(1; 0.66%)	Wt Pg	0.00825	(1; 0.25%)
St Pg	0.00257	(1; 0.61%)	Bk Pg	0.00954	(1; 0.46%)	El Dp Pg	0.00822	(2; 0.25%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Fd Pg	0.0322	(1; 18.%)	Pg	0.0812	(0; 30.%)	Dc Dp Pg	55.6	(2; 33.%)
Dp Pg	0.0255	(1; 14.%)	Wt Pg	0.0128	(1; 4.7%)	Ri Fc Pg	30.9	(2; 18.%)
Fc Pg	0.011	(1; 6.2%)	Fd Pg	0.00931	(1; 3.4%)	Vf Pg	14.4	(1; 8.5%)
Wh Pg	0.00721	(1; 4.1%)	Dp Pg	0.00746	(1; 2.7%)	Su Fd Pg	14.2	(2; 8.4%)
Wt Pg	0.00676	(1; 3.8%)	Rd Pg	0.00602	(1; 2.2%)	Sc Cg Pg	4.61	(2; 2.7%)
Wh Fc Pg	0.00462	(2; 2.6%)	Vf Pg	0.00567	(1; 2.1%)	Wh Pg	2.86	(1; 1.7%)
Vf Pg	0.0042	(1; 2.4%)	Fc Pg	0.00541	(1; 2.%)	Wh Fc Pg	1.83	(2; 1.1%)
Ba Pg	0.00285	(1; 1.6%)	Ms Pg	0.0044	(1; 1.6%)	Ba Pg	1.78	(1; 1.1%)
Pg	0.00276	(0; 1.6%)	Nb Pg	0.00371	(1; 1.4%)	Sc Cg Vf Pg	1.49	(3; 0.88%)
Cg Pg	0.00215	(1; 1.2%)	Cm Pg	0.00365	(1; 1.3%)	Wa Pg	1.46	(1; 0.86%)
Rd Pg	0.00207	(1; 1.2%)	Bk Pg	0.00235	(1; 0.86%)	Vf Fd Pg	1.12	(2; 0.67%)
Wh Fd Pg	0.00192	(2; 1.1%)	Rv Pg	0.00223	(1; 0.82%)	Pg	0.966	(0; 0.57%)
Mp Fd Pg	0.00136	(2; 0.77%)	Dc Dp Pg	0.00218	(2; 0.8%)	Bc Mp Fd Pg	0.923	(3; 0.55%)
Ac Pg	0.00135	(1; 0.76%)	Hs Pg	0.0021	(1; 0.77%)	Wh Fd Pg	0.762	(2; 0.45%)
Fd Dc Dp Pg	0.0013	(3; 0.73%)	Ac Pg	0.00175	(1; 0.64%)	Sc Cg Dc Dp I	0.751	(4; 0.44%)
Bl El Pg	0.00105	(2; 0.59%)	Su Fd Pg	0.00147	(2; 0.54%)	El Pg	0.591	(1; 0.35%)
Of Pg	0.001	(1; 0.57%)	Cg Pg	0.00138	(1; 0.51%)	Dc Dp Fc Pg	0.58	(3; 0.34%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Pg	0.0564	(0; 40.%)	Pg	0.0433	(0; 30.%)	Pg	0.84	(0; 27.%)
Fd Pg	0.00535	(1; 3.8%)	Wt Pg	0.00597	(1; 4.1%)	Wh Pg	0.417	(1; 13.%)
Ac Pg	0.00362	(1; 2.6%)	Fd Pg	0.00451	(1; 3.1%)	Dc Dp Pg	0.289	(2; 9.1%)
Vf Pg	0.00342	(1; 2.4%)	Rd Pg	0.00427	(1; 2.9%)	Wh Fc Pg	0.267	(2; 8.4%)
Fc Pg	0.00263	(1; 1.9%)	Dp Pg	0.00379	(1; 2.6%)	Bc Mp Fd Pg	0.255	(3; 8.%)
Fo Pg	0.00244	(1; 1.7%)	Vf Pg	0.00348	(1; 2.4%)	Ba Pg	0.21	(1; 6.6%)
Dp Pg	0.00198	(1; 1.4%)	Fc Pg	0.00274	(1; 1.9%)	Wh Fd Pg	0.111	(2; 3.5%)
Of Pg	0.00197	(1; 1.4%)	Ms Pg	0.00209	(1; 1.4%)	Bc Mp Pg	0.0638	(2; 2.%)
Wt Pg	0.00192	(1; 1.4%)	Cm Pg	0.00174	(1; 1.2%)	Bc Mp Of Pg	0.0443	(3; 1.4%)
Dc Dp Pg	0.00157	(2; 1.1%)	Nb Pg	0.00156	(1; 1.1%)	Wo Mp Fd Pg	0.0287	(3; 0.91%)
Rd Pg	0.00151	(1; 1.1%)	Dc Dp Pg	0.00139	(2; 0.96%)	Su Fd Pg	0.0227	(2; 0.71%)
Pt Pg	0.00144	(1; 1.%)	Rv Pg	0.00137	(1; 0.94%)	Ri Fc Pg	0.0156	(2; 0.49%)
Cm Pg	0.000994	(1; 0.7%)	Bk Pg	0.0013	(1; 0.89%)	Ba Fd Pg	0.0152	(2; 0.48%)
Ms Pg	0.000959	(1; 0.68%)	Su Fd Pg	0.0009	(2; 0.62%)	Wh Of Pg	0.0142	(2; 0.45%)
Su Fd Pg	0.000886	(2; 0.63%)	Hs Pg	0.000846	(1; 0.58%)	Wh Dc Dp Pg	0.0141	(3; 0.44%)
Pc Pg	0.000852	(1; 0.6%)	In Pg	0.000828	(1; 0.57%)	Vf Pg	0.0136	(1; 0.43%)
Nb Pg	0.000826	(1; 0.58%)	El Pg	0.00081	(1; 0.56%)	Bc Mp Fd Dc I	0.0102	(5; 0.32%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	1.576 ±0.023	(±1.4%)
Downstream	1.370 ±0.088	(±6.4%)

Sector 0106: Poultry and Eggs (Pe)

Poultry for slaughtering, eggs, egg laying hens

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions and water use are two times the average, while land disturbance is three times the average. The social indicator of employment generation is 10% above average, while income and government revenue are 20% and 30% below average respectively. The financial indicators of operating surplus and export propensity are both 20% above average, while import penetration is 40% below average. Downstream issues include food safety, human health and the transition to novel ways of controlling important animal and food chain disease organisms.

Sector Description

Commercial egg production is around 220 million dozen per year with a backyard production of about 26 million dozen. Per capita consumption is about 150 per year, down from 250 per capita in the late 1940s. There are about 14 million laying hens with a productive laying life of 12 to 15 months during which they consume 25 to 30 kg of ration, or 360 000 tonnes yearly. About 630 000 tonnes of chicken meat is produced each year from slaughtering about 430 million chickens which take 50 days to grow to a live weight of 2.5 kg, and a processed weight of 1.7kg. The feed conversion ratio is about 1.9 kg of feed per kg of meat, suggesting a total feed consumption of 1.2 million tonnes per year for chicken meat. Meat consumption is currently 36 kg per capita, up from 4kg per capita in the 1940s. In constant dollar terms, total turnover for egg production has halved in the last 30 years, while turnover for meat production has doubled. Current turnover is about $300 million for eggs, and $1.2 billion for meat with each commodity involving 400 to 500 enterprises.

Place of Industry in the Economy

The poultry and eggs sector ranks 106th out of 135 sectors in terms of value adding in the economy, and contributes 0.09% of GDP in this analysis. It is similar in value adding to the seed cotton, and confectionery sectors. It is a small employer with 2 000 employment years directly embodied in final demand, and another 2 000 years in the sectors suppliers giving a total of 4 000 employment years. In addition it contributes nearly 7 000 employment years to the final demand of downstream industries such as meat products, retail trade, and accommodation cafes and restaurants. It has small absolute resource requirements with less than two tenths of one percent of national land disturbance, water use, energy use and greenhouse emissions. Imports are approximately equal to exports.

Strategic Overview

The spider diagram portrays three outliers for the environmental indicators of greenhouse emissions, water use, and land disturbance. These are indirect production chain effects due to the ingredients in intensive poultry rations, and particularly meat meal from the meat products sector. Downstream issues include animal welfare issues, a public licence to operate, and consumer acceptance of intensive animal production systems. The challenges of antibiotic resistance and transfer of Salmonella-type diseases to the human food chain are stimulating the use of more natural ration additives (bacteriocins, antimicrobial peptides, bacteriophages) and the use of genetic marker technology to select disease resistant animal lines with less fat in preferred body parts. The cholesterol challenge to some facets of human health has reduced egg consumption, but also stimulated egg products with higher concentrations of omega-3 fatty acids. Some systems are ‘vegetarian’ being marketed as using vegetable protein instead of meat and fish protein.

TBL Account #1

The financial indicator of operating surplus is 20% above average and composed of a direct effect of (42%), with contributions from animal feeds (7%), beef cattle (4%), forwarding and storage (3%), liquefied petroleum gas (2%), business services (2%), electricity production (2%), wheat growing (1%) and sugar growing (1%). The social indicator of employment is 10% above average, with a composition similar to the surplus indicator. The environmental indicator of greenhouse emissions is two times the average with a direct sector effect of 20%, and contributions from meat meal in poultry rations from beef cattle and sheep (44%: land clearing and methane), prepared animal feeds (8%), electricity production (7%), and refining of liquefied petroleum gas (1%).

TBL Accounts #2 and #3

The second TBL account shows an export propensity 25% above average, income 20% below average, and water use over two times the average. The third TBL account shows an import penetration 40% below average, government revenue 30% below average, and land disturbance over three times the national average.

Structural Path Analysis and Linkages

The structural path analysis of water use shows that direct sector use is minor and that it is composed of the water use echoes from the components of poultry rations. These include production chains such as ‘beef cattle-meat products-poultry and eggs’ (28%), ‘sugar cane-animal feeds-poultry and eggs’ (25%), ‘seed cotton-cotton ginning-poultry and eggs’ (7%), water delivery sector (4%), ‘vegetable and fruit growing-animal feeds-poultry and eggs’ (2%), barley growing (2%) and wheat growing (1%). The land disturbance indicator is dominated by the beef cattle chain which contributes meat meal to poultry rations (71%), sheep farming (meat meal also) (8%), wheat growing (7%) and barley growing (2%). It may be possible to improve the water use and land disturbance indicators through procurement decisions for poultry rations. However substitution may produce a number of production chain shocks particularly in finding alternative uses for meat meal. It may also simply increase the demand for fish meal. Another approach might be to increase consumer prices through the introduction of water pricing based on user pays and full cost recovery principles. Returns could be hypothecated to address any resultant social inequities and fund improved management in the upstream sectors responsible for water use and land disturbance.

The sector’s stimulus to its upstream suppliers is 45% greater than average, and impacts on sectors such as ‘other foods and animal foods’, meat products, wholesale trade, accounting and marketing, and road transport. The linkages to downstream industries are slightly above average and suggest that any expansion in the sector must be preceded by expansion of sectors such as meat products (slaughtering), accommodation cafes and restaurants, and retail trade. The meat products sector occupies a pivotal position: it is the processing node for poultry meat and also processes animal protein concentrates such as meat and bone meal from slaughtering by-products, which in turn are essential inputs for the feed rations of egg and meat producing poultry flocks.

Future Trends in Sector

The base case scenario of the *Future Dilemmas* study anticipates an increase of domestic requirement for poultry meat of 40%, and a doubling of production, with the surplus for export. Increases in global trade volume and access may disadvantage the Australian poultry meat sector.

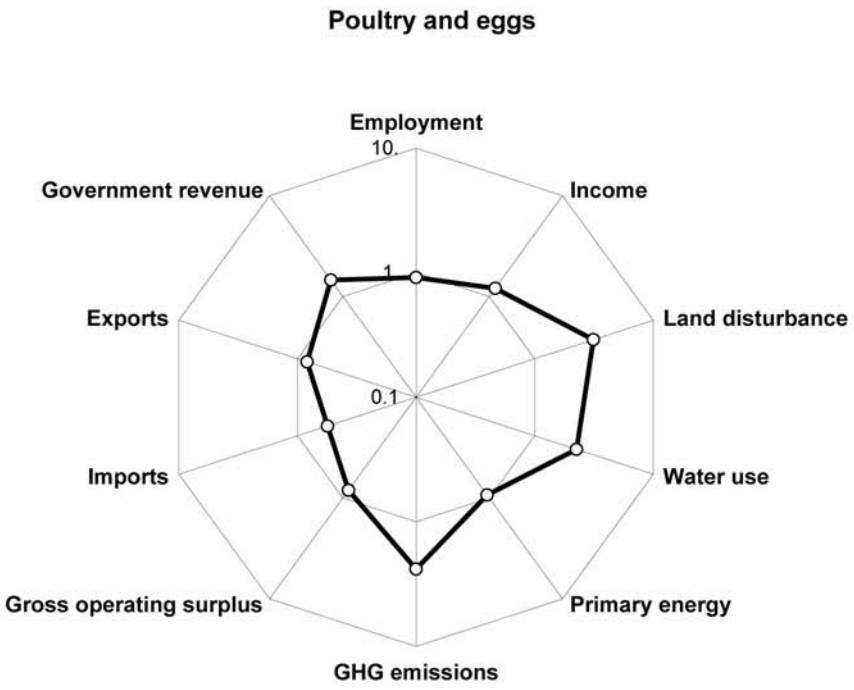
Innovation and Technical Opportunities

Approaches to the bulk production of poultry and eggs will probably mimic current methods but with revolutionary approaches to ensuring animal health, and the replacement of animal protein with legume derived vegetable protein. The ‘natural and organic’ production market may increase.

Sector **Poultry and eggs** **(Pe)**

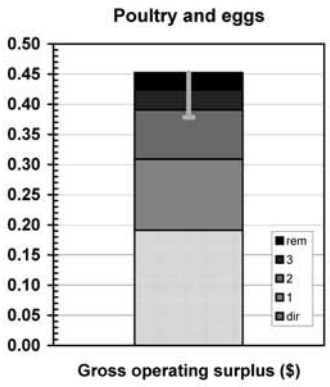
Poultry and eggs

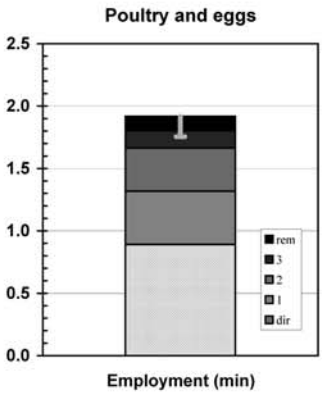
Spider diagram

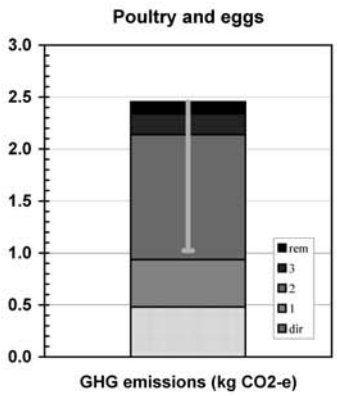


Bar graphs

Account #1







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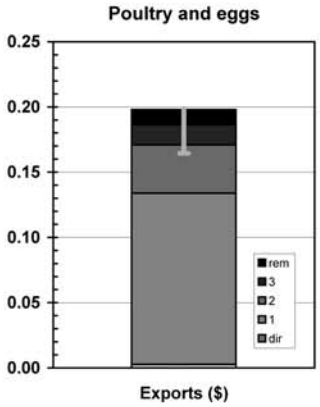

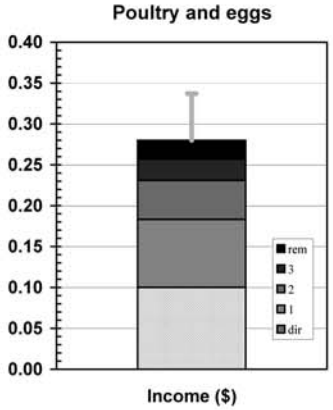

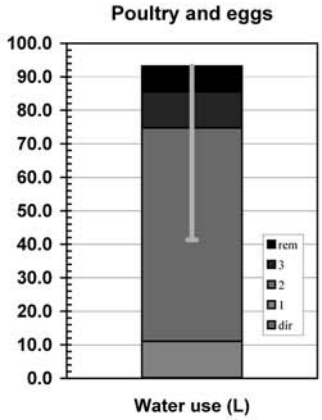

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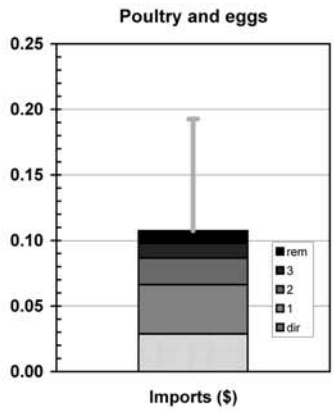
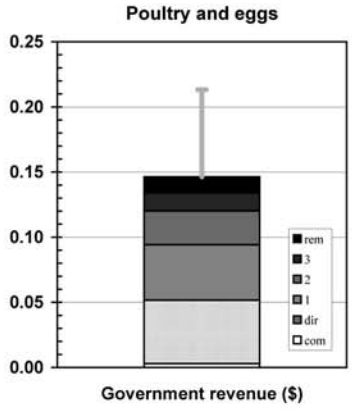
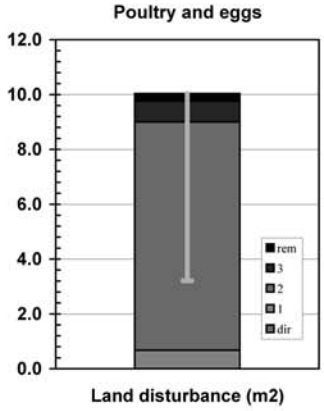






National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 271.9	(0.10% of total)	($m 268.0 domestically produced)
Government final consumption	$m 0.0		
Gross fixed capital expenditure	$m 0.0		
Net changes in stocks	-$m 4.8	-(0.27% of total)	
Sectoral GNE	**$m 267.1**	**(0.06% of GNE)**	**($m 263.2 domestically produced)**
Exports	$m 3.2	(0.00% of total)	($m 3.2 domestically produced)
Final demand	**$m 270.3**	**(0.05% of GNT)**	**($m 266.3 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 120.8	(0.07% of total)	
Gross operating surplus	$m 230.4	(0.12% of total)	
Taxes less subsidies	$m 58.8	(0.07% of total)	
Sectoral GDP*	**$m 410.0**	**(0.09% of GDP)**	
Imports	$m 34.6	(0.04% of total)	
Primary inputs	**$m 444.7**	**(0.08% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 230.4	(0.12%)	$m 51.8	(0.03%)	$m 122.7	(0.06%)
Exports ($m)	$m 3.2	(0.00%)	$m 0.7	(0.00%)	$m 53.7	(0.06%)
Imports ($m)	$m 34.6	(0.04%)	$m 7.8	(0.01%)	$m 29.1	(0.03%)
Employment (e-y)	8,613 e-y	(0.12%)	1,935 e-y	(0.03%)	4,168 e-y	(0.06%)
Income ($m)*	$m 120.8	(0.07%)	$m 27.2	(0.02%)	$m 75.9	(0.04%)
Government revenue ($m)†	$m 59.6	(0.06%)	$m 14.0	(0.01%)	$m 39.7	(0.04%)
GHG emissions (kt CO_2-e)	579 kt	(0.11%)	130 kt	(0.03%)	666 kt	(0.13%)
Water use (ML)	191 ML	(0.00%)	43 ML	(0.00%)	25,280 ML	(0.12%)
Land disturbance (kha)	0 kha	(0.00%)	0 kha	(0.00%)	272 kha	(0.17%)
Primary energy (TJ)	1,776 TJ	(0.05%)	399 TJ	(0.01%)	1,940 TJ	(0.05%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.19	0.45	0.38
Exports ($)	0.00	0.20	0.16
Imports ($)	0.03	0.11	0.19
Employment (min)	0.89	1.92	1.75
Income ($)	0.10	0.28	0.34
Government revenue ($)	0.05	0.15	0.21
GHG emissions (kg CO_2-e)	0.48	2.45	1.02
Water use (L)	0.16	93.23	41.32
Land disturbance (m^2)	0.00	10.04	3.21
Primary energy (MJ)	1.47	7.16	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Pe	0.191	(0; 42.%)	Pe	0.891	(0; 46.%)	Bc Mp Pe	0.985	(2; 40.%)
Fd Pe	0.0293	(1; 6.5%)	Bc Mp Pe	0.0724	(2; 3.8%)	Pe	0.48	(0; 20.%)
Bc Mp Pe	0.0164	(2; 3.6%)	Fd Pe	0.0654	(1; 3.4%)	Fd Pe	0.193	(1; 7.9%)
St Pe	0.013	(1; 2.9%)	Mp Pe	0.0598	(1; 3.1%)	El Pe	0.165	(1; 6.7%)
Lg Pe	0.0081	(1; 1.8%)	Wh Pe	0.0324	(1; 1.7%)	Bc Mp Fd Pe	0.0578	(3; 2.4%)
Ms Pe	0.00683	(1; 1.5%)	Ms Pe	0.0306	(1; 1.6%)	Wo Mp Pe	0.0337	(2; 1.4%)
El Pe	0.00665	(1; 1.5%)	Su Fd Pe	0.0294	(2; 1.5%)	Lg Pe	0.0193	(1; 0.78%)
Wh Pe	0.00655	(1; 1.4%)	Wt Pe	0.028	(1; 1.5%)	Fr Bc Mp Pe	0.0182	(3; 0.74%)
Su Fd Pe	0.00594	(2; 1.3%)	Nb Pe	0.0252	(1; 1.3%)	Wh Pe	0.0138	(1; 0.56%)
Wa Pe	0.00562	(1; 1.2%)	St Pe	0.0212	(1; 1.1%)	Ba Pe	0.0124	(1; 0.51%)
Mp Pe	0.00406	(1; 0.9%)	Pa Pe	0.0139	(1; 0.73%)	Pg Mp Pe	0.0121	(2; 0.49%)
Wt Pe	0.00389	(1; 0.86%)	Bk Pe	0.0131	(1; 0.68%)	El Fd Pe	0.0116	(2; 0.47%)
Rv Pe	0.00379	(1; 0.84%)	Hs Pe	0.0126	(1; 0.66%)	Fo Pe	0.00971	(1; 0.4%)
Bk Pe	0.0033	(1; 0.73%)	Wh Fd Pe	0.0122	(2; 0.63%)	Su Fd Pe	0.00875	(2; 0.36%)
Cm Pe	0.00324	(1; 0.72%)	Ba Pe	0.0115	(1; 0.6%)	Bc Mp Pe Mp	0.00841	(4; 0.34%)
Nb Pe	0.00247	(1; 0.55%)	Cg Pe	0.0112	(1; 0.59%)	El Mp Pe	0.00792	(2; 0.32%)
Wh Fd Pe	0.00246	(2; 0.54%)	Rd Pe	0.011	(1; 0.57%)	Pc Pe	0.00687	(1; 0.28%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Fd Pe	0.0531	(1; 27.%)	Pe	0.1	(0; 36.%)	Bc Mp Pe	26.0	(2; 28.%)
Mp Pe	0.0383	(1; 19.%)	Fd Pe	0.0154	(1; 5.5%)	Su Fd Pe	23.4	(2; 25.%)
Lg Pe	0.00946	(1; 4.8%)	Mp Pe	0.0103	(1; 3.7%)	Sc Cg Pe	6.45	(2; 6.9%)
Wh Pe	0.00842	(1; 4.3%)	Ms Pe	0.00712	(1; 2.5%)	Wa Pe	4.13	(1; 4.4%)
St Pe	0.00321	(1; 1.6%)	Wt Pe	0.00601	(1; 2.1%)	Wh Pe	3.34	(1; 3.6%)
Wt Pe	0.00318	(1; 1.6%)	St Pe	0.0054	(1; 1.9%)	Vf Fd Pe	1.86	(2; 2.%)
Wh Fd Pe	0.00317	(2; 1.6%)	Nb Pe	0.00376	(1; 1.3%)	Bc Mp Fd Pe	1.52	(3; 1.6%)
Cg Pe	0.00301	(1; 1.5%)	Bk Pe	0.00324	(1; 1.2%)	Ba Pe	1.49	(1; 1.6%)
Wo Mp Pe	0.00298	(2; 1.5%)	Pa Pe	0.0032	(1; 1.1%)	Wh Fd Pe	1.26	(2; 1.3%)
Pe	0.00262	(0; 1.3%)	Hs Pe	0.00313	(1; 1.1%)	Wo Mp Pe	1.09	(2; 1.2%)
Ba Pe	0.00238	(1; 1.2%)	Bc Mp Pe	0.00248	(2; 0.89%)	Ri Fc Pe	1.05	(2; 1.1%)
Mp Fd Pe	0.00225	(2; 1.1%)	Su Fd Pe	0.00242	(2; 0.86%)	El Pe	0.91	(1; 0.98%)
Pc Pe	0.00162	(1; 0.82%)	Cm Pe	0.00203	(1; 0.73%)	Sc Cg Mp Pe	0.82	(3; 0.88%)
Bl El Pe	0.00161	(2; 0.81%)	El Pe	0.002	(1; 0.72%)	Sc Cg Bc Mp I	0.813	(4; 0.87%)
Bc Mp Pe	0.00144	(2; 0.73%)	Wt Fd Pe	0.00195	(2; 0.7%)	Vf Bc Mp Pe	0.601	(3; 0.64%)
Ms Pe	0.00106	(1; 0.53%)	Cg Pe	0.00193	(1; 0.69%)	Dc Dp Fd Pe	0.571	(3; 0.61%)
Wt Fd Pe	0.00103	(2; 0.52%)	Rd Pe	0.00189	(1; 0.67%)	Mp Pe	0.327	(1; 0.35%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Pe	0.0287	(0; 27.%)	Pe	0.0488	(0; 34.%)	Bc Mp Pe	7.16	(2; 71.%)
Fd Pe	0.00883	(1; 8.2%)	Fd Pe	0.00745	(1; 5.2%)	Wo Mp Pe	0.809	(2; 8.1%)
Pa Pe	0.00401	(1; 3.7%)	Mp Pe	0.00488	(1; 3.4%)	Wh Pe	0.487	(1; 4.9%)
Pc Pe	0.00345	(1; 3.2%)	Ms Pe	0.00338	(1; 2.4%)	Bc Mp Fd Pe	0.42	(3; 4.2%)
Fo Pe	0.00318	(1; 3.%)	St Pe	0.00288	(1; 2.%)	Wh Fd Pe	0.183	(2; 1.8%)
Ac Pe	0.00265	(1; 2.5%)	Wt Pe	0.00281	(1; 2.%)	Ba Pe	0.176	(1; 1.8%)
Ms Pe	0.00155	(1; 1.4%)	Bk Pe	0.00179	(1; 1.2%)	Bc Mp Pe Mp	0.0611	(4; 0.61%)
Bc Mp Pe	0.00154	(2; 1.4%)	Pa Pe	0.00168	(1; 1.2%)	Wo Mp Fd Pe	0.0474	(3; 0.47%)
Su Fd Pe	0.00146	(2; 1.4%)	Nb Pe	0.00158	(1; 1.1%)	Su Fd Pe	0.0374	(2; 0.37%)
St Pe	0.00117	(1; 1.1%)	Su Fd Pe	0.00149	(2; 1.%)	Ba Fd Pe	0.0252	(2; 0.25%)
Pt Pe	0.0011	(1; 1.%)	Bc Mp Pe	0.00145	(2; 1.%)	Wh Bc Mp Pe	0.00957	(3; 0.095%)
Wt Pe	0.000904	(1; 0.84%)	Rd Pe	0.00134	(1; 0.93%)	Wh Fc Pe	0.00906	(2; 0.09%)
Wa Pe	0.000854	(1; 0.8%)	Hs Pe	0.00127	(1; 0.88%)	Sc Cg Pe	0.00847	(2; 0.084%)
Nb Pe	0.000838	(1; 0.78%)	El Pe	0.00125	(1; 0.87%)	Wo Mp Pe Mp	0.0069	(4; 0.069%)
Wh Pe	0.000754	(1; 0.7%)	Wa Pe	0.00121	(1; 0.85%)	Fr Bc Mp Pe	0.00585	(3; 0.058%)
Lg Pe	0.000597	(1; 0.56%)	Rd Mp Pe	0.00117	(2; 0.81%)	Bc Mp Of Fd F	0.0047	(4; 0.047%)
Ee Pe	0.000595	(1; 0.55%)	Cg Pe	0.00101	(1; 0.71%)	Pg Mp Pe	0.00452	(2; 0.045%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	1.447 ±0.023	(±1.6%)
Downstream	1.073 ±0.067	(±6.3%)

Sector 1610010: Sugar Cane (Su)

Sugar cane for planting and crushing

Short Summary

Sugar cane is the primary growing sector that delivers sugar cane to sugar refining and subsequent processing industries. The environmental indicators show that greenhouse emissions are 25% above average while land disturbance is 25% below average. Issues such as biodiversity and acid sulphate soils are outside this analysis. Water use is thirty times the national average, at 1 250 litres per dollar of final consumption. The social indicators provide a mixed story, with employment generation 20% above average, while income and government revenue are 25% and 35% below average respectively. Regional employment generated by the sector is an important consideration in judging the sector's social performance. The financial indicators are subject to considerable yearly variation. They show that operating surplus is 20% above average, while export propensity and import penetration are 55% and 25% below average respectively. Exports are delivered through the refinery sector so the export indicator is less relevant here. The sector shows strong downstream linkages to sugar refining and fruit and vegetable products. Increased consumer demand for the sector shows below average upstream linkages to services to agriculture, wholesale trade and accommodation and cafes. This analysis suggests that the current farmgate price of sugar cane does not adequately represent the full environmental services embodied in each unit of production, particularly in the case of water. The gradual introduction of full cost recovery pricing for water will eventually increase the consumer price of sugar, and all of its downstream products.

Sector Description

Over the last five years between 400 000 and 430 000 ha of sugar cane was harvested annually from total sugar cane land of 530 000 ha, giving 32 to 42 million tonnes of cane for crushing, and raw sugar production of 4.6-5.6 million tonnes. Around 3-4 million tonnes of sugar is exported each year as part of world trade flows of 60 million tonnes, and total world production of 140 million tonnes from both sugar beet and sugar cane. The total value of the sugar industry in basic prices is around $1.5 billion each year, of which $1 billion is the value of the cut sugarcane. There are 28 sugar mills located mostly in Queensland and in addition to sugar, they produce electricity (from bagasse), ethanol, and stock feed supplements such as molasses. The sector is important regionally.

Place of Industry in the Economy

The industry is a small one in terms of value adding within the economy ranking 92nd out of 135 sectors and contributing 0.13% of GDP. The industry as a whole provides 14 000 employment years, uses 6% of managed water resources, 0.1% of energy and greenhouse gas emissions and is responsible for 0.14% of national land disturbance. The full flow-on effects are restricted in this analysis since the sugar cane is delivered to final demand through the refinery sector.

Strategic Overview

The integrated overview in the spider diagram shows a reasonably balanced TBL account with a major outlier for water use. Employment generation is above average but income is below average suggesting issues of equity. A below average government revenue indicator is shared with many sectors, but world prices periodically stimulate the requirement for industry assistance and restructuring. Immediate downstream issues relate to the effect of farming practice on stream and estuarine quality, and the resilience of the Great Barrier Reef. Broader societal effects relate to the part played by sugar in diet and lifestyle, leading to adverse impacts on population health.

TBL Account #1

The financial surplus is 20% above average with over two thirds of this direct with small contributions from services to agriculture (2%), wholesale trade, machinery repairs and banking (1% each). The employment indicator is 20% above average with two thirds of this a direct effect, reflecting the importance of sugar growing for job creation in regional areas of northern Australia. The greenhouse emissions indicator is 25% above the average with one third a direct effect of fuel combustion in the paddock, another third due to land development and smaller contributions from electricity generation (6%), nitrogen fertiliser manufacture (3%), diesel refining (2%) and mixed fertiliser manufacture (1%).

TBL Accounts #2 and #3

The second TBL account shows income that is 25% below average and water use that is thirty times the economy wide average per dollar of final consumption, most of which is a direct, within paddock effect The export indicator is less relevant since exports are delivered through the refining sector where the export indicator is three times the average. The third TBL account shows import penetration 25% below average, while government revenue and land disturbance are respectively 35% and 25% below average. Outside the focus of this analysis, are local issues such as biodiversity, acid sulphate soils, estuarine water quality and impacts on the Great Barrier Reef.

Structural Path Analysis and Linkages

Given the positive outcome for financial surplus and employment generation, there may be scope to improve the income indicator including the proportion that is returned to the sugar workforce. Examination of the structural paths reveals that while employment generation has a direct effect of 68%, the income indicator has a direct effect of 46%. This is because higher priced activities are outsourced such as services to agriculture, wholesale trade, and road transport which together make up an additional 10%, while banking, insurance and accounting make up another 5%.

Increases in consumer demand show average upstream linkages to suppliers such as services to agriculture, wholesale trade, and accommodation and cafes. The sector shows strong downstream linkages to sugar milling, fruit and vegetable products, and soft drinks.

Future Trends in Sector

A number of scenarios in the *Future Dilemmas* and Decision Points studies anticipate a doubling of sugar cane production by 2050 in response to range of possible market opportunities. These scenarios required a major expansion of agriculture in northern Australia. The current world market is dominated by the EU (where the sugar price is maintained at three times the world price), and Brazil (a large and efficient producer). How these issues will play out over time is uncertain and a reduction in sugar area and production is also feasible. A trend to healthy lifestyles, low calorie foods, and a greater use of corn syrup could reduce the global requirement for sugar despite growth in population and affluence. Increasing interest in sugar based ethanol production as a fuel additive and petrol substitute could increase production. Climate change may affect coastal Queensland.

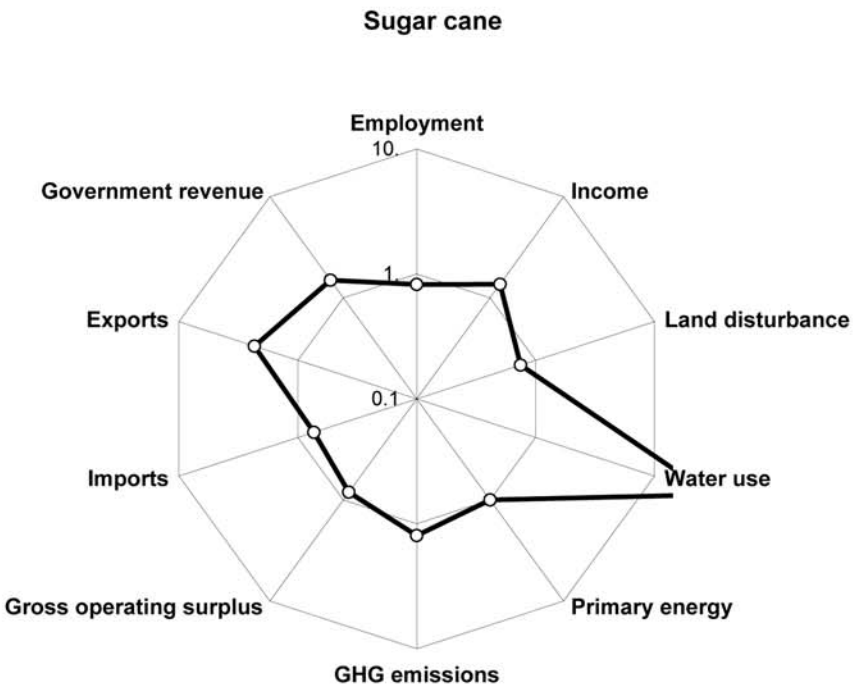
Innovation and Technical Opportunities

Adding more value to the sugar production chain through chemicals and fine foods is receiving considerable attention. Sucrose esters and microbial production of biodegradable plastics are especially promising. These could reduce dependence on petroleum feedstocks, but the farming fuel cycle loop will have to be closed before there is a net benefit. Immediate farming sustainability challenges are receiving strong investment particularly in catchments flowing to the Great Barrier Reef to help decrease environmental impact, particularly on near shore reefs and sea grass beds.

Sector **Sugar cane** **(Su)**

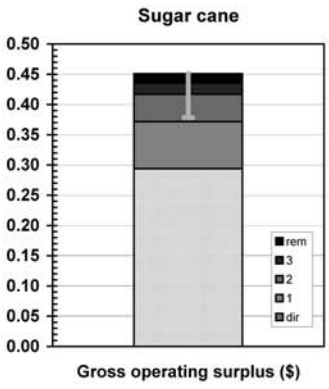
Sugar cane for planting and crushing

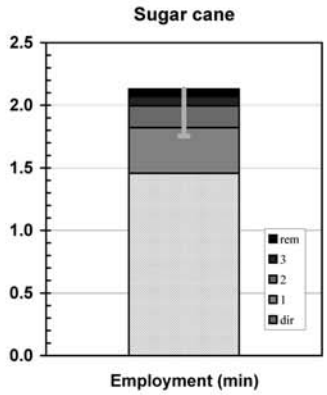
Spider diagram

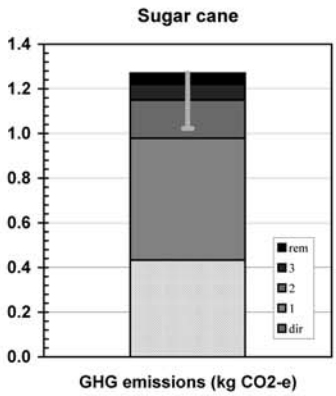


Bar graphs

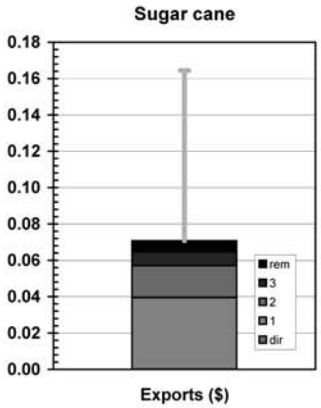
Account #1

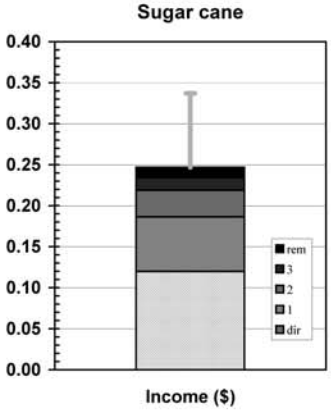


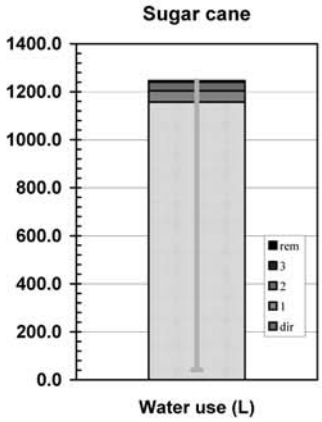




Account #2







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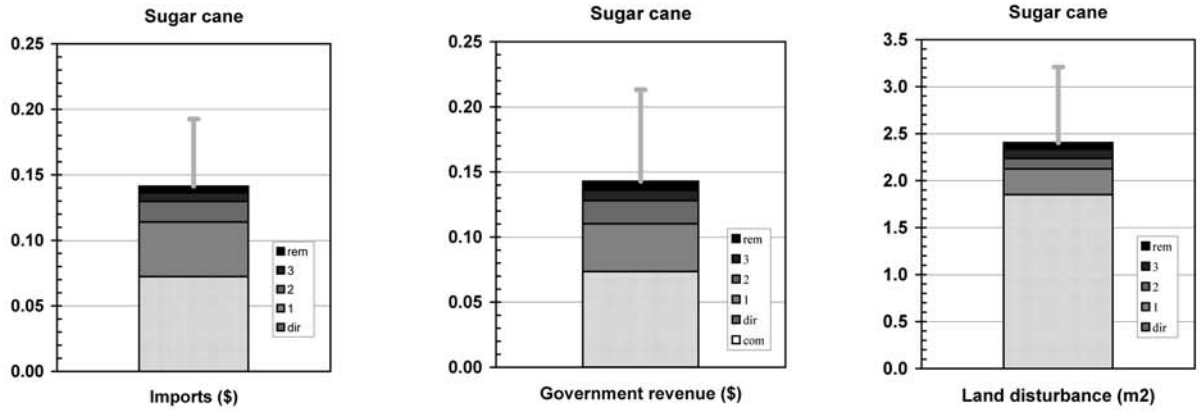


National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 0.0		
Government final consumption	$m 0.0		
Gross fixed capital expenditure	$m 0.0		
Net changes in stocks	-$m 10.8	-(0.61% of total)	
Sectoral GNE	**-$m 10.8**	**(0.00% of GNE)**	
Exports	$m 0.1	(0.00% of total)	($m 0.1 domestically produced)
Final demand	**-$m 10.6**	**(0.00% of GNT)**	
Costs: GNT(I) - industries			
Wages and salaries	$m 143.8	(0.08% of total)	
Gross operating surplus	$m 352.9	(0.18% of total)	
Taxes less subsidies	$m 88.3	(0.10% of total)	
Sectoral GDP*	**$m 585.0**	**(0.13% of GDP)**	
Imports	$m 86.9	(0.09% of total)	
Primary inputs	**$m 671.9**	**(0.12% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 352.9	(0.18%)	$m 0.0	(0.00%)	$m 0.1	(0.00%)
Exports ($m)	$m 0.1	(0.00%)	$m 0.0	(0.00%)	$m 0.0	(0.00%)
Imports ($m)	$m 86.9	(0.09%)	$m 0.0	(0.00%)	$m 0.0	(0.00%)
Employment (e-y)	14,020 e-y	(0.20%)	2 e-y	(0.00%)	3 e-y	(0.00%)
Income ($m)*	$m 143.8	(0.08%)	$m 0.0	(0.00%)	$m 0.0	(0.00%)
Government revenue ($m)†	$m 88.3	(0.08%)	$m 0.0	(0.00%)	$m 0.0	(0.00%)
GHG emissions (kt CO_2-e)	520 kt	(0.10%)	0 kt	(0.00%)	0 kt	(0.00%)
Water use (ML)	1,388,989 ML	(6.63%)	172 ML	(0.00%)	185 ML	(0.00%)
Land disturbance (kha)	222 kha	(0.14%)	0 kha	(0.00%)	0 kha	(0.00%)
Primary energy (TJ)	3,719 TJ	(0.10%)	0 TJ	(0.00%)	1 TJ	(0.00%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.29	0.45	0.38
Exports ($)	0.00	0.07	0.16
Imports ($)	0.07	0.14	0.19
Employment (min)	1.46	2.13	1.75
Income ($)	0.12	0.25	0.34
Government revenue ($)	0.07	0.14	0.21
GHG emissions (kg CO_2-e)	0.43	1.27	1.02
Water use (L)	1156.63	1246.67	41.32
Land disturbance (m^2)	1.85	2.40	3.21
Primary energy (MJ)	3.10	7.63	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Su	0.294	(0; 65.%)	Su	1.46	(0; 68.%)	Su	0.433	(0; 34.%)
Cg Su	0.00834	(1; 1.8%)	Cg Su	0.0549	(1; 2.6%)	Fr Su	0.34	(1; 27.%)
Wt Su	0.00616	(1; 1.4%)	Wt Su	0.0444	(1; 2.1%)	El Su	0.073	(1; 5.7%)
Sc Cg Su	0.00612	(2; 1.4%)	Rd Su	0.0306	(1; 1.4%)	Ch Su	0.0351	(1; 2.8%)
Rv Su	0.00602	(1; 1.3%)	Sc Cg Su	0.0303	(2; 1.4%)	Sc Cg Su	0.0301	(2; 2.4%)
Rd Su	0.00522	(1; 1.2%)	Rv Su	0.0161	(1; 0.76%)	Fo Su	0.0242	(1; 1.9%)
Bk Su	0.00364	(1; 0.81%)	Bk Su	0.0145	(1; 0.68%)	Fe Su	0.0169	(1; 1.3%)
Oi Fo Su	0.00344	(2; 0.76%)	Ms Su	0.0128	(1; 0.6%)	Rd Su	0.00828	(1; 0.65%)
El Su	0.00295	(1; 0.65%)	Ho Su	0.0116	(1; 0.55%)	Oi Fo Su	0.00729	(2; 0.57%)
Ch Su	0.00293	(1; 0.65%)	Ac Su	0.0103	(1; 0.48%)	Fr Sc Cg Su	0.00707	(3; 0.56%)
Ms Su	0.00286	(1; 0.63%)	Ch Su	0.00854	(1; 0.4%)	Wt Su	0.00615	(1; 0.48%)
Ac Su	0.00285	(1; 0.63%)	Ts Su	0.00771	(1; 0.36%)	El Ch Su	0.00529	(2; 0.42%)
Wa Su	0.00249	(1; 0.55%)	Rh Su	0.00759	(1; 0.36%)	Ap Su	0.00444	(1; 0.35%)
Cm Su	0.00223	(1; 0.49%)	In Su	0.00709	(1; 0.33%)	Fd Su	0.00385	(1; 0.3%)
Ts Su	0.00171	(1; 0.38%)	Nb Su	0.0064	(1; 0.3%)	Ch Fe Su	0.00275	(2; 0.22%)
St Su	0.00169	(1; 0.38%)	Cm Su	0.00616	(1; 0.29%)	El Fe Su	0.00267	(2; 0.21%)
Fe Su	0.00148	(1; 0.33%)	Ma Su	0.00589	(1; 0.28%)	Cg Su	0.00261	(1; 0.21%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Cg Su	0.0147	(1; 21.%)	Su	0.12	(0; 49.%)	Su	1,156.6	(0; 93.%)
Wt Su	0.00504	(1; 7.1%)	Wt Su	0.00952	(1; 3.9%)	Sc Cg Su	31.5	(2; 2.5%)
Ch Su	0.00408	(1; 5.8%)	Cg Su	0.00943	(1; 3.8%)	Wa Su	1.83	(1; 0.15%)
Oi Fo Su	0.00235	(2; 3.3%)	Rd Su	0.00527	(1; 2.1%)	Sc Cg Sc Cg S	0.656	(4; 0.053%)
Ac Su	0.00201	(1; 2.8%)	Bk Su	0.00357	(1; 1.4%)	Wh Su	0.601	(1; 0.048%)
Rd Su	0.00181	(1; 2.6%)	In Su	0.00307	(1; 1.2%)	Ri Fc Su	0.538	(2; 0.043%)
Wh Su	0.00151	(1; 2.1%)	Ms Su	0.00298	(1; 1.2%)	Su Fd Su	0.465	(2; 0.037%)
Fd Su	0.00106	(1; 1.5%)	Ac Su	0.00261	(1; 1.1%)	El Su	0.403	(1; 0.032%)
Fo Su	0.000982	(1; 1.4%)	Rv Su	0.00259	(1; 1.1%)	Ri Su	0.345	(1; 0.028%)
Ma Su	0.000866	(1; 1.2%)	Sc Cg Su	0.00249	(2; 1.%)	Ws Su	0.276	(1; 0.022%)
Oi Ap Su	0.000741	(2; 1.%)	Ch Su	0.00181	(1; 0.73%)	Ch Su	0.107	(1; 0.0086%)
At Su	0.000718	(1; 1.%)	Ts Su	0.0018	(1; 0.73%)	Dc Dp Su	0.106	(2; 0.0085%)
Bl El Su	0.000714	(2; 1.%)	Ho Su	0.0017	(1; 0.69%)	Ws Ho Su	0.0848	(2; 0.0068%)
Ho Su	0.000647	(1; 0.91%)	Cm Su	0.0014	(1; 0.57%)	Wa Ms Su	0.0734	(2; 0.0059%)
In Su	0.000595	(1; 0.84%)	Gv Su	0.00131	(1; 0.53%)	Wa Cg Su	0.0634	(2; 0.0051%)
Rf Su	0.00046	(1; 0.65%)	Ma Su	0.00111	(1; 0.45%)	Ri Ws Su	0.0616	(2; 0.0049%)
Ms Su	0.000442	(1; 0.63%)	Nb Su	0.000954	(1; 0.39%)	Bc Mp Ho Su	0.0609	(3; 0.0049%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Su	0.0723	(0; 51.%)	Su	0.0735	(0; 51.%)	Su	1.85	(0; 77.%)
Fo Su	0.00792	(1; 5.6%)	Cg Su	0.00495	(1; 3.5%)	Fr Su	0.109	(1; 4.5%)
Ac Su	0.00539	(1; 3.8%)	Wt Su	0.00445	(1; 3.1%)	Wh Su	0.0875	(1; 3.6%)
Ch Su	0.00409	(1; 2.9%)	Rd Su	0.00374	(1; 2.6%)	Sc Cg Su	0.0414	(2; 1.7%)
Ap Su	0.0025	(1; 1.8%)	In Su	0.0033	(1; 2.3%)	Bc Mp Ho Su	0.0168	(3; 0.7%)
Cg Su	0.00234	(1; 1.7%)	Bk Su	0.00197	(1; 1.4%)	Bc Mp Ch Su	0.0139	(3; 0.58%)
Fe Su	0.00207	(1; 1.5%)	Rv Su	0.0016	(1; 1.1%)	Bc Mp Fd Su	0.00836	(3; 0.35%)
Sc Cg Su	0.00151	(2; 1.1%)	Sc Cg Su	0.00153	(2; 1.1%)	Wh Ac Su	0.00821	(2; 0.34%)
Wt Su	0.00143	(1; 1.%)	Ms Su	0.00141	(1; 0.99%)	Bc Mp Fe Su	0.00705	(3; 0.29%)
Rd Su	0.00132	(1; 0.93%)	Ch Su	0.000904	(1; 0.63%)	Bc Ch Su	0.00701	(2; 0.29%)
Ma Su	0.00102	(1; 0.72%)	Ho Su	0.000894	(1; 0.63%)	Wo Tx Ac Su	0.00576	(3; 0.24%)
Pa Su	0.000884	(1; 0.63%)	Ts Su	0.000889	(1; 0.62%)	Wh Fc Su	0.00465	(2; 0.19%)
Rv Su	0.000779	(1; 0.55%)	Ac Su	0.00078	(1; 0.55%)	Wh Fd Su	0.00365	(2; 0.15%)
Ms Su	0.000649	(1; 0.46%)	Cm Su	0.000668	(1; 0.47%)	Bc Fe Su	0.00355	(2; 0.15%)
Rh Su	0.00064	(1; 0.45%)	El Su	0.000553	(1; 0.39%)	Fr Sc Cg Su	0.00227	(3; 0.095%)
Pc Su	0.000554	(1; 0.39%)	Wa Su	0.000536	(1; 0.38%)	Wo Tx Su	0.00193	(2; 0.08%)
Pl Su	0.000527	(1; 0.37%)	Ma Su	0.000534	(1; 0.37%)	Wo Mp Ho Su	0.0019	(3; 0.079%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.910 ±0.012	(±1.3%)
Downstream	1.509 ±0.086	(±5.7%)

Sector 1620010: Cotton (Sc)

Cotton containing cotton seed

Short Summary

The seed cotton sector provides environmental indicators per dollar of final demand that are more than twice the economy wide average for greenhouse emissions, 39 times the average for water use and 20% less than average for land disturbance. The social indicators show employment that is 20% above average, income that is 25% below average, and government revenue that is 55% below average. The financial indicators reveal an operating surplus that is 20% above average and an import penetration that is 25% below average. The export propensity indicator is 55% below average. This is principally because cotton is exported through the 'services to agriculture' sector where seed cotton is ginned to separate the cotton lint (the export product) from the cottonseed. The sector shows strong downstream linkages due mainly to the by-product cottonseed meal which is used as a feed supplement for the beef and dairy industries. The industry is limited by water availability in southern Australia. Production may double over the next 50 years if prospects in northern Australia are developed. However this carries considerable environmental risks for ecosystem health in the northern river basins.

Sector Description

Cotton was first grown on the Darling Downs in 1840. The sector currently produces between 700 000 and 750 000 tonnes of cotton lint (the cotton boll minus the cotton seed) each year, grown on up to 550 000 ha by 1 500 family farmers in New South Wales and Queensland. Yields of more than 1.5 tonne per hectare are among the highest in the world, coming from a mix of irrigated (73%) and dryland (27%) farming systems. Yearly production is worth $1.5 billion at the farm gate. Australia captures about 10% of the volume of world trade with the USA (30%) being the dominant player. Seed cotton is processed into lint in the 'services to agriculture' sector and exported from that sector in national accounting terms. Little yarn is spun in Australia today because of the low cost processing offered by China, India and Indonesia.

Place of Industry in the Economy

The cotton growing industry ranks 105th out of 135 in terms of value adding and contributes 0.09% of GDP in this analysis. By way of comparison, it is one fifth the size of the sheep and wool sector (which includes sheep grown for meat production) and about one third the size of the clothing sector where its transformed product is eventually located. It is a relatively small employer with a nominal 10 000 employment years but these are very important regionally, especially in western NSW and south western Queensland. The industry uses 1 300 GL (10^9L) of water or 6% of national water use.

Strategic Overview

The integrated overview of the seed cotton sector shows the two environmental indicators of water use and greenhouse emissions as outliers, as well as the financial indicator of export propensity and the social indicator of government revenue. The sector is similar to the beef and dairy cattle sectors in that exports are delivered through the processing sectors, making the export indicator less relevant. In upstream terms, the sector faces a number of public perceptions relating to water use, pesticide use, health of workers and the nature of intensive agriculture. The industry has implemented strong technological and management responses to most of these issues. Downstream issues include claims for irrigation water by other industries, subsequent effluent and contamination effects, and the minimal value adding to the cotton crop within Australian industry.

TBL Account #1

The first TBL account shows the financial indicator of operating surplus is 20% above average, one half of which is direct. Other contributors to the surplus include services to agriculture (4%), wholesale trade, machinery repairs, road transport, diesel refining and banking (1% each). The social indicator of employment generation is 20% above average with a strong direct effect and other contributors similar to the operating surplus. The greenhouse emissions indicator is more than twice the economy wide average with two thirds of this a direct effect.

TBL Accounts #2 and #3

The second TBL account shows the income indicator is 25% below average and the water indicator is 39 times the economy wide average. The third TBL account shows import penetration is 25% below average, government revenue 55% below average and land disturbance 20% below average. Overall improvements may be possible for the social and the water indicators, but improving water management may stimulate energy use.

Structural Path Analysis and Linkages

The structural path analysis for employment shows that 68% of the effect is direct followed by a brace of minor contributors such as services to agriculture (3%), wholesale trade (2%), road transport (2%) and rail transport, banking and marketing (1% each). The greenhouse path shows the direct effect is largest (62%) followed by land development (15%), electricity generation (3%), basic chemicals (2%), diesel refining (1%) and fertiliser manufacture (1%).

Downstream linkages for seed cotton are amongst the strongest shown in this analysis and point to the sector's reliance on downstream sectors to disperse its primary product. The strongest linkage is to the 'services to agriculture' sector which contains the ginning industry where raw cotton is separated into cotton lint (40%) and cotton seed (60%). The cottonseed by-product then flows to the animal feeds sector and thence to the dairy, beef and related sectors. The other forward stimulus follows the obvious route from cotton lint to processed fibres. Increases in consumer demand give an average upstream stimulus to the sector's suppliers.

Future Trends in Sector

The base case scenario in the CSIRO *Future Dilemmas* study anticipates a possible doubling of cotton production over the next 50 years facilitated by development of irrigation potential in Northern Australia. However while land may be available, water is likely to be a constraining factor as suitable impoundment sites are scarce and flows are highly variable. There appears to be little scope for a major increase in irrigated land for cotton in southern Australia due to water limitations and environmental concerns. Industry sources note potential areas of 200 000 ha in northern Australia producing an additional 1.5 million bales (340 000 tonnes) of lint. Australia's market advantage in quality, strength and length will continue to increase with strong whole of industry management and plant breeding for quality. Water reforms and increased water prices may affect cotton's viability in some regions, particularly in southern Australia. Synthetics will continue to compete strongly with cotton, which currently has 28% of the world's fabric markets.

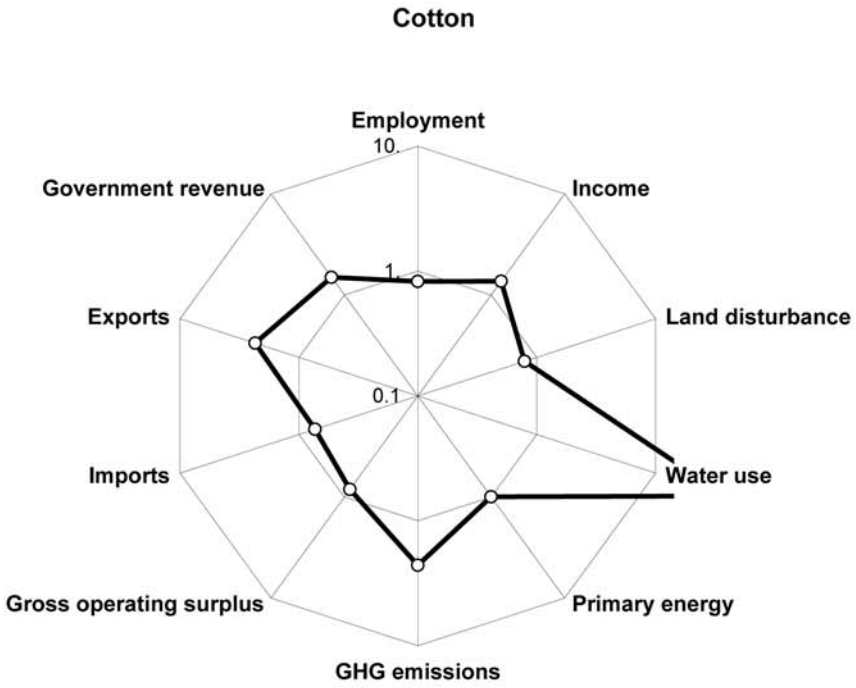
Innovation and Technical Opportunities

A priority for the chain of cotton sectors (growing, processing, weaving, clothing) may be to increase the amount of domestically grown cotton processed into cloth and clothes in Australia. Currently most of the cotton crop is shipped to Asian processing countries, and spun yarn and finished clothes are imported. The potential of value adding is shown by a US study of regional cotton production where a pair of jeans containing $1 of cotton at the farm gate was transformed to $50 at the point of sale. Priorities for research include integrated pest management, water use efficiency, cotton quality, reducing chemical inputs and managing environmental externalities.

Sector **Cotton** **(Sc)**

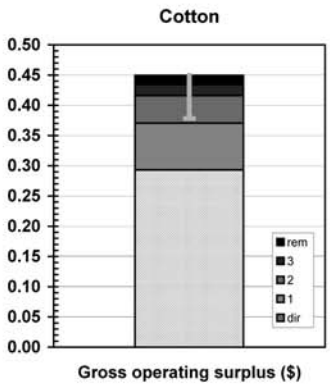
Cotton (excl ginned)

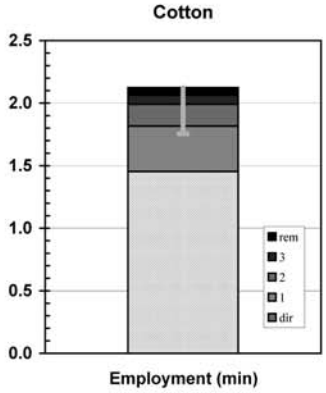
Spider diagram

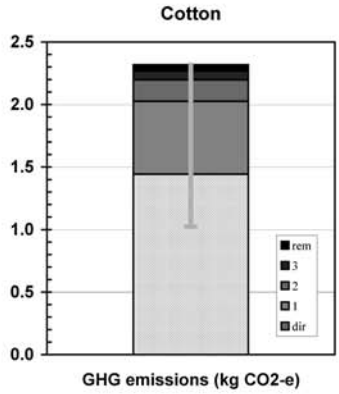


Bar graphs

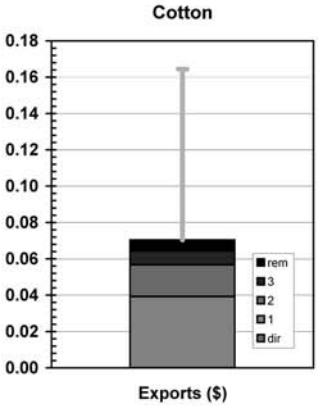
Account #1

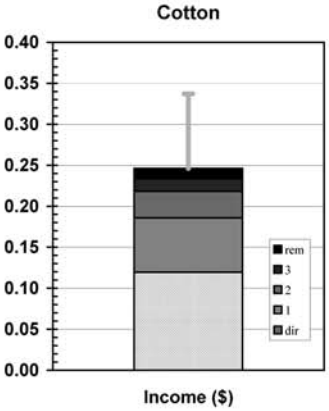


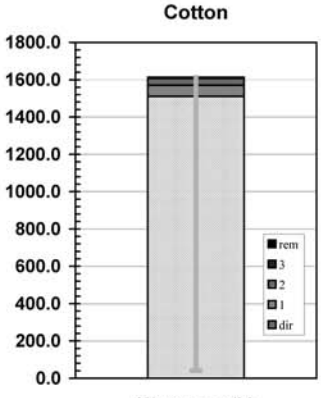




Account #2







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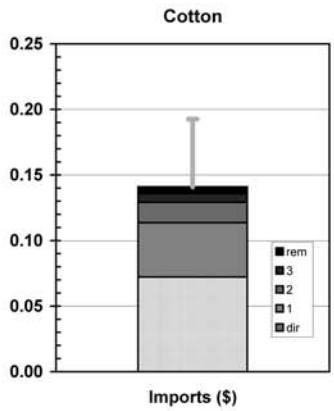
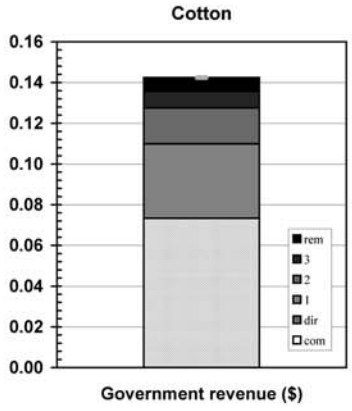
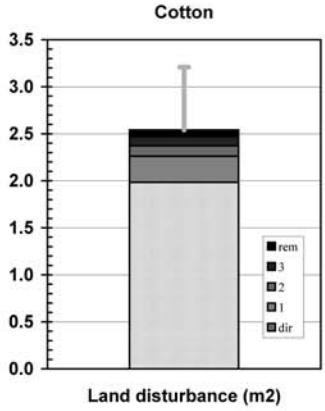






National Accounts extracts		
Receipts: GNT(E) - commodities		
Private final consumption	$m 0.0	
Government final consumption	$m 0.0	
Gross fixed capital expenditure	$m 0.0	
Net changes in stocks	-$m 9.9	-(0.56% of total)
Sectoral GNE	**-$m 9.9**	**(0.00% of GNE)**
Exports	$m 0.0	
Final demand	**-$m 9.9**	**(0.00% of GNT)**
Costs: GNT(I) - industries		
Wages and salaries	$m 101.2	(0.06% of total)
Gross operating surplus	$m 248.2	(0.13% of total)
Taxes less subsidies	$m 62.1	(0.07% of total)
Sectoral GDP*	**$m 411.5**	**(0.09% of GDP)**
Imports	$m 61.1	(0.06% of total)
Primary inputs	**$m 472.6**	**(0.09% of GNT)**

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT	
		(% of national)	direct (% of national)	total (% of national)
Gross operating surplus ($m)	$m 248.2	(0.13%)		
Exports ($m)	$m 0.0			
Imports ($m)	$m 61.1	(0.06%)		
Employment (e-y)	9,861 e-y	(0.14%)		
Income ($m)*	$m 101.2	(0.06%)		
Government revenue ($m)†	$m 62.1	(0.06%)		
GHG emissions (kt CO_2-e)	1,222 kt	(0.24%)		
Water use (ML)	1,279,015 ML	(6.11%)		
Land disturbance (kha)	168 kha	(0.10%)		
Primary energy (TJ)	2,616 TJ	(0.07%)		

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.29	0.45	0.38
Exports ($)	0.00	0.07	0.16
Imports ($)	0.07	0.14	0.19
Employment (min)	1.45	2.12	1.75
Income ($)	0.12	0.25	0.34
Government revenue ($)	0.07	0.14	0.21
GHG emissions (kg CO_2-e)	1.44	2.32	1.02
Water use (L)	1510.18	1613.83	41.32
Land disturbance (m^2)	1.98	2.54	3.21
Primary energy (MJ)	3.09	7.61	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Sc	0.293	(0; 65.%)	Sc	1.45	(0; 68.%)	Sc	1.44	(0; 62.%)
Cg Sc	0.00832	(1; 1.8%)	Cg Sc	0.0548	(1; 2.6%)	Fr Sc	0.339	(1; 15.%)
Wt Sc	0.00615	(1; 1.4%)	Wt Sc	0.0443	(1; 2.1%)	El Sc	0.0728	(1; 3.1%)
Sc Cg Sc	0.0061	(2; 1.4%)	Rd Sc	0.0306	(1; 1.4%)	Ch Sc	0.035	(1; 1.5%)
Rv Sc	0.006	(1; 1.3%)	Sc Cg Sc	0.0302	(2; 1.4%)	Sc Cg Sc	0.03	(2; 1.3%)
Rd Sc	0.0052	(1; 1.2%)	Rv Sc	0.016	(1; 0.76%)	Fo Sc	0.0241	(1; 1.%)
Bk Sc	0.00363	(1; 0.81%)	Bk Sc	0.0144	(1; 0.68%)	Fe Sc	0.0169	(1; 0.73%)
Oi Fo Sc	0.00343	(2; 0.76%)	Ms Sc	0.0128	(1; 0.6%)	Rd Sc	0.00826	(1; 0.36%)
El Sc	0.00294	(1; 0.65%)	Ho Sc	0.0116	(1; 0.55%)	Oi Fo Sc	0.00727	(2; 0.31%)
Ch Sc	0.00292	(1; 0.65%)	Ac Sc	0.0102	(1; 0.48%)	Fr Sc Cg Sc	0.00705	(3; 0.3%)
Ms Sc	0.00285	(1; 0.63%)	Ch Sc	0.00852	(1; 0.4%)	Wt Sc	0.00613	(1; 0.26%)
Ac Sc	0.00284	(1; 0.63%)	Ts Sc	0.00769	(1; 0.36%)	El Ch Sc	0.00527	(2; 0.23%)
Wa Sc	0.00248	(1; 0.55%)	Rh Sc	0.00757	(1; 0.36%)	Ap Sc	0.00442	(1; 0.19%)
Cm Sc	0.00222	(1; 0.49%)	In Sc	0.00707	(1; 0.33%)	Fd Sc	0.00384	(1; 0.17%)
Ts Sc	0.00171	(1; 0.38%)	Nb Sc	0.00638	(1; 0.3%)	Ch Fe Sc	0.00274	(2; 0.12%)
St Sc	0.00169	(1; 0.38%)	Cm Sc	0.00614	(1; 0.29%)	El Fe Sc	0.00267	(2; 0.11%)
Fe Sc	0.00148	(1; 0.33%)	Ma Sc	0.00588	(1; 0.28%)	Cg Sc	0.0026	(1; 0.11%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Cg Sc	0.0146	(1; 21.%)	Sc	0.119	(0; 49.%)	Sc	1,510.2	(0; 94.%)
Wt Sc	0.00503	(1; 7.1%)	Wt Sc	0.0095	(1; 3.9%)	Sc Cg Sc	31.4	(2; 1.9%)
Ch Sc	0.00407	(1; 5.8%)	Cg Sc	0.00941	(1; 3.8%)	Wa Sc	1.82	(1; 0.11%)
Oi Fo Sc	0.00234	(2; 3.3%)	Rd Sc	0.00525	(1; 2.1%)	Sc Cg Sc Cg S	0.654	(4; 0.041%)
Ac Sc	0.002	(1; 2.8%)	Bk Sc	0.00356	(1; 1.4%)	Wh Sc	0.599	(1; 0.037%)
Rd Sc	0.00181	(1; 2.6%)	In Sc	0.00306	(1; 1.2%)	Ri Fc Sc	0.536	(2; 0.033%)
Wh Sc	0.00151	(1; 2.1%)	Ms Sc	0.00297	(1; 1.2%)	Su Fd Sc	0.464	(2; 0.029%)
Fd Sc	0.00105	(1; 1.5%)	Ac Sc	0.0026	(1; 1.1%)	El Sc	0.402	(1; 0.025%)
Fo Sc	0.00098	(1; 1.4%)	Rv Sc	0.00259	(1; 1.1%)	Ri Sc	0.344	(1; 0.021%)
Ma Sc	0.000863	(1; 1.2%)	Sc Cg Sc	0.00249	(2; 1.%)	Ws Sc	0.275	(1; 0.017%)
Oi Ap Sc	0.000739	(2; 1.%)	Ch Sc	0.00181	(1; 0.73%)	Ch Sc	0.107	(1; 0.0066%)
At Sc	0.000716	(1; 1.%)	Ts Sc	0.0018	(1; 0.73%)	Dc Dp Sc	0.106	(2; 0.0066%)
Bl El Sc	0.000712	(2; 1.%)	Ho Sc	0.00169	(1; 0.69%)	Ws Ho Sc	0.0846	(2; 0.0052%)
Ho Sc	0.000646	(1; 0.92%)	Cm Sc	0.00139	(1; 0.57%)	Wa Ms Sc	0.0732	(2; 0.0045%)
In Sc	0.000593	(1; 0.84%)	Gv Sc	0.00131	(1; 0.53%)	Wa Cg Sc	0.0632	(2; 0.0039%)
Rf Sc	0.000458	(1; 0.65%)	Ma Sc	0.0011	(1; 0.45%)	Ri Ws Sc	0.0615	(2; 0.0038%)
Ms Sc	0.000441	(1; 0.63%)	Nb Sc	0.000951	(1; 0.39%)	Bc Mp Ho Sc	0.0607	(3; 0.0038%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Sc	0.0721	(0; 51.%)	Sc	0.0733	(0; 51.%)	Sc	1.98	(0; 78.%)
Fo Sc	0.0079	(1; 5.6%)	Cg Sc	0.00494	(1; 3.5%)	Fr Sc	0.109	(1; 4.3%)
Ac Sc	0.00538	(1; 3.8%)	Wt Sc	0.00444	(1; 3.1%)	Wh Sc	0.0873	(1; 3.4%)
Ch Sc	0.00408	(1; 2.9%)	Rd Sc	0.00373	(1; 2.6%)	Sc Cg Sc	0.0413	(2; 1.6%)
Ap Sc	0.00249	(1; 1.8%)	In Sc	0.00329	(1; 2.3%)	Bc Mp Ho Sc	0.0167	(3; 0.66%)
Cg Sc	0.00233	(1; 1.7%)	Bk Sc	0.00197	(1; 1.4%)	Bc Mp Ch Sc	0.0139	(3; 0.55%)
Fe Sc	0.00206	(1; 1.5%)	Rv Sc	0.00159	(1; 1.1%)	Bc Mp Fd Sc	0.00834	(3; 0.33%)
Sc Cg Sc	0.0015	(2; 1.1%)	Sc Cg Sc	0.00153	(2; 1.1%)	Wh Ac Sc	0.00818	(2; 0.32%)
Wt Sc	0.00143	(1; 1.%)	Ms Sc	0.00141	(1; 0.99%)	Bc Mp Fe Sc	0.00703	(3; 0.28%)
Rd Sc	0.00132	(1; 0.93%)	Ch Sc	0.000902	(1; 0.63%)	Bc Ch Sc	0.00699	(2; 0.28%)
Ma Sc	0.00102	(1; 0.72%)	Ho Sc	0.000891	(1; 0.63%)	Wo Tx Ac Sc	0.00574	(3; 0.23%)
Pa Sc	0.000881	(1; 0.63%)	Ts Sc	0.000887	(1; 0.62%)	Wh Fc Sc	0.00464	(2; 0.18%)
Rv Sc	0.000777	(1; 0.55%)	Ac Sc	0.000778	(1; 0.55%)	Wh Fd Sc	0.00364	(2; 0.14%)
Ms Sc	0.000648	(1; 0.46%)	Cm Sc	0.000666	(1; 0.47%)	Bc Fe Sc	0.00354	(2; 0.14%)
Rh Sc	0.000638	(1; 0.45%)	El Sc	0.000552	(1; 0.39%)	Fr Sc Cg Sc	0.00227	(3; 0.089%)
Pc Sc	0.000552	(1; 0.39%)	Wa Sc	0.000535	(1; 0.38%)	Wo Tx Sc	0.00193	(2; 0.076%)
Pl Sc	0.000525	(1; 0.37%)	Ma Sc	0.000532	(1; 0.37%)	Wo Mp Ho Sc	0.00189	(3; 0.074%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.908 ±0.013	(±1.4%)
Downstream	2.453 ±0.095	(±3.9%)

Sector 0107: Vegetable and Fruit Growing (Vf)

Vegetable and fruit growing, hay, plant nurseries, horse studs, flowers, tobacco, hops, rubber and other agriculture

Short Summary

Against the metric of one dollar of final demand the environmental indicator of greenhouse emissions is 40% above average, water use is more than eight times the average while land disturbance is 75% below average. The social indicator of employment generation is 20% above average, while income and government revenue indicators are 25% and 30% below average respectively. The financial indicators provide positive outcomes with operating surplus 20% above average, export propensity equal to average and import penetration 25% below average. The interaction between the environmental indicators presents an interesting quandary. The focus on high quality and regular supply of fruit and vegetables increases energy use in the paddock or orchard, especially where constrained water supplies require efficient and more complex water delivery systems such as micro-sprays, or where crops are grown in greenhouses or under shade cloth. Extending the seasonal availability of produce with imports from interstate and overseas also increases the energy content of the supply chain. As with most food production systems, there are tradeoffs between the essential place of fruit and vegetables in human diets, the energy and water content of the product and the farm gate price.

Sector Description

This sector produces approximately 3.5 million tonnes of fruit and 4.8 million tonnes of vegetables annually. Because of the sector's diversity an integrated overview is difficult to obtain particularly for volumes of imports and exports of each item. For example, 1.8 million tonnes of grapes are grown, 88% of which go to wine making and the rest to table grapes and dried vine products. After a 50% conversion loss in wine making 385 000 tonnes of wine are consumed locally and 417 000 tonnes exported. For citrus, 570 000 tonnes are produced and one quarter is exported. Australians consume 95 kg of vegetables and 53 kg of fruit per capita each year.

Place of Industry in the Economy

The sector ranks 34th out of 135 in terms of value adding in the economy and contributes 0.64% of GDP in this analysis. By way of comparison, the sector's value adding is seven times the size of the seed cotton industry, one quarter that of banking and one eighth the size of wholesale trade. It is a moderate sized employer with direct requirement of 34 000 employment years with an additional 15 000 years for the sector's suppliers giving a total of 49 000 employment years. In addition it contributes 35 000 employment years to downstream industries. The sector is responsible for five percent of national water use, nearly one percent of national greenhouse emissions, and less than one percent of national energy use and greenhouse emissions.

Strategic Overview

The sector's spider diagram shows a major outlying indicator for water use and minor spikes for greenhouse emissions and government revenue. This sector may provide a reasonable benchmark for water use in the primary food and fibre producing sectors. The level of about 360 litres per dollar of final demand is relatively low compared to other food producing sectors, with a physical equivalent of about 10 00 litres per kilogram of fruit or vegetables produced. The possibility of using this as a benchmark to underpin differential pricing mechanisms designed to cap water use or to allow market mechanisms to allocate water more efficiently warrants more detailed consideration.

TBL Account #1

The financial indicator of surplus is 20% greater than the economy wide average. Two thirds of this is a direct effect, followed by a long chain of small suppliers such as services to agriculture (2%) and wholesale trade, repairs to machinery, road transport and diesel refining (1% each). The social indicator of employment generation is 20% above average, with two thirds of that a direct effect and an employment chain similar to operating surplus. The environmental indicator of greenhouse emissions is 40% greater than average, two fifths of which is a direct effect.

TBL Accounts #2 and #3

The second TBL account shows export propensity is 10% above average, income is 25% below average while water use is over eight times the average. The third TBL account shows import penetration, government revenue and land disturbance are 25, 30% and 75% below average respectively. For most indicators, the direct effects represent at least one half of the total.

Structural Path Analysis and Linkages

The structural path for greenhouse emissions shows they are due to direct energy use in the sector (40%), followed by land development (24%), electricity generation (5%), cotton trash (2%), diesel refining (2%), fertiliser manufacture (1%) and road transport (1%). The path analysis for water use shows the majority is used directly in production (84%) with minor contributions from cotton by-products (9%), water industry (1%), wholesale trade (1%) and rice husks (1%). Thus the sector itself should be the primary focus for improving both greenhouse and water use indicators.

Investment into the sector gives a less than average downstream linkage with effects on accommodation and cafes, wine and spirits, fruit and vegetable products, sugar products and entertainment. Increases in consumer demand for the commodity give less than average upstream stimulus to sectors including wholesale trade, services to agriculture and road freight.

Future Trends in Sector

The CSIRO *Future Dilemmas* study anticipates an expansion to three times current production levels for both fruit and vegetables by 2050. This is driven by: water reforms leading to cropping types that give higher economic returns per unit of water used; domestic population growth to 25 million; large increases in inbound international tourism; and a major penetration into world fresh food markets particularly in South East Asia. The export trade driver carries considerable uncertainties due to competition from other traders (New Zealand already exports ten times more apples than Australia), the effect of global climate change, cheap oil availability, quarantine and disease barriers, and world trade and open market access rules.

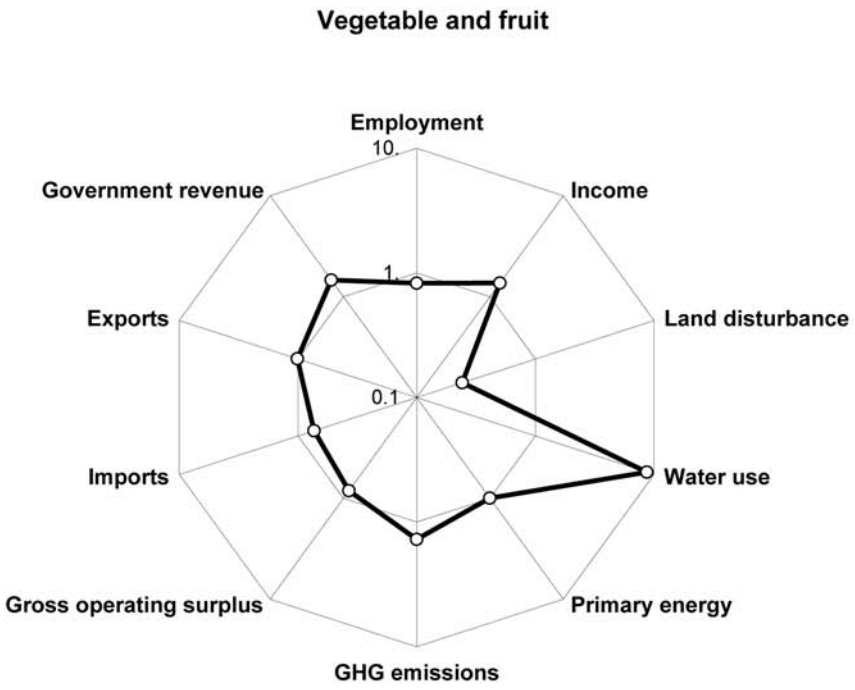
Innovation and Technical Opportunities

Three important areas will drive innovation in the vegetable and fruit growing sector. Firstly, the development of unique, attractive and branded varieties which can re-invent consumer palates and attract higher premiums will drive domestic and export markets. Second, the development of new varieties that are tailor-made to produce higher levels of health-related phyto-chemicals (tomatoes, broccoli, oranges and berries are under final development). Third, the drive to perfect blemish-free produce inevitably involves more chemicals and pesticides. This and related health concerns are driving consumers to shift to more organic and biological forms of vegetable and fruit production. Whether these shifts improve the sector's TBL account requires more investigation. Inevitably a tension is developing between global and economically efficient forms of production that are energy and water rich, and regional modes of production that focus on the spirit of food and its seasonality, rather than its time efficiency, market cost and convenience.

Sector **Vegetable and fruit** **(Vf)**

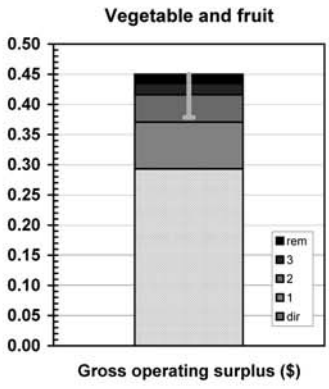
Vegetable and fruit growing, hay, plant nurseries, horse studs, flowers, tobacco, hops, rubber and other agriculture

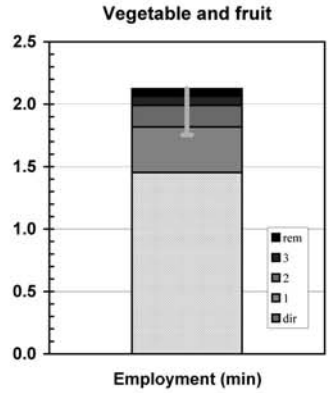
Spider diagram

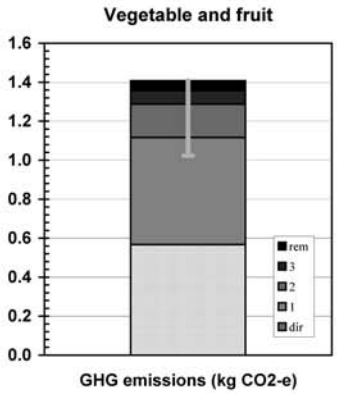


Bar graphs

Account #1







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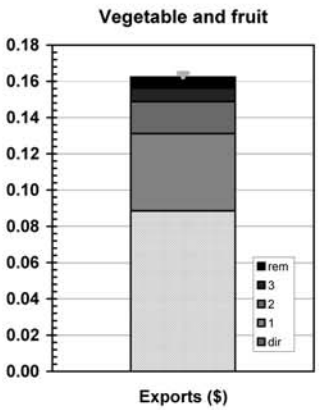
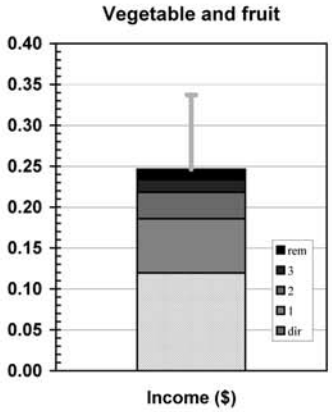
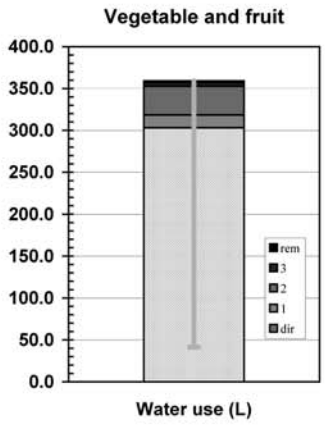
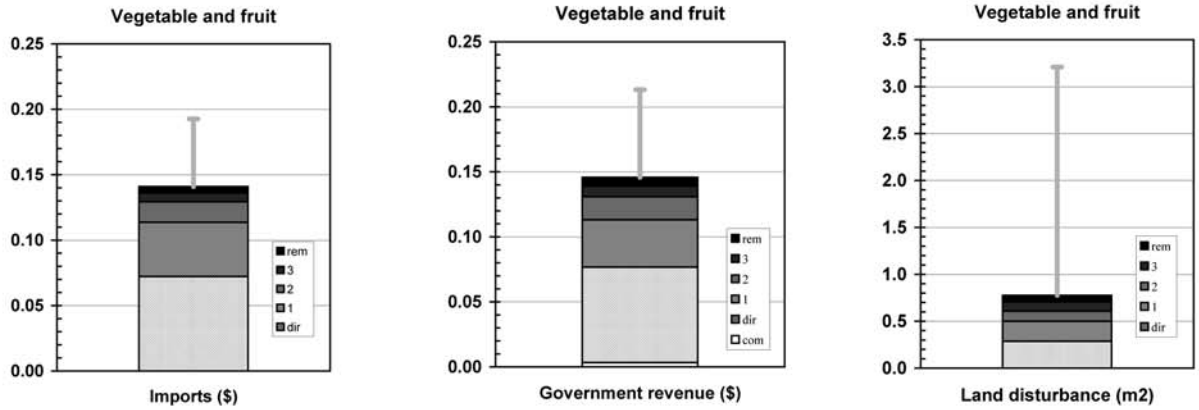






Account #3



National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 2,490.4	(0.94% of total)	($m 2,354.1 domestically produced)
Government final consumption	$m 0.0		
Gross fixed capital expenditure	$m 0.0		
Net changes in stocks	-$m 111.0	-(6.28% of total)	
Sectoral GNE	**$m 2,379.4**	**(0.52% of GNE)**	**($m 2,285.7 domestically produced)**
Exports	$m 525.9	(0.63% of total)	($m 525.9 domestically produced)
Final demand	**$m 2,905.3**	**(0.54% of GNT)**	**($m 2,811.6 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 710.0	(0.42% of total)	
Gross operating surplus	$m 1,741.7	(0.91% of total)	
Taxes less subsidies	$m 435.9	(0.51% of total)	
Sectoral GDP*	**$m 2,887.7**	**(0.64% of GDP)**	
Imports	$m 428.7	(0.44% of total)	
Primary inputs	**$m 3,316.4**	**(0.61% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 1,741.7	(0.91%)	$m 844.1	(0.44%)	$m 1,295.5	(0.68%)
Exports ($m)	$m 525.9	(0.63%)	$m 254.9	(0.31%)	$m 467.7	(0.56%)
Imports ($m)	$m 428.7	(0.44%)	$m 207.8	(0.21%)	$m 406.1	(0.42%)
Employment (e-y)	69,201 e-y	(0.97%)	33,537 e-y	(0.47%)	49,031 e-y	(0.69%)
Income ($m)*	$m 710.0	(0.42%)	$m 344.1	(0.20%)	$m 709.1	(0.42%)
Government revenue ($m)†	$m 445.4	(0.41%)	$m 220.7	(0.20%)	$m 419.7	(0.39%)
GHG emissions (kt CO_2-e)	3,369 kt	(0.65%)	1,633 kt	(0.31%)	4,055 kt	(0.78%)
Water use (ML)	1,800,658 ML	(8.59%)	872,650 ML	(4.17%)	1,034,774 ML	(4.94%)
Land disturbance (kha)	170 kha	(0.11%)	82 kha	(0.05%)	224 kha	(0.14%)
Primary energy (TJ)	18,358 TJ	(0.47%)	8,897 TJ	(0.23%)	21,921 TJ	(0.56%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.29	0.45	0.38
Exports ($)	0.09	0.16	0.16
Imports ($)	0.07	0.14	0.19
Employment (min)	1.45	2.12	1.75
Income ($)	0.12	0.25	0.34
Government revenue ($)	0.08	0.15	0.21
GHG emissions (kg CO_2-e)	0.57	1.41	1.02
Water use (L)	303.01	359.30	41.32
Land disturbance (m^2)	0.29	0.78	3.21
Primary energy (MJ)	3.09	7.61	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Vf	0.293	(0; 65.%)	Vf	1.45	(0; 68.%)	Vf	0.567	(0; 40.%)
Cg Vf	0.00832	(1; 1.8%)	Cg Vf	0.0548	(1; 2.6%)	Fr Vf	0.339	(1; 24.%)
Wt Vf	0.00615	(1; 1.4%)	Wt Vf	0.0443	(1; 2.1%)	El Vf	0.0728	(1; 5.2%)
Sc Cg Vf	0.0061	(2; 1.4%)	Rd Vf	0.0306	(1; 1.4%)	Ch Vf	0.035	(1; 2.5%)
Rv Vf	0.006	(1; 1.3%)	Sc Cg Vf	0.0302	(2; 1.4%)	Sc Cg Vf	0.03	(2; 2.1%)
Rd Vf	0.0052	(1; 1.2%)	Rv Vf	0.0161	(1; 0.76%)	Fo Vf	0.0241	(1; 1.7%)
Bk Vf	0.00363	(1; 0.81%)	Bk Vf	0.0144	(1; 0.68%)	Fe Vf	0.0169	(1; 1.2%)
Oi Fo Vf	0.00343	(2; 0.76%)	Ms Vf	0.0128	(1; 0.6%)	Rd Vf	0.00826	(1; 0.59%)
El Vf	0.00294	(1; 0.65%)	Ho Vf	0.0116	(1; 0.55%)	Oi Fo Vf	0.00727	(2; 0.52%)
Ch Vf	0.00292	(1; 0.65%)	Ac Vf	0.0102	(1; 0.48%)	Fr Sc Cg Vf	0.00705	(3; 0.5%)
Ms Vf	0.00285	(1; 0.63%)	Ch Vf	0.00852	(1; 0.4%)	Wt Vf	0.00613	(1; 0.44%)
Ac Vf	0.00284	(1; 0.63%)	Ts Vf	0.00769	(1; 0.36%)	El Ch Vf	0.00527	(2; 0.37%)
Wa Vf	0.00248	(1; 0.55%)	Rh Vf	0.00757	(1; 0.36%)	Ap Vf	0.00442	(1; 0.31%)
Cm Vf	0.00222	(1; 0.49%)	In Vf	0.00707	(1; 0.33%)	Fd Vf	0.00384	(1; 0.27%)
Ts Vf	0.00171	(1; 0.38%)	Nb Vf	0.00638	(1; 0.3%)	Ch Fe Vf	0.00275	(2; 0.19%)
St Vf	0.00169	(1; 0.38%)	Cm Vf	0.00614	(1; 0.29%)	El Fe Vf	0.00267	(2; 0.19%)
Fe Vf	0.00148	(1; 0.33%)	Ma Vf	0.00588	(1; 0.28%)	Cg Vf	0.0026	(1; 0.18%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Vf	0.0885	(0; 54.%)	Vf	0.119	(0; 49.%)	Vf	303.0	(0; 84.%)
Cg Vf	0.0147	(1; 9.%)	Wt Vf	0.0095	(1; 3.9%)	Sc Cg Vf	31.4	(2; 8.7%)
Wt Vf	0.00503	(1; 3.1%)	Cg Vf	0.00941	(1; 3.8%)	Wa Vf	1.82	(1; 0.51%)
Ch Vf	0.00407	(1; 2.5%)	Rd Vf	0.00526	(1; 2.1%)	Sc Cg Sc Cg \	0.654	(4; 0.18%)
Oi Fo Vf	0.00234	(2; 1.4%)	Bk Vf	0.00356	(1; 1.4%)	Wh Vf	0.599	(1; 0.17%)
Ac Vf	0.002	(1; 1.2%)	In Vf	0.00306	(1; 1.2%)	Ri Fc Vf	0.536	(2; 0.15%)
Rd Vf	0.00181	(1; 1.1%)	Ms Vf	0.00297	(1; 1.2%)	Su Fd Vf	0.464	(2; 0.13%)
Wh Vf	0.00151	(1; 0.93%)	Ac Vf	0.0026	(1; 1.1%)	El Vf	0.402	(1; 0.11%)
Fd Vf	0.00105	(1; 0.65%)	Rv Vf	0.00259	(1; 1.1%)	Ri Vf	0.344	(1; 0.096%)
Fo Vf	0.00098	(1; 0.6%)	Sc Cg Vf	0.00249	(2; 1.%)	Ws Vf	0.275	(1; 0.077%)
Ma Vf	0.000863	(1; 0.53%)	Ch Vf	0.00181	(1; 0.73%)	Ch Vf	0.107	(1; 0.03%)
Oi Ap Vf	0.000739	(2; 0.46%)	Ts Vf	0.0018	(1; 0.73%)	Dc Dp Vf	0.106	(2; 0.03%)
At Vf	0.000716	(1; 0.44%)	Ho Vf	0.00169	(1; 0.69%)	Ws Ho Vf	0.0846	(2; 0.024%)
Bl El Vf	0.000712	(2; 0.44%)	Cm Vf	0.0014	(1; 0.57%)	Wa Ms Vf	0.0733	(2; 0.02%)
Ho Vf	0.000646	(1; 0.4%)	Gv Vf	0.00131	(1; 0.53%)	Wa Cg Vf	0.0632	(2; 0.018%)
In Vf	0.000593	(1; 0.37%)	Ma Vf	0.0011	(1; 0.45%)	Ri Ws Vf	0.0615	(2; 0.017%)
Rf Vf	0.000458	(1; 0.28%)	Nb Vf	0.000951	(1; 0.39%)	Bc Mp Ho Vf	0.0607	(3; 0.017%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Vf	0.0721	(0; 51.%)	Vf	0.0734	(0; 51.%)	Vf	0.286	(0; 37.%)
Fo Vf	0.0079	(1; 5.6%)	Cg Vf	0.00494	(1; 3.5%)	Fr Vf	0.109	(1; 14.%)
Ac Vf	0.00538	(1; 3.8%)	Wt Vf	0.00444	(1; 3.1%)	Wh Vf	0.0873	(1; 11.%)
Ch Vf	0.00408	(1; 2.9%)	Rd Vf	0.00373	(1; 2.6%)	Sc Cg Vf	0.0413	(2; 5.3%)
Ap Vf	0.00249	(1; 1.8%)	In Vf	0.00329	(1; 2.3%)	Bc Mp Ho Vf	0.0167	(3; 2.2%)
Cg Vf	0.00233	(1; 1.7%)	Bk Vf	0.00197	(1; 1.4%)	Bc Mp Ch Vf	0.0139	(3; 1.8%)
Fe Vf	0.00206	(1; 1.5%)	Rv Vf	0.00159	(1; 1.1%)	Bc Mp Fd Vf	0.00834	(3; 1.1%)
Sc Cg Vf	0.0015	(2; 1.1%)	Sc Cg Vf	0.00153	(2; 1.1%)	Wh Ac Vf	0.00819	(2; 1.1%)
Wt Vf	0.00143	(1; 1.%)	Ms Vf	0.00141	(1; 0.99%)	Bc Mp Fe Vf	0.00703	(3; 0.91%)
Rd Vf	0.00132	(1; 0.93%)	Ch Vf	0.000902	(1; 0.63%)	Bc Ch Vf	0.007	(2; 0.9%)
Ma Vf	0.00102	(1; 0.72%)	Ho Vf	0.000891	(1; 0.63%)	Wo Tx Ac Vf	0.00574	(3; 0.74%)
Pa Vf	0.000881	(1; 0.63%)	Ts Vf	0.000887	(1; 0.62%)	Wh Fc Vf	0.00464	(2; 0.6%)
Rv Vf	0.000777	(1; 0.55%)	Ac Vf	0.000778	(1; 0.55%)	Wh Fd Vf	0.00364	(2; 0.47%)
Ms Vf	0.000648	(1; 0.46%)	Cm Vf	0.000667	(1; 0.47%)	Bc Fe Vf	0.00354	(2; 0.46%)
Rh Vf	0.000638	(1; 0.45%)	El Vf	0.000552	(1; 0.39%)	Fr Sc Cg Vf	0.00227	(3; 0.29%)
Pc Vf	0.000552	(1; 0.39%)	Wa Vf	0.000535	(1; 0.38%)	Wo Tx Vf	0.00193	(2; 0.25%)
Pl Vf	0.000526	(1; 0.37%)	Ma Vf	0.000532	(1; 0.37%)	Wo Mp Ho Vf	0.00189	(3; 0.24%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.908 ±0.012	(±1.3%)
Downstream	0.852 ±0.016	(±1.9%)

Sector 0200: Services to Agriculture (Cg)

Services to agriculture, ginned cotton, cotton seed, shearing, aerial agriculture, hunting and trapping

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is equal to average, water use is nearly 14 times the average, and land disturbance is 70% below average. The social indicator of employment generation is 15% above average, income is 10% above average, and government revenue is 20% below average. The financial indicators show that the operating surplus is equal to average, export propensity is two times the average, and import penetration is 30% below average. The sector's future seems assured given the increasing production complexity, its capital intensity, and trend towards outsourcing for specialised skills.

Sector Description

The sector provides a wide range of physical tasks, service provision, and processing systems to most of the primary agricultural sectors. The financial activity is dominated by the provision of ginned cotton (49%), mixed services (38%), aerial agriculture (7%) and shearing (6%). By way of example, aerial agriculture (aerial mustering, crop dusting, aerial spraying) appears to use between 300 and 400 specialised aircraft and employ about 2 000 workers part time. If a shearer works about 40 weeks per year and shears 150 sheep per day, there must be about 4 000 to 5 000 shearers. One issue for shearing is the increasing age profile of shearers, and the advanced age of shearing sheds and equipment. There are about 15 cotton gins in Queensland and New South Wales. In constant dollar terms over the last thirty years, the turnover has halved in aerial agriculture and shearing, increased six fold in cotton ginning, and increased by one half in mixed services. Current turnover is about $4 billion, and involves more than 4 500, mostly small enterprises.

Place of Industry in the Economy

The services to agriculture sector ranks 74th out of 135 sectors in terms of value adding in the economy, and contributes 0.20% of GDP in this analysis. It is similar in value adding to the beer and malt, and uranium, nickel and manganese mining sectors. It is a moderate employer with 6 000 employment years embodied in the sector's final demand, and another 6 000 years in the sector's suppliers giving a total of 12 000 employment years. In addition, it contributes 12 000 employment years to the final demand of downstream industries such as meat products, hay growing, wool growing, beef cattle, and processed wool and yarns. It has moderately large requirements for water with two percent of the national total due to the embodied water in cotton growing which is delivered to final demand in this sector through processing. Cotton lint for weaving and export is 'ginned' from the cottonseed used in animal feeds and oil extraction. It has about one tenth of one percent of national land disturbance, energy use and greenhouse emissions. In financial terms exports outweigh imports by a factor of six.

Strategic Overview

The spider diagram portrays a reasonable TBL account, apart from a large outlier for water use due to cotton growing, and a smaller one for government revenue. Improving the water indicator will require changes in cotton growing management and procurement policies based on the full production chain. Improving the government revenue indicator may be difficult because increased costs may limit cost efficient production and processing and economic viability for many primary sectors. Downstream issues include pesticide safety, professional liability for any poor advice from consultants, and work place safety and training for workers undertaking multiple activities.

TBL Account #1

The financial indicator of operating surplus is equal to average with a direct sector effect of 38% of total, with contributions from cotton growing (28%), wholesale trade (1%), agricultural chemicals (1%), and provision of clean seed for cotton planting (1%). The social indicator of employment generation is 15% above average, with a direct sector effect of 47% and a composition similar to the surplus indicator. The environmental indicator of greenhouse emissions is equal to average and discussed in more detail below.

TBL Accounts #2 and #3

The second TBL account shows export propensity, mainly due to cotton lint, at twice the average and income at 10% above average. Water use is nearly fourteen times the average and is discussed in more detail below. The third TBL account shows import penetration 30% below average, government revenue at 20% below average, and land disturbance at 70% below average.

Structural Path Analysis and Linkages

The structural path analysis for water shows that the direct use of process water in the sector is very small at about one litre per dollar of final demand. Most of the effect (94%) is embodied water from the cotton growing sector as most of the primary product 'seed cotton' is separated into cotton lint and cotton seed in this sector. The cotton growing industry has made substantial advances in water use efficiency over the past decade and is now regarded as a careful and highly efficient user of the water resource. The fact remains nevertheless, that cotton is a water intensive product which is mostly located on the semi-arid floodplains of inland rivers with some dryland cotton in suitable soil and rainfall regimes. The greenhouse gas chain reveals that direct emissions due to within sector fuel combustion are small, at 4% of total. Most emissions are passed through from the cotton growing sector, and due mostly to the nitrification of nitrogen fertilisers (nitrous oxides have a global warming potential more than 300 times that of carbon dioxide). Cotton growing research shows that nitrous oxide emissions can be reduced by using legume rotations to supply biological nitrogen to the cotton crop, or by applying nitrification inhibitors to the soil. Other emissions are due to land development (11%), electricity generation (3%), basic chemical manufacture (nitrogen fertilisers: 3%), and diesel refining for cotton growing (1%). Greenhouse reduction should focus on nitrogen fertiliser management to reduce nitrification.

The sector's stimulus to its upstream suppliers is 20% greater than average and impacts on cotton growing, wholesale trade, road transport, and agricultural chemicals. The linkages to downstream industries are 30% stronger than average and suggest that expansion in the sector must be led by expansion in downstream sectors such as meat products, hay growing, processed wool and yarns, sheep growing, and beef cattle.

Future Trends in Sector

The base case scenario of the *Future Dilemmas* study anticipates that by 2050, cotton production will triple and hay making and wool production will double. These futures assume increased northern irrigation (cotton), further intensification of feedlots (beef), and wool remerging as an affluent fashion fabric using increasingly specialised animals grown in well orchestrated systems.

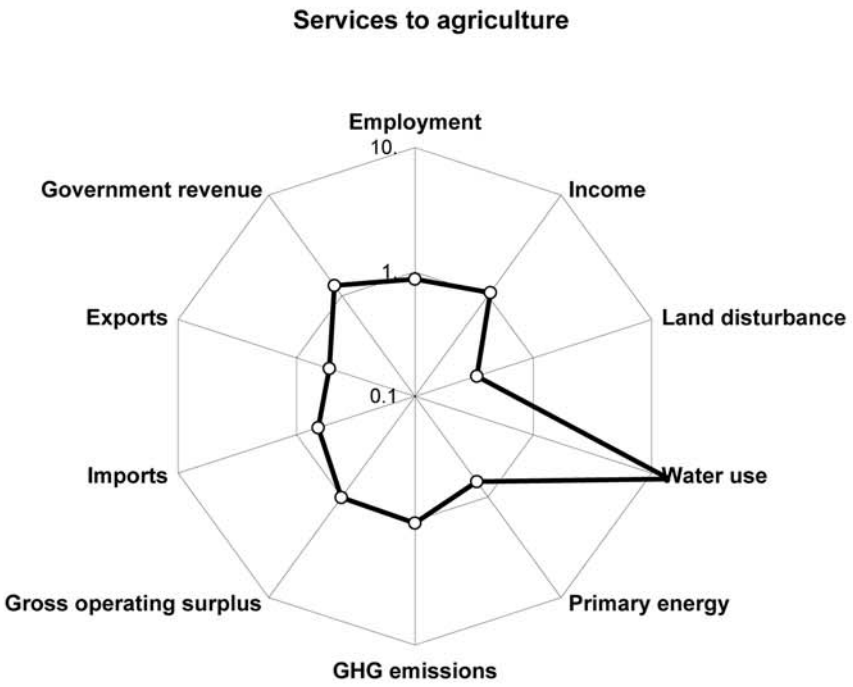
Innovation and Technical Opportunities

The consultancy and advice component of this sector is especially important to the future of Australian farm production, and its place in earning export income from the affluent markets of the world. Increasingly it may have to develop and apply more biological farming systems with life cycle analyses certifying product quality and the sustainability of the production system.

Sector **Services to agriculture** **(Cg)**

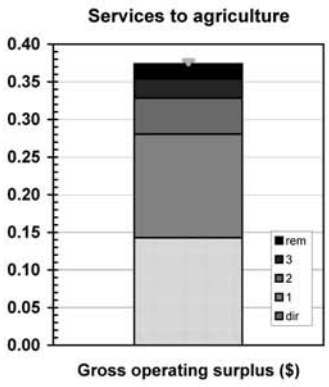
Services to agriculture, ginned cotton, cotton seed, shearing, aerial agriculture, hunting and trapping

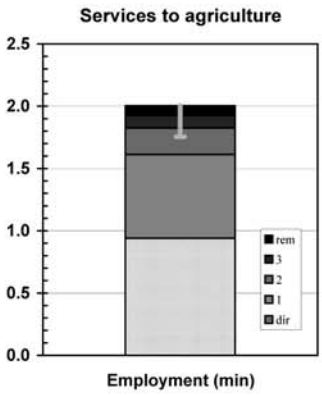
Spider diagram

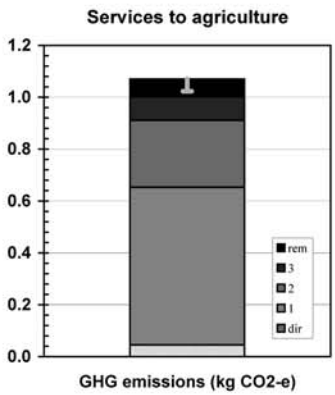


Bar graphs

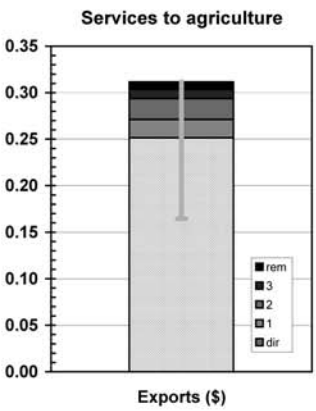
Account #1

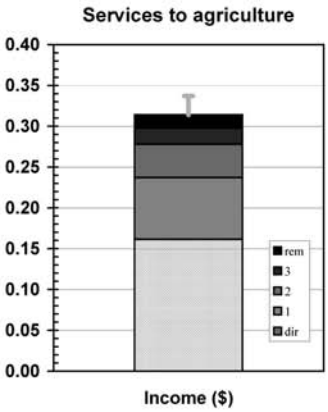


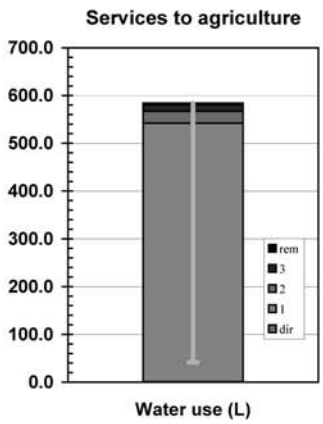




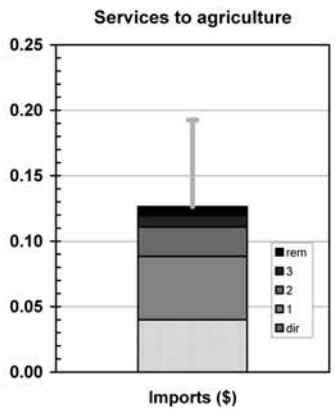
Account #2

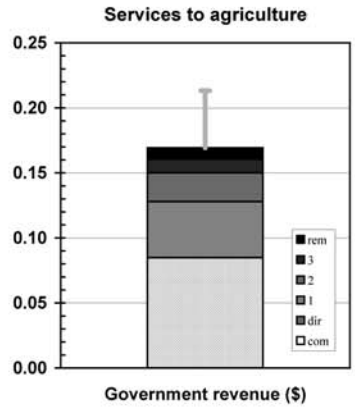


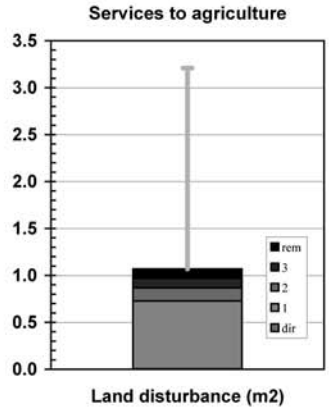




Account #3







National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 40.0	(0.02% of total)	($m 39.3 domestically produced)
Government final consumption	$m 123.3	(0.14% of total)	($m 123.3 domestically produced)
Gross fixed capital expenditure	$m 0.0		
Net changes in stocks	-$m 11.6	-(0.65% of total)	
Sectoral GNE	**$m 151.8**	**(0.03% of GNE)**	**($m 151.0 domestically produced)**
Exports	$m 592.2	(0.71% of total)	($m 592.2 domestically produced)
Final demand	**$m 744.0**	**(0.14% of GNT)**	**($m 743.3 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 380.4	(0.22% of total)	
Gross operating surplus	$m 336.4	(0.18% of total)	
Taxes less subsidies	$m 199.8	(0.23% of total)	
Sectoral GDP*	**$m 916.5**	**(0.20% of GDP)**	
Imports	$m 94.3	(0.10% of total)	
Primary inputs	**$m 1,010.8**	**(0.19% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 336.4	(0.18%)	$m 107.7	(0.06%)	$m 282.2	(0.15%)
Exports ($m)	$m 592.2	(0.71%)	$m 189.7	(0.23%)	$m 235.2	(0.28%)
Imports ($m)	$m 94.3	(0.10%)	$m 30.2	(0.03%)	$m 95.4	(0.10%)
Employment (e-y)	17,750 e-y	(0.25%)	5,686 e-y	(0.08%)	12,120 e-y	(0.17%)
Income ($m)*	$m 380.4	(0.22%)	$m 121.8	(0.07%)	$m 237.0	(0.14%)
Government revenue ($m)†	$m 199.8	(0.18%)	$m 64.0	(0.06%)	$m 127.8	(0.12%)
GHG emissions (kt CO_2-e)	105 kt	(0.02%)	34 kt	(0.01%)	808 kt	(0.16%)
Water use (ML)	1,691 ML	(0.01%)	542 ML	(0.00%)	440,671 ML	(2.10%)
Land disturbance (kha)	1 kha	(0.00%)	0 kha	(0.00%)	81 kha	(0.05%)
Primary energy (TJ)	1,507 TJ	(0.04%)	483 TJ	(0.01%)	4,064 TJ	(0.10%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.14	0.37	0.38
Exports ($)	0.25	0.31	0.16
Imports ($)	0.04	0.13	0.19
Employment (min)	0.94	2.00	1.75
Income ($)	0.16	0.31	0.34
Government revenue ($)	0.08	0.17	0.21
GHG emissions (kg CO_2-e)	0.04	1.07	1.02
Water use (L)	0.72	583.79	41.32
Land disturbance (m^2)	0.00	1.07	3.21
Primary energy (MJ)	0.64	5.38	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Cg	0.143	(0; 38.%)	Cg	0.94	(0; 47.%)	Sc Cg	0.515	(1; 48.%)
Sc Cg	0.105	(1; 28.%)	Sc Cg	0.519	(1; 26.%)	Fr Sc Cg	0.121	(2; 11.%)
Wt Cg	0.00509	(1; 1.4%)	Wt Cg	0.0366	(1; 1.8%)	Cg	0.0447	(0; 4.2%)
Rd Cg	0.00412	(1; 1.1%)	Rd Cg	0.0242	(1; 1.2%)	El Cg	0.0278	(1; 2.6%)
Ac Cg	0.00375	(1; 1.%)	Cg Sc Cg	0.0196	(2; 0.98%)	El Sc Cg	0.026	(2; 2.4%)
Cg Sc Cg	0.00297	(2; 0.79%)	Wt Sc Cg	0.0158	(2; 0.79%)	Ch Cg	0.0232	(1; 2.2%)
Wt Sc Cg	0.00219	(2; 0.59%)	Ac Cg	0.0135	(1; 0.67%)	Ch Sc Cg	0.0125	(2; 1.2%)
Sc Cg Sc Cg	0.00218	(3; 0.58%)	Rd Sc Cg	0.0109	(2; 0.54%)	Sc Cg Sc Cg	0.0107	(3; 1.%)
Rv Sc Cg	0.00214	(2; 0.57%)	Sc Cg Sc Cg	0.0108	(3; 0.54%)	Fo Sc Cg	0.00861	(2; 0.8%)
Ch Cg	0.00194	(1; 0.52%)	Ts Cg	0.00722	(1; 0.36%)	Fd Cg	0.00751	(1; 0.7%)
Rd Sc Cg	0.00186	(2; 0.5%)	Rv Sc Cg	0.00573	(2; 0.29%)	Rd Cg	0.00654	(1; 0.61%)
Ts Cg	0.0016	(1; 0.43%)	Ch Cg	0.00566	(1; 0.28%)	Fe Sc Cg	0.00603	(2; 0.56%)
Wa Cg	0.00148	(1; 0.4%)	Ms Cg	0.00534	(1; 0.27%)	Fo Cg	0.00511	(1; 0.48%)
Bk Sc Cg	0.0013	(2; 0.35%)	Bk Sc Cg	0.00515	(2; 0.26%)	Wt Cg	0.00508	(1; 0.47%)
Bk Cg	0.00129	(1; 0.34%)	Bk Cg	0.0051	(1; 0.25%)	El Ch Cg	0.0035	(2; 0.33%)
Rv Cg	0.00127	(1; 0.34%)	Ms Sc Cg	0.00456	(2; 0.23%)	Fe Cg	0.00348	(1; 0.32%)
Oi Fo Sc Cg	0.00123	(3; 0.33%)	Ho Sc Cg	0.00414	(2; 0.21%)	Rd Sc Cg	0.00295	(2; 0.28%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Cg	0.251	(0; 81.%)	Cg	0.161	(0; 51.%)	Sc Cg	539.3	(1; 92.%)
Cg Sc Cg	0.00523	(2; 1.7%)	Sc Cg	0.0427	(1; 14.%)	Sc Cg Sc Cg	11.2	(3; 1.9%)
Wt Cg	0.00416	(1; 1.3%)	Wt Cg	0.00786	(1; 2.5%)	Wa Cg	1.08	(1; 0.19%)
Ch Cg	0.0027	(1; 0.87%)	Rd Cg	0.00416	(1; 1.3%)	Su Fd Cg	0.908	(2; 0.16%)
Ac Cg	0.00264	(1; 0.85%)	Ac Cg	0.00344	(1; 1.1%)	Cg	0.718	(0; 0.12%)
Fd Cg	0.00206	(1; 0.66%)	Wt Sc Cg	0.00339	(2; 1.1%)	Wa Sc Cg	0.65	(2; 0.11%)
Wt Sc Cg	0.00179	(2; 0.58%)	Cg Sc Cg	0.00336	(2; 1.1%)	Ws Cg	0.311	(1; 0.053%)
Ch Sc Cg	0.00145	(2; 0.47%)	Rd Sc Cg	0.00188	(2; 0.6%)	Dc Dp Cg	0.248	(2; 0.042%)
Rd Cg	0.00143	(1; 0.46%)	Ts Cg	0.00169	(1; 0.54%)	Sc Cg Sc Cg S	0.234	(5; 0.04%)
Ai Cg	0.00115	(1; 0.37%)	Bk Sc Cg	0.00127	(2; 0.4%)	Wh Sc Cg	0.214	(2; 0.037%)
At Cg	0.000925	(1; 0.3%)	Bk Cg	0.00126	(1; 0.4%)	Ri Fc Sc Cg	0.191	(3; 0.033%)
Oi Fo Sc Cg	0.000837	(3; 0.27%)	Ms Cg	0.00124	(1; 0.4%)	Su Fd Sc Cg	0.166	(3; 0.028%)
Ac Sc Cg	0.000715	(2; 0.23%)	Ch Cg	0.0012	(1; 0.38%)	El Cg	0.154	(1; 0.026%)
Rd Sc Cg	0.000646	(2; 0.21%)	In Sc Cg	0.00109	(2; 0.35%)	El Sc Cg	0.144	(2; 0.025%)
Wh Sc Cg	0.000539	(2; 0.17%)	Ms Sc Cg	0.00106	(2; 0.34%)	Ri Sc Cg	0.123	(2; 0.021%)
Oi Fo Cg	0.000496	(2; 0.16%)	Ai Cg	0.00097	(1; 0.31%)	Ws Sc Cg	0.0983	(2; 0.017%)
Wt Ac Cg	0.000456	(2; 0.15%)	Ac Sc Cg	0.000929	(2; 0.3%)	Wh Ac Cg	0.0742	(2; 0.013%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Cg	0.04	(0; 32.%)	Cg	0.0848	(0; 50.%)	Sc Cg	0.708	(1; 66.%)
Sc Cg	0.0258	(1; 20.%)	Sc Cg	0.0262	(1; 15.%)	Fr Sc Cg	0.0389	(2; 3.6%)
Ac Cg	0.00711	(1; 5.6%)	Wt Cg	0.00368	(1; 2.2%)	Wh Sc Cg	0.0312	(2; 2.9%)
Fo Sc Cg	0.00282	(2; 2.2%)	Rd Cg	0.00295	(1; 1.7%)	Bc Mp Fd Cg	0.0163	(3; 1.5%)
Ch Cg	0.00271	(1; 2.1%)	Cg Sc Cg	0.00176	(2; 1.%)	Sc Cg Sc Cg	0.0147	(3; 1.4%)
Ac Sc Cg	0.00192	(2; 1.5%)	Wt Sc Cg	0.00159	(2; 0.94%)	Wh Ac Cg	0.0108	(2; 1.%)
Fo Cg	0.00167	(1; 1.3%)	Rd Sc Cg	0.00133	(2; 0.79%)	Wh Cg	0.00986	(1; 0.92%)
Ai Cg	0.00147	(1; 1.2%)	In Sc Cg	0.00118	(2; 0.69%)	Bc Mp Ch Cg	0.00924	(3; 0.86%)
Ch Sc Cg	0.00146	(2; 1.2%)	Ac Cg	0.00103	(1; 0.61%)	Wo Tx Ac Cg	0.00759	(3; 0.71%)
Wt Cg	0.00118	(1; 0.94%)	Ts Cg	0.000832	(1; 0.49%)	Wh Fd Cg	0.00712	(2; 0.67%)
Rd Cg	0.00104	(1; 0.83%)	Bk Sc Cg	0.000702	(2; 0.41%)	Bc Mp Ho Sc (	0.00598	(4; 0.56%)
Ap Sc Cg	0.00089	(2; 0.7%)	Bk Cg	0.000696	(1; 0.41%)	Wo Tx Cg	0.0055	(2; 0.51%)
Cg Sc Cg	0.000833	(2; 0.66%)	Ai Cg	0.000687	(1; 0.41%)	Bc Mp Ch Sc (	0.00497	(4; 0.46%)
Fe Sc Cg	0.000736	(2; 0.58%)	Ch Cg	0.000598	(1; 0.35%)	Bc Ch Cg	0.00464	(2; 0.43%)
Pc Cg	0.000672	(1; 0.53%)	Ms Cg	0.00059	(1; 0.35%)	Bc Mp Fd Sc (	0.00298	(4; 0.28%)
Sc Cg Sc Cg	0.000536	(3; 0.42%)	Rv Sc Cg	0.000569	(2; 0.34%)	Wh Ac Sc Cg	0.00292	(3; 0.27%)
Wt Sc Cg	0.00051	(2; 0.4%)	Sc Cg Sc Cg	0.000545	(3; 0.32%)	Cg	0.00275	(0; 0.26%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	1.181 ±0.034	(±2.9%)
Downstream	1.300 ±0.027	(±2.1%)

Sector 3020010: Softwoods (Sw)

Softwoods and conifers

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is nearly 24 times the average, water use is 60% below average, and land disturbance is about five times the average. The social indicators show that employment generation is 15% above average, income is 10% below average, and government revenue is 30% below average. The financial indicators show a surplus 10% below average, and export propensity that is 30% below average, and an import penetration equal to average. The high greenhouse indicator is due in part to the accounting protocols used in this analysis, which do not assign emissions offsets to the industries that invest in them. Forest policy is aiming for 500 000 ha or more of new softwood plantations by 2020. Financial indicators will possibly improve, but the land disturbance and greenhouse emissions indicators may increase as imports are replaced by domestic production.

Sector Description

Current annual softwood production is about 13 million cubic metres within a total domestic wood production of 24 million cubic metres. Assuming a mean annual increment of 20 cubic metres per ha and a rotation length of about 20 years, this suggests that 37 000 ha of plantation are harvested annually. About 40% is currently used for pulp, and 60% for sawlogs and particle boards. Significant imports of softwood come from New Zealand and Canada. Of the nearly one million ha of softwood plantation, New South Wales has the highest proportion (28%) followed by Victoria (21%) and Queensland (18%). Most softwood planting is the well known *Pinus radiata*, but this is being augmented in different regions by maritime pine (*Pinus pinaster*), slash pine (*Pinus elliottii*), hoop pine (*Araucaria cunninghamii*), caribbean pine (*Pinus caribaea)*, and native cypress (*Callitris intratropica*). In constant dollar terms, the turnover of the sector has increased fourfold in the last 30 years, and is currently about $850 million.

Place of Industry in the Economy

The softwood plantation sector ranks 127th out of 135 sectors in terms of value adding in the economy, and contributes 0.04% of GDP in this analysis. It is similar in value adding to the leather and leather products, and other petroleum products sectors. It is a small employer with less than 1 000 employment years directly and indirectly embodied in final demand. In addition it contributes 4 000 employment years to the final demand of downstream industries such as sawn timber and woodchips, pulp and paper, domestic building, and plywood and particle board. It has small absolute resource requirements with less than one tenth of one percent of national water use, land disturbance, energy use, and greenhouse emissions. In financial terms, imports outweigh exports by a factor of three.

Strategic Overview

The spider diagram portrays a sector with large outliers for land disturbance and greenhouse emissions, and smaller ones for government revenue and export propensity. The greenhouse and land indicators are partly due to the analytical method (discussed later) but also reflect the physical reality that society's requirements for building materials, paper and packaging require significant hidden resources. As national forest policy unfolds and the plantation estate moves towards three million ha by 2020, the financial indicators should improve. Downstream issues include the hydrological effects of plantations, ownership structures, and social effects of land use change.

TBL Account #1

The financial indicator of operating surplus is 10% below average with a direct sector effect of 53% of total, and contributions from equipment repairs (7%), services to forestry (4%), wholesale trade (4%), concrete products (2%), oil extraction for diesel refining (1%), and heavy machinery manufacture (1%). The social indicator of employment generation is 15% above average, with a direct effect of 64% and a composition similar to the surplus indicator. The greenhouse emissions indicator is nearly 24 times the average and the reason for this is discussed in more detail below.

TBL Accounts #2 and #3

The second TBL account shows that export propensity is 30% below average, income is 10% below average, and water use is 60% below average. The third TBL account shows import penetration equal to average, government revenue 30% below average. Land disturbance is about five times the average and is discussed in more detail below.

Structural Path Analysis and Linkages

Both the greenhouse emissions and land disturbance indicators are outliers. The structural path analysis reveals the direct within sector effect is dominant in both cases with 67% for emissions and 83% for land disturbance. The other significant contribution is the services to forestry sector with 29% (emissions) and 15% (disturbance). For softwoods and the hardwood and services to forestry sectors, definitional and accounting issues cause the high indicator values. Professional foresters may not view a well grown softwood forest as a disturbed area. However others may see widespread softwood monocultures as landscape disturbance precluding other values, particularly if they are established on recently logged native forest. Part of the issue is also methodological: as with other primary sectors, financial values are low at the unprocessed stage causing higher indicator values. The high greenhouse indicator arises from gross emissions being assigned to the sector of origin without adjustment for net sink effects. The approach here is consistent across 135 sectors and could be improved by fully quantifying emission offset effects (eg power stations that plant trees).

The sector's stimulus to its upstream suppliers is about average and impacts mainly on wholesale trade, services to forestry, repairs to machinery, road transport, and machinery manufacture. The linkages to downstream industries are 150% above average and are some of the strongest evidenced in this analysis, highlighting the material importance and diversity of softwood use in the economy. The linkages suggest that any expansion in the softwood plantation sector should be led by expansion in downstream sectors such as sawn timber and woodchips, pulp and paper, domestic building, plywood and particle board, printing and stationery, and paper containers.

Future Trends in Sector

An optimistic scenario in a Federal Government plantations study underpinning the 'Forests 2020 Vision' anticipates 500 000 ha of new softwood plantings by 2020 to complement the nearly one million ha already in the national plantation estate. By the mid 2040s, 25 million cubic metres of softwoods may be harvested annually, 30% for pulp and 70% for logs, within a wood harvest of 50 million cubic metres. The remaining harvest will be hardwood plantations of *Eucalyptus* species.

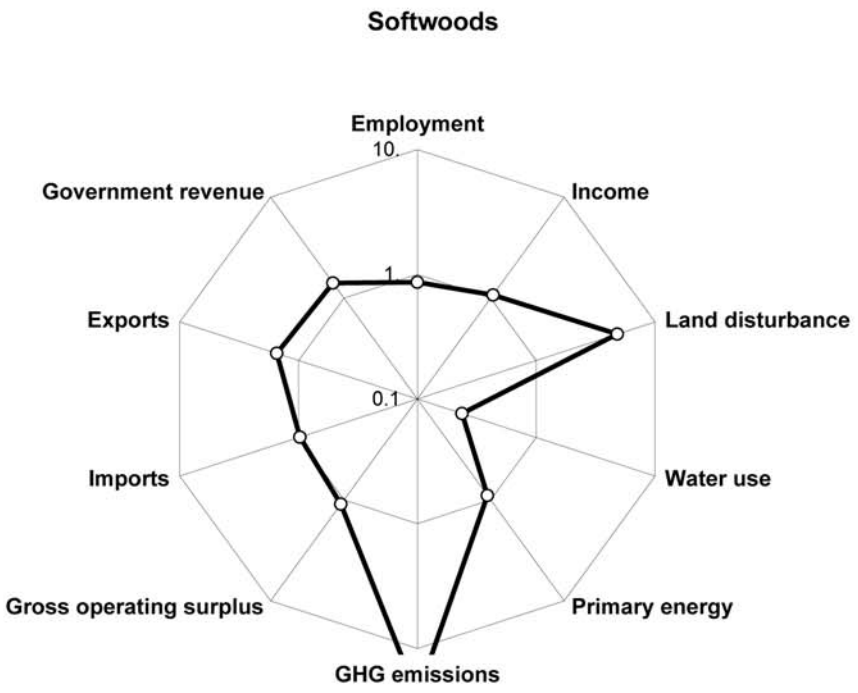
Innovation and Technical Opportunities

The land use policy literature suggests that considerable effort should be devoted to the community institutions in forestry regions, especially since softwood and hardwood plantations may possibly double in the next 20 years to reach the "vision's" target of three million hectares. This will occur in focused areas of higher rainfall with current forestry infrastructure. Careful planning will be required to avoid adverse effects on regional hydrology and knock-on effects to other industries.

Sector **Softwoods** **(Sw)**

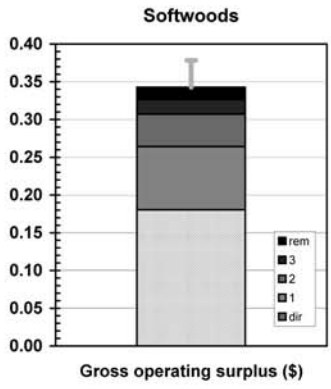
Softwoods, conifers

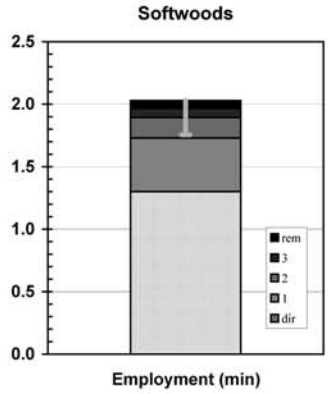
Spider diagram

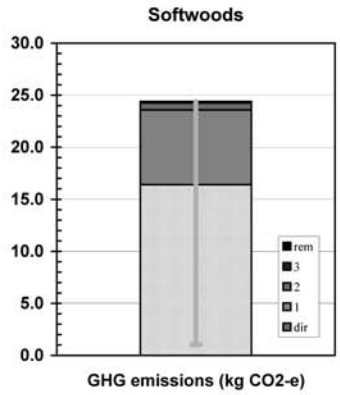


Bar graphs

Account #1







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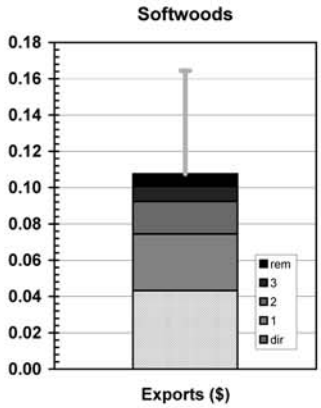

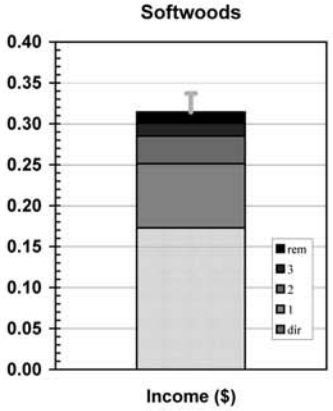

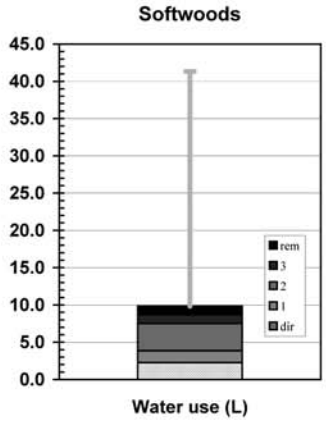

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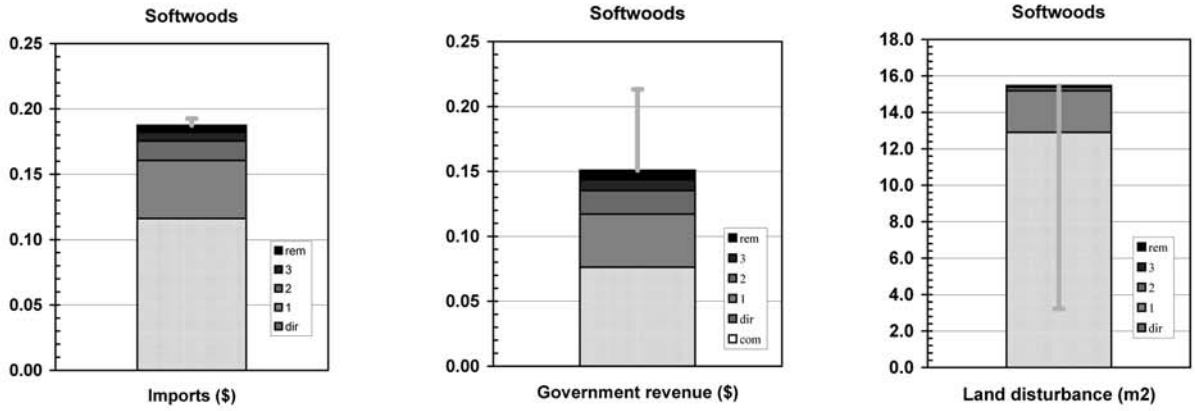


National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 0.0		
Government final consumption	$m 0.0		
Gross fixed capital expenditure	$m 0.0		
Net changes in stocks	-$m 0.7	-(0.04% of total)	
Sectoral GNE	**-$m 0.7**	**(0.00% of GNE)**	
Exports	$m 17.9	(0.02% of total)	($m 17.9 domestically produced)
Final demand	**$m 17.2**	**(0.00% of GNT)**	**($m 17.2 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 71.5	(0.04% of total)	
Gross operating surplus	$m 74.6	(0.04% of total)	
Taxes less subsidies	$m 31.5	(0.04% of total)	
Sectoral GDP*	**$m 177.5**	**(0.04% of GDP)**	
Imports	$m 48.0	(0.05% of total)	
Primary inputs	**$m 225.5**	**(0.04% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 74.6	(0.04%)	$m 3.2	(0.00%)	$m 6.1	(0.00%)
Exports ($m)	$m 17.9	(0.02%)	$m 0.8	(0.00%)	$m 1.9	(0.00%)
Imports ($m)	$m 48.0	(0.05%)	$m 2.1	(0.00%)	$m 3.3	(0.00%)
Employment (e-y)	4,310 e-y	(0.06%)	186 e-y	(0.00%)	291 e-y	(0.00%)
Income ($m)*	$m 71.5	(0.04%)	$m 3.1	(0.00%)	$m 5.6	(0.00%)
Government revenue ($m)†	$m 31.5	(0.03%)	$m 1.4	(0.00%)	$m 2.7	(0.00%)
GHG emissions (kt CO_2-e)	6,780 kt	(1.31%)	293 kt	(0.06%)	436 kt	(0.08%)
Water use (ML)	937 ML	(0.00%)	40 ML	(0.00%)	176 ML	(0.00%)
Land disturbance (kha)	533 kha	(0.33%)	23 kha	(0.01%)	28 kha	(0.02%)
Primary energy (TJ)	1,496 TJ	(0.04%)	65 TJ	(0.00%)	123 TJ	(0.00%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.18	0.34	0.38
Exports ($)	0.04	0.11	0.16
Imports ($)	0.12	0.19	0.19
Employment (min)	1.30	2.03	1.75
Income ($)	0.17	0.31	0.34
Government revenue ($)	0.08	0.15	0.21
GHG emissions (kg CO_2-e)	16.40	24.39	1.02
Water use (L)	2.27	9.84	41.32
Land disturbance (m^2)	12.90	15.48	3.21
Primary energy (MJ)	3.62	6.90	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Sw	0.18	(0; 53.%)	Sw	1.3	(0; 64.%)	Sw	16.4	(0; 67.%)
Rv Sw	0.0221	(1; 6.5%)	Fr Sw	0.103	(1; 5.1%)	Fr Sw	7.08	(1; 29.%)
Fr Sw	0.0143	(1; 4.2%)	Wt Sw	0.0936	(1; 4.6%)	Fo Sw	0.0324	(1; 0.13%)
Wt Sw	0.013	(1; 3.8%)	Rv Sw	0.0592	(1; 2.9%)	Ce Sw	0.0198	(1; 0.081%)
Cp Sw	0.00704	(1; 2.1%)	Eq Sw	0.0381	(1; 1.9%)	El Sw	0.0175	(1; 0.072%)
Oi Fo Sw	0.0046	(2; 1.3%)	Cp Sw	0.0185	(1; 0.91%)	Wt Sw	0.013	(1; 0.053%)
Eq Sw	0.00386	(1; 1.1%)	Ma Sw	0.0148	(1; 0.73%)	Ce Cp Sw	0.0109	(2; 0.045%)
St Wt Sw	0.00248	(2; 0.72%)	Rd Sw	0.0139	(1; 0.69%)	Oi Fo Sw	0.00975	(2; 0.04%)
Rd Sw	0.00237	(1; 0.69%)	Ms Wt Sw	0.00845	(2; 0.42%)	Is Eq Sw	0.00565	(2; 0.023%)
Cm Sw	0.00202	(1; 0.59%)	In Sw	0.00804	(1; 0.4%)	Is Ma Sw	0.00406	(2; 0.017%)
Ms Wt Sw	0.00188	(2; 0.55%)	Wt Fr Sw	0.00742	(2; 0.37%)	El Wt Sw	0.0039	(2; 0.016%)
Fo Sw	0.00178	(1; 0.52%)	Sm Sw	0.00587	(1; 0.29%)	Rd Sw	0.00377	(1; 0.015%)
Rv Fr Sw	0.00175	(2; 0.51%)	Cm Sw	0.00558	(1; 0.28%)	Fo Fr Sw	0.00256	(2; 0.011%)
Pd Wt Sw	0.00149	(2; 0.44%)	Bk Sw	0.00556	(1; 0.27%)	Sc Cg Sw	0.00256	(2; 0.01%)
Sf In Sw	0.00143	(2; 0.42%)	Wt Rv Sw	0.00496	(2; 0.24%)	El Cp Sw	0.00241	(2; 0.0099%)
Bk Sw	0.0014	(1; 0.41%)	Rv Fr Sw	0.00469	(2; 0.23%)	El Eq Sw	0.00202	(2; 0.0083%)
In Sw	0.00123	(1; 0.36%)	Cg Sw	0.00466	(1; 0.23%)	El Rv Sw	0.00196	(2; 0.0081%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Sw	0.0432	(0; 40.%)	Sw	0.173	(0; 55.%)	Sc Cg Sw	2.68	(2; 27.%)
Wt Sw	0.0106	(1; 9.9%)	Wt Sw	0.0201	(1; 6.4%)	Sw	2.27	(0; 23.%)
Eq Sw	0.00679	(1; 6.3%)	Fr Sw	0.0137	(1; 4.4%)	Vf Sw	0.549	(1; 5.6%)
Oi Fo Sw	0.00315	(2; 2.9%)	Rv Sw	0.00953	(1; 3.%)	Ws Sw	0.32	(1; 3.3%)
Ma Sw	0.00217	(1; 2.%)	Eq Sw	0.00672	(1; 2.1%)	Sc Cg Fr Sw	0.212	(3; 2.2%)
Fo Sw	0.00131	(1; 1.2%)	Cp Sw	0.0041	(1; 1.3%)	Fr Sw	0.18	(1; 1.8%)
Cg Sw	0.00125	(1; 1.2%)	In Sw	0.00348	(1; 1.1%)	Wa Sw	0.114	(1; 1.2%)
En Sw	0.00101	(1; 0.94%)	Ma Sw	0.00278	(1; 0.88%)	El Sw	0.0968	(1; 0.98%)
Lg Sw	0.000954	(1; 0.89%)	Rd Sw	0.0024	(1; 0.76%)	Ri Ws Sw	0.0715	(2; 0.73%)
Wt Fr Sw	0.000842	(2; 0.78%)	Ms Wt Sw	0.00196	(2; 0.63%)	Vf Ws Sw	0.0649	(2; 0.66%)
Rd Sw	0.000825	(1; 0.77%)	Wt Fr Sw	0.00159	(2; 0.51%)	Sc Cg Vf Sw	0.0569	(3; 0.58%)
In Sw	0.000675	(1; 0.63%)	Bk Sw	0.00137	(1; 0.44%)	Sc Cg Sc Cg S	0.0557	(4; 0.57%)
Fr Sw	0.000637	(1; 0.59%)	Pd Wt Sw	0.00135	(2; 0.43%)	Wt Sw	0.0524	(1; 0.53%)
St Wt Sw	0.000614	(2; 0.57%)	Cm Sw	0.00127	(1; 0.4%)	Wa Ms Wt Sw	0.0484	(3; 0.49%)
Wt Rv Sw	0.000564	(2; 0.52%)	Wt Rv Sw	0.00107	(2; 0.34%)	Vf Fr Sw	0.0435	(2; 0.44%)
Eq Fr Sw	0.000538	(2; 0.5%)	St Wt Sw	0.00103	(2; 0.33%)	Wa Pd Wt Sw	0.0408	(3; 0.41%)
At Wt Sw	0.000503	(2; 0.47%)	Sm Sw	0.00101	(1; 0.32%)	Fo Sw	0.0387	(1; 0.39%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Sw	0.116	(0; 62.%)	Sw	0.0762	(0; 50.%)	Sw	12.9	(0; 83.%)
Fo Sw	0.0106	(1; 5.7%)	Wt Sw	0.00939	(1; 6.2%)	Fr Sw	2.27	(1; 15.%)
Fr Sw	0.0092	(1; 4.9%)	Fr Sw	0.00604	(1; 4.%)	Wo Tx Tp Sw	0.00638	(3; 0.041%)
Eq Sw	0.00449	(1; 2.4%)	Rv Sw	0.00587	(1; 3.9%)	Bc Mp Ho Sw	0.00456	(3; 0.029%)
Wt Sw	0.00302	(1; 1.6%)	In Sw	0.00374	(1; 2.5%)	Sc Cg Sw	0.00351	(2; 0.023%)
Rv Sw	0.00286	(1; 1.5%)	Eq Sw	0.00333	(1; 2.2%)	Wo Tx Wt Sw	0.00333	(3; 0.022%)
Ma Sw	0.00257	(1; 1.4%)	Cp Sw	0.0019	(1; 1.3%)	Wo Sw	0.00328	(1; 0.021%)
Cp Sw	0.00119	(1; 0.64%)	Rd Sw	0.0017	(1; 1.1%)	Wo Tx Cl Sw	0.00307	(3; 0.02%)
En Sw	0.00118	(1; 0.63%)	Ma Sw	0.00134	(1; 0.89%)	Bc Mp Sw	0.00196	(2; 0.013%)
Ap Sw	0.00103	(1; 0.55%)	Ms Wt Sw	0.000933	(2; 0.62%)	Bc Mp Ho Wt	0.00192	(4; 0.012%)
Mv Rv Sw	0.000856	(2; 0.46%)	Pd Wt Sw	0.000882	(2; 0.58%)	Wo Tx Sw	0.00154	(2; 0.0099%)
Fo Fr Sw	0.00084	(2; 0.45%)	Bk Sw	0.000759	(1; 0.5%)	Bc Mp Wt Sw	0.00127	(3; 0.0082%)
Pt Sw	0.000717	(1; 0.38%)	Wt Fr Sw	0.000744	(2; 0.49%)	Bc Mp Rt Wt S	0.000984	(4; 0.0064%)
Oc Sw	0.000609	(1; 0.33%)	Cm Sw	0.000606	(1; 0.4%)	Wt Sw	0.000794	(1; 0.0051%)
Rd Sw	0.000601	(1; 0.32%)	Oi Fo Sw	0.000559	(2; 0.37%)	Wo Tx Ru Sw	0.000688	(3; 0.0044%)
Ru Sw	0.000489	(1; 0.26%)	St Wt Sw	0.000551	(2; 0.37%)	Bc Mp Bp Sw	0.00066	(3; 0.0043%)
Sm Sw	0.000481	(1; 0.26%)	Wt Rv Sw	0.000498	(2; 0.33%)	Rv Sw	0.000542	(1; 0.0035%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.952 ±0.016	(±1.7%)
Downstream	2.488 ±0.066	(±2.7%)

Sector 3020020: Hardwoods (Hw)

Hardwoods, brushwoods, scrubwoods, hewn and other timber

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is nearly 15 times the average, water use is 75% below average, and land disturbance is twice the average. The social indicators show that employment generation is 15% greater than average, income 10% below average, and government revenue is 30% below average. The financial indicators show an operating surplus 10% below average, an export propensity 50% below average, and import penetration equal to average. The high greenhouse indicator is partly due to accounting protocols. Establishing hardwood plantations on farmland will reduce native forest harvesting.

Sector Description

While exact production data are difficult to reconcile, Australia produces about 11 million cubic metres of roundwood annually from hardwood forests and 4 million tonnes of hardwood woodchips (approximately 8 million cubic metres) for exports. Hardwoods also contribute to domestic pulp and paper production. The hardwood plantation area is currently about 675 000 ha or 41% of all plantations. About 80% of this is native Eucalyptus species with a mix between 8-10 year rotation forests for pulpwood, and 40 year rotations for construction materials. Western Australia has the largest hardwood plantations (37%) with 22% each for Victoria and Tasmania. In 2003, new hardwood plantings covered 31 000 ha or three times the size of new softwood plantings. If Australia is to triple its plantation estate by 2020, it must maintain planting rates for hardwoods and softwoods combined at 80 000 ha per year. The native forest estate is extensive, covering 163 million ha or 21% of the continent. About 2.5 million cubic metres are currently harvested on a regulated sustainable yield basis. In constant dollar terms, the turnover of the sector is now one third of its value 30 years ago which makes it an anomaly compared to most other physical and service sectors. This is due to the forest reform process gradually closing access to logging in native forests, and the rotational 'lull' before plantation hardwoods come fully onstream. Turnover is currently $350 million per year but is difficult to partition from the forestry sector as a whole.

Place of Industry in the Economy

The hardwood forests sector ranks 133rd out of 135 sectors in terms of value adding in the economy and contributes 0.02% of GDP in this analysis. It is similar in value adding to the mixed fertilisers, and rice in the husk sectors. It is a small employer with less than 500 employment years directly and indirectly embodied in final demand. In addition it contributes nearly 2 000 employment years to the final demand of downstream processing industries such as sawn timber and woodchips, residential building, and plywood. It has small absolute resource requirements with less than one tenth of one percent of national water use, land disturbance, energy use, and greenhouse emissions. Nevertheless some intensity values are higher than average due to low value adding in the primary commodity state since most of the product enters final demand only after it has been through downstream wood processing sectors. In financial terms, imports are six times greater than exports.

Strategic Overview

The spider diagram portrays a hardwood timber sector with outliers for land disturbance and greenhouse emissions, but reasonable social (employment and income) and financial (imports and surplus) indicators. Significant ongoing forest reform, and a steady increase in hardwood planting on private land, will see most of these issues substantially improve by 2020.

TBL Account #1

The financial indicator of operating surplus is 10% below average with a direct effect of 53% of total, and contributions from equipment repairs (7%), services to forestry (4%), wholesale trade (4%), concrete products (2%), oil extraction for diesel refining (1%), and wood handling equipment (1%). The social indicator of employment generation is 15% above average with a direct effect of 64% and a composition similar to the surplus indicator. The environmental indicator of greenhouse emissions is nearly 15 times the average, and is discussed in more detail below.

TBL Accounts #2 and #3

The second TBL account shows an export propensity that is 50% below average, income that is 10% below average, and water use that is 75% below average. The third TBL account shows that import penetration is equal to average, government revenue 30% below average, and land disturbance is two times the average.

Structural Path Analysis and Linkages

The structural path analysis for greenhouse emissions shows that most of the effect is shared equally between the direct sector effect and the services to forestry sector with 47% each. This is a somewhat artificial separation due to the disaggregation of the national accounts used in this analysis and exaggerated because primary sectors have relatively little market value until products reach downstream processing sectors. The direct sector effect may be due to ongoing decay in actively growing forests as well as cultural activities such as thinning and pole harvesting about 8 years into a 20 year rotation. The emissions from the services to forestry sector are due to the land preparation activities (removing a forest cover, clearing rough country, regular fire management) that precede planting a hardwood forest. As discussed in more detail in the services to forestry sector, there are few solutions to these emissions-intensive activities. Indicator values would be lower if accounting protocols offset each sector's emissions against its sequestration.

The sector's stimulus to its upstream suppliers is 5% below the economy wide average and impacts on wholesale trade, services to forestry, repairs to machinery, road transport, machinery and equipment, concrete products, and diesel refining. The sector's linkages to downstream industries are 100% above average, one of the strongest in this analysis, reflecting the centrality of wood to many facets of material functioning in the economy. These linkages suggest that expansion of the sector must be led by expansion of downstream sectors such as sawn timber and woodchips, residential building, plywood and particleboard, pulp and paper, paper containers, construction, rail transport (sleepers), and printing and stationery.

Future Trends in Sector

An optimistic scenario in a Federal Government plantations study underpinning the 'Forests 2020 Vision', anticipates 875 000 ha of short rotation hardwoods and 460 000 ha of long rotation hardwoods planted by 2020. By the mid 2040s, there is an estimated harvest of 21 and 4 million cubic metres of hardwood pulpwood and sawlogs respectively, within a total wood harvest of 50 million cubic metres. This will allow native forest harvesting to be reduced to relatively minor levels and to be driven by resource management goals rather than wood production targets.

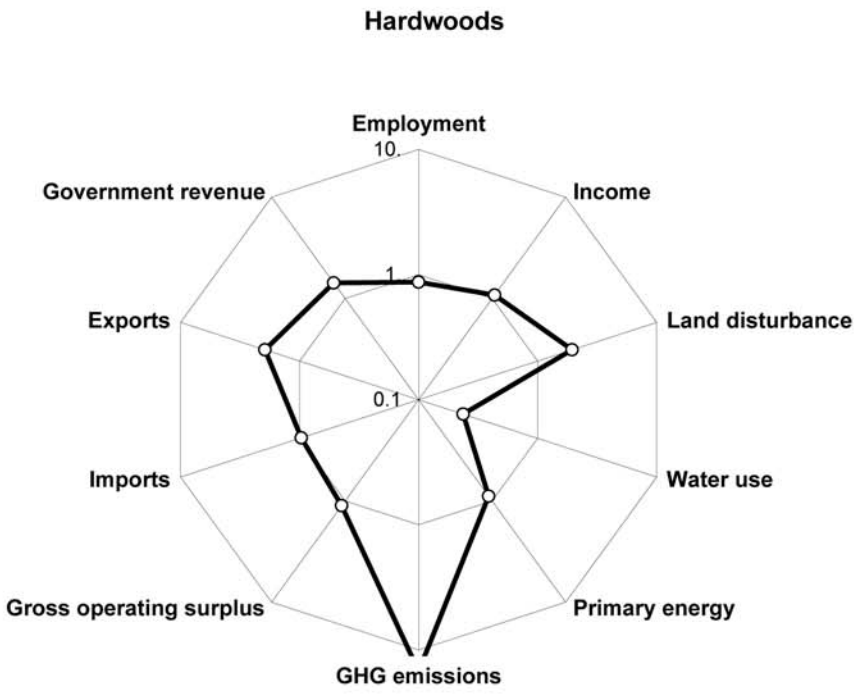
Innovation and Technical Opportunities

Hardwood tree selections will need to be designed to integrate production, wood quality and biodiversity values, while being amenable to diverse planting regimes and multiple product uses.

Sector Hardwoods (Hw)

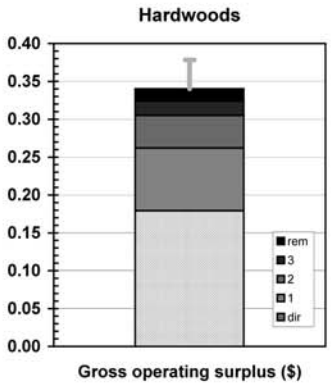
Hardwoods, brushwoods, scrubwoods, hewn and other timber

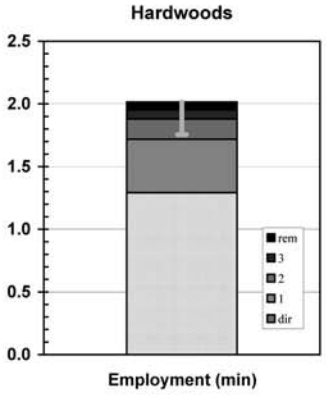
Spider diagram

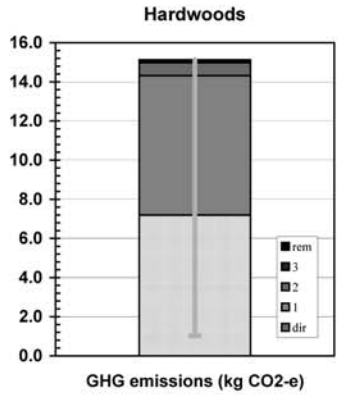


Bar graphs

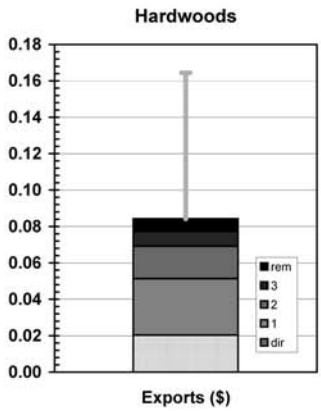
Account #1

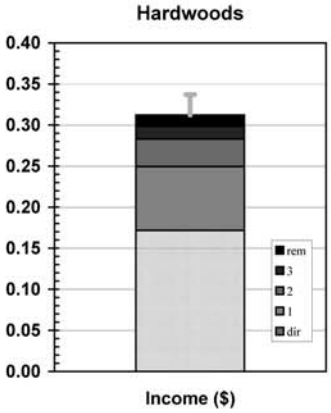


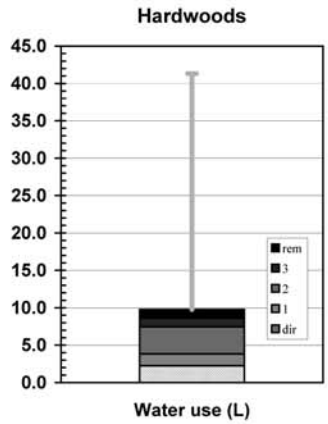




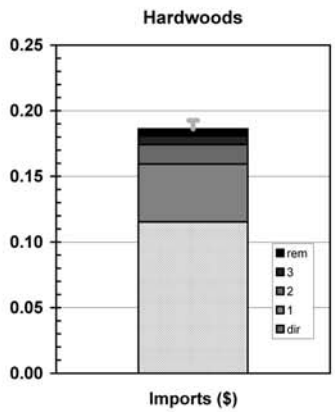
Account #2

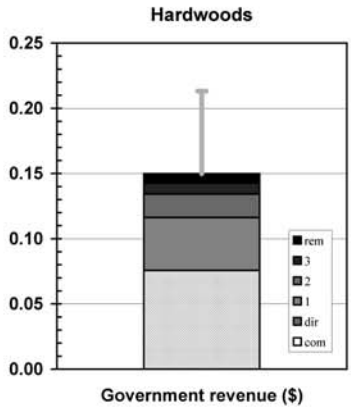


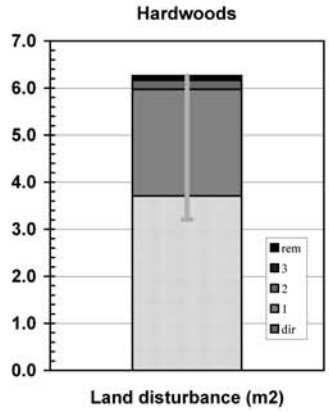




Account #3







National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 6.2	(0.00% of total)	($m 6.2 domestically produced)
Government final consumption	$m 0.0		
Gross fixed capital expenditure	$m 0.0		
Net changes in stocks	-$m 1.5	-(0.09% of total)	
Sectoral GNE	**$m 4.7**	**(0.00% of GNE)**	**($m 4.7 domestically produced)**
Exports	$m 3.5	(0.00% of total)	($m 3.5 domestically produced)
Final demand	**$m 8.2**	**(0.00% of GNT)**	**($m 8.2 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 29.6	(0.02% of total)	
Gross operating surplus	$m 30.9	(0.02% of total)	
Taxes less subsidies	$m 13.1	(0.02% of total)	
Sectoral GDP*	**$m 73.6**	**(0.02% of GDP)**	
Imports	$m 19.9	(0.02% of total)	
Primary inputs	**$m 93.5**	**(0.02% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 30.9	(0.02%)	$m 1.7	(0.00%)	$m 3.3	(0.00%)
Exports ($m)	$m 3.5	(0.00%)	$m 0.2	(0.00%)	$m 0.8	(0.00%)
Imports ($m)	$m 19.9	(0.02%)	$m 1.1	(0.00%)	$m 1.8	(0.00%)
Employment (e-y)	1,788 e-y	(0.03%)	101 e-y	(0.00%)	157 e-y	(0.00%)
Income ($m)*	$m 29.6	(0.02%)	$m 1.7	(0.00%)	$m 3.0	(0.00%)
Government revenue ($m)†	$m 13.1	(0.01%)	$m 0.7	(0.00%)	$m 1.5	(0.00%)
GHG emissions (kt CO_2-e)	1,242 kt	(0.24%)	70 kt	(0.01%)	147 kt	(0.03%)
Water use (ML)	389 ML	(0.00%)	22 ML	(0.00%)	95 ML	(0.00%)
Land disturbance (kha)	64 kha	(0.04%)	4 kha	(0.00%)	6 kha	(0.00%)
Primary energy (TJ)	620 TJ	(0.02%)	35 TJ	(0.00%)	67 TJ	(0.00%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.18	0.34	0.38
Exports ($)	0.02	0.08	0.16
Imports ($)	0.12	0.19	0.19
Employment (min)	1.29	2.02	1.75
Income ($)	0.17	0.31	0.34
Government revenue ($)	0.08	0.15	0.21
GHG emissions (kg CO_2-e)	7.19	15.13	1.02
Water use (L)	2.25	9.76	41.32
Land disturbance (m^2)	3.71	6.26	3.21
Primary energy (MJ)	3.59	6.85	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Hw	0.179	(0; 53.%)	Hw	1.29	(0; 64.%)	Hw	7.19	(0; 48.%)
Rv Hw	0.022	(1; 6.5%)	Fr Hw	0.102	(1; 5.1%)	Fr Hw	7.02	(1; 46.%)
Fr Hw	0.0142	(1; 4.2%)	Wt Hw	0.0929	(1; 4.6%)	Fo Hw	0.0321	(1; 0.21%)
Wt Hw	0.0129	(1; 3.8%)	Rv Hw	0.0587	(1; 2.9%)	Ce Hw	0.0196	(1; 0.13%)
Cp Hw	0.00699	(1; 2.1%)	Eq Hw	0.0378	(1; 1.9%)	El Hw	0.0174	(1; 0.11%)
Oi Fo Hw	0.00457	(2; 1.3%)	Cp Hw	0.0183	(1; 0.91%)	Wt Hw	0.0129	(1; 0.085%)
Eq Hw	0.00383	(1; 1.1%)	Ma Hw	0.0147	(1; 0.73%)	Ce Cp Hw	0.0108	(2; 0.072%)
St Wt Hw	0.00246	(2; 0.72%)	Rd Hw	0.0138	(1; 0.69%)	Oi Fo Hw	0.00968	(2; 0.064%)
Rd Hw	0.00236	(1; 0.69%)	Ms Wt Hw	0.00839	(2; 0.42%)	Is Eq Hw	0.00561	(2; 0.037%)
Cm Hw	0.00201	(1; 0.59%)	In Hw	0.00798	(1; 0.4%)	Is Ma Hw	0.00403	(2; 0.027%)
Ms Wt Hw	0.00187	(2; 0.55%)	Wt Fr Hw	0.00736	(2; 0.37%)	El Wt Hw	0.00387	(2; 0.026%)
Fo Hw	0.00177	(1; 0.52%)	Sm Hw	0.00583	(1; 0.29%)	Rd Hw	0.00374	(1; 0.025%)
Rv Fr Hw	0.00174	(2; 0.51%)	Cm Hw	0.00554	(1; 0.28%)	Fo Fr Hw	0.00255	(2; 0.017%)
Pd Wt Hw	0.00148	(2; 0.44%)	Bk Hw	0.00552	(1; 0.27%)	Sc Cg Hw	0.00254	(2; 0.017%)
Sf In Hw	0.00142	(2; 0.42%)	Wt Rv Hw	0.00493	(2; 0.24%)	El Cp Hw	0.00239	(2; 0.016%)
Bk Hw	0.00139	(1; 0.41%)	Rv Fr Hw	0.00465	(2; 0.23%)	El Eq Hw	0.00201	(2; 0.013%)
In Hw	0.00122	(1; 0.36%)	Cg Hw	0.00463	(1; 0.23%)	El Rv Hw	0.00195	(2; 0.013%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Hw	0.0203	(0; 24.%)	Hw	0.172	(0; 55.%)	Sc Cg Hw	2.66	(2; 27.%)
Wt Hw	0.0106	(1; 13.%)	Wt Hw	0.0199	(1; 6.4%)	Hw	2.25	(0; 23.%)
Eq Hw	0.00674	(1; 8.%)	Fr Hw	0.0136	(1; 4.4%)	Vf Hw	0.545	(1; 5.6%)
Oi Fo Hw	0.00312	(2; 3.7%)	Rv Hw	0.00947	(1; 3.%)	Ws Hw	0.318	(1; 3.3%)
Ma Hw	0.00216	(1; 2.6%)	Eq Hw	0.00667	(1; 2.1%)	Sc Cg Fr Hw	0.211	(3; 2.2%)
Fo Hw	0.0013	(1; 1.5%)	Cp Hw	0.00407	(1; 1.3%)	Fr Hw	0.178	(1; 1.8%)
Cg Hw	0.00124	(1; 1.5%)	In Hw	0.00346	(1; 1.1%)	Wa Hw	0.113	(1; 1.2%)
En Hw	0.001	(1; 1.2%)	Ma Hw	0.00276	(1; 0.88%)	El Hw	0.0961	(1; 0.98%)
Lg Hw	0.000947	(1; 1.1%)	Rd Hw	0.00238	(1; 0.76%)	Ri Ws Hw	0.071	(2; 0.73%)
Wt Fr Hw	0.000836	(2; 0.99%)	Ms Wt Hw	0.00195	(2; 0.63%)	Vf Ws Hw	0.0644	(2; 0.66%)
Rd Hw	0.000819	(1; 0.97%)	Wt Fr Hw	0.00158	(2; 0.51%)	Sc Cg Vf Hw	0.0565	(3; 0.58%)
In Hw	0.00067	(1; 0.8%)	Bk Hw	0.00136	(1; 0.44%)	Sc Cg Sc Cg H	0.0553	(4; 0.57%)
Fr Hw	0.000632	(1; 0.75%)	Pd Wt Hw	0.00134	(2; 0.43%)	Wt Hw	0.052	(1; 0.53%)
St Wt Hw	0.00061	(2; 0.72%)	Cm Hw	0.00126	(1; 0.4%)	Wa Ms Wt Hw	0.0481	(3; 0.49%)
Wt Rv Hw	0.00056	(2; 0.66%)	Wt Rv Hw	0.00106	(2; 0.34%)	Vf Fr Hw	0.0432	(2; 0.44%)
Eq Fr Hw	0.000534	(2; 0.63%)	St Wt Hw	0.00103	(2; 0.33%)	Wa Pd Wt Hw	0.0405	(3; 0.41%)
At Wt Hw	0.000499	(2; 0.59%)	Sm Hw	0.001	(1; 0.32%)	Fo Hw	0.0384	(1; 0.39%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Hw	0.115	(0; 62.%)	Hw	0.0756	(0; 50.%)	Hw	3.71	(0; 59.%)
Fo Hw	0.0105	(1; 5.7%)	Wt Hw	0.00932	(1; 6.2%)	Fr Hw	2.26	(1; 36.%)
Fr Hw	0.00914	(1; 4.9%)	Fr Hw	0.00599	(1; 4.%)	Wo Tx Tp Hw	0.00633	(3; 0.1%)
Eq Hw	0.00446	(1; 2.4%)	Rv Hw	0.00583	(1; 3.9%)	Bc Mp Ho Hw	0.00452	(3; 0.072%)
Wt Hw	0.003	(1; 1.6%)	In Hw	0.00372	(1; 2.5%)	Sc Cg Hw	0.00349	(2; 0.056%)
Rv Hw	0.00284	(1; 1.5%)	Eq Hw	0.00331	(1; 2.2%)	Wo Tx Wt Hw	0.00331	(3; 0.053%)
Ma Hw	0.00255	(1; 1.4%)	Cp Hw	0.00189	(1; 1.3%)	Wo Hw	0.00326	(1; 0.052%)
Cp Hw	0.00118	(1; 0.64%)	Rd Hw	0.00169	(1; 1.1%)	Wo Tx Cl Hw	0.00305	(3; 0.049%)
En Hw	0.00117	(1; 0.63%)	Ma Hw	0.00133	(1; 0.89%)	Bc Mp Hw	0.00195	(2; 0.031%)
Ap Hw	0.00102	(1; 0.55%)	Ms Wt Hw	0.000926	(2; 0.62%)	Bc Mp Ho Wt	0.00191	(4; 0.03%)
Mv Rv Hw	0.00085	(2; 0.46%)	Pd Wt Hw	0.000876	(2; 0.58%)	Wo Tx Hw	0.00153	(2; 0.024%)
Fo Fr Hw	0.000834	(2; 0.45%)	Bk Hw	0.000753	(1; 0.5%)	Bc Mp Wt Hw	0.00126	(3; 0.02%)
Pt Hw	0.000711	(1; 0.38%)	Wt Fr Hw	0.000739	(2; 0.49%)	Bc Mp Rt Wt H	0.000977	(4; 0.016%)
Oc Hw	0.000605	(1; 0.33%)	Cm Hw	0.000601	(1; 0.4%)	Wt Hw	0.000788	(1; 0.013%)
Rd Hw	0.000597	(1; 0.32%)	Oi Fo Hw	0.000555	(2; 0.37%)	Wo Tx Ru Hw	0.000683	(3; 0.011%)
Ru Hw	0.000485	(1; 0.26%)	St Wt Hw	0.000547	(2; 0.37%)	Bc Mp Bp Hw	0.000655	(3; 0.01%)
Sm Hw	0.000478	(1; 0.26%)	Wt Rv Hw	0.000494	(2; 0.33%)	Rv Hw	0.000538	(1; 0.0086%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.945 ±0.016	(±1.7%)
Downstream	2.214 ±0.048	(±2.2%)

Sector Rem. 0300: Forestry (Fr)

Forestry harvesting, logging, land clearing and services to forestry

Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions, water use and land disturbance are respectively 97 times, 75% less than and 10 times the economy wide average. The social indicator of employment is 15% greater than average, income is 10% below average, and government revenue is 30% below average. The financial indicators show that operating surplus is 10% below average, export propensity is 60% below average, and import penetration is equal to average. Wide ranging reforms in the forest industry will play out over the next 20 years and improve the land disturbance, export propensity and import penetration indicators. The high greenhouse indicator is due to the accounting conventions used.

Sector Description

This sector includes all the on-site activities that make up the forest industry to the point of delivering a log, or a bin of wood chips chipped in the forest, to a downstream processing facility such as a saw mill, a particle board mill, or a pulp and paper factory. It does not include the planting and management of plantations which are included in the softwood and hardwood sectors. The heavy machinery used in forestry operations is also used (at least as far as the national accounts are concerned) for land clearing and land preparation (though not crop ploughing) in industries such as beef cattle, cotton growing, and most mining industry sectors. Annually, about 24 million cubic metres (about 12 million dry tonnes) of roundwood are harvested from Australian forests.

Place of Industry in the Economy

The forestry and services to forestry sector ranks 122nd out of 135 sectors in terms of value adding in the economy, and contributes 0.05% of GDP in this analysis. It is similar in value adding to the diesel refining and railway equipment manufacturing sectors. It is a small employer with 4 000 employment years directly embodied in final demand, and another 2 000 employment years in the sector's upstream suppliers giving a total of 6 000 employment years. In addition, it contributes 2 000 employment years to downstream industries such as sawn timber and woodchips, and pulp and paper. The sector has small requirements for water use and energy use with less than one tenth of one percent of national totals. The sector's contribution to national greenhouse emissions has a direct component of 34.5 million tonnes or 6% of total, and 37.6 million tonnes or 7% of total when suppliers are included. The emissions are due to decaying vegetation and litter and soil respiration on the harvested area. Some accounting protocols offset harvesting emissions against the uptake of carbon dioxide by new, actively growing plantation forest. This analysis assigns the sequestration of carbon dioxide to the economy at large, or the 'commons' rather than to particular sectors. The land disturbance account is one percent of the national total and composed of pro-rated impact from harvesting in intensive plantations and extensive native forests.

Strategic Overview

The spider diagram portrays the forestry sector with outliers in environmental, social, and financial areas. As discussed above, some of these outliers may be due to accounting convention. However it is realistic to acknowledge that forest issues generate wide political and community concern due to issues beyond the scope of this analysis, such as biodiversity loss and conservation goals.

TBL Account #1

The operating surplus is 10% below average and composed of a direct sector effect of 53% with contributions from repairs to machinery (6%), wholesale trade (4%), concrete products (2%), oil extraction for diesel refining (1%), and equipment manufacture (1%). The social indicator of employment generation is 15% above average, with a direct effect of 64% and a composition similar to the surplus indicator. Employment in this sector is mostly regional in nature which in part explains the political intensity that accompany changes in forest management policies. The greenhouse gas indicator is 97 times the average and is discussed in more detail below.

TBL Accounts #2 and #3

The second TBL account shows that the export propensity is 60% below average and is due partly to sector production going to downstream processing. However, Australia still has a significant forest products deficit across all wood sectors in total. The income indicator is 10% below average. Water use is 75% below average and partly due to cottonseed husks used to rear plantation seedlings. The third TBL account shows that import penetration is equal to average, government revenue is 30% below average, and land disturbance is 10 times the average.

Structural Path Analysis and Linkages

The land disturbance and greenhouse emissions indicators are partly explained by accounting protocols and the relatively low value of primary commodities before they enter the processing streams. The structural path analysis shows that the direct effect is 92% for both indicators and so improvements could clearly come from within the sector. The land disturbance indicator should decrease gradually over the next 20 years as both hardwood and softwood are harvested from plantations and native forest logging is curtailed. While the characterisation of a sustainable forest plantation of native eucalypt species as a ‘disturbed’ landscape may be debated, nevertheless reducing Australia’s forest products deficit will increase the land use indicator as imports from New Zealand, Canada and parts of Asia are replaced. The tradeoff will be increased regional employment and reduced import penetration. Reducing the greenhouse intensity indicator from harvested land is more difficult due to the relatively low financial value of unprocessed logs. Some environmental accounting systems, focused on valuing ecosystems services, propose that forest products are undervalued in financial terms by a factor of five, for plantations, to ten, for rainforests. However the key issue is the emissions after harvesting when discarded plant material decomposes. Increased waste collection is possible, but doubtful economically and it removes more nutrients from the soil.

The sector’s stimulus to its upstream suppliers is about average and impacts on wholesale trade, property services, other food and animal products, diesel refining and accounting and marketing. The linkages to downstream industries are 25% below average and suggest that expansion in the sector must be led by development activities in agriculture (particularly beef cattle, and vegetable and fruit growing), and expansion in softwoods (land preparation), sawn timber, and pulp and paper.

Future Trends in Sector

Federal Government forest scenarios underpinning the ‘Forests 2020 Vision’ anticipate that by the mid 2040s, wood volumes may increase by 25% to 30 million cubic metres with no new planting, or double to 50 million cubic metres with new planting, to feed 8-13 new world scale pulp mills.

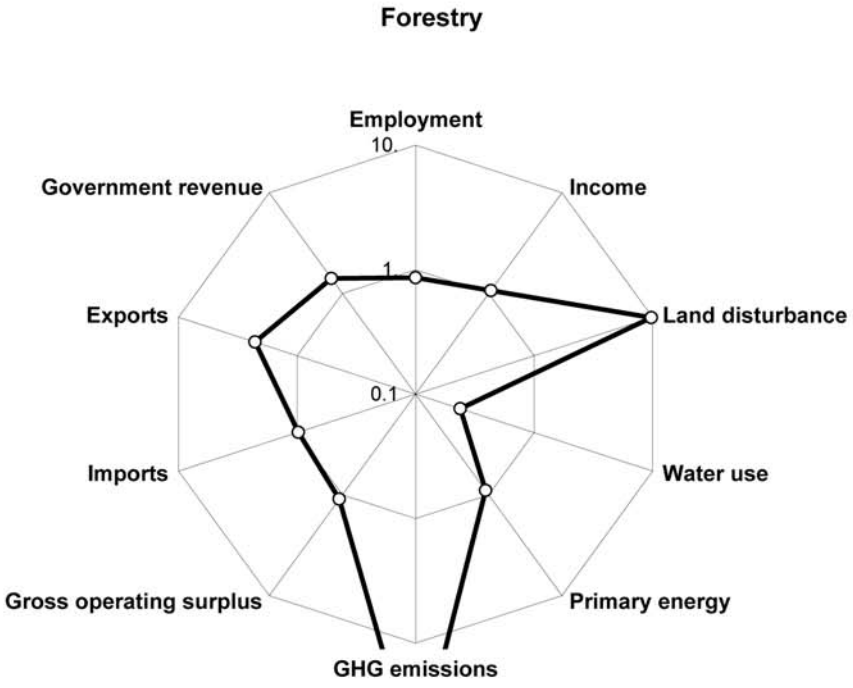
Innovation and Technical Opportunities

Assuming that the forest cycle will be based on plantations by 2020, the drivers for the forestry sector will come from downstream consumers, and be mediated by the processors of wood products. Transitions to a paperless office, a biomass fuel cycle, or wood housing will all have large effects.

Sector **Forestry** **(Fr)**

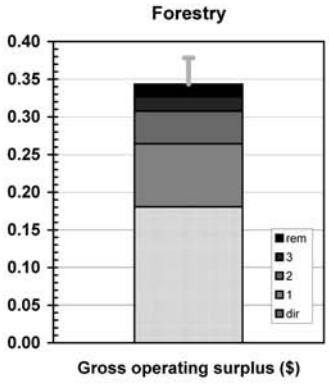
Forestry and services to forestry

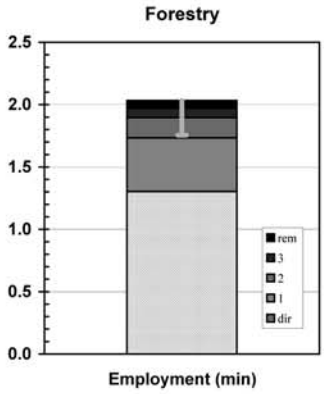
Spider diagram

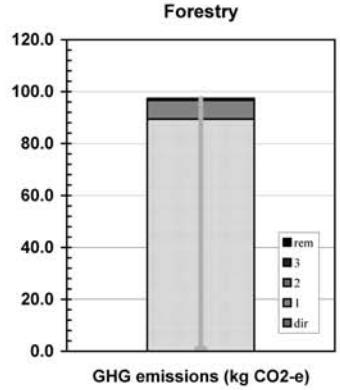


Bar graphs

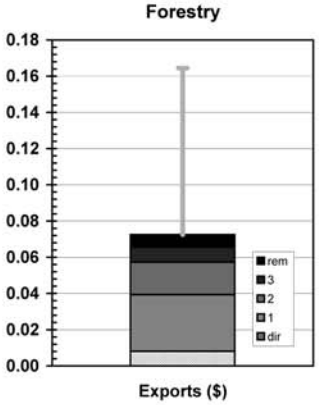
Account #1

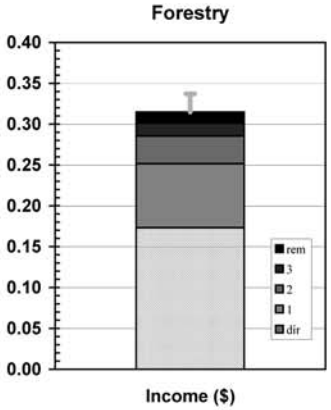


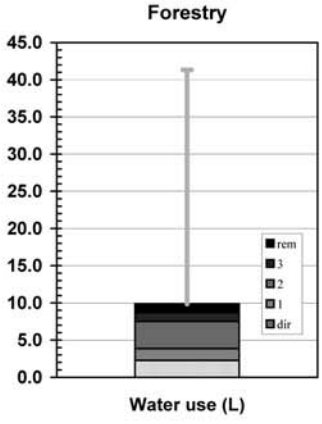




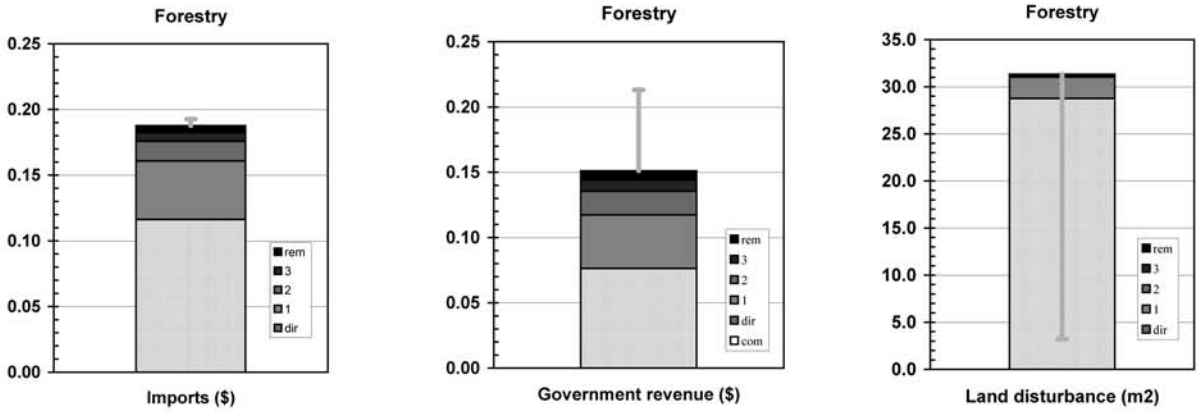
Account #2







Account #3



National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 10.0	(0.00% of total)	($m 8.0 domestically produced)
Government final consumption	$m 353.1	(0.40% of total)	($m 353.1 domestically produced)
Gross fixed capital expenditure	$m 21.3	(0.02% of total)	($m 20.8 domestically produced)
Net changes in stocks	$m 0.0	(0.00% of total)	
Sectoral GNE	**$m 384.3**	**(0.08% of GNE)**	**($m 381.8 domestically produced)**
Exports	$m 4.6	(0.01% of total)	($m 4.6 domestically produced)
Final demand	**$m 388.9**	**(0.07% of GNT)**	**($m 386.4 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 98.5	(0.06% of total)	
Gross operating surplus	$m 102.7	(0.05% of total)	
Taxes less subsidies	$m 43.4	(0.05% of total)	
Sectoral GDP*	**$m 244.6**	**(0.05% of GDP)**	
Imports	$m 66.1	(0.07% of total)	
Primary inputs	**$m 310.8**	**(0.06% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 102.7	(0.05%)	$m 69.8	(0.04%)	$m 132.7	(0.07%)
Exports ($m)	$m 4.6	(0.01%)	$m 3.1	(0.00%)	$m 28.0	(0.03%)
Imports ($m)	$m 66.1	(0.07%)	$m 44.9	(0.05%)	$m 72.5	(0.07%)
Employment (e-y)	5,940 e-y	(0.08%)	4,035 e-y	(0.06%)	6,295 e-y	(0.09%)
Income ($m)*	$m 98.5	(0.06%)	$m 66.9	(0.04%)	$m 121.6	(0.07%)
Government revenue ($m)†	$m 43.4	(0.04%)	$m 29.5	(0.03%)	$m 58.4	(0.05%)
GHG emissions (kt CO_2-e)	50,859 kt	(9.81%)	34,549 kt	(6.66%)	37,644 kt	(7.26%)
Water use (ML)	1,291 ML	(0.01%)	877 ML	(0.00%)	3,806 ML	(0.02%)
Land disturbance (kha)	1,635 kha	(1.01%)	1,111 kha	(0.68%)	1,210 kha	(0.74%)
Primary energy (TJ)	2,061 TJ	(0.05%)	1,400 TJ	(0.04%)	2,672 TJ	(0.07%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.18	0.34	0.38
Exports ($)	0.01	0.07	0.16
Imports ($)	0.12	0.19	0.19
Employment (min)	1.30	2.03	1.75
Income ($)	0.17	0.31	0.34
Government revenue ($)	0.08	0.15	0.21
GHG emissions (kg CO_2-e)	89.41	97.42	1.02
Water use (L)	2.27	9.85	41.32
Land disturbance (m^2)	28.75	31.32	3.21
Primary energy (MJ)	3.62	6.91	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Fr	0.181	(0; 53.%)	Fr	1.3	(0; 64.%)	Fr	89.4	(0; 92.%)
Rv Fr	0.0221	(1; 6.5%)	Wt Fr	0.0937	(1; 4.6%)	Fo Fr	0.0324	(1; 0.033%)
Wt Fr	0.013	(1; 3.8%)	Rv Fr	0.0592	(1; 2.9%)	Ce Fr	0.0198	(1; 0.02%)
Cp Fr	0.00705	(1; 2.1%)	Eq Fr	0.0382	(1; 1.9%)	El Fr	0.0175	(1; 0.018%)
Oi Fo Fr	0.00461	(2; 1.3%)	Cp Fr	0.0185	(1; 0.91%)	Wt Fr	0.013	(1; 0.013%)
Eq Fr	0.00386	(1; 1.1%)	Ma Fr	0.0148	(1; 0.73%)	Ce Cp Fr	0.0109	(2; 0.011%)
St Wt Fr	0.00248	(2; 0.72%)	Rd Fr	0.014	(1; 0.69%)	Oi Fo Fr	0.00976	(2; 0.01%)
Rd Fr	0.00238	(1; 0.69%)	Ms Wt Fr	0.00846	(2; 0.42%)	Is Eq Fr	0.00566	(2; 0.0058%)
Cm Fr	0.00202	(1; 0.59%)	In Fr	0.00805	(1; 0.4%)	Is Ma Fr	0.00406	(2; 0.0042%)
Ms Wt Fr	0.00189	(2; 0.55%)	Sm Fr	0.00588	(1; 0.29%)	El Wt Fr	0.00391	(2; 0.004%)
Fo Fr	0.00178	(1; 0.52%)	Cm Fr	0.00559	(1; 0.28%)	Rd Fr	0.00377	(1; 0.0039%)
Pd Wt Fr	0.00149	(2; 0.44%)	Bk Fr	0.00557	(1; 0.27%)	Sc Cg Fr	0.00256	(2; 0.0026%)
Sf In Fr	0.00143	(2; 0.42%)	Wt Rv Fr	0.00497	(2; 0.24%)	El Cp Fr	0.00241	(2; 0.0025%)
Bk Fr	0.0014	(1; 0.41%)	Cg Fr	0.00467	(1; 0.23%)	El Eq Fr	0.00203	(2; 0.0021%)
In Fr	0.00123	(1; 0.36%)	St Wt Fr	0.00405	(2; 0.2%)	El Rv Fr	0.00197	(2; 0.002%)
Ma Fr	0.00112	(1; 0.33%)	Rh Fr	0.00397	(1; 0.2%)	Lg Fr	0.00194	(1; 0.002%)
Cm Wt Fr	0.000876	(2; 0.26%)	Pd Wt Fr	0.00359	(2; 0.18%)	Is Sm Fr	0.00191	(2; 0.002%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Wt Fr	0.0106	(1; 15.%)	Fr	0.173	(0; 55.%)	Sc Cg Fr	2.68	(2; 27.%)
Fr	0.00805	(0; 11.%)	Wt Fr	0.0201	(1; 6.4%)	Fr	2.27	(0; 23.%)
Eq Fr	0.0068	(1; 9.4%)	Rv Fr	0.00955	(1; 3.%)	Vf Fr	0.549	(1; 5.6%)
Oi Fo Fr	0.00315	(2; 4.3%)	Eq Fr	0.00673	(1; 2.1%)	Ws Fr	0.32	(1; 3.3%)
Ma Fr	0.00218	(1; 3.%)	Cp Fr	0.0041	(1; 1.3%)	Wa Fr	0.114	(1; 1.2%)
Fo Fr	0.00132	(1; 1.8%)	In Fr	0.00349	(1; 1.1%)	El Fr	0.0969	(1; 0.98%)
Cg Fr	0.00125	(1; 1.7%)	Ma Fr	0.00278	(1; 0.88%)	Ri Ws Fr	0.0716	(2; 0.73%)
En Fr	0.00101	(1; 1.4%)	Rd Fr	0.0024	(1; 0.76%)	Vf Ws Fr	0.065	(2; 0.66%)
Lg Fr	0.000956	(1; 1.3%)	Ms Wt Fr	0.00197	(2; 0.63%)	Sc Cg Vf Fr	0.057	(3; 0.58%)
Rd Fr	0.000827	(1; 1.1%)	Bk Fr	0.00138	(1; 0.44%)	Sc Cg Sc Cg F	0.0558	(4; 0.57%)
In Fr	0.000676	(1; 0.93%)	Pd Wt Fr	0.00135	(2; 0.43%)	Wt Fr	0.0524	(1; 0.53%)
St Wt Fr	0.000615	(2; 0.85%)	Cm Fr	0.00127	(1; 0.4%)	Wa Ms Wt Fr	0.0485	(3; 0.49%)
Wt Rv Fr	0.000565	(2; 0.78%)	Wt Rv Fr	0.00107	(2; 0.34%)	Wa Pd Wt Fr	0.0409	(3; 0.41%)
At Wt Fr	0.000504	(2; 0.69%)	St Wt Fr	0.00103	(2; 0.33%)	Fo Fr	0.0388	(1; 0.39%)
Is Eq Fr	0.000501	(2; 0.69%)	Sm Fr	0.00101	(1; 0.32%)	Sm Fr	0.0373	(1; 0.38%)
Sg Fr	0.000401	(1; 0.55%)	Cg Fr	0.000802	(1; 0.25%)	Cp Fr	0.0325	(1; 0.33%)
Oc Fr	0.000395	(1; 0.54%)	Gv Fr	0.000775	(1; 0.25%)	Wa Wt Fr	0.0282	(2; 0.29%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Fr	0.116	(0; 62.%)	Fr	0.0763	(0; 50.%)	Fr	28.7	(0; 92.%)
Fo Fr	0.0106	(1; 5.7%)	Wt Fr	0.0094	(1; 6.2%)	Wo Tx Tp Fr	0.00639	(3; 0.02%)
Eq Fr	0.0045	(1; 2.4%)	Rv Fr	0.00588	(1; 3.9%)	Bc Mp Ho Fr	0.00456	(3; 0.015%)
Wt Fr	0.00302	(1; 1.6%)	In Fr	0.00375	(1; 2.5%)	Sc Cg Fr	0.00352	(2; 0.011%)
Rv Fr	0.00287	(1; 1.5%)	Eq Fr	0.00334	(1; 2.2%)	Wo Tx Wt Fr	0.00334	(3; 0.011%)
Ma Fr	0.00257	(1; 1.4%)	Cp Fr	0.0019	(1; 1.3%)	Wo Fr	0.00329	(1; 0.01%)
Cp Fr	0.00119	(1; 0.64%)	Rd Fr	0.0017	(1; 1.1%)	Wo Tx Cl Fr	0.00307	(3; 0.0098%)
En Fr	0.00118	(1; 0.63%)	Ma Fr	0.00134	(1; 0.89%)	Bc Mp Fr	0.00197	(2; 0.0063%)
Ap Fr	0.00103	(1; 0.55%)	Ms Wt Fr	0.000935	(2; 0.62%)	Bc Mp Ho Wt	0.00193	(4; 0.0062%)
Mv Rv Fr	0.000858	(2; 0.46%)	Pd Wt Fr	0.000883	(2; 0.58%)	Wo Tx Fr	0.00154	(2; 0.0049%)
Pt Fr	0.000718	(1; 0.38%)	Bk Fr	0.00076	(1; 0.5%)	Bc Mp Wt Fr	0.00127	(3; 0.0041%)
Oc Fr	0.00061	(1; 0.33%)	Cm Fr	0.000607	(1; 0.4%)	Bc Mp Rt Wt F	0.000985	(4; 0.0031%)
Rd Fr	0.000602	(1; 0.32%)	Oi Fo Fr	0.00056	(2; 0.37%)	Wt Fr	0.000795	(1; 0.0025%)
Ru Fr	0.00049	(1; 0.26%)	St Wt Fr	0.000552	(2; 0.37%)	Wo Tx Ru Fr	0.000689	(3; 0.0022%)
Sm Fr	0.000482	(1; 0.26%)	Wt Rv Fr	0.000499	(2; 0.33%)	Bc Mp Bp Fr	0.000661	(3; 0.0021%)
Ms Wt Fr	0.000429	(2; 0.23%)	Cg Fr	0.000421	(1; 0.28%)	Rv Fr	0.000542	(1; 0.0017%)
Pr Wt Fr	0.000411	(2; 0.22%)	Sf In Fr	0.000401	(2; 0.27%)	Vf Fr	0.000518	(1; 0.0017%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.954 ±0.016	(±1.7%)
Downstream	0.744 ±0.013	(±1.7%)

Sector 0400: Commercial Fishing (Fi)

Wild-caught fishing and aquaculture

Short Summary

The commercial fishing sector shows a reasonable environmental account with greenhouse emissions, water use and land disturbance 25%, 50%, and 90% below average. However two caveats are worth noting. The land account does not include estuary and ocean disturbance due to fishing, since marine disturbance data is not available. Also recent long term modelling warns that marine fish stocks are under considerable pressure and current production levels cannot be sustained. For the social indicators, employment generation is 15% below average, income is 35% below average while government revenue is 15% below average. For the financial indicators, the operating surplus is 10% below average, export propensity is 90% above average while import penetration is 35% above average. In absolute dollar terms, exports are currently greater than imports due to exports of higher value fish (lobsters, tuna, prawns) balancing the imports of larger volumes of mainly fin fish. There is a weak downstream linkage to the accommodation, cafes and restaurants sector. Increases in consumer demand show an average upstream effect on suppliers such as wholesale trade, boat leasing, seafood processing and marketing. In view of the pressures on many fish stocks, consumer prices for seafood may increase. This could allow higher income for employees and improved fisheries management to be funded directly by consumers.

Sector Description

Australia's wild caught marine fishery harvests about 600 species commercially and has averaged around 200 000 tonnes of production per annum for the past decade. In addition, aquaculture contributes 30 000 to 40 000 tonnes per annum. The current value of fisheries production is around $2.5 billion in basic prices. The value of imports is $1.2 billion while exports are $2.2 billion giving a positive trade balance of $1 billion. The Australian fishing zone is 17% greater than the land mass, and is the third largest in the world. However it is relatively unproductive due to nutrient poor waters and the lack of up welling areas where nutrients are brought to the surface layers.

Place of Industry in the Economy

The commercial fishing sector is a relatively small one in terms of value adding to the economy ranking 81st out of 135, and contributing 0.18% of GDP in this analysis. It is a small employment generation with a total of 17 000 employment years, with 9 000 of these directly within the sector and the remaining 8 000 in the sector's suppliers. In resource terms, it uses less than three tenths of one percent of water, energy and greenhouse gases and has a negligible land requirement, although a large marine area is accessed for the wild capture fishery. Estimates of Australia's functional marine area are about 0.7 ha per capita, a total of 14 million ha, which is equivalent to the area ploughed for the yearly wheat crop. Currently, exports are twice imports in financial terms.

Strategic Overview

The integrated overview in the spider diagram shows a moderately balanced TBL account with below average social and financial outcomes. The most challenging upstream issues relate to the ecological and economic sustainability of Australia's fish stocks. While many shorter lived marine species will be sustained provided that their habitats are not damaged, many important long lived species have been overfished and could take decades to recover. Downstream issues relate to heavy metal accumulation in some fish entering the human food chain. Inevitably aquaculture will increase substantially bringing downstream issues of where to locate and manage these operations.

TBL Account #1

The first TBL account shows that operating surplus is 10% below average with half a direct effect and contributions from wholesale trade (5%), aquaculture feed (2%), diesel (2%) and mechanical repairs (1%). The social indicator of employment generation is 15% below average with a composition similar to the financial surplus. The greenhouse emissions indicator is 25% below average with half a direct effect due to fuel combusted on fishing boats.

TBL Accounts #2 and #3

The second TBL account shows export propensity is nearly twice the average, income is 35% below average and water use is 50% below average. The third TBL account shows import penetration is 35% below average while government revenue and land disturbance are 15% and 90% below average respectively. Marine area disturbance is not included in the land disturbance account.

Structural Path Analysis and Linkages

The upstream linkage to supply sectors such as wholesale trade and marketing is around average. The downstream linkages are weak, as the effects dissipate to private consumption and exports.

Future Trends in Sector

The CSIRO Fish Futures to 2050 study points to a reasonably constrained future for wild caught fishing in the Australian fishing zone. Under an ‘average management’ scenario, the wild catch will slowly decline to 130 000 tonnes per annum (70 000 tonnes below the peak decade of the 1990s). The decline is due to the damage done to the stocks of longer lived fin fish in the 1980s and 1990s when industrial exploitation was at its peak. A number of ecologically based fishing scenarios show that sustainable catch regimes of 170 000 to 190 000 tonnes per annum may be feasible but there are many biological and management uncertainties. It seems certain that aquaculture will play a greater part in the future and these studies assume that it will expand from the current level of 34 000 tonnes per annum to 130 000 tonnes per annum by 2050. Parallel assumptions are that exports of high value fish such as bluefin tuna and rock lobsters kept constant at 70 000 tonnes per year. Under the assumption that the health enhancing and lifestyle factors of seafood will double annual consumption from 11 to 23 kg per capita by 2050, it is possible that seafood imports will grow from 280 000 tonnes per year to over 900 000 tonnes per year by 2050. These figures may be optimistic in assuming that these volumes of fish would be available for purchase.

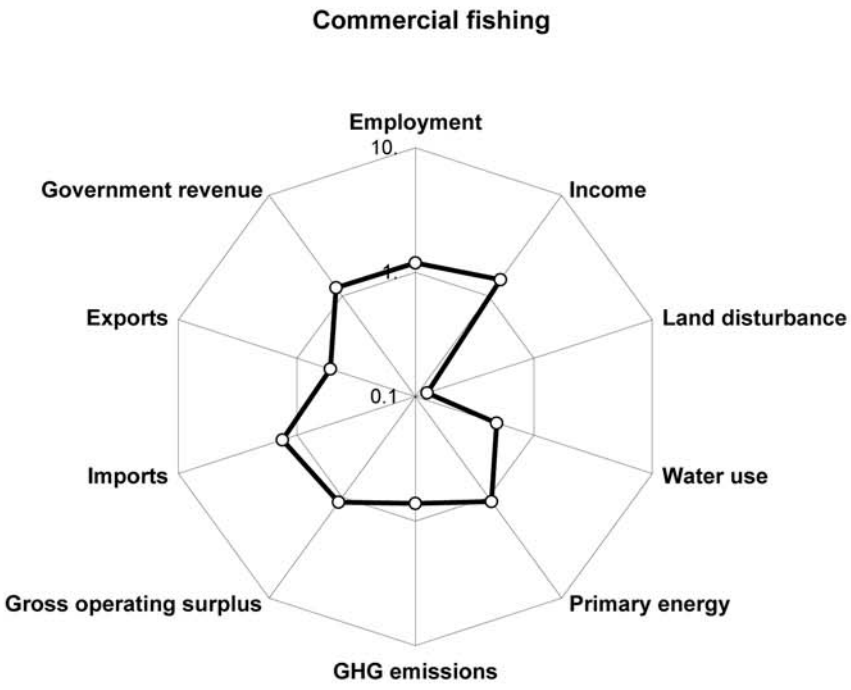
Innovation and Technical Opportunities

The key innovation required in the above scenarios is to decouple marine aquaculture from its requirement for ‘fish as feed’ and fish oil in the feeding regime for fish species Current aquaculture systems for Atlantic salmon and southern bluefin tuna require that 8 to 11 kg of fish be fed for each kg of fish liveweight gain. Without a technological breakthrough in feeding this could mean that the 130 000 tonnes of aquaculture fish in the future scenario could require in excess of one million tonnes of other fish as feed. This is plainly unsustainable. It is anticipated that grain feeding systems will be developed where the key amino acids for taste and health benefits, will be synthesised within the grain or by micro-organisms in vats. Increasing the sophistication of the aquaculture production chain will inevitably increase the energy and materials intensity of the commercial fishing sector and alter its TBL account, although there may be social advantages of increased employment generation. Most innovations relating to wild caught fishing aim at reducing catches and fishing effort, in the expectation of increasing the resilience of the stocks. There is some possibility that undiscovered fish resources still exist, and that by-catch and under utilised species can plug the production gaps, but this is unlikely.

Sector **Commercial fishing** **(Fi)**

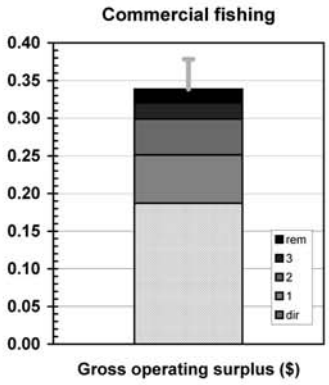
Commercial fishing, fresh seafood

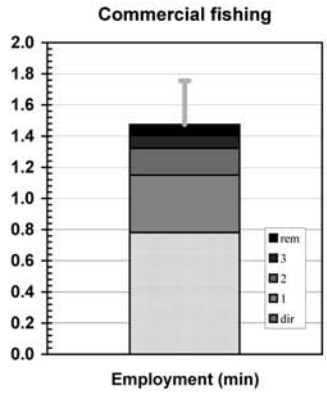
Spider diagram

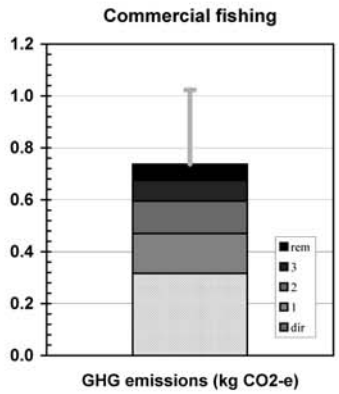


Bar graphs

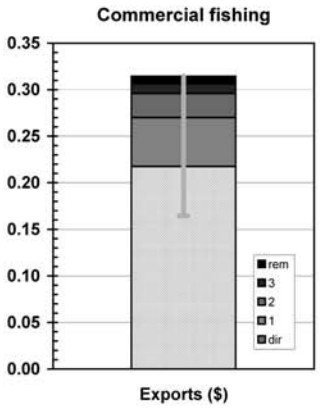
Account #1

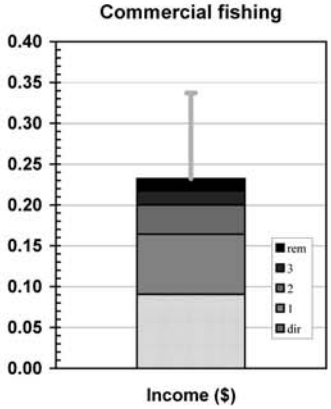


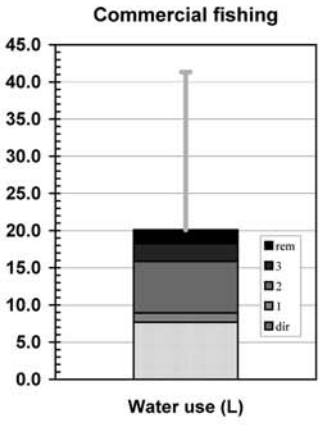




Account #2







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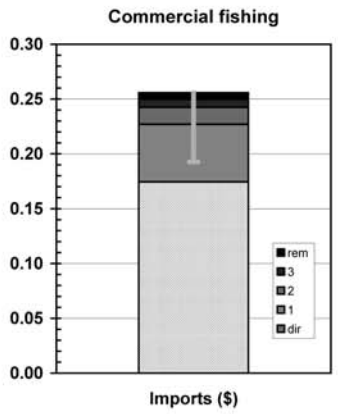
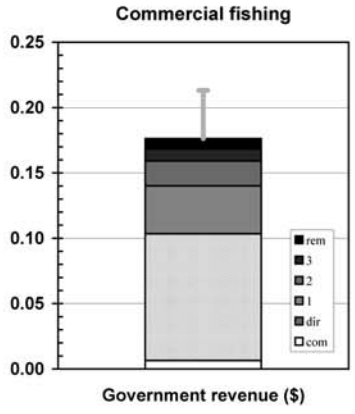
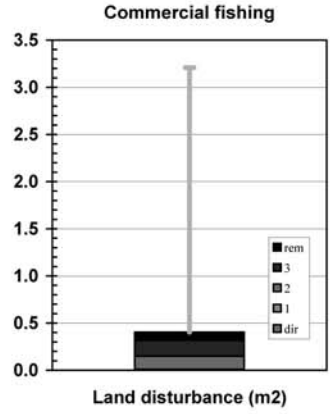






National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 922.4	(0.35% of total)	($m 887.9 domestically produced)
Government final consumption	$m 102.2	(0.12% of total)	($m 102.2 domestically produced)
Gross fixed capital expenditure	$m 0.0		
Net changes in stocks	$m 2.4	(0.14% of total)	($m 2.3 domestically produced)
Sectoral GNE	**$m 1,027.0**	**(0.22% of GNE)**	**($m 992.4 domestically produced)**
Exports	$m 467.9	(0.56% of total)	($m 467.9 domestically produced)
Final demand	**$m 1,494.9**	**(0.28% of GNT)**	**($m 1,460.3 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 195.1	(0.11% of total)	
Gross operating surplus	$m 402.4	(0.21% of total)	
Taxes less subsidies	$m 208.7	(0.24% of total)	
Sectoral GDP*	**$m 806.1**	**(0.18% of GDP)**	
Imports	$m 375.3	(0.38% of total)	
Primary inputs	**$m 1,181.4**	**(0.22% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 402.4	(0.21%)	$m 273.2	(0.14%)	$m 494.6	(0.26%)
Exports ($m)	$m 467.9	(0.56%)	$m 317.7	(0.38%)	$m 459.4	(0.55%)
Imports ($m)	$m 375.3	(0.38%)	$m 254.8	(0.26%)	$m 373.6	(0.38%)
Employment (e-y)	13,463 e-y	(0.19%)	9,140 e-y	(0.13%)	17,252 e-y	(0.24%)
Income ($m)*	$m 195.1	(0.11%)	$m 132.4	(0.08%)	$m 339.1	(0.20%)
Government revenue ($m)†	$m 218.0	(0.20%)	$m 151.0	(0.14%)	$m 257.5	(0.24%)
GHG emissions (kt CO_2-e)	680 kt	(0.13%)	462 kt	(0.09%)	1,077 kt	(0.21%)
Water use (ML)	16,487 ML	(0.08%)	11,193 ML	(0.05%)	29,356 ML	(0.14%)
Land disturbance (kha)	1 kha	(0.00%)	0 kha	(0.00%)	59 kha	(0.04%)
Primary energy (TJ)	9,713 TJ	(0.25%)	6,594 TJ	(0.17%)	12,277 TJ	(0.32%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.19	0.34	0.38
Exports ($)	0.22	0.31	0.16
Imports ($)	0.17	0.26	0.19
Employment (min)	0.78	1.47	1.75
Income ($)	0.09	0.23	0.34
Government revenue ($)	0.10	0.18	0.21
GHG emissions (kg CO_2-e)	0.32	0.74	1.02
Water use (L)	7.66	20.10	41.32
Land disturbance (m^2)	0.00	0.40	3.21
Primary energy (MJ)	4.52	8.41	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Fi	0.187	(0; 55.%)	Fi	0.781	(0; 53.%)	Fi	0.316	(0; 43.%)
Wt Fi	0.0165	(1; 4.9%)	Wt Fi	0.119	(1; 8.1%)	El Fi	0.0396	(1; 5.4%)
Fd Fi	0.00575	(1; 1.7%)	Eq Fi	0.0285	(1; 1.9%)	Fd Fi	0.0379	(1; 5.1%)
Oi Fo Fi	0.00521	(2; 1.5%)	Ma Fi	0.0248	(1; 1.7%)	Fo Fi	0.0366	(1; 5.%)
Rv Fi	0.00462	(1; 1.4%)	Rh Fi	0.013	(1; 0.88%)	Wt Fi	0.0165	(1; 2.2%)
St Wt Fi	0.00315	(2; 0.93%)	Fd Fi	0.0128	(1; 0.87%)	Bc Mp Fd Fi	0.0113	(3; 1.5%)
Eq Fi	0.00289	(1; 0.85%)	Om Fi	0.0127	(1; 0.86%)	Oi Fo Fi	0.011	(2; 1.5%)
Bk Fi	0.00267	(1; 0.79%)	Rv Fi	0.0124	(1; 0.84%)	Is Ma Fi	0.00679	(2; 0.92%)
Ms Wt Fi	0.00239	(2; 0.71%)	Ms Wt Fi	0.0107	(2; 0.73%)	Ap Fi	0.00581	(1; 0.79%)
Rh Fi	0.00213	(1; 0.63%)	Bk Fi	0.0106	(1; 0.72%)	Is Sh Fi	0.00508	(2; 0.69%)
Fo Fi	0.00201	(1; 0.59%)	Sh Fi	0.0104	(1; 0.71%)	El Wt Fi	0.00496	(2; 0.67%)
Pt Fi	0.002	(1; 0.59%)	Pl Fi	0.00986	(1; 0.67%)	Is Eq Fi	0.00423	(2; 0.57%)
Pd Wt Fi	0.0019	(2; 0.56%)	Mv Fi	0.00907	(1; 0.62%)	Ch Pl Fi	0.00412	(2; 0.56%)
Ma Fi	0.00187	(1; 0.55%)	Rd Fi	0.00833	(1; 0.57%)	Nf Fi	0.00366	(1; 0.5%)
Pl Fi	0.00185	(1; 0.55%)	Ps Fi	0.00832	(1; 0.56%)	Oi Ap Fi	0.00301	(2; 0.41%)
Sh Fi	0.00175	(1; 0.52%)	Ee Fi	0.00688	(1; 0.47%)	Bc Mp Fi	0.00299	(2; 0.41%)
Mv Fi	0.00167	(1; 0.49%)	Su Fd Fi	0.00577	(2; 0.39%)	El En Fi	0.00248	(2; 0.34%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Fi	0.218	(0; 69.%)	Fi	0.0907	(0; 39.%)	Fi	7.66	(0; 38.%)
Wt Fi	0.0135	(1; 4.3%)	Wt Fi	0.0255	(1; 11.%)	Su Fd Fi	4.58	(2; 23.%)
Fd Fi	0.0104	(1; 3.3%)	Eq Fi	0.00503	(1; 2.2%)	Vf Fd Fi	0.364	(2; 1.8%)
Eq Fi	0.00508	(1; 1.6%)	Ma Fi	0.00465	(1; 2.%)	Ws Fi	0.352	(1; 1.8%)
Ma Fi	0.00364	(1; 1.2%)	Fd Fi	0.00301	(1; 1.3%)	Dc Dp Fi	0.329	(2; 1.6%)
Oi Fo Fi	0.00356	(2; 1.1%)	Bk Fi	0.00262	(1; 1.1%)	Bc Mp Fd Fi	0.298	(3; 1.5%)
Nf Fi	0.00268	(1; 0.85%)	Ms Wt Fi	0.0025	(2; 1.1%)	Wh Fd Fi	0.246	(2; 1.2%)
En Fi	0.00233	(1; 0.74%)	Sh Fi	0.00206	(1; 0.89%)	El Fi	0.219	(1; 1.1%)
Sb Fi	0.00195	(1; 0.62%)	Pl Fi	0.00199	(1; 0.86%)	Wa Fi	0.212	(1; 1.1%)
Om Fi	0.00164	(1; 0.52%)	Rv Fi	0.00199	(1; 0.86%)	Sc Cg Su Fd F	0.125	(4; 0.62%)
Fo Fi	0.00149	(1; 0.47%)	Pd Wt Fi	0.00171	(2; 0.74%)	Dc Dp Fd Fi	0.112	(3; 0.56%)
Ee Fi	0.00111	(1; 0.35%)	Mv Fi	0.00157	(1; 0.68%)	Wo Tx Fi	0.0791	(2; 0.39%)
Mv Fi	0.0011	(1; 0.35%)	Rd Fi	0.00143	(1; 0.62%)	Bc Mp Fi	0.0788	(2; 0.39%)
Oi Ap Fi	0.000971	(2; 0.31%)	Rh Fi	0.00142	(1; 0.61%)	Ri Ws Fi	0.0787	(2; 0.39%)
St Wt Fi	0.00078	(2; 0.25%)	Om Fi	0.00132	(1; 0.57%)	Vf Ws Fi	0.0714	(2; 0.36%)
At Wt Fi	0.000639	(2; 0.2%)	Ee Fi	0.00132	(1; 0.57%)	Ri Fc Fi	0.0669	(2; 0.33%)
Wh Fd Fi	0.00062	(2; 0.2%)	St Wt Fi	0.00131	(2; 0.57%)	Wt Fi	0.0665	(1; 0.33%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Fi	0.174	(0; 68.%)	Fi	0.097	(0; 57.%)	Bc Mp Fd Fi	0.0823	(3; 20.%)
Fo Fi	0.012	(1; 4.7%)	Wt Fi	0.0119	(1; 7.%)	Wo Tx Fi	0.0587	(2; 15.%)
Ma Fi	0.0043	(1; 1.7%)	Eq Fi	0.00249	(1; 1.5%)	Wh Fd Fi	0.0359	(2; 8.9%)
Wt Fi	0.00384	(1; 1.5%)	Ma Fi	0.00224	(1; 1.3%)	Bc Mp Fi	0.0217	(2; 5.4%)
Eq Fi	0.00336	(1; 1.3%)	Fd Fi	0.00146	(1; 0.86%)	Wo Tx Tp Fi	0.0128	(3; 3.2%)
Ap Fi	0.00327	(1; 1.3%)	Bk Fi	0.00145	(1; 0.85%)	Wo Mp Fd Fi	0.00929	(3; 2.3%)
Mv Fi	0.00275	(1; 1.1%)	In Fi	0.00132	(1; 0.78%)	Bc Mp Ho Fi	0.00745	(3; 1.8%)
En Fi	0.00271	(1; 1.1%)	Rv Fi	0.00123	(1; 0.72%)	Su Fd Fi	0.00733	(2; 1.8%)
Pt Fi	0.00219	(1; 0.86%)	Ms Wt Fi	0.00119	(2; 0.7%)	Wo Tx Cl Fi	0.00607	(3; 1.5%)
Sb Fi	0.00204	(1; 0.8%)	Pd Wt Fi	0.00112	(2; 0.66%)	Ba Fd Fi	0.00493	(2; 1.2%)
Pl Fi	0.0019	(1; 0.74%)	Sb Fi	0.00104	(1; 0.61%)	Wo Tx Wt Fi	0.00423	(3; 1.%)
Fd Fi	0.00173	(1; 0.68%)	Rd Fi	0.00102	(1; 0.6%)	Fi	0.00298	(0; 0.74%)
Ru Fi	0.00165	(1; 0.64%)	Sh Fi	0.000911	(1; 0.54%)	Wo Mp Fi	0.00246	(2; 0.61%)
Sh Fi	0.00121	(1; 0.47%)	Pl Fi	0.00087	(1; 0.51%)	Bc Mp Ho Wt	0.00244	(4; 0.6%)
Rh Fi	0.0011	(1; 0.43%)	St Wt Fi	0.0007	(2; 0.41%)	Wo Tx Ru Fi	0.00232	(3; 0.57%)
Ee Fi	0.00108	(1; 0.42%)	Mv Fi	0.000674	(1; 0.4%)	Wo Tx Pl Fi	0.0019	(3; 0.47%)
Om Fi	0.000773	(1; 0.3%)	En Fi	0.000672	(1; 0.4%)	Dc Dp Fi	0.00171	(2; 0.42%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.995 ±0.016	(±1.6%)
Downstream	0.451 ±0.021	(±4.7%)

Sectors 11010010-12001920: Black Coal (Bl)

Black coal, all types including briquettes

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is two and one quarter times the average, water use is 65% below average, and land disturbance is 95% below average. The social indicators show that employment generation, income, and government revenue are respectively 65%, 50%, and 50% below average. The financial indicators reveal that operating surplus is 60% above average, export propensity is five times the average, and import penetration is 65% below average. Prospects for the black coal industry seem good for the next 10-20 years. Innovations in 'clean coal' electricity and geo-sequestration of CO_2 will determine its future past 2020. The use of advanced coal-to-liquids technology to supply transport fuels could vastly expand its domestic and export requirements.

Sector Description

Australia currently has an annual gross production of 350 million tonnes (Mt) of black coal, 72% of which is from underground mines. This has a net production after cleaning of 274 Mt, of which 68 Mt is used domestically and 206 Mt is exported. Raw coal production is dominated by Queensland (56%) and New South Wales (41%). Domestic consumption is composed of electricity generation with 56 Mt (85%), iron and steel 5.5 Mt (8%), cement manufacture 0.8 Mt (1%), and other uses 4.5 Mt (6%). Exports are made up of coking coal for steel making (106 Mt), and steaming coal for electricity generation (100 Mt). Australia has economic demonstrated resources of black coal of 41 billion tonnes, giving an economic life of over 120 years at current production levels. In constant dollar terms, the turnover of the black coal sector has increased nine fold in the last 30 years. Current turnover is $13 billion and involves about 100 enterprises.

Place of Industry in the Economy

The coal mining sector ranks 22nd out of 135 sectors in terms of value adding in the Australian economy and contributes 1.3% of GDP in this analysis. It is similar in value adding to the police and fire brigades, and business support services sectors. It is a moderate employer with 11 000 employment years directly embodied in the sector's final demand, and another 22 000 years in the sector's suppliers, giving a total of 33 000 employment years. In addition, it contributes 3 000 employment years to the final demand of downstream industries, principally electricity generation. It has moderate resource requirements with one tenth of one percent of national land disturbance and one half of one percent of water use. It has nearly one percent of energy use and nearly three percent of greenhouse emissions. In financial terms, exports outweigh imports twenty fold.

Strategic Overview

The spider diagram highlights two important sets of issues for the black coal mining sector. The first is the set of outliers for the three social indicators due mainly to the capital intensive nature of coal (and other) mining. The second is an outlier for greenhouse gas emissions due mostly to fugitive emissions of methane from coal seams. It is now possible to extract and use methane for power generation ahead of or during mining operations, and in combination with waste coal. Downstream issues for coal mining focus mainly on the greenhouse emissions from its end use combustion. Large investments in clean coal technologies and geo-sequestration are underway.

TBL Account #1

The financial indicator of operating surplus is 60% above average and composed of a direct effect of 83%, and 1% contributions from railway freight, services to mining, electricity generation and banking. The social indicator of employment generation is 65% below average and discussed in more detail below. The environmental indicator of greenhouse emissions is two and one quarter times the average and composed of a direct effect of 85%, with contributions from electricity generation (5%) and railway freight (2%). Most of the emissions are due to methane leakage from coal seams as well as from waste coal oxidation. The industry is well advanced in capturing fugitive methane as an energy source with commercial power plants installed that use methane extracted before and during mining, as well as processes to utilise waste coal onsite for mine operation. Advanced concepts offer the possibility of using CO_2 from nearby thermal power plants to lodge and sequester in the coal matrix, thereby dislodging methane for use by gas turbines.

TBL Accounts #2 and #3

The second TBL account shows an export propensity more than five times the average, an income indicator 50% below average, and water use 65% below average. The third TBL account shows import penetration 60% below average, government revenue 50% below average, and land disturbance 95% below average.

Structural Path Analysis and Linkages

The structural path analysis for the social indicators shows that coal mining, like many primary mining commodities, has a large direct effect (average of 45% across the indicators) and moderate indirect contributions from supplying sectors such as railway freight (8%), services to mining (3%), wholesale trade (3%), banking (3%), community services (2%) and road transport (2%). The coal sector's competitive advantage in export terms is based primarily on the location of high grade coal deposits, linked by relatively short rail distances to large bulk loading terminals at ports. While coal prices are currently higher than normal due to demand from China and an upturn in the world's economic cycle, price for hard coking coal has averaged A$75/tonne for the last five years while steaming coal has averaged $A50/tonne. An industry view would hold that substantial changes to the employment structure of the industry would simply price it out of what is a buyer's market in most years. An employee's view would note the importance of the industry to a number of mining regions, and the difficulties that ensue when further productivity gains are exacted.

The sector's stimulus to its upstream suppliers is 40% below average, and impacts on railway freight, property services, wholesale trade, and services to mining. The linkages to downstream industries are 45% below average, as much of the production effect is dissipated by exports. Nevertheless there are significant linkages to electricity generation and basic iron and steel.

Future Trends in Sector

The base case scenario of the *Future Dilemmas* study anticipates a tripling of raw coal production by 2050 to 1.2 billion tonnes per year, on the assumption that export markets continue to expand. Recent ABARE and COAG studies project a 25% and 100% expansion respectively by 2020. One major coal producer is now investing in major electricity generation infrastructure in Europe to 'lock in' the demand for steaming coal, and maintain value for its mining product. Many industry experts, having seen the booms and busts of diversification, are cautious about such moves.

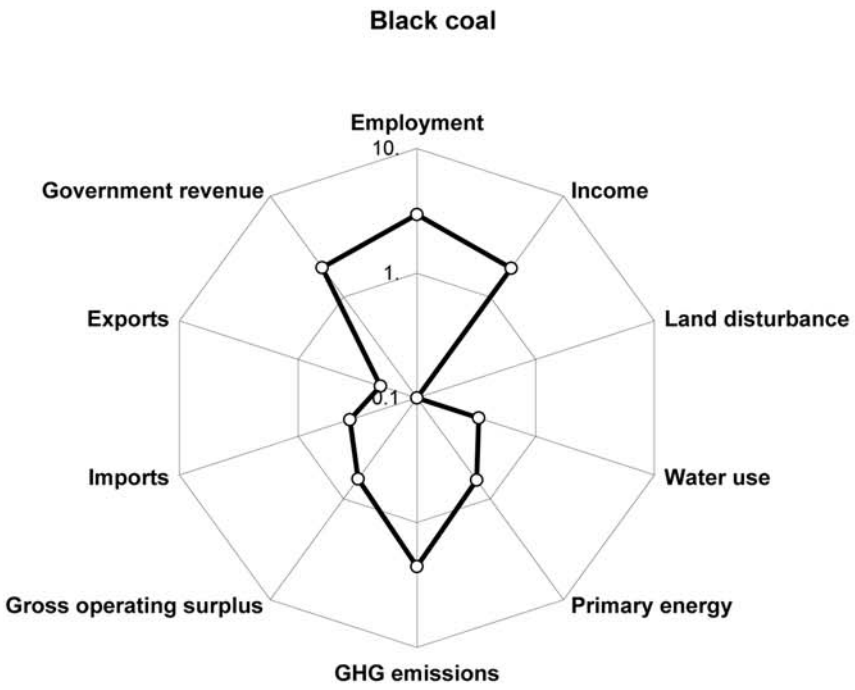
Innovation and Technical Opportunities

For coal to prosper in the long term, the end use must change from a cheap bulk fuel input with end-of-pipe pollution treatments, to becoming the nucleus of integrated industrial ecology complexes.

Sector **Black coal** **(BI)**

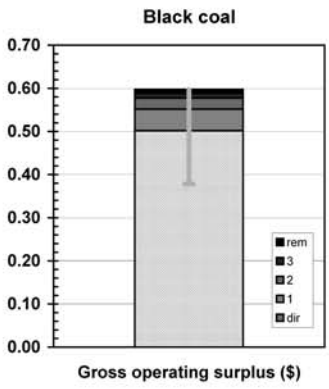
Black coal (all types incl briquettes)

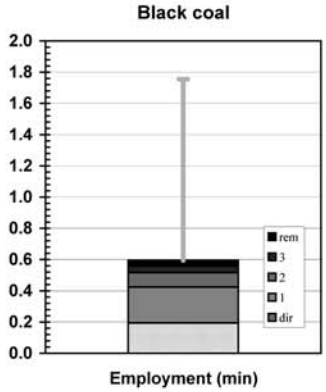
Spider diagram

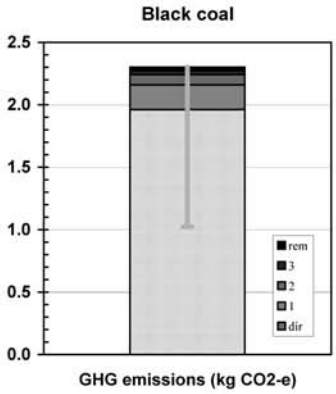


Bar graphs

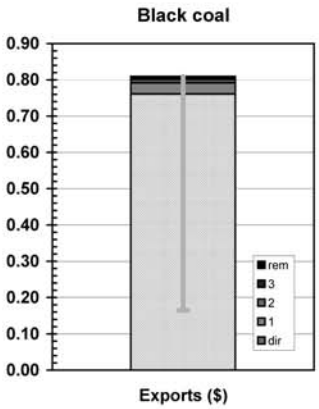
Account #1

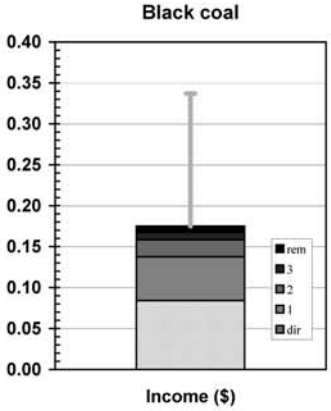


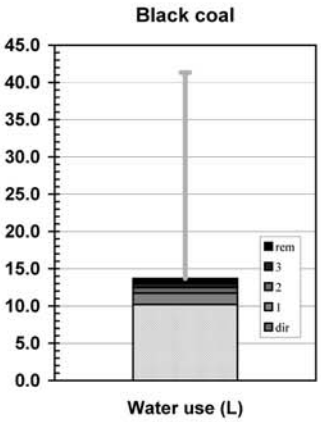




Account #2







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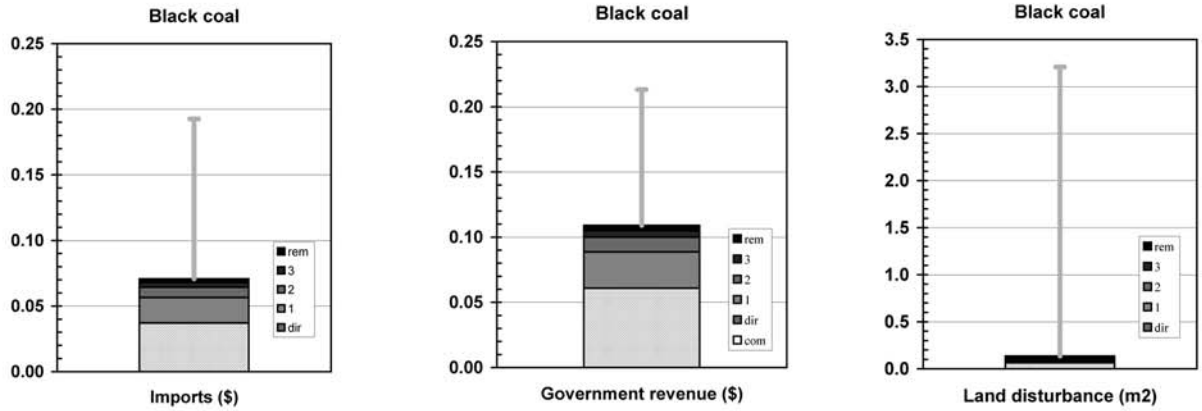


National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 0.2	(0.00% of total)	($m 0.2 domestically produced)
Government final consumption	$m 0.0		
Gross fixed capital expenditure	$m 0.0		
Net changes in stocks	-$m 320.5	-(18.13% of total)	
Sectoral GNE	**-$m 320.3**	**(0.07% of GNE)**	
Exports	$m 6,861.5	(8.23% of total)	($m 6,861.5 domestically produced)
Final demand	**$m 6,541.3**	**(1.21% of GNT)**	**($m 6,543.0 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 757.5	(0.44% of total)	
Gross operating surplus	$m 4,521.9	(2.36% of total)	
Taxes less subsidies	$m 549.0	(0.64% of total)	
Sectoral GDP*	**$m 5,828.4**	**(1.30% of GDP)**	
Imports	$m 333.6	(0.34% of total)	
Primary inputs	**$m 6,162.0**	**(1.13% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 4,521.9	(2.36%)	$m 3,441.2	(1.79%)	$m 4,098.9	(2.14%)
Exports ($m)	$m 6,861.5	(8.23%)	$m 5,221.6	(6.26%)	$m 5,557.0	(6.67%)
Imports ($m)	$m 333.6	(0.34%)	$m 253.9	(0.26%)	$m 485.8	(0.50%)
Employment (e-y)	13,980 e-y	(0.20%)	10,639 e-y	(0.15%)	32,656 e-y	(0.46%)
Income ($m)*	$m 757.5	(0.44%)	$m 576.5	(0.34%)	$m 1,201.7	(0.70%)
Government revenue ($m)†	$m 549.0	(0.51%)	$m 417.8	(0.39%)	$m 748.1	(0.69%)
GHG emissions (kt CO_2-e)	17,683 kt	(3.41%)	13,457 kt	(2.59%)	15,794 kt	(3.05%)
Water use (ML)	91,768 ML	(0.44%)	69,835 ML	(0.33%)	93,965 ML	(0.45%)
Land disturbance (kha)	58 kha	(0.04%)	44 kha	(0.03%)	94 kha	(0.06%)
Primary energy (TJ)	13,817 TJ	(0.36%)	10,515 TJ	(0.27%)	34,185 TJ	(0.88%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.50	0.60	0.38
Exports ($)	0.76	0.81	0.16
Imports ($)	0.04	0.07	0.19
Employment (min)	0.19	0.59	1.75
Income ($)	0.08	0.18	0.34
Government revenue ($)	0.06	0.11	0.21
GHG emissions (kg CO_2-e)	1.96	2.30	1.02
Water use (L)	10.18	13.69	41.32
Land disturbance (m^2)	0.06	0.14	3.21
Primary energy (MJ)	1.53	4.98	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Bl	0.501	(0; 84.%)	Bl	0.193	(0; 33.%)	Bl	1.96	(0; 85.%)
Rf Bl	0.00745	(1; 1.2%)	Rf Bl	0.0595	(1; 10.%)	El Bl	0.121	(1; 5.3%)
Mn Bl	0.00581	(1; 0.97%)	Cs Bl	0.0225	(1; 3.8%)	El Rf Bl	0.0217	(2; 0.94%)
El Bl	0.00489	(1; 0.82%)	Wt Bl	0.021	(1; 3.5%)	Rf Bl	0.0216	(1; 0.94%)
Bk Bl	0.00445	(1; 0.75%)	Bk Bl	0.0177	(1; 3.%)	Fo Bl	0.00956	(1; 0.42%)
Wt Bl	0.00292	(1; 0.49%)	Mn Bl	0.0122	(1; 2.1%)	Is Bl	0.00412	(1; 0.18%)
St Bl	0.00236	(1; 0.4%)	Rd Bl	0.00857	(1; 1.4%)	Bl El Bl	0.00305	(2; 0.13%)
Pd Bl	0.00184	(1; 0.31%)	Ma Bl	0.00744	(1; 1.3%)	Wt Bl	0.00291	(1; 0.13%)
Sf Bk Bl	0.00156	(2; 0.26%)	Rh Bl	0.00702	(1; 1.2%)	Oi Fo Bl	0.00288	(2; 0.13%)
Rd Bl	0.00146	(1; 0.24%)	Ts Mn Bl	0.00582	(2; 0.98%)	El Cs Bl	0.00272	(2; 0.12%)
Sf Bl	0.00143	(1; 0.24%)	El Bl	0.00543	(1; 0.91%)	Ch Bl	0.0027	(1; 0.12%)
Oi Fo Bl	0.00136	(2; 0.23%)	Eq Bl	0.00528	(1; 0.89%)	Hw Bl	0.00241	(1; 0.1%)
Ts Mn Bl	0.00129	(2; 0.22%)	Os Bl	0.00522	(1; 0.88%)	Fr Hw Bl	0.00235	(2; 0.1%)
Rh Bl	0.00115	(1; 0.19%)	Gv Bl	0.00505	(1; 0.85%)	Rd Bl	0.00231	(1; 0.1%)
Fn Bl	0.000968	(1; 0.16%)	Pd Bl	0.00441	(1; 0.74%)	Pc Bl	0.00216	(1; 0.094%)
Cm Bl	0.000916	(1; 0.15%)	Fn Bl	0.00387	(1; 0.65%)	Is Ma Bl	0.00204	(2; 0.089%)
El Rf Bl	0.000877	(2; 0.15%)	St Bl	0.00386	(1; 0.65%)	At Bl	0.00133	(1; 0.058%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Bl	0.761	(0; 94.%)	Bl	0.084	(0; 48.%)	Bl	10.2	(0; 74.%)
Rf Bl	0.0122	(1; 1.5%)	Rf Bl	0.0167	(1; 9.5%)	El Bl	0.668	(1; 4.9%)
Wt Bl	0.00239	(1; 0.29%)	Wt Bl	0.00451	(1; 2.6%)	Mn Bl	0.387	(1; 2.8%)
Bl El Bl	0.00118	(2; 0.15%)	Bk Bl	0.00436	(1; 2.5%)	Wa Bl	0.128	(1; 0.93%)
Ma Bl	0.00109	(1; 0.13%)	Mn Bl	0.0041	(1; 2.3%)	El Rf Bl	0.12	(2; 0.88%)
Eq Bl	0.000941	(1; 0.12%)	Cs Bl	0.00269	(1; 1.5%)	Rf Bl	0.0649	(1; 0.47%)
Oi Fo Bl	0.000929	(2; 0.11%)	Pd Bl	0.00166	(1; 0.95%)	Wa Cs Bl	0.0568	(2; 0.41%)
Oc Bl	0.000655	(1; 0.081%)	Rd Bl	0.00147	(1; 0.84%)	Wa Pd Bl	0.0502	(2; 0.37%)
St Bl	0.000586	(1; 0.072%)	El Bl	0.00147	(1; 0.84%)	Wa El Bl	0.0387	(2; 0.28%)
Pc Bl	0.000511	(1; 0.063%)	Os Bl	0.00146	(1; 0.84%)	Wa Pd Rf Bl	0.0228	(3; 0.17%)
Rd Bl	0.000507	(1; 0.063%)	Ma Bl	0.0014	(1; 0.8%)	Sg Bl	0.0208	(1; 0.15%)
At Bl	0.000423	(1; 0.052%)	Ts Mn Bl	0.00136	(2; 0.78%)	Wa Ts Mn Bl	0.0174	(3; 0.13%)
Sg Bl	0.000407	(1; 0.05%)	Gv Bl	0.00127	(1; 0.72%)	Sm Rf Bl	0.0169	(2; 0.12%)
Fo Bl	0.000388	(1; 0.048%)	In Bl	0.00102	(1; 0.58%)	Bl El Bl	0.0158	(2; 0.12%)
Is Bl	0.000365	(1; 0.045%)	St Bl	0.000985	(1; 0.56%)	Wa Ms Bl	0.0155	(2; 0.11%)
Bk Bl	0.000347	(1; 0.043%)	Eq Bl	0.000932	(1; 0.53%)	Ws Ho Bl	0.0155	(2; 0.11%)
Rw Rf Bl	0.000344	(2; 0.042%)	Rh Bl	0.000767	(1; 0.44%)	El Cs Bl	0.0151	(2; 0.11%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Bl	0.037	(0; 52.%)	Bl	0.0609	(0; 56.%)	Bl	0.0638	(0; 47.%)
Fo Bl	0.00313	(1; 4.4%)	Rf Bl	0.00769	(1; 7.1%)	Rf Bl	0.00839	(1; 6.1%)
Mn Bl	0.00266	(1; 3.8%)	Mn Bl	0.00279	(1; 2.6%)	Bc Mp Ho Bl	0.00306	(3; 2.2%)
Rf Bl	0.00192	(1; 2.7%)	Bk Bl	0.00241	(1; 2.2%)	Wo Cs Bl	0.0023	(2; 1.7%)
Ma Bl	0.00129	(1; 1.8%)	Wt Bl	0.00211	(1; 1.9%)	El Bl	0.00195	(1; 1.4%)
Pc Bl	0.00109	(1; 1.5%)	In Bl	0.00109	(1; 1.%)	Wo Tx Bl	0.00157	(2; 1.2%)
Oc Bl	0.00101	(1; 1.4%)	Pd Bl	0.00109	(1; 1.%)	Bc Mp Cs Bl	0.00145	(3; 1.1%)
Cs Bl	0.000686	(1; 0.97%)	Rd Bl	0.00105	(1; 0.96%)	Hw Bl	0.00124	(1; 0.91%)
Wt Bl	0.000679	(1; 0.96%)	El Bl	0.000917	(1; 0.84%)	Bc Mp Ch Bl	0.00107	(3; 0.78%)
Eq Bl	0.000622	(1; 0.88%)	Cs Bl	0.00078	(1; 0.72%)	Fr Hw Bl	0.000756	(2; 0.55%)
Rh Bl	0.000592	(1; 0.84%)	Os Bl	0.000679	(1; 0.62%)	Wo Tx Wt Bl	0.000749	(3; 0.55%)
Rw Rf Bl	0.000533	(2; 0.75%)	Ma Bl	0.000673	(1; 0.62%)	Hw Rf Bl	0.000654	(2; 0.48%)
Bk Bl	0.000431	(1; 0.61%)	Ts Mn Bl	0.000671	(2; 0.62%)	Bc Mp Ho Bk I	0.000645	(4; 0.47%)
Ru Bl	0.000412	(1; 0.58%)	St Bl	0.000526	(1; 0.48%)	Bc Mp Ho Mn	0.000611	(4; 0.45%)
Ts Mn Bl	0.000371	(2; 0.52%)	Pd Rf Bl	0.000492	(2; 0.45%)	Wo Tx Ru Bl	0.000579	(3; 0.42%)
Rd Bl	0.000369	(1; 0.52%)	Eq Bl	0.000462	(1; 0.42%)	Bc Mp Oc Bl	0.00055	(3; 0.4%)
El Bl	0.000339	(1; 0.48%)	Gv Bl	0.000442	(1; 0.41%)	Bc Ch Bl	0.000539	(2; 0.39%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.561 ±0.008	(±1.5%)
Downstream	0.533 ±0.020	(±3.7%)

Sector 12000011: Crude Oil (Oi)

Crude oil including condensate

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 30% above average, while water use and land disturbance are 85% and 95% below average respectively. The social indicators show that employment generation, income and government revenue are 70%, 50% and 50% below average respectively. The financial indicators show an operating surplus 50% above average, export propensity more than two times the average, and import penetration 65% below average. Locating several ‘Bass Strait‘ sized oil fields by 2010 will be central to constraining the anticipated decline in domestic oil self sufficiency.

Sector Description

Current annual domestic production of crude oil is 26 billion litres and condensate is 7 billion litres, giving a total of 33 billion litres (25 million tonnes, or 210 million barrels). This domestic production compares with a total petroleum product use of 50 billion litres yearly, giving a domestic self sufficiency of 66%, which is expected to decrease to 40% by the year 2010. Oil production comes from between 300 and 400 production wells, two thirds of which are offshore. Production processes release 300 kg of greenhouse gas equivalents per tonne of product produced, and this is due to fuel gas (48%), flaring (17%), diesel (3%) and venting and fugitive emissions (32%). While Australia has large gas resources, current economic demonstrated resources for oil and condensate are 208 million tonnes or 9 000 petajoules, while sub-economic and inferred resources add another 245 million tonnes or 10 000 petajoules. If all oil consumed were produced domestically, there would be only 12 years of oil cover at current rates of consumption. In constant dollar terms, it has increased eightfold over the last 30 years, and turnover is around $10 billion.

Place of Industry in the Economy

The oil extraction sector ranks 32nd out of 135 sectors in terms of value adding in the economy and contributes 0.68% of GDP in this analysis. It is similar in value adding to the printing and stationery, and repairs to household and business equipment sectors. It is a small employer with 2 000 employment years directly embodied in the sector’s final demand, and 5 000 employment years in the sector’s upstream suppliers giving a total of 7 000 employment years. In addition, it contributes 5 000 employment years to the final demand of downstream industries such as automotive petrol, diesel, petroleum products, air transport, and kerosene. It has low requirements for water use and land disturbance with less than one tenth of one percent of national totals. Its requirements for energy use and greenhouse emissions are two tenths and three tenths respectively, of one percent of national totals. In financial terms, exports outweigh imports by a ratio of 8:1 in this analysis, but that ratio may have lessened with the declining domestic oil availability.

Strategic Overview

The spider diagram portrays a sector with excellent financial and environmental indicators (apart from greenhouse emissions) and three outliers for the social indicators, common with most of the primary mining sectors. Apart from water, oil is probably the most critical fluid for any modern economy and there are many looming issues, the most problematic of which are dealing with the oil trade balance beyond 2010, and developing the transitional routes to domestically produced alternative transport fuels. Obvious downstream issues relate to air pollutants and greenhouse emissions when oil products are combusted in freight and transport vehicles.

TBL Account #1

The financial indicator of operating surplus is 50% above average with a direct effect of 83% of total, and 1% contributions from services to mining, railway freight, wholesale trade, and property services. The social indicator of employment is 70% below average and is discussed in more detail below. The environmental indicator of greenhouse emissions is 30% above average and composed of a direct sector effect of 76%, and contributions from electricity production (9%), railway freight (3%) and diesel refining (1%). Industry sources report an active engagement in reducing greenhouse emissions from oil extraction but there is a limit to what is physically possible. Industry data for the period 1990-2002 report remarkably consistent greenhouse emissions that vary from 310-360 kg per tonne of product. While consumption of fuel can be improved with efficient engines and better management, there are circumstances where gas is flared for safety, and where exploration activities vent emissions in drilling with little production results. At major centralised production facilities, it is possible to consider injecting CO_2 back into oil reservoirs to improve oil recovery.

TBL Accounts #2 and #3

The second TBL account shows an export propensity that is more than two times the average, income that is 50% below average, and water use that is 85% below average. The third TBL account reveals an import penetration 65% below average, government revenue (see below) 50% below average and land disturbance 95% below average.

Structural Path Analysis and Linkages

The social indicators of employment generation and income are below average. The structural path analysis shows that the direct sector effects are 33% and 48% respectively. Given the absence of other major contributions, any improvement may be a sector issue. However lower than average employment and income multipliers are typical of capital intensive industries. In addition consumer prices paid for the final product may not reflect the full societal and environmental implications of the integrated petroleum products chain. The government revenue indicator may be greater than is suggested by this analysis. The key issue is the way in which resource rent payments for oil production, currently about $1 billion per year, are accounted for in the national input-output tables underlying this analysis. The current international convention is that resource rents are not included. These payments made by oil producers before refining, are in addition to the excise tax paid by consumers and reflected in the government revenue indicators of the refined products sectors.

The sector's stimulus to its upstream suppliers is 40% below average and impacts on services to mining, wholesale trade, railway freight and property services. The linkages to downstream industries are 70% stronger than average emphasising the importance of oil to the function of the economy. The linkages are strongest to downstream products such as petrol, diesel, and kerosene.

Future Trends in Sector

The base case scenario of the *Future Dilemmas* study shows a plateauing of domestic oil production out to 2010 and then a steady decline so that production at 2050 is about one sixth of current levels, while requirements have increased by 60%. The domestic self sufficiency declines from 66% currently to 5% by 2050. The possibility of such challenging oil deficits is causing policy responses such as a 150% tax deductibility for petroleum exploration, and project development for a range of gas-to-liquid, coal-to-liquid, sugar-to-ethanol, and biomass-to-methanol substitutes for oil fuels.

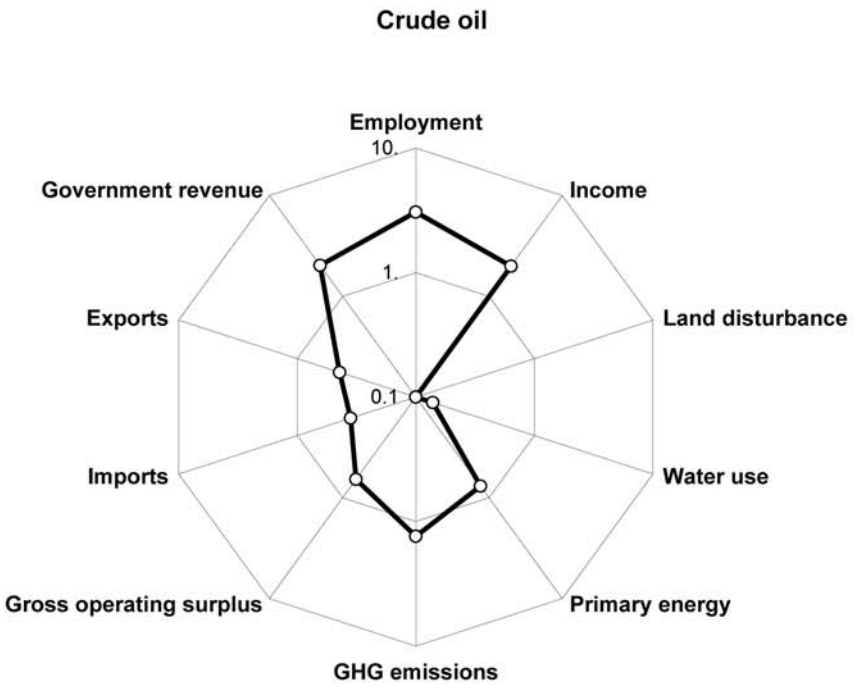
Innovation and Technical Opportunities

At a macro level in 25-50 year time frames, there seems little alternative but to begin the transition from oil products to new fuels, and end use devices and machines that are more energy efficient.

Sector **Crude oil** **(Oi)**

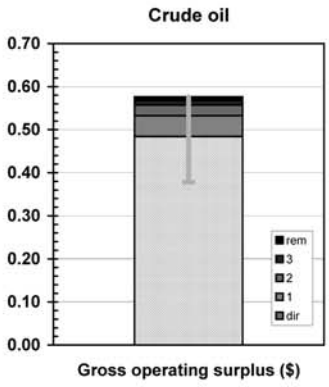
Crude oil (incl condensate)

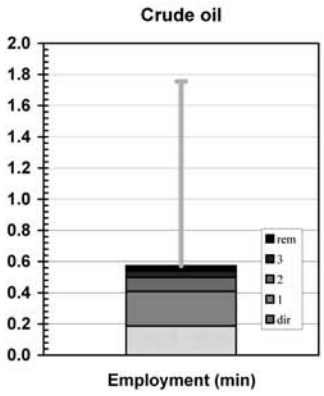
Spider diagram

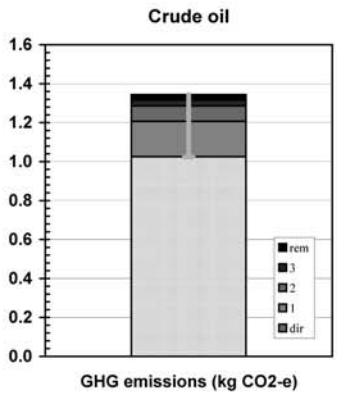


Bar graphs

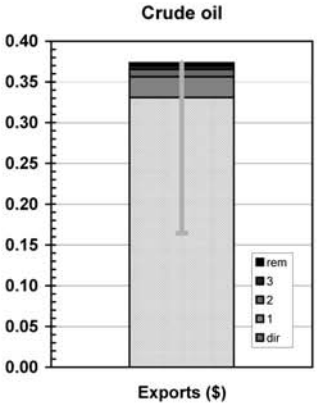
Account #1

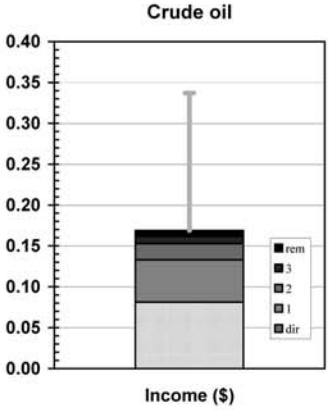


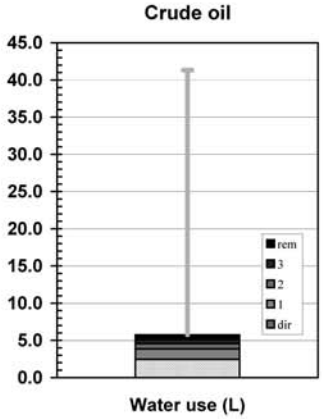




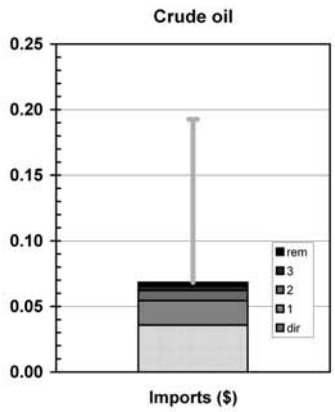
Account #2

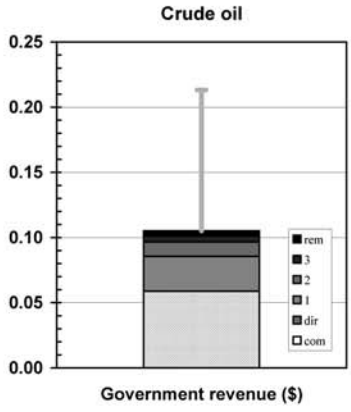


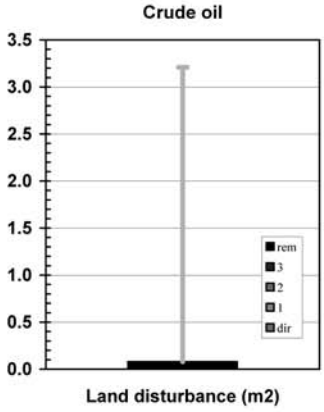




Account #3







National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 0.0		
Government final consumption	$m 0.0		
Gross fixed capital expenditure	$m 0.0		
Net changes in stocks	-$m 637.0	-(36.04% of total)	
Sectoral GNE	**-$m 637.0**	**(0.14% of GNE)**	
Exports	$m 1,620.0	(1.94% of total)	($m 1,620.0 domestically produced)
Final demand	**$m 983.0**	**(0.18% of GNT)**	**($m 1,283.6 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 397.3	(0.23% of total)	
Gross operating surplus	$m 2,371.6	(1.24% of total)	
Taxes less subsidies	$m 287.9	(0.34% of total)	
Sectoral GDP*	**$m 3,056.8**	**(0.68% of GDP)**	
Imports	$m 175.0	(0.18% of total)	
Primary inputs	**$m 3,231.7**	**(0.59% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 2,371.6	(1.24%)	$m 784.4	(0.41%)	$m 934.0	(0.49%)
Exports ($m)	$m 1,620.0	(1.94%)	$m 535.8	(0.64%)	$m 605.1	(0.73%)
Imports ($m)	$m 175.0	(0.18%)	$m 57.9	(0.06%)	$m 110.7	(0.11%)
Employment (e-y)	7,332 e-y	(0.10%)	2,425 e-y	(0.03%)	7,441 e-y	(0.10%)
Income ($m)*	$m 397.3	(0.23%)	$m 131.4	(0.08%)	$m 273.8	(0.16%)
Government revenue ($m)†	$m 287.9	(0.27%)	$m 95.2	(0.09%)	$m 170.5	(0.16%)
GHG emissions (kt CO_2-e)	5,022 kt	(0.97%)	1,661 kt	(0.32%)	2,178 kt	(0.42%)
Water use (ML)	11,975 ML	(0.06%)	3,960 ML	(0.02%)	9,330 ML	(0.04%)
Land disturbance (kha)	4 kha	(0.00%)	1 kha	(0.00%)	13 kha	(0.01%)
Primary energy (TJ)	12,406 TJ	(0.32%)	4,103 TJ	(0.11%)	9,513 TJ	(0.25%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.48	0.58	0.38
Exports ($)	0.33	0.37	0.16
Imports ($)	0.04	0.07	0.19
Employment (min)	0.19	0.57	1.75
Income ($)	0.08	0.17	0.34
Government revenue ($)	0.06	0.11	0.21
GHG emissions (kg CO_2-e)	1.03	1.34	1.02
Water use (L)	2.44	5.76	41.32
Land disturbance (m^2)	0.01	0.08	3.21
Primary energy (MJ)	2.53	5.87	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Oi	0.484	(0; 84.%)	Oi	0.187	(0; 33.%)	Oi	1.03	(0; 76.%)
Rf Oi	0.00719	(1; 1.2%)	Rf Oi	0.0575	(1; 10.%)	El Oi	0.117	(1; 8.7%)
Mn Oi	0.00561	(1; 0.97%)	Cs Oi	0.0217	(1; 3.8%)	El Rf Oi	0.021	(2; 1.6%)
El Oi	0.00472	(1; 0.82%)	Wt Oi	0.0203	(1; 3.5%)	Rf Oi	0.0209	(1; 1.6%)
Bk Oi	0.0043	(1; 0.75%)	Bk Oi	0.0171	(1; 3.%)	Fo Oi	0.00923	(1; 0.69%)
Wt Oi	0.00282	(1; 0.49%)	Mn Oi	0.0118	(1; 2.1%)	Is Oi	0.00398	(1; 0.3%)
St Oi	0.00228	(1; 0.4%)	Rd Oi	0.00827	(1; 1.4%)	Bl El Oi	0.00294	(2; 0.22%)
Pd Oi	0.00177	(1; 0.31%)	Ma Oi	0.00718	(1; 1.3%)	Wt Oi	0.00281	(1; 0.21%)
Sf Bk Oi	0.0015	(2; 0.26%)	Rh Oi	0.00677	(1; 1.2%)	Oi Fo Oi	0.00278	(2; 0.21%)
Rd Oi	0.00141	(1; 0.24%)	Ts Mn Oi	0.00562	(2; 0.98%)	El Cs Oi	0.00263	(2; 0.2%)
Sf Oi	0.00138	(1; 0.24%)	El Oi	0.00525	(1; 0.92%)	Ch Oi	0.0026	(1; 0.19%)
Oi Fo Oi	0.00131	(2; 0.23%)	Eq Oi	0.0051	(1; 0.89%)	Hw Oi	0.00232	(1; 0.17%)
Ts Mn Oi	0.00125	(2; 0.22%)	Os Oi	0.00504	(1; 0.88%)	Fr Hw Oi	0.00227	(2; 0.17%)
Rh Oi	0.00111	(1; 0.19%)	Gv Oi	0.00487	(1; 0.85%)	Rd Oi	0.00223	(1; 0.17%)
Fn Oi	0.000935	(1; 0.16%)	Pd Oi	0.00426	(1; 0.74%)	Pc Oi	0.00209	(1; 0.16%)
Cm Oi	0.000884	(1; 0.15%)	Fn Oi	0.00374	(1; 0.65%)	Is Ma Oi	0.00197	(2; 0.15%)
El Rf Oi	0.000847	(2; 0.15%)	St Oi	0.00372	(1; 0.65%)	At Oi	0.00128	(1; 0.096%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Oi	0.331	(0; 89.%)	Oi	0.0811	(0; 48.%)	Oi	2.44	(0; 42.%)
Rf Oi	0.0118	(1; 3.2%)	Rf Oi	0.0161	(1; 9.5%)	El Oi	0.645	(1; 11.%)
Wt Oi	0.00231	(1; 0.62%)	Wt Oi	0.00436	(1; 2.6%)	Mn Oi	0.374	(1; 6.5%)
Bl El Oi	0.00114	(2; 0.31%)	Bk Oi	0.00421	(1; 2.5%)	Wa Oi	0.123	(1; 2.1%)
Ma Oi	0.00105	(1; 0.28%)	Mn Oi	0.00396	(1; 2.3%)	El Rf Oi	0.116	(2; 2.%)
Eq Oi	0.000909	(1; 0.24%)	Cs Oi	0.00259	(1; 1.5%)	Rf Oi	0.0627	(1; 1.1%)
Oi Fo Oi	0.000897	(2; 0.24%)	Pd Oi	0.0016	(1; 0.95%)	Wa Cs Oi	0.0548	(2; 0.95%)
Oc Oi	0.000633	(1; 0.17%)	Rd Oi	0.00142	(1; 0.84%)	Wa Pd Oi	0.0485	(2; 0.84%)
St Oi	0.000565	(1; 0.15%)	El Oi	0.00142	(1; 0.84%)	Wa El Oi	0.0373	(2; 0.65%)
Pc Oi	0.000493	(1; 0.13%)	Os Oi	0.00141	(1; 0.84%)	Wa Pd Rf Oi	0.022	(3; 0.38%)
Rd Oi	0.00049	(1; 0.13%)	Ma Oi	0.00135	(1; 0.8%)	Sg Oi	0.02	(1; 0.35%)
At Oi	0.000409	(1; 0.11%)	Ts Mn Oi	0.00132	(2; 0.78%)	Wa Ts Mn Oi	0.0168	(3; 0.29%)
Sg Oi	0.000393	(1; 0.11%)	Gv Oi	0.00122	(1; 0.72%)	Sm Rf Oi	0.0163	(2; 0.28%)
Fo Oi	0.000375	(1; 0.1%)	In Oi	0.000982	(1; 0.58%)	Bl El Oi	0.0153	(2; 0.27%)
Is Oi	0.000352	(1; 0.094%)	St Oi	0.00095	(1; 0.56%)	Wa Ms Oi	0.0149	(2; 0.26%)
Bk Oi	0.000335	(1; 0.09%)	Eq Oi	0.000899	(1; 0.53%)	Ws Ho Oi	0.0149	(2; 0.26%)
Rw Rf Oi	0.000332	(2; 0.089%)	Rh Oi	0.000741	(1; 0.44%)	El Cs Oi	0.0145	(2; 0.25%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Oi	0.0357	(0; 52.%)	Oi	0.0588	(0; 56.%)	Oi	0.00845	(0; 11.%)
Fo Oi	0.00302	(1; 4.4%)	Rf Oi	0.00742	(1; 7.1%)	Rf Oi	0.0081	(1; 10.%)
Mn Oi	0.00257	(1; 3.8%)	Mn Oi	0.00269	(1; 2.6%)	Bc Mp Ho Oi	0.00295	(3; 3.8%)
Rf Oi	0.00186	(1; 2.7%)	Bk Oi	0.00233	(1; 2.2%)	Wo Cs Oi	0.00222	(2; 2.8%)
Ma Oi	0.00125	(1; 1.8%)	Wt Oi	0.00204	(1; 1.9%)	El Oi	0.00188	(1; 2.4%)
Pc Oi	0.00105	(1; 1.5%)	In Oi	0.00106	(1; 1.%)	Wo Tx Oi	0.00152	(2; 1.9%)
Oc Oi	0.000978	(1; 1.4%)	Pd Oi	0.00105	(1; 1.%)	Bc Mp Cs Oi	0.0014	(3; 1.8%)
Cs Oi	0.000662	(1; 0.97%)	Rd Oi	0.00101	(1; 0.96%)	Hw Oi	0.0012	(1; 1.5%)
Wt Oi	0.000655	(1; 0.96%)	El Oi	0.000885	(1; 0.84%)	Bc Mp Ch Oi	0.00103	(3; 1.3%)
Eq Oi	0.000601	(1; 0.88%)	Cs Oi	0.000753	(1; 0.72%)	Fr Hw Oi	0.00073	(2; 0.93%)
Rh Oi	0.000571	(1; 0.84%)	Os Oi	0.000655	(1; 0.62%)	Wo Tx Wt Oi	0.000723	(3; 0.92%)
Rw Rf Oi	0.000515	(2; 0.75%)	Ma Oi	0.00065	(1; 0.62%)	Hw Rf Oi	0.000632	(2; 0.81%)
Bk Oi	0.000416	(1; 0.61%)	Ts Mn Oi	0.000648	(2; 0.62%)	Bc Mp Ho Bk (	0.000623	(4; 0.79%)
Ru Oi	0.000397	(1; 0.58%)	St Oi	0.000507	(1; 0.48%)	Bc Mp Ho Mn	0.00059	(4; 0.75%)
Ts Mn Oi	0.000358	(2; 0.52%)	Pd Rf Oi	0.000475	(2; 0.45%)	Wo Tx Ru Oi	0.000559	(3; 0.71%)
Rd Oi	0.000357	(1; 0.52%)	Eq Oi	0.000446	(1; 0.42%)	Bc Mp Oc Oi	0.000531	(3; 0.68%)
El Oi	0.000327	(1; 0.48%)	Gv Oi	0.000426	(1; 0.41%)	Bc Ch Oi	0.00052	(2; 0.66%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.541 ±0.008	(±1.5%)
Downstream	1.669 ±0.037	(±2.2%)

Sector 12000024: Natural Gas (Ng)

Natural gas in the gaseous state, gas extraction (not distribution)

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is nearly three times the average, while water use and land disturbance are respectively 80% and 95% below average. The social indicators of employment generation, income, and government revenue are respectively 65%, 50%, and 50% below average. The financial indicator of operating surplus is 60% above average, while export propensity and import penetration are 75% and 60% below average respectively. With large potential gas resources, the future of the sector should be secure. Depletion of oil reserves may generate production tensions between domestic uses and export demand for LNG. The relatively lower carbon intensity of natural gas may advance it into many new uses if carbon constraints are introduced in the future.

Sector Description

Natural gas mining or extraction in Australia comes from major basins such as the Carnarvon Basin (in north-west Western Australia); the Gippsland Basin (in Bass Strait, off Victoria's south-east coast); and the Cooper/Eromanga Basins (on the borders of South Australia and Queensland). In 2002 production was 1 242 PJ (PJ=10^{15}J; 33 billion cubic meters, or 214 million barrel of oil equivalents) of which 440 PJ was exported in liquefied form, leaving 800 PJ to be used by 3.4 million households and 105 000 commercial and industry customers. Major domestic consumers of gas are manufacturing (36%), electricity generation (25%), mining (17%), and households (14%). The distribution network is contained predominantly in the pipeline transport sector and includes 20 000 km of high pressure pipelines, and 75 000 km of distribution pipes. Australian gas reserves are large (150 000 PJ) and could last more than 100 years at current production levels, but growing liquefied natural gas exports could reduce this potential gas cover to less than 50 years. East coast reserves of gas may decline before 2020. In constant dollar terms, the turnover of the sector has increased sixfold in the last 30 years, and the domestic turnover is currently about $1.5 billion.

Place of Industry in the Economy

The natural gas extraction sector ranks 77th out of 135 sectors in terms of value adding in this economy and contributes 0.20% of GDP in this analysis. It is similar in value adding to the alumina, and bus and tram transport sectors. It is a relatively small employer with less than 2 000 employment years directly and indirectly embodied in final demand. In addition it supplies 2 000 employment years to the final demand of downstream industries such as wholesale trade, electricity generation, accommodation cafes and restaurants, residential building, and alumina refining. It has small resource requirements for water use and land disturbance, with less than one tenth of one percent of national totals. For energy use and greenhouse emissions, its requirements are slightly higher, with respectively one tenth and two tenths of one percent of national totals.

Strategic Overview

The spider diagram portrays the natural gas production sector as having relatively good financial attributes (exports are in the LNG sector), but with outlying indicators for the three social indicators, and the environmental indicators of energy use and greenhouse emissions. The social issues are held in common with most primary mining sectors and are due to the capital intensive nature of production.

TBL Account #1

The financial indicator of operating surplus is 60% above average and composed of a direct effect of 84% and 1% contributions from railway freight, services to mining, electricity production and banking. The social indicator of employment generation is 65% below average and discussed in more detail below. The environmental indicator of greenhouse emissions is nearly three times the average with a direct sector effect of 87%, and contributions from electricity generation (5%), and railway freight (2%). Based on this analysis, the production and transmission of natural gas releases CO_2 equivalent emissions of 12 500 tonnes for each petajoule (10^{15}J) of production, or 300 kg for each tonne of gas delivered. This indicator could be improved in a number of ways with CO_2 stripping and re-injection into oil reservoirs being a primary option at the well head. Improving the physical efficiency of compressors which use natural gas as a fuel to move gas through a high pressure pipeline is a second option, along with reducing compressor and pipeline leakage.

TBL Accounts #2 and #3

The second TBL account reports a low export propensity (not relevant for domestic gas), income that is 50% below average, and water use that is 80% below average. The third TBL account reports an import penetration that is 60% below average, government revenue that is 50% below average and land disturbance that is 95% below average.

Structural Path Analysis and Linkages

In common with many primary mining sectors, the social indicators are all well below average due mainly to the capital intensive nature of equipment, that once built (activity take place mainly in construction and metal fabrication sectors) requires relatively little labour for normal operation. The government revenue indicator is relatively low because of modest resource rents applied to the whole primary mining sector in an effort to retain the competitive position of Australian industry, to ensure that large and long term infrastructure investments are made, and to deliver gas as an industrial input for modest prices. Given these issues, the structural path analysis shows that the direct sector effect averages 45% across the three indicators, and that improvement is not likely given the issues noted above.

The sector's stimulus to its upstream suppliers is 40% below average and impacts on property services, wholesale trade, services to mining, and railway freight. The linkages to downstream industries are 55% greater than average, and suggest that any expansion in the sector must be led by increased activity in sectors such as wholesale trade, electricity generation, accommodation cafes and restaurants, residential building, and alumina refining.

Future Trends in Sector

The base case scenario of the *Future Dilemmas* study anticipates a tripling of production of natural gas in total, and a doubling of domestic requirements by 2050. With optimistic assumptions for new discoveries and steadily expanding exports of LNG, gas imports may be required after 2050 to help meet domestic requirements. Studies by ABARE suggest sufficient resources to meet domestic and export requirements to 2020, but thereafter a need for development of coal seam methane, and pipelines to Papua New Guinea and Timor Gap fields to supply the east coast of Australia.

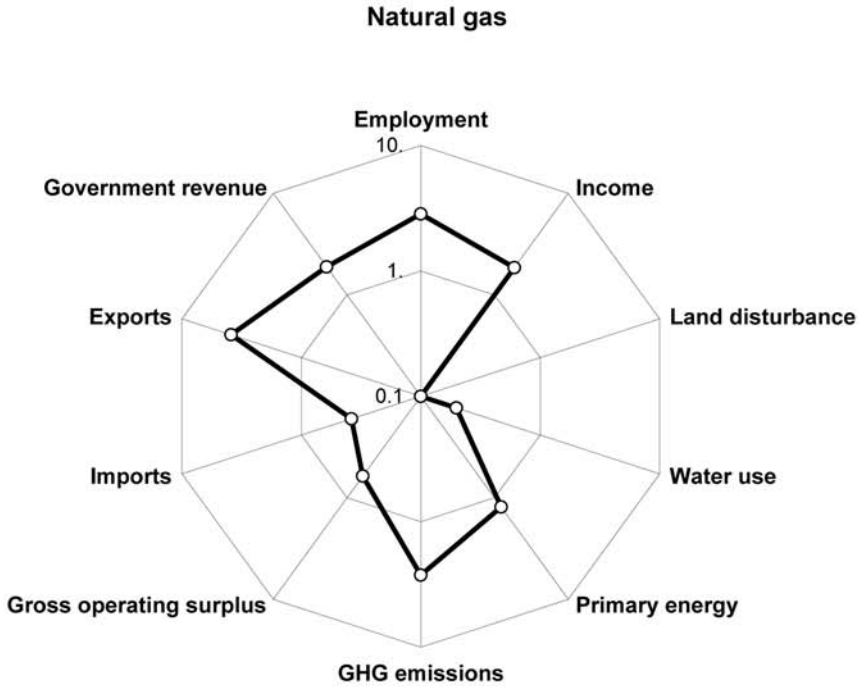
Innovation and Technical Opportunities

Current innovation in drive trains for motor vehicles and distributed electricity generators (micro-turbines, fuel cells in the home etc.) as well as gas-to-liquids conversion and methanol, may provide opportunities for natural gas to capitalise on its relatively lower carbon intensity.

Sector **Natural gas** **(Ng)**

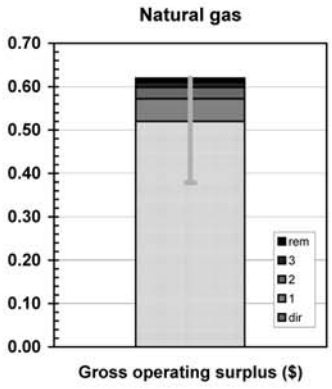
Natural gas (in the gaseous state)

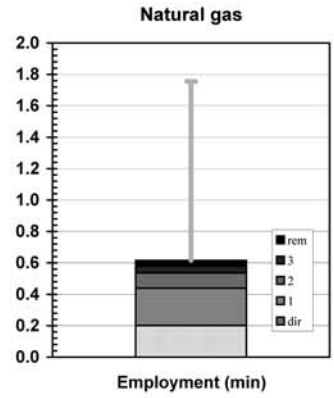
Spider diagram

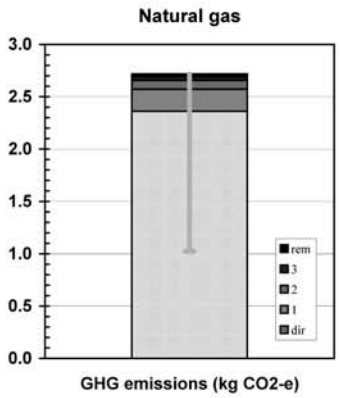


Bar graphs

Account #1







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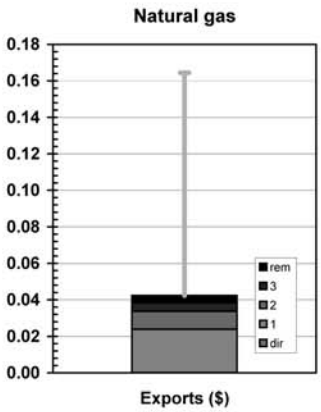

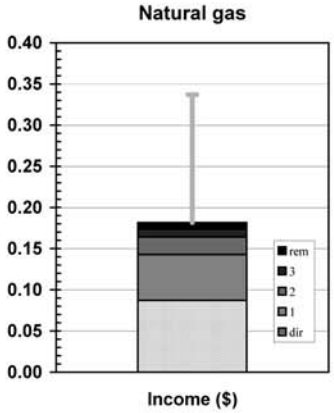

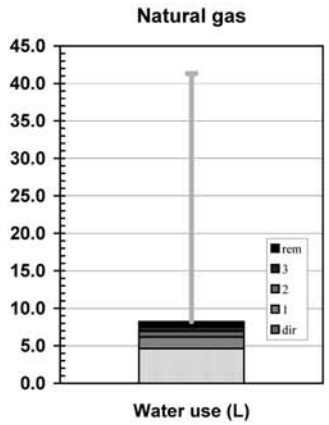

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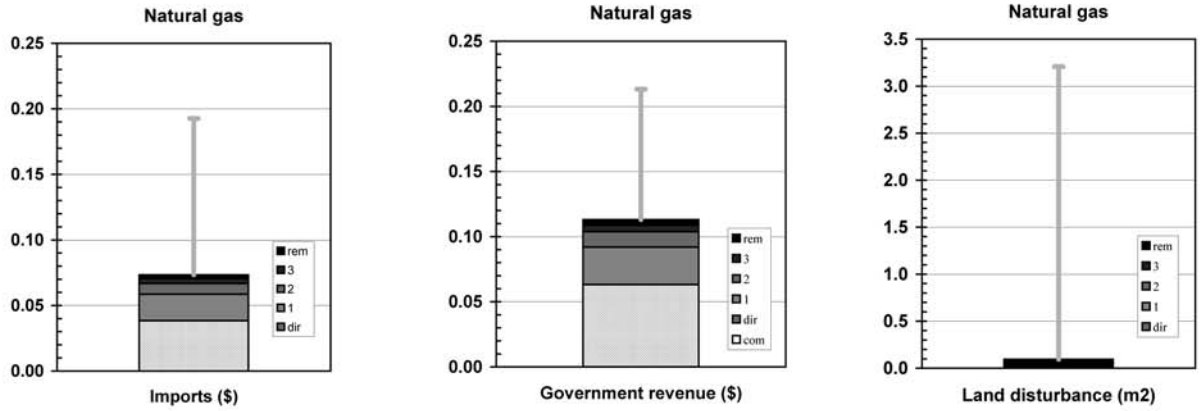


National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 282.6	(0.11% of total)	($m 282.6 domestically produced)
Government final consumption	$m 0.0		
Gross fixed capital expenditure	$m 0.0		
Net changes in stocks	$m 17.8	(1.01% of total)	($m 17.8 domestically produced)
Sectoral GNE	**$m 300.4**	**(0.07% of GNE)**	**($m 300.4 domestically produced)**
Exports	$m 0.0	(0.00% of total)	($m 0.0 domestically produced)
Final demand	**$m 300.4**	**(0.06% of GNT)**	**($m 300.4 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 114.0	(0.07% of total)	
Gross operating surplus	$m 680.6	(0.35% of total)	
Taxes less subsidies	$m 82.6	(0.10% of total)	
Sectoral GDP*	**$m 877.2**	**(0.20% of GDP)**	
Imports	$m 50.2	(0.05% of total)	
Primary inputs	**$m 927.4**	**(0.17% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 680.6	(0.35%)	$m 156.2	(0.08%)	$m 186.1	(0.10%)
Exports ($m)	$m 0.0	(0.00%)	$m 0.0	(0.00%)	$m 12.7	(0.02%)
Imports ($m)	$m 50.2	(0.05%)	$m 11.5	(0.01%)	$m 22.1	(0.02%)
Employment (e-y)	2,104 e-y	(0.03%)	483 e-y	(0.01%)	1,483 e-y	(0.02%)
Income ($m)*	$m 114.0	(0.07%)	$m 26.2	(0.02%)	$m 54.6	(0.03%)
Government revenue ($m)†	$m 82.6	(0.08%)	$m 19.0	(0.02%)	$m 34.0	(0.03%)
GHG emissions (kt CO_2-e)	3,091 kt	(0.60%)	709 kt	(0.14%)	817 kt	(0.16%)
Water use (ML)	6,067 ML	(0.03%)	1,392 ML	(0.01%)	2,469 ML	(0.01%)
Land disturbance (kha)	3 kha	(0.00%)	1 kha	(0.00%)	3 kha	(0.00%)
Primary energy (TJ)	7,584 TJ	(0.20%)	1,740 TJ	(0.04%)	2,829 TJ	(0.07%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.52	0.62	0.38
Exports ($)	0.00	0.04	0.16
Imports ($)	0.04	0.07	0.19
Employment (min)	0.20	0.62	1.75
Income ($)	0.09	0.18	0.34
Government revenue ($)	0.06	0.11	0.21
GHG emissions (kg CO_2-e)	2.36	2.72	1.02
Water use (L)	4.63	8.22	41.32
Land disturbance (m^2)	0.02	0.09	3.21
Primary energy (MJ)	5.79	9.42	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Ng	0.52	(0; 84.%)	Ng	0.201	(0; 33.%)	Ng	2.36	(0; 87.%)
Rf Ng	0.00772	(1; 1.2%)	Rf Ng	0.0617	(1; 10.%)	El Ng	0.125	(1; 4.6%)
Mn Ng	0.00602	(1; 0.97%)	Cs Ng	0.0233	(1; 3.8%)	El Rf Ng	0.0225	(2; 0.83%)
El Ng	0.00507	(1; 0.82%)	Wt Ng	0.0218	(1; 3.5%)	Rf Ng	0.0224	(1; 0.82%)
Bk Ng	0.00462	(1; 0.75%)	Bk Ng	0.0183	(1; 3.%)	Fo Ng	0.00991	(1; 0.36%)
Wt Ng	0.00303	(1; 0.49%)	Mn Ng	0.0127	(1; 2.1%)	Is Ng	0.00427	(1; 0.16%)
St Ng	0.00245	(1; 0.4%)	Rd Ng	0.00888	(1; 1.4%)	Bl El Ng	0.00316	(2; 0.12%)
Pd Ng	0.0019	(1; 0.31%)	Ma Ng	0.00771	(1; 1.3%)	Wt Ng	0.00302	(1; 0.11%)
Sf Bk Ng	0.00161	(2; 0.26%)	Rh Ng	0.00727	(1; 1.2%)	Oi Fo Ng	0.00298	(2; 0.11%)
Rd Ng	0.00151	(1; 0.24%)	Ts Mn Ng	0.00603	(2; 0.98%)	El Cs Ng	0.00282	(2; 0.1%)
Sf Ng	0.00148	(1; 0.24%)	El Ng	0.00563	(1; 0.91%)	Ch Ng	0.0028	(1; 0.1%)
Oi Fo Ng	0.00141	(2; 0.23%)	Eq Ng	0.00547	(1; 0.89%)	Hw Ng	0.00249	(1; 0.092%)
Ts Mn Ng	0.00134	(2; 0.22%)	Os Ng	0.00542	(1; 0.88%)	Fr Hw Ng	0.00244	(2; 0.09%)
Rh Ng	0.00119	(1; 0.19%)	Gv Ng	0.00523	(1; 0.85%)	Rd Ng	0.0024	(1; 0.088%)
Fn Ng	0.001	(1; 0.16%)	Pd Ng	0.00457	(1; 0.74%)	Pc Ng	0.00224	(1; 0.083%)
Cm Ng	0.000949	(1; 0.15%)	Fn Ng	0.00401	(1; 0.65%)	Is Ma Ng	0.00211	(2; 0.078%)
El Rf Ng	0.00091	(2; 0.15%)	St Ng	0.004	(1; 0.65%)	At Ng	0.00138	(1; 0.051%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Rf Ng	0.0127	(1; 30.%)	Ng	0.0871	(0; 48.%)	Ng	4.63	(0; 56.%)
Wt Ng	0.00248	(1; 5.8%)	Rf Ng	0.0173	(1; 9.5%)	El Ng	0.693	(1; 8.4%)
Bl El Ng	0.00123	(2; 2.9%)	Wt Ng	0.00468	(1; 2.6%)	Mn Ng	0.401	(1; 4.9%)
Ma Ng	0.00113	(1; 2.7%)	Bk Ng	0.00452	(1; 2.5%)	Wa Ng	0.133	(1; 1.6%)
Eq Ng	0.000976	(1; 2.3%)	Mn Ng	0.00425	(1; 2.3%)	El Rf Ng	0.124	(2; 1.5%)
Oi Fo Ng	0.000963	(2; 2.3%)	Cs Ng	0.00279	(1; 1.5%)	Rf Ng	0.0673	(1; 0.82%)
Oc Ng	0.000679	(1; 1.6%)	Pd Ng	0.00172	(1; 0.94%)	Wa Cs Ng	0.0589	(2; 0.72%)
St Ng	0.000607	(1; 1.4%)	Rd Ng	0.00153	(1; 0.84%)	Wa Pd Ng	0.052	(2; 0.63%)
Pc Ng	0.00053	(1; 1.3%)	El Ng	0.00152	(1; 0.84%)	Wa El Ng	0.0401	(2; 0.49%)
Rd Ng	0.000526	(1; 1.2%)	Os Ng	0.00152	(1; 0.84%)	Wa Pd Rf Ng	0.0236	(3; 0.29%)
At Ng	0.000439	(1; 1.%)	Ma Ng	0.00145	(1; 0.8%)	Sg Ng	0.0215	(1; 0.26%)
Sg Ng	0.000422	(1; 1.%)	Ts Mn Ng	0.00141	(2; 0.78%)	Wa Ts Mn Ng	0.0181	(3; 0.22%)
Fo Ng	0.000402	(1; 0.95%)	Gv Ng	0.00132	(1; 0.72%)	Sm Rf Ng	0.0175	(2; 0.21%)
Is Ng	0.000378	(1; 0.89%)	In Ng	0.00105	(1; 0.58%)	Bl El Ng	0.0164	(2; 0.2%)
Bk Ng	0.000359	(1; 0.85%)	St Ng	0.00102	(1; 0.56%)	Wa Ms Ng	0.016	(2; 0.19%)
Rw Rf Ng	0.000357	(2; 0.84%)	Eq Ng	0.000966	(1; 0.53%)	Ws Ho Ng	0.016	(2; 0.19%)
Oi Pc Ng	0.000334	(2; 0.79%)	Rh Ng	0.000796	(1; 0.44%)	El Cs Ng	0.0156	(2; 0.19%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Ng	0.0384	(0; 52.%)	Ng	0.0631	(0; 56.%)	Ng	0.0193	(0; 20.%)
Fo Ng	0.00325	(1; 4.4%)	Rf Ng	0.00797	(1; 7.%)	Rf Ng	0.00869	(1; 9.2%)
Mn Ng	0.00276	(1; 3.8%)	Mn Ng	0.00289	(1; 2.6%)	Bc Mp Ho Ng	0.00317	(3; 3.4%)
Rf Ng	0.00199	(1; 2.7%)	Bk Ng	0.0025	(1; 2.2%)	Wo Cs Ng	0.00238	(2; 2.5%)
Ma Ng	0.00134	(1; 1.8%)	Wt Ng	0.00219	(1; 1.9%)	El Ng	0.00202	(1; 2.1%)
Pc Ng	0.00113	(1; 1.5%)	In Ng	0.00113	(1; 1.%)	Wo Tx Ng	0.00163	(2; 1.7%)
Oc Ng	0.00105	(1; 1.4%)	Pd Ng	0.00112	(1; 0.99%)	Bc Mp Cs Ng	0.0015	(3; 1.6%)
Cs Ng	0.000711	(1; 0.97%)	Rd Ng	0.00108	(1; 0.96%)	Hw Ng	0.00129	(1; 1.4%)
Wt Ng	0.000703	(1; 0.96%)	El Ng	0.00095	(1; 0.84%)	Bc Mp Ch Ng	0.00111	(3; 1.2%)
Eq Ng	0.000645	(1; 0.88%)	Cs Ng	0.000809	(1; 0.72%)	Fr Hw Ng	0.000783	(2; 0.83%)
Rh Ng	0.000614	(1; 0.84%)	Os Ng	0.000704	(1; 0.62%)	Wo Tx Wt Ng	0.000776	(3; 0.82%)
Rw Rf Ng	0.000552	(2; 0.75%)	Ma Ng	0.000698	(1; 0.62%)	Hw Rf Ng	0.000678	(2; 0.72%)
Bk Ng	0.000447	(1; 0.61%)	Ts Mn Ng	0.000696	(2; 0.62%)	Bc Mp Ho Bk I	0.000669	(4; 0.71%)
Ru Ng	0.000427	(1; 0.58%)	St Ng	0.000545	(1; 0.48%)	Bc Mp Ho Mn	0.000633	(4; 0.67%)
Ts Mn Ng	0.000384	(2; 0.52%)	Pd Rf Ng	0.00051	(2; 0.45%)	Wo Tx Ru Ng	0.0006	(3; 0.63%)
Rd Ng	0.000383	(1; 0.52%)	Eq Ng	0.000479	(1; 0.42%)	Bc Mp Oc Ng	0.00057	(3; 0.6%)
El Ng	0.000352	(1; 0.48%)	Gv Ng	0.000458	(1; 0.41%)	Bc Ch Ng	0.000559	(2; 0.59%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.582 ±0.009	(±1.5%)
Downstream	1.553 ±0.018	(±1.2%)

Sector 12000027: LNG, LPG (Lg)

Liquefied natural gas, liquefied petroleum gases

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse gas is 55% above average, while water use and land disturbance are 85% and 95% below average respectively. The social indicators show that employment generation, income and government revenue are respectively 65%, 50% and 45% below average respectively. The financial indicators reveal that operating surplus is 60% above average, export propensity is more than four times the average, and import penetration is 70% below average. The LNG sector is a rapidly growing industry backed by strong demand from China and Japan. While proven and inferred gas stocks are large in relation to current domestic consumption, rapid export growth may deplete gas stocks to the possible detriment of the future function and growth potential of the domestic economy.

Sector Description

Australia currently exports nearly 8 million tonnes (10.5 billion cubic metres or 440 PJ) of liquefied natural gas from the North West Shelf off the coast of Western Australia. It produces 4.6 billion litres of liquefied petroleum gas (LPG), consumes 3.9 billion litres, exports 3.2 billion litres and must therefore import approximately 2.5 billion litres. The current LNG exports are supplied from the North West Shelf with three gas trains, large integrated complexes that transform natural gas to a liquid. A new gas train on will take export capacity to 12 million tonnes per year, and another train at Darwin will further expand capacity. Australia has economic demonstrated resources of natural gas of 620 million tonnes (34 000 PJ) giving an economic life of 21 years at current consumption. There are large inferred resources of 2 300 million tonnes (125 000 PJ) which in total give an economic life of 100 years at today's consumption levels, but only 50 years at the consumption (domestic plus export) expected in the year 2020. The liquefaction of natural gas is an energy intensive process consuming about 10% of the feedstock in the process. Process analyses of liquefaction plants suggest that greenhouse emissions vary from 210-800 kg of CO_2 per tonne of gas liquefied and delivered. In constant dollar terms, the turnover of the sector has quadrupled over the last twenty years. Current turnover of the LNG part of the sector is in excess of $3 billion.

Place of Industry in the Economy

The liquefied natural gas and liquefied petroleum gas sector ranks 62nd out of 135 sectors in terms of value adding in the economy, and contributes 0.26% of GDP in this analysis. It is similar in value adding to the clothing manufacturing, and wheat and other grains sectors. It is a small employer with 2 000 employment years directly embodied in the sector's final demand, as well as 4 000 years in the sector's upstream suppliers, giving a total of 6 000 employment years. In addition, the sector supplies 1 000 employment years to the final demand of downstream industries such as alumina, basic chemicals, non-ferrous metal smelting, and basic iron and steel manufacturing. It has moderate resource requirements with less than one tenth of one percent of national water use and land disturbance, and two tenths and four tenths of one percent respectively of national energy use, and greenhouse emissions. In financial terms, exports outweigh imports by a factor of sixteen.

Strategic Overview

The spider diagram reveals strong financial indicators, reasonable environmental indicators and outliers for the three social indicators and greenhouse emissions. Possible downstream issues are greenhouse emissions in the full life cycle of LNG, and gas stock depletion within 40 years.

TBL Account #1

The financial indicator of operating surplus is 60% above average with a direct effect of 84% and small 1% contributions from railway freight, services to mining, electricity generation and banking. The social indicator of employment generation is 65% below average and is discussed in more detail below. The environmental indicator of greenhouse emissions is 55% above average, and composed of a direct effect of 78% and contributions from electricity generation (8%), railway freight (3%), and diesel refining (1%). Improved designs for liquefaction plants can reduce the greenhouse emissions. The original design for liquefaction of gas from the Gorgon Field on the North West Shelf has emissions of 1.2 tonnes of CO_2 per tonne of LNG produced. Seven years of design evolution reduced this to 0.7 tonnes/tonne and 0.3 tonnes/tonne if the CO_2 is reinjected back into saline aquifers below the Barrow Island oil field. These efficiencies can be achieved without increasing capital cost of the plant by better integrating the process thermal flows, improved gas turbines driving better gas compressors, and preventing venting and flaring.

TBL Accounts #2 and #3

The second TBL account shows that export propensity is more than four times the average, income is 50% below average, and water use is 85% below average. The third TBL account reveals that import penetration is 70% below average, government revenue is 45% below average and that land disturbance is 95% below average.

Structural Path Analysis and Linkages

The social indicators may require further scrutiny of options for improvement. An examination of the structural path analysis shows that the direct effect for employment generation is 33%, income is 48%, and government revenue is 56%. Indirect effects include railway freight (8%), services to mining (3%), wholesale trade (3%), banking (3%), and road freight (1%). Given the size of the direct effect and the relatively small and diverse contributions from the supply chain, improvements may have to focus on within the sector. The sector shares social indicator issues with most of the primary mining sectors which are capital intensive and employment poor. The issues are sometimes polarised by the multinational ownership patterns of the petroleum giants who can choose projects from a wide array of countries, all eager for the export earning potential of LNG plants and interdependent trade deals that might accompany them. Natural resource development has been subject to a range of taxes, including resource rent taxes. The government revenue indicator would be affected by any changes in such taxation regimes.

The sector's stimulus to its upstream suppliers is 40% below average and impacts on railway freight, property services, wholesale trade, and services to mining. Once an LNG plant and pipeline feeds are constructed, the sector is essentially self contained and the entire production is loaded directly from the plant onto specialised LNG ships. The linkages to downstream industries are 30% below average as most of the production is dissipated directly by exports. Nevertheless, there are linkages to alumina, basic chemicals, non-ferrous metal smelting, and basic iron and steel.

Future Trends in Sector

The base case scenario of the *Future Dilemmas* study anticipates a tripling of LNG to 2030, and then a decline as resource stocks become depleted. ABARE projections triple LNG exports by 2020. Substantial new discoveries may extend the economic and physical life of gas reserves.

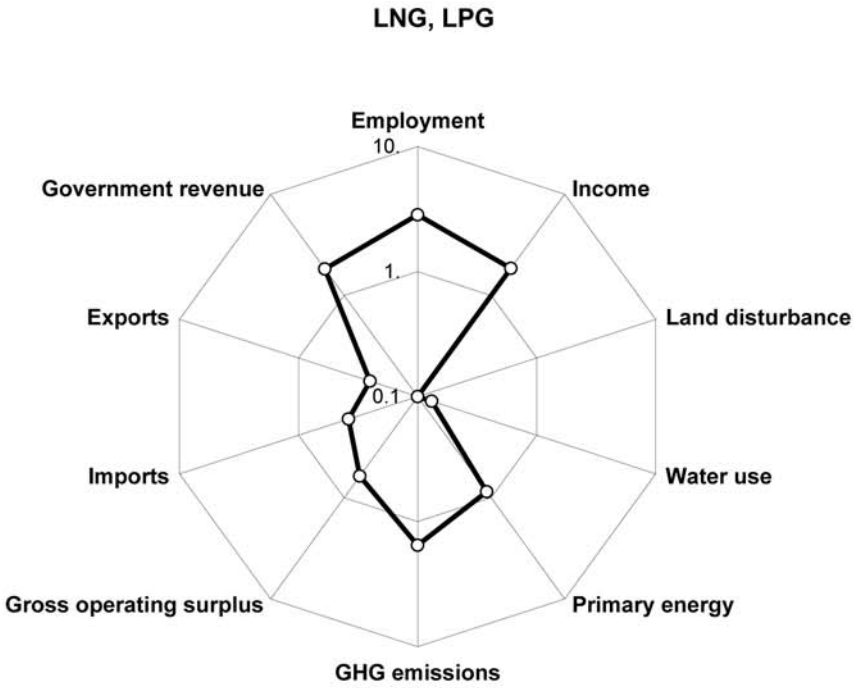
Innovation and Technical Opportunities

Apart from reducing energy use and emissions inherent in LNG production, innovation may follow the Shell 'GameChanger' technology, which standardises production of highly efficient plants, allowing fast construction on land, or on specialised barges for use in small stranded gas reserves.

Sector LNG, LPG (Lg)

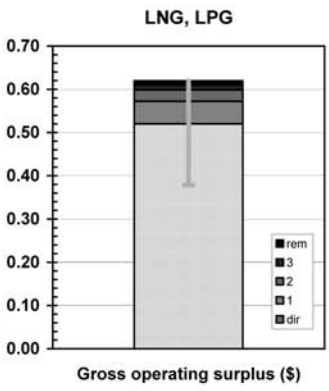
Liquefied natural gas, liquefied petroleum gases (natural)

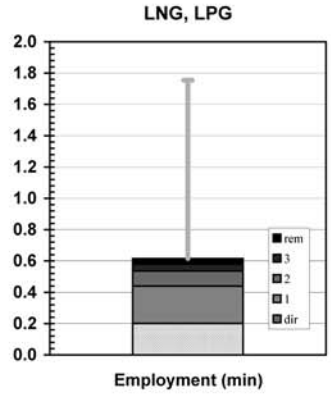
Spider diagram

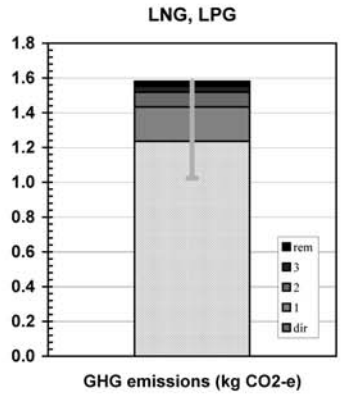


Bar graphs

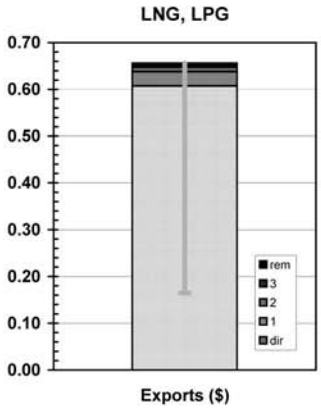
Account #1

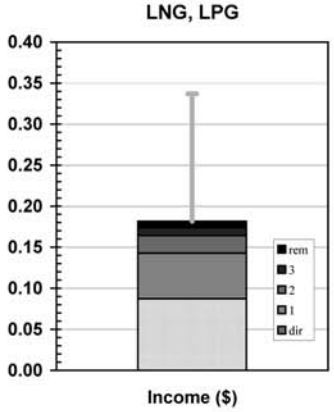


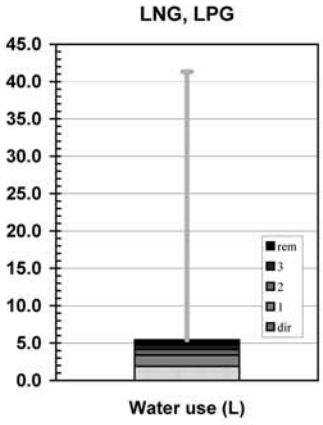




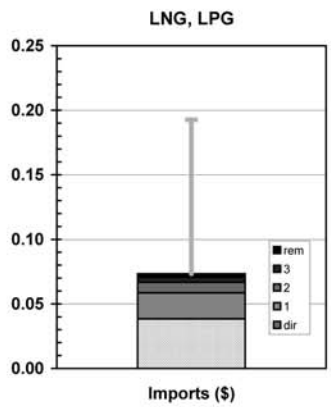
Account #2

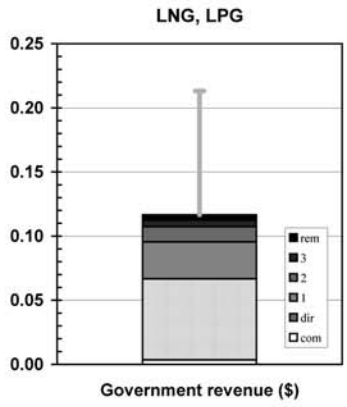


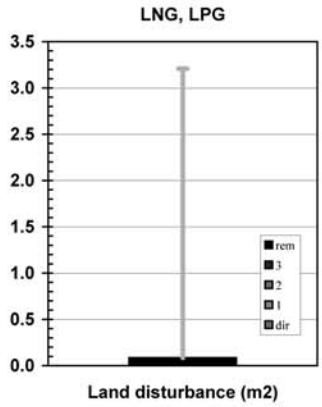




Account #3







National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 64.3	(0.02% of total)	($m 64.3 domestically produced)
Government final consumption	$m 0.0		
Gross fixed capital expenditure	$m 0.0		
Net changes in stocks	$m 20.7	(1.17% of total)	($m 20.7 domestically produced)
Sectoral GNE	**$m 84.9**	**(0.02% of GNE)**	**($m 84.9 domestically produced)**
Exports	$m 1,068.1	(1.28% of total)	($m 1,068.1 domestically produced)
Final demand	**$m 1,153.1**	**(0.21% of GNT)**	**($m 1,153.1 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 153.1	(0.09% of total)	
Gross operating surplus	$m 914.1	(0.48% of total)	
Taxes less subsidies	$m 111.0	(0.13% of total)	
Sectoral GDP*	**$m 1,178.2**	**(0.26% of GDP)**	
Imports	$m 67.4	(0.07% of total)	
Primary inputs	**$m 1,245.6**	**(0.23% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 914.1	(0.48%)	$m 599.5	(0.31%)	$m 714.3	(0.37%)
Exports ($m)	$m 1,068.1	(1.28%)	$m 700.5	(0.84%)	$m 757.0	(0.91%)
Imports ($m)	$m 67.4	(0.07%)	$m 44.2	(0.05%)	$m 84.7	(0.09%)
Employment (e-y)	2,826 e-y	(0.04%)	1,853 e-y	(0.03%)	5,691 e-y	(0.08%)
Income ($m)*	$m 153.1	(0.09%)	$m 100.4	(0.06%)	$m 209.4	(0.12%)
Government revenue ($m)†	$m 115.1	(0.11%)	$m 76.9	(0.07%)	$m 134.5	(0.12%)
GHG emissions (kt CO_2-e)	2,173 kt	(0.42%)	1,425 kt	(0.27%)	1,823 kt	(0.35%)
Water use (ML)	3,294 ML	(0.02%)	2,160 ML	(0.01%)	6,260 ML	(0.03%)
Land disturbance (kha)	2 kha	(0.00%)	1 kha	(0.00%)	10 kha	(0.01%)
Primary energy (TJ)	5,404 TJ	(0.14%)	3,544 TJ	(0.09%)	7,689 TJ	(0.20%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.52	0.62	0.38
Exports ($)	0.61	0.66	0.16
Imports ($)	0.04	0.07	0.19
Employment (min)	0.20	0.62	1.75
Income ($)	0.09	0.18	0.34
Government revenue ($)	0.07	0.12	0.21
GHG emissions (kg CO_2-e)	1.24	1.58	1.02
Water use (L)	1.87	5.43	41.32
Land disturbance (m^2)	0.01	0.09	3.21
Primary energy (MJ)	3.07	6.67	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Lg	0.52	(0; 84.%)	Lg	0.201	(0; 33.%)	Lg	1.24	(0; 78.%)
Rf Lg	0.00772	(1; 1.2%)	Rf Lg	0.0617	(1; 10.%)	El Lg	0.125	(1; 7.9%)
Mn Lg	0.00602	(1; 0.97%)	Cs Lg	0.0233	(1; 3.8%)	El Rf Lg	0.0225	(2; 1.4%)
El Lg	0.00507	(1; 0.82%)	Wt Lg	0.0218	(1; 3.5%)	Rf Lg	0.0224	(1; 1.4%)
Bk Lg	0.00462	(1; 0.75%)	Bk Lg	0.0183	(1; 3.%)	Fo Lg	0.00991	(1; 0.63%)
Wt Lg	0.00303	(1; 0.49%)	Mn Lg	0.0127	(1; 2.1%)	Is Lg	0.00427	(1; 0.27%)
St Lg	0.00245	(1; 0.4%)	Rd Lg	0.00888	(1; 1.4%)	Bl El Lg	0.00316	(2; 0.2%)
Pd Lg	0.0019	(1; 0.31%)	Ma Lg	0.00771	(1; 1.3%)	Wt Lg	0.00302	(1; 0.19%)
Sf Bk Lg	0.00161	(2; 0.26%)	Rh Lg	0.00727	(1; 1.2%)	Oi Fo Lg	0.00298	(2; 0.19%)
Rd Lg	0.00151	(1; 0.24%)	Ts Mn Lg	0.00603	(2; 0.98%)	El Cs Lg	0.00282	(2; 0.18%)
Sf Lg	0.00148	(1; 0.24%)	El Lg	0.00563	(1; 0.91%)	Ch Lg	0.0028	(1; 0.18%)
Oi Fo Lg	0.00141	(2; 0.23%)	Eq Lg	0.00547	(1; 0.89%)	Hw Lg	0.00249	(1; 0.16%)
Ts Mn Lg	0.00134	(2; 0.22%)	Os Lg	0.00542	(1; 0.88%)	Fr Hw Lg	0.00244	(2; 0.15%)
Rh Lg	0.00119	(1; 0.19%)	Gv Lg	0.00523	(1; 0.85%)	Rd Lg	0.0024	(1; 0.15%)
Fn Lg	0.001	(1; 0.16%)	Pd Lg	0.00457	(1; 0.74%)	Pc Lg	0.00224	(1; 0.14%)
Cm Lg	0.000949	(1; 0.15%)	Fn Lg	0.00401	(1; 0.65%)	Is Ma Lg	0.00211	(2; 0.13%)
El Rf Lg	0.00091	(2; 0.15%)	St Lg	0.004	(1; 0.65%)	At Lg	0.00138	(1; 0.087%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Lg	0.607	(0; 93.%)	Lg	0.0871	(0; 48.%)	Lg	1.87	(0; 35.%)
Rf Lg	0.0127	(1; 1.9%)	Rf Lg	0.0173	(1; 9.5%)	El Lg	0.693	(1; 13.%)
Wt Lg	0.00248	(1; 0.38%)	Wt Lg	0.00468	(1; 2.6%)	Mn Lg	0.401	(1; 7.4%)
Bl El Lg	0.00123	(2; 0.19%)	Bk Lg	0.00452	(1; 2.5%)	Wa Lg	0.133	(1; 2.4%)
Ma Lg	0.00113	(1; 0.17%)	Mn Lg	0.00425	(1; 2.3%)	El Rf Lg	0.124	(2; 2.3%)
Eq Lg	0.000976	(1; 0.15%)	Cs Lg	0.00279	(1; 1.5%)	Rf Lg	0.0673	(1; 1.2%)
Oi Fo Lg	0.000963	(2; 0.15%)	Pd Lg	0.00172	(1; 0.94%)	Wa Cs Lg	0.0589	(2; 1.1%)
Oc Lg	0.000679	(1; 0.1%)	Rd Lg	0.00153	(1; 0.84%)	Wa Pd Lg	0.052	(2; 0.96%)
St Lg	0.000607	(1; 0.092%)	El Lg	0.00152	(1; 0.84%)	Wa El Lg	0.0401	(2; 0.74%)
Pc Lg	0.00053	(1; 0.081%)	Os Lg	0.00152	(1; 0.84%)	Wa Pd Rf Lg	0.0236	(3; 0.43%)
Rd Lg	0.000526	(1; 0.08%)	Ma Lg	0.00145	(1; 0.8%)	Sg Lg	0.0215	(1; 0.4%)
At Lg	0.000439	(1; 0.067%)	Ts Mn Lg	0.00141	(2; 0.78%)	Wa Ts Mn Lg	0.0181	(3; 0.33%)
Sg Lg	0.000422	(1; 0.064%)	Gv Lg	0.00132	(1; 0.72%)	Sm Rf Lg	0.0175	(2; 0.32%)
Fo Lg	0.000402	(1; 0.061%)	In Lg	0.00105	(1; 0.58%)	Bl El Lg	0.0164	(2; 0.3%)
Is Lg	0.000378	(1; 0.058%)	St Lg	0.00102	(1; 0.56%)	Wa Ms Lg	0.016	(2; 0.3%)
Bk Lg	0.000359	(1; 0.055%)	Eq Lg	0.000966	(1; 0.53%)	Ws Ho Lg	0.016	(2; 0.3%)
Rw Rf Lg	0.000357	(2; 0.054%)	Rh Lg	0.000796	(1; 0.44%)	El Cs Lg	0.0156	(2; 0.29%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Lg	0.0384	(0; 52.%)	Lg	0.0631	(0; 56.%)	Lg	0.0103	(0; 12.%)
Fo Lg	0.00325	(1; 4.4%)	Rf Lg	0.00797	(1; 7.%)	Rf Lg	0.00869	(1; 10.%)
Mn Lg	0.00276	(1; 3.8%)	Mn Lg	0.00289	(1; 2.6%)	Bc Mp Ho Lg	0.00317	(3; 3.7%)
Rf Lg	0.00199	(1; 2.7%)	Bk Lg	0.0025	(1; 2.2%)	Wo Cs Lg	0.00238	(2; 2.8%)
Ma Lg	0.00134	(1; 1.8%)	Wt Lg	0.00219	(1; 1.9%)	El Lg	0.00202	(1; 2.4%)
Pc Lg	0.00113	(1; 1.5%)	In Lg	0.00113	(1; 1.%)	Wo Tx Lg	0.00163	(2; 1.9%)
Oc Lg	0.00105	(1; 1.4%)	Pd Lg	0.00112	(1; 0.99%)	Bc Mp Cs Lg	0.0015	(3; 1.8%)
Cs Lg	0.000711	(1; 0.97%)	Rd Lg	0.00108	(1; 0.96%)	Hw Lg	0.00129	(1; 1.5%)
Wt Lg	0.000703	(1; 0.96%)	El Lg	0.00095	(1; 0.84%)	Bc Mp Ch Lg	0.00111	(3; 1.3%)
Eq Lg	0.000645	(1; 0.88%)	Cs Lg	0.000809	(1; 0.72%)	Fr Hw Lg	0.000783	(2; 0.92%)
Rh Lg	0.000614	(1; 0.84%)	Os Lg	0.000704	(1; 0.62%)	Wo Tx Wt Lg	0.000776	(3; 0.91%)
Rw Rf Lg	0.000552	(2; 0.75%)	Ma Lg	0.000698	(1; 0.62%)	Hw Rf Lg	0.000678	(2; 0.79%)
Bk Lg	0.000447	(1; 0.61%)	Ts Mn Lg	0.000696	(2; 0.62%)	Bc Mp Ho Bk I	0.000669	(4; 0.78%)
Ru Lg	0.000427	(1; 0.58%)	St Lg	0.000545	(1; 0.48%)	Bc Mp Ho Mn	0.000633	(4; 0.74%)
Ts Mn Lg	0.000384	(2; 0.52%)	Pd Rf Lg	0.00051	(2; 0.45%)	Wo Tx Ru Lg	0.0006	(3; 0.7%)
Rd Lg	0.000383	(1; 0.52%)	Eq Lg	0.000479	(1; 0.42%)	Bc Mp Oc Lg	0.00057	(3; 0.67%)
El Lg	0.000352	(1; 0.48%)	Gv Lg	0.000458	(1; 0.41%)	Bc Ch Lg	0.000559	(2; 0.65%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.582 ±0.009	(±1.5%)
Downstream	0.673 ±0.007	(±1.1%)

Sector 11020010: Brown Coal (Br)

Brown coal-lignite including briquettes

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 50% below average, water use is 10% above average, and land disturbance is 95% below average. The social indicators of employment generation, income and government revenue are respectively 65%, 50% and 50% below average. The financial indicator of operating surplus is 60% above average, export propensity is 70% below average, and import penetration is 65% below average. Macro-environmental issues such as global greenhouse emissions will determine the future of the brown coal mining sector. Gaining the technological high ground with highly efficient power generators is the first stage, and then a successful technology for permanent CO_2 geo-sequestration.

Sector Description

Australia currently produces 66 million tonnes of brown coal or lignite annually, almost all of which is used domestically for electricity generation, with minor amounts made into briquettes for home heating, and as inputs to some industrial processes. Brown coal has a 60% water content and must undergo a range of dewatering processes before combustion. In its raw state, it has about one third the energy content (9.7 GJ/t) of black coal (28.5GJ/t) and power stations are therefore close to mines to reduce the physical and economic costs of transporting the water content. Compared to a typical black coal power plant operating at a thermal efficiency of 35%, brown coal plants typically operate in the range of 22% to 32%. New designs have the potential to raise efficiency to over 40%. More than 98% of lignite production occurs in the La Trobe Valley in Victoria where the economic demonstrated resource is 42 billion tonnes, giving an economic life at current consumption rates of over 600 years. There are over 100 billion tonnes of inferred resources, giving a 1 000 year production horizon. In constant dollar terms, the sector turnover has increased by a factor of nine in the last 30 years. Current turnover is about $640 million and involves three enterprises.

Place of Industry in the Economy

The brown coal mining sector ranks 110th out of 135 sectors in terms of value adding in the economy and contributes 0.09% of GDP in this analysis. It is similar in value adding to the agricultural chemicals, and ‘coins, jewellery, sporting goods and toy’ sectors. It is a small employer with less than 500 employment years embodied, both directly and indirectly, in the final demand of the sector’s product. In addition it contributes 1 000 employment years to the final demand of downstream industries such as electricity production, basic iron and steel, alumina, aluminium and property services. It has small resource requirements with less than one tenth of one percent of national water use, land disturbance, energy use and greenhouse emissions. In financial terms, imports are approximately equal to exports.

Strategic Overview

The spider diagram reveals a TBL account with positive environmental and economic indicators, but with outliers for the three social indicators of employment generation, income, and government revenue. The export propensity indicator is less relevant since, apart from the brown coal production embodied in electricity production and then into export products, brown coal mining is a local activity not open to export. While brown coal electricity has advantages in cost, the downstream implications are that with current technology, brown coal electricity has 25-60% more carbon emissions per unit than black coal, and more than three times that of gas combined-cycle generation.

TBL Account #1

The financial indicator of operating surplus is 60% above average with a direct sector effect of 84% of total, with 1% additions from sectors such as railway freight, mining services, electricity generation, and banking. The social indicator of employment generation is 65% below average and discussed in more detail below. The environmental indicator of greenhouse emissions is 50% below average and has a within sector effect of 32%, and contributions from electricity generation (25%), rail freight (9%), diesel refining (2%), and basic iron and steel production (1%).

TBL Accounts #2 and #3

The second TBL account shows an export propensity (not particularly relevant in this case) 70% below average, income 50% below average, and water use 10% above average. The third TBL account shows import penetration 65% below average, government revenue 50% below average, and land disturbance 95% below average. The income and government revenue indicators are discussed in more detail below.

Structural Path Analysis and Linkages

The three social indicators of employment generation, income, and government revenue are below average. The structural path analysis shows that the direct sector effect is 33% for employment, 48% for income and 56% for government revenue. Additional factors are railway freight (7%), services to mining (3%), banking (3%), and wholesale trade (3%). This breakdown suggests that social indicator improvements may have to be sought in the sector rather than within its supply chain. Brown coal's price is limited at the coal face by the capital cost of mining and transportation equipment, and in the market place by high levels of competition, and national policies to constrain electricity prices (especially for long term and large electricity users in energy intensive processing industries).

The sector's stimulus to its upstream suppliers is 40% below average and impacts primarily on railway freight, property services, wholesale trade, and services to mining. The linkages to downstream industries are double the economy wide average and suggest that any expansion in brown coal mining must be led by expansion in key industries that use brown coal through its product electricity. The main industries are electricity generation, basic iron and steel (electric arc furnace technology), aluminium, property services, and accommodation cafes and restaurants.

Future Trends in Sector

The base case scenario of the *Future Dilemmas* study anticipates that brown coal mining will double by 2050 and that new brown coal electricity generators will achieve 45% thermal efficiency. Shorter term projections by ABARE suggest a more conservative 10% increase in mining by 2020, due to policy constraints, and penetration of the current brown coal market share by advanced gas and black coal technologies. There are a number of industry and government initiatives aimed at ensuring the continued utilisation of extensive Victorian brown coal reserves. Some of these include an accelerated program of geo-sequestration of carbon dioxide emissions in used Bass Strait oil and gas fields, and the development of a synthesis plant to convert brown coal to low sulphur diesel.

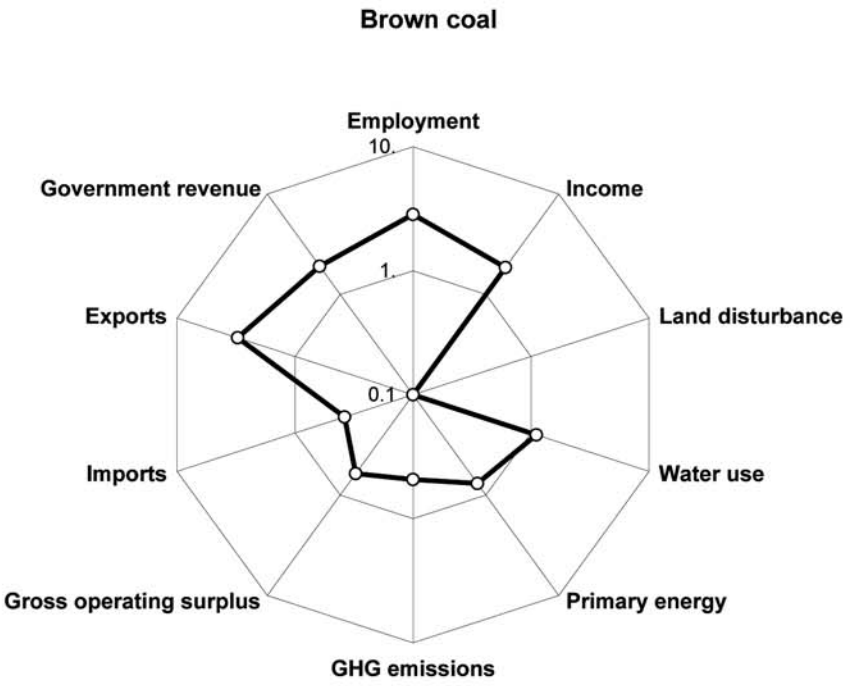
Innovation and Technical Opportunities

Improved lignite de-watering processes offer considerable improvements in the efficiency of electricity generation and a decrease in greenhouse gas emissions. Advanced processes aim to gasify lignite at 800ºC to 900ºC to fuel the highly efficient gas turbine cycle. Other programs focus on geo-sequestration of CO_2, and a strategic assessment of the place of coal in sustainable development.

Sector **Brown coal** **(Br)**

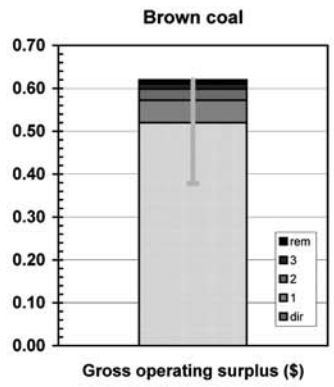
Brown coal, lignite (all types incl briquettes)

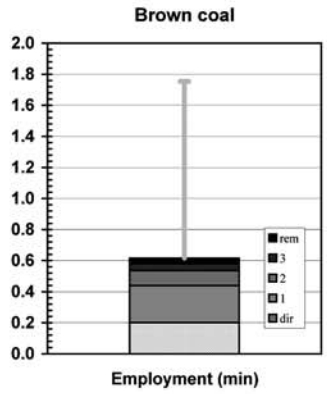
Spider diagram

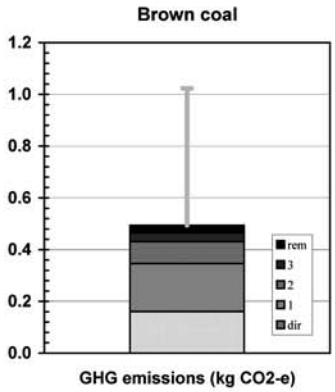


Bar graphs

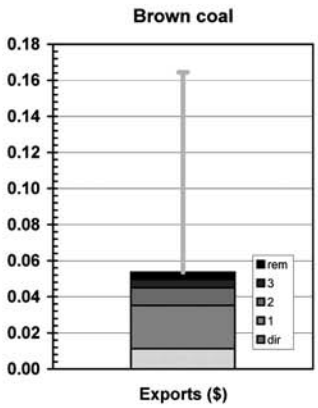
Account #1

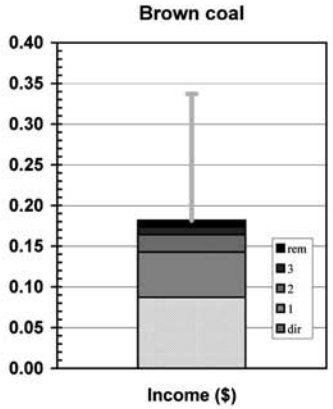


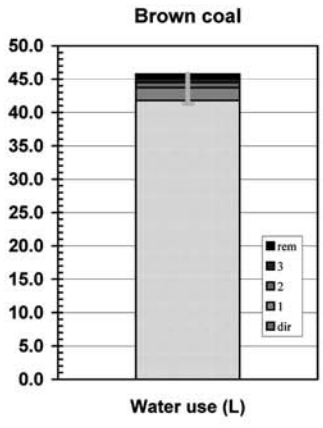




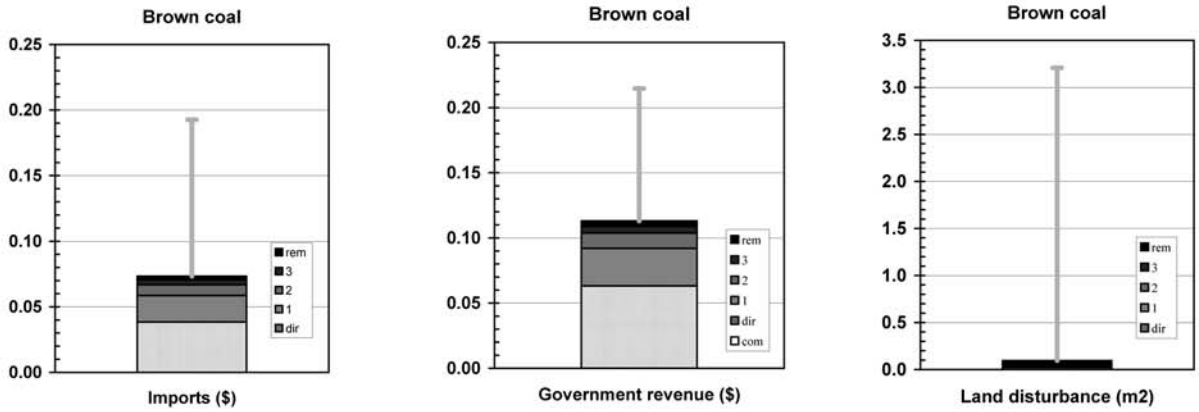
Account #2







Account #3



National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 14.1	(0.01% of total)	($m 14.1 domestically produced)
Government final consumption	$m 0.9	(0.00% of total)	($m 0.9 domestically produced)
Gross fixed capital expenditure	$m 50.9	(0.05% of total)	($m 50.9 domestically produced)
Net changes in stocks	$m 4.0	(0.22% of total)	($m 4.0 domestically produced)
Sectoral GNE	**$m 69.8**	**(0.02% of GNE)**	**($m 69.8 domestically produced)**
Exports	$m 6.5	(0.01% of total)	($m 6.5 domestically produced)
Final demand	**$m 76.3**	**(0.01% of GNT)**	**($m 76.3 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 50.5	(0.03% of total)	
Gross operating surplus	$m 301.5	(0.16% of total)	
Taxes less subsidies	$m 36.6	(0.04% of total)	
Sectoral GDP*	**$m 388.6**	**(0.09% of GDP)**	
Imports	$m 22.2	(0.02% of total)	
Primary inputs	**$m 410.9**	**(0.08% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 301.5	(0.16%)	$m 39.7	(0.02%)	$m 47.3	(0.02%)
Exports ($m)	$m 6.5	(0.01%)	$m 0.9	(0.00%)	$m 4.1	(0.00%)
Imports ($m)	$m 22.2	(0.02%)	$m 2.9	(0.00%)	$m 5.6	(0.01%)
Employment (e-y)	932 e-y	(0.01%)	123 e-y	(0.00%)	377 e-y	(0.01%)
Income ($m)*	$m 50.5	(0.03%)	$m 6.6	(0.00%)	$m 13.9	(0.01%)
Government revenue ($m)†	$m 36.5	(0.03%)	$m 4.7	(0.00%)	$m 8.5	(0.01%)
GHG emissions (kt CO_2-e)	93 kt	(0.02%)	12 kt	(0.00%)	38 kt	(0.01%)
Water use (ML)	24,235 ML	(0.12%)	3,188 ML	(0.02%)	3,493 ML	(0.02%)
Land disturbance (kha)	1 kha	(0.00%)	0 kha	(0.00%)	1 kha	(0.00%)
Primary energy (TJ)	1,323 TJ	(0.03%)	174 TJ	(0.00%)	448 TJ	(0.01%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.52	0.62	0.38
Exports ($)	0.01	0.05	0.16
Imports ($)	0.04	0.07	0.19
Employment (min)	0.20	0.62	1.75
Income ($)	0.09	0.18	0.34
Government revenue ($)	0.06	0.11	0.21
GHG emissions (kg CO_2-e)	0.16	0.49	1.02
Water use (L)	41.78	45.78	41.32
Land disturbance (m^2)	0.02	0.10	3.21
Primary energy (MJ)	2.28	5.87	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Br	0.52	(0; 84.%)	Br	0.201	(0; 33.%)	Br	0.16	(0; 32.%)
Rf Br	0.00772	(1; 1.2%)	Rf Br	0.0617	(1; 10.%)	El Br	0.125	(1; 25.%)
Mn Br	0.00602	(1; 0.97%)	Cs Br	0.0233	(1; 3.8%)	El Rf Br	0.0225	(2; 4.6%)
El Br	0.00507	(1; 0.82%)	Wt Br	0.0218	(1; 3.5%)	Rf Br	0.0224	(1; 4.5%)
Bk Br	0.00462	(1; 0.75%)	Bk Br	0.0183	(1; 3.%)	Fo Br	0.00991	(1; 2.%)
Wt Br	0.00303	(1; 0.49%)	Mn Br	0.0127	(1; 2.1%)	Is Br	0.00427	(1; 0.87%)
St Br	0.00245	(1; 0.4%)	Rd Br	0.00888	(1; 1.4%)	Bl El Br	0.00316	(2; 0.64%)
Pd Br	0.0019	(1; 0.31%)	Ma Br	0.00771	(1; 1.3%)	Wt Br	0.00302	(1; 0.61%)
Sf Bk Br	0.00161	(2; 0.26%)	Rh Br	0.00727	(1; 1.2%)	Oi Fo Br	0.00298	(2; 0.6%)
Rd Br	0.00151	(1; 0.24%)	Ts Mn Br	0.00603	(2; 0.98%)	El Cs Br	0.00282	(2; 0.57%)
Sf Br	0.00148	(1; 0.24%)	El Br	0.00563	(1; 0.91%)	Ch Br	0.0028	(1; 0.57%)
Oi Fo Br	0.00141	(2; 0.23%)	Eq Br	0.00547	(1; 0.89%)	Hw Br	0.00249	(1; 0.51%)
Ts Mn Br	0.00134	(2; 0.22%)	Os Br	0.00542	(1; 0.88%)	Fr Hw Br	0.00244	(2; 0.49%)
Rh Br	0.00119	(1; 0.19%)	Gv Br	0.00523	(1; 0.85%)	Rd Br	0.0024	(1; 0.49%)
Fn Br	0.001	(1; 0.16%)	Pd Br	0.00457	(1; 0.74%)	Pc Br	0.00224	(1; 0.45%)
Cm Br	0.000949	(1; 0.15%)	Fn Br	0.00401	(1; 0.65%)	Is Ma Br	0.00211	(2; 0.43%)
El Rf Br	0.00091	(2; 0.15%)	St Br	0.004	(1; 0.65%)	At Br	0.00138	(1; 0.28%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Rf Br	0.0127	(1; 24.%)	Br	0.0871	(0; 48.%)	Br	41.8	(0; 91.%)
Br	0.0112	(0; 21.%)	Rf Br	0.0173	(1; 9.5%)	El Br	0.693	(1; 1.5%)
Wt Br	0.00248	(1; 4.6%)	Wt Br	0.00468	(1; 2.6%)	Mn Br	0.401	(1; 0.88%)
Bl El Br	0.00123	(2; 2.3%)	Bk Br	0.00452	(1; 2.5%)	Wa Br	0.133	(1; 0.29%)
Ma Br	0.00113	(1; 2.1%)	Mn Br	0.00425	(1; 2.3%)	El Rf Br	0.124	(2; 0.27%)
Eq Br	0.000976	(1; 1.8%)	Cs Br	0.00279	(1; 1.5%)	Rf Br	0.0673	(1; 0.15%)
Oi Fo Br	0.000963	(2; 1.8%)	Pd Br	0.00172	(1; 0.94%)	Wa Cs Br	0.0589	(2; 0.13%)
Oc Br	0.000679	(1; 1.3%)	Rd Br	0.00153	(1; 0.84%)	Wa Pd Br	0.052	(2; 0.11%)
St Br	0.000607	(1; 1.1%)	El Br	0.00152	(1; 0.84%)	Wa El Br	0.0401	(2; 0.088%)
Pc Br	0.00053	(1; 0.99%)	Os Br	0.00152	(1; 0.84%)	Wa Pd Rf Br	0.0236	(3; 0.052%)
Rd Br	0.000526	(1; 0.98%)	Ma Br	0.00145	(1; 0.8%)	Sg Br	0.0215	(1; 0.047%)
At Br	0.000439	(1; 0.82%)	Ts Mn Br	0.00141	(2; 0.78%)	Wa Ts Mn Br	0.0181	(3; 0.039%)
Sg Br	0.000422	(1; 0.79%)	Gv Br	0.00132	(1; 0.72%)	Sm Rf Br	0.0175	(2; 0.038%)
Fo Br	0.000402	(1; 0.75%)	In Br	0.00105	(1; 0.58%)	Bl El Br	0.0164	(2; 0.036%)
Is Br	0.000378	(1; 0.71%)	St Br	0.00102	(1; 0.56%)	Wa Ms Br	0.016	(2; 0.035%)
Bk Br	0.000359	(1; 0.67%)	Eq Br	0.000966	(1; 0.53%)	Ws Ho Br	0.016	(2; 0.035%)
Rw Rf Br	0.000357	(2; 0.67%)	Rh Br	0.000796	(1; 0.44%)	El Cs Br	0.0156	(2; 0.034%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Br	0.0384	(0; 52.%)	Br	0.0631	(0; 56.%)	Br	0.0209	(0; 22.%)
Fo Br	0.00325	(1; 4.4%)	Rf Br	0.00797	(1; 7.%)	Rf Br	0.00869	(1; 9.%)
Mn Br	0.00276	(1; 3.8%)	Mn Br	0.00289	(1; 2.6%)	Bc Mp Ho Br	0.00317	(3; 3.3%)
Rf Br	0.00199	(1; 2.7%)	Bk Br	0.0025	(1; 2.2%)	Wo Cs Br	0.00238	(2; 2.5%)
Ma Br	0.00134	(1; 1.8%)	Wt Br	0.00219	(1; 1.9%)	El Br	0.00202	(1; 2.1%)
Pc Br	0.00113	(1; 1.5%)	In Br	0.00113	(1; 1.%)	Wo Tx Br	0.00163	(2; 1.7%)
Oc Br	0.00105	(1; 1.4%)	Pd Br	0.00112	(1; 0.99%)	Bc Mp Cs Br	0.0015	(3; 1.6%)
Cs Br	0.000711	(1; 0.97%)	Rd Br	0.00108	(1; 0.96%)	Hw Br	0.00129	(1; 1.3%)
Wt Br	0.000703	(1; 0.96%)	El Br	0.00095	(1; 0.84%)	Bc Mp Ch Br	0.00111	(3; 1.2%)
Eq Br	0.000645	(1; 0.88%)	Cs Br	0.000809	(1; 0.72%)	Fr Hw Br	0.000783	(2; 0.81%)
Rh Br	0.000614	(1; 0.84%)	Os Br	0.000704	(1; 0.62%)	Wo Tx Wt Br	0.000776	(3; 0.81%)
Rw Rf Br	0.000552	(2; 0.75%)	Ma Br	0.000698	(1; 0.62%)	Hw Rf Br	0.000678	(2; 0.71%)
Bk Br	0.000447	(1; 0.61%)	Ts Mn Br	0.000696	(2; 0.62%)	Bc Mp Ho Bk I	0.000669	(4; 0.7%)
Ru Br	0.000427	(1; 0.58%)	St Br	0.000545	(1; 0.48%)	Bc Mp Ho Mn	0.000633	(4; 0.66%)
Ts Mn Br	0.000384	(2; 0.52%)	Pd Rf Br	0.00051	(2; 0.45%)	Wo Tx Ru Br	0.0006	(3; 0.62%)
Rd Br	0.000383	(1; 0.52%)	Eq Br	0.000479	(1; 0.42%)	Bc Mp Oc Br	0.00057	(3; 0.59%)
El Br	0.000352	(1; 0.48%)	Gv Br	0.000458	(1; 0.41%)	Bc Ch Br	0.000559	(2; 0.58%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.582 ±0.009	(±1.5%)
Downstream	1.981 ±0.040	(±2.0%)

Sector 1301: Iron Ores (Io)

Iron ores including treatment; excluding pelletising

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 50% below average, while water use and land disturbance are 60% and 95% below average respectively. The social indicators of employment generation, income, and government revenue, are 65%, 60% and 40% below average respectively. The financial indicator of operating surplus is 55% above average, export propensity is more than five times the average, and import penetration is 50% below average. Industry sources note a possible check to export growth in about 30 years when iron ore stocks low in phosphorus become less available.

Sector Description

Australia produces nearly 190 million tonnes of iron ore annually. Domestic consumption is 11 million tonnes the rest is exported in a variety of forms to Japan (42%), China (26%), Korea (15%), and Europe (9%). The economic demonstrated resource for iron ore is 12 400 million tonnes giving an economic life of 65 years with current levels of production. However there are a further 14 000 million tonnes of sub-marginal and inferred resources which could double the proven economic life to 130 years. Australian production levels rank third behind China and Brazil, but Russia and Ukraine have large undeveloped resources. Western Australia is the main producer, and haematite (Fe_2O_3) the main mineral containing about 70% iron. Production is dominated by two companies, Rio Tinto and BHP Billiton. Each has just under one half of total production. The iron ores are crushed and beneficiated near the mines, separating the heavier iron from the lighter overburden, to give ore with a high concentration of iron. Rio Tinto's 'HIsmelt' plant at Kwinana in Perth, and BHP Billiton's hot briquetted iron plant at Port Hedland, are aimed at value adding to iron ores in Australia, and exporting less raw product. In constant dollar terms, the industry has tripled over the last 30 years. Current turnover is about $6 billion, and involves 19 enterprises.

Place of Industry in the Economy

The iron ores sector ranks 48th out of 135 sectors in terms of value adding in the economy, and contributes 0.40% of GDP in this analysis. It is similar in value adding to the furniture making, and the 'libraries, parks, museums and the arts' sectors. It is a small employer with 6 000 employment years directly embodied in final demand, and another 8 000 employment years in the sector's upstream suppliers, giving a total of 14 000 employment years. In addition, it contributes 2 000 employment years to downstream industries such as basic iron and steel to enable them to deliver their final demand. The sector has relatively small resource requirements with less than two tenths of one percent of national water use, land disturbance, and greenhouse gas emissions, and about three tenths of one percent of energy use. In financial terms, exports outweigh imports by 17 times.

Strategic Overview

The spider diagram reveals advantaged indicators for the environmental and financial themes, but a number of significant outliers for the social indicators. This signature is typical of many primary metal commodities. It reflects the capital intensity of bulk commodity operations and also the intense global competition based on price, supply continuity and quality. Some downstream issues relate to the leakage of financial returns from the mining region to corporate centres in Australia and overseas. The question then, is what industries might underpin these regions in 30 to 60 years when lower quality ore grades cut in, or low wage competition from overseas prevails.

TBL Account #1

The financial indicator of operating surplus is 55% above the economy wide average and composed of a dominant sector effect (75%), with small contributions from mining services (4%), banking (1%), electricity generation (1%), and technical services (1%). The social indicator of employment generation is 65% below average, and discussed in more detail below. The environmental indicator of greenhouse emissions is 50% below average and composed of a direct effect (29%), and contributions from electricity generation (27%), diesel refining (3%), garbage disposal (1%), and rail freight (2%). The greenhouse emissions indicator could be reduced further by sourcing lower carbon electricity and using more efficient electrical motors on iron ore beneficiation plants. Future options may arise if ore shovel and ore truck operations are powered by fuel cell drive trains, provided that a hydrogen source and carrier such as methanol or a metal hydride, can be obtained from a production cycle with low net greenhouse emissions on a full life cycle basis.

TBL Accounts #2 and #3

The second TBL account shows an export propensity more than five times the average, income 60% below the average, and water use 60% below average. Water is used as part of the iron ore beneficiation process to help separate high iron content material from accompanying material. The third TBL account shows an import penetration 50% below average, government revenue 40% below average, and land disturbance 95% below average.

Structural Path Analysis and Linkages

The social indicators are below average. The structural path analysis shows that the direct sector effect for employment generation, income, and government revenue, is respectively 43%, 47% and 49% of the total. This suggests that improvement may have to come from within the sector. Other contributions averages across the three social indicators include mining services (7%), banking (3%), wholesale trade (2%) and technical services (2%). Given the efficiency of labour use in these sectors, it is unlikely that they will increase in an absolute and proportional sense, to allow an overall improvement in the performance of social indicators. Increases in resource rents are theoretically feasible, but given the strength of competition globally, the cyclical nature of iron ore prices, and the political strength of the dominant companies, resource rent increases seem unlikely.

The sector's stimulus to its upstream suppliers is 30% below the economy wide average and impacts on services to mining, property development and real estate, and wholesale trade. The linkages to downstream industries are also weaker than average as most of the industry effect is dissipated by high levels of exports. However there is one strong link to the basic iron and steel making sector which processes iron ore for domestic steel consumption and for export.

Future Trends in Sector

In the base case scenario of the *Future Dilemmas* study, iron ore production doubles by 2050. Current rates of growth in production, driven by overall world economic growth and China particularly, suggest that this is feasible. However uncertainties abound. Significant shocks downstream of iron ore mining (e.g. constraints in cheap oil availability, carbon constraints, metal stewardship programs, material substitutions) could slow the anticipated growth.

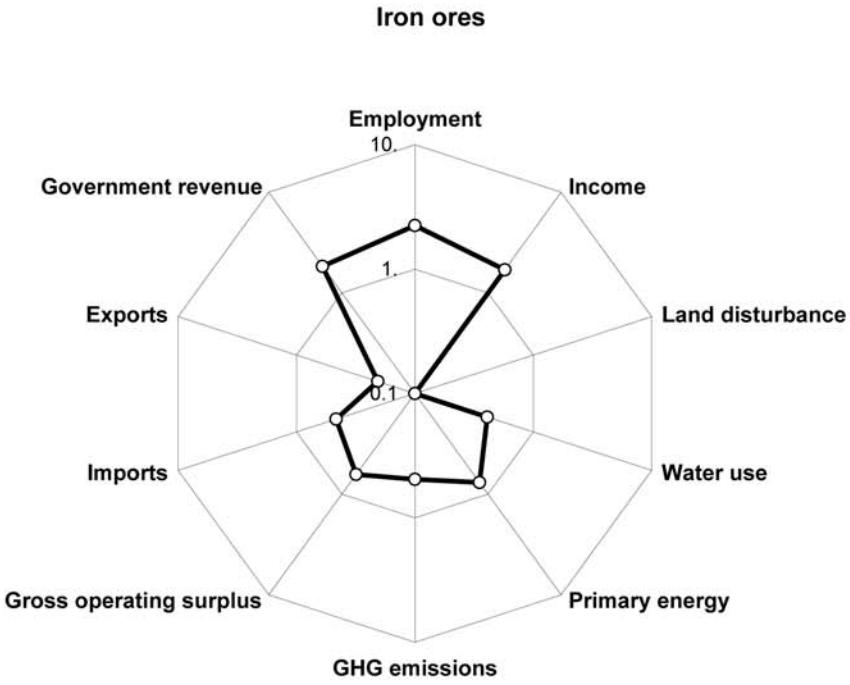
Innovation and Technical Opportunities

Regimes of metal stewardship and 'cradle to cradle' life cycle manufacturing will require that major iron ore exporters such as Australia and Brazil pre-process and/or pre-select ores before shipping so that steel making has high energy efficiencies, and low waste and greenhouse emissions. Unlikely future markets may include ocean fertilisation to increase ocean greenhouse gas sequestration.

Sector **Iron ores** **(Io)**

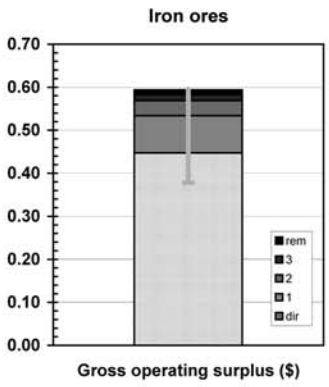
Iron ores (jncl tratment; excl pelletising)

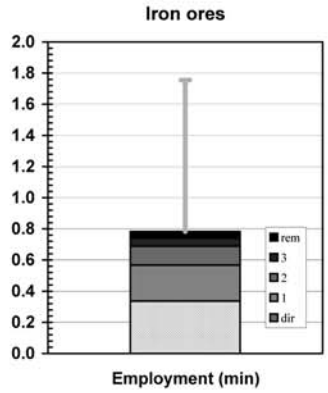
Spider diagram

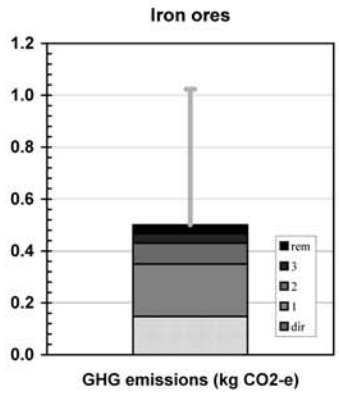


Bar graphs

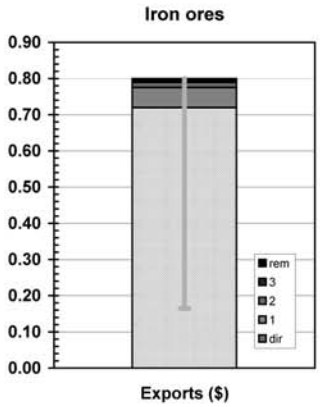
Account #1

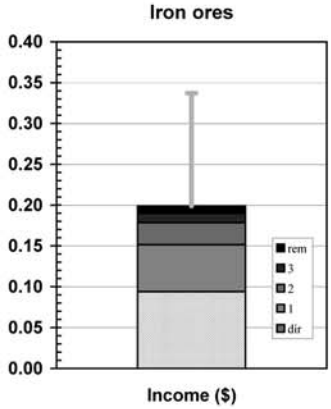


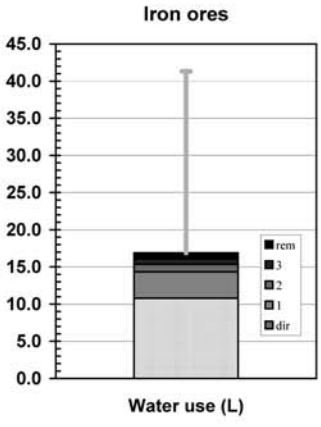




Account #2







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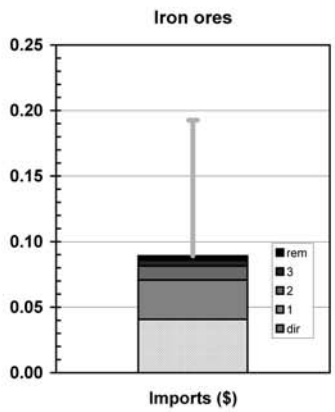
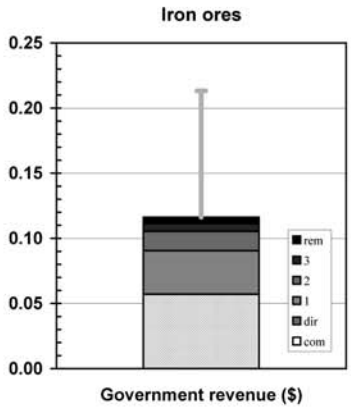
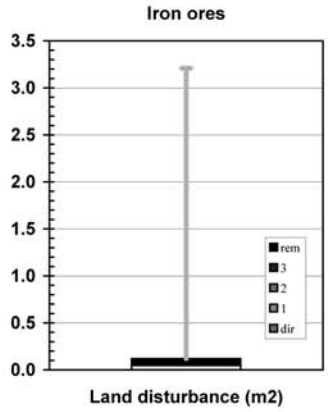






National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 7.5	(0.00% of total)	($m 7.5 domestically produced)
Government final consumption	$m 0.3	(0.00% of total)	($m 0.3 domestically produced)
Gross fixed capital expenditure	$m 13.4	(0.01% of total)	($m 13.4 domestically produced)
Net changes in stocks	$m 11.1	(0.63% of total)	($m 9.4 domestically produced)
Sectoral GNE	**$m 32.2**	**(0.01% of GNE)**	**($m 30.5 domestically produced)**
Exports	$m 2,152.6	(2.58% of total)	($m 2,152.6 domestically produced)
Final demand	**$m 2,184.8**	**(0.40% of GNT)**	**($m 2,183.1 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 281.1	(0.16% of total)	
Gross operating surplus	$m 1,337.9	(0.70% of total)	
Taxes less subsidies	$m 170.7	(0.20% of total)	
Sectoral GDP*	**$m 1,789.7**	**(0.40% of GDP)**	
Imports	$m 121.7	(0.12% of total)	
Primary inputs	**$m 1,911.4**	**(0.35% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 1,337.9	(0.70%)	$m 976.1	(0.51%)	$m 1,296.7	(0.68%)
Exports ($m)	$m 2,152.6	(2.58%)	$m 1,570.5	(1.88%)	$m 1,746.5	(2.10%)
Imports ($m)	$m 121.7	(0.12%)	$m 88.8	(0.09%)	$m 194.8	(0.20%)
Employment (e-y)	8,059 e-y	(0.11%)	5,880 e-y	(0.08%)	13,694 e-y	(0.19%)
Income ($m)*	$m 281.1	(0.16%)	$m 205.1	(0.12%)	$m 434.2	(0.25%)
Government revenue ($m)†	$m 170.7	(0.16%)	$m 124.5	(0.12%)	$m 253.9	(0.23%)
GHG emissions (kt CO_2-e)	440 kt	(0.08%)	321 kt	(0.06%)	1,092 kt	(0.21%)
Water use (ML)	32,257 ML	(0.15%)	23,534 ML	(0.11%)	36,859 ML	(0.18%)
Land disturbance (kha)	14 kha	(0.01%)	10 kha	(0.01%)	26 kha	(0.02%)
Primary energy (TJ)	6,261 TJ	(0.16%)	4,568 TJ	(0.12%)	12,806 TJ	(0.33%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.45	0.59	0.38
Exports ($)	0.72	0.80	0.16
Imports ($)	0.04	0.09	0.19
Employment (min)	0.34	0.78	1.75
Income ($)	0.09	0.20	0.34
Government revenue ($)	0.06	0.12	0.21
GHG emissions (kg CO_2-e)	0.15	0.50	1.02
Water use (L)	10.78	16.88	41.32
Land disturbance (m^2)	0.05	0.12	3.21
Primary energy (MJ)	2.09	5.87	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Io	0.447	(0; 75.%)	Io	0.336	(0; 43.%)	Io	0.147	(0; 29.%)
Mn Io	0.0213	(1; 3.6%)	Mn Io	0.0448	(1; 5.7%)	El Io	0.137	(1; 27.%)
Bk Io	0.00639	(1; 1.1%)	Bk Io	0.0253	(1; 3.2%)	Fo Io	0.015	(1; 3.%)
El Io	0.00555	(1; 0.93%)	Wt Io	0.0221	(1; 2.8%)	Ga Io	0.00543	(1; 1.1%)
Ts Mn Io	0.00474	(2; 0.8%)	Ts Mn Io	0.0213	(2; 2.7%)	El Rf Io	0.00517	(2; 1.%)
Wt Io	0.00307	(1; 0.52%)	Rf Io	0.0142	(1; 1.8%)	Rf Io	0.00514	(1; 1.%)
Sf Io	0.00234	(1; 0.39%)	Rh Io	0.0138	(1; 1.8%)	Is Io	0.0049	(1; 0.98%)
Rh Io	0.00226	(1; 0.38%)	Rd Io	0.00689	(1; 0.88%)	Oi Fo Io	0.00452	(2; 0.9%)
Sf Bk Io	0.00223	(2; 0.38%)	El Io	0.00617	(1; 0.79%)	Bl El Io	0.00346	(2; 0.69%)
Oi Fo Io	0.00213	(2; 0.36%)	Gv Io	0.00589	(1; 0.75%)	Ng Io	0.00341	(1; 0.68%)
Pd Io	0.00212	(1; 0.36%)	Fn Io	0.0052	(1; 0.66%)	Wt Io	0.00306	(1; 0.61%)
Rf Io	0.00177	(1; 0.3%)	Sm Io	0.00514	(1; 0.66%)	At Io	0.00296	(1; 0.59%)
Sg Io	0.00166	(1; 0.28%)	Pd Io	0.0051	(1; 0.65%)	Ch Io	0.0028	(1; 0.56%)
Fn Io	0.0013	(1; 0.22%)	Ma Io	0.0048	(1; 0.61%)	Mn Io	0.00249	(1; 0.5%)
Rd Io	0.00117	(1; 0.2%)	Eq Io	0.00456	(1; 0.58%)	Pc Io	0.00198	(1; 0.4%)
Bl El Io	0.000885	(2; 0.15%)	Ho Io	0.0033	(1; 0.42%)	Rd Io	0.00186	(1; 0.37%)
St Io	0.000867	(1; 0.15%)	Ms Io	0.00325	(1; 0.42%)	Is Mn Io	0.00181	(2; 0.36%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Io	0.719	(0; 90.%)	Io	0.0939	(0; 47.%)	Io	10.8	(0; 64.%)
Rf Io	0.0029	(1; 0.36%)	Mn Io	0.015	(1; 7.6%)	Mn Io	1.42	(1; 8.4%)
Wt Io	0.00251	(1; 0.31%)	Bk Io	0.00626	(1; 3.1%)	El Io	0.759	(1; 4.5%)
Oi Fo Io	0.00146	(2; 0.18%)	Ts Mn Io	0.005	(2; 2.5%)	Wa Io	0.512	(1; 3.%)
Bl El Io	0.00134	(2; 0.17%)	Wt Io	0.00474	(1; 2.4%)	Dc Dp Io	0.158	(2; 0.93%)
At Io	0.000943	(1; 0.12%)	Rf Io	0.00398	(1; 2.%)	Wa Ts Mn Io	0.0639	(3; 0.38%)
Sg Io	0.000824	(1; 0.1%)	Pd Io	0.00191	(1; 0.96%)	Wa Pd Io	0.0581	(2; 0.34%)
Eq Io	0.000814	(1; 0.1%)	El Io	0.00167	(1; 0.84%)	Wa El Io	0.0439	(2; 0.26%)
Ts Mn Io	0.000752	(2; 0.094%)	Rh Io	0.00151	(1; 0.76%)	Sg Io	0.042	(1; 0.25%)
Ma Io	0.000705	(1; 0.088%)	Gv Io	0.00148	(1; 0.74%)	Sm Io	0.0326	(1; 0.19%)
Oc Io	0.000685	(1; 0.086%)	In Io	0.0012	(1; 0.61%)	El Rf Io	0.0286	(2; 0.17%)
Nf Io	0.000615	(1; 0.077%)	Rd Io	0.00118	(1; 0.6%)	Ws Ho Io	0.024	(2; 0.14%)
Fo Io	0.000609	(1; 0.076%)	Fn Io	0.000971	(1; 0.49%)	Wa Ms Io	0.0187	(2; 0.11%)
En Io	0.000516	(1; 0.065%)	Ma Io	0.000901	(1; 0.45%)	Bl El Io	0.018	(2; 0.11%)
Bk Io	0.000497	(1; 0.062%)	Sm Io	0.000886	(1; 0.45%)	Fo Io	0.0179	(1; 0.11%)
Pc Io	0.000467	(1; 0.058%)	Eq Io	0.000805	(1; 0.4%)	Bc Mp Ho Io	0.0172	(3; 0.1%)
Sp Io	0.000448	(1; 0.056%)	Ms Io	0.000756	(1; 0.38%)	Rf Io	0.0154	(1; 0.092%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Io	0.0407	(0; 46.%)	Io	0.057	(0; 49.%)	Io	0.0477	(0; 40.%)
Mn Io	0.00976	(1; 11.%)	Mn Io	0.0102	(1; 8.8%)	Bc Mp Ho Io	0.00475	(3; 4.%)
Fo Io	0.00491	(1; 5.5%)	Bk Io	0.00346	(1; 3.%)	Bc Mp Ho Mn	0.00224	(4; 1.9%)
Ts Mn Io	0.00136	(2; 1.5%)	Ts Mn Io	0.00246	(2; 2.1%)	El Io	0.00222	(1; 1.9%)
Rh Io	0.00117	(1; 1.3%)	Wt Io	0.00222	(1; 1.9%)	Rf Io	0.002	(1; 1.7%)
Oc Io	0.00106	(1; 1.2%)	Rf Io	0.00183	(1; 1.6%)	Bc Mp Ch Io	0.00111	(3; 0.93%)
Pc Io	0.000994	(1; 1.1%)	In Io	0.00129	(1; 1.1%)	Bc Mp Bp Io	0.000991	(3; 0.83%)
Ma Io	0.000833	(1; 0.93%)	Pd Io	0.00126	(1; 1.1%)	Bc Mp Ho Bk I	0.000926	(4; 0.77%)
Wt Io	0.000713	(1; 0.8%)	El Io	0.00104	(1; 0.9%)	Wo Ts Mn Io	0.000819	(3; 0.69%)
Bk Io	0.000618	(1; 0.69%)	Rd Io	0.00084	(1; 0.72%)	Dc Dp Io	0.000818	(2; 0.68%)
En Io	0.000599	(1; 0.67%)	Rh Io	0.000695	(1; 0.6%)	Wo Tx Wt Io	0.000786	(3; 0.66%)
Fo Mn Io	0.000548	(2; 0.61%)	Sf Io	0.000655	(1; 0.56%)	Ba Bm Io	0.000761	(2; 0.64%)
Eq Io	0.000538	(1; 0.6%)	Sf Bk Io	0.000625	(2; 0.54%)	Bc Mp Ts Mn	0.00067	(4; 0.56%)
Sg Io	0.000519	(1; 0.58%)	Gv Io	0.000515	(1; 0.44%)	Wo Tx Ru Io	0.000646	(3; 0.54%)
Ru Io	0.000459	(1; 0.51%)	Fn Io	0.000476	(1; 0.41%)	Bc Mp Oc Io	0.000575	(3; 0.48%)
Rf Io	0.000458	(1; 0.51%)	Ma Io	0.000435	(1; 0.37%)	Bc Ch Io	0.000559	(2; 0.47%)
Sm Io	0.000421	(1; 0.47%)	At Io	0.000422	(1; 0.36%)	Bc Mp Bk Io	0.000548	(3; 0.46%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.726 ±0.012	(±1.6%)
Downstream	0.687 ±0.025	(±3.6%)

Sector 13120010: Bauxite (Bx)

Bauxite mining and cleaning

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 10% below average, water use is nearly nine times the average, and land disturbance is 95% below average. The social indicators show that employment generation is 50% below average, income is 40% below average, and government revenue is 40% below average. The financial indicators show that the operating surplus is 25% greater than average, export propensity is equal to average (most exports are from downstream products alumina and aluminium), and the import penetration is 25% below average. Bauxite mining faces few resource limits over the next century.

Sector Description

Australia currently produces 54 million tonnes of bauxite ore yearly, 49 million tonnes of which are processed to alumina, and 5 million tonnes shipped to overseas processors. Six tonnes of bauxite makes approximately two tonnes of alumina which makes one tonne of aluminium. Economic demonstrated resources are 8 700 million tonnes giving an economic life at current production levels of over 160 years. These proven resources give Australia first ranking in world terms, followed by Guinea, Brazil, Jamaica, China, and India. Currently domestic production is 40% of the world total, and is centred on five mines in Weipa in Queensland, Gove in the Northern Territory, and Huntly, Willowdale, and Worsley in the Darling Ranges of Western Australia. In constant dollar terms, the sector turnover has increased by 20% in the last 30 years, despite a fivefold increase in the volume of physical production. This is possibly due to the greater efficiency of physical production, and the transition of aluminium from a metal with special status to an average commodity. Current turnover is about $1.2 billion and involves nine enterprises.

Place of Industry in the Economy

The bauxite mining sector ranks 108th out of 135 sectors in terms of value adding in the economy, and contributes 0.09% of GDP in this analysis. It is similar in value adding to the confectionery manufacturing, and coins, jewellery and sporting goods sectors. It is a small employer with less than 1 000 employment years embodied both directly in final demand, and indirectly through its upstream suppliers. In addition, the sector supplies 2 000 employment years to the downstream processing industries of alumina production and aluminium smelting. It has relatively small resource requirements with less than one tenth of one percent of national energy use, greenhouse emissions, and land disturbance, and less than two tenths of one percent of national water use. In financial terms, exports are approximately equal to imports. In this embodied product analysis, most of the physical processing liabilities are passed on to the value adding stages of alumina production and aluminium smelting, from where the product is sold, and thus enters final demand.

Strategic Overview

The spider diagram portrays a TBL account with significant outliers for the environmental indicators of water and primary energy, and the three social indicators of employment, income, and government revenue. Environmental issues relating to bauxite mining, especially those of mine reclamation, have been addressed by the development and application of leading edge ecologically based approaches. The key downstream issues, outside the scope of this analysis, relate to the carbon intensity of the eventual product aluminium, and potential health impacts of emissions from alumina and aluminium refineries.

TBL Account #1

The financial indicator of operating surplus is 25% above average, and composed of a direct effect of 70%, with contributions from services to mining (4%), electricity production (3%), wholesale trade (1%) and communications (1%). The social indicator of employment generation is 50% below average with a direct effect of 41%, and a similar composition to the surplus indicator. The greenhouse emissions indicator is 10% below average with a direct sector effect of 28% and contributions from electricity production (36%), land development (5%) and diesel refining (3%). Accessing lower carbon electricity could reduce greenhouse emissions.

TBL Accounts #2 and #3

The second TBL account shows that export propensity is average and income is 40% below average. Water use is nine times the average and is discussed in more detail below. The third TBL account shows that import penetration is 25% below average, government revenue is 40% below average, and land disturbance is 95% below average but with some effects on local ecosystems.

Structural Path Analysis and Linkages

Apart from the three social indicators which are outliers in most primary mining sectors due to the capital intensive nature of the industry, the issues that warrant analysis in bauxite mining relate to the water use and primary energy indicators. The structural pathway for the water indicator shows that the direct sector effect represents 97% of the total with minor additions from electricity production, services to mining, and the water delivery sectors. Water is used in bauxite mining to dampen strip mine surfaces and reduce blowing dust and to separate dust from bauxite pebbles, so purifying the ore and increasing the chemical efficiency of the alumina production process. Industry sources suggest that 500 to 1 000 litres per tonne are required, with this analysis giving 750 litres per tonne. Industry sources also suggest that considerable improvements have been implemented in new bauxite washing plants and one mining group has reduced its water use from 2 000 litres per tonne of ore treated, to 500 litres per tonne in a three year period.
The energy outlier is composed of electricity (36%), fuel combusted directly within the sector, presumably mainly for mining machines (35%), diesel refining (4%), basic chemicals (1%) and wholesale trade (1%). The electricity and diesel engine fuel together make up 71% of total energy consumption. Bauxite extraction, treatment and crushing are physical activities and energy efficiency may be approaching the process limit.

The sector's stimulus to its upstream suppliers is 25% below the economy wide average and impacts on services to mining, wholesale trade, electricity supply, and property development and real estate. The linkages to downstream industries are 10% greater than average and composed of two dominant links to alumina production and aluminium smelting.

Future Trends in Sector

Under the base case scenario of the *Future Dilemmas* study, bauxite mining may double over the next 50 years, from 54 million tonnes currently to 110 million tonnes in 2050. This is feasible given the proven stocks of Australian bauxite and its record as a reliable low cost supplier.

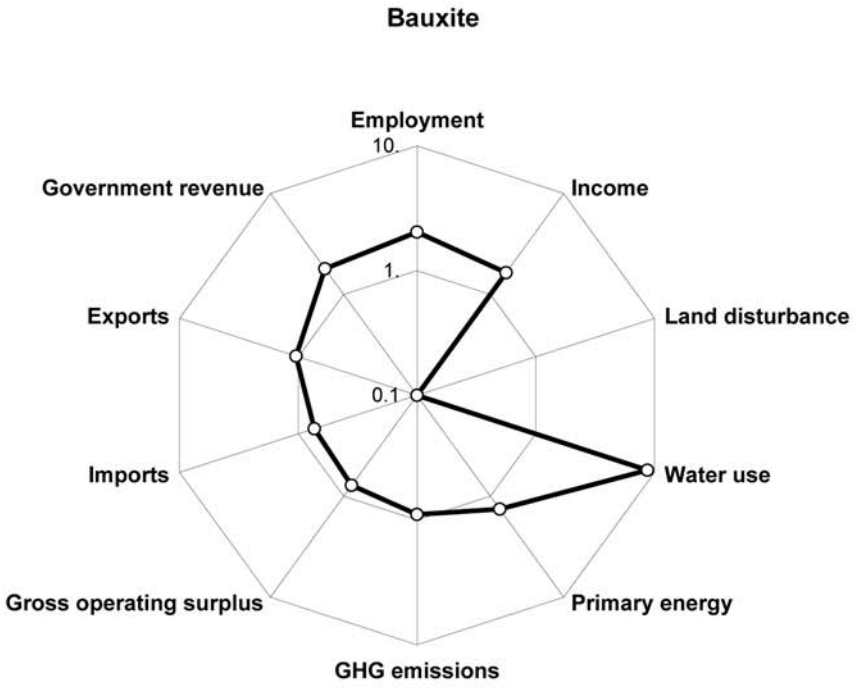
Innovation and Technical Opportunities

Reducing the water content of bauxite mining is a well progressed management issue, leaving energy and greenhouse as the next process challenge. Tests are well underway in Canada of fuel cell powered mining machinery which could double the efficiency of fuel usage, provided that tractable fuels such as methanol were used. Currently fuel cells are fuelled by hydrogen or hydride compounds which generally have an indirect or hidden carbon dioxide content, due to the method of producing gaseous hydrogen from reforming of natural gas, or from the gasification of coal.

Sector **Bauxite** **(Bx)**

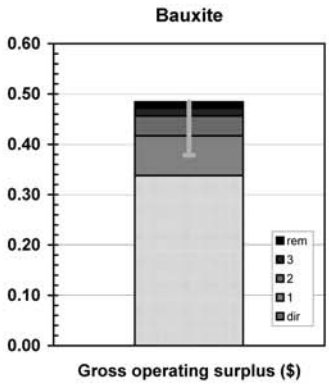
Bauxite

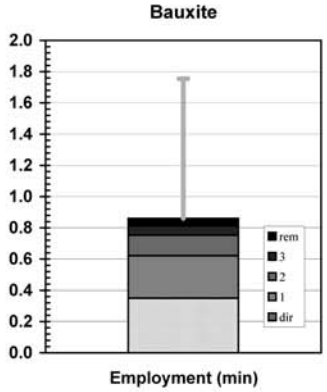
Spider diagram

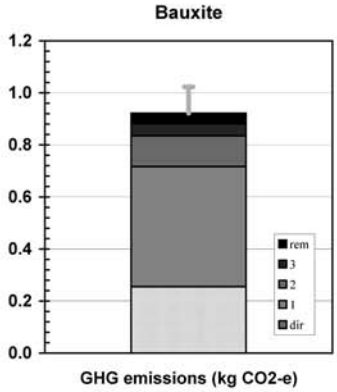


Bar graphs

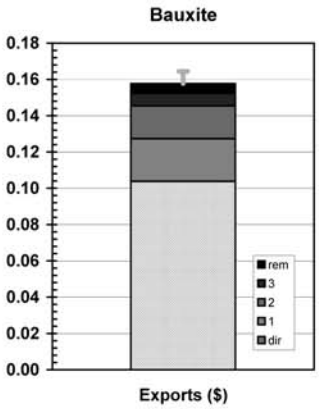
Account #1

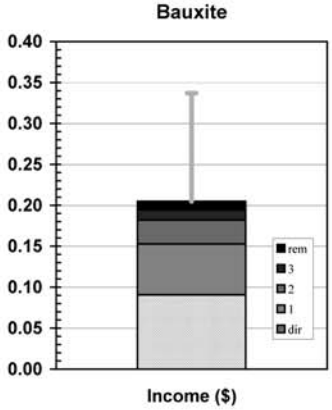


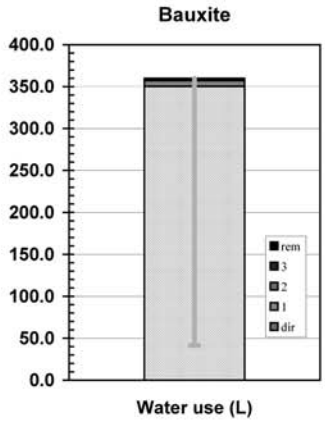




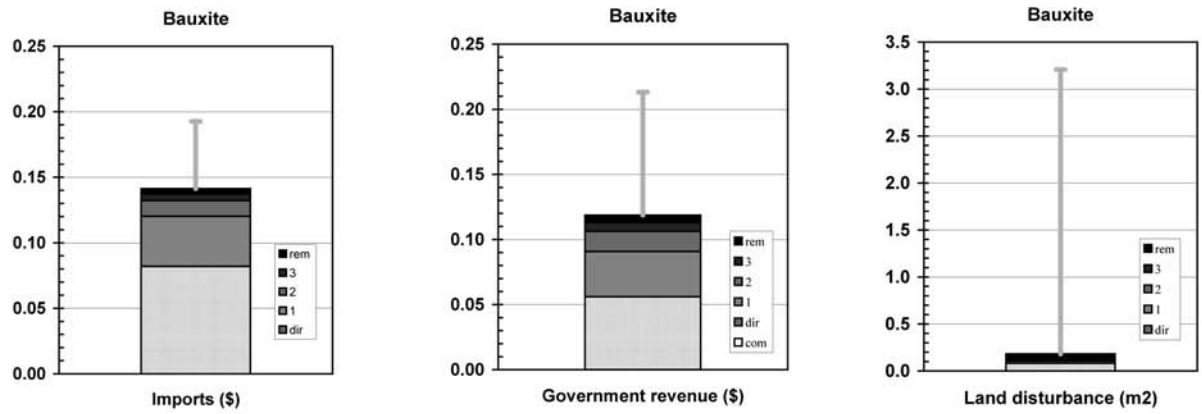
Account #2







Account #3



National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 0.0		
Government final consumption	$m 0.0		
Gross fixed capital expenditure	$m 0.0		
Net changes in stocks	$m 2.6	(0.15% of total)	($m 2.6 domestically produced)
Sectoral GNE	**$m 2.6**	**(0.00% of GNE)**	**($m 2.6 domestically produced)**
Exports	$m 85.1	(0.10% of total)	($m 85.1 domestically produced)
Final demand	**$m 87.7**	**(0.02% of GNT)**	**($m 87.7 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 74.3	(0.04% of total)	
Gross operating surplus	$m 277.0	(0.14% of total)	
Taxes less subsidies	$m 46.0	(0.05% of total)	
Sectoral GDP*	**$m 397.3**	**(0.09% of GDP)**	
Imports	$m 67.2	(0.07% of total)	
Primary inputs	**$m 464.5**	**(0.09% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 277.0	(0.14%)	$m 29.6	(0.02%)	$m 42.5	(0.02%)
Exports ($m)	$m 85.1	(0.10%)	$m 9.1	(0.01%)	$m 13.8	(0.02%)
Imports ($m)	$m 67.2	(0.07%)	$m 7.2	(0.01%)	$m 12.4	(0.01%)
Employment (e-y)	2,293 e-y	(0.03%)	245 e-y	(0.00%)	605 e-y	(0.01%)
Income ($m)*	$m 74.3	(0.04%)	$m 7.9	(0.00%)	$m 18.0	(0.01%)
Government revenue ($m)†	$m 46.0	(0.04%)	$m 4.9	(0.00%)	$m 10.4	(0.01%)
GHG emissions (kt CO_2-e)	209 kt	(0.04%)	22 kt	(0.00%)	81 kt	(0.02%)
Water use (ML)	287,297 ML	(1.37%)	30,714 ML	(0.15%)	31,558 ML	(0.15%)
Land disturbance (kha)	7 kha	(0.00%)	1 kha	(0.00%)	2 kha	(0.00%)
Primary energy (TJ)	2,980 TJ	(0.08%)	319 TJ	(0.01%)	901 TJ	(0.02%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.34	0.48	0.38
Exports ($)	0.10	0.16	0.16
Imports ($)	0.08	0.14	0.19
Employment (min)	0.35	0.86	1.75
Income ($)	0.09	0.20	0.34
Government revenue ($)	0.06	0.12	0.21
GHG emissions (kg CO_2-e)	0.26	0.92	1.02
Water use (L)	350.31	359.94	41.32
Land disturbance (m^2)	0.08	0.18	3.21
Primary energy (MJ)	3.63	10.27	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Bx	0.338	(0; 70.%)	Bx	0.349	(0; 41.%)	El Bx	0.332	(1; 36.%)
Mn Bx	0.0193	(1; 4.%)	Wt Bx	0.0409	(1; 4.7%)	Bx	0.255	(0; 28.%)
El Bx	0.0134	(1; 2.8%)	Mn Bx	0.0405	(1; 4.7%)	Fr Bx	0.044	(1; 4.8%)
Wt Bx	0.00568	(1; 1.2%)	Nb Bx	0.0218	(1; 2.5%)	Fo Bx	0.0279	(1; 3.%)
Cm Bx	0.00523	(1; 1.1%)	Ts Mn Bx	0.0193	(2; 2.2%)	Ch Bx	0.00856	(1; 0.93%)
Ts Mn Bx	0.00428	(2; 0.88%)	El Bx	0.0149	(1; 1.7%)	Oi Fo Bx	0.00842	(2; 0.91%)
Oi Fo Bx	0.00397	(2; 0.82%)	Cm Bx	0.0145	(1; 1.7%)	Bl El Bx	0.00837	(2; 0.91%)
Bk Bx	0.00303	(1; 0.62%)	Eq Bx	0.0131	(1; 1.5%)	Wt Bx	0.00566	(1; 0.61%)
Sg Bx	0.0027	(1; 0.56%)	Ma Bx	0.012	(1; 1.4%)	Is Bx	0.00483	(1; 0.52%)
Bl El Bx	0.00214	(2; 0.44%)	Bk Bx	0.012	(1; 1.4%)	Ce Bx	0.00455	(1; 0.49%)
Nb Bx	0.00214	(1; 0.44%)	Rd Bx	0.0105	(1; 1.2%)	Is Ma Bx	0.0033	(2; 0.36%)
Sf Bx	0.00213	(1; 0.44%)	Rh Bx	0.00826	(1; 0.96%)	Pc Bx	0.00327	(1; 0.35%)
Rd Bx	0.00178	(1; 0.37%)	Sm Bx	0.00583	(1; 0.68%)	Lm Bx	0.00306	(1; 0.33%)
Fo Bx	0.00154	(1; 0.32%)	Bs Bx	0.00511	(1; 0.59%)	Rd Bx	0.00283	(1; 0.31%)
Rh Bx	0.00135	(1; 0.28%)	Gv Bx	0.00499	(1; 0.58%)	Bl Bx	0.00261	(1; 0.28%)
Pd Bx	0.00134	(1; 0.28%)	Sh Bx	0.00457	(1; 0.53%)	Ga Bx	0.00249	(1; 0.27%)
Eq Bx	0.00133	(1; 0.27%)	Rf Bx	0.0045	(1; 0.52%)	Mn Bx	0.00225	(1; 0.24%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Bx	0.104	(0; 66.%)	Bx	0.0906	(0; 44.%)	Bx	350.3	(0; 97.%)
Wt Bx	0.00464	(1; 2.9%)	Mn Bx	0.0136	(1; 6.6%)	El Bx	1.84	(1; 0.51%)
Bl El Bx	0.00325	(2; 2.1%)	Wt Bx	0.00877	(1; 4.3%)	Mn Bx	1.28	(1; 0.36%)
Oi Fo Bx	0.00272	(2; 1.7%)	Ts Mn Bx	0.00451	(2; 2.2%)	Wa Bx	0.538	(1; 0.15%)
Eq Bx	0.00234	(1; 1.5%)	El Bx	0.00404	(1; 2.%)	Wa El Bx	0.106	(2; 0.03%)
Ma Bx	0.00177	(1; 1.1%)	Cm Bx	0.00328	(1; 1.6%)	Sg Bx	0.0684	(1; 0.019%)
Sg Bx	0.00134	(1; 0.85%)	Nb Bx	0.00325	(1; 1.6%)	Wa Ts Mn Bx	0.0577	(3; 0.016%)
Fo Bx	0.00113	(1; 0.72%)	Bk Bx	0.00297	(1; 1.4%)	Bl El Bx	0.0435	(2; 0.012%)
Bl Bx	0.00101	(1; 0.64%)	Eq Bx	0.00231	(1; 1.1%)	Sm Bx	0.037	(1; 0.01%)
Ch Bx	0.000996	(1; 0.63%)	Ma Bx	0.00226	(1; 1.1%)	Wa Pd Bx	0.0367	(2; 0.01%)
Rf Bx	0.000922	(1; 0.58%)	Rd Bx	0.0018	(1; 0.88%)	Fo Bx	0.0334	(1; 0.0093%)
Pc Bx	0.000771	(1; 0.49%)	Rf Bx	0.00126	(1; 0.62%)	Ws Bx	0.0287	(1; 0.008%)
Oc Bx	0.000723	(1; 0.46%)	Gv Bx	0.00126	(1; 0.61%)	Ch Bx	0.0261	(1; 0.0073%)
Cm Bx	0.000698	(1; 0.44%)	Pd Bx	0.00121	(1; 0.59%)	Wa Ms Bx	0.0233	(2; 0.0065%)
At Bx	0.000694	(1; 0.44%)	Sm Bx	0.001	(1; 0.49%)	Wt Bx	0.0229	(1; 0.0064%)
Ts Mn Bx	0.000679	(2; 0.43%)	In Bx	0.000984	(1; 0.48%)	Wa Ms Wt Bx	0.0212	(3; 0.0059%)
Nf Bx	0.000653	(1; 0.41%)	Ms Bx	0.000945	(1; 0.46%)	Oi Fo Bx	0.0201	(2; 0.0056%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Bx	0.082	(0; 58.%)	Bx	0.0561	(0; 47.%)	Bx	0.0826	(0; 45.%)
Fo Bx	0.00915	(1; 6.5%)	Mn Bx	0.00923	(1; 7.8%)	Fr Bx	0.0141	(1; 7.8%)
Mn Bx	0.00882	(1; 6.2%)	Wt Bx	0.0041	(1; 3.5%)	El Bx	0.00537	(1; 2.9%)
Ma Bx	0.00209	(1; 1.5%)	El Bx	0.00252	(1; 2.1%)	Bc Mp Ho Bx	0.00358	(3; 2.%)
Pc Bx	0.00164	(1; 1.2%)	Ts Mn Bx	0.00222	(2; 1.9%)	Bc Mp Ch Bx	0.0034	(3; 1.9%)
Eq Bx	0.00154	(1; 1.1%)	Bk Bx	0.00164	(1; 1.4%)	Wo Tx Bx	0.00312	(2; 1.7%)
Wt Bx	0.00132	(1; 0.93%)	Cm Bx	0.00157	(1; 1.3%)	Bc Mp Ho Mn	0.00202	(4; 1.1%)
Ts Mn Bx	0.00123	(2; 0.87%)	Nb Bx	0.00137	(1; 1.2%)	Bc Ch Bx	0.00171	(2; 0.94%)
Oc Bx	0.00112	(1; 0.79%)	Rd Bx	0.00128	(1; 1.1%)	Wo Tx Wt Bx	0.00145	(3; 0.8%)
Ch Bx	0.000997	(1; 0.71%)	Eq Bx	0.00115	(1; 0.97%)	Wo Tx Ru Bx	0.000967	(3; 0.53%)
El Bx	0.000932	(1; 0.66%)	Ma Bx	0.00109	(1; 0.92%)	Bc Mp Ho Wt	0.00084	(4; 0.46%)
Cm Bx	0.000895	(1; 0.63%)	In Bx	0.00106	(1; 0.89%)	Ba Bm Bx	0.000798	(2; 0.44%)
Sg Bx	0.000845	(1; 0.6%)	Pd Bx	0.000793	(1; 0.67%)	Wo Ts Mn Bx	0.00074	(3; 0.41%)
Nb Bx	0.000725	(1; 0.51%)	Sf Bx	0.000595	(1; 0.5%)	Bc Mp Bp Bx	0.000672	(3; 0.37%)
Rh Bx	0.000697	(1; 0.49%)	Rf Bx	0.000581	(1; 0.49%)	Rf Bx	0.000633	(1; 0.35%)
Ru Bx	0.000687	(1; 0.49%)	Oi Fo Bx	0.000483	(2; 0.41%)	Bc Mp Oc Bx	0.000606	(3; 0.33%)
Sh Bx	0.000529	(1; 0.37%)	Ms Bx	0.000449	(1; 0.38%)	Bc Mp Ts Mn	0.000605	(4; 0.33%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.794 ±0.011	(±1.4%)
Downstream	1.139 ±0.077	(±6.8%)

Sector 13130010: Copper (Co)

Copper concentrates, oxides, precipitates and ores

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 10% below average, while water use and land disturbance are 70% and 95% below average respectively. The social indicators reveal that income generation is 50% below average, while income and government revenue are both 40% below average. The financial indicators show that the operating surplus is 25% above average, export propensity is nearly three times the average, and import penetration is 25% below average. Copper stewardship programs may possibly develop where copper metal is leased on a regenerative 'cradle to cradle' life cycle basis.

Sector Description

Australia produces about 880 000 tonnes of copper, consumes 190 000 tonnes (22%), and exports 690 000 tonnes (78%) annually. Production is dominated by Queensland with six mines and 53% of production, and South Australia where Olympic Dam produces 23% of the national total. Australia ranks fourth in terms of world supply behind Chile, USA, and Indonesia. Australia has an economic demonstrated resource of 24.3 million tonnes of copper giving an economic life of 28 years at current levels of production. There are an additional 34 million tonnes of resource identified but not yet fully quantified giving an estimated total resource base of 58.5 million tonnes and a possible resource life in excess of 50 years, with future exploration opportunities still to be explored. Worldwide, copper consumption is about 20 million tonnes of which 75% is derived from virgin metal recently mined and smelted and 25% from recycled scrap. Industry sources are confident that demand from developing countries will make up the short fall where it is substituted by aluminium, glass fibre and plastic. In constant dollar terms, the sector's production has tripled in the last 30 years. Turnover is currently about $2 billion and involves 14 enterprises.

Place of Industry in the Economy

The copper mining and concentrating sector (smelting is undertaken in the non-ferrous metals smelting sector) ranks 97th out of 135 sectors in terms of value adding, and contributes 0.11% of GDP in this analysis. It is similar in value adding to the concrete and mortar, and wine and spirit manufacturing sectors. It is a small employer with 1 000 employment years directly embodied in final demand, and another 1 000 years in the sector's upstream suppliers, giving a total of 2 000 employment years. In addition, it contributes 2 000 employment years to the final demand of downstream industries such as non-ferrous metal smelting, electrical equipment, structural metals, and nuts bolts nails and springs. It has small resource requirements in an absolute sense, with less than one tenth of one percent of national water use, land disturbance, energy use, and greenhouse emissions. In financial terms, exports outweigh imports by a factor of 4:1.

Strategic Overview

The spider diagram shows the copper mining and concentrating sector has positive environmental and financial indicators, but outliers in the three social indicators of employment generation, income, and government revenue. Copper shares this type of TBL profile with most of the mining commodities which compete on a world market against efficient low wage suppliers. There are downstream issues for copper in its status as a heavy metal, with ecotoxic effects when it is liberated to the environment. Metal stewardship approaches may possibly develop where miners and recyclers integrate and lease copper products on a 'cradle to cradle' life cycle basis.

TBL Account #1

The financial indicator of operating surplus is 25% above average, and 70% of this total is a direct sector effect with additional contributions from mining services (4%), electricity generation (3%), wholesale trade (1%), communications (1%) and technical services (1%). The social indicator of employment generation is 50% below average and of that, 41% is a direct sector effect and a similar makeup to the surplus indicator. The environmental indicator of greenhouse emissions is 10% below average with a direct sector effect of 28%, and contributions from electricity generation (36%), land preparation (5%), diesel refining (3%), basic chemicals (1%), and oil production leading to diesel refining (1%). Greenhouse emissions could be reduced in two areas: reducing fuel combustion in mining and concentrating and by sourcing lower carbon forms of electricity (possibly from natural gas fired gas turbines). Installing variable speed electrical motors, where motor activity responds directly to the load, can reduce electricity consumption by 25% in many applications.

TBL Accounts #2 and #3

The second TBL account shows an export propensity that is nearly three times the average and income that is 40% below average. Water use is 70% below average but some water extraction is locally significant. The third TBL account reveals an import penetration indicator 25% below average, government revenue 40% below average, and land disturbance 95% below average.

Structural Path Analysis and Linkages

For the three social indicators, the structural path analysis reveals that the direct sector effects are 41%, 44% and 47% for employment, income and government revenue, suggesting that any improvement probably has to come from within the sector. In common with the other mining sectors, there are additions from mining services (6%), wholesale trade (4%), technical services (2%) and electricity generation (2%), but most of these categories are already well focused and efficient in a low-labour sense and are unlikely to augment these social indicators appreciably.

The sector's stimulus to its upstream suppliers is 20% below average and impacts on services to mining, wholesale trade, electricity production, and property development. The linkages to downstream industries are 40% above average due mainly to the non-ferrous metal smelting and products sector, with minor linkages to electrical equipment, structural metal products, nuts bolts nails and springs, and government administration.

Future Trends in Sector

Under the base case scenario of the *Future Dilemmas* study, a mixed basket of metals including copper are anticipated to double yearly production by the year 2050 i.e. from 880 000 tonnes currently to 1.76 million tonnes. Using the economic demonstrated resource of 24.3 million tonnes and the identified resource of 34.2 million tonnes, the doubling of production is physically feasible with the total stock of 58.5 million tonnes exhausted in the year 2047. It is assumed that improvements in extraction efficiency will allow the identified resources to be mined economically, and that exploration success from the 'glass earth' exploration technologies will identify additional stocks to allow the copper sector to continue after the middle of the century.

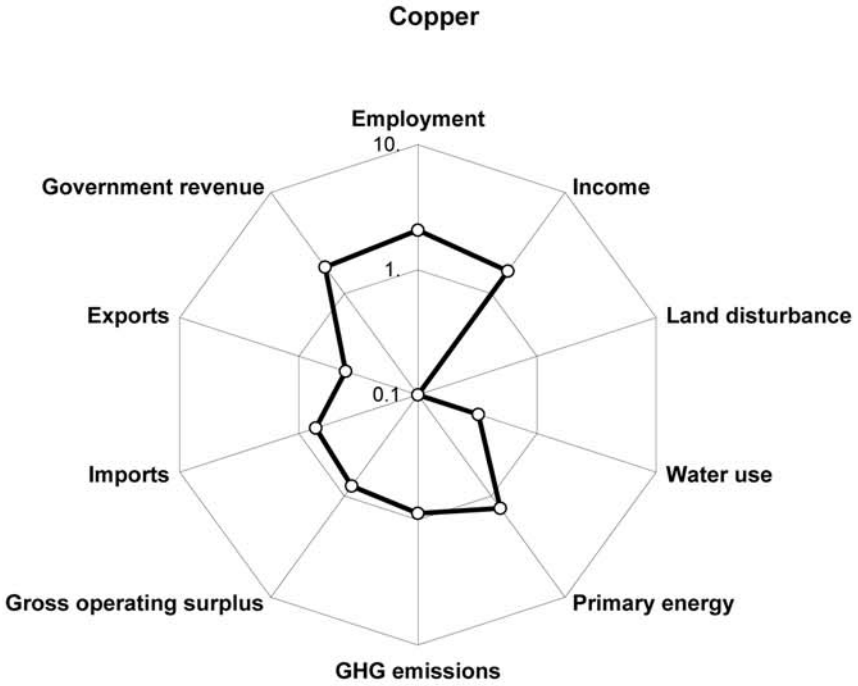
Innovation and Technical Opportunities

In many industrialised countries it is possible that the economy-wide stock of copper embodied in infrastructure, which becomes available during stock turnover and substitution, is sufficient to form a sustainable source of fully recycled copper well into the future. This may impact negatively on copper mining for virgin copper. Copper's heavy metal status will come under more scrutiny, particularly the possibility of bio-magnification as it moves through the food web after human use.

Sector **Copper** **(Co)**

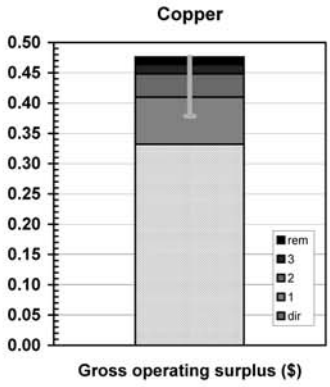
Copper concentrates, oxides, precipitates and ores

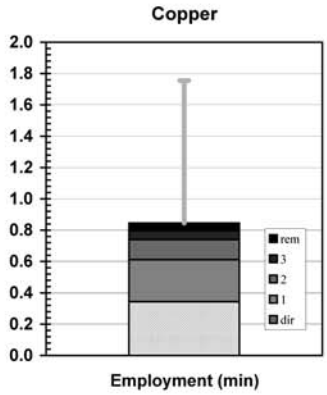
Spider diagram

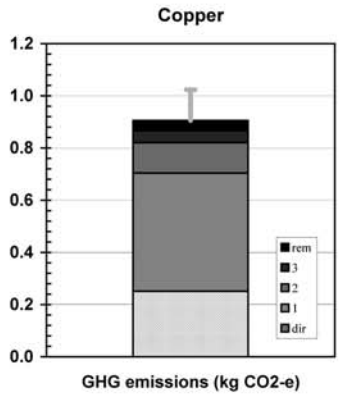


Bar graphs

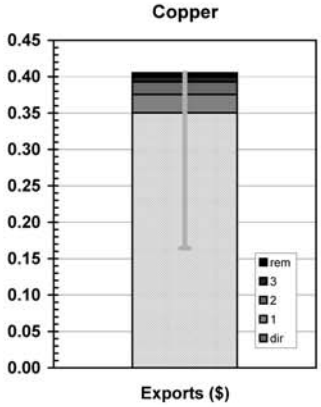
Account #1

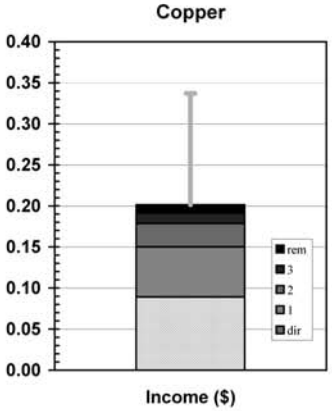


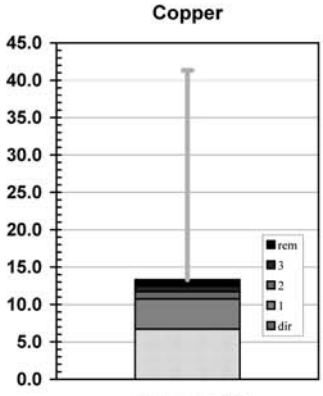




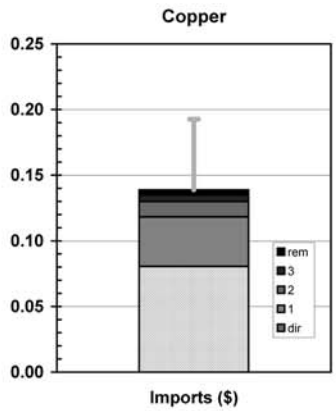
Account #2

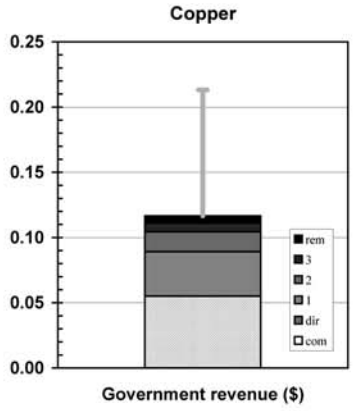


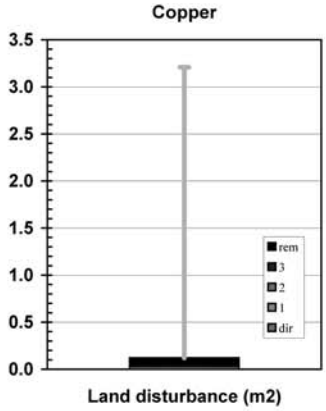




Account #3







National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 0.0		
Government final consumption	$m 0.0		
Gross fixed capital expenditure	$m 0.0		
Net changes in stocks	-$m 19.1	-(1.08% of total)	
Sectoral GNE	**-$m 19.1**	**(0.00% of GNE)**	
Exports	$m 374.6	(0.45% of total)	($m 374.6 domestically produced)
Final demand	**$m 355.4**	**(0.07% of GNT)**	**($m 356.1 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 95.2	(0.06% of total)	
Gross operating surplus	$m 355.1	(0.19% of total)	
Taxes less subsidies	$m 58.9	(0.07% of total)	
Sectoral GDP*	**$m 509.2**	**(0.11% of GDP)**	
Imports	$m 86.2	(0.09% of total)	
Primary inputs	**$m 595.4**	**(0.11% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 355.1	(0.19%)	$m 124.3	(0.06%)	$m 178.3	(0.09%)
Exports ($m)	$m 374.6	(0.45%)	$m 131.1	(0.16%)	$m 151.8	(0.18%)
Imports ($m)	$m 86.2	(0.09%)	$m 30.2	(0.03%)	$m 52.0	(0.05%)
Employment (e-y)	2,939 e-y	(0.04%)	1,029 e-y	(0.01%)	2,538 e-y	(0.04%)
Income ($m)*	$m 95.2	(0.06%)	$m 33.3	(0.02%)	$m 75.4	(0.04%)
Government revenue ($m)†	$m 58.9	(0.05%)	$m 20.6	(0.02%)	$m 43.7	(0.04%)
GHG emissions (kt CO_2-e)	268 kt	(0.05%)	94 kt	(0.02%)	339 kt	(0.07%)
Water use (ML)	7,172 ML	(0.03%)	2,511 ML	(0.01%)	4,988 ML	(0.02%)
Land disturbance (kha)	3 kha	(0.00%)	1 kha	(0.00%)	5 kha	(0.00%)
Primary energy (TJ)	3,820 TJ	(0.10%)	1,337 TJ	(0.03%)	3,780 TJ	(0.10%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.33	0.48	0.38
Exports ($)	0.35	0.41	0.16
Imports ($)	0.08	0.14	0.19
Employment (min)	0.34	0.85	1.75
Income ($)	0.09	0.20	0.34
Government revenue ($)	0.06	0.12	0.21
GHG emissions (kg CO_2-e)	0.25	0.91	1.02
Water use (L)	6.70	13.32	41.32
Land disturbance (m^2)	0.02	0.12	3.21
Primary energy (MJ)	3.57	10.09	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Co	0.332	(0; 70.%)	Co	0.343	(0; 41.%)	El Co	0.327	(1; 36.%)
Mn Co	0.0189	(1; 4.%)	Wt Co	0.0402	(1; 4.7%)	Co	0.251	(0; 28.%)
El Co	0.0132	(1; 2.8%)	Mn Co	0.0398	(1; 4.7%)	Fr Co	0.0432	(1; 4.8%)
Wt Co	0.00558	(1; 1.2%)	Nb Co	0.0214	(1; 2.5%)	Fo Co	0.0275	(1; 3.%)
Cm Co	0.00514	(1; 1.1%)	Ts Mn Co	0.0189	(2; 2.2%)	Ch Co	0.00842	(1; 0.93%)
Ts Mn Co	0.00421	(2; 0.88%)	El Co	0.0147	(1; 1.7%)	Oi Fo Co	0.00827	(2; 0.91%)
Oi Fo Co	0.00391	(2; 0.82%)	Cm Co	0.0142	(1; 1.7%)	Bl El Co	0.00823	(2; 0.91%)
Bk Co	0.00297	(1; 0.62%)	Eq Co	0.0129	(1; 1.5%)	Wt Co	0.00557	(1; 0.61%)
Sg Co	0.00265	(1; 0.56%)	Ma Co	0.0118	(1; 1.4%)	Is Co	0.00474	(1; 0.52%)
Bl El Co	0.0021	(2; 0.44%)	Bk Co	0.0118	(1; 1.4%)	Ce Co	0.00447	(1; 0.49%)
Nb Co	0.0021	(1; 0.44%)	Rd Co	0.0103	(1; 1.2%)	Is Ma Co	0.00324	(2; 0.36%)
Sf Co	0.00209	(1; 0.44%)	Rh Co	0.00812	(1; 0.96%)	Pc Co	0.00321	(1; 0.35%)
Rd Co	0.00175	(1; 0.37%)	Sm Co	0.00572	(1; 0.68%)	Lm Co	0.003	(1; 0.33%)
Fo Co	0.00151	(1; 0.32%)	Bs Co	0.00502	(1; 0.59%)	Rd Co	0.00278	(1; 0.31%)
Rh Co	0.00133	(1; 0.28%)	Gv Co	0.00491	(1; 0.58%)	Bl Co	0.00256	(1; 0.28%)
Pd Co	0.00132	(1; 0.28%)	Sh Co	0.00449	(1; 0.53%)	Ga Co	0.00245	(1; 0.27%)
Eq Co	0.0013	(1; 0.27%)	Rf Co	0.00442	(1; 0.52%)	Mn Co	0.00221	(1; 0.24%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Co	0.35	(0; 86.%)	Co	0.089	(0; 44.%)	Co	6.7	(0; 50.%)
Wt Co	0.00456	(1; 1.1%)	Mn Co	0.0133	(1; 6.6%)	El Co	1.81	(1; 14.%)
Bl El Co	0.00319	(2; 0.79%)	Wt Co	0.00862	(1; 4.3%)	Mn Co	1.26	(1; 9.5%)
Oi Fo Co	0.00267	(2; 0.66%)	Ts Mn Co	0.00443	(2; 2.2%)	Wa Co	0.529	(1; 4.%)
Eq Co	0.0023	(1; 0.57%)	El Co	0.00397	(1; 2.%)	Wa El Co	0.104	(2; 0.78%)
Ma Co	0.00174	(1; 0.43%)	Cm Co	0.00323	(1; 1.6%)	Sg Co	0.0672	(1; 0.5%)
Sg Co	0.00132	(1; 0.33%)	Nb Co	0.0032	(1; 1.6%)	Wa Ts Mn Co	0.0567	(3; 0.43%)
Fo Co	0.00112	(1; 0.28%)	Bk Co	0.00291	(1; 1.4%)	Bl El Co	0.0427	(2; 0.32%)
Bl Co	0.000993	(1; 0.25%)	Eq Co	0.00227	(1; 1.1%)	Sm Co	0.0363	(1; 0.27%)
Ch Co	0.000979	(1; 0.24%)	Ma Co	0.00222	(1; 1.1%)	Wa Pd Co	0.0361	(2; 0.27%)
Rf Co	0.000906	(1; 0.22%)	Rd Co	0.00177	(1; 0.88%)	Fo Co	0.0328	(1; 0.25%)
Pc Co	0.000758	(1; 0.19%)	Rf Co	0.00124	(1; 0.62%)	Ws Co	0.0282	(1; 0.21%)
Oc Co	0.00071	(1; 0.18%)	Gv Co	0.00123	(1; 0.61%)	Ch Co	0.0257	(1; 0.19%)
Cm Co	0.000686	(1; 0.17%)	Pd Co	0.00119	(1; 0.59%)	Wa Ms Co	0.0229	(2; 0.17%)
At Co	0.000682	(1; 0.17%)	Sm Co	0.000986	(1; 0.49%)	Wt Co	0.0225	(1; 0.17%)
Ts Mn Co	0.000667	(2; 0.16%)	In Co	0.000967	(1; 0.48%)	Wa Ms Wt Co	0.0208	(3; 0.16%)
Nf Co	0.000641	(1; 0.16%)	Ms Co	0.000929	(1; 0.46%)	Oi Fo Co	0.0197	(2; 0.15%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Co	0.0806	(0; 58.%)	Co	0.0551	(0; 47.%)	Co	0.0245	(0; 20.%)
Fo Co	0.009	(1; 6.5%)	Mn Co	0.00908	(1; 7.8%)	Fr Co	0.0139	(1; 11.%)
Mn Co	0.00866	(1; 6.2%)	Wt Co	0.00403	(1; 3.5%)	El Co	0.00527	(1; 4.3%)
Ma Co	0.00205	(1; 1.5%)	El Co	0.00248	(1; 2.1%)	Bc Mp Ho Co	0.00352	(3; 2.9%)
Pc Co	0.00161	(1; 1.2%)	Ts Mn Co	0.00218	(2; 1.9%)	Bc Mp Ch Co	0.00334	(3; 2.7%)
Eq Co	0.00152	(1; 1.1%)	Bk Co	0.00161	(1; 1.4%)	Wo Tx Co	0.00307	(2; 2.5%)
Wt Co	0.0013	(1; 0.93%)	Cm Co	0.00154	(1; 1.3%)	Bc Mp Ho Mn	0.00199	(4; 1.6%)
Ts Mn Co	0.00121	(2; 0.87%)	Nb Co	0.00135	(1; 1.2%)	Bc Ch Co	0.00168	(2; 1.4%)
Oc Co	0.0011	(1; 0.79%)	Rd Co	0.00125	(1; 1.1%)	Wo Tx Wt Co	0.00143	(3; 1.2%)
Ch Co	0.00098	(1; 0.71%)	Eq Co	0.00113	(1; 0.97%)	Wo Tx Ru Co	0.00095	(3; 0.78%)
El Co	0.000916	(1; 0.66%)	Ma Co	0.00107	(1; 0.92%)	Bc Mp Ho Wt	0.000825	(4; 0.68%)
Cm Co	0.00088	(1; 0.63%)	In Co	0.00104	(1; 0.89%)	Ba Bm Co	0.000784	(2; 0.64%)
Sg Co	0.00083	(1; 0.6%)	Pd Co	0.000779	(1; 0.67%)	Wo Ts Mn Co	0.000727	(3; 0.6%)
Nb Co	0.000712	(1; 0.51%)	Sf Co	0.000585	(1; 0.5%)	Bc Mp Bp Co	0.00066	(3; 0.54%)
Rh Co	0.000685	(1; 0.49%)	Rf Co	0.000571	(1; 0.49%)	Rf Co	0.000623	(1; 0.51%)
Ru Co	0.000675	(1; 0.49%)	Oi Fo Co	0.000474	(2; 0.41%)	Bc Mp Oc Co	0.000596	(3; 0.49%)
Sh Co	0.00052	(1; 0.37%)	Ms Co	0.000441	(1; 0.38%)	Bc Mp Ts Mn	0.000595	(4; 0.49%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.780 ±0.011	(±1.4%)
Downstream	1.372 ±0.072	(±5.2%)

Sectors 13140010 and 13170010: Gold and Lead (Gl)

Gold bullion and ores; lead ores and concentrates (excluding silver-lead-zinc)

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 35% below average, while water use and land disturbance are 85% and 95% below average respectively. The social indicators show that employment generation, income and government revenue are 60%, 50%, and 50% below average respectively. The financial indicators show that operating surplus is 10% above average, export propensity is nearly six times the average, and import penetration is 40% below average. Gold seems assured of a relatively buoyant future with increasing industrial uses as well as its traditional use as a hedge against inflation, but the large material flows associated with its extraction may come under more scrutiny. The leakage of lead into the biosphere will catalyse whole-of-life stewardship efforts on a cradle-to-cradle basis.

Sector Description

Civilisation's fascination with gold began over 8 000 years ago and about 145 000 tonnes have been mined since 2 000 BC. Only 10 000 tonnes of this had been mined up to the Californian Gold Rush in 1848. About 60% of the total 'ever mined' has occurred since 1950, and central banks now hold 32 000 tonnes in stock. Australia has economic demonstrated reserves of 5 165 tonnes and yearly production of 260 tonnes giving an economic life of 18-20 years, although there is considerable ongoing exploration in both brownfield and greenfield sites. Australia is ranked third in world gold production behind South Africa and USA, and is followed by Russia. The economic demonstrated resource for lead in Australia is 17.3 million tonnes and total identified resources are 50.6 million tonnes. Lead production is more than 700 000 tonnes annually, giving a current economic life of 25 years. Lead is already the focus of a concerted metal stewardship program to substantially increase recovery and recycling rates which are currently low. In constant dollar terms, gold has increased by a factor of 40 over the last 30 years, while lead is still at the same level after a major peak and decline in the late 1970s. Currently the turnover is about $6 billion and involves 90 enterprises.

Place of Industry in the Economy

The gold and lead sector ranks 40th out of 135 in terms of value adding in the economy, and contributes 0.49% of GDP in this analysis. It is similar in value adding to the money market corporation and credit unions sector and the railway freight sector. It is a moderate employer with 11 000 employment years directly embodied in final demand, and 16 000 years in the sector's suppliers giving a total of 27 000 employment years. In addition, it contributes 2 000 employment years to the final demand of downstream industries, particularly non-ferrous metal smelting and products. It has moderate resource requirements with nearly one percent of national energy use, one half of one percent of greenhouse emissions, and about one tenth of one percent of national water use and land disturbance. In financial terms, exports are twelve times the level of imports.

Strategic Overview

The spider diagram shows three outliers for the social indicators, and positive outcomes for the financial and environmental indicators. This signature is typical of a primary mining sector. The downstream issues of material flows associated with gold extraction and lead leakage to the biosphere may require regulatory changes, which could increase the labour requirements.

TBL Account #1

The financial indicator of operating surplus is 10% above average, and shows a direct sector effect of 70% with additional contributions from services to mining (4%), electricity generation (3%), wholesale trade (1%), communications (1%) and technical services (1%). The social indicator of employment generation is 60% below average, and is discussed in more detail below. The environmental indicator of greenhouse emissions is 35% below average. It has a direct effect of 13% with contributions from electricity generation (44%), land preparation (6%), diesel refining (4%), basic chemicals (1%), oil production leading to diesel refining (1%), and black coal mining for electricity production (1%). Greenhouse emissions, while already below average, could be further reduced by accessing lower carbon electricity, possibly from more efficient gas turbines.

TBL Accounts #2 and #3

The second TBL account shows export propensity is six times the average, income is 50% below average, and water use is 85% below average. The third TBL account shows import penetration 40% below average and government revenue 80% below average. Land disturbance is 95% below average but mining activities may introduce exotic weeds in new locations.

Structural Path Analysis and Linkages

The structural path analysis for the social indicators are all below average and the direct sector effect accounts for 41%, 44% and 47% of the employment, income and government revenue indicators respectively. The sectors of services to mining, and wholesale trade, each contribute 4-5% of the indicators with smaller contributions from non-building construction, technical services, and electricity generation. Whether these social indicators should be closer to the economy wide average is a complex debate. Currently most states levy mineral producers at 3-4% of the ex-mine value for their products. In Western Australia, the introduction of this levy to gold production caused a widespread debate about the viability issues and prompted the development of a two tier system where smaller producers are partially exempted. In an aggregate sense, many nations seek to balance imports and exports for a range of macro economic goals. Maintaining a flow of competitively price mining exports contributes to this policy, and less than average social returns could be seen as part of the trade off between the social goal of employment and the economic goal of export income.

The sector's stimulus to its upstream suppliers is 25% below the economy wide average and focuses on services to mining, wholesale trade and electricity generation. The linkages to downstream industries are 65% below average as most of the effect is dissipated by exports, apart from one linkage to the non-ferrous metal smelting and products sector.

Future Trends in Sector

In the base case scenario of the *Future Dilemmas* study, gold production is anticipated to remain at around 300 tonnes per annum until about 2020 when the price constraints of central banks stocks of gold lift, and gold production then increases gradually to 500 tonnes per annum by 2050. This scenario assumed continued exploration success in finding and proving deeper sources of gold deposits. Lead production, included in a generalised basket of metals, is assumed to double by 2050.

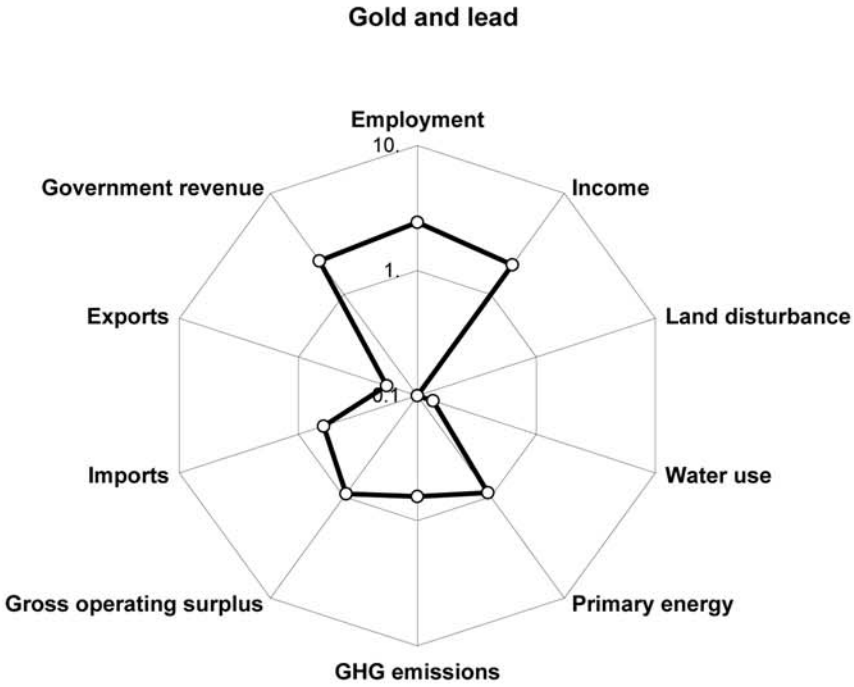
Innovation and Technical Opportunities

Expected innovations in personal vehicles may possibly control future demand for both gold and lead. Gold is seen as a possible replacement for the rarer metals such as platinum in building fuel cells for vehicle drive trains. Hybrid and hyper-cars will require increased battery storage and perhaps higher voltages. Advanced lead acid batteries currently have cost advantages, and full stewardship of the lead cycle will assist in containing the leakage of lead into the biosphere.

Sector **Gold and lead** **(GI)**

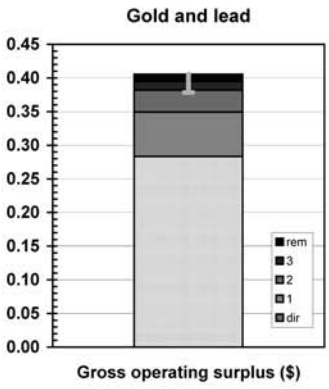
Gold bullion and ores; lead ores and concentrates (excl silver-lead-zinc)

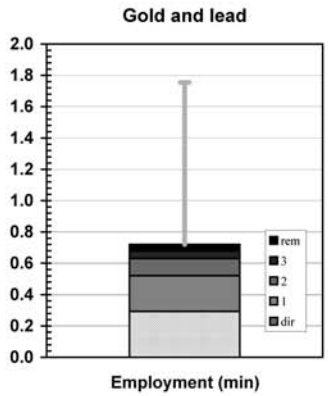
Spider diagram

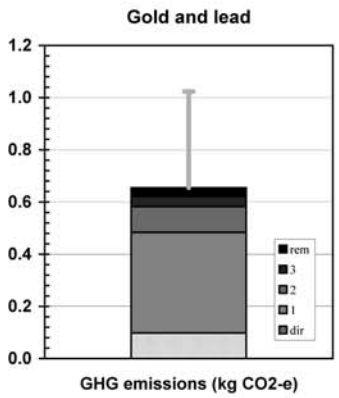


Bar graphs

Account #1







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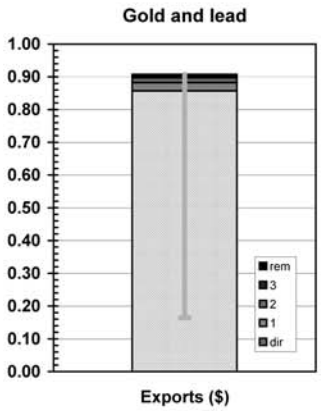

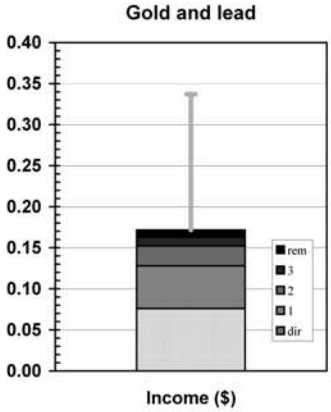

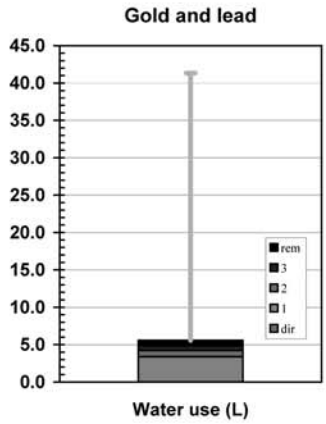

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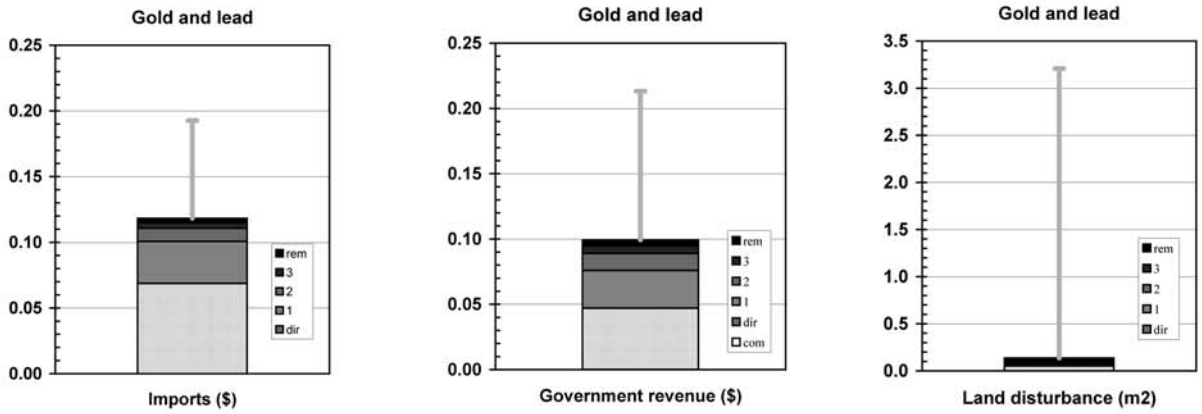


National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 0.0		
Government final consumption	$m 0.0		
Gross fixed capital expenditure	$m 0.0		
Net changes in stocks	-$m 332.0	-(18.78% of total)	
Sectoral GNE	**-$m 332.0**	**(0.07% of GNE)**	
Exports	$m 4,630.2	(5.55% of total)	($m 4,630.2 domestically produced)
Final demand	**$m 4,298.3**	**(0.79% of GNT)**	**($m 3,757.3 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 410.1	(0.24% of total)	
Gross operating surplus	$m 1,529.4	(0.80% of total)	
Taxes less subsidies	$m 253.8	(0.30% of total)	
Sectoral GDP*	**$m 2,193.3**	**(0.49% of GDP)**	
Imports	$m 371.2	(0.38% of total)	
Primary inputs	**$m 2,564.5**	**(0.47% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 1,529.4	(0.80%)	$m 1,311.2	(0.68%)	$m 1,878.2	(0.98%)
Exports ($m)	$m 4,630.2	(5.55%)	$m 3,969.7	(4.76%)	$m 4,203.7	(5.04%)
Imports ($m)	$m 371.2	(0.38%)	$m 318.2	(0.33%)	$m 547.9	(0.56%)
Employment (e-y)	12,657 e-y	(0.18%)	10,851 e-y	(0.15%)	26,732 e-y	(0.38%)
Income ($m)*	$m 410.1	(0.24%)	$m 351.6	(0.21%)	$m 794.7	(0.47%)
Government revenue ($m)†	$m 253.8	(0.23%)	$m 217.6	(0.20%)	$m 459.8	(0.43%)
GHG emissions (kt CO_2-e)	527 kt	(0.10%)	452 kt	(0.09%)	3,032 kt	(0.58%)
Water use (ML)	2 ML	(0.00%)	2 ML	(0.00%)	25,875 ML	(0.12%)
Land disturbance (kha)	29 kha	(0.02%)	25 kha	(0.02%)	63 kha	(0.04%)
Primary energy (TJ)	7,659 TJ	(0.20%)	6,567 TJ	(0.17%)	32,226 TJ	(0.83%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.28	0.41	0.38
Exports ($)	0.86	0.91	0.16
Imports ($)	0.07	0.12	0.19
Employment (min)	0.29	0.72	1.75
Income ($)	0.08	0.17	0.34
Government revenue ($)	0.05	0.10	0.21
GHG emissions (kg CO_2-e)	0.10	0.65	1.02
Water use (L)	0.00	5.59	41.32
Land disturbance (m^2)	0.05	0.14	3.21
Primary energy (MJ)	1.42	6.96	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Gl	0.283	(0; 70.%)	Gl	0.292	(0; 41.%)	El Gl	0.279	(1; 43.%)
Mn Gl	0.0161	(1; 4.%)	Wt Gl	0.0343	(1; 4.8%)	Gl	0.0976	(0; 15.%)
El Gl	0.0113	(1; 2.8%)	Mn Gl	0.0339	(1; 4.7%)	Fr Gl	0.0369	(1; 5.6%)
Wt Gl	0.00476	(1; 1.2%)	Nb Gl	0.0183	(1; 2.5%)	Fo Gl	0.0234	(1; 3.6%)
Cm Gl	0.00439	(1; 1.1%)	Ts Mn Gl	0.0162	(2; 2.2%)	Ch Gl	0.00718	(1; 1.1%)
Ts Mn Gl	0.00359	(2; 0.88%)	El Gl	0.0125	(1; 1.7%)	Oi Fo Gl	0.00706	(2; 1.1%)
Oi Fo Gl	0.00333	(2; 0.82%)	Cm Gl	0.0121	(1; 1.7%)	Bl El Gl	0.00702	(2; 1.1%)
Bk Gl	0.00254	(1; 0.63%)	Eq Gl	0.011	(1; 1.5%)	Wt Gl	0.00475	(1; 0.73%)
Sg Gl	0.00226	(1; 0.56%)	Ma Gl	0.0101	(1; 1.4%)	Is Gl	0.00405	(1; 0.62%)
Bl El Gl	0.0018	(2; 0.44%)	Bk Gl	0.0101	(1; 1.4%)	Ce Gl	0.00381	(1; 0.58%)
Nb Gl	0.00179	(1; 0.44%)	Rd Gl	0.00877	(1; 1.2%)	Is Ma Gl	0.00277	(2; 0.42%)
Sf Gl	0.00178	(1; 0.44%)	Rh Gl	0.00693	(1; 0.96%)	Pc Gl	0.00274	(1; 0.42%)
Rd Gl	0.00149	(1; 0.37%)	Sm Gl	0.00488	(1; 0.68%)	Lm Gl	0.00256	(1; 0.39%)
Fo Gl	0.00129	(1; 0.32%)	Bs Gl	0.00428	(1; 0.59%)	Rd Gl	0.00237	(1; 0.36%)
Rh Gl	0.00113	(1; 0.28%)	Gv Gl	0.00419	(1; 0.58%)	Bl Gl	0.00218	(1; 0.33%)
Pd Gl	0.00112	(1; 0.28%)	Sh Gl	0.00383	(1; 0.53%)	Ga Gl	0.00209	(1; 0.32%)
Eq Gl	0.00111	(1; 0.27%)	Rf Gl	0.00377	(1; 0.52%)	Mn Gl	0.00189	(1; 0.29%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Gl	0.857	(0; 94.%)	Gl	0.0759	(0; 44.%)	El Gl	1.54	(1; 28.%)
Wt Gl	0.00389	(1; 0.43%)	Mn Gl	0.0114	(1; 6.6%)	Mn Gl	1.08	(1; 19.%)
Bl El Gl	0.00272	(2; 0.3%)	Wt Gl	0.00735	(1; 4.3%)	Wa Gl	0.451	(1; 8.1%)
Oi Fo Gl	0.00228	(2; 0.25%)	Ts Mn Gl	0.00378	(2; 2.2%)	Wa El Gl	0.0891	(2; 1.6%)
Eq Gl	0.00196	(1; 0.22%)	El Gl	0.00339	(1; 2.%)	Sg Gl	0.0573	(1; 1.%)
Ma Gl	0.00148	(1; 0.16%)	Cm Gl	0.00275	(1; 1.6%)	Wa Ts Mn Gl	0.0484	(3; 0.87%)
Sg Gl	0.00112	(1; 0.12%)	Nb Gl	0.00273	(1; 1.6%)	Bl El Gl	0.0364	(2; 0.65%)
Fo Gl	0.000951	(1; 0.1%)	Bk Gl	0.00249	(1; 1.4%)	Sm Gl	0.031	(1; 0.55%)
Bl Gl	0.000848	(1; 0.093%)	Eq Gl	0.00194	(1; 1.1%)	Wa Pd Gl	0.0308	(2; 0.55%)
Ch Gl	0.000835	(1; 0.092%)	Ma Gl	0.00189	(1; 1.1%)	Fo Gl	0.028	(1; 0.5%)
Rf Gl	0.000773	(1; 0.085%)	Rd Gl	0.00151	(1; 0.88%)	Ws Gl	0.0241	(1; 0.43%)
Pc Gl	0.000646	(1; 0.071%)	Rf Gl	0.00106	(1; 0.62%)	Ch Gl	0.0219	(1; 0.39%)
Oc Gl	0.000606	(1; 0.067%)	Gv Gl	0.00105	(1; 0.61%)	Wa Ms Gl	0.0195	(2; 0.35%)
Cm Gl	0.000585	(1; 0.064%)	Pd Gl	0.00101	(1; 0.59%)	Wt Gl	0.0192	(1; 0.34%)
At Gl	0.000582	(1; 0.064%)	Sm Gl	0.000841	(1; 0.49%)	Wa Ms Wt Gl	0.0177	(3; 0.32%)
Ts Mn Gl	0.000569	(2; 0.063%)	In Gl	0.000825	(1; 0.48%)	Oi Fo Gl	0.0168	(2; 0.3%)
Nf Gl	0.000547	(1; 0.06%)	Ms Gl	0.000792	(1; 0.46%)	Ws Ho Gl	0.0152	(2; 0.27%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Gl	0.0687	(0; 58.%)	Gl	0.047	(0; 47.%)	Gl	0.053	(0; 39.%)
Fo Gl	0.00767	(1; 6.5%)	Mn Gl	0.00774	(1; 7.8%)	Fr Gl	0.0118	(1; 8.7%)
Mn Gl	0.00739	(1; 6.2%)	Wt Gl	0.00344	(1; 3.5%)	El Gl	0.0045	(1; 3.3%)
Ma Gl	0.00175	(1; 1.5%)	El Gl	0.00211	(1; 2.1%)	Bc Mp Ho Gl	0.003	(3; 2.2%)
Pc Gl	0.00137	(1; 1.2%)	Ts Mn Gl	0.00186	(2; 1.9%)	Bc Mp Ch Gl	0.00285	(3; 2.1%)
Eq Gl	0.0013	(1; 1.1%)	Bk Gl	0.00137	(1; 1.4%)	Wo Tx Gl	0.00262	(2; 1.9%)
Wt Gl	0.00111	(1; 0.93%)	Cm Gl	0.00132	(1; 1.3%)	Bc Mp Ho Mn	0.0017	(4; 1.2%)
Ts Mn Gl	0.00103	(2; 0.87%)	Nb Gl	0.00115	(1; 1.2%)	Bc Ch Gl	0.00143	(2; 1.1%)
Oc Gl	0.000937	(1; 0.79%)	Rd Gl	0.00107	(1; 1.1%)	Wo Tx Wt Gl	0.00122	(3; 0.9%)
Ch Gl	0.000836	(1; 0.71%)	Eq Gl	0.000961	(1; 0.97%)	Wo Tx Ru Gl	0.00081	(3; 0.59%)
El Gl	0.000782	(1; 0.66%)	Ma Gl	0.000914	(1; 0.92%)	Bc Mp Ho Wt	0.000704	(4; 0.52%)
Cm Gl	0.00075	(1; 0.63%)	In Gl	0.000887	(1; 0.89%)	Ba Bm Gl	0.000669	(2; 0.49%)
Sg Gl	0.000708	(1; 0.6%)	Pd Gl	0.000665	(1; 0.67%)	Wo Ts Mn Gl	0.00062	(3; 0.46%)
Nb Gl	0.000608	(1; 0.51%)	Sf Gl	0.000499	(1; 0.5%)	Bc Mp Bp Gl	0.000563	(3; 0.41%)
Rh Gl	0.000584	(1; 0.49%)	Rf Gl	0.000487	(1; 0.49%)	Rf Gl	0.000531	(1; 0.39%)
Ru Gl	0.000576	(1; 0.49%)	Oi Fo Gl	0.000405	(2; 0.41%)	Bc Mp Oc Gl	0.000508	(3; 0.37%)
Sh Gl	0.000443	(1; 0.37%)	Ms Gl	0.000376	(1; 0.38%)	Bc Mp Ts Mn	0.000507	(4; 0.37%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.665 ±0.010	(±1.4%)
Downstream	0.354 ±0.017	(±4.7%)

Sector 13170020: Silver and Zinc (Sz)

Silver and zinc ores

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 25% below average, while water use and land disturbance are 40% and 95% below average respectively. The social indicator of employment generation is 55% below average, income is 45% below average and government revenue is 50% below average. The financial indicators show that operating surplus is 15% above average, export propensity is nearly five times the average and import penetration is 30% below average. Zinc appears to have a promising future but the stewardship of products during use and at the end of life may have to increase.

Sector Description

Zinc and silver, as mined in ores today, often comes in combination with lead and copper, and the commercial viability of any ore body is based on a complex interaction between the ease of extraction and concentration and fluctuating world commodity prices. Zinc is used mainly as a coating in steel beams, sheets, vehicle panels, zinc pigments, additives to rubber, and for zinc chemicals in agriculture. Australia leads the world with its economic demonstrated resources of zinc (35 million tonnes). When combined with its current yearly production (1.5 million tonnes) this gives a reserve to production ratio or economic life of 23 years. There are at least 40 million tonnes of zinc containing ore identified by exploration, but not yet fully assessed. While silver is no longer a major constituent of coins, it still has many applications in photographic paper and film, electronics, jewellery and tableware. Its use is set to double in the next decade in water treatment, and as a biocide and bacteriostat in plastic and textile formulations. The yearly production of silver is about 2 000 tonnes per year and with an economically demonstrated resource of 42 000 tonnes, this gives an economic life of about 21 years. In constant dollar terms, the sector's turnover has quintupled over the last 30 years and is currently about $1 billion, involveing nine enterprises.

Place of Industry in the Economy

The silver and zinc sector ranks 119th out of 135 sectors in terms of value adding in the economy, and contributes 0.06% of GDP in this analysis. It is similar in value adding to the cement manufacture and unmilled barley sectors. The sector is a small employer with 1 000 employment years directly embodied in final demand, and another 1 000 years in the sector's upstream suppliers giving a total of 2 000 employment years. In addition, it contributes 500 employment years to the final demand of downstream industries, particularly the non-ferrous metal smelting sector. It has relatively small resource requirements in absolute terms, with less than one tenth of one percent of national land disturbance, water use, energy use, and greenhouse emissions. In financial terms, exports are about eight times the size of imports.

Strategic Overview

The spider diagram portrays a sector with relatively good environmental indicators, excellent financial indicators and below average social indicators. This is typical of the basic mining sectors where the social indicators are pressured on one side by export orientated production levels and commodity prices in globalised markets, and on the other by the need to maintain a continuing supply of suitably trained workers in remote locations. A downstream issue faced by all mining commodities is that resource rents and profits are not invested in the region of extraction, and so longer term benefits of mining accrue to areas of capital accumulation in cities, and overseas.

TBL Account #1

The financial indicator of operating surplus is 15% above average with a direct sector effect of 70% and contributions from mining services (4%), electricity generation (3%), wholesale trade (1%) and communications (1%). The social indicator of employment generation is 55% below average with a similar composition to the surplus indicator. The environmental indicator of greenhouse emissions is 25% below average, with a direct effect of 20% and contributions from electricity generation (40%), land preparation (5%), diesel refining (3%), and basic chemicals (1%).

TBL Accounts #2 and #3

The second TBL account shows that export propensity is nearly five times the average, income is 45% below average, and water use is 40% below average. The third TBL account shows that import penetration is 30% below average, government revenue is 50% below average, and land disturbance is 95% below average.

Structural Path Analysis and Linkages

While the social indicators are below average, as noted earlier there are a number of structural issues affecting the prices of mineral commodities on the world market that may restrict domestic employment. The direct sector effects are 41%, 44% and 47% respectively, for employment generation, income and government revenue. Small contributions from wholesale trade (4%), mining services (6%), technical services (2%) and electricity supply (2%), emphasise that improvement would be a within sector effort.

The sector's stimulus to its upstream suppliers is 25% below average and impacts most on the sectors of services to mining, wholesale trade, and electricity supply. The linkages to downstream industries are below average, and focused on the non-ferrous metal smelting and products sector.

Future Trends in Sector

Under the base case scenario of the *Future Dilemmas* study, zinc production as a component of the 'metallic minerals' sector is expected to at least double by 2050. This level of production can be achieved assuming the current economic demonstrated resources, zinc containing ore bodies currently unquantified, and exploration success over the next five decades. Uncertainties include the substitution of zinc as an anti-corrosion agent by another material, the downstream effects of zinc use (see below), and the effect that restrictions on the use of an associated mineral in complex ore bodies might have on the financial parameters faced by effective zinc extraction, refining and subsequent use in consumer products.

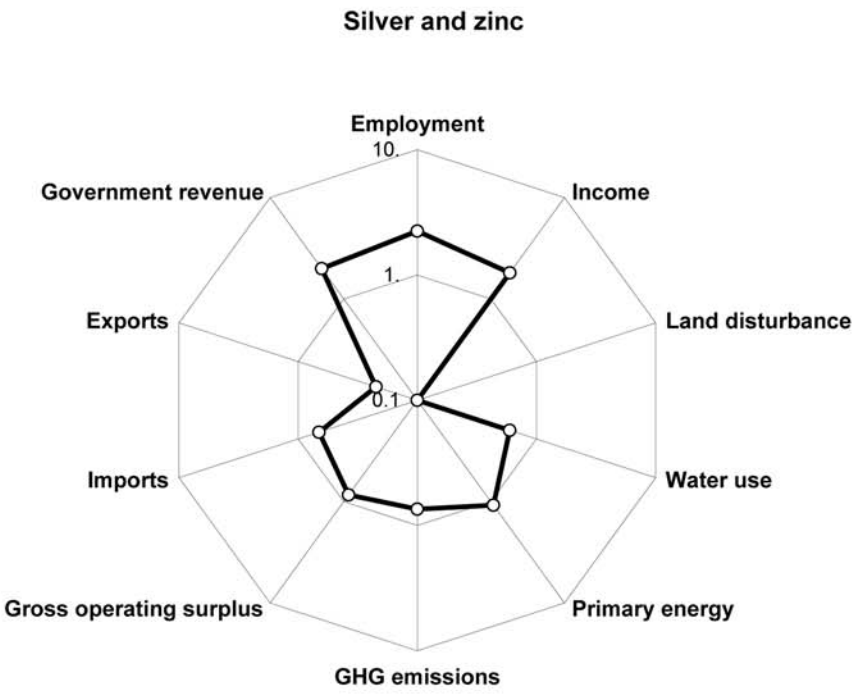
Innovation and Technical Opportunities

The importance of zinc as an aid to human health and human infrastructure, as well as its possible toxic effects on soil micro-organisms and in water systems, will facilitate a more complete stewardship of the metal from mining and smelting, through its many uses in industrialised economies, to its end of life storage, and/or possible renewal under 'cradle to cradle' life cycle approaches. Zinc enters the environment primarily through runoff from roads (from tyres and vehicles), corrosion of zinc coated built infrastructure, and in effluents from intensive animal production such as feedlots, dairies and marine aquaculture. It is often highly bio-available as free zinc ions, and can be spread widely through water systems and accumulate in sewage sludge, wetlands, estuaries, and near zinc smelters. The stewardship of zinc will be complex because coatings are difficult to separate and it interacts with other heavy metal complexes. Paradoxically, zinc is a critical input into human, animal and plant health and the fine line between immediate positive effects and eventual long term negative effects presents a major management challenge.

Sector **Silver and zinc** **(Sz)**

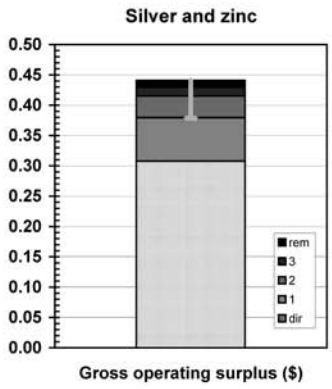
Silver and zinc ores

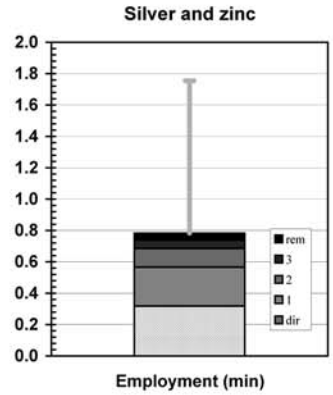
Spider diagram

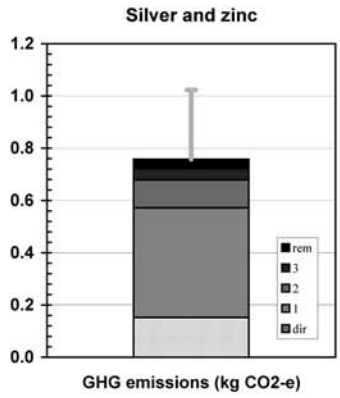


Bar graphs

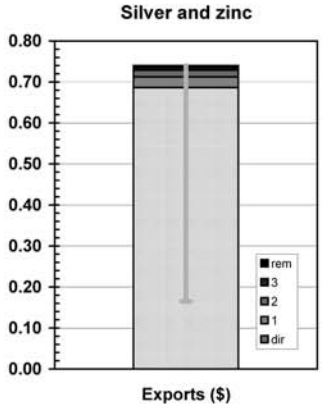
Account #1

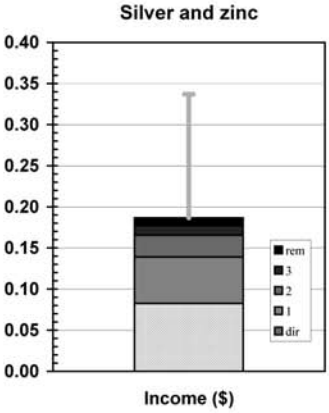


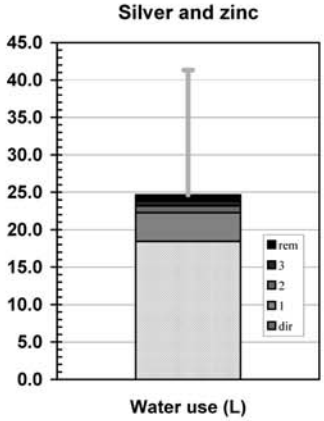




Account #2







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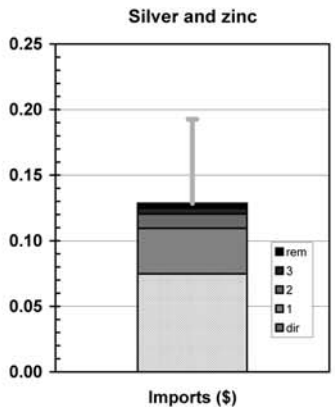
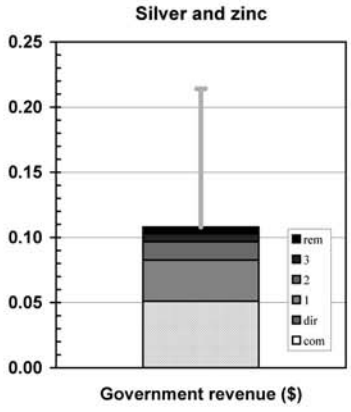
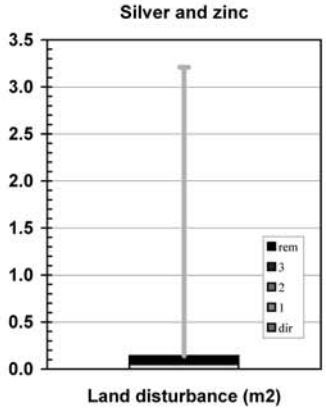






National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 0.0		
Government final consumption	$m 0.0		
Gross fixed capital expenditure	$m 0.0		
Net changes in stocks	-$m 56.2	-(3.18% of total)	
Sectoral GNE	**-$m 56.2**	**(0.01% of GNE)**	
Exports	$m 401.3	(0.48% of total)	($m 401.3 domestically produced)
Final demand	**$m 345.1**	**(0.06% of GNT)**	**($m 349.1 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 48.2	(0.03% of total)	
Gross operating surplus	$m 179.8	(0.09% of total)	
Taxes less subsidies	$m 29.8	(0.03% of total)	
Sectoral GDP*	**$m 257.9**	**(0.06% of GDP)**	
Imports	$m 43.6	(0.04% of total)	
Primary inputs	**$m 301.5**	**(0.06% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 179.8	(0.09%)	$m 123.4	(0.06%)	$m 176.9	(0.09%)
Exports ($m)	$m 401.3	(0.48%)	$m 275.5	(0.33%)	$m 297.0	(0.36%)
Imports ($m)	$m 43.6	(0.04%)	$m 30.0	(0.03%)	$m 51.6	(0.05%)
Employment (e-y)	1,488 e-y	(0.02%)	1,022 e-y	(0.01%)	2,518 e-y	(0.04%)
Income ($m)*	$m 48.2	(0.03%)	$m 33.1	(0.02%)	$m 74.9	(0.04%)
Government revenue ($m)†	$m 29.5	(0.03%)	$m 20.1	(0.02%)	$m 43.0	(0.04%)
GHG emissions (kt CO_2-e)	89 kt	(0.02%)	61 kt	(0.01%)	304 kt	(0.06%)
Water use (ML)	10,775 ML	(0.05%)	7,397 ML	(0.04%)	9,891 ML	(0.05%)
Land disturbance (kha)	3 kha	(0.00%)	2 kha	(0.00%)	6 kha	(0.00%)
Primary energy (TJ)	1,325 TJ	(0.03%)	910 TJ	(0.02%)	3,330 TJ	(0.09%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.31	0.44	0.38
Exports ($)	0.69	0.74	0.16
Imports ($)	0.07	0.13	0.19
Employment (min)	0.32	0.78	1.75
Income ($)	0.08	0.19	0.34
Government revenue ($)	0.05	0.11	0.21
GHG emissions (kg CO_2-e)	0.15	0.76	1.02
Water use (L)	18.43	24.65	41.32
Land disturbance (m^2)	0.05	0.14	3.21
Primary energy (MJ)	2.27	8.30	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Sz	0.308	(0; 70.%)	Sz	0.318	(0; 41.%)	El Sz	0.303	(1; 40.%)
Mn Sz	0.0175	(1; 4.%)	Wt Sz	0.0372	(1; 4.8%)	Sz	0.152	(0; 20.%)
El Sz	0.0122	(1; 2.8%)	Mn Sz	0.0368	(1; 4.7%)	Fr Sz	0.04	(1; 5.3%)
Wt Sz	0.00517	(1; 1.2%)	Nb Sz	0.0199	(1; 2.5%)	Fo Sz	0.0254	(1; 3.4%)
Cm Sz	0.00476	(1; 1.1%)	Ts Mn Sz	0.0176	(2; 2.2%)	Ch Sz	0.0078	(1; 1.%)
Ts Mn Sz	0.0039	(2; 0.88%)	El Sz	0.0136	(1; 1.7%)	Oi Fo Sz	0.00766	(2; 1.%)
Oi Fo Sz	0.00362	(2; 0.82%)	Cm Sz	0.0132	(1; 1.7%)	Bl El Sz	0.00763	(2; 1.%)
Bk Sz	0.00276	(1; 0.63%)	Eq Sz	0.0119	(1; 1.5%)	Wt Sz	0.00516	(1; 0.68%)
Sg Sz	0.00246	(1; 0.56%)	Ma Sz	0.011	(1; 1.4%)	Is Sz	0.00439	(1; 0.58%)
Bl El Sz	0.00195	(2; 0.44%)	Bk Sz	0.0109	(1; 1.4%)	Ce Sz	0.00414	(1; 0.55%)
Nb Sz	0.00194	(1; 0.44%)	Rd Sz	0.00953	(1; 1.2%)	Is Ma Sz	0.00301	(2; 0.4%)
Sf Sz	0.00194	(1; 0.44%)	Rh Sz	0.00752	(1; 0.96%)	Pc Sz	0.00297	(1; 0.39%)
Rd Sz	0.00162	(1; 0.37%)	Sm Sz	0.00531	(1; 0.68%)	Lm Sz	0.00278	(1; 0.37%)
Fo Sz	0.0014	(1; 0.32%)	Bs Sz	0.00465	(1; 0.59%)	Rd Sz	0.00257	(1; 0.34%)
Rh Sz	0.00123	(1; 0.28%)	Gv Sz	0.00455	(1; 0.58%)	Bl Sz	0.00237	(1; 0.31%)
Pd Sz	0.00122	(1; 0.28%)	Sh Sz	0.00416	(1; 0.53%)	Ga Sz	0.00227	(1; 0.3%)
Eq Sz	0.00121	(1; 0.27%)	Rf Sz	0.0041	(1; 0.52%)	Mn Sz	0.00205	(1; 0.27%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Sz	0.687	(0; 93.%)	Sz	0.0825	(0; 44.%)	Sz	18.4	(0; 75.%)
Wt Sz	0.00423	(1; 0.57%)	Mn Sz	0.0124	(1; 6.6%)	El Sz	1.67	(1; 6.8%)
Bl El Sz	0.00296	(2; 0.4%)	Wt Sz	0.00799	(1; 4.3%)	Mn Sz	1.17	(1; 4.7%)
Oi Fo Sz	0.00247	(2; 0.33%)	Ts Mn Sz	0.00411	(2; 2.2%)	Wa Sz	0.49	(1; 2.%)
Eq Sz	0.00213	(1; 0.29%)	El Sz	0.00368	(1; 2.%)	Wa El Sz	0.0968	(2; 0.39%)
Ma Sz	0.00161	(1; 0.22%)	Cm Sz	0.00299	(1; 1.6%)	Sg Sz	0.0623	(1; 0.25%)
Sg Sz	0.00122	(1; 0.16%)	Nb Sz	0.00296	(1; 1.6%)	Wa Ts Mn Sz	0.0526	(3; 0.21%)
Fo Sz	0.00103	(1; 0.14%)	Bk Sz	0.0027	(1; 1.4%)	Bl El Sz	0.0396	(2; 0.16%)
Bl Sz	0.000921	(1; 0.12%)	Eq Sz	0.00211	(1; 1.1%)	Sm Sz	0.0337	(1; 0.14%)
Ch Sz	0.000907	(1; 0.12%)	Ma Sz	0.00206	(1; 1.1%)	Wa Pd Sz	0.0334	(2; 0.14%)
Rf Sz	0.000839	(1; 0.11%)	Rd Sz	0.00164	(1; 0.88%)	Fo Sz	0.0304	(1; 0.12%)
Pc Sz	0.000702	(1; 0.095%)	Rf Sz	0.00115	(1; 0.62%)	Ws Sz	0.0261	(1; 0.11%)
Oc Sz	0.000658	(1; 0.089%)	Gv Sz	0.00114	(1; 0.61%)	Ch Sz	0.0238	(1; 0.097%)
Cm Sz	0.000635	(1; 0.086%)	Pd Sz	0.0011	(1; 0.59%)	Wa Ms Sz	0.0212	(2; 0.086%)
At Sz	0.000632	(1; 0.085%)	Sm Sz	0.000914	(1; 0.49%)	Wt Sz	0.0208	(1; 0.084%)
Ts Mn Sz	0.000618	(2; 0.084%)	In Sz	0.000896	(1; 0.48%)	Wa Ms Wt Sz	0.0193	(3; 0.078%)
Nf Sz	0.000594	(1; 0.08%)	Ms Sz	0.000861	(1; 0.46%)	Oi Fo Sz	0.0183	(2; 0.074%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Sz	0.0747	(0; 58.%)	Sz	0.051	(0; 47.%)	Sz	0.0512	(0; 36.%)
Fo Sz	0.00834	(1; 6.5%)	Mn Sz	0.00841	(1; 7.8%)	Fr Sz	0.0129	(1; 9.1%)
Mn Sz	0.00803	(1; 6.2%)	Wt Sz	0.00373	(1; 3.5%)	El Sz	0.00489	(1; 3.4%)
Ma Sz	0.0019	(1; 1.5%)	El Sz	0.00229	(1; 2.1%)	Bc Mp Ho Sz	0.00326	(3; 2.3%)
Pc Sz	0.00149	(1; 1.2%)	Ts Mn Sz	0.00202	(2; 1.9%)	Bc Mp Ch Sz	0.0031	(3; 2.2%)
Eq Sz	0.00141	(1; 1.1%)	Bk Sz	0.00149	(1; 1.4%)	Wo Tx Sz	0.00284	(2; 2.%)
Wt Sz	0.0012	(1; 0.93%)	Cm Sz	0.00143	(1; 1.3%)	Bc Mp Ho Mn	0.00184	(4; 1.3%)
Ts Mn Sz	0.00112	(2; 0.87%)	Nb Sz	0.00125	(1; 1.2%)	Bc Ch Sz	0.00156	(2; 1.1%)
Oc Sz	0.00102	(1; 0.79%)	Rd Sz	0.00116	(1; 1.1%)	Wo Tx Wt Sz	0.00132	(3; 0.94%)
Ch Sz	0.000908	(1; 0.71%)	Eq Sz	0.00104	(1; 0.97%)	Wo Tx Ru Sz	0.00088	(3; 0.62%)
El Sz	0.000849	(1; 0.66%)	Ma Sz	0.000993	(1; 0.92%)	Bc Mp Ho Wt	0.000765	(4; 0.54%)
Cm Sz	0.000815	(1; 0.63%)	In Sz	0.000964	(1; 0.89%)	Ba Bm Sz	0.000727	(2; 0.51%)
Sg Sz	0.000769	(1; 0.6%)	Pd Sz	0.000722	(1; 0.67%)	Wo Ts Mn Sz	0.000674	(3; 0.48%)
Nb Sz	0.00066	(1; 0.51%)	Sf Sz	0.000542	(1; 0.5%)	Bc Mp Bp Sz	0.000612	(3; 0.43%)
Rh Sz	0.000635	(1; 0.49%)	Rf Sz	0.000529	(1; 0.49%)	Rf Sz	0.000577	(1; 0.41%)
Ru Sz	0.000626	(1; 0.49%)	Oi Fo Sz	0.000439	(2; 0.41%)	Bc Mp Oc Sz	0.000552	(3; 0.39%)
Sh Sz	0.000482	(1; 0.37%)	Ms Sz	0.000409	(1; 0.38%)	Bc Mp Ts Mn	0.000551	(4; 0.39%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.722 ±0.010	(±1.4%)
Downstream	0.726 ±0.036	(±4.9%)

Sector Rem. 1302: Other Non-ferrous Metal Ores (Uo)

Uranium, nickel, tin, manganese and other non-ferrous metal ores

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 15% below average, while water use and land disturbance are 45% and 95% below average respectively. The social indicator of employment generation is 55% below average, while income and government revenue are 45% and 50% below average respectively. The financial indicators show that operating surplus is 20% above average, export propensity is nearly four times the average, and import penetration is 30% below average. Many sector products contribute to the fabrication of advanced materials and due to this market's size, the sector's future seems assured.

Sector Description

In financial terms, the output of the sector is dominated by nickel (50%) and mineral sands (25%), leaving other minerals such as uranium, tin and manganese (25%). Annual levels of production include manganese (2.2 million tonnes), nickel (207 000 tonnes), ilmenite or titanium ore (2 million tonnes), rutile (200 000 tonnes), uranium (10 000 tonnes of U_2O_3), and tin (7 000 tonnes). Some commodities may expand several fold over the next two decades. Large mineral sands deposits in the Murray Darling Basin could underpin a 300 000 tonnes per annum titanium industry provided that the full value chain can be integrated and harmonised within Australian industry. This would require breakthroughs in ore transformation and metal refining and casting technologies for industrial use of the metal. The nickel industry is currently experiencing boom times driven particularly by Chinese industrial demand which is enabling the nickel laterite ores to complement the nickel sulphide ore production, on which domestic production has been based. Australia holds one third of the world's uranium reserves and production is currently limited by regulation to four mines, Ranger, Olympic Dam, Beverley and Honeymoon. In constant dollar terms, production of commodities in the sector has quintupled over the last thirty years except uranium (doubled), rutile (same), and tin (halved). Current turnover is about $3.8 billion and involves 30 enterprises.

Place of Industry in the Economy

The nickel, manganese, and uranium sector ranks 75th out of 135 sectors in term of value adding in the economy, and contributes 0.20% of GDP in this analysis. It is similar in value adding to the bus and tram transport, and services to agriculture sectors. It is a small employer with 3 000 employment years directly embodied in final demand, and another 4 000 years in the sector's upstream suppliers giving a total of 7 000 employment years. In addition, it contributes 2 000 employment years to the final demand of downstream industries such as non-ferrous metal smelting and products. It has relatively small resource requirements with less than two tenths of one percent of national land disturbance, water use and greenhouse emissions and three tenths of one percent of primary energy use. In financial terms, exports are nearly seven times the size of imports.

Strategic Overview

The spider diagram portrays a TBL account with outliers for the three social indicators, and with primary energy use above average. Below average social outcomes are shared with many mineral commodities which face highly competitive world markets, require efficient and capital intensive plant, and have difficulty attracting and retaining skilled staff in remote mine locations.

TBL Account #1

The financial indicator of operating surplus is 20% above average and composed of a direct effect of 70% with contributions from services to mining (4%), electricity generation (3%), wholesale trade (1%), communications (1%), and technical services (1%). The social indicator of employment generation is 55% below average with a direct effect of 41% and a composition similar to the surplus indicator. The greenhouse emissions indicator is 15% below average and discussed below.

TBL Accounts #2 and #3

The second TBL account shows that the export propensity is nearly four times the average, income is 45% below average, and water use is 45% below average. The third TBL account shows that the import penetration is 30% below average and government revenue is 50% below average. Land disturbance is 95% below average with some downstream contamination issues, particularly long lived in the case of uranium mining.

Structural Path Analysis and Linkages

While the social indicators are below average, they are driven more by decisions made by globalised commodity markets than within national boundaries. The greenhouse emissions indicator has a direct sector effect of 28% which is overshadowed by electricity generation (36%) and then a diffuse chain of smaller entities such as land preparation (5%), diesel refining (3%), basic chemicals (1%), oil extraction for diesel refining (1%), and black coal mining for electricity production (1%). Any activities related to greenhouse emissions should therefore focus on efficient machinery use, electricity use, and the source of electricity. Many mining sites are remote, and for practical purposes must rely on stand-alone diesel generators for which there are currently few substitutes. However where a mine is grid connected, changing from a black or brown coal electricity source to a gas turbine may be more expensive, but will have a lower greenhouse signature particularly if installed onsite to yield combined heat and power. Variable speed electric motors for industrial applications have the potential to save 25% of energy use over a wide range of industrial applications, according to a recent European Union study.

The sector's stimulus to its upstream suppliers is 25% below average and impacts on services to mining, wholesale trade, electricity production and property development. The linkages to downstream industries are also weaker than average and focus on non-ferrous metal refining.

Future Trends in Sector

Under the base case scenario for the *Future Dilemmas* study, most bulk mining commodities will expand threefold over the next 50 years, while some of this sector's products will double. At current rates of production, Australia has economically demonstrated reserves of nickel (105 years), uranium (90 years), manganese (30 years), tin (15 years), rutile (90 years) and ilmenite (80 years). Many of these estimates are conservative and advances in exploration techniques and methods of processing may make many resources now considered economically or physically marginal, more accessible. Some science literature suggests that thorium reactors may supersede uranium reactors. If all the weapons grade uranium, currently in weapons or warehoused were processed, it could supply the world's nuclear reactors producing electricity until 2030.

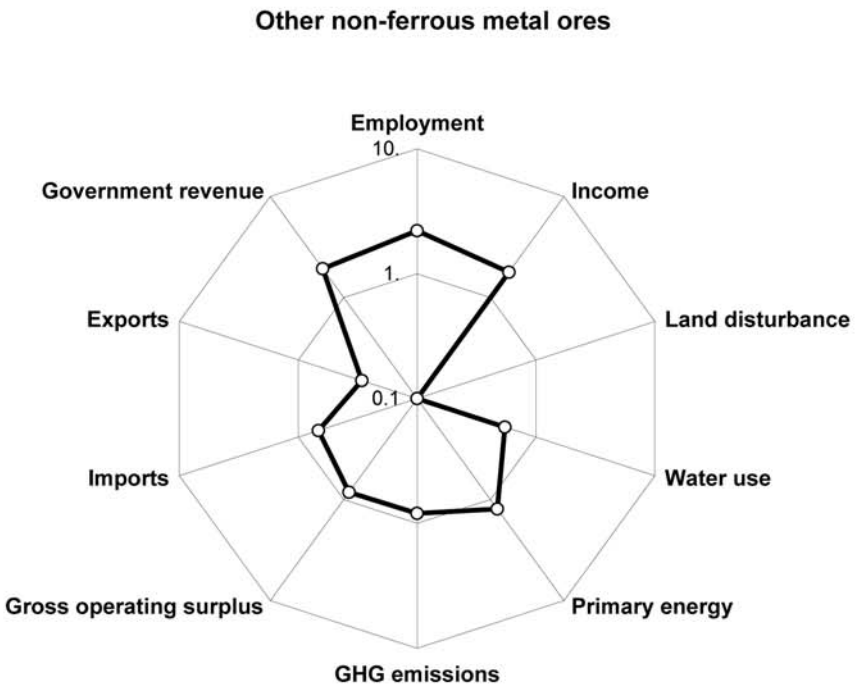
Innovation and Technical Opportunities

The key challenge for this and other Australian mineral commodity sectors is to escape the constraints of ore and metal production, and make the transition to fabrication and more elaborately transformed components. Advanced markets will require products with low embodied greenhouse content. Public perceptions of the short and long term downstream risks of uranium use continue.

Sector **Other non-ferrous metal ores** **(Uo)**

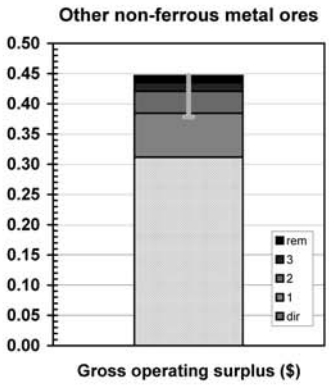
Uranium, nickel, tin, manganese and other non-ferrous metal ores

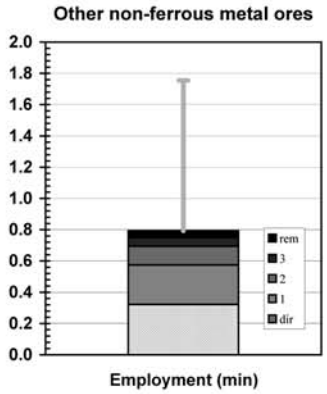
Spider diagram

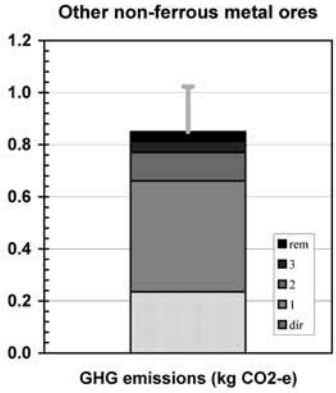


Bar graphs

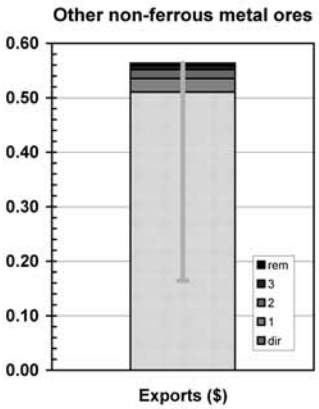
Account #1

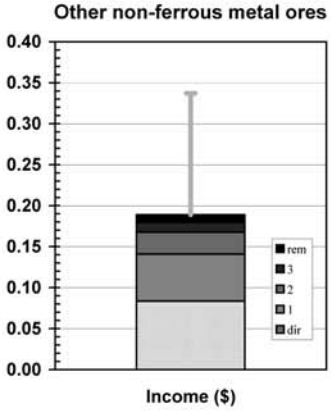


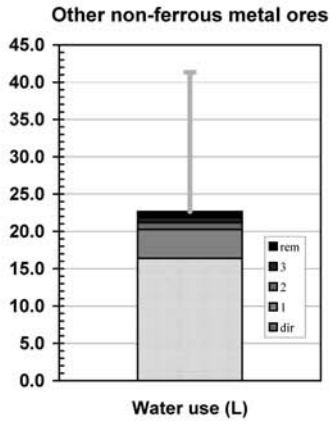




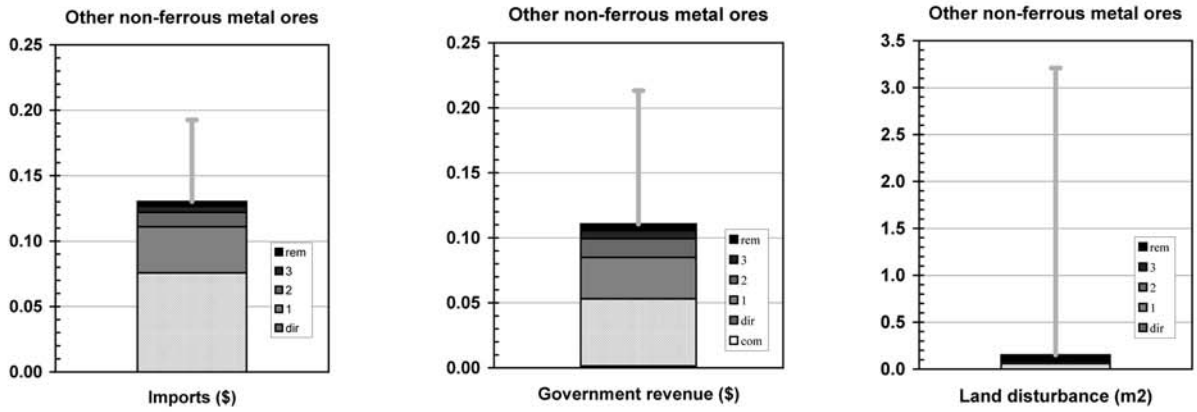
Account #2







Account #3



National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 4.4	(0.00% of total)	($m 4.4 domestically produced)
Government final consumption	$m 0.2	(0.00% of total)	($m 0.2 domestically produced)
Gross fixed capital expenditure	$m 133.4	(0.13% of total)	($m 133.4 domestically produced)
Net changes in stocks	-$m 155.4	-(8.79% of total)	
Sectoral GNE	**-$m 17.5**	**(0.00% of GNE)**	
Exports	$m 1,025.1	(1.23% of total)	($m 1,025.1 domestically produced)
Final demand	**$m 1,007.7**	**(0.19% of GNT)**	**($m 1,007.7 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 167.8	(0.10% of total)	
Gross operating surplus	$m 625.7	(0.33% of total)	
Taxes less subsidies	$m 103.8	(0.12% of total)	
Sectoral GDP*	**$m 897.3**	**(0.20% of GDP)**	
Imports	$m 151.9	(0.16% of total)	
Primary inputs	**$m 1,049.1**	**(0.19% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 625.7	(0.33%)	$m 362.5	(0.19%)	$m 519.6	(0.27%)
Exports ($m)	$m 1,025.1	(1.23%)	$m 593.9	(0.71%)	$m 655.5	(0.79%)
Imports ($m)	$m 151.9	(0.16%)	$m 88.0	(0.09%)	$m 151.6	(0.16%)
Employment (e-y)	5,178 e-y	(0.07%)	3,000 e-y	(0.04%)	7,395 e-y	(0.10%)
Income ($m)*	$m 167.8	(0.10%)	$m 97.2	(0.06%)	$m 219.8	(0.13%)
Government revenue ($m)†	$m 105.4	(0.10%)	$m 61.7	(0.06%)	$m 128.8	(0.12%)
GHG emissions (kt CO_2-e)	472 kt	(0.09%)	274 kt	(0.05%)	989 kt	(0.19%)
Water use (ML)	32,892 ML	(0.16%)	19,055 ML	(0.09%)	26,361 ML	(0.13%)
Land disturbance (kha)	12 kha	(0.01%)	7 kha	(0.00%)	18 kha	(0.01%)
Primary energy (TJ)	6,730 TJ	(0.17%)	3,899 TJ	(0.10%)	11,015 TJ	(0.28%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.31	0.45	0.38
Exports ($)	0.51	0.56	0.16
Imports ($)	0.08	0.13	0.19
Employment (min)	0.32	0.79	1.75
Income ($)	0.08	0.19	0.34
Government revenue ($)	0.05	0.11	0.21
GHG emissions (kg CO_2-e)	0.24	0.85	1.02
Water use (L)	16.38	22.66	41.32
Land disturbance (m^2)	0.06	0.15	3.21
Primary energy (MJ)	3.35	9.47	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Uo	0.312	(0; 70.%)	Uo	0.322	(0; 41.%)	El Uo	0.307	(1; 36.%)
Mn Uo	0.0178	(1; 4.%)	Wt Uo	0.0377	(1; 4.8%)	Uo	0.235	(0; 28.%)
El Uo	0.0124	(1; 2.8%)	Mn Uo	0.0373	(1; 4.7%)	Fr Uo	0.0406	(1; 4.8%)
Wt Uo	0.00524	(1; 1.2%)	Nb Uo	0.0201	(1; 2.5%)	Fo Uo	0.0258	(1; 3.%)
Cm Uo	0.00483	(1; 1.1%)	Ts Mn Uo	0.0178	(2; 2.2%)	Ch Uo	0.0079	(1; 0.93%)
Ts Mn Uo	0.00395	(2; 0.88%)	El Uo	0.0138	(1; 1.7%)	Oi Fo Uo	0.00776	(2; 0.91%)
Oi Fo Uo	0.00367	(2; 0.82%)	Cm Uo	0.0133	(1; 1.7%)	Bl El Uo	0.00773	(2; 0.91%)
Bk Uo	0.00279	(1; 0.63%)	Eq Uo	0.0121	(1; 1.5%)	Wt Uo	0.00522	(1; 0.61%)
Sg Uo	0.00249	(1; 0.56%)	Ma Uo	0.0111	(1; 1.4%)	Is Uo	0.00445	(1; 0.52%)
Bl El Uo	0.00198	(2; 0.44%)	Bk Uo	0.0111	(1; 1.4%)	Ce Uo	0.00419	(1; 0.49%)
Nb Uo	0.00197	(1; 0.44%)	Rd Uo	0.00965	(1; 1.2%)	Is Ma Uo	0.00305	(2; 0.36%)
Sf Uo	0.00196	(1; 0.44%)	Rh Uo	0.00762	(1; 0.96%)	Pc Uo	0.00301	(1; 0.35%)
Rd Uo	0.00164	(1; 0.37%)	Sm Uo	0.00537	(1; 0.68%)	Lm Uo	0.00282	(1; 0.33%)
Fo Uo	0.00142	(1; 0.32%)	Bs Uo	0.00472	(1; 0.59%)	Rd Uo	0.00261	(1; 0.31%)
Rh Uo	0.00125	(1; 0.28%)	Gv Uo	0.00461	(1; 0.58%)	Bl Uo	0.0024	(1; 0.28%)
Pd Uo	0.00124	(1; 0.28%)	Sh Uo	0.00422	(1; 0.53%)	Ga Uo	0.0023	(1; 0.27%)
Eq Uo	0.00123	(1; 0.27%)	Rf Uo	0.00415	(1; 0.52%)	Mn Uo	0.00208	(1; 0.24%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Uo	0.511	(0; 91.%)	Uo	0.0836	(0; 44.%)	Uo	16.4	(0; 72.%)
Wt Uo	0.00428	(1; 0.76%)	Mn Uo	0.0125	(1; 6.6%)	El Uo	1.7	(1; 7.5%)
Bl El Uo	0.003	(2; 0.53%)	Wt Uo	0.00809	(1; 4.3%)	Mn Uo	1.18	(1; 5.2%)
Oi Fo Uo	0.0025	(2; 0.44%)	Ts Mn Uo	0.00416	(2; 2.2%)	Wa Uo	0.497	(1; 2.2%)
Eq Uo	0.00216	(1; 0.38%)	El Uo	0.00373	(1; 2.%)	Wa El Uo	0.098	(2; 0.43%)
Ma Uo	0.00163	(1; 0.29%)	Cm Uo	0.00303	(1; 1.6%)	Sg Uo	0.0631	(1; 0.28%)
Sg Uo	0.00124	(1; 0.22%)	Nb Uo	0.003	(1; 1.6%)	Wa Ts Mn Uo	0.0532	(3; 0.23%)
Fo Uo	0.00105	(1; 0.19%)	Bk Uo	0.00274	(1; 1.4%)	Bl El Uo	0.0401	(2; 0.18%)
Bl Uo	0.000933	(1; 0.17%)	Eq Uo	0.00213	(1; 1.1%)	Sm Uo	0.0341	(1; 0.15%)
Ch Uo	0.000919	(1; 0.16%)	Ma Uo	0.00208	(1; 1.1%)	Wa Pd Uo	0.0339	(2; 0.15%)
Rf Uo	0.00085	(1; 0.15%)	Rd Uo	0.00166	(1; 0.88%)	Fo Uo	0.0308	(1; 0.14%)
Pc Uo	0.000711	(1; 0.13%)	Rf Uo	0.00116	(1; 0.62%)	Ws Uo	0.0265	(1; 0.12%)
Oc Uo	0.000667	(1; 0.12%)	Gv Uo	0.00116	(1; 0.61%)	Ch Uo	0.0241	(1; 0.11%)
Cm Uo	0.000644	(1; 0.11%)	Pd Uo	0.00112	(1; 0.59%)	Wa Ms Uo	0.0215	(2; 0.095%)
At Uo	0.00064	(1; 0.11%)	Sm Uo	0.000926	(1; 0.49%)	Wt Uo	0.0211	(1; 0.093%)
Ts Mn Uo	0.000626	(2; 0.11%)	In Uo	0.000908	(1; 0.48%)	Wa Ms Wt Uo	0.0195	(3; 0.086%)
Nf Uo	0.000602	(1; 0.11%)	Ms Uo	0.000872	(1; 0.46%)	Oi Fo Uo	0.0185	(2; 0.082%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Uo	0.0756	(0; 58.%)	Uo	0.0517	(0; 47.%)	Uo	0.0591	(0; 39.%)
Fo Uo	0.00844	(1; 6.5%)	Mn Uo	0.00852	(1; 7.8%)	Fr Uo	0.013	(1; 8.6%)
Mn Uo	0.00813	(1; 6.2%)	Wt Uo	0.00378	(1; 3.5%)	El Uo	0.00495	(1; 3.3%)
Ma Uo	0.00193	(1; 1.5%)	El Uo	0.00232	(1; 2.1%)	Bc Mp Ho Uo	0.0033	(3; 2.2%)
Pc Uo	0.00151	(1; 1.2%)	Ts Mn Uo	0.00205	(2; 1.9%)	Bc Mp Ch Uo	0.00314	(3; 2.1%)
Eq Uo	0.00143	(1; 1.1%)	Bk Uo	0.00151	(1; 1.4%)	Wo Tx Uo	0.00288	(2; 1.9%)
Wt Uo	0.00122	(1; 0.93%)	Cm Uo	0.00145	(1; 1.3%)	Bc Mp Ho Mn	0.00187	(4; 1.2%)
Ts Mn Uo	0.00113	(2; 0.87%)	Nb Uo	0.00126	(1; 1.2%)	Bc Ch Uo	0.00158	(2; 1.%)
Oc Uo	0.00103	(1; 0.79%)	Rd Uo	0.00118	(1; 1.1%)	Wo Tx Wt Uo	0.00134	(3; 0.89%)
Ch Uo	0.00092	(1; 0.71%)	Eq Uo	0.00106	(1; 0.97%)	Wo Tx Ru Uo	0.000892	(3; 0.59%)
El Uo	0.00086	(1; 0.66%)	Ma Uo	0.00101	(1; 0.92%)	Bc Mp Ho Wt	0.000775	(4; 0.51%)
Cm Uo	0.000826	(1; 0.63%)	In Uo	0.000976	(1; 0.89%)	Ba Bm Uo	0.000736	(2; 0.49%)
Sg Uo	0.000779	(1; 0.6%)	Pd Uo	0.000732	(1; 0.67%)	Wo Ts Mn Uo	0.000683	(3; 0.45%)
Nb Uo	0.000669	(1; 0.51%)	Sf Uo	0.000549	(1; 0.5%)	Bc Mp Bp Uo	0.00062	(3; 0.41%)
Rh Uo	0.000643	(1; 0.49%)	Rf Uo	0.000536	(1; 0.49%)	Rf Uo	0.000584	(1; 0.39%)
Ru Uo	0.000634	(1; 0.49%)	Oi Fo Uo	0.000445	(2; 0.41%)	Bc Mp Oc Uo	0.000559	(3; 0.37%)
Sh Uo	0.000488	(1; 0.37%)	Ms Uo	0.000414	(1; 0.38%)	Bc Mp Ts Mn	0.000558	(4; 0.37%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.732 ±0.011	(±1.4%)
Downstream	0.861 ±0.042	(±4.8%)

Sector 1400: Other Mining (Sg)

Sand, gravel, limestone, clay, gypsum and other construction materials, salt, silica, gemstones, phosphates and other fertiliser minerals, and other mining

Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions, water use and land disturbance, are respectively 40%, 70%, and 95% below average. The social indicators of employment generation and income are 40% and 35% below average respectively, while government revenue is 40% below average. The financial indicator of operating surplus is 25% above average, export propensity is 40% above average, and import penetration is equal to average. Increasing reuse of defunct building materials, new types of cement and new housing designs to reduce embodied emissions may reduce the requirement for sector products.

Sector Description

In financial terms, the turnover of this sector is composed of sand and gravel mining (22%), construction materials such as gravel, crushed stone, dimension stone, limestone, and gypsum (44%), and mining of gemstones (diamonds, opals and sapphires), silica and talc (34%). Yearly physical production outputs include gravel and crushed stone (100 million tonnes), sand (35 million tonnes), limestone (16 million tonnes), gypsum (3.5 million tonnes), salt (10 million tonnes), silica (4 million tonnes), talc (170 000 tonnes) and gemstones (value of $740 million of which: diamonds-90%, opals-8%, sapphires-2%). The basic materials in this sector underpin Australia's built infrastructure so in a physical sense, it is probably one of the more important sectors in the economy. Regional constraints in major cities are emerging as gravel and sand pits become worked out, and urban environmental regulations restrict further extraction within city boundaries. In constant dollar terms, most product categories in this sector have at least quadrupled in the last 30 years. Current turnover is around $3 billion, and involves over 400 enterprises.

Place of Industry in the Economy

The 'other mining' sector ranks 53rd out of 135 sectors in terms of value adding in the economy and contributes 0.36% of GDP in this analysis. It is similar in value adding to the structural metal products, and electrical equipment sectors. It is a small employer with 2 000 employment years directly embodied in final demand, and another 5 000 years in the sector's upstream suppliers, giving a total of 7 000 employment years. In addition, it contributes 10 000 employment years to the final demand of downstream industries such as non-residential construction, residential building, concrete and mortar, plaster products, cement, and stock foods. It has small resource requirements with less than one tenth of one percent of national land disturbance, water use, energy use, and greenhouse emissions. In financial terms, exports are 60% greater than imports.

Strategic Overview

The spider diagram portrays a reasonable TBL account for the other mining sector, save for three outliers of employment generation, income, and government revenue. Part of this is due to the large and physically efficient machinery used for mass material movement within the sector, which requires relatively few operators. In one sense, the physical efficiencies in this sector are passed onto consumers in the form of cheaper building materials, and thereby affordable housing. Some obvious downstream issues include the reclamation of quarry areas but this issue is frequently turned to advantage in the form of waterside estates in urban areas. A move towards the recycling of defunct building materials instead of landfilling may increase the labour requirements in the sector.

TBL Account #1

The financial indicator of operating surplus is 25% above the average, and is dominated by a direct sector effect of 66%, and receives minor contributions from road transport (3%), wholesale trade (2%), communications (1%), diesel refining (1%) and services to mining (1%). Given the data constraints of an aggregated sector, it is difficult to ascertain whether the majority of the profits come from the large volumes of bulk materials such as stone, or the minor volume but high value products such as gemstones. The social indicator of employment generation is 40% below average, and has a similar composition to the surplus indicator which is discussed in more detail below. The environmental indicator of greenhouse emissions is 40% below average. It has a direct sector effect of 40% (mostly fuel used by sector machinery) and contributions from diesel refining (7%), road transport (4%), land preparation (3%), electricity production (3%), oil extraction (2%), wholesale trade (2%) and lime production (2%).

TBL Accounts #2 and #3

The second TBL account shows an export propensity that is 40% above average, income that is 35% below average, and water use that is 70% below average. The third TBL account shows the import penetration as average, government revenue as 40% below average, and land disturbance as 95% below average. Attempts to improve social indicators could reduce the operating surplus, and would flow on to building and construction costs and affordability.

Structural Path Analysis and Linkages

The social indicators of employment generation and income are below average. The structural pathways reveal that around one third of each indicator is a direct sector effect, with additional contributions from road transport (8%), wholesale trade (7%), heavy machinery (2%), services to mining (2%) and a long chain of minor additions. Given the diverse structural paths of these two indicators, there is not a simple way to improve them, especially given the competitive pressure on product prices, labour being a significant component, from the downstream industries.

The sector's stimulus to its upstream suppliers is equal to the economy wide average and impacts on road transport, wholesale trade, and property development. The linkages to downstream industries is 50% stronger than average, and suggests that any expansion in the industry must be led by expansion in obvious sectors such as residential and non-residential construction, concrete and mortar, plaster products, cement manufacture, and basic iron and steel smelting.

Future Trends in Sector

Under the base case scenario of the *Future Dilemmas* study with 25 million people by 2050, the requirement for concrete and bricks will be about 5% lower than today. This will feed back to the basic ingredients such as sand, gravel, clay, and limestone. This is based on the assumption that houses and commercial buildings have a similar composition to today's built infrastructure. The main reason for the decline is the stability of the human population at 2050 in this scenario, where births plus immigration equals deaths plus emigration. Without the strong driver of population growth, and apart from some regional growth centres, the building stock dynamics will have moved into equilibrium with the populations dynamics. In addition to population growth, uncertainties include material mass and composition of buildings and roads, and resource taxation.

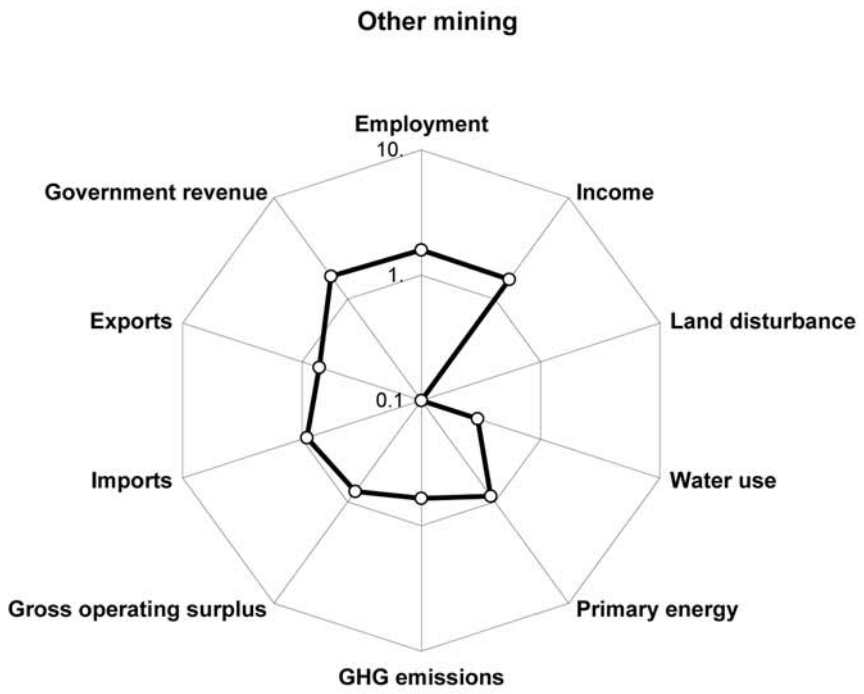
Innovation and Technical Opportunities

Current policy in the OECD to introduce material flow analysis as one measure of a nation's sustainability, may impact heavily on this sector, particularly if taxes on large material flows are introduced. Onsite recycling is increasing. Industrial ecology may deliver new geopolymer cements.

Sector **Other mining** **(Sg)**

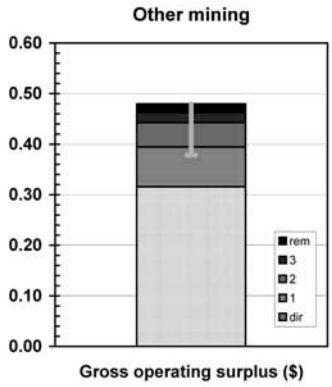
Sand, gravel, limestones, clay, gypsum and other construction materials, salt, silica, gemstones, phosphates and other fertiliser minerals, and other mining

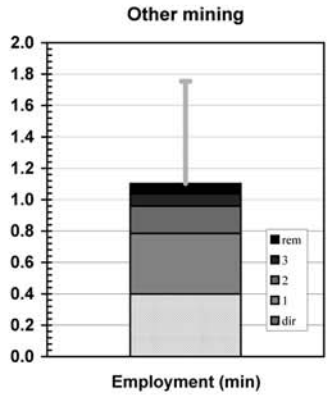
Spider diagram

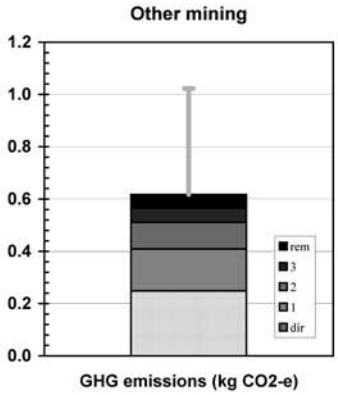


Bar graphs

Account #1







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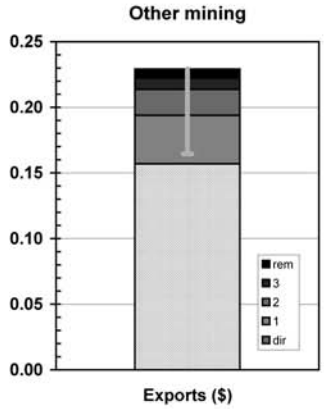
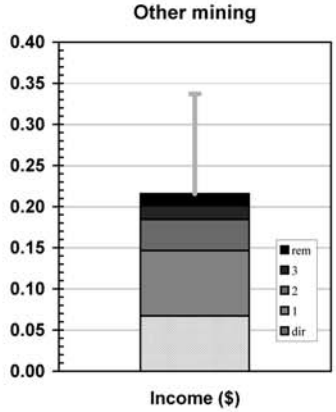
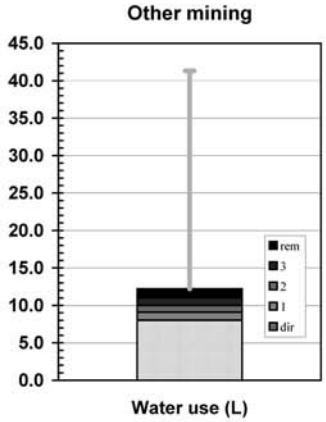
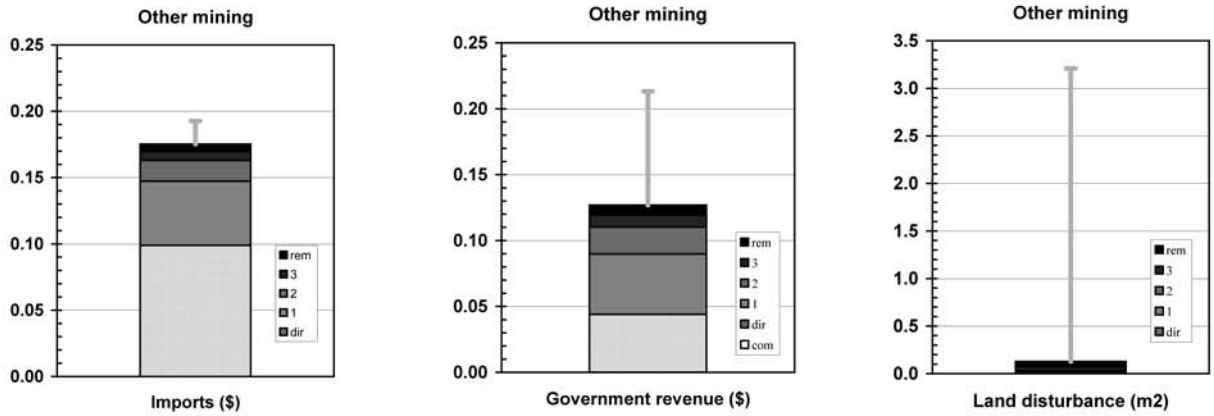






Account #3



National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 5.3	(0.00% of total)	($m 4.2 domestically produced)
Government final consumption	$m 0.0	(0.00% of total)	($m 0.0 domestically produced)
Gross fixed capital expenditure	$m 3.4	(0.00% of total)	($m 3.4 domestically produced)
Net changes in stocks	$m 167.5	(9.48% of total)	($m 167.9 domestically produced)
Sectoral GNE	**$m 176.1**	**(0.04% of GNE)**	**($m 175.5 domestically produced)**
Exports	$m 590.2	(0.71% of total)	($m 590.2 domestically produced)
Final demand	**$m 766.3**	**(0.14% of GNT)**	**($m 765.7 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 252.4	(0.15% of total)	
Gross operating surplus	$m 1,187.3	(0.62% of total)	
Taxes less subsidies	$m 165.5	(0.19% of total)	
Sectoral GDP*	**$m 1,605.2**	**(0.36% of GDP)**	
Imports	$m 371.7	(0.38% of total)	
Primary inputs	**$m 1,976.9**	**(0.36% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 1,187.3	(0.62%)	$m 241.8	(0.13%)	$m 367.4	(0.19%)
Exports ($m)	$m 590.2	(0.71%)	$m 120.2	(0.14%)	$m 175.6	(0.21%)
Imports ($m)	$m 371.7	(0.38%)	$m 75.7	(0.08%)	$m 134.2	(0.14%)
Employment (e-y)	12,013 e-y	(0.17%)	2,446 e-y	(0.03%)	6,769 e-y	(0.09%)
Income ($m)*	$m 252.4	(0.15%)	$m 51.4	(0.03%)	$m 165.1	(0.10%)
Government revenue ($m)†	$m 165.5	(0.15%)	$m 33.7	(0.03%)	$m 97.2	(0.09%)
GHG emissions (kt CO_2-e)	935 kt	(0.18%)	190 kt	(0.04%)	473 kt	(0.09%)
Water use (ML)	30,092 ML	(0.14%)	6,127 ML	(0.03%)	9,361 ML	(0.04%)
Land disturbance (kha)	3 kha	(0.00%)	1 kha	(0.00%)	10 kha	(0.01%)
Primary energy (TJ)	11,286 TJ	(0.29%)	2,298 TJ	(0.06%)	5,132 TJ	(0.13%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.32	0.48	0.38
Exports ($)	0.16	0.23	0.16
Imports ($)	0.10	0.18	0.19
Employment (min)	0.40	1.10	1.75
Income ($)	0.07	0.22	0.34
Government revenue ($)	0.04	0.13	0.21
GHG emissions (kg CO_2-e)	0.25	0.62	1.02
Water use (L)	8.00	12.23	41.32
Land disturbance (m^2)	0.01	0.13	3.21
Primary energy (MJ)	3.00	6.70	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Sg	0.316	(0; 66.%)	Sg	0.399	(0; 36.%)	Sg	0.249	(0; 40.%)
Rd Sg	0.015	(1; 3.1%)	Rd Sg	0.0882	(1; 8.%)	Fo Sg	0.0406	(1; 6.6%)
Wt Sg	0.00967	(1; 2.%)	Wt Sg	0.0696	(1; 6.3%)	Rd Sg	0.0238	(1; 3.9%)
Cm Sg	0.00622	(1; 1.3%)	Ma Sg	0.0245	(1; 2.2%)	Fr Sg	0.0188	(1; 3.1%)
Oi Fo Sg	0.00578	(2; 1.2%)	Rh Sg	0.0198	(1; 1.8%)	El Sg	0.0159	(1; 2.6%)
Mn Sg	0.00543	(1; 1.1%)	Cm Sg	0.0172	(1; 1.6%)	Oi Fo Sg	0.0122	(2; 2.%)
Sf Sg	0.00474	(1; 0.99%)	Eq Sg	0.0171	(1; 1.6%)	Wt Sg	0.00965	(1; 1.6%)
Rh Sg	0.00324	(1; 0.67%)	Mn Sg	0.0114	(1; 1.%)	Lm Sg	0.00928	(1; 1.5%)
Pd Sg	0.00261	(1; 0.54%)	Nb Sg	0.0102	(1; 0.92%)	Pc Sg	0.0085	(1; 1.4%)
Bk Sg	0.00244	(1; 0.51%)	Ho Sg	0.00994	(1; 0.9%)	Is Ma Sg	0.00672	(2; 1.1%)
Fo Sg	0.00223	(1; 0.47%)	Bk Sg	0.00967	(1; 0.88%)	Ch Sg	0.00554	(1; 0.9%)
Oc Sg	0.00205	(1; 0.43%)	Gv Sg	0.00906	(1; 0.82%)	At Sg	0.00474	(1; 0.77%)
Oi Pc Sg	0.00185	(2; 0.39%)	In Sg	0.00863	(1; 0.78%)	Is Sg	0.00404	(1; 0.65%)
Ma Sg	0.00185	(1; 0.39%)	Bu Sg	0.00712	(1; 0.64%)	Oi Pc Sg	0.00392	(2; 0.64%)
St Wt Sg	0.00184	(2; 0.38%)	Ms Wt Sg	0.00628	(2; 0.57%)	El Rd Sg	0.00304	(2; 0.49%)
Eq Sg	0.00173	(1; 0.36%)	Pd Sg	0.00627	(1; 0.57%)	El Wt Sg	0.0029	(2; 0.47%)
Sf In Sg	0.00153	(2; 0.32%)	Sf Sg	0.00616	(1; 0.56%)	Ce Sg	0.00269	(1; 0.44%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Sg	0.157	(0; 68.%)	Sg	0.0671	(0; 31.%)	Sg	8.0	(0; 65.%)
Wt Sg	0.0079	(1; 3.4%)	Rd Sg	0.0152	(1; 7.%)	Mn Sg	0.362	(1; 3.%)
Rd Sg	0.00522	(1; 2.3%)	Wt Sg	0.0149	(1; 6.9%)	Wa Sg	0.112	(1; 0.92%)
Oi Fo Sg	0.00395	(2; 1.7%)	Ma Sg	0.0046	(1; 2.1%)	El Sg	0.0879	(1; 0.72%)
Ma Sg	0.0036	(1; 1.6%)	Cm Sg	0.0039	(1; 1.8%)	Ws Ho Sg	0.0724	(2; 0.59%)
Eq Sg	0.00305	(1; 1.3%)	Mn Sg	0.00383	(1; 1.8%)	Wa Pd Sg	0.0714	(2; 0.58%)
Pc Sg	0.00201	(1; 0.87%)	In Sg	0.00374	(1; 1.7%)	Rd Sg	0.0626	(1; 0.51%)
Oc Sg	0.00183	(1; 0.8%)	Eq Sg	0.00302	(1; 1.4%)	Bc Mp Ho Sg	0.052	(3; 0.42%)
Fo Sg	0.00165	(1; 0.72%)	Bk Sg	0.00239	(1; 1.1%)	Fo Sg	0.0486	(1; 0.4%)
At Sg	0.00151	(1; 0.66%)	Pd Sg	0.00235	(1; 1.1%)	Dc Dp Ho Sg	0.0431	(3; 0.35%)
Oi Pc Sg	0.00127	(2; 0.55%)	Gv Sg	0.00228	(1; 1.1%)	Wt Sg	0.0389	(1; 0.32%)
Cm Sg	0.000829	(1; 0.36%)	Rh Sg	0.00216	(1; 1.%)	Wa Ms Wt Sg	0.036	(3; 0.29%)
Rf Sg	0.0008	(1; 0.35%)	Sf Sg	0.00153	(1; 0.71%)	Ri Fc Ho Sg	0.0334	(3; 0.27%)
In Sg	0.000724	(1; 0.32%)	Nb Sg	0.00152	(1; 0.7%)	Wa Oc Sg	0.0326	(2; 0.27%)
Ch Sg	0.000645	(1; 0.28%)	Ms Wt Sg	0.00146	(2; 0.68%)	Bu Sg	0.0315	(1; 0.26%)
Is Ma Sg	0.000594	(2; 0.26%)	Oc Sg	0.00146	(1; 0.67%)	Wa Pd Wt Sg	0.0304	(3; 0.25%)
Ho Sg	0.000553	(1; 0.24%)	Ho Sg	0.00145	(1; 0.67%)	Oi Fo Sg	0.0292	(2; 0.24%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Sg	0.0988	(0; 56.%)	Sg	0.044	(0; 35.%)	Bc Mp Ho Sg	0.0143	(3; 11.%)
Fo Sg	0.0133	(1; 7.6%)	Rd Sg	0.0108	(1; 8.5%)	Sg	0.00808	(0; 6.3%)
Pc Sg	0.00427	(1; 2.4%)	Wt Sg	0.00698	(1; 5.5%)	Fr Sg	0.00606	(1; 4.7%)
Ma Sg	0.00425	(1; 2.4%)	In Sg	0.00402	(1; 3.2%)	Wo Tx Wt Sg	0.00248	(3; 1.9%)
Rd Sg	0.0038	(1; 2.2%)	Mn Sg	0.0026	(1; 2.1%)	Bc Mp Ch Sg	0.0022	(3; 1.7%)
Oc Sg	0.00283	(1; 1.6%)	Ma Sg	0.00222	(1; 1.7%)	Rd Sg	0.00185	(1; 1.4%)
Mn Sg	0.00249	(1; 1.4%)	Cm Sg	0.00186	(1; 1.5%)	Bc Mp Sg	0.00178	(2; 1.4%)
Wt Sg	0.00225	(1; 1.3%)	Pd Sg	0.00154	(1; 1.2%)	Wo Mp Ho Sg	0.00162	(3; 1.3%)
Eq Sg	0.00202	(1; 1.2%)	Eq Sg	0.0015	(1; 1.2%)	Bc Mp Oc Sg	0.00153	(3; 1.2%)
Rh Sg	0.00167	(1; 0.95%)	Sf Sg	0.00133	(1; 1.%)	Wo Tx Ru Sg	0.00149	(3; 1.2%)
Cm Sg	0.00106	(1; 0.61%)	Bk Sg	0.00132	(1; 1.%)	Wo Tx Oc Sg	0.00144	(3; 1.1%)
Ru Sg	0.00106	(1; 0.6%)	Rh Sg	0.000993	(1; 0.78%)	Bc Mp Ho Wt	0.00143	(4; 1.1%)
Bu Sg	0.000718	(1; 0.41%)	Oc Sg	0.000864	(1; 0.68%)	Bc Mp Bp Sg	0.00135	(3; 1.1%)
Fo Rd Sg	0.000711	(2; 0.41%)	Gv Sg	0.000793	(1; 0.62%)	Bc Mp Ho Rd	0.00127	(4; 0.99%)
Ch Sg	0.000645	(1; 0.37%)	Ho Sg	0.000763	(1; 0.6%)	Ba Bm Ho Sg	0.00117	(3; 0.92%)
Mv Rd Sg	0.000554	(2; 0.32%)	Oi Fo Sg	0.000702	(2; 0.55%)	Bc Ch Sg	0.00111	(2; 0.87%)
At Sg	0.00045	(1; 0.26%)	Ms Wt Sg	0.000694	(2; 0.55%)	Hw Sg	0.000968	(1; 0.76%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	1.007 ±0.016	(±1.6%)
Downstream	1.499 ±0.029	(±1.9%)

Sector 1500: Services to Mining (Mn)

Petroleum and mineral exploration and services to mining

Short Summary

Against the metric of one dollar of final demand, the environmental indicators of greenhouse emissions, water use and land disturbance, are respectively 75%, 50%, and 95% below average. The social indicators reveal that employment generation is 40% below average, income is 15% above average, and government revenue is 15% below average. The financial indicators show that operating surplus is equal to average, export propensity is 70% below average, and import penetration is 20% below average. The sector's technological challenge is to mould several billion years of continental evolution and mineralisation, 150 years of European mining history and the evolving science of informatics, into the precise identification of high grade mineral resources.

Sector Description

In financial terms, the sector is dominated by firms which service mining activity or undertake mining operations on contract (64%), in-house petroleum exploration (21%) and in-house mineral exploration (15%). The mining contracting component of the sector is growing strongly as most major mining houses outsource physical mining to specialist engineering firms. The activity in the sector is highly variable and can be driven by market sentiment, the depletion of resource stocks, 'bull' market conditions for a particular commodity, and institutional arrangements such as tax concessions. As a measure of yearly exploration activity in petroleum, there are currently 80 000 km of 2D or areal seismic lines (mostly offshore), 12 000 sq km of 3D or volumetric seismic lines (75% offshore) and about 130 exploration wells drilled. Mineral industry sources note concerns with current levels of exploration, which are relatively static after a small peak in the mid-1990s. Increasingly, exploration will be based on informatics rather than field survey, but it requires a blending of new theories of landscape evolution and mineralisation, advanced data mining and visualisation techniques, with ready access to on-ground reality checking. In constant dollar terms, the turnover of the sector has quintupled over the last 30 years with a peak and then a decline in the late 1970s and early 1980s. The current turnover is about $5 billion, and involves 300 enterprises.

Place of Industry in the Economy

The services to mining sector ranks 51st out of 135 sectors in terms of value adding in the economy, and contributes 0.38% of GDP in this analysis. It is similar in value adding to the structural metal products, and the pumps bearings and air conditioning sectors. It is a small employer with 7 000 employment years directly embodied in final demand, and another 8 000 years in the sector's upstream suppliers giving a total of 15 000 employment years. In addition, it supplies 6 000 employment years to the final demand of the downstream industries it serves, such as gold and lead, iron ore, copper, black coal, uranium and nickel, and crude oil. In financial terms, the import to export ratio is 23:1, although recent trends in the industry, responding to downturns in domestic exploration, see many companies focusing on overseas opportunities and exports of services.

Strategic Overview

The spider diagram reveals a reasonable TBL account with a small outlier for employment generation and a larger one for export propensity. The social indicators are perhaps less of an issue because of the capital intensity of petroleum exploration, and because government revenue is generated downstream from exploration when resource rents are extracted on mining revenues. Export propensity is improving as Australian expertise is called on by global mining operations.

TBL Account #1

The financial indicator of operating surplus is equal to average and has a direct sector effect of 62%, with contributions from technical services (14%), and security broking (2%). The social indicator of employment generation is 40% below average and is discussed in more detail below. Greenhouse emissions are 75% below average and show an extended chain with a direct effect of 11%, and contributions from basic iron and steel (8%), diesel refining (7%), electricity used by technical services (5%), cement manufacture (4%), electricity generation (3%), airline travel (2%), oil production leading to diesel refining (2%) and water transport (2%).

TBL Accounts #2 and #3

The second TBL account reveals an export propensity 70% below average, income 15% below average and water use 50% below average. The third TBL account shows import penetration 20% below average, government revenue 15% below average, and land disturbance 95% below average. While the land disturbance indicator is minimal, a number of downstream issues relating to increased access and ingress of weeds, are noted in environmental reports and are actively managed in exploration activities. Ocean seismic activities are claimed to disrupt communication by whales and attempts to minimise potential impacts are increasingly part of exploration protocols.

Structural Path Analysis and Linkages

For employment, the structural path analysis shows that the direct sector effect is dominant at 44% of the total with technical services (21%), accommodation (2%), business services (2%), legal and accounting (1%) and wholesale trade (1%). Export propensity is dominated by technical services (17%), followed by the direct effect (9%), airline travel (4%), diesel refining (4%), basic iron and steel (4%), water transport (3%) and wholesale trade (3%). Improving the two indicators is most likely a within sector challenge. A number of government and industry reports highlight institutional barriers such as access to exploration land, taxation arrangements for spreading risk, and the lack of pre-exploration data, which must be overcome to stimulate and maintain exploration activity.

The sector's stimulus to its upstream suppliers is 25% below average as much of the activity is self resourced, from within the sector. There are upstream impacts on scientific and technical services, legal accounting and marketing, and wholesale trade. The linkages to downstream industries are 15% below average, and feature gold and lead, iron ore, black coal, crude oil, and base metals.

Future Trends in Sector

The base case scenario of the *Future Dilemmas* report anticipates that total mineral production will increase by a factor of three by 2050, driven by strong and continuing export demand. In a pro-rata sense, this sector's activities are expected to mimic this growth. As resources such as domestic oil and gas become constrained over the next 20-40 years, exploration activity may increase several fold as the search intensifies, until dry holes and low reserve quality cause petroleum exploration to decline. Other uncertainties include the issue of future carbon constraints affecting demand for fossil fuels, and 'cradle to cradle' minerals stewardship where virgin minerals are displaced by recycled metals, thus reducing the need for exploration success in locating new deposits.

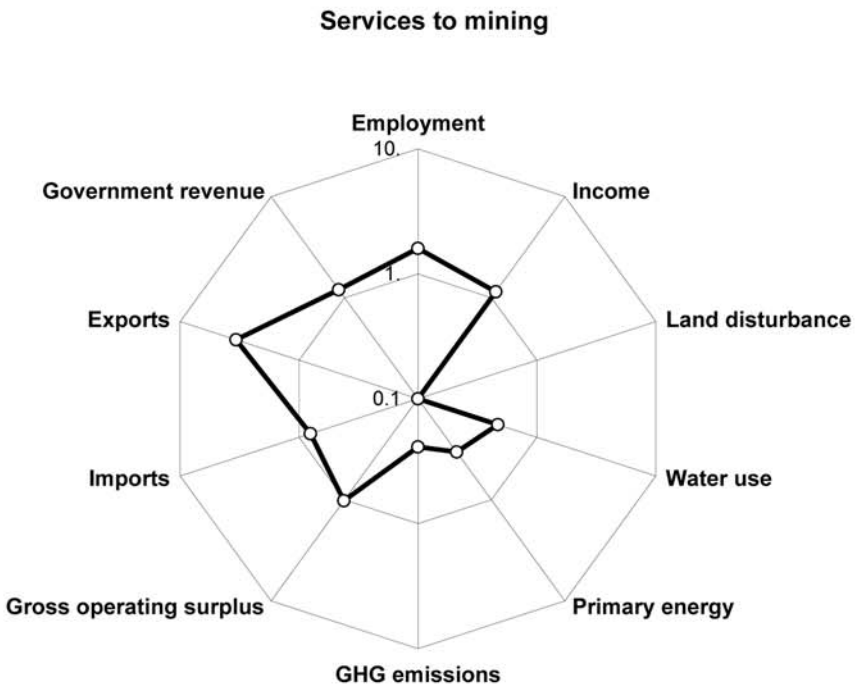
Innovation and Technical Opportunities

The exploration literature sees a critical requirement for the integration of the many sub-disciplines related to geology, exploration, and mining into a fluent and functioning 'whole'. Many individual programs are being focused on sensing in 3D up to 1000 metres below the surface, overcoming the non-detectability of key minerals, deep sea mineral prospecting, using nano-machines to explore and mine, and finally the tension of discovering too much and thereby reducing the financial returns.

Sector **Services to mining** **(Mn)**

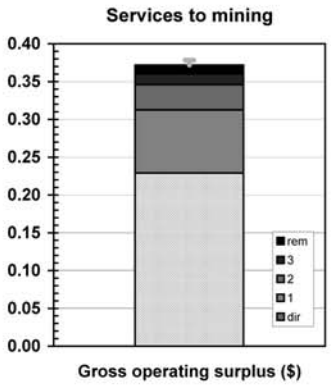
Petroleum and mineral exploration and services to mining

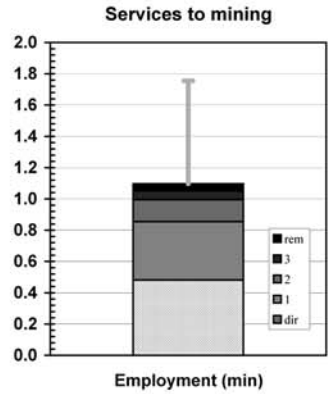
Spider diagram

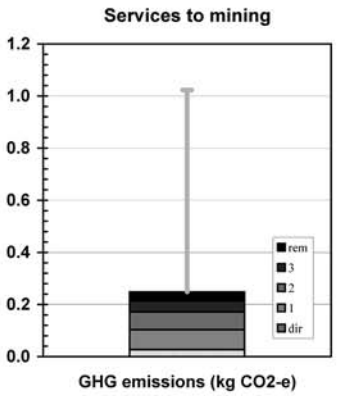


Bar graphs

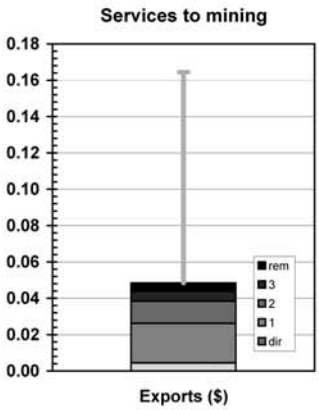
Account #1

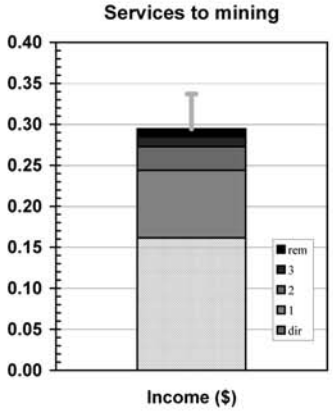


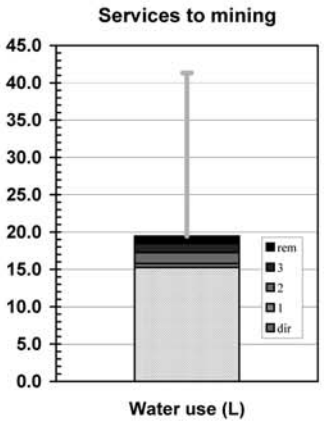




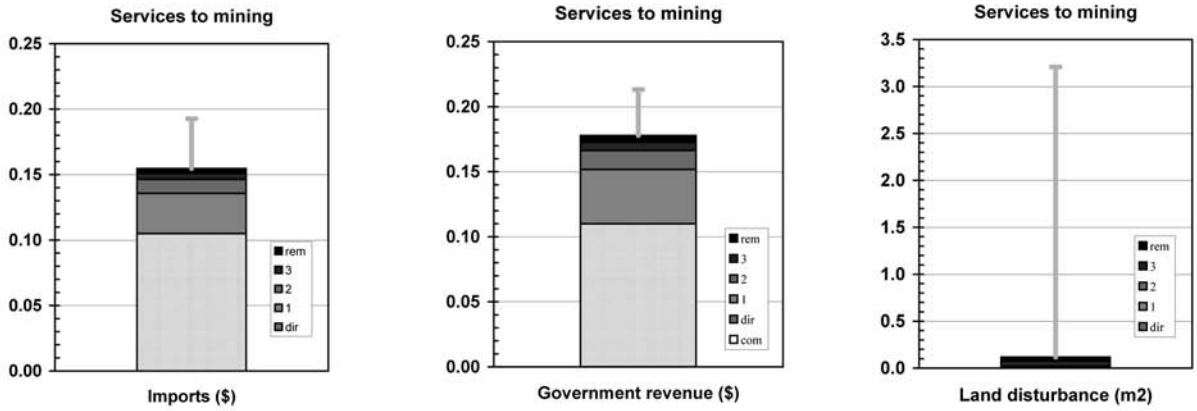
Account #2







Account #3



National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 0.0		
Government final consumption	$m 95.6	(0.11% of total)	($m 95.6 domestically produced)
Gross fixed capital expenditure	$m 1,600.6	(1.53% of total)	($m 1,600.6 domestically produced)
Net changes in stocks	$m 0.0		
Sectoral GNE	**$m 1,696.2**	**(0.37% of GNE)**	**($m 1,696.2 domestically produced)**
Exports	$m 15.0	(0.02% of total)	($m 15.0 domestically produced)
Final demand	**$m 1,711.1**	**(0.32% of GNT)**	**($m 1,711.1 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 547.3	(0.32% of total)	
Gross operating surplus	$m 776.5	(0.40% of total)	
Taxes less subsidies	$m 372.5	(0.44% of total)	
Sectoral GDP*	**$m 1,696.3**	**(0.38% of GDP)**	
Imports	$m 355.6	(0.36% of total)	
Primary inputs	**$m 2,051.8**	**(0.38% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 776.5	(0.40%)	$m 392.0	(0.20%)	$m 636.1	(0.33%)
Exports ($m)	$m 15.0	(0.02%)	$m 7.6	(0.01%)	$m 83.0	(0.10%)
Imports ($m)	$m 355.6	(0.36%)	$m 179.5	(0.18%)	$m 264.6	(0.27%)
Employment (e-y)	13,075 e-y	(0.18%)	6,601 e-y	(0.09%)	15,040 e-y	(0.21%)
Income ($m)*	$m 547.3	(0.32%)	$m 276.3	(0.16%)	$m 503.7	(0.29%)
Government revenue ($m)†	$m 372.5	(0.34%)	$m 188.1	(0.17%)	$m 304.2	(0.28%)
GHG emissions (kt CO_2-e)	91 kt	(0.02%)	46 kt	(0.01%)	425 kt	(0.08%)
Water use (ML)	51,729 ML	(0.25%)	26,116 ML	(0.12%)	33,262 ML	(0.16%)
Land disturbance (kha)	0 kha	(0.00%)	0 kha	(0.00%)	20 kha	(0.01%)
Primary energy (TJ)	1,298 TJ	(0.03%)	655 TJ	(0.02%)	4,389 TJ	(0.11%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.23	0.37	0.38
Exports ($)	0.00	0.05	0.16
Imports ($)	0.10	0.15	0.19
Employment (min)	0.48	1.10	1.75
Income ($)	0.16	0.29	0.34
Government revenue ($)	0.11	0.18	0.21
GHG emissions (kg CO_2-e)	0.03	0.25	1.02
Water use (L)	15.26	19.44	41.32
Land disturbance (m^2)	0.00	0.12	3.21
Primary energy (MJ)	0.38	2.57	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Mn	0.229	(0; 62.%)	Mn	0.481	(0; 44.%)	Mn	0.0268	(0; 11.%)
Ts Mn	0.0509	(1; 14.%)	Ts Mn	0.229	(1; 21.%)	Is Mn	0.0195	(1; 7.8%)
Sf Mn	0.0065	(1; 1.7%)	Ho Mn	0.0167	(1; 1.5%)	Fo Mn	0.018	(1; 7.2%)
Ms Ts Mn	0.00315	(2; 0.85%)	Bs Ts Mn	0.0142	(2; 1.3%)	El Ts Mn	0.0127	(2; 5.1%)
Bk Mn	0.00263	(1; 0.71%)	Ms Ts Mn	0.0141	(2; 1.3%)	Ce Mn	0.00885	(1; 3.6%)
Oi Fo Mn	0.00256	(2; 0.69%)	Wt Mn	0.0136	(1; 1.2%)	El Mn	0.00621	(1; 2.5%)
Is Mn	0.00225	(1; 0.61%)	Bs Mn	0.0123	(1; 1.1%)	At Mn	0.0055	(1; 2.2%)
Wt Mn	0.00189	(1; 0.51%)	Bk Mn	0.0104	(1; 0.95%)	Oi Fo Mn	0.00542	(2; 2.2%)
Cm Ts Mn	0.00186	(2; 0.5%)	Sf Mn	0.00844	(1; 0.77%)	Sp Mn	0.00385	(1; 1.6%)
Cm Mn	0.0016	(1; 0.43%)	Rh Mn	0.00842	(1; 0.77%)	Bc Mp Ho Mn	0.00331	(3; 1.3%)
Bs Ts Mn	0.00144	(2; 0.39%)	Sm Mn	0.00796	(1; 0.73%)	Is Sm Mn	0.00259	(2; 1.%)
Rh Mn	0.00138	(1; 0.37%)	Wt Ts Mn	0.00618	(2; 0.56%)	El Is Mn	0.00255	(2; 1.%)
Ms Mn	0.00135	(1; 0.36%)	Ms Mn	0.00604	(1; 0.55%)	El Ho Mn	0.00218	(2; 0.88%)
Ho Mn	0.00133	(1; 0.36%)	Rd Mn	0.00602	(1; 0.55%)	Gd Ts Mn	0.00218	(2; 0.88%)
Bs Mn	0.00124	(1; 0.33%)	Is Mn	0.00538	(1; 0.49%)	Sw Pp Mn	0.0021	(2; 0.84%)
Rd Mn	0.00102	(1; 0.28%)	Cm Ts Mn	0.00513	(2; 0.47%)	Pp Mn	0.00205	(1; 0.82%)
Rv Mn	0.00102	(1; 0.27%)	Ma Mn	0.00451	(1; 0.41%)	Ts Mn	0.00198	(1; 0.8%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Ts Mn	0.00808	(1; 17.%)	Mn	0.161	(0; 55.%)	Mn	15.3	(0; 79.%)
Mn	0.00442	(0; 9.1%)	Ts Mn	0.0537	(1; 18.%)	Wa Ts Mn	0.687	(2; 3.5%)
At Mn	0.00175	(1; 3.6%)	Ms Ts Mn	0.00329	(2; 1.1%)	Ws Ho Mn	0.122	(2; 0.63%)
Oi Fo Mn	0.00175	(2; 3.6%)	Wt Mn	0.00292	(1; 0.99%)	Bc Mp Ho Mn	0.0873	(3; 0.45%)
Is Mn	0.00172	(1; 3.6%)	Bk Mn	0.00258	(1; 0.87%)	Wa Ms Ts Mn	0.0811	(3; 0.42%)
Sp Mn	0.00163	(1; 3.4%)	Ho Mn	0.00243	(1; 0.83%)	Ts Mn	0.0793	(1; 0.41%)
Wt Mn	0.00155	(1; 3.2%)	Sf Mn	0.00209	(1; 0.71%)	Dc Dp Ho Mn	0.0724	(3; 0.37%)
Ho Mn	0.000928	(1; 1.9%)	Bs Ts Mn	0.00174	(2; 0.59%)	El Ts Mn	0.0701	(2; 0.36%)
Fo Mn	0.000731	(1; 1.5%)	Bs Mn	0.00151	(1; 0.51%)	Sc Cg Ts Mn	0.0674	(3; 0.35%)
Wt Ts Mn	0.000702	(2; 1.4%)	Ms Mn	0.00141	(1; 0.48%)	Dc Dp Ts Mn	0.0572	(3; 0.29%)
Ma Mn	0.000663	(1; 1.4%)	Sm Mn	0.00137	(1; 0.47%)	Ri Fc Ho Mn	0.0562	(3; 0.29%)
Uo Mn	0.000525	(1; 1.1%)	Wt Ts Mn	0.00133	(2; 0.45%)	Is Mn	0.0516	(1; 0.27%)
Ms Ts Mn	0.000489	(2; 1.%)	Is Mn	0.00128	(1; 0.44%)	Pp Mn	0.0512	(1; 0.26%)
Io Is Mn	0.000468	(2; 0.96%)	Cm Ts Mn	0.00117	(2; 0.4%)	Sm Mn	0.0505	(1; 0.26%)
At Ts Mn	0.000415	(2; 0.86%)	Rd Mn	0.00103	(1; 0.35%)	Vf Ho Mn	0.0461	(2; 0.24%)
Rd Mn	0.000356	(1; 0.73%)	Cm Mn	0.001	(1; 0.34%)	Ri Fc Bp Mn	0.044	(3; 0.23%)
Lg Mn	0.000339	(1; 0.7%)	At Mn	0.000975	(1; 0.33%)	Wa Bs Ts Mn	0.0435	(3; 0.22%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Mn	0.105	(0; 68.%)	Mn	0.11	(0; 62.%)	Bc Mp Ho Mn	0.0241	(3; 21.%)
Ts Mn	0.0146	(1; 9.4%)	Ts Mn	0.0265	(1; 15.%)	Wo Ts Mn	0.0088	(2; 7.5%)
Fo Mn	0.00589	(1; 3.8%)	Sf Mn	0.00182	(1; 1.%)	Bc Mp Ts Mn	0.0072	(3; 6.2%)
Is Mn	0.000811	(1; 0.52%)	Ms Ts Mn	0.00156	(2; 0.88%)	Bc Mp Ho Ts I	0.00349	(4; 3.%)
Ma Mn	0.000783	(1; 0.51%)	Bk Mn	0.00142	(1; 0.8%)	Wo Tx Ts Mn	0.00347	(3; 3.%)
Ms Ts Mn	0.000718	(2; 0.46%)	Wt Mn	0.00137	(1; 0.77%)	Wo Mp Ho Mn	0.00272	(3; 2.3%)
Rh Mn	0.00071	(1; 0.46%)	Ho Mn	0.00128	(1; 0.72%)	Bc Mp Bp Mn	0.00214	(3; 1.8%)
Sp Mn	0.000687	(1; 0.44%)	At Mn	0.000784	(1; 0.44%)	Ba Bm Ho Mn	0.00197	(3; 1.7%)
Sm Mn	0.000652	(1; 0.42%)	Rd Mn	0.000734	(1; 0.41%)	Sw Pp Mn	0.00165	(2; 1.4%)
Ho Mn	0.000619	(1; 0.4%)	Ms Mn	0.000668	(1; 0.38%)	Ts Mn	0.00137	(1; 1.2%)
At Mn	0.000522	(1; 0.34%)	Wt Ts Mn	0.00062	(2; 0.35%)	Mn	0.00112	(0; 0.96%)
Wt Mn	0.00044	(1; 0.28%)	Is Mn	0.000588	(1; 0.33%)	Wo Mp Ts Mn	0.000813	(3; 0.7%)
Et Ts Mn	0.000406	(2; 0.26%)	Cm Ts Mn	0.000557	(2; 0.31%)	Bc Mp Ho Ms	0.000765	(5; 0.65%)
Pr Ts Mn	0.000357	(2; 0.23%)	Sm Mn	0.000526	(1; 0.3%)	Wo Tx Ho Mn	0.000682	(3; 0.58%)
Cm Ts Mn	0.000318	(2; 0.21%)	Bs Ts Mn	0.000517	(2; 0.29%)	At Mn	0.000597	(1; 0.51%)
Pp Mn	0.000314	(1; 0.2%)	Cm Mn	0.000478	(1; 0.27%)	Bc Mp Ch Mn	0.000534	(3; 0.46%)
Ms Mn	0.000307	(1; 0.2%)	In Mn	0.000462	(1; 0.26%)	Ba Bm Mn	0.000494	(2; 0.42%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	0.774 ±0.021	(±2.8%)
Downstream	0.804 ±0.015	(±1.8%)

Sector 2101: Meat Products (Mp)

Fresh, chilled or frozen meal for human consumption, edible offals, rendered lard, raw hides and skins, blood meat, slaughtered poultry, bacon, ham and smallgoods

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is over 11 times the average, water use is 8 times the average, and land disturbance is 26 times the average. The social indicators show that employment generation is 35% greater than average, income is 10% below average, and government revenue is 25% below average. The financial indicators show that operating surplus is 15% greater than average, export propensity is more than three times the average and import penetration is 50% below average. There are a number of national accounting issues that could, if reconciled, improve the land disturbance and greenhouse indicators. Certification of meat from lower impact production systems may give market advantage.

Sector Description

In financial terms the sector's turnover is dominated by the processing of beef and sheep meats (65%), poultry (22%) and pig meats (13%). Australia produces over 2 million tonnes of beef annually, consumes 730 000 tonnes and exports 1.4 million tonnes. Sheep meat production is 340 000 tonnes annually of which 220 000 tonnes are consumed domestically, and 120 000 tonnes exported. Annual production of pig meat is 400 000 tonnes, while poultry is 740 000 tonnes. Per capita consumption is 37 kg for beef and veal, 15 kg for lamb and mutton, 21 kg for pig meat and 36 kg for poultry. In constant dollar terms over the last 30 years, fresh meat has tripled at the expense of preserved meat which has halved, while poultry has increased by 60%, and its by-products have remained nearly stable. Turnover is currently about $14.6 billion and involves over 800 enterprises.

Place of Industry in the Economy

The meat products sector ranks 45th out of 135 sectors in terms of value adding in the economy, and contributes 0.46% of GDP in this analysis. It is similar in value adding to the sheep and shorn wool, and the nuts bolts nails and springs sectors. It is a large employer with 38 000 employment years directly embodied in final demand, and 115 000 years in the sector's upstream suppliers, giving a total of 153 000 employment years, or over two percent of the national total. In addition, it contributes 13 000 employment years to the final demand of downstream industries such as retail trade, accommodation and restaurants, and other human and stock foods. It has extremely large resource requirements with 41% of national land disturbance, 13% of water use, 18% of greenhouse emissions and 1% of energy use. In financial terms, exports are 100 times the size of imports.

Strategic Overview

The meat products sector reveals a challenging TBL account with spikes for the environmental indicators of land disturbance, water use and greenhouse gas emissions. Against these, it has excellent outcomes for the financial indicators, a higher than average employment generation most of which is in regional areas, and an average income. A large proportion of the environmental indicators are due to forage production systems embodied in beef and sheep production. Moderating these environmental resource intensities may require production and consumption adjustments. Improving meat production systems and increasing basic prices of meat products are both possible. Radical methods of environmental valuation suggest that beef is undervalued in money terms by a factor of 5-10, if the value of the ecosystem goods embodied in its production chain are included. Debate could focus on balancing market prices and the environmental costs of meat production.

TBL Account #1

The financial indicator of operating surplus is 15% above average with a direct sector effect of 9% and contributions from beef cattle (37%), sheep farming (5%), poultry farming (4%), road transport (4%), pig farming (2%), fodder production (1%) and wholesale trade (1%). The social indicator of employment generation is 35% above average with a direct effect of 25%, and a composition similar to the surplus indicator. The environmental indicator of greenhouse emissions is 11 times the average and is discussed in more detail below.

TBL Accounts #2 and #3

The second TBL account reveals that export propensity is more than three times the average, income is 10% below average, and water use is eight times the average. The third TBL account shows that import penetration is 50% below average, government revenue is 25% below average, and land disturbance is 26 times the average. The water and land indicators are discussed below.

Structural Path Analysis and Linkages

The three environmental indicators are well above average. The structural pathway for greenhouse gas emissions is dominated by beef cattle production (86%) with small contributions from sheep production (3%), land development (2%), and pig production (1%). The emissions from the beef production chain are two thirds attributable to land clearing in northern Australia, and one third methane emissions from gut fermentation. The water indicator is dominated by beef cattle (78%) from irrigated pasture and fodder crops with minor contributions from cotton growing (5%) for cottonseed meal, sheep farming, hay growing (2%), and a direct sector effect of 1%. The land disturbance indicator is dominated by beef cattle (88%), with 10% due to sheep grazing.

The sector's stimulus to its upstream suppliers is 75% greater than average and impacts on beef cattle, road transport, wholesale trade, poultry farming, sheep farming, pig farming, accounting and marketing and property development. The linkages to downstream industries are 65% weaker than average and most output is dissipated by domestic consumption and exports. Weak downstream linkages suggest that any expansion in the sector should be led by expansion in export opportunities for processed meat.

Future Trends in Sector

The base case scenario of the *Future Dilemmas* study, with 25 million people by 2050, anticipates that total production of the four meats in this sector will increase by 50%. About one half of this is due to growth in domestic population and inbound tourism, and the other half to expansion in export trade, particularly for beef exports to the Pacific Rim trading partners. Much of this is based on the assumption that we will maintain our total meat consumption at around 110 kg per capita per year, while allowing for changes in market share of different meat types. There are several sources of uncertainty relating to the human health and the environmental impacts of intensive animal production systems. These could drive change to a more vegetarian diet. A buoyant export market might increase domestic consumer prices. Changes to more biological or pseudo-organic production systems may elevate some meats to high priced high return boutique items, consumed infrequently.

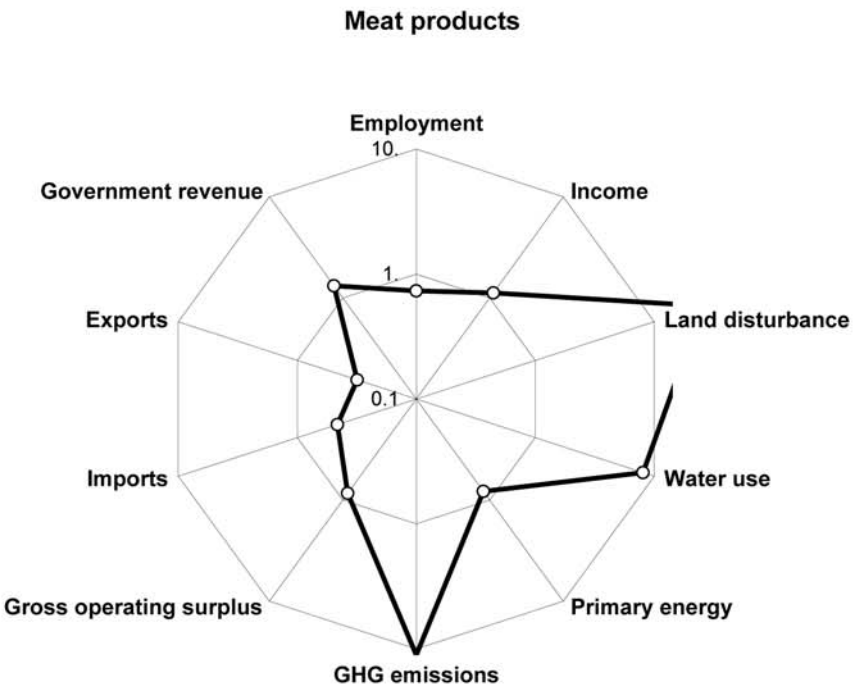
Innovation and Technical Opportunities

There is a trend in the ecological scientific literature to question the size and sustainability of many meat production systems, in the light of the land, energy and water resources devoted to their maintenance and expansion. Allied with this is the expected 'animal revolution' in South East Asia where a rising standard of living and large populations promise a boom for meat producers. Certified production systems based on forage and perceived as healthy will retain a market position.

Sector **Meat products** **(Mp)**

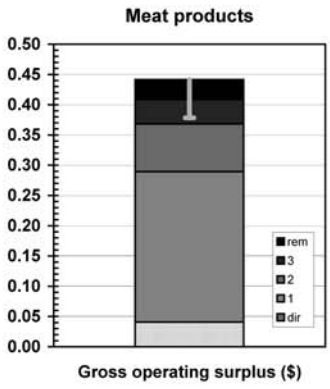
Meat and meat products

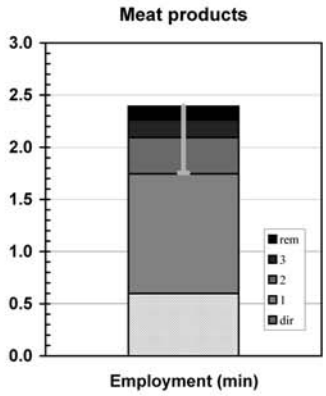
Spider diagram

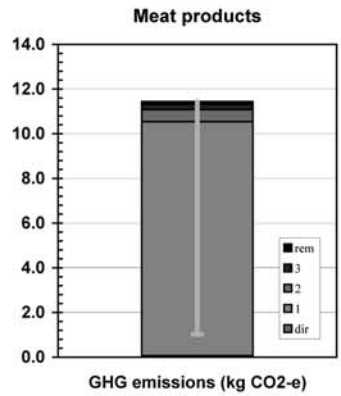


Bar graphs

Account #1







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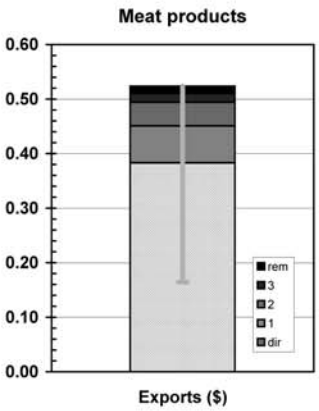

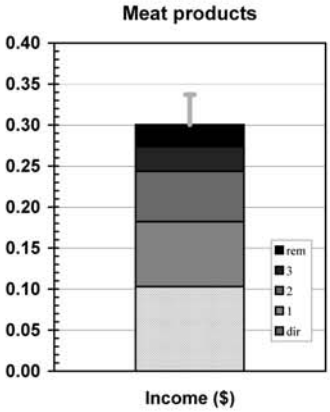

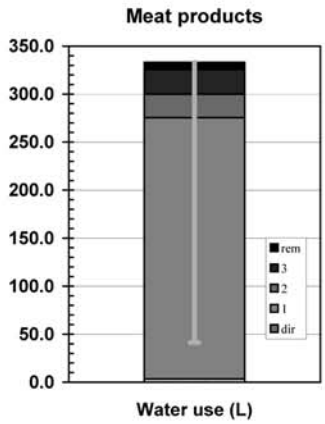

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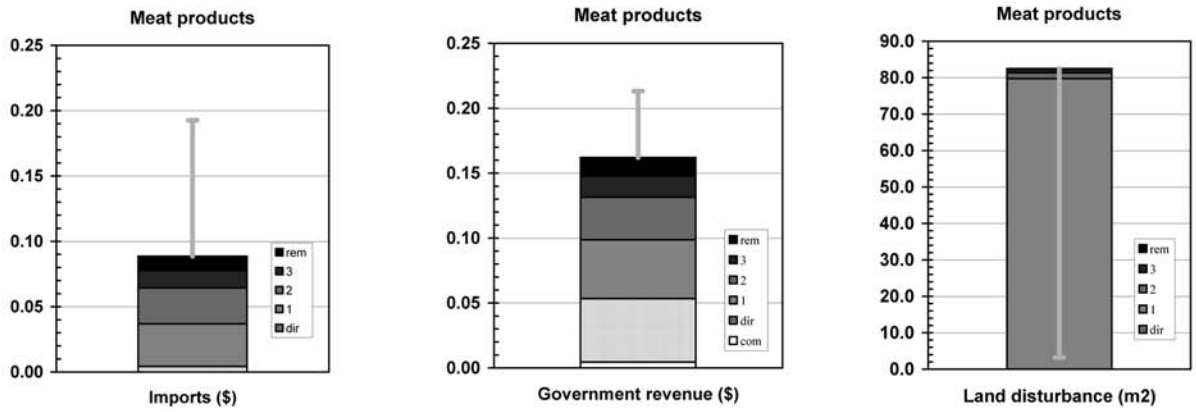


National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 3,862.1	(1.46% of total)	($m 3,802.5 domestically produced)
Government final consumption	$m 0.0	(0.00% of total)	($m 0.0 domestically produced)
Gross fixed capital expenditure	$m 29.2	(0.03% of total)	($m 29.2 domestically produced)
Net changes in stocks	$m 97.4	(5.51% of total)	($m 94.4 domestically produced)
Sectoral GNE	**$m 3,988.8**	**(0.87% of GNE)**	**($m 3,926.2 domestically produced)**
Exports	$m 4,070.7	(4.88% of total)	($m 4,070.7 domestically produced)
Final demand	**$m 8,059.5**	**(1.49% of GNT)**	**($m 7,996.8 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 1,094.7	(0.64% of total)	
Gross operating surplus	$m 431.6	(0.23% of total)	
Taxes less subsidies	$m 519.0	(0.61% of total)	
Sectoral GDP*	**$m 2,045.3**	**(0.46% of GDP)**	
Imports	$m 44.4	(0.05% of total)	
Primary inputs	**$m 2,089.6**	**(0.38% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 431.6	(0.23%)	$m 324.8	(0.17%)	$m 3,530.1	(1.84%)
Exports ($m)	$m 4,070.7	(4.88%)	$m 3,063.1	(3.67%)	$m 4,189.7	(5.03%)
Imports ($m)	$m 44.4	(0.05%)	$m 33.4	(0.03%)	$m 708.8	(0.73%)
Employment (e-y)	50,913 e-y	(0.71%)	38,311 e-y	(0.54%)	153,338 e-y	(2.15%)
Income ($m)*	$m 1,094.7	(0.64%)	$m 823.8	(0.48%)	$m 2,401.9	(1.41%)
Government revenue ($m)†	$m 554.4	(0.51%)	$m 426.0	(0.39%)	$m 1,295.5	(1.20%)
GHG emissions (kt CO_2-e)	680 kt	(0.13%)	512 kt	(0.10%)	91,478 kt	(17.64%)
Water use (ML)	34,729 ML	(0.17%)	26,133 ML	(0.12%)	2,665,116 ML	(12.72%)
Land disturbance (kha)	3 kha	(0.00%)	2 kha	(0.00%)	65,976 kha	(40.55%)
Primary energy (TJ)	9,513 TJ	(0.25%)	7,158 TJ	(0.18%)	50,118 TJ	(1.29%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.04	0.44	0.38
Exports ($)	0.38	0.52	0.16
Imports ($)	0.00	0.09	0.19
Employment (min)	0.60	2.39	1.75
Income ($)	0.10	0.30	0.34
Government revenue ($)	0.05	0.16	0.21
GHG emissions (kg CO_2-e)	0.06	11.44	1.02
Water use (L)	3.27	333.27	41.32
Land disturbance (m^2)	0.00	82.50	3.21
Primary energy (MJ)	0.90	6.27	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Bc Mp	0.164	(1; 37.%)	Bc Mp	0.724	(1; 30.%)	Bc Mp	9.85	(1; 86.%)
Mp	0.0406	(0; 9.2%)	Mp	0.598	(0; 25.%)	Wo Mp	0.337	(1; 2.9%)
Wo Mp	0.0238	(1; 5.4%)	Wo Mp	0.0975	(1; 4.1%)	Fr Bc Mp	0.182	(2; 1.6%)
Pe Mp	0.0163	(1; 3.7%)	Rd Mp	0.0956	(1; 4.%)	Pg Mp	0.121	(1; 1.1%)
Rd Mp	0.0163	(1; 3.7%)	Pe Mp	0.076	(1; 3.2%)	Bc Mp Pe Mp	0.0841	(3; 0.73%)
Pg Mp	0.00793	(1; 1.8%)	Pg Mp	0.0532	(1; 2.2%)	El Mp	0.0792	(1; 0.69%)
Vf Bc Mp	0.00581	(2; 1.3%)	Wt Mp	0.0299	(1; 1.2%)	Mp	0.064	(0; 0.56%)
Wt Mp	0.00415	(1; 0.94%)	Vf Bc Mp	0.0288	(2; 1.2%)	Pe Mp	0.0409	(1; 0.36%)
El Mp	0.0032	(1; 0.72%)	Cg Mp	0.0143	(1; 0.6%)	El Bc Mp	0.03	(2; 0.26%)
Fd Pe Mp	0.00251	(2; 0.57%)	Cg Bc Mp	0.0142	(2; 0.59%)	Rd Mp	0.0258	(1; 0.23%)
Rd Bc Mp	0.0023	(2; 0.52%)	Rd Bc Mp	0.0135	(2; 0.57%)	Fd Pe Mp	0.0165	(2; 0.14%)
Cg Mp	0.00217	(1; 0.49%)	Wt Bc Mp	0.00901	(2; 0.38%)	El Pe Mp	0.0141	(2; 0.12%)
Cg Bc Mp	0.00215	(2; 0.49%)	Ms Bc Mp	0.00897	(2; 0.37%)	Ch Bc Mp	0.0134	(2; 0.12%)
Rv Bc Mp	0.00209	(2; 0.47%)	Nb Bc Mp	0.00849	(2; 0.35%)	Vf Bc Mp	0.0112	(2; 0.098%)
Ms Bc Mp	0.002	(2; 0.45%)	Sc Cg Mp	0.00789	(2; 0.33%)	Sc Cg Mp	0.00784	(2; 0.068%)
Bk Bc Mp	0.00197	(2; 0.45%)	Bk Bc Mp	0.00783	(2; 0.33%)	Sc Cg Bc Mp	0.00777	(3; 0.068%)
Cm Bc Mp	0.00186	(2; 0.42%)	Sc Cg Bc Mp	0.00782	(3; 0.33%)	Dc Dp Pg Mp	0.00744	(3; 0.065%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Mp	0.383	(0; 73.%)	Mp	0.103	(0; 34.%)	Bc Mp	259.6	(1; 78.%)
Wo Mp	0.0298	(1; 5.7%)	Bc Mp	0.0248	(1; 8.3%)	Wo Mp	10.9	(1; 3.3%)
Bc Mp	0.0144	(1; 2.7%)	Rd Mp	0.0164	(1; 5.5%)	Sc Cg Mp	8.2	(2; 2.5%)
Rd Mp	0.00566	(1; 1.1%)	Pe Mp	0.00855	(1; 2.8%)	Sc Cg Bc Mp	8.13	(3; 2.4%)
Fd Pe Mp	0.00454	(2; 0.87%)	Wt Mp	0.00642	(1; 2.1%)	Vf Bc Mp	6.01	(2; 1.8%)
Cg Mp	0.00382	(1; 0.73%)	Pg Mp	0.00437	(1; 1.5%)	Mp	3.27	(0; 0.98%)
Cg Bc Mp	0.00379	(2; 0.72%)	Wo Mp	0.00334	(1; 1.1%)	Dc Dp Pg Mp	3.0	(3; 0.9%)
Wt Mp	0.0034	(1; 0.65%)	Cg Mp	0.00246	(1; 0.82%)	Bc Mp Pe Mp	2.22	(3; 0.66%)
Mp Pe Mp	0.00327	(2; 0.62%)	Cg Bc Mp	0.00243	(2; 0.81%)	Sc Cg Wo Mp	2.04	(3; 0.61%)
Vf Bc Mp	0.00175	(2; 0.33%)	Vf Bc Mp	0.00237	(2; 0.79%)	Su Fd Pe Mp	2.0	(3; 0.6%)
Fd Bc Mp	0.00174	(2; 0.33%)	Rd Bc Mp	0.00233	(2; 0.78%)	Ri Fc Pg Mp	1.66	(3; 0.5%)
Fd Pg Mp	0.00173	(2; 0.33%)	Ms Bc Mp	0.00209	(2; 0.69%)	Ri Fc Mp	0.808	(2; 0.24%)
Wh Bc Mp	0.00165	(2; 0.32%)	Wt Bc Mp	0.00193	(2; 0.64%)	Vf Pg Mp	0.774	(2; 0.23%)
Ch Bc Mp	0.00156	(2; 0.3%)	Bk Bc Mp	0.00193	(2; 0.64%)	Su Fd Bc Mp	0.764	(3; 0.23%)
Dp Pg Mp	0.00137	(2; 0.26%)	Fd Pe Mp	0.00131	(2; 0.44%)	Su Fd Pg Mp	0.762	(3; 0.23%)
Fd Mp	0.00106	(1; 0.2%)	Nb Bc Mp	0.00127	(2; 0.42%)	Wa Mp	0.715	(1; 0.21%)
Wt Bc Mp	0.00102	(2; 0.2%)	Ts Bc Mp	0.00122	(2; 0.41%)	Wh Bc Mp	0.657	(2; 0.2%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Bc Mp	0.0154	(1; 17.%)	Mp	0.0488	(0; 31.%)	Bc Mp	71.6	(1; 87.%)
Mp	0.00417	(0; 4.7%)	Bc Mp	0.0145	(1; 9.2%)	Wo Mp	8.09	(1; 9.8%)
Rd Mp	0.00412	(1; 4.6%)	Rd Mp	0.0117	(1; 7.4%)	Bc Mp Pe Mp	0.611	(3; 0.74%)
Pg Mp	0.00304	(1; 3.4%)	Pe Mp	0.00416	(1; 2.6%)	Wh Bc Mp	0.0957	(2; 0.12%)
Pe Mp	0.00245	(1; 2.8%)	Wt Mp	0.003	(1; 1.9%)	Wo Mp Pe Mp	0.069	(3; 0.084%)
Wo Mp	0.00169	(1; 1.9%)	Pg Mp	0.00233	(1; 1.5%)	Fr Bc Mp	0.0585	(2; 0.071%)
Ac Bc Mp	0.00161	(2; 1.8%)	Wo Mp	0.00193	(1; 1.2%)	Pg Mp	0.0452	(1; 0.055%)
Ch Bc Mp	0.00156	(2; 1.8%)	Rd Bc Mp	0.00165	(2; 1.%)	Bc Mp Bc Mp	0.0421	(3; 0.051%)
Vf Bc Mp	0.00143	(2; 1.6%)	Vf Bc Mp	0.00145	(2; 0.92%)	Wh Pe Mp	0.0416	(2; 0.05%)
Pa Mp	0.00134	(1; 1.5%)	Cg Mp	0.00129	(1; 0.82%)	Bc Mp Fd Pe I	0.0359	(4; 0.043%)
Wt Mp	0.000965	(1; 1.1%)	Cg Bc Mp	0.00128	(2; 0.81%)	Wh Pg Mp	0.0224	(2; 0.027%)
Fo Rd Mp	0.00077	(2; 0.87%)	Bk Bc Mp	0.00107	(2; 0.68%)	Wh Fd Pe Mp	0.0156	(3; 0.019%)
Fd Pe Mp	0.000754	(2; 0.85%)	Ms Bc Mp	0.00099	(2; 0.63%)	Dc Dp Pg Mp	0.0155	(3; 0.019%)
Cg Mp	0.000609	(1; 0.69%)	Wt Bc Mp	0.000904	(2; 0.57%)	Ba Bc Mp	0.0153	(2; 0.019%)
Cg Bc Mp	0.000603	(2; 0.68%)	Fd Pe Mp	0.000636	(2; 0.4%)	Ba Pe Mp	0.015	(2; 0.018%)
Mv Rd Mp	0.0006	(2; 0.68%)	Ts Bc Mp	0.000603	(2; 0.38%)	Wh Fc Pg Mp	0.0144	(3; 0.017%)
Rd Bc Mp	0.000584	(2; 0.66%)	El Mp	0.0006	(1; 0.38%)	Bc Mp Fd Bc I	0.0137	(4; 0.017%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	1.765 ±0.038	(±2.2%)
Downstream	0.354 ±0.010	(±2.8%)

Sector 2102: Dairy Products (Dp)

Milk, cream, butter, cheese, whole milk drinks, ice cream, yoghurt and other dairy products

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is more than twice the average, water use is more than 15 times the average and land disturbance is 20% above average. The social indicators show employment generation is equal to average, while income and government revenue are 20% and 25% below average respectively. The financial indicator of operating surplus is 20% above average and export propensity is more than twice the average, while import penetration is 40% below average. This TBL account suggests a number of challenges but has much in common with many Australia food and fibre sectors producing for domestic consumption and export markets. TBL outcomes could be improved through a two-pronged strategy whereby production innovations are sought at the same time as price adjustments and product labelling drive change in household consumption decisions. The dairy products sector appears set for a period of sustained evolution as product ranges diversify and add value through health giving properties and lifestyle choices.

Sector Description

The dairy products sector receives un-pasteurised whole milk from the dairy cows sector as the feedstock for manufacturing. It processes almost 12 billion litres of milk with exports accounting for 51%, drinking milk 19% and milk products 30%. Most manufacturing milk is used for cheese (41%) and butter (32%). Australia has fifteen integrated dairy companies: six of these are multinationals and the remainder based on a cooperative structure. Australia has 12% of the global export dairy market with New Zealand (31%) and Europe (38%) being the major players. The current farm gate value of milk production is $3.4 billion. Australians consume 100 litres of milk, 3 kg of butter, 11 kg of cheese (9 kg made locally) and 3 kg of milk powder per capita each year.

Place of Industry in the Economy

The dairy products industry ranks 59th out of 135 in value adding terms in the Australian economy, and contributes 0.29% of GDP in this analysis. By comparison it is four times the size of the cement manufacturing sector, one third the size of basic iron and steel and one sixth the size of the road freight sector. It is a moderate sized employer with a direct requirement of 10 000 employment years and another 53 000 employment years in the sector's suppliers, giving a total of 63 000 employment years. In addition it contributes 4 000 employment years to the final demand of downstream sectors. The sector is responsible for nearly 15% of national water use, 2% of national greenhouse emissions and 1% of national energy use and land disturbance. In financial terms, exports are fourteen times the size of imports.

Strategic Overview

The sector's spider diagram shows two outliers for the environmental indicators of water use and greenhouse emissions. Upstream issues for the sector include water use in, and effluents and emissions from diary production systems. The key downstream issues focus on tensions between the many positive dietary properties of milk products and some negative health effects from inappropriate consumption levels. However, the sector is one of the food industry's leaders in product development and diversification, with niche products focused on every conceivable dietary requirement. Reducing the water indicator by moving to production regions of high rainfall or changing to grain diets is feasible, but may increase the land disturbance indicator.

TBL Account #1

The financial indicator of operating surplus is 20% above the economy wide average with one fifth of that a direct effect of the sector. Whole milk from dairy farms contributes most of the surplus (29%) supplemented by a long chain of minor contributors such as wholesale trade (2%), road freight (2%), sugar (2%), plastic products (1%) and marketing (1%). The social indicator of employment generation is equal to average with one sixth of that a direct effect. Greenhouse emissions are more than twice the average with only one tenth due to energy use in the manufacturing plant. This highlights the limitations of cleaner production and energy efficiency initiatives focused on activities within manufacturing plants. Most emissions are due to methane from dairy cows and effluent, and nitrous oxide emissions from pasture fertilisers. Broadening the boundaries of environmental analysis and attributing some responsibility to the product consumer, rather than just the producer, may stimulate a number of future policy challenges.

TBL Accounts #2 and #3

The second TBL account reveals an export propensity more than twice the average, income 20% below average and water use over fifteen times the economy wide average. The third TBL account shows import penetration 40% below average, government revenue 25% below average and land disturbance 20% above average. These two accounts show positive financial outcomes but room for improvement in the social and environmental outcomes.

Structural Path Analysis and Linkages

The greenhouse emissions chain shows that dairy cattle and grazing practices on farm are responsible for 56% of emissions followed by direct energy use in factory (4%), electricity use in the factory (3%), electricity on farm (3%), land development (2%) and chemicals for plastic packaging (1%). The remaining 30% of emissions are contributed by many hundreds of products and suppliers in the production process. For the water indicator, three litres of the total of 650 litres is used in factory. Irrigation water on farm accounts for 81% of the total with minor contributions from cottonseed meal, the by-product of sugar molasses, and vegetable and fruit growing (1% each).

A decision to invest in the sector gives a weak downstream linkage to the sector of accommodation, cafes and restaurants sector. Thus apart from exports, production stimulated from extra capacity can only be absorbed by extra personal consumption and thus has a relatively narrow base. Increasing consumer demand gives one of the strongest upstream stimuli to sectors seen in this analysis.

Future Trends in Sector

The CSIRO *Future Dilemmas* study sees a doubling in milk production (to 20 billion litres) and therefore milk products by 2050, driven mostly by international trade, particularly with new products for emerging markets in South East Asia. This is uncertain due to the dynamics of world trade, particularly with the current ‘structural surplus’ of 15-20 billion litres of milk in the EU.

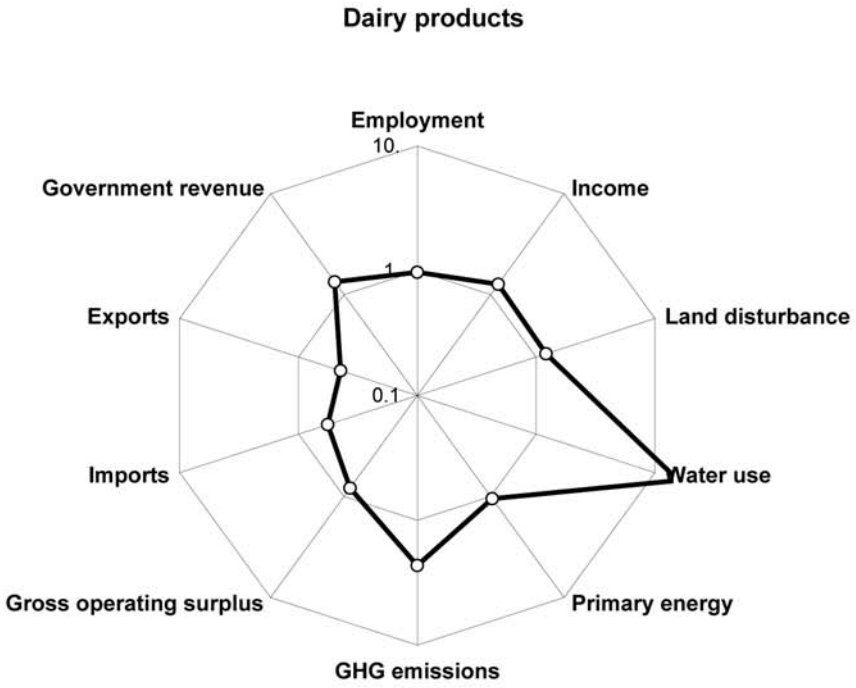
Innovation and Technical Opportunities

At least four issues seem set to guide the paths of innovation in the dairy products sector. The health promoting aspects of dairy products (especially for ageing populations) need to be balanced against toxic products and nutrient overload that may arise from intensive production systems. The increasing use of the dairy chain as a base for pharmaceuticals production will evolve with the genetic engineering of key bacteria and the development of more pro-biotic foods. Moves to a greater product diversity made and delivered more frequently will use more energy and materials, but might also increase labour use and profits. Finally the sector may evolve from a price taking product chain to a value chain where products are purchased for image and health properties.

Sector **Dairy products** **(Dp)**

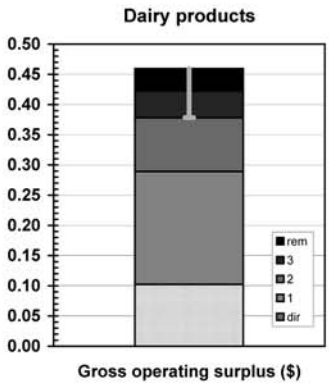
Milk, cream, butter, cheese, whole milk drinks, ice cream, yogurt and other dairy products

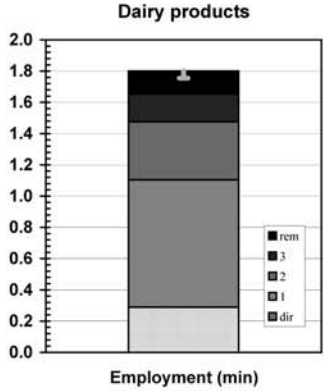
Spider diagram

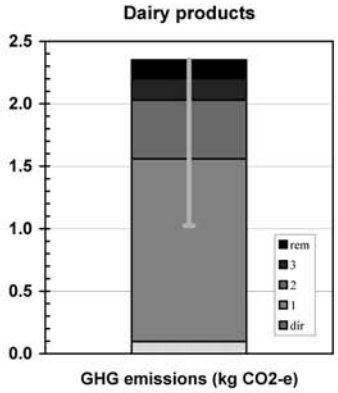


Bar graphs

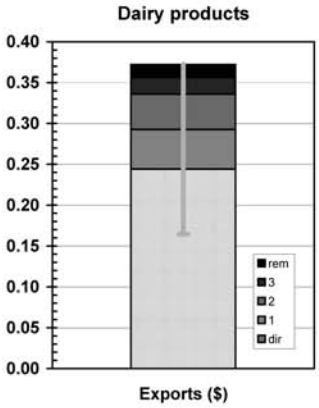
Account #1

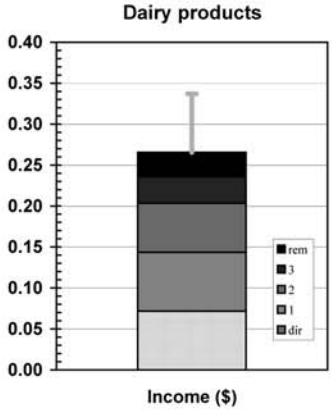


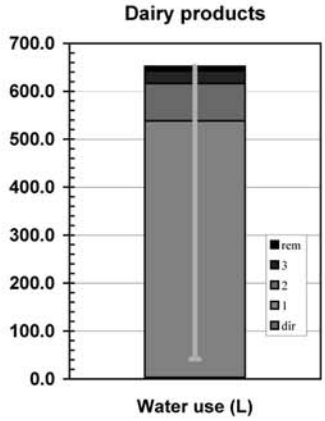




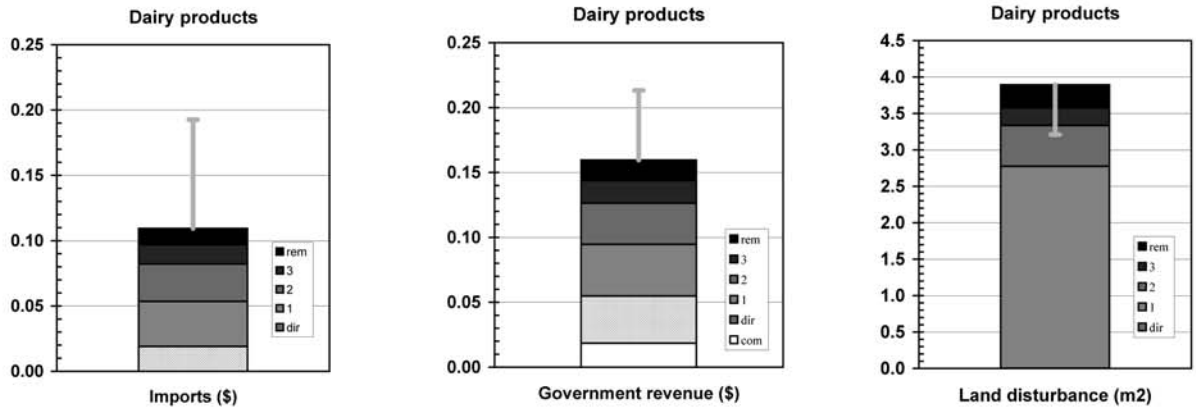
Account #2







Account #3



National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 3,031.2	(1.15% of total)	($m 2,854.2 domestically produced)
Government final consumption	$m 0.0	(0.00% of total)	($m 0.0 domestically produced)
Gross fixed capital expenditure	$m 28.2	(0.03% of total)	($m 28.2 domestically produced)
Net changes in stocks	-$m 30.8	-(1.74% of total)	
Sectoral GNE	**$m 3,028.6**	**(0.66% of GNE)**	**($m 2,823.0 domestically produced)**
Exports	$m 1,515.7	(1.82% of total)	($m 1,515.7 domestically produced)
Final demand	**$m 4,544.3**	**(0.84% of GNT)**	**($m 4,338.7 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 444.3	(0.26% of total)	
Gross operating surplus	$m 634.5	(0.33% of total)	
Taxes less subsidies	$m 225.6	(0.26% of total)	
Sectoral GDP*	**$m 1,304.4**	**(0.29% of GDP)**	
Imports	$m 117.7	(0.12% of total)	
Primary inputs	**$m 1,422.1**	**(0.26% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 634.5	(0.33%)	$m 449.5	(0.23%)	$m 2,021.0	(1.05%)
Exports ($m)	$m 1,515.7	(1.82%)	$m 1,073.9	(1.29%)	$m 1,637.4	(1.96%)
Imports ($m)	$m 117.7	(0.12%)	$m 83.4	(0.09%)	$m 480.8	(0.49%)
Employment (e-y)	14,375 e-y	(0.20%)	10,185 e-y	(0.14%)	63,486 e-y	(0.89%)
Income ($m)*	$m 444.3	(0.26%)	$m 314.8	(0.18%)	$m 1,167.7	(0.68%)
Government revenue ($m)†	$m 306.8	(0.28%)	$m 241.0	(0.22%)	$m 702.2	(0.65%)
GHG emissions (kt CO_2-e)	594 kt	(0.11%)	421 kt	(0.08%)	10,340 kt	(1.99%)
Water use (ML)	17,919 ML	(0.09%)	12,695 ML	(0.06%)	2,868,528 ML	(13.69%)
Land disturbance (kha)	2 kha	(0.00%)	1 kha	(0.00%)	1,712 kha	(1.05%)
Primary energy (TJ)	8,046 TJ	(0.21%)	5,701 TJ	(0.15%)	35,357 TJ	(0.91%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.10	0.46	0.38
Exports ($)	0.24	0.37	0.16
Imports ($)	0.02	0.11	0.19
Employment (min)	0.29	1.80	1.75
Income ($)	0.07	0.27	0.34
Government revenue ($)	0.05	0.16	0.21
GHG emissions (kg CO_2-e)	0.10	2.35	1.02
Water use (L)	2.89	652.21	41.32
Land disturbance (m^2)	0.00	3.89	3.21
Primary energy (MJ)	1.30	8.04	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Dc Dp	0.134	(1; 29.%)	Dc Dp	0.575	(1; 32.%)	Dc Dp	1.33	(1; 56.%)
Dp	0.102	(0; 22.%)	Dp	0.289	(0; 16.%)	Dp	0.0957	(0; 4.1%)
Wt Dp	0.00787	(1; 1.7%)	Wt Dp	0.0567	(1; 3.1%)	El Dp	0.0789	(1; 3.4%)
Rd Dp	0.0078	(1; 1.7%)	Rd Dp	0.0459	(1; 2.5%)	El Dc Dp	0.0712	(2; 3.%)
Fd Dc Dp	0.00686	(2; 1.5%)	Pl Dp	0.0311	(1; 1.7%)	Fr Dc Dp	0.0556	(2; 2.4%)
Pl Dp	0.00583	(1; 1.3%)	Vf Dc Dp	0.0224	(2; 1.2%)	Fd Dc Dp	0.0452	(2; 1.9%)
Vf Dc Dp	0.00452	(2; 0.98%)	Ms Dp	0.0188	(1; 1.%)	Bc Mp Fd Dc I	0.0135	(4; 0.57%)
Ms Dp	0.00418	(1; 0.91%)	Wt Dc Dp	0.0159	(2; 0.89%)	Ch Pl Dp	0.013	(2; 0.55%)
El Dp	0.00319	(1; 0.69%)	Fd Dc Dp	0.0153	(2; 0.85%)	Rd Dp	0.0124	(1; 0.53%)
Rv Dc Dp	0.00316	(2; 0.69%)	Cg Dc Dp	0.0125	(2; 0.7%)	Ch Dc Dp	0.0112	(2; 0.48%)
El Dc Dp	0.00288	(2; 0.63%)	Rd Dc Dp	0.0117	(2; 0.65%)	Vf Dc Dp	0.00874	(2; 0.37%)
Wa Dc Dp	0.0028	(2; 0.61%)	Nb Dc Dp	0.0115	(2; 0.64%)	Wt Dp	0.00786	(1; 0.33%)
Wt Dc Dp	0.00221	(2; 0.48%)	Wh Dc Dp	0.00897	(2; 0.5%)	Fd Dp	0.00768	(1; 0.33%)
Rd Dc Dp	0.002	(2; 0.43%)	Rv Dc Dp	0.00845	(2; 0.47%)	Sc Cg Dc Dp	0.00688	(3; 0.29%)
Cg Dc Dp	0.00191	(2; 0.41%)	Pa Dp	0.00786	(1; 0.44%)	El Pl Dp	0.00677	(2; 0.29%)
Wh Dc Dp	0.00182	(2; 0.4%)	Hs Dc Dp	0.00725	(2; 0.4%)	Fo Dc Dp	0.00669	(2; 0.28%)
Bk Dc Dp	0.00164	(2; 0.36%)	Sc Cg Dc Dp	0.00693	(3; 0.38%)	Ga Dp	0.00595	(1; 0.25%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Dp	0.244	(0; 66.%)	Dp	0.0716	(0; 27.%)	Dc Dp	533.6	(1; 82.%)
Fd Dc Dp	0.0124	(2; 3.3%)	Dc Dp	0.0209	(1; 7.9%)	Sc Cg Dc Dp	7.2	(3; 1.1%)
Wt Dp	0.00644	(1; 1.7%)	Wt Dp	0.0122	(1; 4.6%)	Su Fd Dc Dp	5.46	(3; 0.84%)
Cg Dc Dp	0.00335	(2; 0.9%)	Rd Dp	0.00789	(1; 3.%)	Vf Dc Dp	4.67	(2; 0.72%)
Rd Dp	0.00271	(1; 0.73%)	Pl Dp	0.00628	(1; 2.4%)	Dp	2.89	(0; 0.44%)
Wh Dc Dp	0.00233	(2; 0.63%)	Ms Dp	0.00436	(1; 1.6%)	Wa Dc Dp	2.06	(2; 0.32%)
Fd Dp	0.00211	(1; 0.57%)	Fd Dc Dp	0.00359	(2; 1.4%)	Su Fd Dp	0.929	(2; 0.14%)
Wt Dc Dp	0.00181	(2; 0.49%)	Wt Dc Dp	0.00342	(2; 1.3%)	Wh Dc Dp	0.927	(2; 0.14%)
Pl Dp	0.00169	(1; 0.45%)	Cg Dc Dp	0.00215	(2; 0.81%)	Wa Dp	0.54	(1; 0.083%)
Ch Pl Dp	0.00151	(2; 0.41%)	Rd Dc Dp	0.00202	(2; 0.76%)	Sc Cg Vf Dc D	0.485	(4; 0.074%)
Vf Dc Dp	0.00136	(2; 0.37%)	Vf Dc Dp	0.00184	(2; 0.69%)	El Dp	0.436	(1; 0.067%)
Ch Dc Dp	0.0013	(2; 0.35%)	Pa Dp	0.00181	(1; 0.68%)	Vf Fd Dc Dp	0.434	(3; 0.067%)
Rf Dp	0.000877	(1; 0.24%)	Hs Dc Dp	0.0018	(2; 0.68%)	El Dc Dp	0.394	(2; 0.06%)
Bl El Dp	0.000771	(2; 0.21%)	Nb Dc Dp	0.00171	(2; 0.64%)	Bc Mp Fd Dc I	0.356	(4; 0.055%)
Wh Fd Dc D	0.00074	(3; 0.2%)	Bk Dc Dp	0.00161	(2; 0.61%)	Ri Fc Dc Dp	0.324	(3; 0.05%)
Bl El Dc Dp	0.000696	(3; 0.19%)	Ms Dc Dp	0.00145	(2; 0.54%)	Wh Fd Dc Dp	0.294	(3; 0.045%)
Rd Dc Dp	0.000695	(2; 0.19%)	Rv Dc Dp	0.00136	(2; 0.51%)	Vf Dp	0.284	(1; 0.043%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Dp	0.019	(0; 17.%)	Dp	0.0363	(0; 26.%)	Dc Dp	2.77	(1; 71.%)
Dc Dp	0.015	(1; 14.%)	Dc Dp	0.0134	(1; 9.5%)	Wh Dc Dp	0.135	(2; 3.5%)
Pl Dp	0.00598	(1; 5.5%)	Wt Dp	0.00569	(1; 4.%)	Bc Mp Fd Dc I	0.0982	(4; 2.5%)
Pa Dp	0.00227	(1; 2.1%)	Rd Dp	0.0056	(1; 4.%)	Wh Fd Dc Dp	0.0428	(3; 1.1%)
Fo Dc Dp	0.00219	(2; 2.%)	Pl Dp	0.00274	(1; 1.9%)	Bc Mp Dc Dp	0.0233	(3; 0.6%)
Fd Dc Dp	0.00206	(2; 1.9%)	Ms Dp	0.00207	(1; 1.5%)	Ba Dc Dp	0.0222	(2; 0.57%)
Rd Dp	0.00198	(1; 1.8%)	Fd Dc Dp	0.00174	(2; 1.2%)	Fr Dc Dp	0.0179	(2; 0.46%)
Wt Dp	0.00183	(1; 1.7%)	Wt Dc Dp	0.0016	(2; 1.1%)	Bc Mp Fd Dp	0.0167	(3; 0.43%)
Ch Pl Dp	0.00151	(2; 1.4%)	Rd Dc Dp	0.00143	(2; 1.%)	Wo Mp Fd Dc	0.0111	(4; 0.28%)
Ch Dc Dp	0.0013	(2; 1.2%)	Cg Dc Dp	0.00113	(2; 0.8%)	Bc Mp Dp	0.00953	(2; 0.24%)
Ac Dc Dp	0.00119	(2; 1.1%)	Vf Dc Dp	0.00113	(2; 0.8%)	Sc Cg Dc Dp	0.00945	(3; 0.24%)
Vf Dc Dp	0.00111	(2; 1.%)	Pa Dp	0.000951	(1; 0.67%)	Su Fd Dc Dp	0.00874	(3; 0.22%)
Ms Dp	0.000952	(1; 0.87%)	Bk Dc Dp	0.00089	(2; 0.63%)	Bc Mp Ho Dc	0.00779	(4; 0.2%)
Sh Dp	0.000775	(1; 0.71%)	Rv Dc Dp	0.000839	(2; 0.59%)	Wh Fd Dp	0.00728	(2; 0.19%)
Pc Dp	0.000614	(1; 0.56%)	Hs Dc Dp	0.000727	(2; 0.51%)	Wo Tx Pl Dp	0.00599	(3; 0.15%)
Cg Dc Dp	0.000534	(2; 0.49%)	Nb Dc Dp	0.00072	(2; 0.51%)	Ba Fd Dc Dp	0.00588	(3; 0.15%)
Wt Dc Dp	0.000515	(2; 0.47%)	Ms Dc Dp	0.000687	(2; 0.49%)	Bc Mp Ch Pl D	0.00516	(4; 0.13%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	1.786 ±0.043	(±2.4%)
Downstream	0.427 ±0.014	(±3.3%)

Sector 2103: Fruit and Vegetable Products (Fp)

Processed vegetable and fruit products including juices, frozen, dried and canned food, pasta and prepared salads

Short Summary

The fruit and vegetable products sector provides a reasonable environmental account with greenhouse emissions 5% below average, land disturbance 35% below average and water use over twice the average. Nearly half the water indicator is an indirect effect due to the supply of raw materials from the vegetable and fruit growing sector. Employment generation is 20% below average and income and government revenue are both 15% below average. The sector's financial indicators show operating surplus and export propensity are 10% and 45% above average respectively while import penetration is 30% below average. The sector shows weak downstream linkages with a small effect on the accommodation café and restaurants sector. Increased consumer demand strongly stimulates upstream suppliers such as vegetable and fruit growing, plastic and steel containers, wholesale trade, road freight and marketing. Both government revenue and water use indicators could be improved if the embodied water content of the sector's products were subject to a resource use levy delivered through best practice full cost pricing for water. This would shift the cost of maintaining and improving national water resources from government to consumers. However processed food is a nutritional staple in many lower income households and the social and distributional effects and dietary impacts of resource pricing would need to be considered.

Sector Description

The sector includes processing of fruits and vegetables and produces a wide range of frozen, dried, canned and partly prepared products. Weight or volumetric measures are difficult to obtain but major components by financial value include fruit juices (25%), frozen vegetables (17%), preserved fruit (15%), sauces (8%) and jams (7%). The sector has a strong regional orientation with about half of the factories and employment located outside major urban areas. In 2002, the turnover was $4.4 billion and involved over 200 enterprises.

Place of Industry in the Economy

The sector is a relatively small one in terms of value adding in the economy ranking 71st out of 135 and contributing 0.21% of GDP in this analysis. While the food industry in total is a large generator of employment, this particular sector generates 30 000 employment years of which 8 000 are used directly and 22 000 are located in the sector's suppliers. It has a moderate requirement for environmental resources with one percent of national water use, one half of one percent of national energy use and greenhouse emissions, and one fifth of one percent of national land disturbance. Exports are three times imports in financial terms.

Strategic Overview

The integrated overview in the spider diagram shows a reasonably balanced TBL outcome with one outlier for water use and three below average indicators of government revenue, employment generation and income. The key upstream issues for the sector relate to embodied water use and land sustainability issues and the long term effect of current agricultural production systems on the health of process workers (particularly itinerant fruit and vegetable pickers). Downstream issues include the composition of processed food, the loss of nutritional value particularly vitamins and micronutrients, and the part that convenience food and time-poor lifestyles play in emerging population health issues such as obesity and diabetes.

TBL Account #1

The financial surplus is 10% above average. About two fifths is a direct effect with contributions from vegetable and fruit growing (8%) and road transport, steel containers, glass products and wholesale trade (2% each). The social indicator of employment generation is 20% below average reflecting the increasingly automated and capital intensive nature of the food chain, as well as strong competition from a globalised marketplace. The greenhouse emissions indicator is 5% below average with a direct effect of 10% and contributions from electricity (11%), vegetable and fruit growing (7%), land development (4%), beef cattle (4%), steel making (3%) and sugar refining (3%).

TBL Accounts #2 and #3

In the second TBL account, the export propensity is 45% below average, income is 15% below average and water use is more than twice the average. In the third TBL account, import penetration, government revenue and land disturbance are respectively 30%, 15% and 65% below average.

Structural Path Analysis and Linkages

The structural path analysis for water use shows an extended chain with the water in the raw product (from the vegetable and fruit growing sector) being the largest at 40% of the total. The direct effect is 13%, and then rice (10%), dairy (4%) sugar (3%), grains and water delivery (2% each).

Increases in consumer demand show strong upstream linkages to sectors such as vegetable and fruit growing, plastic products, steel containers, wholesale trade, road freight and marketing. The sector shows extremely weak downstream linkages being dissipated by personal consumption and exports.

Future Trends in Sector

Trade policies will increasingly target affluent countries or classes on the Pacific Rim for high value processed products, while average quality products will concentrate on water constrained countries such as the Middle East, South Korea, Taiwan and Singapore. Exchanges based on bartering as well as traditional financial forms may enable large food processors to broaden their business base. While the future demarcation between fresh and processed foods remains uncertain, on the assumption that Australians will retain a similar dietary composition, the *Future Dilemmas* study anticipates an expansion of processed food by 25-35% in line with population growth and tourism.

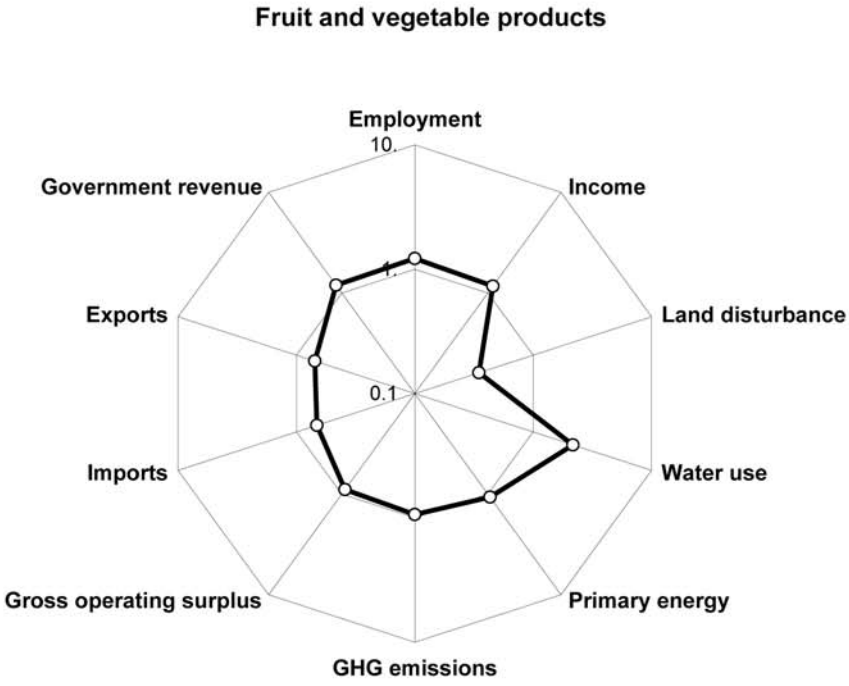
Innovation and Technical Opportunities

A range of current eco-efficiency initiatives in food processing aim to reduce water use from three to one half tonnes per tonne of fruit processed, and to reduce energy use per unit by 30%. Tensions between the marketing goals of the food processing and fresh food sectors will continue, although they may be owned by the same companies. The ageing of Australia's population will enhance the focus on processed foods that are delicious, easy, health enhancing, cancer preventing, allergy neutral, rich in antioxidants, GM free, from biological or non-chemical production systems, with a low embodied energy and water content, having a regional identity that links to images of Australian farms and farmers and contributing to the economic and social vitality of rural communities. While in total these requirements may seem excessive, the average product will produce an average return, and may soon disappear from the consumption basket of contemporary shoppers. New production technologies (eg pulsed electric field and high pressure preservation) will avoid heat treatment where possible, to retain taste and active ingredients. Chilled and minimally processed food will include 'shelf life decision systems' that report on toxicity and spoilage. Production chain information may become part of labelling requirements to support traceability from 'paddock to plate'. Residues from processing will increasingly be re-processed to new products such as functional food ingredients, fruity food flavours and waste bio-adsorbants.

Sector **Fruit and vegetable products** **(Fp)**

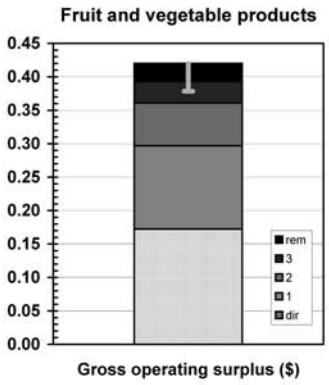
Vegetables, fruit, juices, jams, salads, canned vegetable-mixed pasta and meat and other fruit and vegetable products

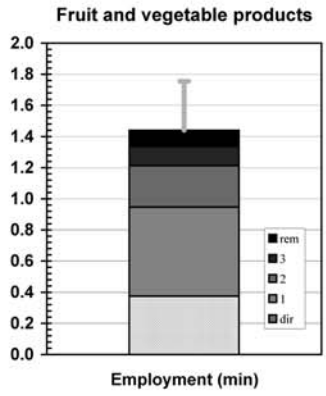
Spider diagram

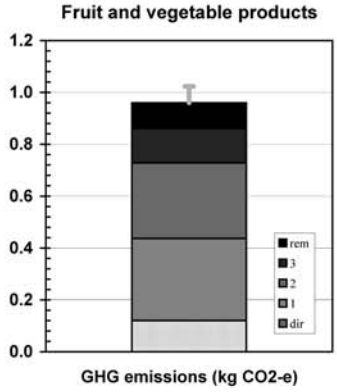


Bar graphs

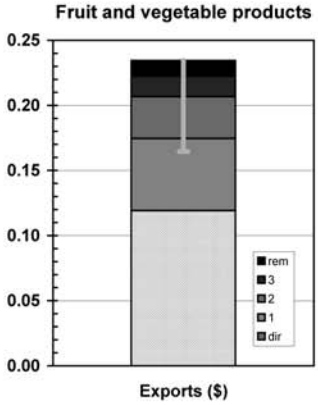
Account #1

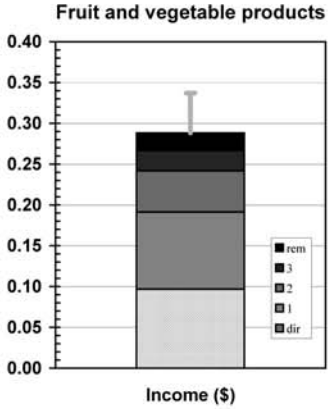


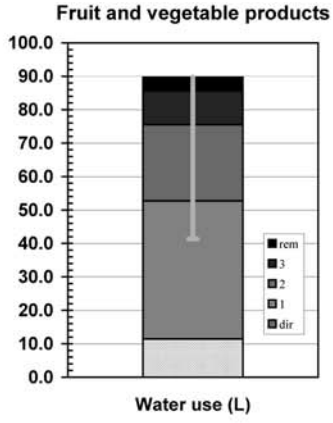




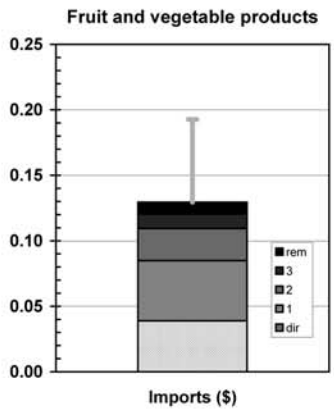
Account #2

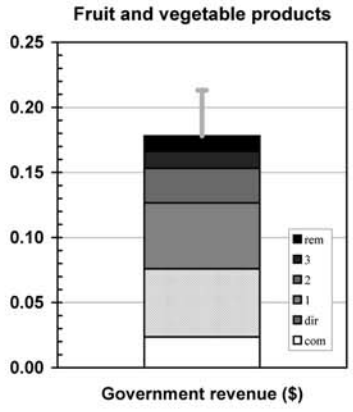


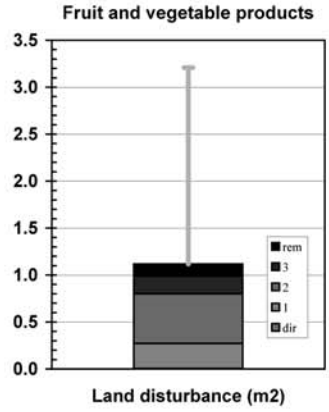




Account #3







National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 2,661.9	(1.01% of total)	($m 2,185.5 domestically produced)
Government final consumption	$m 0.0	(0.00% of total)	($m 0.0 domestically produced)
Gross fixed capital expenditure	$m 27.4	(0.03% of total)	($m 27.4 domestically produced)
Net changes in stocks	$m 12.8	(0.72% of total)	($m 11.7 domestically produced)
Sectoral GNE	**$m 2,702.1**	**(0.59% of GNE)**	**($m 2,224.7 domestically produced)**
Exports	$m 352.8	(0.42% of total)	($m 352.8 domestically produced)
Final demand	**$m 3,054.9**	**(0.56% of GNT)**	**($m 2,577.5 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 286.6	(0.17% of total)	
Gross operating surplus	$m 509.9	(0.27% of total)	
Taxes less subsidies	$m 155.3	(0.18% of total)	
Sectoral GDP*	**$m 951.8**	**(0.21% of GDP)**	
Imports	$m 115.0	(0.12% of total)	
Primary inputs	**$m 1,066.7**	**(0.20% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 509.9	(0.27%)	$m 444.0	(0.23%)	$m 1,083.1	(0.56%)
Exports ($m)	$m 352.8	(0.42%)	$m 307.2	(0.37%)	$m 604.7	(0.73%)
Imports ($m)	$m 115.0	(0.12%)	$m 100.1	(0.10%)	$m 333.9	(0.34%)
Employment (e-y)	8,875 e-y	(0.12%)	7,728 e-y	(0.11%)	29,730 e-y	(0.42%)
Income ($m)*	$m 286.6	(0.17%)	$m 249.5	(0.15%)	$m 742.9	(0.43%)
Government revenue ($m)†	$m 215.9	(0.20%)	$m 195.8	(0.18%)	$m 459.0	(0.42%)
GHG emissions (kt CO_2-e)	354 kt	(0.07%)	309 kt	(0.06%)	2,474 kt	(0.48%)
Water use (ML)	33,832 ML	(0.16%)	29,461 ML	(0.14%)	231,319 ML	(1.10%)
Land disturbance (kha)	1 kha	(0.00%)	1 kha	(0.00%)	288 kha	(0.18%)
Primary energy (TJ)	4,602 TJ	(0.12%)	4,007 TJ	(0.10%)	21,107 TJ	(0.54%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.17	0.42	0.38
Exports ($)	0.12	0.23	0.16
Imports ($)	0.04	0.13	0.19
Employment (min)	0.37	1.44	1.75
Income ($)	0.10	0.29	0.34
Government revenue ($)	0.08	0.18	0.21
GHG emissions (kg CO_2-e)	0.12	0.96	1.02
Water use (L)	11.43	89.75	41.32
Land disturbance (m^2)	0.00	1.12	3.21
Primary energy (MJ)	1.55	8.19	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Fp	0.172	(0; 41.%)	Fp	0.374	(0; 26.%)	Fp	0.12	(0; 12.%)
Vf Fp	0.035	(1; 8.3%)	Vf Fp	0.174	(1; 12.%)	El Fp	0.104	(1; 11.%)
Rd Fp	0.00928	(1; 2.2%)	Sh Fp	0.0552	(1; 3.8%)	Vf Fp	0.0678	(1; 7.1%)
Sh Fp	0.00926	(1; 2.2%)	Rd Fp	0.0546	(1; 3.8%)	Fr Vf Fp	0.0405	(2; 4.2%)
Gp Fp	0.00798	(1; 1.9%)	Wt Fp	0.047	(1; 3.3%)	Bc Mp Fp	0.0402	(2; 4.2%)
Wt Fp	0.00653	(1; 1.6%)	Pl Fp	0.0305	(1; 2.1%)	Is Sh Fp	0.0269	(2; 2.8%)
Pl Fp	0.00573	(1; 1.4%)	Gp Fp	0.0279	(1; 1.9%)	Fd Fp	0.0234	(1; 2.4%)
El Fp	0.00422	(1; 1.%)	Pa Fp	0.0208	(1; 1.4%)	Gd Fp	0.0168	(1; 1.7%)
Fd Fp	0.00356	(1; 0.85%)	Bs Fp	0.0188	(1; 1.3%)	Gp Fp	0.0155	(1; 1.6%)
Is Sh Fp	0.00312	(2; 0.74%)	Wh Fp	0.0147	(1; 1.%)	Rd Fp	0.0147	(1; 1.5%)
Pa Fp	0.00308	(1; 0.73%)	Ms Fp	0.0129	(1; 0.9%)	Ga Fp	0.0138	(1; 1.4%)
Fc Fp	0.00306	(1; 0.73%)	Ts Fp	0.0122	(1; 0.85%)	Ch Pl Fp	0.0127	(2; 1.3%)
Wh Fp	0.00298	(1; 0.71%)	Fd Fp	0.00793	(1; 0.55%)	Ng Fp	0.0112	(1; 1.2%)
Ms Fp	0.00288	(1; 0.69%)	Fc Fp	0.00757	(1; 0.53%)	El Gp Fp	0.00943	(2; 0.98%)
Ts Fp	0.0027	(1; 0.64%)	Is Sh Fp	0.00744	(2; 0.52%)	Dc Dp Fp	0.00913	(2; 0.95%)
Ng Fp	0.00247	(1; 0.59%)	Gd Fp	0.00662	(1; 0.46%)	El Vf Fp	0.0087	(2; 0.91%)
Rv Fp	0.00233	(1; 0.56%)	Cg Vf Fp	0.00655	(2; 0.46%)	Bc Mp Fd Fp	0.00701	(3; 0.73%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Fp	0.119	(0; 51.%)	Fp	0.0968	(0; 34.%)	Vf Fp	36.2	(1; 40.%)
Vf Fp	0.0106	(1; 4.5%)	Vf Fp	0.0143	(1; 5.%)	Fp	11.4	(0; 13.%)
Fd Fp	0.00644	(1; 2.7%)	Sh Fp	0.0109	(1; 3.8%)	Ri Fc Fp	8.77	(2; 9.8%)
Wt Fp	0.00534	(1; 2.3%)	Wt Fp	0.0101	(1; 3.5%)	Sc Cg Vf Fp	3.76	(3; 4.2%)
Wh Fp	0.00383	(1; 1.6%)	Rd Fp	0.00938	(1; 3.3%)	Dc Dp Fp	3.68	(2; 4.1%)
Rd Fp	0.00323	(1; 1.4%)	Pl Fp	0.00617	(1; 2.1%)	Su Fd Fp	2.83	(2; 3.2%)
Fc Fp	0.00311	(1; 1.3%)	Gp Fp	0.00521	(1; 1.8%)	Wh Fp	1.52	(1; 1.7%)
Is Sh Fp	0.00238	(2; 1.%)	Pa Fp	0.00479	(1; 1.7%)	Wa Fp	1.46	(1; 1.6%)
Nf Sh Fp	0.00225	(2; 0.96%)	Ms Fp	0.00301	(1; 1.%)	Bc Mp Fp	1.06	(2; 1.2%)
Sh Fp	0.00223	(1; 0.95%)	Ts Fp	0.00285	(1; 0.99%)	El Fp	0.577	(1; 0.64%)
Gp Fp	0.00187	(1; 0.8%)	Bs Fp	0.00231	(1; 0.8%)	Wh Fc Fp	0.521	(2; 0.58%)
Cg Vf Fp	0.00175	(2; 0.75%)	Fd Fp	0.00186	(1; 0.65%)	Ws Fp	0.335	(1; 0.37%)
Dp Fp	0.00168	(1; 0.72%)	Gd Fp	0.00185	(1; 0.64%)	Vf Fd Fp	0.225	(2; 0.25%)
Pl Fp	0.00166	(1; 0.71%)	Is Sh Fp	0.00177	(2; 0.62%)	Wa Vf Fp	0.218	(2; 0.24%)
Mp Fp	0.00156	(1; 0.67%)	Fc Fp	0.00154	(1; 0.53%)	Bc Mp Fd Fp	0.185	(3; 0.21%)
At Fp	0.00151	(1; 0.64%)	In Fp	0.00143	(1; 0.49%)	Dc Dp Fc Fp	0.165	(3; 0.18%)
Ch Pl Fp	0.00148	(2; 0.63%)	Os Fp	0.00128	(1; 0.44%)	Wh Fd Fp	0.153	(2; 0.17%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Fp	0.0388	(0; 30.%)	Fp	0.0525	(0; 34.%)	Bc Mp Fp	0.293	(2; 26.%)
Vf Fp	0.00863	(1; 6.7%)	Vf Fp	0.00877	(1; 5.7%)	Wh Fp	0.222	(1; 20.%)
Sh Fp	0.00639	(1; 4.9%)	Rd Fp	0.00666	(1; 4.3%)	Wh Fc Fp	0.0759	(2; 6.8%)
Pa Fp	0.00601	(1; 4.6%)	Sh Fp	0.00483	(1; 3.1%)	Bc Mp Fd Fp	0.051	(3; 4.6%)
Pl Fp	0.00587	(1; 4.5%)	Wt Fp	0.00471	(1; 3.1%)	Vf Fp	0.0342	(1; 3.1%)
Gp Fp	0.00245	(1; 1.9%)	Pl Fp	0.00269	(1; 1.7%)	Wo Mp Fp	0.033	(2; 3.%)
Rd Fp	0.00235	(1; 1.8%)	Pa Fp	0.00252	(1; 1.6%)	Wh Fd Fp	0.0222	(2; 2.%)
Pc Fp	0.00203	(1; 1.6%)	Gp Fp	0.00252	(1; 1.6%)	Dc Dp Fp	0.0191	(2; 1.7%)
Wt Fp	0.00152	(1; 1.2%)	In Fp	0.00153	(1; 0.99%)	Fr Vf Fp	0.013	(2; 1.2%)
Ch Pl Fp	0.00148	(2; 1.1%)	Ms Fp	0.00143	(1; 0.92%)	Bc Mp Of Fp	0.012	(3; 1.1%)
Is Sh Fp	0.00112	(2; 0.87%)	Ts Fp	0.0014	(1; 0.91%)	Wh Vf Fp	0.0104	(2; 0.93%)
Fd Fp	0.00107	(1; 0.83%)	Fd Fp	0.000903	(1; 0.58%)	Wo Tx Pl Fp	0.00588	(3; 0.53%)
Fo Vf Fp	0.000945	(2; 0.73%)	Gd Fp	0.00086	(1; 0.56%)	Wo Mp Fd Fp	0.00575	(3; 0.52%)
Pp Pa Fp	0.000778	(2; 0.6%)	Is Sh Fp	0.000814	(2; 0.53%)	Bc Mp Ch Pl F	0.00507	(4; 0.45%)
Ts Fp	0.000775	(1; 0.6%)	El Fp	0.000792	(1; 0.51%)	Sc Cg Vf Fp	0.00494	(3; 0.44%)
Fc Fp	0.000747	(1; 0.58%)	Fc Fp	0.000778	(1; 0.5%)	Bc Mp Ho Fp	0.00459	(3; 0.41%)
Ms Fp	0.000655	(1; 0.51%)	Bs Fp	0.000685	(1; 0.44%)	Su Fd Fp	0.00454	(2; 0.41%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	1.425 ±0.020	(±1.4%)
Downstream	0.170 ±0.006	(±3.5%)

Sector 2104: Oil and Fats (Of)

Crude vegetable oils, oil cake, refined vegetable and animal oils, acid oils and margarine

Short Summary

Against the metric of one dollar of final consumption, the environmental indicators of greenhouse emissions and water use are 40% and 50% above average respectively while land disturbance is two times the average. The social indicators of employment generation, income and government revenue are respectively 40%, 30% and 30% below average. The financial indicator of operating surplus is 5% below average, while export propensity and import penetration are 40% and 30% above average respectively. Industry strategic plans, which aim to replace imports substantially, may advantage some social and financial indicators, but may disadvantage environmental indicators as more crop production and processing takes place domestically.

Sector Description

Australia consumes about 550 000 tonnes of oils and fats annually including 100 000 tonnes each of the soft saturated oils palm oil and tallow. The retail sector provides 185 000 tonnes annually for private consumption, and the commercial and food preparation sectors use the remaining 365 000 tonnes. The strategic aims set by the industry include the import replacement of palm oil, sunflower oil, olive oil and soy meal. For raw materials, Australia produces about 2 million tonnes of canola seed, and 100 000 tonnes each of sunflower and soybean grains. Currently more than 9 million olive trees have been planted across Australia, and while annual domestic production is now 1 000 tonnes, it has the potential to reach 30 000 tonnes later in the decade, and eventually 50 000 tonnes. Currently 30 000 tonnes of olive oil are imported annually. The yield of oil from seed or fruit is variable and quoted at 40% for canola, 20% for olives, 35% for sunflowers and 20% for soybeans. On a per capita basis, Australians purchase around five kg of table margarine and two kg of vegetable oils per annum. For domestic cooking oil sales, canola oil, olive oil and blended mixes make up 30% each. In constant dollar terms, the turnover of the oil and fats sector has doubled in the last 30 years, and is currently around $2.2 billion and involves 30 enterprises.

Place of Industry in the Economy

The oil and fats sector ranks 125th out of 135 sectors in terms of value adding in the economy and contributes 0.05% of GDP in this analysis. It is similar in value adding to the footwear, and petroleum refinery products sectors. It is a small employer with 500 employment years directly embodied in final demand, and another 3 000 employment years in the sector's upstream suppliers, giving a total of 3 500 employment years. The sector has relatively small resource requirements with between one tenth and two tenths of one percent of national land disturbance, water use, energy use, and greenhouse emissions. In financial terms, the import export ratio is 2:1.

Strategic Overview

The spider diagram shows the sector's environmental indicators are well above average, and all of the social indicators are below average. The relatively high levels of import penetration, particularly for soft oils may flow onto below average outcomes for employment generation and income. However higher imports also advantage some of the environmental variables, as growing and processing takes place overseas. Strategic goals set by the industry aim to redress some of the oil import issues, and these may play out over the next decade. There are downstream issues for the sector related to excessive fat consumption in human diets and subsequent health impacts from the obesity 'crisis'. The fat in consumer products is a production chain issue which can be managed.

TBL Account #1

The financial indicator of operating surplus is 5% below average with a direct sector effect of 39% and contributions from oilseed growing (4%), wholesale trade (3%), beef cattle (2%), forwarding and storage (2%), plastic products (2%) and road transport (2%). The social indicator of employment generation is 40% below average with a direct sector effect of 13%, and a composition similar to the surplus indicator. This outcome may reflect the capital intensity of oil extraction plant, as well as the high level of imports. The greenhouse indicator is 40% above average, and is described in more detail below.

TBL Accounts #2 and #3

The second TBL account shows an export propensity 40% above average, an income indicator 30% below average, and a water indicator 50% above average. The third TBL account reveals import penetration 30% above average and government revenue 30% below average. The land disturbance indicator is twice the average. The effects due to rainforest clearance for imported palm oil are outside the scope of this analysis.

Structural Path Analysis and Linkages

The environmental indicators of greenhouse emissions, water use, and land disturbance are all above average. The structural path for greenhouse shows that it has a direct sector effect of 15% with a major effect from the ‘beef cattle-meat products-oil products’ chain of 35%, and additional contributions from electricity production (7%), other foods (3%), oil seed growing (2%), the ‘sheep-meat products-oil products’ chain (1%), and ‘basic chemicals-plastic products-oil products’ (1%). A simple accounting for the emissions embodied in imports increases the greenhouse intensity to 50% above the average, or another 10%. The direct effect for the water indicator is 14% of the total with contributions from ‘beef cattle-meat products-oil products’ (22%), oil seed growing (13%), sugar growing (7%), cotton growing (6%), dairy products (3%), rice growing (1%), and water delivery (1%). The land disturbance indicator is dominated by beef and sheep meat production (63%) which supply tallow to the oil products sector as a by-product, with contributions from oil seed growing (19%) and a diffuse chain of minor contributions. Thus animal production contributes significantly to the three environmental indicators. For an individual firm, a focused procurement program may be a simple way to reduce the environmental intensity of its products.

The sector’s stimulus to its upstream suppliers is 30% higher than average and impacts on wholesale trade, road transport, oil seed growing, accounting and marketing, meat products and other foods. The linkages to downstream industries are 25% weaker than average and part of the influence is dissipated by domestic consumption. The downstream effect also suggests that any expansion in this sector needs to be led by expansion in sectors such as other foods, accommodation cafes and restaurants, retail trade, and bakery products.

Future Trends in Sector

The base case scenario of the *Future Dilemmas* study anticipates a 60% increase of non-petroleum oil requirements by 2050. This is driven by growth in domestic population, inbound tourism, and increased exports of processed foods. Additional expansion could be driven by increased bio-diesel production and an ‘extra virgin’ olive oil industry producing out of season for European markets which replicates the quality focus of our wine industry. Food faddism is a key uncertainty.

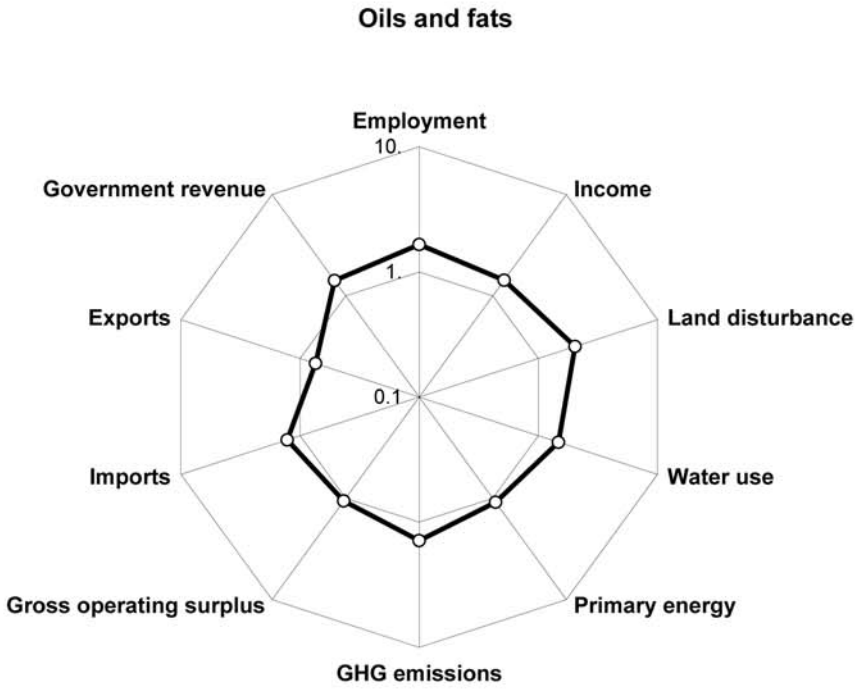
Innovation and Technical Opportunities

Edible oils are part of the trend towards functional and active food as shown by the saturated versus unsaturated fat debate. The health enhancing lipid composition of dietary oil will require analysis and certification, while factory scale processes will allow bulk oils to be tailored and upgraded.

Sector **Oils and fats** **(Of)**

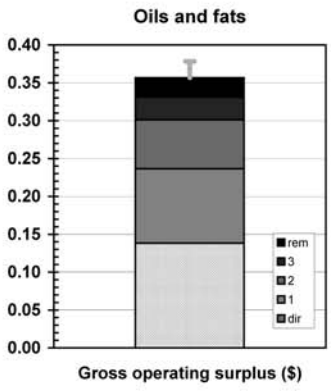
Oils and fats, margarine

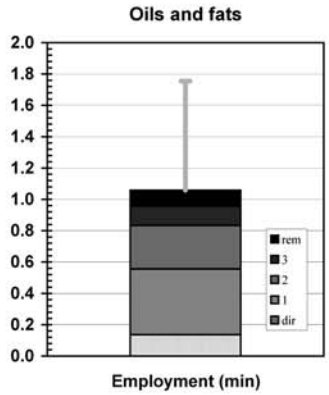
Spider diagram

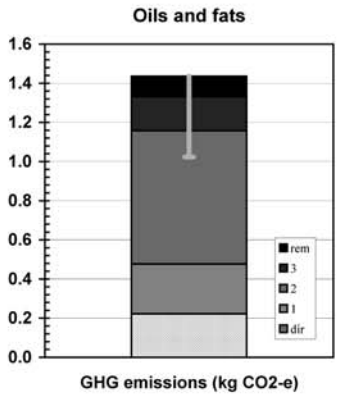


Bar graphs

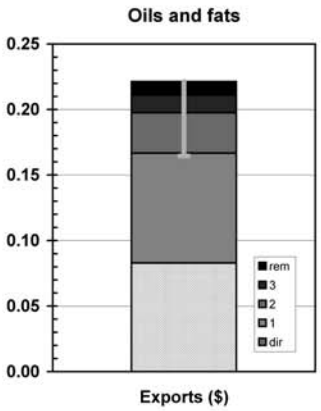
Account #1

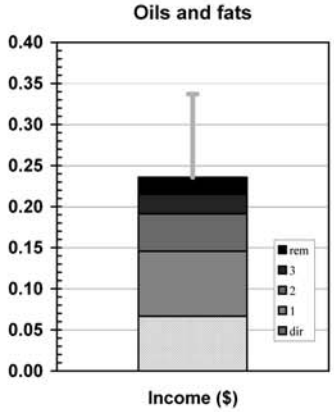


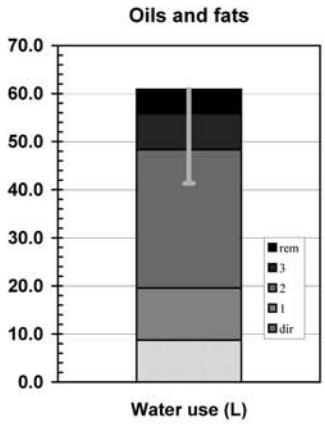




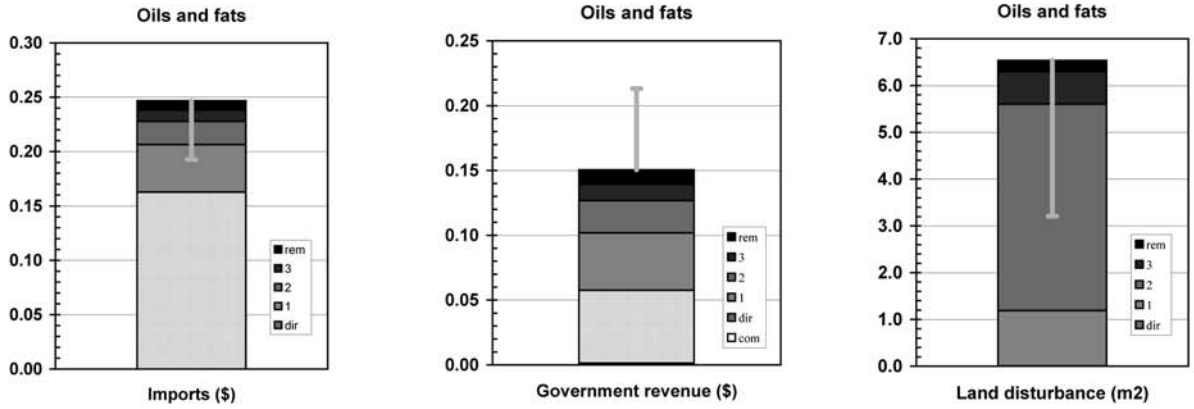
Account #2







Account #3



National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 435.6	(0.16% of total)	($m 347.4 domestically produced)
Government final consumption	$m 0.0	(0.00% of total)	($m 0.0 domestically produced)
Gross fixed capital expenditure	$m 0.8	(0.00% of total)	($m 0.8 domestically produced)
Net changes in stocks	$m 4.1	(0.23% of total)	($m 3.7 domestically produced)
Sectoral GNE	**$m 440.5**	**(0.10% of GNE)**	**($m 351.9 domestically produced)**
Exports	$m 67.2	(0.08% of total)	($m 67.2 domestically produced)
Final demand	**$m 507.7**	**(0.09% of GNT)**	**($m 419.0 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 53.9	(0.03% of total)	
Gross operating surplus	$m 112.1	(0.06% of total)	
Taxes less subsidies	$m 45.6	(0.05% of total)	
Sectoral GDP*	**$m 211.5**	**(0.05% of GDP)**	
Imports	$m 131.8	(0.13% of total)	
Primary inputs	**$m 343.3**	**(0.06% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 112.1	(0.06%)	$m 58.0	(0.03%)	$m 149.5	(0.08%)
Exports ($m)	$m 67.2	(0.08%)	$m 34.7	(0.04%)	$m 92.8	(0.11%)
Imports ($m)	$m 131.8	(0.13%)	$m 68.2	(0.07%)	$m 103.4	(0.11%)
Employment (e-y)	888 e-y	(0.01%)	459 e-y	(0.01%)	3,555 e-y	(0.05%)
Income ($m)*	$m 53.9	(0.03%)	$m 27.9	(0.02%)	$m 98.8	(0.06%)
Government revenue ($m)†	$m 46.1	(0.04%)	$m 24.1	(0.02%)	$m 63.1	(0.06%)
GHG emissions (kt CO_2-e)	180 kt	(0.03%)	93 kt	(0.02%)	602 kt	(0.12%)
Water use (ML)	7,068 ML	(0.03%)	3,655 ML	(0.02%)	25,515 ML	(0.12%)
Land disturbance (kha)	0 kha	(0.00%)	0 kha	(0.00%)	274 kha	(0.17%)
Primary energy (TJ)	2,585 TJ	(0.07%)	1,337 TJ	(0.03%)	3,503 TJ	(0.09%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.14	0.36	0.38
Exports ($)	0.08	0.22	0.16
Imports ($)	0.16	0.25	0.19
Employment (min)	0.14	1.06	1.75
Income ($)	0.07	0.24	0.34
Government revenue ($)	0.06	0.15	0.21
GHG emissions (kg CO_2-e)	0.22	1.44	1.02
Water use (L)	8.72	60.89	41.32
Land disturbance (m^2)	0.00	6.54	3.21
Primary energy (MJ)	3.19	8.36	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Of	0.138	(0; 39.%)	Of	0.137	(0; 13.%)	Bc Mp Of	0.504	(2; 35.%)
Wh Of	0.0158	(1; 4.4%)	Wh Of	0.0783	(1; 7.4%)	Of	0.222	(0; 15.%)
Wt Of	0.0108	(1; 3.%)	Wt Of	0.0779	(1; 7.4%)	El Of	0.0978	(1; 6.8%)
Bc Mp Of	0.00842	(2; 2.4%)	Rd Of	0.0399	(1; 3.8%)	Fd Of	0.0373	(1; 2.6%)
St Of	0.0074	(1; 2.1%)	Pl Of	0.039	(1; 3.7%)	Wh Of	0.0334	(1; 2.3%)
Pl Of	0.00732	(1; 2.1%)	Bc Mp Of	0.0371	(2; 3.5%)	Wo Mp Of	0.0172	(2; 1.2%)
Rd Of	0.00679	(1; 1.9%)	Mp Of	0.0306	(1; 2.9%)	Ch Pl Of	0.0163	(2; 1.1%)
Fd Of	0.00566	(1; 1.6%)	Ms Of	0.0206	(1; 1.9%)	Bc Mp Fd Of	0.0111	(3; 0.78%)
Ms Of	0.0046	(1; 1.3%)	Pa Of	0.0157	(1; 1.5%)	Wt Of	0.0108	(1; 0.75%)
El Of	0.00395	(1; 1.1%)	Fd Of	0.0126	(1; 1.2%)	Rd Of	0.0108	(1; 0.75%)
Pa Of	0.00232	(1; 0.65%)	St Of	0.0121	(1; 1.1%)	Fr Bc Mp Of	0.00931	(3; 0.65%)
Rv Of	0.00209	(1; 0.58%)	Ms Wt Of	0.00704	(2; 0.66%)	Ng Of	0.00865	(1; 0.6%)
Mp Of	0.00208	(1; 0.58%)	Sh Of	0.00676	(1; 0.64%)	El Pl Of	0.0085	(2; 0.59%)
St Wt Of	0.00206	(2; 0.58%)	Cg Of	0.00634	(1; 0.6%)	Ga Of	0.0084	(1; 0.59%)
Ng Of	0.0019	(1; 0.53%)	Su Fd Of	0.00568	(2; 0.54%)	Pg Mp Of	0.0062	(2; 0.43%)
Ms Wt Of	0.00157	(2; 0.44%)	Rv Of	0.00558	(1; 0.53%)	At Of	0.00518	(1; 0.36%)
Ch Pl Of	0.00136	(2; 0.38%)	Rf Of	0.00554	(1; 0.52%)	Dc Dp Of	0.00511	(2; 0.36%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Of	0.0829	(0; 37.%)	Of	0.0665	(0; 28.%)	Bc Mp Of	13.3	(2; 22.%)
Wh Of	0.0204	(1; 9.2%)	Wt Of	0.0167	(1; 7.1%)	Of	8.72	(0; 14.%)
Mp Of	0.0196	(1; 8.9%)	Pl Of	0.00788	(1; 3.3%)	Wh Of	8.09	(1; 13.%)
Fd Of	0.0102	(1; 4.6%)	Rd Of	0.00686	(1; 2.9%)	Su Fd Of	4.51	(2; 7.4%)
Wt Of	0.00885	(1; 4.%)	Mp Of	0.00527	(1; 2.2%)	Sc Cg Of	3.63	(2; 6.%)
Rd Of	0.00236	(1; 1.1%)	Ms Of	0.00479	(1; 2.%)	Dc Dp Of	2.06	(2; 3.4%)
Pl Of	0.00212	(1; 0.96%)	Pa Of	0.00361	(1; 1.5%)	Ri Fc Of	0.778	(2; 1.3%)
Ch Pl Of	0.00189	(2; 0.86%)	St Of	0.00308	(1; 1.3%)	Wa Of	0.61	(1; 1.%)
St Of	0.00183	(1; 0.83%)	Fd Of	0.00296	(1; 1.3%)	Wo Mp Of	0.558	(2; 0.92%)
Cg Of	0.00169	(1; 0.76%)	Wh Of	0.00268	(1; 1.1%)	El Of	0.54	(1; 0.89%)
At Of	0.00165	(1; 0.74%)	In Of	0.00238	(1; 1.%)	Sc Cg Wh Of	0.477	(3; 0.78%)
Wo Mp Of	0.00153	(2; 0.69%)	Ms Wt Of	0.00164	(2; 0.69%)	Sc Cg Mp Of	0.42	(3; 0.69%)
Rf Of	0.00114	(1; 0.51%)	Rf Of	0.00155	(1; 0.66%)	Sc Cg Bc Mp (	0.416	(4; 0.68%)
Bl El Of	0.000956	(2; 0.43%)	Sh Of	0.00134	(1; 0.57%)	Vf Fd Of	0.358	(2; 0.59%)
Pa Of	0.000945	(1; 0.43%)	Bc Mp Of	0.00127	(2; 0.54%)	Vf Bc Mp Of	0.308	(3; 0.51%)
Dp Of	0.000941	(1; 0.42%)	El Of	0.00119	(1; 0.5%)	Bc Mp Fd Of	0.294	(3; 0.48%)
Bc Mp Of	0.000735	(2; 0.33%)	Ed Of	0.00112	(1; 0.48%)	Wh Fd Of	0.243	(2; 0.4%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Of	0.163	(0; 66.%)	Of	0.0562	(0; 38.%)	Bc Mp Of	3.67	(2; 56.%)
Pl Of	0.00749	(1; 3.%)	Wt Of	0.00782	(1; 5.2%)	Wh Of	1.18	(1; 18.%)
Pa Of	0.00452	(1; 1.8%)	Rd Of	0.00487	(1; 3.3%)	Wo Mp Of	0.414	(2; 6.3%)
Wt Of	0.00252	(1; 1.%)	Pl Of	0.00344	(1; 2.3%)	Bc Mp Fd Of	0.081	(3; 1.2%)
Ch Pl Of	0.0019	(2; 0.77%)	In Of	0.00256	(1; 1.7%)	Wh Fd Of	0.0353	(2; 0.54%)
Wh Of	0.00182	(1; 0.74%)	Mp Of	0.0025	(1; 1.7%)	Bc Mp Pe Mp	0.0313	(4; 0.48%)
Rd Of	0.00172	(1; 0.7%)	Ms Of	0.00228	(1; 1.5%)	Dc Dp Of	0.0107	(2; 0.16%)
Fd Of	0.0017	(1; 0.69%)	Pa Of	0.0019	(1; 1.3%)	Wo Mp Fd Of	0.00915	(3; 0.14%)
Ms Of	0.00105	(1; 0.42%)	Wh Of	0.00183	(1; 1.2%)	Wo Tx Pl Of	0.00752	(3; 0.11%)
Bc Mp Of	0.00079	(2; 0.32%)	St Of	0.00165	(1; 1.1%)	Su Fd Of	0.00721	(2; 0.11%)
Sh Of	0.000782	(1; 0.32%)	Fd Of	0.00144	(1; 0.96%)	Wh Fc Of	0.00673	(2; 0.1%)
St Of	0.00067	(1; 0.27%)	Ms Wt Of	0.000777	(2; 0.52%)	Bc Mp Ch Pl (	0.00647	(4; 0.099%)
Pp Pa Of	0.000586	(2; 0.24%)	Bc Mp Of	0.000744	(2; 0.5%)	Bc Mp Ho Of	0.00644	(3; 0.098%)
At Of	0.000491	(1; 0.2%)	El Of	0.000741	(1; 0.5%)	Wh Bc Mp Of	0.0049	(3; 0.075%)
Ms Wt Of	0.000357	(2; 0.14%)	At Of	0.000738	(1; 0.49%)	Ba Fd Of	0.00485	(2; 0.074%)
Pr Wt Of	0.000342	(2; 0.14%)	Pd Wt Of	0.000734	(2; 0.49%)	Sc Cg Of	0.00477	(2; 0.073%)
Ap Of	0.000338	(1; 0.14%)	Rf Of	0.000715	(1; 0.48%)	Of	0.00392	(0; 0.06%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	1.318 ±0.020	(±1.5%)
Downstream	0.751 ±0.017	(±2.2%)

Sector 2105: Flour and Cereal Foods (Fc)

Flour, cereal foods, rice, pasta and other flour mill products

Short Summary

Against the metric of one dollar of final consumption, the environmental indicator of greenhouse gas is 10% above average. Water use is 15 times the average due primarily to irrigation water used upstream in rice production, and land disturbance is 70% above average. The social indicators reveal that employment generation is 5% below average, income is 20% below average, and government revenue is 30% below average. The financial indicators show that the operating surplus is 15% above average, export propensity is more than twice the average, and import penetration is 40% below average. The micronutrient status of flour may be a future human diet issue.

Sector Description

In financial terms the products from the sector include grain flours (22%), cereal foods (25%), rice products (20%), pasta (7%), and a wide range of specialist products such as baking powders, prepared bread and cake mixes, cereal bran, starch, glucose, and residual stock feed products. The average Australian adult consumes 0.4 kg of cereal based food daily (including this sector and the bakery products sector) giving a yearly consumption of 146 kg per capita, and a national total of about 3 million tonnes. Of the 24 million tonnes of wheat produced in a typical year, 2.2 million tonnes passes through this sector for domestic human consumption, 2.1 million tonnes is consumed by animals, 0.5 million tonnes is seed for the next crop, 16 million tonnes is exported as grain, 0.2 million tonnes is exported as flour, and 3 million tonnes is held over as stocks for the following year. In constant dollar terms, pastas and breakfast cereals have more than quadrupled over the last 30 years, wheat flour has doubled, and bread and cake mixes have increased by a factor of eight. Current turnover is around $4 billion and includes over 100 enterprises.

Place of Industry in the Economy

The flour and cereal foods sector ranks 83rd out of 135 sectors in terms of value adding in the economy, and contributes 0.17% of GDP in this analysis. It is similar in value adding to the aluminium smelting, and pulp and paper sectors. It is a moderate employer with 5 000 employment years embodied in final demand, and another 16 000 years in the sector's upstream suppliers, giving a total of 21 000 employment years. In addition, it contributes 4 000 employment years to the final demand of downstream industries such as bakery products, accommodation cafes and restaurants, and retail trade. It has moderate to large resource requirements with one half of one percent of land disturbance, nearly five percent of water use, and three tenths of one percent of energy use, and greenhouse emissions. The large water quotient is due to the embodiment of rice growing in the sector's processing. In financial terms, exports are four times the size of imports.

Strategic Overview

The spider diagram reveals two above-average spikes for the environmental indicators of water use and land disturbance, together with reasonable social indicators, and good financial outcomes. The upstream challenges for the sector relate to the land and water intensity of grain production. The downstream challenges relate to maintaining the inherent nutritional quality of the original grain through the sector's transformation and storage activities, as well as the health-inducing fortification of flour with minerals and active or functional ingredients. There is an emerging tension between traditional high input agriculture focused on per hectare returns and more biological modes of production with lower production but possibly higher available nutrients in the grain products.

TBL Account #1

The financial indicator of operating surplus is 15% above average with a direct sector effect of 34% and contributions from wheat growing (11%), rice growing (5%), wholesale trade (2%), accounting and marketing (2%) and road transport (2%). The social indicator of employment generation is 5% below average, with a direct effect of 22% and a makeup similar to the surplus indicator. The greenhouse emissions indicator is 10% above average with a direct effect of 11%, and contributions from rice growing (19%), electricity production (12%), wheat growing (9%) and dairy cattle (2%).

TBL Accounts #2 and #3

The second TBL account shows an export propensity that is two times the average, an income indicator that is 20% below the average, and water use that is 15 times the average due to the embodied water for rice growing included in the final demand of this processing sector. The third TBL account shows an import penetration 40% below average, a government revenue indicator 30% below average, and land disturbance 70% above average.

Structural Path Analysis and Linkages

Both the water use and land disturbance indicators are above average. The structural path analysis shows that the direct within-mill water use is less than one percent and that the indicator is dominated by rice growing (70%) with additional contributions from wheat growing (4%) (some specialist wheats have supplementary irrigation), dairy products (1%), and sugar growing (<1%). The land disturbance indicator is dominated by wheat growing (68%), rice growing (4%), the ‘beef cattle-meat products-other food-flour products’ chain (2%), and the ‘dairy cows-dairy products-flour products’ chain (1%). Raw material procurement policies focused on water and land efficient suppliers and production systems present an initial option for improving these two indicators.

The sector’s stimulus to its upstream suppliers is 55% greater than average with impacts on grain growing, wholesale trade, accounting and marketing, road transport, rice growing, and property development. The linkages to downstream industries are 30% weaker than average and suggest that any expansion in the sector must be led by increased activity in the sectors of bakery products, accommodation cafes and restaurants, and retail trade.

Future Trends in Sector

Under the base case scenario in the *Future Dilemmas* study, the domestic requirement for dietary grain increases by 35% at 2050, due to a mixture of population growth and inbound tourism. Grain production and processing for export, either directly or through animal products, could double or triple, depending on the development of export markets and the evolution of varieties in Australian grain production systems. However, uncertainties abound. Although improbable, consumer and environmental concerns focused on intensive animal production systems, could promote a more vegetarian, grain based diet with a higher legume content as evidenced by the Russian people in the 1980s with twice the grain consumption of the world average. Water constraints and irrigation salinity may limit domestic rice production and thereby its processing to products within this sector.

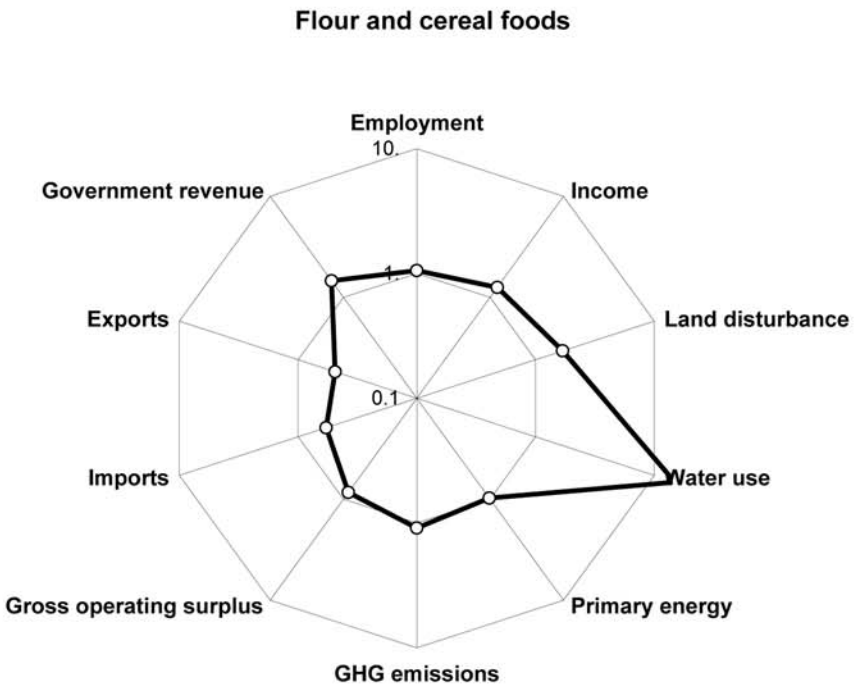
Innovation and Technical Opportunities

Human nutrition concerns relating to modern industrialised agriculture may have a large impact on the upstream procurement policies of this sector and the approaches in downstream processing and storage systems. Micronutrient malnutrition or ‘hidden hunger’ due to imbalances or non-availability of iron, zinc, copper and other ions and vitamins, may lead processed products to rely on assessments of soil health. Some studies show that more biological production systems are superior in this regard, but face cost disadvantages because of lower yields and limited market rewards.

Sector **Flour and cereal foods** **(Fc)**

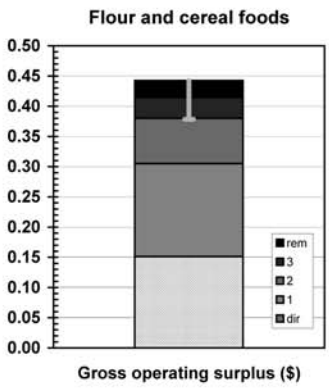
Flour, cereal foods, rice, pasta and other flour mill products

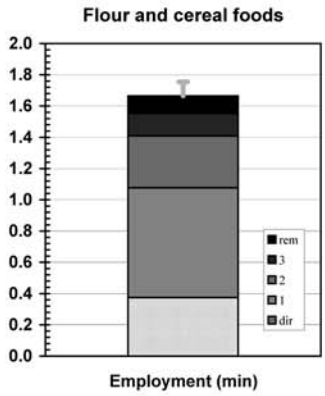
Spider diagram

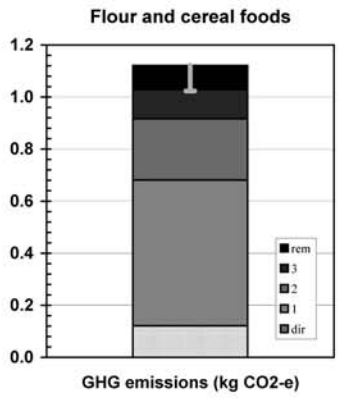


Bar graphs

Account #1







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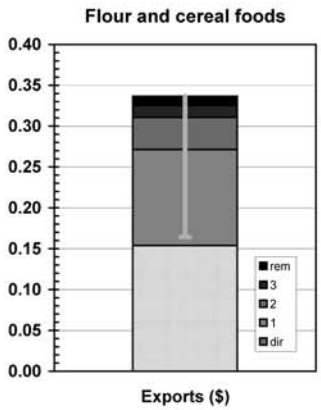
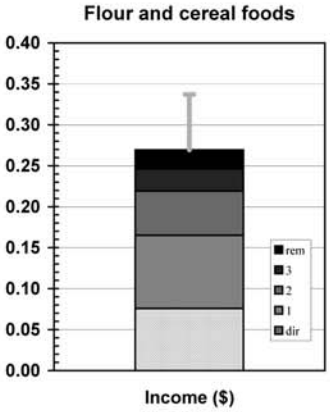
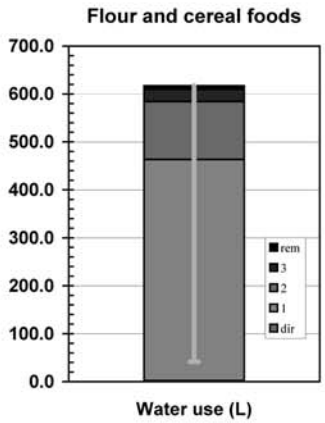
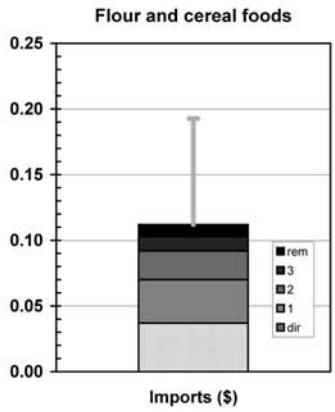
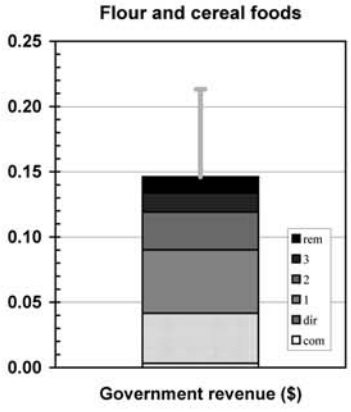


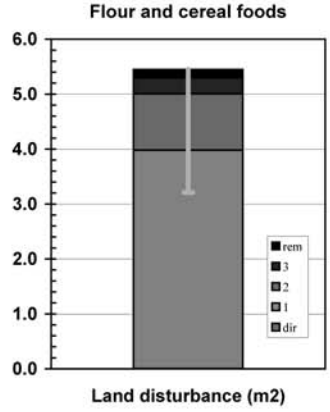




Account #3







National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 1,159.0	(0.44% of total)	($m 1,083.4 domestically produced)
Government final consumption	$m 0.0	(0.00% of total)	($m 0.0 domestically produced)
Gross fixed capital expenditure	$m 10.3	(0.01% of total)	($m 10.3 domestically produced)
Net changes in stocks	$m 20.6	(1.17% of total)	($m 19.6 domestically produced)
Sectoral GNE	**$m 1,189.9**	**(0.26% of GNE)**	**($m 1,113.3 domestically produced)**
Exports	$m 449.1	(0.54% of total)	($m 449.1 domestically produced)
Final demand	**$m 1,639.1**	**(0.30% of GNT)**	**($m 1,562.4 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 221.5	(0.13% of total)	
Gross operating surplus	$m 441.4	(0.23% of total)	
Taxes less subsidies	$m 112.1	(0.13% of total)	
Sectoral GDP*	**$m 775.0**	**(0.17% of GDP)**	
Imports	$m 107.8	(0.11% of total)	
Primary inputs	**$m 882.8**	**(0.16% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 441.4	(0.23%)	$m 236.2	(0.12%)	$m 691.6	(0.36%)
Exports ($m)	$m 449.1	(0.54%)	$m 240.3	(0.29%)	$m 526.0	(0.63%)
Imports ($m)	$m 107.8	(0.11%)	$m 57.7	(0.06%)	$m 175.1	(0.18%)
Employment (e-y)	8,750 e-y	(0.12%)	4,682 e-y	(0.07%)	20,842 e-y	(0.29%)
Income ($m)*	$m 221.5	(0.13%)	$m 118.5	(0.07%)	$m 420.8	(0.25%)
Government revenue ($m)†	$m 117.0	(0.11%)	$m 64.9	(0.06%)	$m 228.3	(0.21%)
GHG emissions (kt CO_2-e)	354 kt	(0.07%)	189 kt	(0.04%)	1,752 kt	(0.34%)
Water use (ML)	5,871 ML	(0.03%)	3,141 ML	(0.01%)	964,961 ML	(4.61%)
Land disturbance (kha)	1 kha	(0.00%)	1 kha	(0.00%)	851 kha	(0.52%)
Primary energy (TJ)	5,142 TJ	(0.13%)	2,751 TJ	(0.07%)	11,675 TJ	(0.30%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.15	0.44	0.38
Exports ($)	0.15	0.34	0.16
Imports ($)	0.04	0.11	0.19
Employment (min)	0.37	1.66	1.75
Income ($)	0.08	0.27	0.34
Government revenue ($)	0.04	0.15	0.21
GHG emissions (kg CO_2-e)	0.12	1.12	1.02
Water use (L)	2.01	617.60	41.32
Land disturbance (m^2)	0.00	5.45	3.21
Primary energy (MJ)	1.76	7.47	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Fc	0.151	(0; 34.%)	Fc	0.374	(0; 22.%)	Ri Fc	0.216	(1; 19.%)
Wh Fc	0.0504	(1; 11.%)	Wh Fc	0.249	(1; 15.%)	El Fc	0.132	(1; 12.%)
Ri Fc	0.0211	(1; 4.8%)	Ri Fc	0.104	(1; 6.3%)	Fc	0.121	(0; 11.%)
Wt Fc	0.00964	(1; 2.2%)	Wt Fc	0.0694	(1; 4.2%)	Wh Fc	0.106	(1; 9.5%)
Ms Fc	0.00908	(1; 2.1%)	Rd Fc	0.0415	(1; 2.5%)	Dc Dp Fc	0.0202	(2; 1.8%)
Rd Fc	0.00706	(1; 1.6%)	Ms Fc	0.0407	(1; 2.4%)	Fd Fc	0.0201	(1; 1.8%)
St Fc	0.00551	(1; 1.2%)	Rf Fc	0.0218	(1; 1.3%)	Gd Fc	0.0121	(1; 1.1%)
El Fc	0.00533	(1; 1.2%)	Pa Fc	0.0103	(1; 0.62%)	Rd Fc	0.0112	(1; 1.%)
Fd Fc	0.00305	(1; 0.69%)	Wt Wh Fc	0.00977	(2; 0.59%)	Wt Fc	0.00962	(1; 0.86%)
Rf Fc	0.00273	(1; 0.62%)	St Fc	0.00898	(1; 0.54%)	El Rf Fc	0.00796	(2; 0.71%)
Cm Fc	0.00271	(1; 0.61%)	Dc Dp Fc	0.00877	(2; 0.53%)	Rf Fc	0.00792	(1; 0.71%)
Rv Fc	0.00207	(1; 0.47%)	Pl Fc	0.00784	(1; 0.47%)	Bc Mp Fd Fc	0.00601	(3; 0.54%)
Dc Dp Fc	0.00204	(2; 0.46%)	Cm Fc	0.00748	(1; 0.45%)	Ga Fc	0.00565	(1; 0.5%)
St Wt Fc	0.00184	(2; 0.42%)	Ts Fc	0.00696	(1; 0.42%)	Bc Mp Fc	0.00531	(2; 0.47%)
Dp Fc	0.00156	(1; 0.35%)	Bs Fc	0.00689	(1; 0.41%)	At Fc	0.00461	(1; 0.41%)
Ts Fc	0.00154	(1; 0.35%)	Fd Fc	0.0068	(1; 0.41%)	Ng Fc	0.00459	(1; 0.41%)
Pa Fc	0.00152	(1; 0.34%)	Cn Fc	0.00653	(1; 0.39%)	El Ms Fc	0.0038	(2; 0.34%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Fc	0.154	(0; 46.%)	Fc	0.0759	(0; 28.%)	Ri Fc	433.1	(1; 70.%)
Wh Fc	0.0648	(1; 19.%)	Wt Fc	0.0149	(1; 5.5%)	Wh Fc	25.7	(1; 4.2%)
Wt Fc	0.00788	(1; 2.3%)	Ms Fc	0.00947	(1; 3.5%)	Dc Dp Fc	8.13	(2; 1.3%)
Fd Fc	0.00552	(1; 1.6%)	Wh Fc	0.00853	(1; 3.2%)	Su Fd Fc	2.43	(2; 0.39%)
Rf Fc	0.00447	(1; 1.3%)	Rd Fc	0.00713	(1; 2.6%)	Fc	2.01	(0; 0.33%)
Dp Fc	0.00372	(1; 1.1%)	Rf Fc	0.00613	(1; 2.3%)	Sc Cg Wh Fc	1.52	(3; 0.25%)
Rd Fc	0.00246	(1; 0.73%)	Ri Fc	0.00357	(1; 1.3%)	El Fc	0.729	(1; 0.12%)
Cn Fc	0.00153	(1; 0.45%)	Pa Fc	0.00236	(1; 0.88%)	Wa Fc	0.727	(1; 0.12%)
At Fc	0.00147	(1; 0.44%)	St Fc	0.00229	(1; 0.85%)	Sc Cg Ri Fc	0.635	(3; 0.1%)
Ms Fc	0.00141	(1; 0.42%)	Wt Wh Fc	0.0021	(2; 0.78%)	Wa Ms Fc	0.234	(2; 0.038%)
St Fc	0.00136	(1; 0.41%)	In Fc	0.00178	(1; 0.66%)	Vf Fd Fc	0.193	(2; 0.031%)
Bl El Fc	0.00129	(2; 0.38%)	Cm Fc	0.0017	(1; 0.63%)	Vf Fc	0.174	(1; 0.028%)
Wt Wh Fc	0.00111	(2; 0.33%)	Ts Fc	0.00163	(1; 0.6%)	Bc Mp Fd Fc	0.158	(3; 0.026%)
Ri Fc	0.000923	(1; 0.27%)	Gv Fc	0.00162	(1; 0.6%)	Vf Fp Fc	0.153	(2; 0.025%)
Cg Wh Fc	0.000707	(2; 0.21%)	El Fc	0.0016	(1; 0.6%)	Wa Wh Fc	0.152	(2; 0.025%)
Pa Fc	0.000618	(1; 0.18%)	Fd Fc	0.0016	(1; 0.59%)	Bc Mp Fc	0.14	(2; 0.023%)
Fp Fc	0.000504	(1; 0.15%)	Pl Fc	0.00159	(1; 0.59%)	Wh Fd Fc	0.131	(2; 0.021%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Fc	0.0369	(0; 33.%)	Fc	0.0384	(0; 27.%)	Wh Fc	3.75	(1; 69.%)
Wh Fc	0.0058	(1; 5.2%)	Wt Fc	0.00696	(1; 4.9%)	Ri Fc	0.218	(1; 4.%)
Pa Fc	0.00296	(1; 2.6%)	Wh Fc	0.00582	(1; 4.1%)	Bc Mp Fd Fc	0.0437	(3; 0.8%)
Ri Fc	0.00243	(1; 2.2%)	Rd Fc	0.00506	(1; 3.5%)	Dc Dp Fc	0.0422	(2; 0.77%)
Wt Fc	0.00224	(1; 2.%)	Ms Fc	0.0045	(1; 3.1%)	Bc Mp Fc	0.0386	(2; 0.71%)
Ms Fc	0.00207	(1; 1.8%)	Rf Fc	0.00282	(1; 2.%)	Wh Fd Fc	0.019	(2; 0.35%)
Rd Fc	0.00179	(1; 1.6%)	Ri Fc	0.00244	(1; 1.7%)	Bc Mp Of Fc	0.0118	(3; 0.22%)
Pl Fc	0.00151	(1; 1.3%)	In Fc	0.00191	(1; 1.3%)	Wo Tx Fc	0.00607	(2; 0.11%)
Fd Fc	0.000918	(1; 0.82%)	Pa Fc	0.00124	(1; 0.87%)	Bc Mp Ho Fc	0.00558	(3; 0.1%)
Pr Fc	0.000889	(1; 0.79%)	St Fc	0.00122	(1; 0.86%)	Wo Mp Fd Fc	0.00493	(3; 0.091%)
Cn Fc	0.000755	(1; 0.67%)	El Fc	0.000999	(1; 0.7%)	Wo Mp Fc	0.00436	(2; 0.08%)
Rf Fc	0.000705	(1; 0.63%)	Wt Wh Fc	0.00098	(2; 0.69%)	Su Fd Fc	0.00389	(2; 0.071%)
Fo Wh Fc	0.000578	(2; 0.52%)	Cm Fc	0.000811	(1; 0.57%)	Fc	0.00385	(0; 0.071%)
Of Fc	0.000522	(1; 0.47%)	Ts Fc	0.000802	(1; 0.56%)	Wh Of Fc	0.00378	(2; 0.069%)
St Fc	0.000498	(1; 0.44%)	Fd Fc	0.000774	(1; 0.54%)	Rf Fc	0.00307	(1; 0.056%)
Cm Fc	0.000463	(1; 0.41%)	Cn Fc	0.000708	(1; 0.5%)	Ba Fd Fc	0.00261	(2; 0.048%)
Ts Fc	0.000443	(1; 0.4%)	Ms Wt Fc	0.000692	(2; 0.48%)	Wo Tx Wt Fc	0.00247	(3; 0.045%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	1.543 ±0.026	(±1.7%)
Downstream	0.681 ±0.021	(±3.0%)

Sector 2106: Bakery Products (Bp)

Bread, cake, biscuits, meat pies and other bakery products

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 15% greater than average while water use is over three times the average and land disturbance is 40% above average. This is due to production inputs rather than activities within the sector. Social indicators of employment and income are 40% and 10% above average respectively, while government revenue is 15% below average. The financial indicator of operating surplus is 5% below average, export propensity is 20% above average and import penetration is 40% below average. The environmental indicators pose challenges to Australians through their direct purchasing decisions, and to bakery manufacturers through their supply chain.

Sector Description

The bakery products sector includes the production of all types of bread, meat pies, cakes, pastries and biscuits. Australians consume directly (ie not embodied in intensive meat products such as chicken, pork and beef) about 96 kg of cereals per capita each year, of which 80 kg are consumed as bread products. Nearly two million tonnes of flour is produced each year with bread using 46%, pastries 4% and biscuits 5%. Today it is estimated that the large bakery companies supply about 65% of the national bread market, hot bread shops about 25%, in-store bakeries 5% and independent bakeries 5%. An important factor behind the success of hot bread shops has been the development of premix flours. Worldwide, the sector is becoming more complex as bread becomes a boutique food with functional food additives, whilst also remaining a basic food staple.

Place of Industry in the Economy

This is a moderate sized sector in terms of value adding in the Australian economy, ranking 60th out of 135 sectors and contributing 0.29% of GDP in this analysis. In terms of value adding, the bakery products sector gives four times that of cement manufacturing and twice that of concrete production but is only one tenth the size of residential building. The industry is a moderate employment generator with a direct requirement of 30 000 employment years and another 17 000 years in the sector's suppliers, giving a total of 47 000 employment years. In addition, the sector supplies 5 000 employment years to downstream sectors. The sector is responsible for 1.6% of national water use and about one half of one percent of national greenhouse emissions, primary energy use and land disturbance. In financial terms, exports are 30% greater than imports.

Strategic Overview

The strategic overview provided by the spider diagram shows a reasonably balanced TBL account with the two environmental indicators of water use and land disturbance as outliers. Upstream issues relate to the national implications of land and water use in Australia. The structural paths highlight the beef cattle and grains sectors as important components of the land disturbance indicator, while rice growing and dairy products are important in the water chain. Altering both the composition of bakery products as well as the selection of component suppliers could help reduce the water and land disturbance indicators. Downstream issues relate to the accumulated effects of bakery products on lifetime attributes of individual and population health. There is an increasing emphasis on the glycaemic index of products, micronutrient deficiencies, fibre content, and in the future the use of products that actively enhance health, rather than merely provide staple food products and basic nutrition.

TBL Account #1

The financial indicator of gross operating surplus is 5% below the economy wide average. About half of the effect is direct and the rest is due to the sector's suppliers such as flour milling (6%), wholesale trade (2%), sugar (2%), beef products (2%) and diary products (1%). The social indicator of employment is 40% above average and three fifths of this is a direct effect, emphasising the importance of human labour in producing an increasingly diverse range of bakery products. The environmental indicator of greenhouse emissions is 15% above average with only one tenth of the effect due to energy use in the sector itself. Most of the emissions are due to sectors embodied in the bakery products chain such as beef (33%), electricity (8%), sugar (4%), dairy (4%) and rice (3%). Some eco-efficiency projects have focused on baking plant energy and emissions savings. This analysis highlights the potential of a broader lifecycle approach and consideration of upstream impacts in improving the overall environmental performance of products.

TBL Accounts #2 and #3

The second TBL account shows that export propensity and income are 20% and 10% above average respectively. About half of both indicators is due to direct sector effects. However the water use indicator of is over three times the economy wide average due to the product chains of the basic ingredients used in the sector. The third TBL account shows that import penetration is 40% below average, government revenue is 15% below average and land disturbance is 40% above average.

Structural Path Analysis and Linkages

Structural path analyses reveal long and complex production chains for water use and land disturbance which are both above average and may require improvement. Only 1% of water is used directly within the sector with major contributions from rice (40%), dairy (12%), beef (7%), sugar (4%) wheat (3%) and vegetable and fruit growing (2%). These components together contribute over 70% of the total water used. Beef cattle contribute to the land disturbance indicator (60%) together with wheat (12%), sheep meat (7%) and dairy cows (2%).

Increases in consumer demand give a strong upstream stimulus to the suppliers of the bakery products sector such as flour mill products, wholesale trade, raw sugar, road transport and marketing. The sector shows very weak downstream linkages to the cafes and restaurants sector.

Future Trends in Sector

The CSIRO *Future Dilemmas* study anticipates a 35% increase in direct dietary grain consumption over the next 50 years. This is driven mainly by population growth to 25 million people over that time and an expanding tourism industry. Consumer trends (eg wholemeal breads, rice flour based gluten free breads) and marketing will be important determinants of future demand. The level of environmental resources embodied in everyday necessities may emerge as a policy issue.

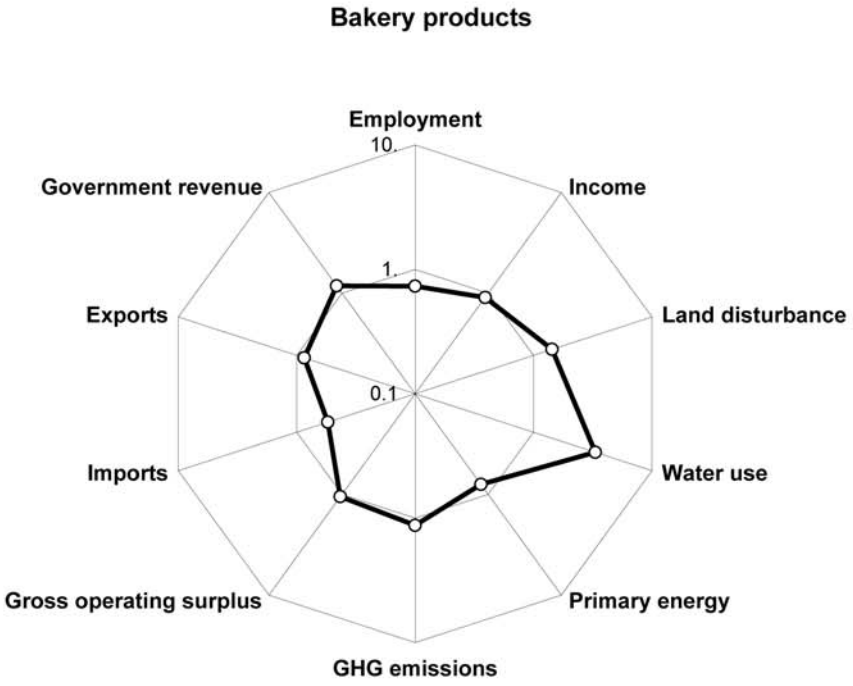
Innovation and Technical Opportunities

The centrality of bread as a staple food in most cultures will probably see it evolve into an important active or functional food delivering basic energy and bulk, as well as a range of food supplements to provide health benefits or reduce health problems. In the context of TBL accounting, this could increase the social worth of bakery products but also increase the complexity of manufacture and thereby the embodiment of energy, water and land. Managing and auditing the water and land chains behind the product may become a critical priority as dietary worth becomes aligned with the integrity of ecosystems. With organic grain production already established as a consumer reality, bakery companies will need to expand the selection criteria for appropriate suppliers of product inputs. Lower yielding organic systems may increase the land disturbance indicator.

Sector **Bakery products** **(Bp)**

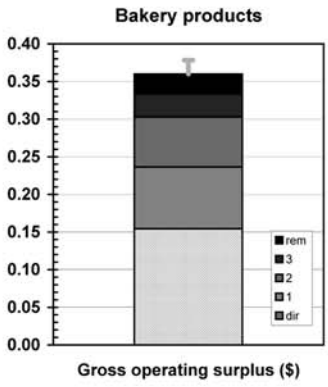
Bread, cakes, biscuits, meat pies and other bakery products

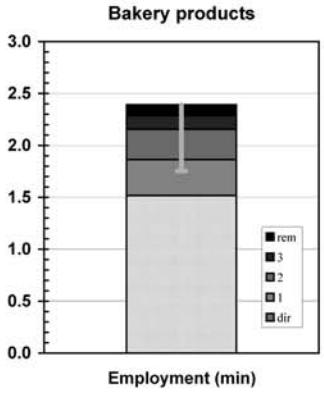
Spider diagram

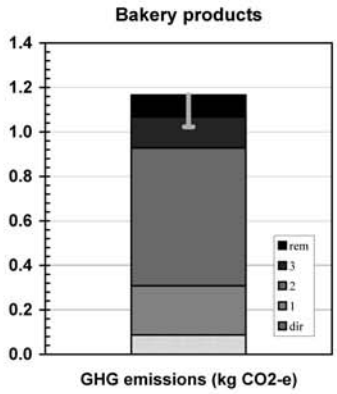


Bar graphs

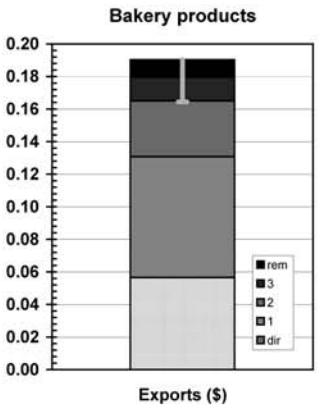
Account #1

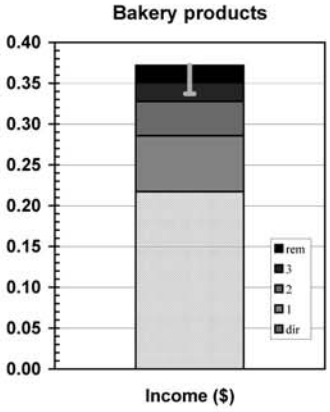


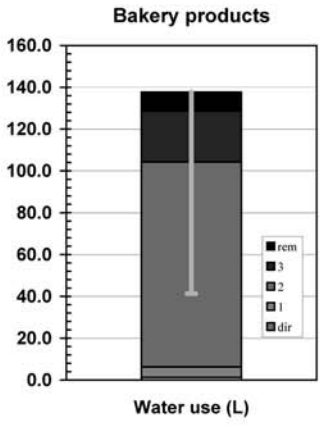




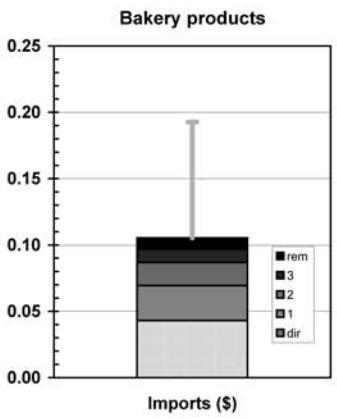
Account #2

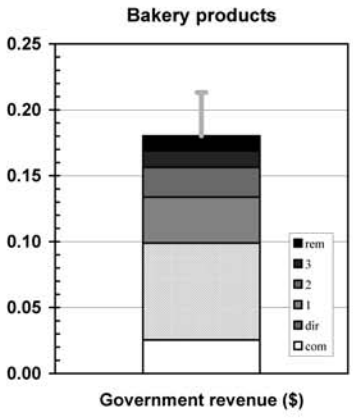


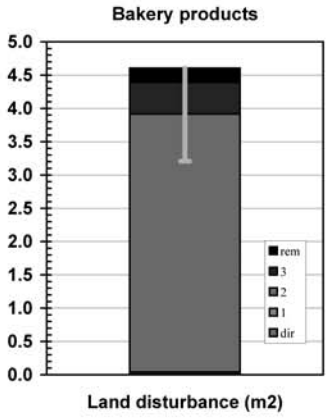




Account #3







National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 2,404.2	(0.91% of total)	($m 2,237.5 domestically produced)
Government final consumption	$m 0.0	(0.00% of total)	($m 0.0 domestically produced)
Gross fixed capital expenditure	$m 21.8	(0.02% of total)	($m 21.8 domestically produced)
Net changes in stocks	$m 6.9	(0.39% of total)	($m 6.2 domestically produced)
Sectoral GNE	**$m 2,432.9**	**(0.53% of GNE)**	**($m 2,265.5 domestically produced)**
Exports	$m 163.8	(0.20% of total)	($m 163.8 domestically produced)
Final demand	**$m 2,596.7**	**(0.48% of GNT)**	**($m 2,429.3 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 629.5	(0.37% of total)	
Gross operating surplus	$m 447.2	(0.23% of total)	
Taxes less subsidies	$m 213.0	(0.25% of total)	
Sectoral GDP*	**$m 1,289.7**	**(0.29% of GDP)**	
Imports	$m 124.6	(0.13% of total)	
Primary inputs	**$m 1,414.4**	**(0.26% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 447.2	(0.23%)	$m 374.7	(0.20%)	$m 874.4	(0.46%)
Exports ($m)	$m 163.8	(0.20%)	$m 137.2	(0.16%)	$m 462.5	(0.55%)
Imports ($m)	$m 124.6	(0.13%)	$m 104.4	(0.11%)	$m 255.9	(0.26%)
Employment (e-y)	35,250 e-y	(0.49%)	29,536 e-y	(0.41%)	46,555 e-y	(0.65%)
Income ($m)*	$m 629.5	(0.37%)	$m 527.4	(0.31%)	$m 903.7	(0.53%)
Government revenue ($m)†	$m 274.7	(0.25%)	$m 240.2	(0.22%)	$m 437.8	(0.40%)
GHG emissions (kt CO_2-e)	252 kt	(0.05%)	211 kt	(0.04%)	2,833 kt	(0.55%)
Water use (ML)	3,580 ML	(0.02%)	3,000 ML	(0.01%)	334,574 ML	(1.60%)
Land disturbance (kha)	1 kha	(0.00%)	1 kha	(0.00%)	1,119 kha	(0.69%)
Primary energy (TJ)	4,440 TJ	(0.11%)	3,720 TJ	(0.10%)	14,756 TJ	(0.38%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.15	0.36	0.38
Exports ($)	0.06	0.19	0.16
Imports ($)	0.04	0.11	0.19
Employment (min)	1.52	2.39	1.75
Income ($)	0.22	0.37	0.34
Government revenue ($)	0.10	0.18	0.21
GHG emissions (kg CO_2-e)	0.09	1.17	1.02
Water use (L)	1.23	137.72	41.32
Land disturbance (m^2)	0.00	4.60	3.21
Primary energy (MJ)	1.53	6.07	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Bp	0.154	(0; 43.%)	Bp	1.52	(0; 63.%)	Bc Mp Bp	0.391	(2; 34.%)
Fc Bp	0.0204	(1; 5.7%)	Fc Bp	0.0506	(1; 2.1%)	El Bp	0.0958	(1; 8.2%)
Fd Bp	0.00685	(1; 1.9%)	Wt Bp	0.0425	(1; 1.8%)	Bp	0.0869	(0; 7.4%)
Wh Fc Bp	0.00681	(2; 1.9%)	Wh Fc Bp	0.0337	(2; 1.4%)	Fd Bp	0.0452	(1; 3.9%)
Bc Mp Bp	0.00653	(2; 1.8%)	Bc Mp Bp	0.0288	(2; 1.2%)	Dc Dp Bp	0.0419	(2; 3.6%)
Wt Bp	0.00591	(1; 1.6%)	Mp Bp	0.0238	(1; 0.99%)	Ri Fc Bp	0.0292	(2; 2.5%)
Dc Dp Bp	0.00422	(2; 1.2%)	Rd Bp	0.0191	(1; 0.8%)	El Fc Bp	0.0178	(2; 1.5%)
St Bp	0.00411	(1; 1.1%)	Dc Dp Bp	0.0182	(2; 0.76%)	Fc Bp	0.0164	(1; 1.4%)
El Bp	0.00387	(1; 1.1%)	Rh Bp	0.0156	(1; 0.65%)	Wh Fc Bp	0.0144	(2; 1.2%)
Ms Bp	0.00326	(1; 0.91%)	Fd Bp	0.0153	(1; 0.64%)	Bc Mp Fd Bp	0.0135	(3; 1.2%)
Rd Bp	0.00326	(1; 0.91%)	Ms Bp	0.0146	(1; 0.61%)	Wo Mp Bp	0.0134	(2; 1.1%)
Dp Bp	0.00323	(1; 0.9%)	Vf Bp	0.0141	(1; 0.59%)	Ga Bp	0.00965	(1; 0.83%)
Ri Fc Bp	0.00285	(2; 0.79%)	Ri Fc Bp	0.0141	(2; 0.59%)	Ng Bp	0.0083	(1; 0.71%)
Vf Bp	0.00284	(1; 0.79%)	Pl Bp	0.0138	(1; 0.58%)	Gd Bp	0.00805	(1; 0.69%)
Pl Bp	0.0026	(1; 0.72%)	Ho Bp	0.0138	(1; 0.58%)	Fr Bc Mp Bp	0.00723	(3; 0.62%)
Rh Bp	0.00256	(1; 0.71%)	Ts Bp	0.0104	(1; 0.44%)	Wt Bp	0.0059	(1; 0.51%)
Ts Bp	0.00232	(1; 0.64%)	Wt Fc Bp	0.00938	(2; 0.39%)	Ch Pl Bp	0.00579	(2; 0.5%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Bp	0.0565	(0; 30.%)	Bp	0.217	(0; 58.%)	Ri Fc Bp	58.6	(2; 43.%)
Fc Bp	0.0208	(1; 11.%)	Fc Bp	0.0103	(1; 2.8%)	Dc Dp Bp	16.9	(2; 12.%)
Mp Bp	0.0152	(1; 8.%)	Wt Bp	0.00913	(1; 2.5%)	Bc Mp Bp	10.3	(2; 7.5%)
Fd Bp	0.0124	(1; 6.5%)	Mp Bp	0.00409	(1; 1.1%)	Su Fd Bp	5.46	(2; 4.%)
Wh Fc Bp	0.00876	(2; 4.6%)	Fd Bp	0.00359	(1; 0.97%)	Wh Fc Bp	3.48	(2; 2.5%)
Dp Bp	0.00771	(1; 4.1%)	Ms Bp	0.0034	(1; 0.91%)	Vf Bp	2.94	(1; 2.1%)
Wt Bp	0.00483	(1; 2.5%)	Rd Bp	0.00329	(1; 0.88%)	Bp	1.23	(0; 0.9%)
Cn Bp	0.00188	(1; 0.99%)	Pl Bp	0.0028	(1; 0.75%)	Dc Dp Fc Bp	1.1	(3; 0.8%)
Wo Mp Bp	0.00119	(2; 0.62%)	Ts Bp	0.00244	(1; 0.66%)	El Bp	0.53	(1; 0.38%)
Rd Bp	0.00113	(1; 0.6%)	Dp Bp	0.00226	(1; 0.61%)	Vf Fd Bp	0.434	(2; 0.31%)
Wt Fc Bp	0.00107	(2; 0.56%)	Wt Fc Bp	0.00201	(2; 0.54%)	Wo Mp Bp	0.433	(2; 0.31%)
St Bp	0.00102	(1; 0.54%)	Ho Bp	0.00201	(1; 0.54%)	Wa Bp	0.36	(1; 0.26%)
Bl El Bp	0.000937	(2; 0.49%)	Cn Bp	0.00187	(1; 0.5%)	Bc Mp Fd Bp	0.356	(3; 0.26%)
Vf Bp	0.000859	(1; 0.45%)	St Bp	0.00171	(1; 0.46%)	Su Fd Fc Bp	0.329	(3; 0.24%)
Of Bp	0.000798	(1; 0.42%)	Rh Bp	0.00171	(1; 0.46%)	Sc Cg Mp Bp	0.326	(3; 0.24%)
Ho Bp	0.000766	(1; 0.4%)	Pa Bp	0.00151	(1; 0.41%)	Sc Cg Bc Mp I	0.323	(4; 0.23%)
Pl Bp	0.000753	(1; 0.4%)	Ms Fc Bp	0.00128	(2; 0.34%)	Sc Cg Vf Bp	0.305	(3; 0.22%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Bp	0.043	(0; 41.%)	Bp	0.0735	(0; 47.%)	Bc Mp Bp	2.85	(2; 62.%)
Fc Bp	0.00499	(1; 4.7%)	Fc Bp	0.00519	(1; 3.4%)	Wh Fc Bp	0.507	(2; 11.%)
Pl Bp	0.00266	(1; 2.5%)	Wt Bp	0.00427	(1; 2.8%)	Wo Mp Bp	0.321	(2; 7.%)
Fd Bp	0.00206	(1; 2.%)	Rd Bp	0.00234	(1; 1.5%)	Bc Mp Fd Bp	0.0981	(3; 2.1%)
Pa Bp	0.0019	(1; 1.8%)	Mp Bp	0.00194	(1; 1.3%)	Dc Dp Bp	0.0874	(2; 1.9%)
Of Bp	0.00157	(1; 1.5%)	Fd Bp	0.00174	(1; 1.1%)	Wh Fd Bp	0.0428	(2; 0.93%)
Wt Bp	0.00137	(1; 1.3%)	Ms Bp	0.00162	(1; 1.%)	Bc Mp Of Bp	0.0353	(3; 0.77%)
Rh Bp	0.00132	(1; 1.3%)	In Bp	0.00131	(1; 0.84%)	Ri Fc Bp	0.0295	(2; 0.64%)
Cn Bp	0.000928	(1; 0.88%)	Pl Bp	0.00122	(1; 0.79%)	Wh Bp	0.027	(1; 0.59%)
Rd Bp	0.000825	(1; 0.78%)	Ts Bp	0.0012	(1; 0.78%)	Bc Mp Pe Mp	0.0243	(4; 0.53%)
Wh Fc Bp	0.000784	(2; 0.74%)	Dp Bp	0.00115	(1; 0.74%)	Bc Mp Ho Bp	0.0199	(3; 0.43%)
Ms Bp	0.000742	(1; 0.7%)	Ho Bp	0.00106	(1; 0.68%)	Wh Of Bp	0.0113	(2; 0.25%)
Vf Bp	0.0007	(1; 0.66%)	Wt Fc Bp	0.000942	(2; 0.61%)	Wo Mp Fd Bp	0.0111	(3; 0.24%)
Ch Pl Bp	0.000674	(2; 0.64%)	St Bp	0.000914	(1; 0.59%)	Su Fd Bp	0.00874	(2; 0.19%)
Ts Bp	0.000664	(1; 0.63%)	Cn Bp	0.00087	(1; 0.56%)	Bc Mp Fd Fc E	0.00591	(4; 0.13%)
Bc Mp Bp	0.000613	(2; 0.58%)	Pa Bp	0.000796	(1; 0.51%)	Ba Fd Bp	0.00587	(2; 0.13%)
Dp Bp	0.000599	(1; 0.57%)	Wh Fc Bp	0.000787	(2; 0.51%)	Dc Dp Fc Bp	0.0057	(3; 0.12%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	1.244 ±0.018	(±1.5%)
Downstream	0.236 ±0.007	(±2.9%)

Sector 2107: Confectionery (Cn)

Chocolate, chewing gum, other confectionery, nuts, crystallised and glace fruit

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 10% below average, water use is two times the average, and land disturbance is 65% below average. The social indicators show that employment generation is 5% below average, income is equal to average, and government revenue is 40% above average. The financial indicators show that surplus is 20% below average, export propensity is 90% above average and import penetration is 15% below average. There are possible upstream social issues relating to cocoa production and downstream health benefits from the moderate consumption of dark chocolate.

Sector Description

Australians consume about 200 000 tonnes of confectionery per year, or about 10 kg per capita comprising six kg of chocolate and four kg of sugar confectionery. Late teenagers are the highest consumers. There are over 5 000 different confectionery products on sale with the market being dominated by three international companies which together have 75% of the market. Australia is attractive for confectionery manufacture because of the local production of most ingredients except 40 000 tonnes of cocoa which is imported annually. Dutch life cycle studies show that one kg of chocolate consumption embodies 32 kg of CO_2 equivalents. In constant dollar terms, the turnover has doubled in the last 30 years and is currently $1.7 billion involving about 130 enterprises.

Place of Industry in the Economy

The confectionery sector ranks 107th out of 135 sectors in terms of value adding in the economy, and contributes 0.09% of GDP in this analysis. It is similar in value adding to the bauxite mining, and poultry and eggs sectors. It is a small employer with 6 000 employment years embodied in final demand, and another 7 000 years in the sector's upstream suppliers, giving a total of 13 000 employment years. In addition it contributes 1 000 employment years to the final demand of downstream industries such as retail trade cafes and restaurants, flour and cereal products, and bakery products. It has moderate resource requirements with one tenth of one percent of land disturbance, four tenths of one percent of water use, and two tenths of one percent of energy use and greenhouse emissions. In financial terms, exports are twice the size of imports.

Strategic Overview

The spider diagram reveals a reasonable TBL account for the confectionery sector, with one above-average spike for water use. This is due to the embodied water of confectionery ingredients such as milk, sugar, rice, fruit, and wine and spirits. There are a number of important upstream and downstream issues outside the boundaries of this analysis. Some trade and environmental groups have voiced concerns about the adverse biodiversity and environmental effects of cocoa production systems in tropical countries, child labour, and the economic effects of low product prices in cartel-like commodity markets. Claims of dental health problems from confectionery consumption are less definite in the recent science literature. Dental health influences include modern hygiene (twice daily brushing), use of new chewing gums containing milk-derived casein phospho-peptides, a broader ecological theory including changes in mouth pH and bacterial flora, and the influence of both starches and sugars. Health benefits of moderate dark chocolate consumption are well supported due to its dietary flavonoid content, which may have both antithrombotic (clotting) and antioxidant properties, important for cardiovascular and other health issues.

TBL Account #1

The financial indicator of operating surplus is 20% below average with a direct sector effect of 28% and contributions from accounting and marketing (4%), other foods (4%), wholesale trade (3%), milk production (5%) and plastic products (2%). The social indicator of employment generation is 5% below average with a direct effect of 43% and a composition similar to the surplus indicator. The greenhouse emissions indicator is 10% below average with a direct within factory effect of 15%, and contributions from electricity production (12%), dairy cattle (9%) and the 'beef cattle-meat products-other foods-confectionery' chain (2%) which is probably due to the use of gelatin as a setting and binding agents in fruit jellies, fruit chews, marshmallows, toffees and nougat.

TBL Accounts #2 and #3

The second TBL account shows that export propensity is 90% above average, income is equal to average and water use is twice the average. The third TBL account shows that import propensity is 15% below average, government revenue is 40% above average and land disturbance is 65% below average.

Structural Path Analysis and Linkages

The water indicator is twice the average and its structural pathway shows that the direct sector effect is only 1% of the total. The 'dairy cows-dairy products-confectionery' chain representing the milk and cream content of chocolate makes up 35% of the total water indicator. This may be lower in production areas where milk is derived from rain-fed pasture systems. However Cadbury's chocolate factory at Claremont in Hobart sources its milk from the Burnie area of Tasmania which supplies 65 million litres per year to manufacture 33 000 tonnes of chocolate, or two litres of milk per kilogram (the famous 'glass and a half of rich cream dairy milk'). In addition to rain-fed pasture growth, industry reports note that 5.6 ML (10^6 L) per hectare of irrigation water is applied to more than 32 00 ha of irrigated pasture in this region. Additional water content includes rice (13%), sugar (9%), wine and spirit manufacture (3%), and fruit growing (2%).

The sector's stimulus to its upstream suppliers is 35% above average and impacts on wholesale trade, accounting and marketing, sugar refining, dairy products, road transport, paper containers, and plastic products. The linkages to downstream industries are weak as most of the effect is dissipated by private consumption and partly by exports. The downstream linkages suggest that any increase in this sector's production would have to be led by the sectors of retail trade, cafes and restaurants, bakery products, and flour and cereal foods.

Future Trends in Sector

For most food items in the *Future Dilemmas* study, domestic consumption increases by 40% at 2050 due to a mixture of population growth and inbound tourism. Industry literature notes many uncertainties concerning future consumer demand such as changes to shopping patterns, growth in market share of other snack foods, and changing perceptions of confectionery in health and body image terms. In addition, an ageing population with over 45 year olds and under 45 year olds equal by 2050, may affect total sales. Currently, consumption declines markedly for over 45 year olds.

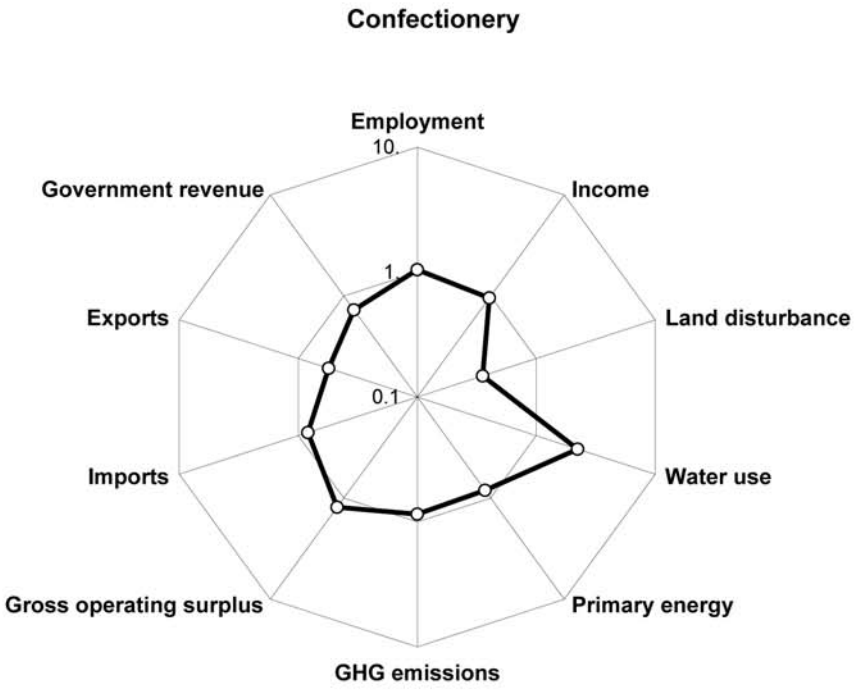
Innovation and Technical Opportunities

The increasing focus on functionally active foods that have health and lifestyle benefits may transform the confectionery sector. The dental health advantages of chewing gum currently make it one of the more dynamic products, while the health advantages of dark chocolate may soon be more actively promoted in the marketplace. It is interesting that the earliest cocoa makers in England were apothecaries, the forerunner of today's pharmacists. Perhaps little has changed in the last 400 years.

Sector **Confectionery** **(Cn)**

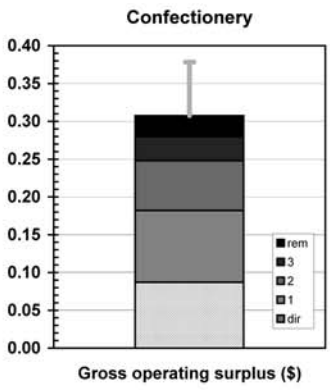
Confectionery

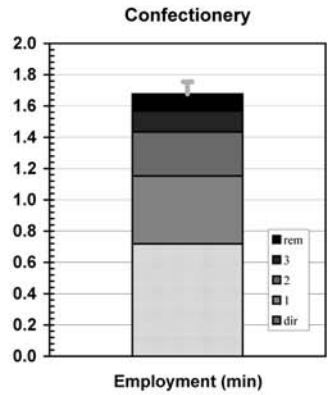
Spider diagram

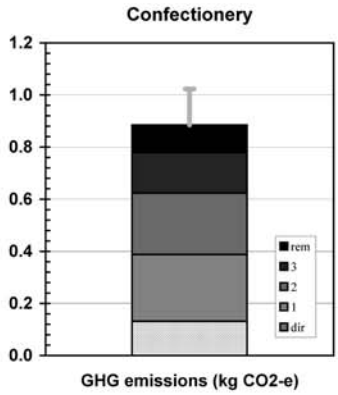


Bar graphs

Account #1







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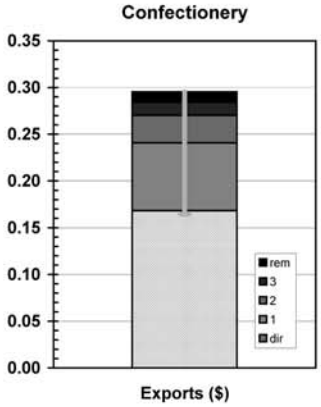

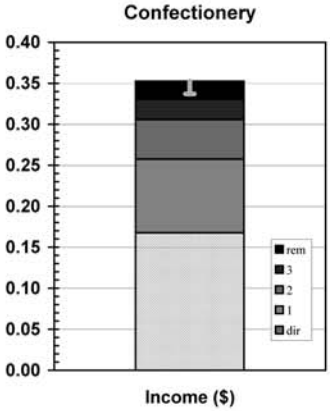

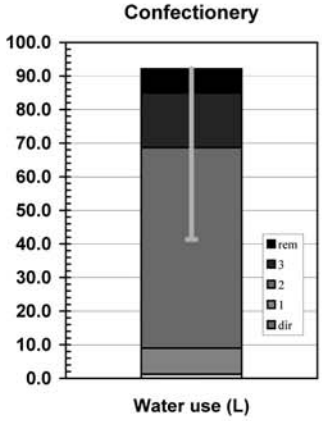

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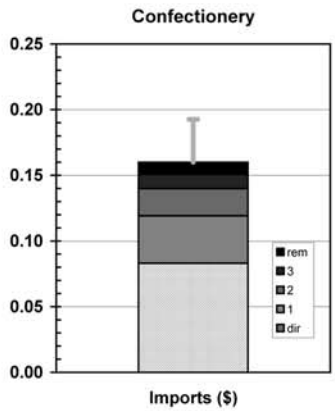
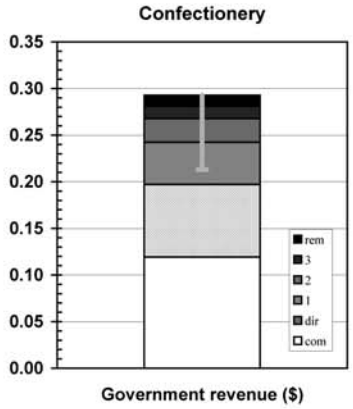
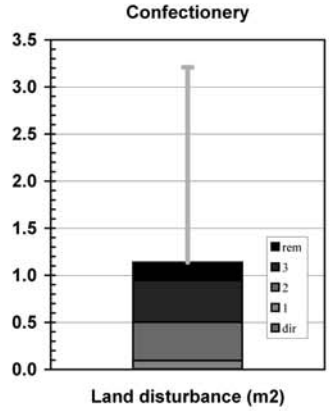






National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 1,002.5	(0.38% of total)	($m 782.5 domestically produced)
Government final consumption	$m 0.0	(0.00% of total)	($m 0.0 domestically produced)
Gross fixed capital expenditure	$m 4.9	(0.00% of total)	($m 4.9 domestically produced)
Net changes in stocks	$m 9.9	(0.56% of total)	($m 7.5 domestically produced)
Sectoral GNE	**$m 1,017.4**	**(0.22% of GNE)**	**($m 795.0 domestically produced)**
Exports	$m 202.5	(0.24% of total)	($m 202.5 domestically produced)
Final demand	**$m 1,219.9**	**(0.22% of GNT)**	**($m 997.4 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 201.7	(0.12% of total)	
Gross operating surplus	$m 104.8	(0.05% of total)	
Taxes less subsidies	$m 93.8	(0.11% of total)	
Sectoral GDP*	**$m 400.3**	**(0.09% of GDP)**	
Imports	$m 100.0	(0.10% of total)	
Primary inputs	**$m 500.3**	**(0.09% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 104.8	(0.05%)	$m 86.8	(0.05%)	$m 306.7	(0.16%)
Exports ($m)	$m 202.5	(0.24%)	$m 167.7	(0.20%)	$m 294.8	(0.35%)
Imports ($m)	$m 100.0	(0.10%)	$m 82.8	(0.08%)	$m 159.5	(0.16%)
Employment (e-y)	6,933 e-y	(0.10%)	5,743 e-y	(0.08%)	13,403 e-y	(0.19%)
Income ($m)*	$m 201.7	(0.12%)	$m 167.1	(0.10%)	$m 351.7	(0.21%)
Government revenue ($m)†	$m 212.6	(0.20%)	$m 196.5	(0.18%)	$m 292.1	(0.27%)
GHG emissions (kt CO_2-e)	158 kt	(0.03%)	131 kt	(0.03%)	883 kt	(0.17%)
Water use (ML)	1,479 ML	(0.01%)	1,225 ML	(0.01%)	91,906 ML	(0.44%)
Land disturbance (kha)	0 kha	(0.00%)	0 kha	(0.00%)	114 kha	(0.07%)
Primary energy (TJ)	1,524 TJ	(0.04%)	1,262 TJ	(0.03%)	6,381 TJ	(0.16%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.09	0.31	0.38
Exports ($)	0.17	0.30	0.16
Imports ($)	0.08	0.16	0.19
Employment (min)	0.72	1.68	1.75
Income ($)	0.17	0.35	0.34
Government revenue ($)	0.20	0.29	0.21
GHG emissions (kg CO_2-e)	0.13	0.89	1.02
Water use (L)	1.23	92.14	41.32
Land disturbance (m^2)	0.00	1.14	3.21
Primary energy (MJ)	1.27	6.40	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Cn	0.087	(0; 28.%)	Cn	0.719	(0; 43.%)	Cn	0.131	(0; 15.%)
Ms Cn	0.0116	(1; 3.8%)	Wt Cn	0.0702	(1; 4.2%)	El Cn	0.109	(1; 12.%)
Fd Cn	0.0109	(1; 3.5%)	Ms Cn	0.0521	(1; 3.1%)	Dc Dp Cn	0.0805	(2; 9.1%)
Wt Cn	0.00975	(1; 3.2%)	Dc Dp Cn	0.0349	(2; 2.1%)	Fd Cn	0.0718	(1; 8.1%)
Dc Dp Cn	0.00812	(2; 2.6%)	Bp Cn	0.0331	(1; 2.%)	Bc Mp Fd Cn	0.0215	(3; 2.4%)
Dp Cn	0.0062	(1; 2.%)	Rd Cn	0.0269	(1; 1.6%)	Ch Pl Cn	0.0108	(2; 1.2%)
Pl Cn	0.00485	(1; 1.6%)	Pl Cn	0.0258	(1; 1.5%)	Wt Cn	0.00973	(1; 1.1%)
St Cn	0.00477	(1; 1.6%)	Pa Cn	0.0258	(1; 1.5%)	Bc Mp Bp Cn	0.00855	(3; 0.97%)
Rd Cn	0.00458	(1; 1.5%)	Fd Cn	0.0243	(1; 1.4%)	Pa Cn	0.00765	(1; 0.86%)
El Cn	0.0044	(1; 1.4%)	Dp Cn	0.0175	(1; 1.%)	Rd Cn	0.00727	(1; 0.82%)
Fc Cn	0.00434	(1; 1.4%)	Ho Cn	0.0144	(1; 0.86%)	Sw Pp Pa Cn	0.00643	(3; 0.73%)
Pa Cn	0.00381	(1; 1.2%)	Su Fd Cn	0.0109	(2; 0.65%)	Pp Pa Cn	0.00627	(2; 0.71%)
Bp Cn	0.00337	(1; 1.1%)	Fc Cn	0.0107	(1; 0.64%)	Ga Cn	0.00621	(1; 0.7%)
Fp Cn	0.00222	(1; 0.72%)	Vf Cn	0.00861	(1; 0.51%)	Ri Fc Cn	0.0062	(2; 0.7%)
Su Fd Cn	0.0022	(2; 0.72%)	St Cn	0.00778	(1; 0.46%)	Dp Cn	0.00581	(1; 0.66%)
St Wt Cn	0.00186	(2; 0.6%)	Wh Fc Cn	0.00715	(2; 0.43%)	El Pl Cn	0.00563	(2; 0.64%)
Rv Cn	0.00175	(1; 0.57%)	Gv Cn	0.00658	(1; 0.39%)	Ng Cn	0.00536	(1; 0.61%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Cn	0.168	(0; 57.%)	Cn	0.168	(0; 48.%)	Dc Dp Cn	32.4	(2; 35.%)
Fd Cn	0.0197	(1; 6.7%)	Wt Cn	0.0151	(1; 4.3%)	Ri Fc Cn	12.4	(2; 13.%)
Dp Cn	0.0148	(1; 5.%)	Ms Cn	0.0121	(1; 3.4%)	Su Fd Cn	8.68	(2; 9.4%)
Wt Cn	0.00797	(1; 2.7%)	Pa Cn	0.00593	(1; 1.7%)	Ws Cn	2.56	(1; 2.8%)
Fc Cn	0.00442	(1; 1.5%)	Fd Cn	0.00571	(1; 1.6%)	Vf Cn	1.8	(1; 1.9%)
Ws Cn	0.00221	(1; 0.75%)	Pl Cn	0.00522	(1; 1.5%)	Cn	1.23	(0; 1.3%)
Wh Fc Cn	0.00186	(2; 0.63%)	Bp Cn	0.00474	(1; 1.3%)	Wa Cn	0.888	(1; 0.96%)
Ms Cn	0.0018	(1; 0.61%)	Rd Cn	0.00463	(1; 1.3%)	Wh Fc Cn	0.738	(2; 0.8%)
Rd Cn	0.00159	(1; 0.54%)	Dp Cn	0.00434	(1; 1.2%)	Vf Fd Cn	0.689	(2; 0.75%)
Pa Cn	0.00155	(1; 0.53%)	Fc Cn	0.00218	(1; 0.62%)	El Cn	0.602	(1; 0.65%)
Fp Cn	0.00153	(1; 0.52%)	Ho Cn	0.0021	(1; 0.6%)	Ri Ws Cn	0.572	(2; 0.62%)
Pl Cn	0.0014	(1; 0.48%)	St Cn	0.00199	(1; 0.56%)	Bc Mp Fd Cn	0.565	(3; 0.61%)
Wh Cn	0.00136	(1; 0.46%)	In Cn	0.00168	(1; 0.48%)	Wh Cn	0.54	(1; 0.59%)
Ch Pl Cn	0.00125	(2; 0.42%)	Gv Cn	0.00165	(1; 0.47%)	Vf Ws Cn	0.519	(2; 0.56%)
Bp Cn	0.00123	(1; 0.42%)	Ms Wt Cn	0.00147	(2; 0.42%)	Wh Fd Cn	0.467	(2; 0.51%)
St Cn	0.00118	(1; 0.4%)	El Cn	0.00133	(1; 0.38%)	Vf Fp Cn	0.466	(2; 0.51%)
Wh Fd Cn	0.00118	(2; 0.4%)	Dc Dp Cn	0.00127	(2; 0.36%)	Sc Cg Dc Dp (	0.437	(4; 0.47%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Cn	0.083	(0; 52.%)	Cn	0.0779	(0; 45.%)	Dc Dp Cn	0.168	(2; 15.%)
Pa Cn	0.00744	(1; 4.7%)	Wt Cn	0.00704	(1; 4.1%)	Bc Mp Fd Cn	0.156	(3; 14.%)
Pl Cn	0.00497	(1; 3.1%)	Ms Cn	0.00576	(1; 3.3%)	Wh Fc Cn	0.108	(2; 9.5%)
Fd Cn	0.00328	(1; 2.%)	Rd Cn	0.00329	(1; 1.9%)	Wh Cn	0.0787	(1; 6.9%)
Ms Cn	0.00264	(1; 1.7%)	Pa Cn	0.00312	(1; 1.8%)	Wh Fd Cn	0.068	(2; 6.%)
Wt Cn	0.00226	(1; 1.4%)	Fd Cn	0.00276	(1; 1.6%)	Bc Mp Bp Cn	0.0621	(3; 5.5%)
Ch Pl Cn	0.00126	(2; 0.79%)	Pl Cn	0.00228	(1; 1.3%)	Bc Mp Ho Cn	0.0208	(3; 1.8%)
Rd Cn	0.00116	(1; 0.73%)	Dp Cn	0.00221	(1; 1.3%)	Wo Mp Fd Cn	0.0176	(3; 1.5%)
Dp Cn	0.00115	(1; 0.72%)	In Cn	0.0018	(1; 1.%)	Su Fd Cn	0.0139	(2; 1.2%)
Fc Cn	0.00106	(1; 0.66%)	Bp Cn	0.0016	(1; 0.92%)	Bc Mp Of Cn	0.0117	(3; 1.%)
Pp Pa Cn	0.000963	(2; 0.6%)	Ho Cn	0.00111	(1; 0.64%)	Wh Fc Bp Cn	0.0111	(3; 0.97%)
Bp Cn	0.000939	(1; 0.59%)	Fc Cn	0.0011	(1; 0.63%)	Ba Fd Cn	0.00934	(2; 0.82%)
Dc Dp Cn	0.000912	(2; 0.57%)	St Cn	0.00106	(1; 0.61%)	Wh Dc Dp Cn	0.0082	(3; 0.72%)
Et Cn	0.000704	(1; 0.44%)	El Cn	0.000826	(1; 0.48%)	Wo Mp Bp Cn	0.00702	(3; 0.62%)
Su Fd Cn	0.000543	(2; 0.34%)	Dc Dp Cn	0.000812	(2; 0.47%)	Ri Fc Cn	0.00627	(2; 0.55%)
Ho Cn	0.000534	(1; 0.33%)	Ms Wt Cn	0.0007	(2; 0.4%)	Bc Mp Fd Dc I	0.00596	(5; 0.52%)
Of Cn	0.000521	(1; 0.33%)	Fp Cn	0.000675	(1; 0.39%)	Sw Pp Pa Cn	0.00506	(3; 0.44%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	1.361 ±0.019	(±1.4%)
Downstream	0.225 ±0.007	(±3.1%)

Sector 2108: Other Food Products (Fd)

Raw and refined sugar, animal feeds, frozen and processed seafoods, coffee, tea, peanut butter, salt, spices and other food products

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is twice the average, while water use and land disturbance are five times and nearly two times the average, respectively. The social indicators show that employment generation is 10% below average, income is 20% below average, and government revenue is 25% below average. The financial indicators show that operating surplus is 15% greater than average, export propensity is three times the average, and import penetration is 30% below average. Human and animal foods components may have good prospects but sugar and processed fish could face an uncertain future.

Sector Description

In financial terms the sector is broadly composed of manufactured foods (43%), animal feeds (23%), raw and refined sugar (19%) and processed seafoods (15%). Production of raw and refined sugar is currently about 4.6 million tonnes, of which one million tonnes is for domestic use, and the rest for export. Over one million tonnes of the by-product molasses is used as an animal feed, to ferment ethanol or exported. Domestic fisheries live catch is about 230 000 tonnes with an additional 107 000 tonnes imported. It is difficult to separate the processed and raw proportions of this seafood. Nearly one million tonnes of cottonseed from cotton ginning (the services to agriculture sector) are processed for animal feeds particularly for dairy and beef cattle feeding. In constant dollar terms over the last 30 years there have been large variations in turnover of components in this sector, especially in the seafood lines. Some such as manufactured food products and raw and refined sugar have doubled, while animal foods have quintupled. The current turnover is about $10 billion, and involves over 800 enterprises.

Place of Industry in the Economy

The sector ranks 37th out of 135 sectors in the economy in terms of value adding and contributes 0.59% of GDP in this analysis. It is similar in value adding to the childcare and community services, and beef cattle production sectors. It is a large employer with 19 000 employment years directly embodied in final demand, and 58 000 years in the sector's upstream suppliers, giving a total of 77 000 employment years or one percent of national total. In addition, it contributes 8 000 employment years to the final demand for downstream industries such as dairy cattle, dairy products and meat products. The sector has substantial resource requirements with six percent of national water use, two percent of land disturbance, one percent of energy use, and three percent of greenhouse emissions. In financial terms, exports are six times the size of imports.

Strategic Overview

The spider diagram reveals three outliers for the indicators of water use, land disturbance and greenhouse emissions. The sector forms an important bridge between the primary growing sectors and the re-routing of products and by products to important nodes of final and intermediate use. For example, cottonseed meal and molasses are vital inputs to intensive animal production systems such as dairy farming and cattle feedlots. Some sector components such as sugar refining and fish processing have upstream environmental and production issues that have yet to be resolved. In a the broader sense of industrial ecology it may be necessary to co-locate many types of food and other processing activities to allow development of a material chain that gives many products and few wastes. Brazil has designed an integrated sugar refining, ethanol refining and beef feedlot system.

TBL Account #1

The financial indicator of operating surplus is 15% above average with a direct sector effect of 39% and contributions from sugar (8%), grain growing (3%), hay growing (2%) and road transport (2%). The employment indicator is 10% below average with a direct sector effect of 25% and a composition similar to the surplus indicator. Greenhouse gas emissions are twice the average.

TBL Accounts #2 and #3

The second TBL account reveals an export propensity three times the average, income that is 20% below the average, and water use that is five times the average. The third TBL account shows import penetration 30% below average, government revenue 25% below average, and land disturbance that is nearly twice the average. The land and water indicators are discussed fully below.

Structural Path Analysis and Linkages

The greenhouse emissions indicator is dominated by a direct sector effect of 49% with contributions from the 'beef cattle to meat products' chain (15%), electricity production (3%), sugar production (2%), land development (2%) and wholesale trade (1%). Much of the sector effect comes from integrated sugar refining which generates much of its own process heat and electricity from combusting cane bagasse. Without this biomass energy, more fuel and electricity would be required from fossil fuel sectors. Technological improvement programs are improving the bagasse boiler efficiencies with the aim of doubling installed electricity generating capacity, and contributing 200 MW installed capacity to the national grid. The water use indicator is dominated by sugar cane (62%) with contributions from hay growing (5%), meat products (4%), grain growing (3%), cotton (2%), dairy products (2%) and rice growing (1%). The land disturbance indicator is dominated by beef cattle (47%) with contributions from grain growing (20%), sheep meats (5%), sugar (4%) and barley (3%). The water and land indicators could be improved by targeted procurement decisions.

The sector's stimulus to its upstream suppliers is 40% greater than average with impacts on road transport, sugar cane, wholesale trade, accounting and marketing, grain growing (cotton seed), hay growing, and meat products. Linkages to downstream industries are weaker than average because much of the activity is dissipated by final consumption and exports of sugar and seafoods. Animal feed, much of it transformed from by-products of human food or fibre processing (molasses and cottonseed meal) also becomes an intermediate product for other final demand production chains.

Future Trends in Sector

The base case scenario of the *Future Dilemmas* study anticipates that the 'other human foods' part of this sector will increase 40% by the year 2050, due to population growth and international tourism. Sugar refining may remain challenged by world trade issues and may have to make a fundamental transition to producing feedstocks for plastics and alcohols. Fish consumption, faced with the possibility of fragile domestic stocks in many areas may be dominated by imports, most of which may already be processed and packaged. The animal foods component may double, driven by growth and intensification in meat and dairy production.

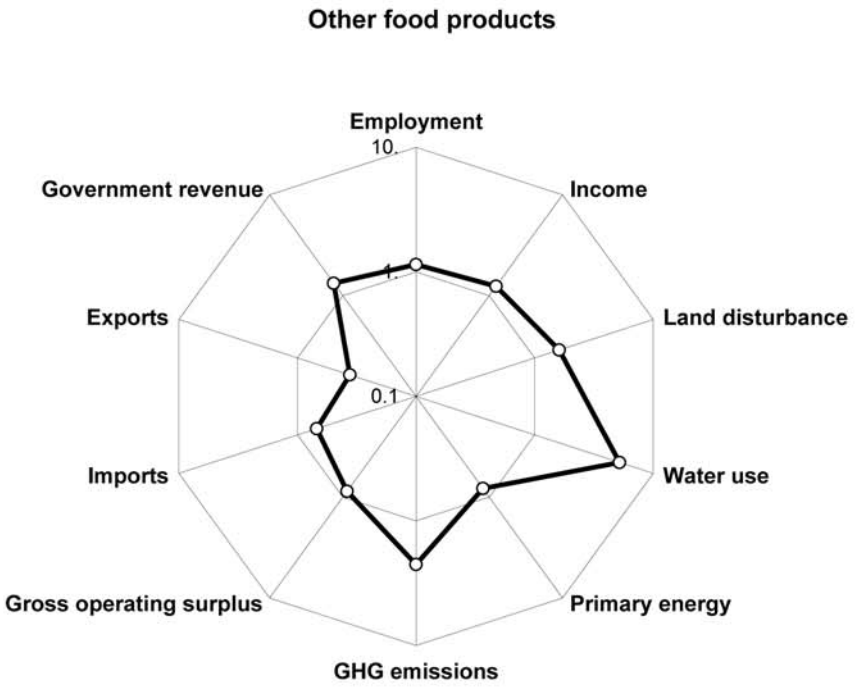
Innovation and Technical Opportunities

Because of the sector's processing and transformation capabilities, it has the potential to become the central node of the overall sustainability transition as feedstock and chemical chains are 'greened' and human and animal foods become more 'functional and active'. Advanced bio-refineries designed for whole crops (grains), green crops (lucerne), and lignocellulose, are already in pilot testing with the strategic goal of replacing petrochemical feedstocks. Proof of the 'bio-origin' of feedstocks is necessary to ensure to the integrity of the supply chain and its derived products.

Sector **Other food products** **(Fd)**

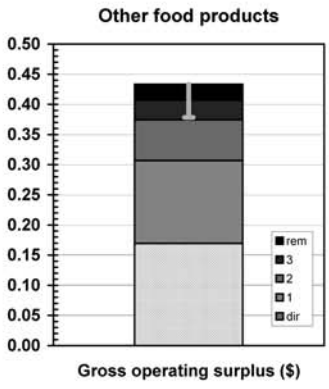
Raw and refined sugar, animal feeds, frozen and processed seafoods, coffee, tea, peanut butter, salt, spices and other food products

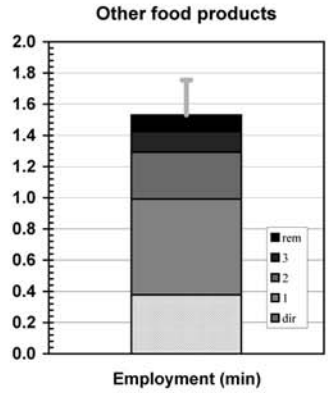
Spider diagram

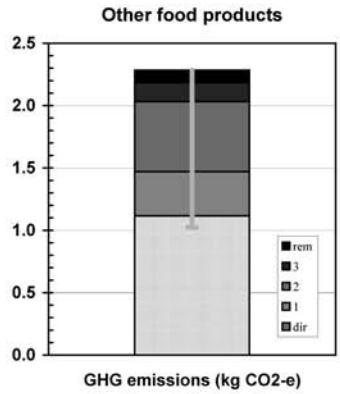


Bar graphs

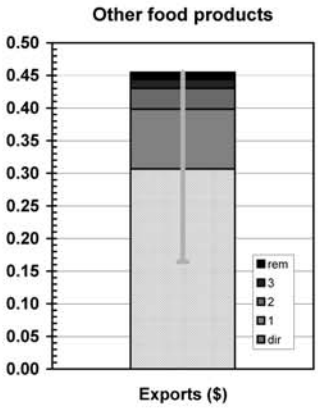
Account #1

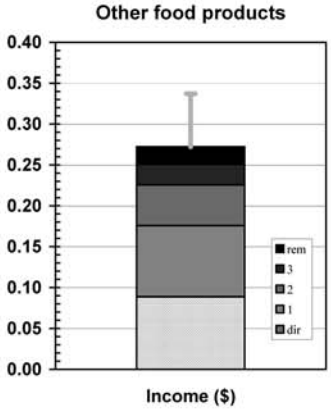


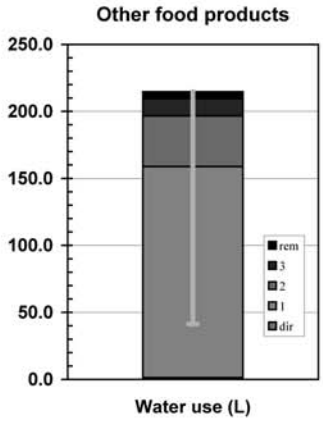




Account #2







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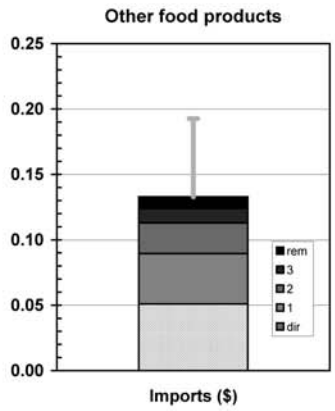
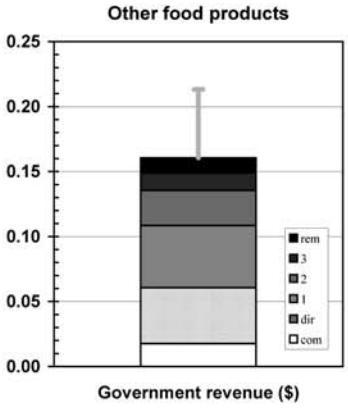
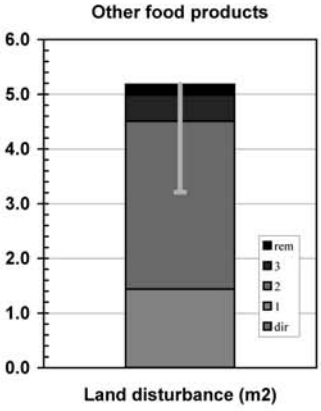






National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 4,475.8	(1.69% of total)	($m 3,477.7 domestically produced)
Government final consumption	$m 0.0	(0.00% of total)	($m 0.0 domestically produced)
Gross fixed capital expenditure	$m 68.3	(0.07% of total)	($m 68.3 domestically produced)
Net changes in stocks	$m 14.8	(0.84% of total)	
Sectoral GNE	**$m 4,558.9**	**(0.99% of GNE)**	**($m 3,520.5 domestically produced)**
Exports	$m 2,685.7	(3.22% of total)	($m 2,685.7 domestically produced)
Final demand	**$m 7,244.7**	**(1.33% of GNT)**	**($m 6,206.2 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 776.8	(0.45% of total)	
Gross operating surplus	$m 1,483.2	(0.77% of total)	
Taxes less subsidies	$m 376.3	(0.44% of total)	
Sectoral GDP*	**$m 2,636.3**	**(0.59% of GDP)**	
Imports	$m 446.2	(0.46% of total)	
Primary inputs	**$m 3,082.5**	**(0.56% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 1,483.2	(0.77%)	$m 1,054.9	(0.55%)	$m 2,701.6	(1.41%)
Exports ($m)	$m 2,685.7	(3.22%)	$m 1,910.1	(2.29%)	$m 2,834.9	(3.40%)
Imports ($m)	$m 446.2	(0.46%)	$m 317.4	(0.32%)	$m 828.0	(0.85%)
Employment (e-y)	26,492 e-y	(0.37%)	18,841 e-y	(0.26%)	76,414 e-y	(1.07%)
Income ($m)*	$m 776.8	(0.45%)	$m 552.5	(0.32%)	$m 1,696.8	(0.99%)
Government revenue ($m)†	$m 486.3	(0.45%)	$m 377.7	(0.35%)	$m 1,000.8	(0.93%)
GHG emissions (kt CO_2-e)	9,771 kt	(1.88%)	6,949 kt	(1.34%)	14,233 kt	(2.74%)
Water use (ML)	10,729 ML	(0.05%)	7,631 ML	(0.04%)	1,338,394 ML	(6.39%)
Land disturbance (kha)	3 kha	(0.00%)	2 kha	(0.00%)	3,228 kha	(1.98%)
Primary energy (TJ)	10,705 TJ	(0.28%)	7,613 TJ	(0.20%)	39,128 TJ	(1.01%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.17	0.43	0.38
Exports ($)	0.31	0.45	0.16
Imports ($)	0.05	0.13	0.19
Employment (min)	0.38	1.53	1.75
Income ($)	0.09	0.27	0.34
Government revenue ($)	0.06	0.16	0.21
GHG emissions (kg CO_2-e)	1.12	2.28	1.02
Water use (L)	1.22	214.77	41.32
Land disturbance (m^2)	0.00	5.18	3.21
Primary energy (MJ)	1.22	6.28	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Fd	0.169	(0; 39.%)	Fd	0.377	(0; 25.%)	Fd	1.12	(0; 49.%)
Su Fd	0.0343	(1; 7.9%)	Su Fd	0.17	(1; 11.%)	Bc Mp Fd	0.333	(2; 15.%)
Wh Fd	0.0142	(1; 3.3%)	Wh Fd	0.0702	(1; 4.6%)	El Fd	0.0668	(1; 2.9%)
Vf Fd	0.0104	(1; 2.4%)	Wt Fd	0.0524	(1; 3.4%)	Su Fd	0.0505	(1; 2.2%)
Rd Fd	0.00774	(1; 1.8%)	Vf Fd	0.0514	(1; 3.4%)	Fr Su Fd	0.0396	(2; 1.7%)
Wt Fd	0.00728	(1; 1.7%)	Rd Fd	0.0455	(1; 3.%)	Wh Fd	0.03	(1; 1.3%)
St Fd	0.00706	(1; 1.6%)	Bc Mp Fd	0.0245	(2; 1.6%)	Vf Fd	0.02	(1; 0.88%)
Sg Fd	0.00703	(1; 1.6%)	Mp Fd	0.0202	(1; 1.3%)	Rd Fd	0.0123	(1; 0.54%)
Bc Mp Fd	0.00556	(2; 1.3%)	Ms Fd	0.0176	(1; 1.2%)	Fr Vf Fd	0.012	(2; 0.52%)
Ms Fd	0.00393	(1; 0.91%)	Pl Fd	0.0164	(1; 1.1%)	Wo Mp Fd	0.0114	(2; 0.5%)
Pl Fd	0.00308	(1; 0.71%)	St Fd	0.0115	(1; 0.75%)	Ba Fd	0.0102	(1; 0.45%)
El Fd	0.0027	(1; 0.62%)	Gv Fd	0.0111	(1; 0.72%)	El Su Fd	0.00851	(2; 0.37%)
Ba Fd	0.00192	(1; 0.44%)	Ba Fd	0.00948	(1; 0.62%)	Dc Dp Fd	0.00819	(2; 0.36%)
Ts Fd	0.00179	(1; 0.41%)	Sg Fd	0.00887	(1; 0.58%)	Wt Fd	0.00726	(1; 0.32%)
St Wt Fd	0.00139	(2; 0.32%)	Ts Fd	0.00806	(1; 0.53%)	Ch Pl Fd	0.00685	(2; 0.3%)
Mp Fd	0.00137	(1; 0.32%)	Ho Fd	0.00747	(1; 0.49%)	Fr Bc Mp Fd	0.00615	(3; 0.27%)
Rv Fd	0.00134	(1; 0.31%)	Pa Fd	0.00714	(1; 0.47%)	Ga Fd	0.00565	(1; 0.25%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Fd	0.307	(0; 67.%)	Fd	0.0887	(0; 33.%)	Su Fd	134.8	(1; 63.%)
Wh Fd	0.0183	(1; 4.%)	Su Fd	0.014	(1; 5.1%)	Vf Fd	10.7	(1; 5.%)
Mp Fd	0.013	(1; 2.8%)	Wt Fd	0.0112	(1; 4.1%)	Bc Mp Fd	8.79	(2; 4.1%)
Wt Fd	0.00595	(1; 1.3%)	Rd Fd	0.00782	(1; 2.9%)	Wh Fd	7.25	(1; 3.4%)
Sg Fd	0.00349	(1; 0.77%)	Vf Fd	0.00422	(1; 1.6%)	Sc Cg Su Fd	3.67	(3; 1.7%)
Vf Fd	0.00313	(1; 0.69%)	Ms Fd	0.0041	(1; 1.5%)	Dc Dp Fd	3.3	(2; 1.5%)
Rd Fd	0.00269	(1; 0.59%)	Mp Fd	0.00349	(1; 1.3%)	Ri Fd	1.7	(1; 0.79%)
Ba Fd	0.00196	(1; 0.43%)	Pl Fd	0.00332	(1; 1.2%)	Ba Fd	1.23	(1; 0.57%)
St Fd	0.00175	(1; 0.38%)	St Fd	0.00294	(1; 1.1%)	Fd	1.22	(0; 0.57%)
Cg Su Fd	0.00171	(2; 0.38%)	Gv Fd	0.00278	(1; 1.%)	Ri Fc Fd	1.17	(2; 0.55%)
Dp Fd	0.00151	(1; 0.33%)	Wh Fd	0.00241	(1; 0.88%)	Sc Cg Vf Fd	1.11	(3; 0.52%)
Rf Fd	0.00137	(1; 0.3%)	Ts Fd	0.00189	(1; 0.69%)	Wa Fd	0.626	(1; 0.29%)
Wo Mp Fd	0.00101	(2; 0.22%)	Rf Fd	0.00188	(1; 0.69%)	Sc Cg Wh Fd	0.428	(3; 0.2%)
Pl Fd	0.000892	(1; 0.2%)	Pa Fd	0.00164	(1; 0.6%)	El Fd	0.37	(1; 0.17%)
Ch Pl Fd	0.000797	(2; 0.18%)	In Fd	0.00156	(1; 0.57%)	Wo Mp Fd	0.369	(2; 0.17%)
Bl El Fd	0.000654	(2; 0.14%)	Sg Fd	0.00149	(1; 0.55%)	Sc Cg Mp Fd	0.278	(3; 0.13%)
At Fd	0.000621	(1; 0.14%)	Wt Su Fd	0.00111	(2; 0.41%)	Sc Cg Bc Mp I	0.275	(4; 0.13%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Fd	0.0509	(0; 38.%)	Fd	0.0429	(0; 30.%)	Bc Mp Fd	2.42	(2; 47.%)
Su Fd	0.00843	(1; 6.3%)	Su Fd	0.00857	(1; 6.%)	Wh Fd	1.06	(1; 20.%)
Pl Fd	0.00315	(1; 2.4%)	Rd Fd	0.00555	(1; 3.9%)	Wo Mp Fd	0.274	(2; 5.3%)
Vf Fd	0.00255	(1; 1.9%)	Wt Fd	0.00526	(1; 3.7%)	Su Fd	0.216	(1; 4.2%)
Sg Fd	0.0022	(1; 1.7%)	Vf Fd	0.00259	(1; 1.8%)	Ba Fd	0.145	(1; 2.8%)
Pa Fd	0.00206	(1; 1.5%)	Ms Fd	0.00195	(1; 1.4%)	Bc Mp Of Fd	0.0271	(3; 0.52%)
Rd Fd	0.00196	(1; 1.5%)	In Fd	0.00168	(1; 1.2%)	Bc Mp Pe Mp	0.0207	(4; 0.4%)
Wt Fd	0.00169	(1; 1.3%)	Mp Fd	0.00165	(1; 1.2%)	Dc Dp Fd	0.0171	(2; 0.33%)
Wh Fd	0.00164	(1; 1.2%)	Wh Fd	0.00164	(1; 1.1%)	Fr Su Fd	0.0127	(2; 0.25%)
Of Fd	0.0012	(1; 0.91%)	St Fd	0.00157	(1; 1.1%)	Bc Mp Ho Fd	0.0108	(3; 0.21%)
Fo Su Fd	0.000924	(2; 0.7%)	Pl Fd	0.00145	(1; 1.%)	Wh Su Fd	0.0102	(2; 0.2%)
Ms Fd	0.000895	(1; 0.67%)	Sg Fd	0.000979	(1; 0.69%)	Wh Fc Fd	0.0102	(2; 0.2%)
Ch Pl Fd	0.000798	(2; 0.6%)	Gv Fd	0.000967	(1; 0.68%)	Vf Fd	0.0101	(1; 0.2%)
St Fd	0.00064	(1; 0.48%)	Ts Fd	0.000929	(1; 0.65%)	Wh Of Fd	0.00872	(2; 0.17%)
Ac Su Fd	0.000629	(2; 0.47%)	Pa Fd	0.000864	(1; 0.6%)	Bc Mp Bp Fd	0.00715	(3; 0.14%)
Bc Mp Fd	0.000522	(2; 0.39%)	Rf Fd	0.000864	(1; 0.6%)	Sc Cg Su Fd	0.00483	(3; 0.093%)
Ts Fd	0.000513	(1; 0.39%)	Cg Su Fd	0.000578	(2; 0.4%)	Fr Vf Fd	0.00385	(2; 0.074%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	1.432 ±0.021	(±1.5%)
Downstream	0.479 ±0.012	(±2.5%)

Sector 2109: Soft Drinks, Cordials and Syrups (Bv)

Soft drinks, mineral and aerated waters, cordials and syrups

Short Summary

Against the metric of one dollar of final demand, the environmental indicator of greenhouse emissions is 10% above average, water use is over two times the average and land disturbance is 80% below average. The social indicators reveal that employment generation is 20% below average, income is 15% below average, and government revenue is 25% above average. The financial indicators show that operating surplus is 10% above average, export propensity is equal to average, and import penetration is 30% below average. The sector's stewardship of its packaging has shown substantial gains in the last decade. The sector may face increasing challenges from possible downstream issues such as childhood obesity and skeletal and dental health.

Sector Description

Australia currently consumes 3.2 billion litres of this sector's products, of which 2.4 billion litres or 75%, are carbonated 'soft' drinks, with still and carbonated waters, sports drinks etc. making up the remainder. The per capita consumption of carbonated drinks is about 120 litres annually, compared to beer with 95 litres, and milk with 105 litres. The packaging of carbonated drinks is dominated by PET bottles comprising 60% of the total, aluminium cans (24%), glass (4%) and bulk 'post mix' dispensing in bars and restaurants (12%). Cola-type drinks dominate the flavours with nearly 60% of total soft drinks, followed by orange and clear lemonade. Australians consume nearly 80 million litres of sports and energy drinks, and nearly 700 million litres of bulk and bottled water. There are over four billion containers available for recycling each year and recycling fractions are about 55% for PET bottles and over 70% for aluminium cans. In constant dollar terms, the sector's turnover has tripled over the last 30 years, and turnover is around $3.3 billion involving about 90 enterprises.

Place of Industry in the Economy

The soft drinks and cordials sector ranks 89th out of 135 sectors in terms of value adding in the economy, and contributes 0.14% of GDP in this analysis. It is similar in value adding to the aircraft manufacturing, and photographic, medical and scientific equipment sectors. It is a moderate employer with 4 000 employment years directly embodied in final demand, and 17 000 years in the sector's upstream suppliers, giving a total of 21 000 employment years. It has moderate resource requirements with one percent of national water use, one tenth of one percent of land disturbance, and about four tenths of one percent of energy use and greenhouse emissions. In financial terms, the exports are 30% greater than imports.

Strategic Overview

The spider diagram shows that the soft drinks and cordials sector uses more water than average and has near average or better than average outcomes for the remaining nine indicators. In addition to the disposal of packaging, the sector faces a number of downstream issues which highlight the challenges of shared responsibility between consumers and the producers. Health institutions hypothesise that in addition to childhood obesity issues from inappropriate diet and exercise regimes, displacement of tap by bottled water avoids fluoride and its teeth protection properties, while displacement of milk by soft drinks could lessen calcium intake, and thus weaken long term bone resilience. Distribution chains could provide ready market access for health-enhancing drinks.

TBL Account #1

The financial indicator of operating surplus is 10% above average and shows a direct sector effect of 41%, with contributions from sheet metal containers (6%), sugar cane (5%), plastic products (2%), forwarding and storage (2%), sugar refining (2%), iron and steel making (2%), glass products (2%) and road transport (1%). The social indicator of employment generation is 20% below average with a direct effect of 20% due to the capital intensity of current manufacturing methods, and an extended chain of small contributions. The greenhouse emissions indicator is 20% below average, with a direct in-factory effect of 11%, and contributions from basic iron and steel (8%), sugar refining (6%), electricity production (6%), sugar growing (6%) and basic chemicals (2%).

TBL Accounts #2 and #3

The second TBL account shows an export propensity that is equal to average, an income indicator that is 15% below average, and water use that is over two times the average and discussed in more detail below. The third TBL account shows an import penetration that is 30% below average, government revenue 25% above average, and land disturbance that is 80% below average.

Structural Path Analysis and Linkages

An examination of the structural path for water use shows that the direct sector effect is about four litres per dollar and 4% of the total. The dominant component is irrigation water for sugar cane growing at 76 litres per dollar, or 72% of total. Additional small contributions include water used in sugar refining (6%) and water delivery (1%). Consumer demand and health institutional requirements for lower sugar content of carbonated drinks, currently around 10%, promises to be a strong driver for reducing the water intensity of the soft drink lifecycle. Additionally it is possible that purchasing sugar grown in high rainfall areas with little supplemental irrigation, such as around Tully and the Atherton Tableland, may significantly reduce the water use intensity of these products. The net environmental benefit would need to be established through more detailed analysis.

The sector's stimulus to its upstream suppliers is 50% greater than the economy wide average and impacts on sheet metal containers, wholesale trade, sugar cane, sugar refining, plastic products, road transport, accounting and marketing, basic iron and steel, and accommodation and restaurants. The linkages to downstream industries are weak, as most production is dissipated by final consumption.

Future Trends in Sector

Under the base case scenario of the *Future Dilemmas* study with 25 million people by 2050, the requirement for most food items increases by 40% due to a mixture of population growth and inbound international tourism. Industry literature notes that higher than normal increases in sales is due in part to a 'greying population'. This consumption driver will increase as by 2050, the under 45 year olds will equal in number the over 45 year olds. Industry sources note that bottled water consumption is projected to be 14 litres per capita by 2006, but that this is still well below consumption in the US (45 litres) and France (122 litres). Given the already challenged nature of many Australian water catchments, it is possible that bottled water consumption will rise, driven by water quality crises particularly if global climate change gives extended lower rainfall periods, that reduce the positive flushing and dilution effects of high rainfall events. Continuing demand growth will also be determined by the sector's contribution and responses to the obesity 'explosion'.

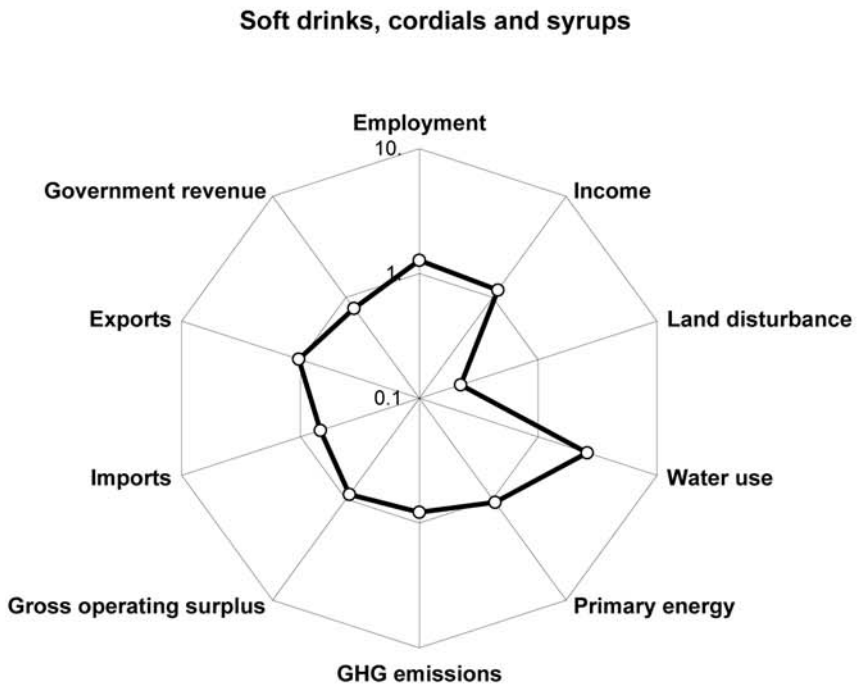
Innovation and Technical Opportunities

The developing food science area of 'active foods', partially featured in the sector's products such as sports drinks, pure water, and diet drinks, will become more important. It is possible to envisage the full integration of soft drink consumption with public health programs for diabetes and obesity avoidance, skeletal strength, healthy teeth, and active lives, while enhancing a robust brand image.

Sector **Soft drinks, cordials and syrups** **(Bv)**

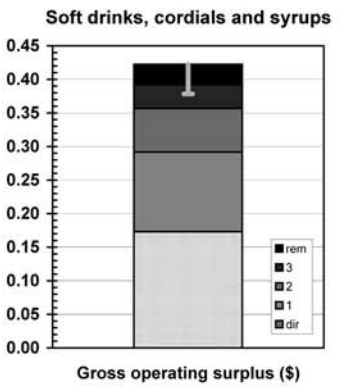
Soft drinks, mineral and aerated waters, cordials and syrups

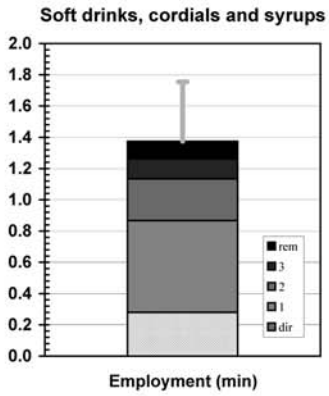
Spider diagram

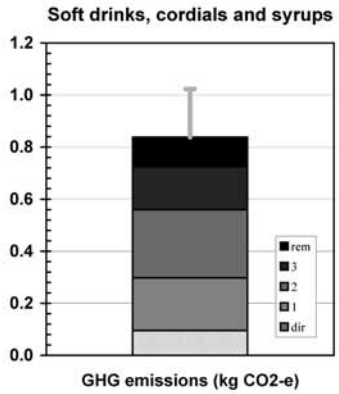


Bar graphs

Account #1







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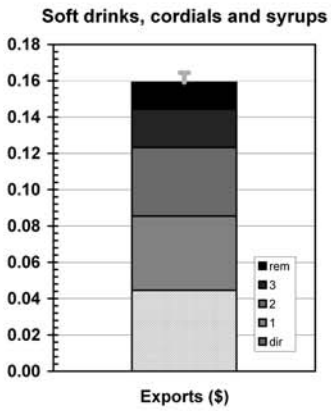

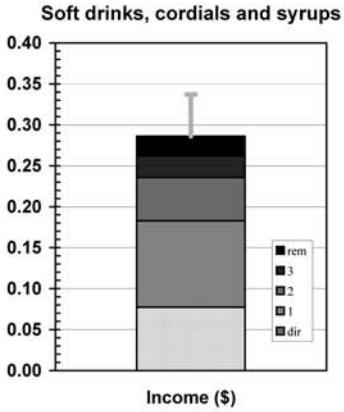

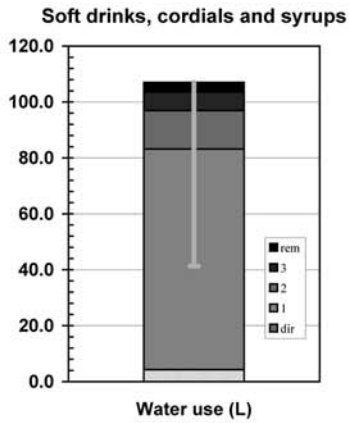

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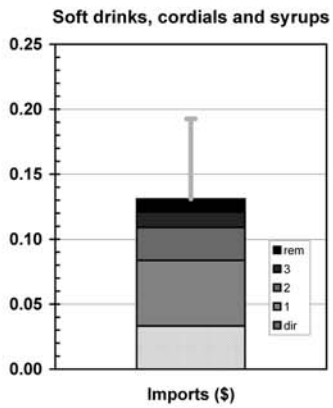
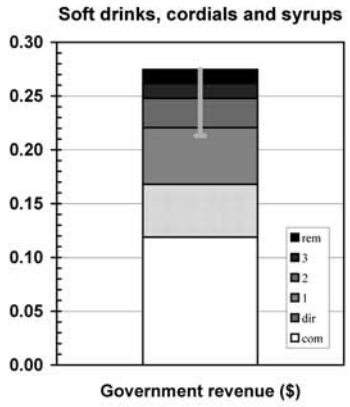
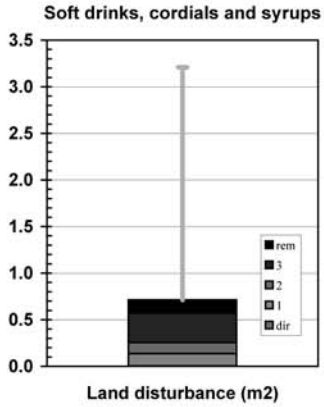






National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 2,061.5	(0.78% of total)	($m 1,814.1 domestically produced)
Government final consumption	$m 0.0	(0.00% of total)	($m 0.0 domestically produced)
Gross fixed capital expenditure	$m 11.9	(0.01% of total)	($m 11.9 domestically produced)
Net changes in stocks	$m 43.2	(2.44% of total)	($m 38.6 domestically produced)
Sectoral GNE	**$m 2,116.6**	**(0.46% of GNE)**	**($m 1,864.6 domestically produced)**
Exports	$m 93.2	(0.11% of total)	($m 93.2 domestically produced)
Final demand	**$m 2,209.8**	**(0.41% of GNT)**	**($m 1,957.9 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 162.2	(0.09% of total)	
Gross operating surplus	$m 362.8	(0.19% of total)	
Taxes less subsidies	$m 102.7	(0.12% of total)	
Sectoral GDP*	**$m 627.7**	**(0.14% of GDP)**	
Imports	$m 69.6	(0.07% of total)	
Primary inputs	**$m 697.3**	**(0.13% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 362.8	(0.19%)	$m 339.1	(0.18%)	$m 827.3	(0.43%)
Exports ($m)	$m 93.2	(0.11%)	$m 87.1	(0.10%)	$m 311.6	(0.37%)
Imports ($m)	$m 69.6	(0.07%)	$m 65.1	(0.07%)	$m 256.5	(0.26%)
Employment (e-y)	4,689 e-y	(0.07%)	4,383 e-y	(0.06%)	21,558 e-y	(0.30%)
Income ($m)*	$m 162.2	(0.09%)	$m 151.6	(0.09%)	$m 560.0	(0.33%)
Government revenue ($m)†	$m 335.4	(0.31%)	$m 328.7	(0.30%)	$m 537.8	(0.50%)
GHG emissions (kt CO_2-e)	199 kt	(0.04%)	186 kt	(0.04%)	1,642 kt	(0.32%)
Water use (ML)	8,990 ML	(0.04%)	8,402 ML	(0.04%)	209,529 ML	(1.00%)
Land disturbance (kha)	1 kha	(0.00%)	1 kha	(0.00%)	140 kha	(0.09%)
Primary energy (TJ)	3,482 TJ	(0.09%)	3,255 TJ	(0.08%)	16,098 TJ	(0.41%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.17	0.42	0.38
Exports ($)	0.04	0.16	0.16
Imports ($)	0.03	0.13	0.19
Employment (min)	0.28	1.37	1.75
Income ($)	0.08	0.29	0.34
Government revenue ($)	0.17	0.27	0.21
GHG emissions (kg CO_2-e)	0.10	0.84	1.02
Water use (L)	4.29	107.02	41.32
Land disturbance (m^2)	0.00	0.71	3.21
Primary energy (MJ)	1.66	8.22	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Bv	0.173	(0; 41.%)	Bv	0.279	(0; 20.%)	Bv	0.0952	(0; 11.%)
Sh Bv	0.0235	(1; 5.6%)	Sh Bv	0.14	(1; 10.%)	Is Sh Bv	0.0682	(2; 8.1%)
Su Bv	0.0195	(1; 4.6%)	Su Bv	0.0968	(1; 7.%)	Fd Bv	0.0533	(1; 6.4%)
Pl Bv	0.00923	(1; 2.2%)	Ho Bv	0.0648	(1; 4.7%)	El Bv	0.0473	(1; 5.6%)
St Bv	0.00831	(1; 2.%)	Pl Bv	0.0491	(1; 3.6%)	Su Bv	0.0288	(1; 3.4%)
Fd Bv	0.00809	(1; 1.9%)	Rd Bv	0.0336	(1; 2.4%)	Fr Su Bv	0.0226	(2; 2.7%)
Is Sh Bv	0.00789	(2; 1.9%)	Wt Bv	0.0286	(1; 2.1%)	Ch Pl Bv	0.0205	(2; 2.4%)
Gp Bv	0.00665	(1; 1.6%)	Ms Bv	0.0241	(1; 1.8%)	Bc Mp Fd Bv	0.0159	(3; 1.9%)
Rd Bv	0.00571	(1; 1.4%)	Gp Bv	0.0232	(1; 1.7%)	El Sh Bv	0.0142	(2; 1.7%)
Ms Bv	0.00537	(1; 1.3%)	Is Sh Bv	0.0188	(2; 1.4%)	Gp Bv	0.0129	(1; 1.5%)
Ho Bv	0.00516	(1; 1.2%)	Fd Bv	0.018	(1; 1.3%)	Bc Mp Ho Bv	0.0129	(3; 1.5%)
Wt Bv	0.00397	(1; 0.94%)	Fm Sh Bv	0.0146	(2; 1.1%)	El Pl Bv	0.0107	(2; 1.3%)
Ng Bv	0.00204	(1; 0.48%)	St Bv	0.0136	(1; 0.99%)	Ga Bv	0.0105	(1; 1.2%)
Bm Bv	0.00193	(1; 0.46%)	Pa Bv	0.0111	(1; 0.8%)	Sh Bv	0.0102	(1; 1.2%)
El Bv	0.00191	(1; 0.45%)	Gv Bv	0.0107	(1; 0.78%)	Ng Bv	0.00925	(1; 1.1%)
St Sh Bv	0.00175	(2; 0.41%)	Su Fd Bv	0.00812	(2; 0.59%)	Rd Bv	0.00907	(1; 1.1%)
Ch Pl Bv	0.00171	(2; 0.41%)	Bs Bv	0.00796	(1; 0.58%)	El Is Sh Bv	0.00895	(3; 1.1%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Bv	0.0445	(0; 28.%)	Bv	0.0774	(0; 27.%)	Su Bv	76.9	(1; 72.%)
Fd Bv	0.0147	(1; 9.2%)	Sh Bv	0.0277	(1; 9.7%)	Su Fd Bv	6.45	(2; 6.%)
Is Sh Bv	0.00603	(2; 3.8%)	Pl Bv	0.00994	(1; 3.5%)	Bv	4.29	(0; 4.%)
Nf Sh Bv	0.00571	(2; 3.6%)	Ho Bv	0.00945	(1; 3.3%)	Sc Cg Su Bv	2.09	(3; 2.%)
Sh Bv	0.00564	(1; 3.5%)	Su Bv	0.00796	(1; 2.8%)	Wa Bv	0.65	(1; 0.61%)
Ho Bv	0.00361	(1; 2.3%)	Wt Bv	0.00614	(1; 2.1%)	Vf Fd Bv	0.512	(2; 0.48%)
Wt Bv	0.00325	(1; 2.%)	Rd Bv	0.00577	(1; 2.%)	Ws Ho Bv	0.472	(2; 0.44%)
Pl Bv	0.00267	(1; 1.7%)	Ms Bv	0.0056	(1; 2.%)	Bc Mp Fd Bv	0.42	(3; 0.39%)
Ch Pl Bv	0.00239	(2; 1.5%)	Is Sh Bv	0.00449	(2; 1.6%)	Wh Fd Bv	0.347	(2; 0.32%)
St Bv	0.00206	(1; 1.3%)	Gp Bv	0.00434	(1; 1.5%)	Bc Mp Ho Bv	0.339	(3; 0.32%)
Rd Bv	0.00199	(1; 1.2%)	Fd Bv	0.00424	(1; 1.5%)	Sh Bv	0.318	(1; 0.3%)
Al Sh Bv	0.00197	(2; 1.2%)	St Bv	0.00346	(1; 1.2%)	Dc Dp Ho Bv	0.281	(3; 0.26%)
Io Is Sh Bv	0.00164	(3; 1.%)	Gv Bv	0.00268	(1; 0.94%)	El Bv	0.261	(1; 0.24%)
Gp Bv	0.00156	(1; 0.98%)	Pa Bv	0.00254	(1; 0.89%)	Ri Fc Ho Bv	0.218	(3; 0.2%)
Gl Nf Sh Bv	0.00104	(3; 0.65%)	Fm Sh Bv	0.00229	(2; 0.8%)	Vf Bv	0.195	(1; 0.18%)
Cg Su Bv	0.000976	(2; 0.61%)	Ts Bv	0.00174	(1; 0.61%)	Ba Bm Bv	0.183	(2; 0.17%)
Wh Fd Bv	0.000874	(2; 0.55%)	Bk Bv	0.0013	(1; 0.45%)	Is Sh Bv	0.181	(2; 0.17%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Bv	0.0332	(0; 25.%)	Bv	0.0491	(0; 31.%)	Su Bv	0.123	(1; 17.%)
Sh Bv	0.0162	(1; 12.%)	Sh Bv	0.0122	(1; 7.8%)	Bc Mp Fd Bv	0.116	(3; 16.%)
Pl Bv	0.00945	(1; 7.2%)	Ho Bv	0.00498	(1; 3.2%)	Bc Mp Ho Bv	0.0935	(3; 13.%)
Su Bv	0.00481	(1; 3.7%)	Su Bv	0.00489	(1; 3.1%)	Wh Fd Bv	0.0505	(2; 7.1%)
Pa Bv	0.00319	(1; 2.4%)	Pl Bv	0.00433	(1; 2.8%)	Ba Bm Bv	0.0216	(2; 3.%)
Is Sh Bv	0.00284	(2; 2.2%)	Rd Bv	0.0041	(1; 2.6%)	Wo Mp Fd Bv	0.0131	(3; 1.8%)
Fd Bv	0.00243	(1; 1.9%)	Wt Bv	0.00287	(1; 1.8%)	Wo Mp Ho Bv	0.0106	(3; 1.5%)
Ho Bv	0.0024	(1; 1.8%)	Ms Bv	0.00266	(1; 1.7%)	Su Fd Bv	0.0103	(2; 1.4%)
Ch Pl Bv	0.00239	(2; 1.8%)	Gp Bv	0.0021	(1; 1.3%)	Wo Tx Pl Bv	0.00948	(3; 1.3%)
Gp Bv	0.00204	(1; 1.6%)	Is Sh Bv	0.00206	(2; 1.3%)	Bc Mp Ch Pl E	0.00816	(4; 1.1%)
Rd Bv	0.00145	(1; 1.1%)	Fd Bv	0.00205	(1; 1.3%)	Ba Bm Ho Bv	0.00764	(3; 1.1%)
Ms Bv	0.00122	(1; 0.93%)	St Bv	0.00185	(1; 1.2%)	Fr Su Bv	0.00726	(2; 1.%)
Fm Sh Bv	0.00099	(2; 0.76%)	Pa Bv	0.00134	(1; 0.86%)	Ba Fd Bv	0.00694	(2; 0.97%)
Wt Bv	0.000922	(1; 0.7%)	In Bv	0.00103	(1; 0.66%)	Wh Su Bv	0.00582	(2; 0.82%)
St Bv	0.000752	(1; 0.57%)	Gv Bv	0.000934	(1; 0.6%)	Sh Bv	0.00429	(1; 0.6%)
Nf Sh Bv	0.000687	(2; 0.52%)	Ts Bv	0.000859	(1; 0.55%)	Bv	0.00414	(0; 0.58%)
Fo Su Bv	0.000527	(2; 0.4%)	Fm Sh Bv	0.0008	(2; 0.51%)	Bc Ch Pl Bv	0.0041	(3; 0.58%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	1.513 ±0.023	(±1.5%)
Downstream	0.111 ±0.002	(±1.4%)

Sector 2110: Beer and Malt (Bm)

Beer, ale, and stout (bottled, canned and bulk) and malt

Short Summary

Against the metric of one dollar of final consumption, the environmental indicator of greenhouse emissions is 20% below average, while water use and land disturbance are 20% and 25% above average respectively. The social indicators show that employment generation and income are both 30% below average, while government revenue is 10 times the average. The financial indicators give positive outcomes with operating surplus 35% above average, export propensity 55% above average, and import penetration 50% below average. While a number of upstream issues could be improved, the main issue appears to be the tension between the negative effects of excessive alcohol consumption on community health and the government revenue gained from its use.

Sector Description

Australia currently produces 1 745 million litres of beer and 670 000 tonnes of malted barley per year. Australians consume about 1 720 million litres of beer or 95 litres per capita ranking ninth in world in per capita beer consumption. Beer accounts for 75% of pure alcohol consumption (wine 20%, spirits 2%, other 5%). Full strength beers account for 75% of domestic consumption and reduced alcohol beers for 25%. Consumption has dropped from a peak of 130 litres per capita in the mid 1970s. While consumption of normal brand beer is currently static, sales of both light beers and premium quality beers are growing, with the latter consumption at 140 million litres, or about 10 litres per capita for the over 18 years population. Beer brewing is moderately water intensive requiring about seven litres of factory process water for each litre produced. Malting is an early stage of beer making where malting quality barley (around 11% protein) is soaked (steeped), germinated, and kiln dried. Australia consumes around 200 000 tonnes of malted barley for domestic brewing, and exports about 470 000 tonnes. Excise on beer is levied on alcohol content. In constant dollar terms, the sector's turnover is similar to 30 years ago, with a current turnover of about $3 billion involving about ten enterprises.

Place of Industry in the Economy

The beer and malt sector ranks 73rd out of 135 sectors in terms of value adding in the economy and contributes 0.20% of GDP in this analysis. It is similar in value adding to the paper containers and products, and the services to agriculture sectors. It is a small employer with 1 000 employment years embodied in final demand, and another 7 000 years in the sector's upstream suppliers, giving a total of 8 000 employment years. In addition, the sector contributes 2 000 employment years to downstream industries such as accommodation cafes and restaurants. The sector has moderate resource requirements with between one tenth and two tenths of one percent of national water use, land disturbance, energy use, and greenhouse emissions. Exports are six times the size of imports.

Strategic Overview

The spider diagram portrays a reasonable TBL account with no spikes and a much greater than average government revenue. The sector has higher than average land disturbance and water use, lower than average employment generation and income, but higher than average outcomes for the financial indicators. Health experts hypothesise an alcohol 'J-curve' effect with some positive health outcomes from moderate consumption, but excessive consumption causing acute health problems costing over $5 billion yearly. Beer contributes $1.8 billion (45%) of the $4 billion of alcohol excise levies collected yearly, and represents 75% of the pure alcohol consumed.

TBL Account #1

The financial indicator of operating surplus is 50% above average, the social indicator of employment generation is 20% below average and greenhouse emissions are 10% below average. The emissions indicator is composed of barley growing (34%), electricity production (13%), the direct sector effect (10%), iron and steel making (3%), and road transport (2%).

TBL Accounts #2 and #3

The second TBL account shows an export propensity that is 65% above average, income that is 20% below average, and water use that is 35% above average. The third TBL account reveals an import penetration that is 50% below average, a government revenue indicator that is 11 times the average, and a land disturbance indicator that is 45% above average.

Structural Path Analysis and Linkages

Both the water use and land disturbance indicators are above average. The in-factory or direct sector water use is 8% of total, with the majority (50%) due to barley growing where irrigation is used sometimes in drier seasons and specifically during the period of growth when the grain is being filled. Water use is also due to the water provision sector (6%), wheat growing (4%), electricity production (1%) and hop growing (1%). The land disturbance indicator is also dominated by barley growing (70%) and wheat growing (6%) for specialist wheat beers.

The sector's stimulus to upstream suppliers is 35% greater than the economy wide average with impacts on barley growing, wholesale trade, road transport, metal containers, accommodation cafes and restaurants, and banking. The linkages to downstream industries are average and suggest that production increases must be led by expansion of the accommodation, cafes and restaurants sector.

Future Trends in Sector

Under the base case scenario in the *Future Dilemmas* study with 25 million people by 2050, beer consumption may expand by over 40% provided that beer makers can maintain the current per capita beer consumption in the face of wine and 'ready to drink' mixers. Part of this increase is based on a large increase in international tourism. There are many finer scale marketing challenges focused on demographic and income segments, especially given that the over 45 year olds will equal the under 45 year olds in absolute numbers, though possibly not discretionary spending power. The malting part of the sector may have a secure future given the steady expansion of beer drinking in Asia, driven by both population growth as well as per capita economic development. Currently Australian malt exports go to Japan (25%), Philippines (14%), Vietnam (17%), Thailand (12%), and Korea (12%). However China is a major malt producer and its future influence on Australian exports will be determined by its excess malt production over domestic consumption. One uncertainly is that of global climate change, particularly its effect on malting quality generally, and on production levels in Western Australia which has 25% of current Australian barley production.

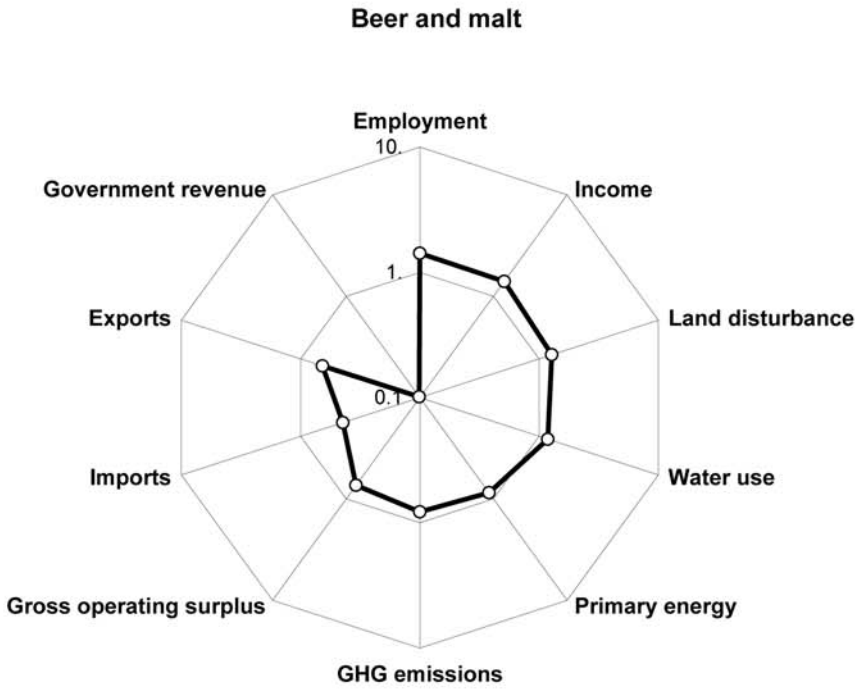
Innovation and Technical Opportunities

A recent technical review reveals a number of interesting tensions for beer producers. The reasonably flat market for normal bulk produced beers, and expanding market for premium and 'different' beers, requires frequent changes of brewing runs. This diversity requires longer downtime and changeover times for machinery and plant. One alternative is to produce a homogenous base fluid to which colours, tastes, and special effects are added just before bottling. However beer connoisseurs are unlikely to accept synthetic approaches to the production of higher quality and higher priced beers. Stewardship programs similar to some North American producers may be required for the 3.3 billion glass, plastic and aluminium beer containers used yearly.

Sector **Beer and malt** **(Bm)**

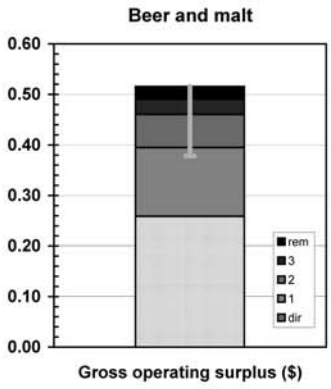
Beer and malt

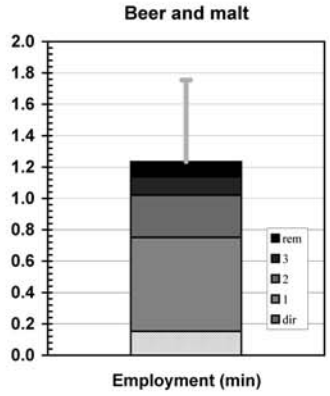
Spider diagram

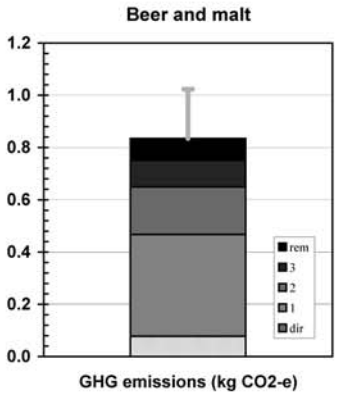


Bar graphs

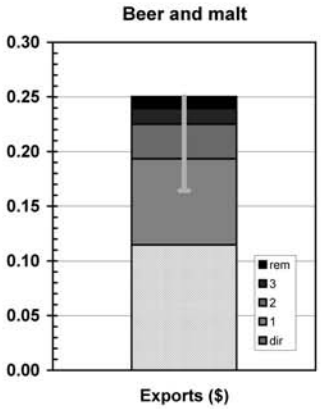
Account #1

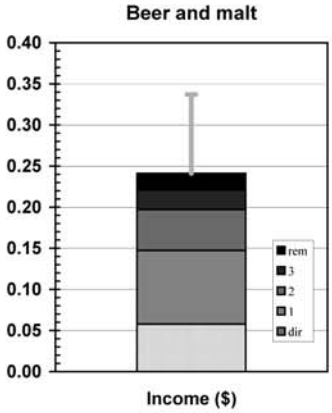


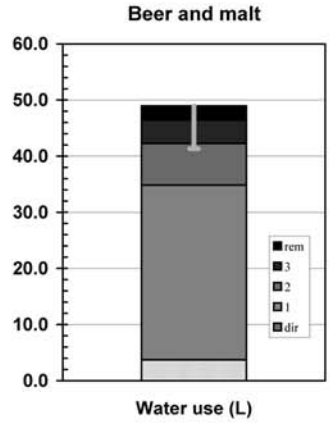




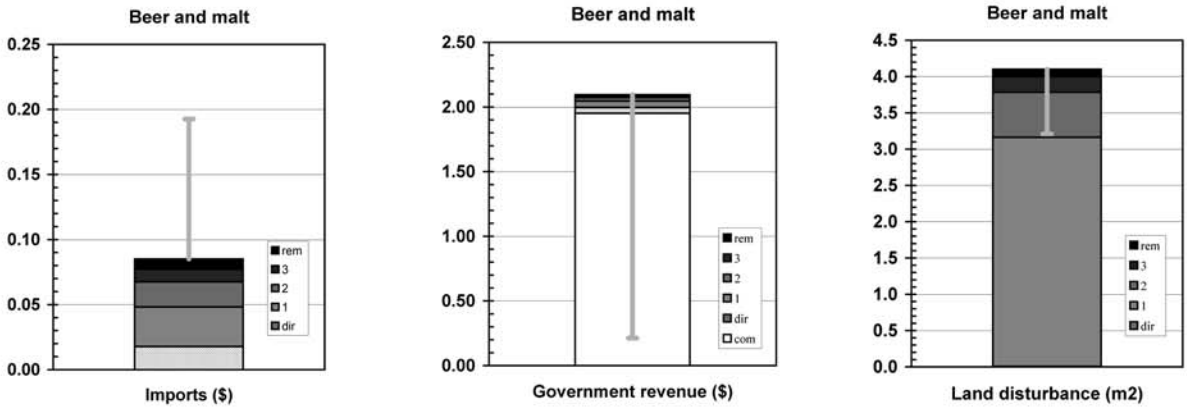
Account #2







Account #3



National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 541.6	(0.20% of total)	($m 497.4 domestically produced)
Government final consumption	$m 0.0	(0.00% of total)	($m 0.0 domestically produced)
Gross fixed capital expenditure	$m 2.1	(0.00% of total)	($m 2.1 domestically produced)
Net changes in stocks	$m 8.3	(0.47% of total)	($m 7.8 domestically produced)
Sectoral GNE	**$m 552.0**	**(0.12% of GNE)**	**($m 507.3 domestically produced)**
Exports	$m 290.9	(0.35% of total)	($m 290.9 domestically produced)
Final demand	**$m 842.9**	**(0.16% of GNT)**	**($m 798.2 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 146.3	(0.09% of total)	
Gross operating surplus	$m 657.1	(0.34% of total)	
Taxes less subsidies	$m 114.4	(0.13% of total)	
Sectoral GDP*	**$m 917.9**	**(0.20% of GDP)**	
Imports	$m 45.2	(0.05% of total)	
Primary inputs	**$m 963.1**	**(0.18% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 657.1	(0.34%)	$m 206.6	(0.11%)	$m 411.6	(0.21%)
Exports ($m)	$m 290.9	(0.35%)	$m 91.4	(0.11%)	$m 199.7	(0.24%)
Imports ($m)	$m 45.2	(0.05%)	$m 14.2	(0.01%)	$m 67.9	(0.07%)
Employment (e-y)	3,110 e-y	(0.04%)	977 e-y	(0.01%)	7,894 e-y	(0.11%)
Income ($m)*	$m 146.3	(0.09%)	$m 46.0	(0.03%)	$m 192.4	(0.11%)
Government revenue ($m)†	$m 1,672.0	(1.55%)	$m 1,593.5	(1.47%)	$m 1,673.0	(1.55%)
GHG emissions (kt CO_2-e)	196 kt	(0.04%)	62 kt	(0.01%)	666 kt	(0.13%)
Water use (ML)	9,418 ML	(0.04%)	2,960 ML	(0.01%)	39,063 ML	(0.19%)
Land disturbance (kha)	1 kha	(0.00%)	0 kha	(0.00%)	327 kha	(0.20%)
Primary energy (TJ)	3,091 TJ	(0.08%)	972 TJ	(0.03%)	5,305 TJ	(0.14%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.26	0.52	0.38
Exports ($)	0.11	0.25	0.16
Imports ($)	0.02	0.09	0.19
Employment (min)	0.15	1.23	1.75
Income ($)	0.06	0.24	0.34
Government revenue ($)	2.00	2.10	0.21
GHG emissions (kg CO_2-e)	0.08	0.83	1.02
Water use (L)	3.71	48.94	41.32
Land disturbance (m^2)	0.00	4.10	3.21
Primary energy (MJ)	1.22	6.65	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Bm	0.259	(0; 50.%)	Ba Bm	0.189	(1; 15.%)	Ba Bm	0.204	(1; 24.%)
Ba Bm	0.0383	(1; 7.4%)	Bm	0.153	(0; 12.%)	El Bm	0.11	(1; 13.%)
Wt Bm	0.0115	(1; 2.2%)	Wt Bm	0.0826	(1; 6.7%)	Bm	0.0772	(0; 9.3%)
Sh Bm	0.00861	(1; 1.7%)	Ho Bm	0.0521	(1; 4.2%)	Is Sh Bm	0.025	(2; 3.%)
Rd Bm	0.00806	(1; 1.6%)	Sh Bm	0.0513	(1; 4.2%)	Rd Bm	0.0128	(1; 1.5%)
Bk Bm	0.00767	(1; 1.5%)	Rd Bm	0.0474	(1; 3.8%)	Wt Bm	0.0114	(1; 1.4%)
St Bm	0.00766	(1; 1.5%)	Bk Bm	0.0304	(1; 2.5%)	Bc Mp Ho Bm	0.0103	(3; 1.2%)
El Bm	0.00446	(1; 0.87%)	Ms Bm	0.0192	(1; 1.6%)	Wh Bm	0.00725	(1; 0.87%)
Ms Bm	0.00429	(1; 0.83%)	Wh Bm	0.017	(1; 1.4%)	El Ho Bm	0.00682	(2; 0.82%)
Ho Bm	0.00415	(1; 0.81%)	Pa Bm	0.0141	(1; 1.1%)	Ga Bm	0.00639	(1; 0.77%)
Wa Bm	0.00379	(1; 0.74%)	Rf Bm	0.0133	(1; 1.1%)	Gp Bm	0.00546	(1; 0.65%)
Wh Bm	0.00344	(1; 0.67%)	St Bm	0.0125	(1; 1.%)	El Sh Bm	0.0052	(2; 0.62%)
Is Sh Bm	0.0029	(2; 0.56%)	Gp Bm	0.0098	(1; 0.79%)	Ng Bm	0.00496	(1; 0.59%)
Gp Bm	0.00281	(1; 0.54%)	Ms Wt Bm	0.00746	(2; 0.6%)	El Rf Bm	0.00486	(2; 0.58%)
Sf Bk Bm	0.00268	(2; 0.52%)	Wt Ba Bm	0.00742	(2; 0.6%)	Rf Bm	0.00484	(1; 0.58%)
St Wt Bm	0.00219	(2; 0.42%)	Fn Bm	0.00724	(1; 0.59%)	Pa Bm	0.00418	(1; 0.5%)
Pa Bm	0.00208	(1; 0.4%)	Is Sh Bm	0.00691	(2; 0.56%)	Sh Bm	0.00374	(1; 0.45%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Bm	0.115	(0; 46.%)	Bm	0.0576	(0; 24.%)	Ba Bm	24.5	(1; 50.%)
Ba Bm	0.0391	(1; 16.%)	Wt Bm	0.0177	(1; 7.4%)	Bm	3.71	(0; 7.6%)
Wt Bm	0.00938	(1; 3.7%)	Sh Bm	0.0102	(1; 4.2%)	Wa Bm	2.79	(1; 5.7%)
Wh Bm	0.00442	(1; 1.8%)	Rd Bm	0.00815	(1; 3.4%)	Wh Bm	1.75	(1; 3.6%)
Ho Bm	0.0029	(1; 1.2%)	Ho Bm	0.0076	(1; 3.2%)	Sc Cg Ba Bm	1.15	(3; 2.4%)
Rd Bm	0.0028	(1; 1.1%)	Bk Bm	0.00751	(1; 3.1%)	El Bm	0.611	(1; 1.2%)
Rf Bm	0.00273	(1; 1.1%)	Ba Bm	0.00648	(1; 2.7%)	Vf Bm	0.431	(1; 0.88%)
Is Sh Bm	0.00221	(2; 0.88%)	Ms Bm	0.00447	(1; 1.9%)	Ws Ho Bm	0.38	(2; 0.78%)
Nf Sh Bm	0.0021	(2; 0.84%)	Rf Bm	0.00374	(1; 1.6%)	Ri Bm	0.28	(1; 0.57%)
Sh Bm	0.00207	(1; 0.83%)	Pa Bm	0.00324	(1; 1.3%)	Bc Mp Ho Bm	0.273	(3; 0.56%)
St Bm	0.0019	(1; 0.76%)	St Bm	0.00319	(1; 1.3%)	Dc Dp Ho Bm	0.226	(3; 0.46%)
Bl El Bm	0.00108	(2; 0.43%)	Gp Bm	0.00183	(1; 0.76%)	Ri Fc Ho Bm	0.175	(3; 0.36%)
Pa Bm	0.000849	(1; 0.34%)	Ms Wt Bm	0.00173	(2; 0.72%)	Vf Ho Bm	0.144	(2; 0.29%)
Wt Ba Bm	0.000842	(2; 0.34%)	Is Sh Bm	0.00165	(2; 0.68%)	Sh Bm	0.117	(1; 0.24%)
Al Sh Bm	0.000723	(2; 0.29%)	Wt Ba Bm	0.00159	(2; 0.66%)	Wa Ba Bm	0.116	(2; 0.24%)
Ms Bm	0.000664	(1; 0.27%)	Fn Bm	0.00135	(1; 0.56%)	Wa Ms Bm	0.11	(2; 0.23%)
Gp Bm	0.000657	(1; 0.26%)	El Bm	0.00134	(1; 0.56%)	Sc Cg Wh Bm	0.104	(3; 0.21%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Bm	0.0178	(0; 21.%)	Bm	0.0451	(0; 31.%)	Ba Bm	2.89	(1; 71.%)
Sh Bm	0.00594	(1; 7.%)	Wt Bm	0.00829	(1; 5.7%)	Wh Bm	0.256	(1; 6.2%)
Ba Bm	0.00441	(1; 5.2%)	Rd Bm	0.00578	(1; 4.%)	Bc Mp Ho Bm	0.0752	(3; 1.8%)
Pa Bm	0.00406	(1; 4.8%)	Sh Bm	0.00449	(1; 3.1%)	Wo Mp Ho Bm	0.00849	(3; 0.21%)
Wt Bm	0.00267	(1; 3.1%)	Ba Bm	0.00442	(1; 3.1%)	Ba Bm Ho Bm	0.00614	(3; 0.15%)
Rd Bm	0.00204	(1; 2.4%)	Bk Bm	0.00415	(1; 2.9%)	Bm	0.00389	(0; 0.095%)
Ho Bm	0.00193	(1; 2.3%)	Ho Bm	0.004	(1; 2.8%)	Wo Tx Wt Bm	0.00294	(3; 0.072%)
Is Sh Bm	0.00104	(2; 1.2%)	Ms Bm	0.00212	(1; 1.5%)	Sw Pp Pa Bm	0.00276	(3; 0.067%)
Ms Bm	0.000975	(1; 1.1%)	Rf Bm	0.00172	(1; 1.2%)	Wo Tx Ho Bm	0.00213	(3; 0.052%)
Gp Bm	0.000862	(1; 1.%)	Pa Bm	0.0017	(1; 1.2%)	Rf Bm	0.00188	(1; 0.046%)
Bk Bm	0.000742	(1; 0.87%)	St Bm	0.0017	(1; 1.2%)	El Bm	0.00178	(1; 0.043%)
St Bm	0.000693	(1; 0.81%)	In Bm	0.00113	(1; 0.78%)	Wo Tx Pa Bm	0.00172	(3; 0.042%)
Wa Bm	0.000577	(1; 0.68%)	Gp Bm	0.000885	(1; 0.61%)	Bc Mp Ho Wt	0.0017	(4; 0.041%)
Pp Pa Bm	0.000526	(2; 0.62%)	El Bm	0.000838	(1; 0.58%)	Sh Bm	0.00157	(1; 0.038%)
Pl Bm	0.00044	(1; 0.52%)	Ms Wt Bm	0.000824	(2; 0.57%)	Wh Fc Ho Bm	0.00152	(3; 0.037%)
Fo Ba Bm	0.000439	(2; 0.52%)	Wa Bm	0.000819	(1; 0.57%)	Sc Cg Ba Bm	0.00151	(3; 0.037%)
Rf Bm	0.00043	(1; 0.51%)	Pd Wt Bm	0.000778	(2; 0.54%)	Bc Mp Ho Ba	0.00139	(4; 0.034%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	1.365 ±0.022	(±1.6%)
Downstream	1.084 ±0.055	(±5.1%)

Sector 2111: Wine and Spirits (Ws)

Wine, cider, spirits, vinegar, liqueurs and mixed drinks

Short Summary

The wine and spirits sector has greenhouse emissions 15% below average, land disturbance 65% below average and water use twelve times the economy wide average at 500 litres per dollar of final demand. Two thirds of the water is used directly within the sector and includes the water used for growing grapes as well as for processing. A further one quarter is used to grow non-grape inputs (rice for sake, apples for cider) where one quarter of the water effect is located. The social indicators show that employment generation is 5% below average, income is 15% below average and government revenue is five times the average, due to excise taxes on alcohol. The financial indicators show that operating surplus is 10% above average, exports propensity is over twice the average and import penetration is 25% below average. The downstream linkages are average and strongest to the accommodation, cafés and restaurants sector. Increased consumer demand strongly stimulates upstream suppliers, particularly fruit growing, cardboard and glass containers, wholesale trade, road freight and marketing. The wine and spirits sector shows a reasonable TBL account against the indicators used in this analysis. The negative social consequences of alcohol abuse are outside the scope of this analysis. Product levies based on embodied water content could help improve the water indicator.

Sector Description

Around 150 000 hectares of vineyards produce 1.6 million tonnes of grapes for crushing which produces 1.2 billion litres of wine. Domestic sales and exports of wine are each around 400 million litres per year and returns sales of around $2 billion annually, making it a $4 billion industry. The wine inventory (the stock for cellaring) is around 1.5 billion litres and takes in 400 million litres per year. The production of Australian brandy is around 400 000 litres per year. Australians consume around 20 litres of wine per capita per year. The industry is very important in a regional sense. In 2002, the financial turnover was $5.2 billion and involved over 1 100 enterprises.

Place of Industry in the Economy

The wine and spirit sector is a small one in terms of value adding in the economy ranking 98th out of 135 sectors and contributing 0.11% of GDP in this analysis. It is a small generator of employment with around 9 000 employment years, 2 000 of which are used directly in the industry and 7 000 by the industry's suppliers. It requires around two percent of national water use and is responsible for less than one tenth of one percent of land disturbance, energy use and greenhouse emissions. In financial terms, exports of wine currently outweigh imports by a ratio of 20:1.

Strategic Overview

The integrated overview shown in the spider diagram gives a reasonable TBL account but for one outlier of water use. The social indicators show near average employment and income outcomes and high levels of government revenue due to the taxes levied on alcohol content (in the case of spirits) and product price (for wine). In addition to water use, upstream issues relate to the occupational health and safety issues of farmers, grape pickers and process workers. Downstream issues relate to disposal of process water and organic waste such as grape skins. The organic content of process water (technically its biological oxygen demand) is a key issue. One policy option may be to explore cross compliance arrangements between tax excise paid, and the innovation and investment required to return waste water to streams with equal or better quality than at its entry point to the plant.

TBL Account #1

The financial surplus is 10% above average with one third a direct effect, and another third due to first order effects including fruit growing (15%), glass products (3%), storage (2%) and paper containers (2%). Employment generation is 5% below average with one quarter a direct effect and almost half due to first order effects, particularly fruit growing. Greenhouse emissions are 15% below average with a direct effect of only one tenth, while first order and second order effects contribute one third each. The first order effects include fruit growing (13%), electricity (7%), rice growing (4%), glass products (3%) and paper containers (2%). The second order effects are dominated by land development and electricity production that lie behind grape growing.

TBL Accounts #2 and #3

The second TBL account shows an export propensity over twice the average, with two thirds a direct effect and the rest due to obvious inputs such as grape growing, grains, wholesale trade and accommodation. The income indicator is 15% below average with one third a direct effect, and the rest due to the product chain. The water indicator is twelve times the economy wide average. The third TBL account shows an import penetration 20% above average, government revenue over five times the average and land disturbance 65% below average.

Structural Path Analysis and Linkages

An examination of the structural path for water use shows that two thirds of the 500 litres per dollar used is a direct sector effect. Wine and spirit making can require process water of 2 000 litres per tonne of grapes crushed (or 2 tonnes of water per tonne of grapes) mainly to wash down equipment. Fruit growing and rice growing each contribute 13% of water requirements. Rice growing may seem a strange part of the wine sector, but Australia produces over one million litres yearly of rice wine (or sake) in Penrith near Sydney, and more in South Australia.

Increases in consumer demand show strong upstream linkages to grape growing, cardboard containers, glass makers, wholesale trade, road freight and marketing. The sector shows relatively weak downstream linkages as most activity dissipates to personal consumption and exports.

Future Trends in Sector

If domestic per capita consumption remains steady at 20 litres per annum (significantly less than France, Italy and Portugal where consumption is 50-60 litres per capita), then total consumption may grow by one quarter to 500 million litres per year if the population grows to 25 million by 2050, the base case scenario in the *Future Dilemmas* study. If per capita consumption increases, for example because older Australians select wine as a functional food as well as a lifestyle complement, then higher growth in the sector may be possible. Export volumes may not continue to grow forever. Capping production levels and focusing on quality, value adding and reducing the water and greenhouse intensity of the product chain, may be worth considering as an alternative strategy.

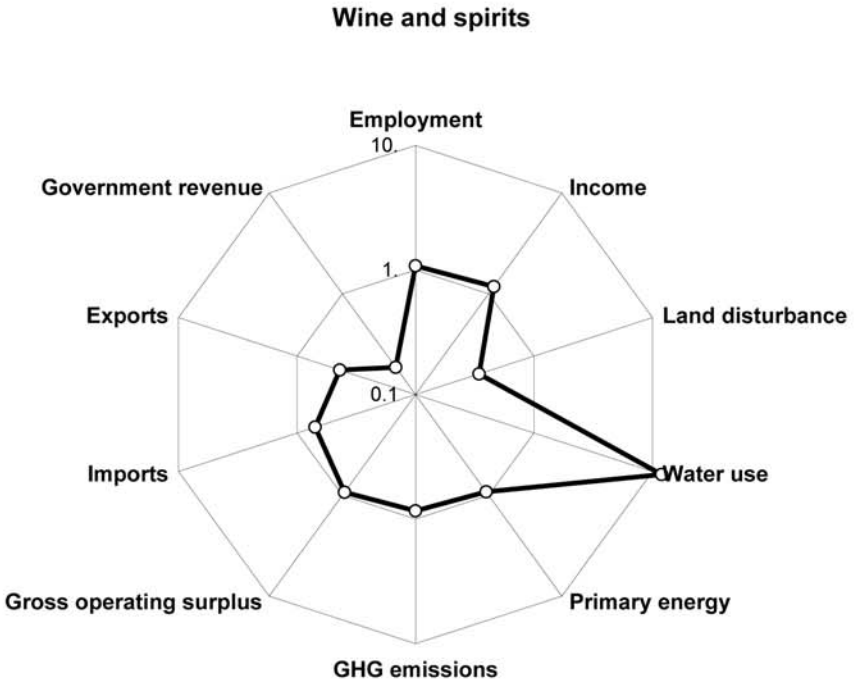
Innovation and Technical Opportunities

Increasing the health-giving properties of wine consumption may provide the next focus for product chain development. The return of process water back to the environment presents a real sustainability challenge to the Australian industry, given its current international profile, and the degraded nature of many Australian rivers. Energy intensive mechanical approaches to processing and waste and are well developed. They will be augmented increasingly by bacterial (Bacillus sp.) and fungal (Aspergillus sp.) processors which yield other by-products (animal protein, methane) as well as enabling the return of high quality and valued added water back to rivers and streams.

Sector **Wine and spirits** **(Ws)**

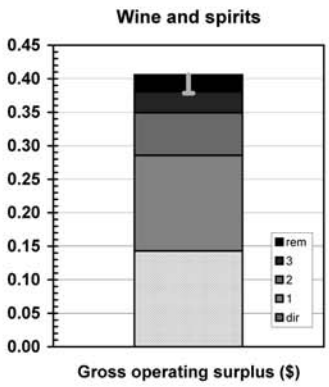
Wine and spirits

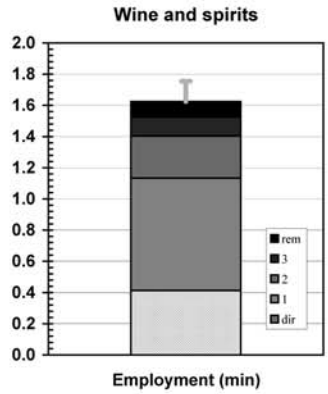
Spider diagram

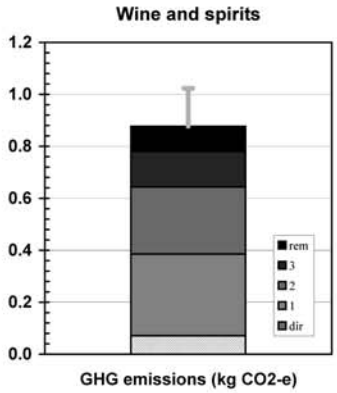


Bar graphs

Account #1







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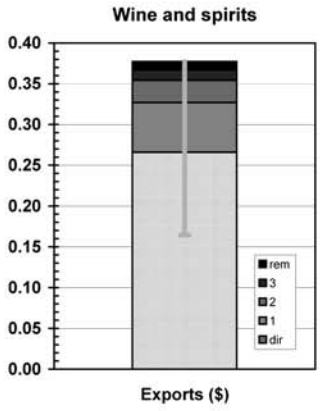

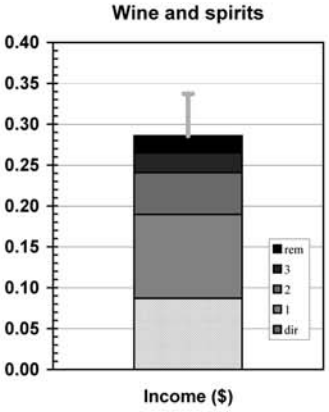

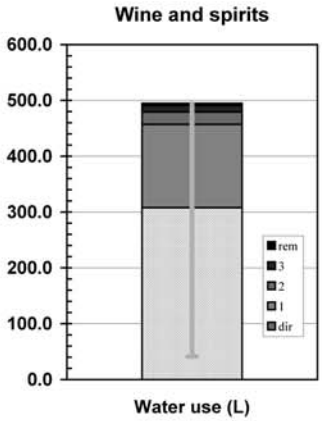

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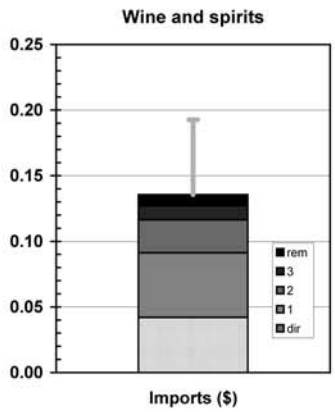

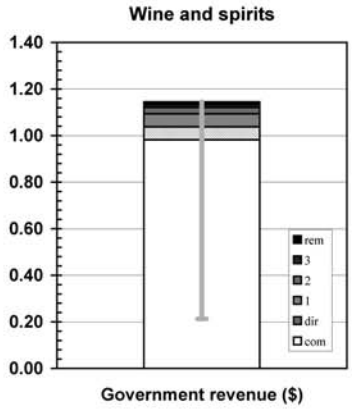

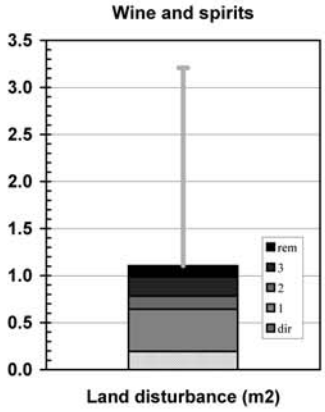

National Accounts extracts			
Receipts: GNT(E) - commodities			
Private final consumption	$m 253.3	(0.10% of total)	($m 149.5 domestically produced)
Government final consumption	$m 0.0	(0.00% of total)	($m 0.0 domestically produced)
Gross fixed capital expenditure	$m 12.9	(0.01% of total)	($m 12.9 domestically produced)
Net changes in stocks	$m 60.3	(3.41% of total)	($m 59.5 domestically produced)
Sectoral GNE	**$m 326.4**	**(0.07% of GNE)**	**($m 221.9 domestically produced)**
Exports	$m 471.1	(0.57% of total)	($m 471.1 domestically produced)
Final demand	**$m 797.6**	**(0.15% of GNT)**	**($m 693.0 domestically produced)**
Costs: GNT(I) - industries			
Wages and salaries	$m 154.1	(0.09% of total)	
Gross operating surplus	$m 253.5	(0.13% of total)	
Taxes less subsidies	$m 99.0	(0.12% of total)	
Sectoral GDP*	**$m 506.6**	**(0.11% of GDP)**	
Imports	$m 74.3	(0.08% of total)	
Primary inputs	**$m 580.9**	**(0.11% of GNT)**	

* Sectoral gross value added + net taxes on products

TBL factors	in supplying industry		embodied in commodity GNT			
		(% of national)	direct	(% of national)	total	(% of national)
Gross operating surplus ($m)	$m 253.5	(0.13%)	$m 99.1	(0.05%)	$m 281.3	(0.15%)
Exports ($m)	$m 471.1	(0.57%)	$m 184.3	(0.22%)	$m 261.6	(0.31%)
Imports ($m)	$m 74.3	(0.08%)	$m 29.1	(0.03%)	$m 93.9	(0.10%)
Employment (e-y)	5,864 e-y	(0.08%)	2,293 e-y	(0.03%)	9,021 e-y	(0.13%)
Income ($m)*	$m 154.1	(0.09%)	$m 60.3	(0.04%)	$m 198.0	(0.12%)
Government revenue ($m)†	$m 779.3	(0.72%)	$m 719.0	(0.67%)	$m 793.4	(0.73%)
GHG emissions (kt CO_2-e)	126 kt	(0.02%)	49 kt	(0.01%)	608 kt	(0.12%)
Water use (ML)	545,159 ML	(2.60%)	213,232 ML	(1.02%)	342,800 ML	(1.64%)
Land disturbance (kha)	34 kha	(0.02%)	13 kha	(0.01%)	77 kha	(0.05%)
Primary energy (TJ)	1,827 TJ	(0.05%)	715 TJ	(0.02%)	4,893 TJ	(0.13%)

*excludes income tax † includes net commodity taxes on final demand and income tax

TBL multipliers - commodities	per $ of GNE/GNT*		Nation-wide average
	direct	total	total
Gross operating surplus ($)	0.14	0.41	0.38
Exports ($)	0.27	0.38	0.16
Imports ($)	0.04	0.14	0.19
Employment (min)	0.41	1.62	1.75
Income ($)	0.09	0.29	0.34
Government revenue ($)	1.04	1.14	0.21
GHG emissions (kg CO_2-e)	0.07	0.88	1.02
Water use (L)	307.68	494.63	41.32
Land disturbance (m^2)	0.19	1.11	3.21
Primary energy (MJ)	1.03	7.06	7.65

*refers to GNE/GNT produced in the actual year, excludes decreases in stocks

Structural Paths (intensities - commodities)

Gross operating surplus ($/$)			Employment (min/$)			GHG emissions (kg CO_2-e/$)		
Ws	0.143	(0; 35.%)	Ws	0.413	(0; 25.%)	Vf Ws	0.117	(1; 13.%)
Vf Ws	0.0603	(1; 15.%)	Vf Ws	0.299	(1; 18.%)	Ws	0.0711	(0; 8.1%)
Gp Ws	0.0128	(1; 3.2%)	Ho Ws	0.0675	(1; 4.2%)	Fr Vf Ws	0.0698	(2; 8.%)
St Ws	0.00844	(1; 2.1%)	Pa Ws	0.0469	(1; 2.9%)	El Ws	0.0655	(1; 7.5%)
Pa Ws	0.00692	(1; 1.7%)	Gp Ws	0.0447	(1; 2.7%)	Ri Ws	0.0343	(1; 3.9%)
Ho Ws	0.00538	(1; 1.3%)	Wt Ws	0.0327	(1; 2.%)	Gp Ws	0.0249	(1; 2.8%)
Rd Ws	0.00495	(1; 1.2%)	Rd Ws	0.0291	(1; 1.8%)	El Gp Ws	0.0151	(2; 1.7%)
Wt Ws	0.00455	(1; 1.1%)	Wh Ws	0.0224	(1; 1.4%)	El Vf Ws	0.015	(2; 1.7%)
Wh Ws	0.00454	(1; 1.1%)	Ri Ws	0.0165	(1; 1.%)	Pa Ws	0.0139	(1; 1.6%)
Ms Ws	0.00347	(1; 0.86%)	Ms Ws	0.0156	(1; 0.96%)	Gd Ws	0.0139	(1; 1.6%)
Ri Ws	0.00335	(1; 0.82%)	Bs Ws	0.0146	(1; 0.9%)	Bc Mp Ho Ws	0.0134	(3; 1.5%)
El Ws	0.00265	(1; 0.65%)	St Ws	0.0138	(1; 0.85%)	Sw Pp Pa Ws	0.0117	(3; 1.3%)
Ts Ws	0.00248	(1; 0.61%)	Sh Ws	0.0123	(1; 0.76%)	Pp Pa Ws	0.0114	(2; 1.3%)
Sh Ws	0.00206	(1; 0.51%)	Cg Vf Ws	0.0113	(2; 0.69%)	Wh Ws	0.00957	(1; 1.1%)
Bk Ws	0.00189	(1; 0.47%)	Ts Ws	0.0112	(1; 0.69%)	El Pa Ws	0.0093	(2; 1.1%)
Pp Pa Ws	0.00185	(2; 0.46%)	Wt Vf Ws	0.00911	(2; 0.56%)	El Ho Ws	0.00883	(2; 1.%)
Cg Vf Ws	0.00171	(2; 0.42%)	Os Ws	0.00812	(1; 0.5%)	Rd Ws	0.00786	(1; 0.9%)

Exports ($/$)			Income ($/$)			Water use (L/$)		
Ws	0.266	(0; 70.%)	Ws	0.0869	(0; 30.%)	Ws	307.7	(0; 62.%)
Vf Ws	0.0182	(1; 4.8%)	Vf Ws	0.0246	(1; 8.6%)	Ri Ws	68.7	(1; 14.%)
Wh Ws	0.00583	(1; 1.5%)	Pa Ws	0.0108	(1; 3.8%)	Vf Ws	62.4	(1; 13.%)
Ho Ws	0.00375	(1; 0.99%)	Ho Ws	0.00985	(1; 3.4%)	Sc Cg Vf Ws	6.47	(3; 1.3%)
Wt Ws	0.00372	(1; 0.99%)	Gp Ws	0.00835	(1; 2.9%)	Wh Ws	2.32	(1; 0.47%)
Cg Vf Ws	0.00302	(2; 0.8%)	Wt Ws	0.00703	(1; 2.5%)	Ws Ho Ws	0.492	(2; 0.099%)
Gp Ws	0.00299	(1; 0.79%)	Rd Ws	0.005	(1; 1.8%)	Wa Vf Ws	0.375	(2; 0.076%)
Pa Ws	0.00282	(1; 0.75%)	Ms Ws	0.00362	(1; 1.3%)	El Ws	0.362	(1; 0.073%)
St Ws	0.00209	(1; 0.55%)	St Ws	0.00352	(1; 1.2%)	Bc Mp Ho Ws	0.353	(3; 0.071%)
Rd Ws	0.00172	(1; 0.46%)	Ts Ws	0.00262	(1; 0.92%)	Su Fd Ws	0.33	(2; 0.067%)
Wt Vf Ws	0.00103	(2; 0.27%)	Sh Ws	0.00244	(1; 0.85%)	Dc Dp Ws	0.31	(2; 0.063%)
Ch Vf Ws	0.000838	(2; 0.22%)	Os Ws	0.00228	(1; 0.8%)	Dc Dp Ho Ws	0.293	(3; 0.059%)
Rf Ws	0.000774	(1; 0.21%)	Wt Vf Ws	0.00196	(2; 0.68%)	Wa Ws	0.289	(1; 0.058%)
At Ws	0.000766	(1; 0.2%)	Cg Vf Ws	0.00194	(2; 0.68%)	Pp Pa Ws	0.285	(2; 0.058%)
Fd Ws	0.000749	(1; 0.2%)	Bk Ws	0.00185	(1; 0.65%)	Pa Ws	0.27	(1; 0.055%)
Bl El Ws	0.00064	(2; 0.17%)	Bs Ws	0.00179	(1; 0.63%)	Ri Fc Ho Ws	0.227	(3; 0.046%)
Ms Ws	0.000538	(1; 0.14%)	Gd Ws	0.00153	(1; 0.54%)	Vf Ho Ws	0.186	(2; 0.038%)

Imports ($/$)			Government revenue ($/$)			Land disturbance (m^2/$)		
Ws	0.042	(0; 31.%)	Ws	0.0559	(0; 34.%)	Wh Ws	0.337	(1; 31.%)
Vf Ws	0.0149	(1; 11.%)	Vf Ws	0.0151	(1; 9.2%)	Ws	0.193	(0; 17.%)
Pa Ws	0.0135	(1; 10.%)	Pa Ws	0.00567	(1; 3.5%)	Bc Mp Ho Ws	0.0974	(3; 8.8%)
Gp Ws	0.00393	(1; 2.9%)	Ho Ws	0.00518	(1; 3.2%)	Vf Ws	0.0589	(1; 5.3%)
Ho Ws	0.0025	(1; 1.8%)	Gp Ws	0.00403	(1; 2.5%)	Ri Ws	0.0346	(1; 3.1%)
Pp Pa Ws	0.00175	(2; 1.3%)	Rd Ws	0.00355	(1; 2.2%)	Fr Vf Ws	0.0224	(2; 2.%)
Fo Vf Ws	0.00163	(2; 1.2%)	Wt Ws	0.00328	(1; 2.%)	Wh Vf Ws	0.018	(2; 1.6%)
Sh Ws	0.00142	(1; 1.1%)	St Ws	0.00188	(1; 1.1%)	Wo Mp Ho Ws	0.011	(3; 0.99%)
Rd Ws	0.00126	(1; 0.93%)	Ms Ws	0.00172	(1; 1.1%)	Bc Mp Ws	0.00992	(2; 0.9%)
Ac Vf Ws	0.00111	(2; 0.82%)	Ts Ws	0.00129	(1; 0.79%)	Sw Pp Pa Ws	0.00918	(3; 0.83%)
Wt Ws	0.00106	(1; 0.78%)	Sh Ws	0.00108	(1; 0.66%)	Sc Cg Vf Ws	0.0085	(3; 0.77%)
Pl Ws	0.00104	(1; 0.77%)	Os Ws	0.00106	(1; 0.65%)	Ba Bm Ho Ws	0.00795	(3; 0.72%)
Ch Vf Ws	0.000839	(2; 0.62%)	Bk Ws	0.00102	(1; 0.63%)	Ba Bm Ws	0.00724	(2; 0.65%)
Ms Ws	0.00079	(1; 0.58%)	Cg Vf Ws	0.00102	(2; 0.62%)	Bc Mp Fd Ws	0.00592	(3; 0.54%)
St Ws	0.000764	(1; 0.56%)	In Ws	0.00102	(1; 0.62%)	Wo Tx Pa Ws	0.00572	(3; 0.52%)
Ts Ws	0.000713	(1; 0.53%)	Wt Vf Ws	0.000914	(2; 0.56%)	Bc Mp Ho Vf W	0.00345	(4; 0.31%)
Wh Ws	0.000522	(1; 0.39%)	Rd Vf Ws	0.000768	(2; 0.47%)	Bc Mp Ch Vf W	0.00286	(4; 0.26%)

Linkages (average = 1)

	Value	C.o.V.
Upstream	1.442 ±0.024	(±1.7%)
Downstream	0.966 ±0.045	(±4.6%)