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THE IMPACT OF BIOFUEL PRODUCTION ON THE WESTERN AUSTRALIAN LIVESTOCK INDUSTRY

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TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

The Western Australian biofuels industry is in its infancy. There is currently only one small commercial biodiesel manufacturer in the State but there have been several announcements of new biofuel projects in 2006 that will be commercialised by 2010.

The projected growth of a new biofuels industry in Western Australia (WA), will create greater competition with other industries that rely on grain as an input in their enterprises. Intensive livestock industries such as beef cattle lot feeding, pig rearing, fattening lambs, growing poultry for meat and eggs and feeding dairy cows depend on a consistent supply of high quality whole or compound grain products and biofuels will create additional competition for these inputs.

WA is the largest grain producer and most reliable and consistent marketer of grain in Australia. These conditions have provided a competitive advantage for Western Australian grain growers and livestock producers alike to enjoy continued growth in their respective businesses. This report identifies the opportunities and impacts of an emerging biofuels industry on the livestock feeding sectors in the State. These include:

- WA produces 12.2 million tonnes of total grains per annum based on a five year average which represents 32 per cent of national grain production.
- In WA, there is a large grain surplus particularly wheat, which allows opportunities such as the expansion of a biofuels industry. However the availability of high energy grains is currently restricted and a new industry such as biofuels will increase competition with the livestock industry to purchase this type of grain.
- Western Australia's livestock industry is small compared to other States in Australia. In total, all livestock sectors combined in WA utilise 0.6 million tonnes of feed grain for both energy and protein inputs in rations compared to 7.48 million tonnes in the Eastern States; Victoria (2.25 million tonnes), New South Wales (2.68 million tonnes) and Queensland (2.55 million tonnes) (Table 10).
- The demand from a potential ethanol industry would create significant competition for low quality wheat on the domestic market in the absence of industrial wheat.
- Western Australia's current potential ethanol projects could deliver 740 million litres of ethanol per annum utilising 2 million tonnes of wheat.
- This volume of ethanol would produce 587 000 tonnes of DDG potentially available for livestock compared to current potential inclusion in rations of 57 000 tonnes. This would mean that there would be some 525 000 tonnes surplus of DDG surplus to requirements for livestock.
- Western Australia's biodiesel projects are currently planned at approximately 200 million litres of biodiesel per annum.
- If all of the canola crop was used for biodiesel, there would be over 275 000 tonnes of canola meal surplus to domestic livestock requirements.
- It is unlikely that all the projected biodiesel plants will go ahead in WA due to the shortage of feedstocks, unless the biodiesel manufacturers could rely on lower priced imported palm oil.

Therefore WA has a strong surplus of food quality wheat and some capacity to produce ethanol from lower quality wheat although the availability varies each year. This situation would improve significantly if new industrial wheats were bred and commercially available. There is not sufficient capacity to supply the State's total demand for biodiesel from canola and other local feedstocks such as tallow and used cooking oil which highlights the current need for an industrial oilseed.

In summary, there will be a significant surplus of co-products from the biofuels industry which will be readily and cheaply available for livestock feed. The supply of protein from dry distillers grains (DDG) will mainly benefit the ruminant livestock industry, because the variability of the amino acid profile makes it unsuitable currently as a feed source for monogastrics. However, researchers in the United States have started trialling DDG in monogastric diets, which if successful, could increase the market for DDG in WA in the future. There could also be a large surplus of canola meal which would also be a cheap protein source for the livestock industry in WA however there are limitations to inclusion rates in rations.

1. INTRODUCTION

The Western Australian Government is actively investigating alternative, renewable energy sources for both the stationary energy and transport sectors. A State Government Biofuels Taskforce was established in January 2006 to determine the opportunities and impediments in the biofuels industry in WA. The Taskforce comprised of eight State Departments members and four parliamentarians, and had an across Government and industry approach. The Taskforce reported to the Minister for Agriculture and Food in April 2007 with recommendations on appropriate strategies and policies for the future development of the biofuels industry in WA. The Minister released the Taskforce's report for public comment which closed on 15 July 2007.

This report focuses on the potential impacts of an emerging biofuels industry in WA on the livestock industry. There has been considerable research and discussions on this topic to date but the debate is primarily Eastern States focused. This report concentrates solely on WA and discusses the opportunities and threats of development of the biofuels industry on the different livestock sectors in the State.

2. OVERVIEW OF WESTERN AUSTRALIAN LIVESTOCK INDUSTRY

The Western Australian livestock industry consists of the major sectors including pigs, sheep, beef and milk cattle, poultry and goats. Each livestock sector is discussed below.

The pig population has been volatile over the past eight years from 1997 to 2005. The pig herd peaked at 361 000 in 2002 before declining to 285 000 in 2005. Sheep numbers fell from 27.8 million in 1997 to a low of 23.1 million in 2001 and 2003, before gradually improving to 26.2 million in 2005. The relatively poor seasons over the past decade and the fall of the pastoral wool industry, decreased sheep numbers in the early 2000s. In comparison, the beef cattle population has been relatively stable at around 1.8-2.0 million over the same period. Chicken numbers have increased significantly over the past five years increasing nearly 1.5 million from 6.92 million in 2001 to 8.39 million in 2005. Dairy cattle numbers have increased from 126 000 in 2001 to 135 000 in 2005. WA also has a reasonable goat herd and the majority are located in the northern rangeland areas which support 800 000 to 900 000 domesticated and feral goats.

Note that goat numbers are not quoted in Table 1 below because the Australian Bureau of Statistics (ABS) does not report goat data.

Table 1. Livestock population movements

	Pigs (000s)	Sheep (millions)	Cattle (millions)	Chickens (millions)	Dairy (000s)
1997	297	27.8	1.79	N/A	N/A
2001	286	23.1	2.00	6.92	126
2002	361	23.1	1.98	6.97	124
2003	309	23.9	1.82	7.77	130
2004	291	25.1	1.96	8.18	133
2005	285	26.2	2.05	8.39	135

Source: ABS, DAFWA, 2006.

The geographic location of the different livestock sectors varies. Chickens are mainly located in the metropolitan areas and pigs are located in the Midlands and Great Southern regions (Table 2). There are also several chicken producers in the Lower Great Southern region of WA. In comparison, sheep are located generally in the southern regions and cattle are spread between the south and north of the State. Dairy cattle are found solely in the South West region.

Table 2. Distribution of Western Australian livestock at June 2005 ('000s)

	Pigs	Sheep	Cattle
Perth	10.4	65.1	26.6
South West	28.2	1279.5	409.8
Lower Great Southern	54.3	6267.1	230.5
Upper Great Southern	40.2	6253.7	96.5
Midlands	115.9	6722.2	188.1
South Eastern	4.3	2198.8	175.6
Central	13.2	2749.1	216.7
Pilbara	0	56.8	265.1
Kimberley	0	0	402.1
TOTAL	**266.5**	**25592.3**	**2010.9**

Source: ABS, 2006.

From a biofuels perspective, if the majority of biofuel plants are to be potentially located in the metropolitan areas, this could mainly impact the monogastrics industries. This is because these sectors would compete for the grain. There will also be a large supply of by-products such as meal and DDG which will be very accessible and a cheap protein source. Stockfeed manufacturing companies are located in the metropolitan area so they will benefit from the by-products of biofuel production, however only relatively small amounts of this protein source can be used in ration formulations.

From a demand of grain perspective, sheep for live export and meat, pigs and poultry are the most intensive livestock sectors that utilise feed grain in WA. The beef cattle industry is the lowest consumer of feed grain (Table 3). Therefore sheep, pigs, poultry and dairy cattle will be impacted more from a biofuels industry in WA compared to beef cattle. This depends also on the availability of by-products for the various species.

Table 3. Livestock numbers (June 2005) ('000s) and feed consumption in WA ('000 tonnes)

	Cattle	Sheep	Pigs	Goats	Poultry	Dairy
Livestock numbers	2,011	25,592	267	30*	8,393	135
Feed grain consumption	111	150	162	neg#	154	72

* Agricultural areas.
\# Number of goats fed is negligible.

Source: ABS, Stockfeed Manufacturers Association of WA, DAFWA, 2006.

Feeding livestock can be segregated into two main categories; intensive and extensive feeding. Intensive industries such as beef and dairy cattle lot feeding, pig rearing, fattening lambs and growing poultry for meat and eggs depend on a consistent supply of high quality whole grain or compound grain products. Extensive livestock enterprises also use feed grains, such as beef cattle and sheep pastoralists but grain consumption is not as consistent and is more opportunistic particularly in times of drought.

Today, WA also has a large number of domesticated goats but only a very small percentage would be fed grain. Goat rations are similar to sheep.

Each livestock sector and its reliance on feed grain are discussed in more detail below.

Beef cattle

The beef industry in WA integrates pastoral grazing with beef lot feeding. This has been achieved by the Western Australian beef industry developing several supply chains where pastoral producers are transferring weaners from the north into the agricultural regions, particularly the northern agricultural region, to ensure that young animals meet the export meat quality standards.

One of the major issues for the feed lotting industry in WA is that there are a low number of cattle that are lot fed. On average only 16 per cent of Western Australian cattle are lot fed compared to an average of 29 per cent in other States in Australia. This could increase in the future as the export abattoir capacity in WA increases due to more beef being exported to the high value North East Asian markets. This will mean greater reliance on feed grain potentially in the future and greater competition with the biofuels industry although there will be increased availability of the biofuel by-products which are cheap protein sources. These protein sources only make up 20 per cent of a ration, with the remainder being predominantly grain. If feed grain supply is tightly contested then the benefits of a cheap protein source may not counteract the increased price of feed grain.

Table 4 demonstrates the effect on total ration cost of varying grain and protein source price. If a biofuels industry in WA increases average feed grain prices by $10 per tonne, there needs to be a $40 per tonne reduction in protein source prices to off set the higher grain price.

Table 4. Sensitivity analysis; cost of a feedlot ration ($/tonne), assuming 80 per cent grain and 20 per cent protein source

	Protein source ($/tonne)					
Grain price ($/tonne)	120	140	160	180	190	220
170	160	164	168	172	174	180
175	164	168	172	176	178	184
180	168	172	176	180	182	188
185	172	176	180	184	186	192
190	176	180	184	188	190	196
195	180	184	188	192	194	200

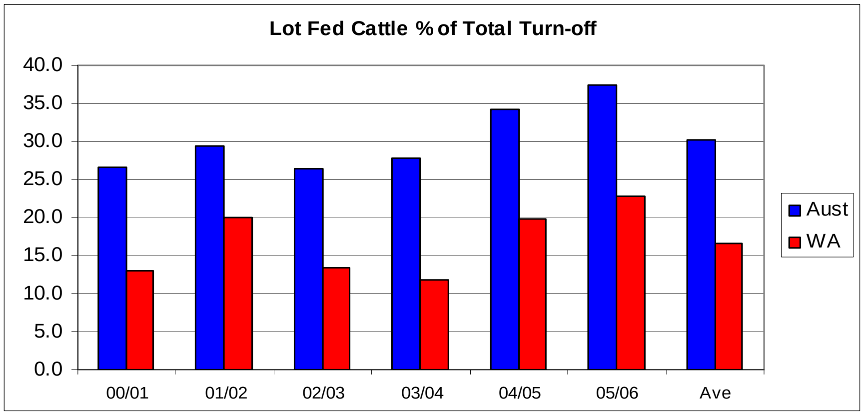

Figure 1. Lot fed cattle % of total turn-off in WA and Australia.

Source: Australian Bureau of Statistics (ABS), Australian Lot Feeders Association (ALFA), Department of Agriculture and Food Western Australia (DAFWA), 2006.

Unfortunately, over the past seven years, the utilisation of feedlots in WA has been very poor. The average capacity of feedlots over that period was 251 000 head while the average number on cattle lot feed was only 117 300 head. This represents an utilisation rate of only 47 per cent compared to an Australia wide rate of 77 per cent. Underutilised infra-structure has been undermining the profit in the supply chain.

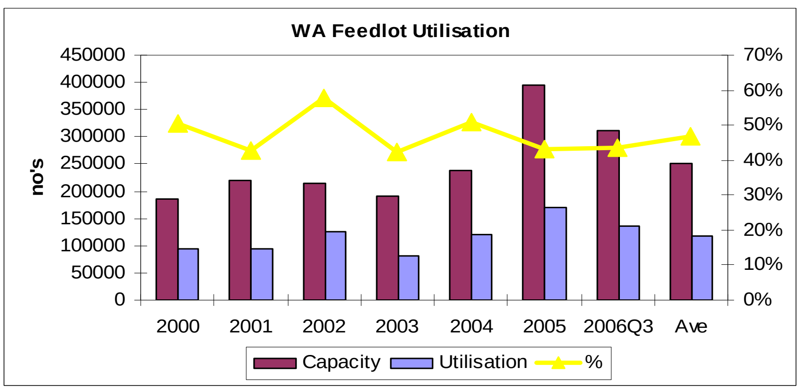

Figure 2. Western Australian cattle feedlot utilisation (numbers and %).

Source: ABS, ALFA, DAFWA, 2006.

Dairy cattle

The dairy industry in WA is relatively small compared to the other States. In 2000, the dairy industry across Australia was deregulated and many of the particularly smaller dairy farmers closed down. In WA, the dairy herd has gradually improved since the deregulation to 135 000 head in 2005 and most are now very large producers with contracts with the major milk companies such as Fontera and National Foods. WA also exports live dairy cattle to China and Turkey.

Sheep

Although sheep numbers declined in the early 2000s, particularly in the rangelands, southern rangelands sheep producers have been feeding sheep for high quality meat exports. Meat and Livestock Australia (MLA) has also provided assistance with this market sector by helping develop supply chains for sheep meats in the southern rangelands of WA. A national MLA survey in August 2005 suggested that the percentages of lambs expected to be sold out of a feedlot was 15.8 and in WA there could be 9.2 per cent. However in the longer term, meat sheep in the pastoral regions are likely to be overtaken by the various exotic breeds which will eventually find their way to live export markets. The Middle East in particular has a preference to these exotic breeds meat. With the introduction of a biofuels industry in WA, the lamb sector in the southern rangelands may benefit due to the increase of by-products; canola meal and dry distillers grains which will be a cheap and reliable protein source for rations. However the cost of transportation of DDG will have to be taken into account considering its lower bulk density and the distance from refinery to lamb feedlots.

Pigs and poultry

Most pigs and chickens are fed in confined sheds with 100 per cent customised rations. Chickens in WA are solely for the domestic market. While most Western Australian pigs are slaughtered for the domestic market, an estimated 25 per cent of pork production is exported, mainly to the Singapore market. If competition for feed grain forces prices higher, then the benefits of readily available protein source in DDG may not offset total feed input costs.

Western Australian livestock exports

Access to affordable grain in WA underpins the capacity of the livestock industry to remain reliable suppliers to global meat markets. Highly managed feeding regimes allow Western Australian cattle, dairy, sheep, pig, goat and chicken producers to distinguish themselves from the low cost producers in South America or other countries where labour is very cheap. Australia has world renowned food safety standards and traceability schemes such as the National Livestock Identification Scheme (NLIS).

The professional feeding regimes and a growing appetite for lot feeding livestock in WA has been beneficial for meat exports to major North Asian markets. Western Australia's beef, lamb and pork export markets have grown substantially over the past five years. As shown in Figure 3, these feeding regimes have driven up export values for beef and pork through to 2004/05 and lamb to 2005/06.

The Western Australian beef industry has also benefited enormously from the Bovine Spongiform Encephalopathy (BSE) outbreaks in North America. This has given Western Australian exporters access to the high value North Asian markets. A lack of consistency and competitiveness in the WA grain fed livestock sectors however could well undermine customer loyalty and confidence in both domestic and export markets as customers will insist the product must be available all year round and of consistent high quality.

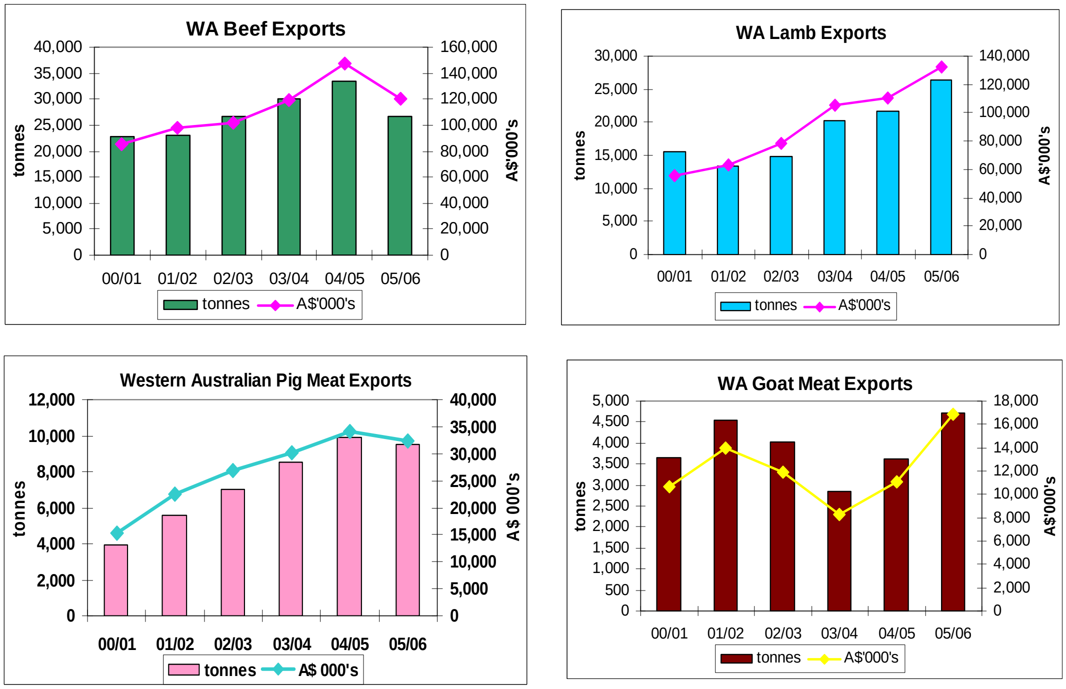

Figure 3. Western Australian livestock exports, 2000/01-2005/06 (tonnes and $'000).

Source: ABS, DAFWA, 2006.

3. OVERVIEW OF SUPPLY AND DEMAND OF THE WESTERN AUSTRALIAN GRAIN INDUSTRY

WA is a large producer of grain and is well suited to biofuels production. On a five year average, WA produces 12.2 million tonnes of grain per annum. Wheat is the major grain produced in WA, comprising approximately 8 million tonnes annually. There are currently eight wheat grade classifications in WA. The current classifications are: Australian Hard Premium Choice (AHP), Australian Hard (AH), Australian Premium White (APW), Australian Standard White (ASW), Australian Standard White Noodle (ASWN), Australian Soft (Soft), Australian General Purpose (AGP) and Feed. Each grade is separated by protein content and other quality characteristics, such as hardness, milling quality and dough strength (to just name a few). The grades most suitable for ethanol production are APW, ASW, AGP and Feed wheat however ethanol producers will be targeting AGP and feed grade wheat (Menegola pers. comm. 2007). Of the total wheat production, there are 0.9 million tonnes of the two grades produced on average and a significant amount of AGP is blended with other grades for export. The consumption of 1.5 million tonne per year of low quality wheat for the ethanol industry would create significant price pressure of feed wheat prices.

Barley is the second largest crop at 2.3 million tonnes per annum based on a five year average. The breakdown of barley production in WA is approximately 60 per cent feed barley and 40 per cent malting barley. This is the equivalent of 1.4 million tonnes of feed barley and 0.9 million tonnes of malting barley. There are ample supplies of both feed and malting barley for the domestic market.

Other crops include lupins, oats and canola while field peas, chickpeas, faba beans and triticale represent less than one per cent of production. All of these grains can be used in stockfeed rations whereas wheat, barley and canola would be the major sources for biofuel production.

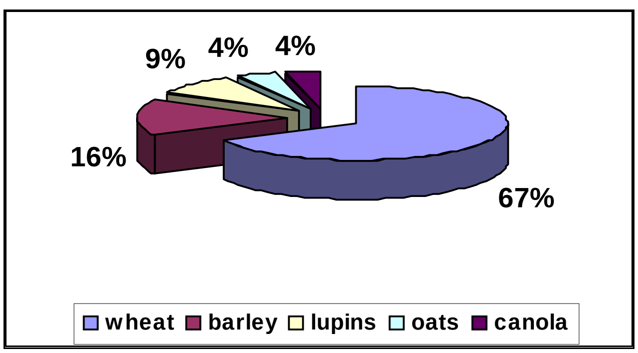

Figure 4. Average Western Australian grain production (%).

Source: ABS, DAFWA, 2006.

3.1 WESTERN AUSTRALIAN AVERAGE GRAIN USAGE AND OPPORTUNITIES

WA is a large producer of grain but has a small domestic market for both food and feed consumption (Table 5).

Table 5. Five year average Western Australian domestic grain demand, 2000/01-2005/06 ('000 tonnes)

Domestic demand	Wheat	Barley	Lupins	Oats	Canola
Food	200	250	-	90	50
Feed	220	200	350	380	-
Seed	330	64	65	20	2
Total domestic	**750**	**514**	**415**	**490**	**52**

Source: DAFWA, 2006.

Table 5 shows domestic feed demand for grain based on a five year average which equates to 1.15 million tonnes compared to a five year average for total grain production of 12.18 million tonnes. Feed grain consumption for livestock industry in WA therefore accounts for 9.4 per cent of the total grain market suggesting there is ample opportunity for further feed grain if required by livestock feeders. However some further analysis is required so as to breakdown total grain production into feed grain production and then make the comparison with feed grain consumption (refer to Section 3.2).

Table 6 illustrates the breakdown of the lower wheat grade production in WA. Examining each grade indicates that feed wheat production of 75 000 tonnes is less than domestic feed demand of 220 000 tonnes of wheat, based on a five year average. The production of GP wheat of 900 000 tonnes exceeds domestic feed demand. The potential addition of 2 million tonnes of domestic demand from an ethanol industry would consume all AGP, feed and some ASW wheat if current production trends continue.

Table 6. Five year average Western Australian ASW, AGP and feed wheat production, 2002/03-2006/07 ('000 tonnes)

	Average	Range
ASW	1,700	150-4000
AGP	900	500-1200
Feed	75	5- 400
Total	**2,675**	

Source: DAFWA, 2006.

Table 7. Five year average Western Australian feed barley production, 2002/03-2006/07 ('000 tonnes)

	Average	Range
Feed barley	1,300	900-2000

Source: DAFWA, 2006.

Table 7 shows the five year average feed barley production is well in excess of domestic feed consumption of 200 000 tonnes; indicating that there is room for some substitution of feed wheat for feed barley if domestic wheat prices are higher as a result of a biofuels industry.

Figure 5 demonstrate the uses of each Western Australian grain.

Figure 5. Western Australian Grain supply and demand (%).
Source: DAFWA, 2006.

Therefore, in each of the major grain types, there is a large exportable surplus which is currently exported as commodities but there is the opportunity to value-add this grain locally and process the grain to products such as biofuels.

3.2 WESTERN AUSTRALIAN FEED GRAIN DEMAND BY THE LIVESTOCK INDUSTRY

Australian Bureau of Agricultural Research and Economics (ABARE) has assessed the demand for grains dedicated to feeding each livestock sector and the relevant usage by grain type, including compound feeds and estimates for on-farm supplementation. Table 8 shows the **forecast** trend.

Table 8. Western Australian *forecast* trends in feed grain demand, 2007 ('000 tonnes)

	Wheat	Barley	Lupins	Oats	Peas	Triticale	Total
Beef	59	52	0	0	0	0	111
Broiler	65	10.5	15.7	6.3	5.2	6.3	109
Dairy	4.6	9.3	13.9	0	0	13.9	41.7
Layer	31.4	3.1	6.3	2.1	2.1	0	45
Pig	52.3	52.3	40.8	2.1	2.1	12.5	162.1
Sheep	5.4	64.5	64.5	16.1	0	0	150.5
Total	218	192	141	27	9	33	620

*Source: ABS, *Yates and Coombs, 2003.*

Table 8 differs to Table 5 because Table 5 is an average over a five year period from 2000/01 to 2005/06 which incorporates a drought so feeding livestock increased significantly in the drought year of 2002/03.

Table 9 compares the ten year average total winter and summer crop production in each State and the estimated percentage of total feedstock demand in each major grain producing State in Australia.

Table 9. Ten year average feed grain demand by State as percentage of total production, 1995/96-2005/06 (million tonnes)

	NSW	VIC	QLD	WA	SA	Total
Total grain production (Mt)	8.16	4.16	3.05	11.39	5.47	31.85
Demand for feed grain (Mt)*	2.6	1.7	2.2	0.62	0.97	11.88
Percentage	32%	41%	72%	5.4%	17.7%	18%

*Source: ABS, *Yates and Coombs (2007 estimates) 2003, DAFWA, 2006.*

Table 10. Five year average feed grain production and demand per State, 2002/03-2006/07 (million tonnes)

	NSW	VIC	QLD	WA	SA	Total
Feed grain prod'n incl. ASW	4.08	1.55	1.55	4.27	2.62	14.06
Feed grain prod'n excl. ASW	3.47	1.09	1.52	2.79	1.70	10.57
Feed grain consumption	2.68	2.25	2.55	0.59	0.66	8.74
% of prod'n incl. ASW	66%	145%	165%	14%	25%	62%
% of prod'n excl. ASW	77%	208%	168%	21%	39%	83%

Source: ABARE 2007, DAFWA, 2007.

Both tables above (Tables 9 and 10) indicate that Victoria is the greatest allocation of feed grain consumed as a percentage of production followed by Queensland, New South Wales (NSW), South Australia (SA and then WA). In Table 9, total grain production per State was used for the calculations whereas in Table 10, feed grain production data was used. There are two different percentages because the first calculation includes ASW wheat production whereas the second calculation excludes ASW production. Queensland is a small producer of ASW wheat so when it is included in the calculations, it has the greatest deficit due to its high feed grain consumption levels. However, when ASW is excluded, Victoria has the greatest deficit as it is a high feed grain consumer and also produces approximately 25 per cent of its wheat as ASW. In both scenarios, there is insufficient feed grain production in Queensland and Victoria to supply the livestock industry and grain must be transported in from NSW and SA to meet the surplus demand for feed grain.

The data confirms the low utilisation of grain for stock feeding in WA in relation to total production and also the dominance of WA as a grain producer. Queensland and Victoria in particular demonstrate a very low propensity to meet their future needs for feed grains while WA and SA have a substantial excess. This implies that WA and SA are likely to be affected less by the growing demand for biofuels compared to the other States. In WA, the utilisation rate for feed grain by the livestock industry is 14 21 per cent depending on whether ASW wheat is included in the rations. This compared to 9.4 per cent utilisation if all grain was included in the calculations.

Furthermore, there is the opportunity for an industrial wheat to be developed which could be economically grown by producers to meet demand from a wheat based ethanol industry which could also benefit the livestock industry. This wheat type could be a widely grown alternative to milling grade wheat and there could also be opportunities for grain producers to transport feed wheat either overseas or to the Eastern States, or to supply new local industries such as biofuels.

3.3 IMPACT OF BIOFUELS PRODUCTION ON THE LIVESTOCK INDUSTRY IN WA

Biofuels are generated from biological sources including crops such as grain and sugar, cellulosic materials (including grasses and trees) and municipal solid wastes. There are currently two types of biofuels available in Australia; ethanol and biodiesel. The conversion of organic material into biofuels also produces by-products which are very useful for the livestock industry. In the case of ethanol derived from grains, the direct by-product is distillers grain, while canola meal is the by-product of biodiesel production from canola oil. Distillers grains and canola meal are two important livestock feed supplements.

4. ETHANOL AND DISTILLERS GRAINS

4.1 ETHANOL MARKET IN WA

Ethanol is not commercially available currently in WA but is likely to be available by mid 2009. Ethanol is likely to be available in Perth and the major regional towns as E10; a 10 per cent ethanol blend with petrol.

The average Western Australian petrol consumption is 1.9 billion litres per annum. If an E10 blend was introduced, 190 million litres of ethanol would be required. If the ethanol was derived from wheat, it would require 510 000 tonnes of wheat or 50 per cent of the average AGP and feed grade wheat produced in Western Australian to achieve the required blend.

Western Australia's current proposals of ethanol plants are as follows:

Confidential	200 million litres
Primary energy	160 million litres
Grainol	380 million litres
Total	740 million litres

This anticipated ethanol production will consume 2 million tonnes of wheat including all AGP and feed wheat and on average 1 million tonnes (or 60%) of ASW wheat.

A further analysis has been done to combine the ideal wheat grades for ethanol production in WA. Grades ideal for E10 production have a protein content of less than 10.5 per cent. Table 11 represents the quantity of wheat required to replace the average Western Australian petrol consumption with E10. At current fuel consumption levels there will be a demand for 11 per cent of Western Australia's current APW, ASW, AGP and Feed wheat production. Therefore, 90 per cent of the State's annual production of these grades will remain available for traditional market use. Although the projected ethanol production is much higher than the E10 level, it still leaves more than 70 per cent of the State's wheat for domestic and international consumption.

Table 11. Predicted consumption of low grade WA wheat for E10 and projected ethanol production

	Wheat production (million tonne)	Grain requirement if mandate E10	Projected ethanol usage from wheat supply
Total production	8.0	6%	25%
ASW AGP and feed wheat production	2.7	18%	71%

If ASW, AGP and Feed wheat grades were only used for ethanol production, then 36 per cent of the wheat crop could be utilised for the ethanol and livestock industries. This would be equivalent to 2.7 million tonnes. If the ethanol industry consumed 2 million tonnes, there would still be 0.7 million tonnes of higher energy wheat left for the livestock industry. According to stockfeeders in WA, there is currently between 0.2-0.22 million tonnes of wheat used by the livestock industry. Therefore theoretically, there could be 0.5 million tonnes of lower wheat grades available for exports or blends. However this is not a definitive quantity as there are some weather events issues each year that affect wheat quality significantly and consequently determine the amounts of each grade produced. In the past five years, total production of ASW, AGP and feed wheat has ranged from 1.4 million tonnes to 4.9 million tonnes, indicating the potential for shortfall, and the need for an industrial wheat.

If there is future development of industrial wheat varieties that are ideal for ethanol production, this could also service the livestock industry too. This would increase the supply of grain delivered into the feed grade segregation. The development of industrial grade wheat will reduce the significant competition between the existing livestock industry and the potential ethanol industry for the cheapest available feedstocks.

4.2 DRIED DISTILLERS GRAIN MARKET IN WA

Primary Energy ethanol plant will be 160 million litres and will utilise 400 000 tonnes of wheat. It will have the capacity to produce 128 000 tonnes of distillers grain. Primary Energy is planning on utilising its distillers grains for biogas to generate energy.

Grainol is looking at building two 190 million litre ethanol plants in WA. Each plant would utilise 500 000 tonnes of wheat each and produce 170 000 tonnes of DDG at each plant. Grainol potentially could produce a total of 340 000 tonnes of DDG.

Grainol are still undecided at this stage on how they are going to manage its DDG. It is considering the two options of marketing the DDG. The first is to the livestock industry both locally and/or export to the Asian markets. The second option is to use it for biogas for electricity.

There is another 200 million litre per year ethanol plant proposed which could produce 170 000 tonnes of DDG.

If all the proposed plants are completed there will be a total of 640 000 tonnes of DDG per year in WA.

4.3 OVERVIEW OF DISTILLERS GRAINS

Wet Distillers Grains and Dried Distillers Grains are the two most common versions of distillers grains consumed by the livestock industry:

- Wet Distillers Grains (WDG) contains primarily unfermented grain residues (protein, fibre, fat and up to 70 per cent moisture. WDG has a shelf life of four to five days and involves the transport of 70 per cent water by weight of total product. WDG transport is economically viable usually within a 200 km radius from the ethanol production facility. These facts are important as they affect both profitability and logistical issues.
- Dried Distillers Grains (DDG) is WDG that has been dried to 10-12 per cent moisture (Figure 6). DDG have an almost indefinite shelf life and may be sold and shipped to any market regardless of its vicinity to an ethanol plant. Drying is costly, as it requires the input of further energy.
- During the ethanol process, the conversion rate of wheat to ethanol and distillers grains is: one tonne of wheat produces 372 litres of ethanol and 457 kg WDG (70 per cent moisture content), or 295 kg of DDG when it is dried (10 per cent moisture content).

The nutrient composition of distillers grains, depends on the type, variety and quality of the grains used, as well as the efficiency of starch conversion and the processing technique. Colour and handling properties of DDG can also change substantially between manufacturing plants.

Table 12 illustrates the protein levels in DDG and other selected feed supplements. DDG has the second highest protein content and has a higher percentage protein content than the grain from which it originated.

Table 12. Average percentage of available protein in selected feed supplements

Feed	Unit	DDG	Wheat	Barley	Sorghum	Canola meal	Lupins
Protein content (range)	% DM	30-32	7.5-11.5			35-37	20-32
Protein content (average)	% DM	31.00	10.00	11.00	9.00	36.00	30.00

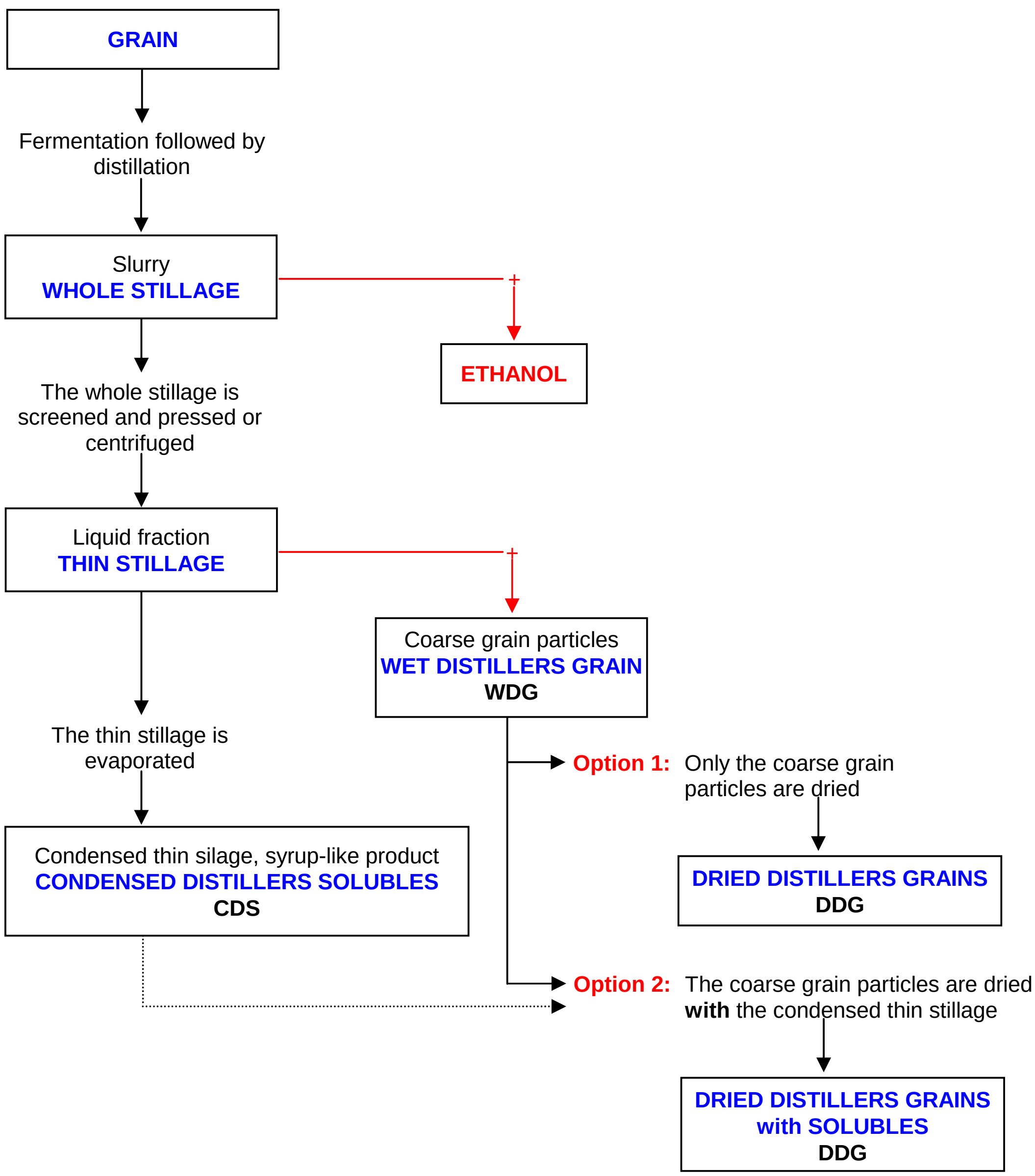

Figure 6. Distillers grains flowchart.

The chemical composition and amino acid profiles are illustrated in Table 13 for wheat and wheat DDG. Wheat DDG has higher amino acid concentrations compared to wheat. Therefore distillers grains can be a valuable source of protein for ruminants.

Table 13. Essential amino acids profile

	Wheat	Wheat DDG
Isoleucine (per cent)	0.363	1.165
Leucine (per cent)	0.719	2.257
Lysine (per cent)	0.321	0.679
Methionine (per cent)	0.178	0.568
Phenylalanine (per cent)	0.505	1.602
Threonine (per cent)	0.540	1.783
Trytophan (per cent)	0.163	0.283
Valine (per cent)	0.475	1.517

Source: International Distillers Grains Conference 2006, Minneapolis.

DDG is a valuable source of protein, and is also one of the cheapest sources of protein (Table 14).

Table 14. Average price of available protein from selected feed supplements

Feed	Unit	DDG	Wheat	Barley	Sorghum	Canola meal	Lupins
Price range	*$/t*	*120-130*	*184-238*			*280-400*	*160-300*
Average	*$/t*	*125*	*211*	*181*	*177*	*345*	*230*
Protein content (range)	% DM	31.00	12.00	11.00	9.00	36.00	30.00
Protein content (average)	**$/kg protein**	**0.40**	**1.76**	**1.65**	**1.97**	**0.96**	**0.77**

Source: University of Minnesota and the Department of Agriculture and Food, WA (DAFWA).

* The $120-130 per tonne for DDG is the estimated sale price at refinery gate Some ethanol projects have assumed a Free On Board (FOB) price of $175 per tonne. The price will vary depending on the protein and moisture content.

However, stock feeders purchase grain on energy basis - not protein concentration. Grain is fed to livestock primarily to provide energy, as opposed to protein. Table 15 shows DDG contains as much energy as the major grain types that are produced and utilised by the livestock industry.

Table 15. Average and range of available energy content* of feed supplements for each animal type, expressed in MJ/kg, as ME for ruminants, AME for poultry and DE for pigs

Feed	DDG[2]	Wheat[1,5]	Barley[1,5]	Oats[1]	Triticale[1,5]	Sorghum[1,5]	Canola meal[3]	Sweet lupins[4]
Sheep at maintenance		12.8-13.7	11.5-13.9	11.2-15.7	12.3-13.4	13.6-14.3		10.0-13.0
Average	15.00	13.25	12.70	13.45	12.85	13.95	12.20	11.50
Cattle and Dairy *ad libitum*		12.2-13.1	12.2-13.2	10.8-13.4	12.9-13.2	10.2-13.1		
Average	13.72	12.65	12.70	12.10	13.05	11.65	10.37	13.00
Pig DE	14.3-14.8	12.4-15.0	10.6-14.7	0	12.3-16.5	15.5-16.6		12.0-17.0
Average	14.60	13.70	12.65	n/a	13.05	14.45	13.00	14.50
Broiler AME	8.74-10.11	11.2-14.0	9.9-12.3	11.3-12.8	9.7-13.0	13.3-14.9		10.0-10.7
Average	9.45	12.60	11.10	12.05	11.35	14.10	8.36	10.35

* All values are based on 90% dry matter.

Source: [1]GRDC, [2]University of Minnesota, US, [3]Canola Council of Canada, [4]DAFWA, [5]Pork CRC.

DDG also appears to be the most economical source of feed energy (Table 16).

Table 16. Average price of available energy from selected feed supplements for various animal types

Feed	Unit	DDG	Wheat	Barley	Sorghum	Canola meal	Lupins
Price range	*$/t*	*120-130*	*184-238*			*280-400*	*160-300*
Average	*$/t*	*125*	*211*	*181*	*177*	*345*	*230*
Sheep at maintenance	**cent/MJ of ME**	**0.83**	**1.60**	**1.43**	**1.27**	**2.83**	**2.00**
Cattle and dairy *ad libitum*	**cent/MJ of ME**	**0.91**	**1.67**	**1.43**	**1.52**	**3.33**	**1.77**
Pig DE	**cent/MJ of DE**	**0.86**	**1.54**	**1.43**	**1.22**	**2.65**	**1.59**
Broiler AME	**cent/MJ of AME**	**1.32**	**1.68**	**1.63**	**1.26**	**4.13**	**2.22**

The energy in DDG is mainly in the form of protein, while starch is the source of energy in the grain. Protein as a source of energy is less efficient than starch (65%). When purchasing DDG, the high protein content needs to be considered. Excess protein in the diet increases animal energy requirement to degrade and excrete. Since feedstocks are digested with different efficiencies by the animal types (Table 16), there is a limit to the amount of DDG that can be fed to livestock (Table 17).

Table 17. Feeding value of DDG in livestock rations

Animal	Max % of DDG in rations
Pigs	
Nursery pigs	25%
Sows	20%
Poultry	
Broilers	10%
Chicken layers	15%
Turkeys	10%
Ruminants	
Dairy cattle	20%
Beef cattle	20%

Source: Dr Jerry Shurson, University of Minnesota's Department of Animal Science, 2006.

DDG can be a very useful feed source for livestock, especially beef, milk cattle and sheep however the product can be highly variable in quality, consistency and digestibility depending on how the DDG has been treated during the drying process. To ensure positive outcomes with DDG, stock feeders will need to closely analyse the DDG product to ensure that heat damage does not reduce digestibility.

University of Minnesota University data shows a wide range of lysine digestibility in DDG samples. It ranges from an average of 70 per cent to a low of 47 per cent for lysine digestibility. Due to this variability, these feed regimes would not be appropriate for poultry and pigs. Only small amounts of DDG could be used in pig and poultry rations due to the variability of amino acids in the product and it would only be included in rations when it is cheap. However, the US has just started trialling DDG in monogastric diets in 2007 which if successful, could provide future opportunities in WA for the monogastric sectors.

The current price of DDG, its protein and its energy content, makes DDG a suitable feed supplement for the sheep, feedlot beef and dairy sectors.

4.4 POTENTIAL IMPACT OF DISTILLERS GRAIN ON THE LIVESTOCK INDUSTRY IN WA

Based on the above inclusion calculations, total demand for DDG for both monogastrics and ruminants is 56 800 tonnes compared to a predicted potential supply of DDG of 152 000 tonnes if there was a 10 per cent mandate of ethanol in the State. Alternatively, there could be approximately 510 000 tonnes if all of Grainol's and a proposed new ethanol plants in WA are completed and reach full capacity. This would mean that there could be about 443 000 tonnes of DDG surplus that could be used either to produce electricity or exported as a feed grain for the livestock industry. If Primary Energy did not use its distillers grains for biogas to generate electricity, there would be a further 130 000 tonnes of surplus by-product. This would total 640 000 tonnes of DDG and there would be approximately 583 000 tonnes of surplus DDG available for the livestock industry.

5. BIODIESEL AND CANOLA MEAL

Biodiesel is an alternative fuel for diesel engines that can be made from straight vegetable oil, animal fats such as tallow (a by-product of the meat processing industry) and waste oils which are chemically reacted with an alcohol, usually methanol, to produce fatty methyl esters.

5.1 BIODIESEL MARKET IN WA

Biodiesel is currently commercially available in WA with Australian Renewable Fuels (AR Fuels) commencing production in July 2006. Gull Petroleum (Gull) also started retailing biodiesel at nine of its Western Australian fuel stations in April 2006. Gull has gradually increased the number and currently sells B20 at 30 sites – almost half its sites in Western Australia. The retail price of B20 at each of these sites is published on the FuelWatch website and Gull is currently pricing B20 at around four cents per litre cheaper than regular diesel at its sites that sell both fuel types. Gull has reported strong interest in its B20 blend with significant, and increasing, sales. As a result, Gull has stopped selling regular diesel at 21 of these sites. This shows that a significant number of Western Australian diesel users have been willing to use B20.

Western Australia's current biodiesel plants proposals include:

Gull Petroleum	40 million litres	Biodiesel supplied by Qld
Australian Renewable Fuels	45 million litres	Feedstocks: tallow, UCO, canola oil
Confidential	100 million litres	Feedstocks: imported palm oil
Total	**385 million litres**	

To determine the potential biodiesel market and its impact, some analysis on the diesel market is required. Annual consumption of diesel in WA is 3.2 billion litres per annum. To produce a B10 biodiesel blend, WA would require 323 million litres of biodiesel. This would require 1 077 000 tonnes of canola or a combination of other feedstocks such as tallow, used cooking oil (UCO) and imported palm oil.

5.2 OVERVIEW OF FEEDSTOCK TYPES FOR BIODIESEL PRODUCTION

The likely growth in production of feedstocks for biodiesel in the short to medium term future is assumed to be restricted to UCO and tallow because they are the cheapest feedstocks currently commercially available. For UCO and tallow, it has been assumed that production grows at the same rate as the State's population. For canola, the projections are based on assumptions about the area of land planted to the oilseed will increase by 0.3 per cent per annum and the growth in yields from 2005/06 to 2014/15 will be 1.5 per cent per annum. The projections are driven off recent levels of production in non-drought years, and take account of past growth in yields (Table 19). Note: the projections are driven off a base of average production from 2000/01 to 2005/06, excluding the drought year 2002-03. Production in 2005/06 was considerably higher than the average: hence despite assumed growth in yields and area planted, projected production is lower than 2005/06 levels: the projections represent production in 'average' years.

Suitable feedstocks for biodiesel production in WA include, in order of increasing cost; used cooking fats, tallow, palm oil (imported) and canola oil (Table 18). Local biodiesel users will use all of these feedstocks and the quantities will be used in descending order; as they become more expensive. It would be expected that the demand for domestic supplies of used cooking oil and tallow from a biodiesel industry would increase the price of these feedstocks for both the biodiesel industry and the livestock industry.

Table 18. Feedstocks and estimated costs of producing biodiesel (A$ per litre)

Feedstock	Estimated cost of production
Used cooking oil	A$0.35 per litre
Tallow ($950/t)	A$0.87 per litre
Canola ($1 200/t)	A$1.38 per litre

Source: Riverland Oilseeds and ARFuels, 2007.

Table 19. Projected feedstock production for biodiesel, 2005-06 to 2014-15 (‘000 tonnes)

Feedstock	2005-06	2009-10	2014-15
UCO[a]	5	5	6
Tallow[b]	36	37	39
Canola seed	630	525	574
– oil yield (%)	44	44	44
Canola oil equivalent	277	231	253
Total feedstock resource	**318**	**273**	**297**

[a] Used cooking oil.
[b] Fat and oil of meat processing.

Source: CIE calculations.

In Table 19, the canola oil content is 44 per cent which is based on the five year average from 2002/03 to 2006/07. Western Australian canola oil contents are now between 2.5 to 5 per cent higher than all other States in Australia.

Based on these projections, and given current yields of biodiesel, in 2014/15 WA would have sufficient locally grown feedstock to, in principle, support production of around 260 mL of biodiesel (Table 20).

Table 20. Potential production of biodiesel from local feedstock, 2005-06 to 2014-15

Biofuel and feedstock		2005-06	2009-10	2014-15
UCO	mL	4	5	5
Tallow	mL	32	33	35
Canola oil equivalent	mL	243	202	221
Total	**mL**	**279**	**240**	**261**

Note: Assumes biodiesel yields of 870 litres/tonne of UCO, 894 litres/tonne of tallow, and 873 litres/tonne of canola oil. Although the long run trend is generally upwards there is short term annual variation in crops hence the low figures for 2009-10.

Source: CIE calculations.

If all the biodiesel was produced from canola and the five year average of canola production in WA is 500 000 tonnes, the State could only supply 46 per cent of its theoretical B10 requirements from the current canola crop. A further 600 000 tonnes of canola would be required to achieve the State’s potential needs if biodiesel was mandated at 10 per cent and canola was the major feedstock used to produce B10. Unless there are new canola varieties or alternative oilseeds suited to the Eastern Wheatbelt or other new feedstocks such as trees (*Pongamia* and *Moringa* which have large pods with high oil contents) and/or algae, there is insufficient feedstock to supply the biodiesel market in WA currently. Imported palm oil would assist with the shortfall in feedstocks whilst new alternative feedstocks are developed.

5.3 OVERVIEW OF THE CANOLA MEAL FOR THE LIVESTOCK INDUSTRY

Used cooking oil and tallow are waste products that are mainly utilised currently by the livestock industry. Canola meal is the by-product from canola crushing that produces the canola oil used for making biodiesel (Figure 7). For each tonne of canola oil produced, there would be 650 kg canola meal produced. If large scale biodiesel plants that relied on canola as the main feedstock were built in WA, there could be large surpluses of canola meal.

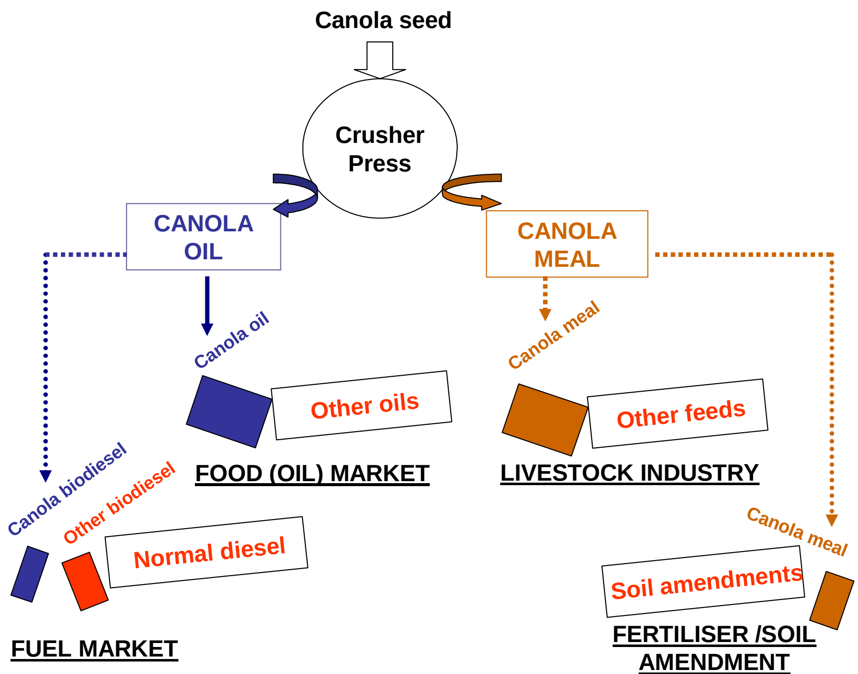

Figure 7. Canola seed flowchart.

Ingredients used by the stock feed manufacturing sector can be easily substituted, and thus feed processors tend to purchase competitively priced ingredients. Energy values are a function of protein level, residual oil content and available carbohydrates. Australia typically produces mid protein meals (36-38 per cent) which have a lower energy value. As a result, rations that substitute imported soybean meal with canola, sunflower or cottonseed meal must be balanced with a high-energy feedstuff such as stabilised tallow. The nutrient composition of canola meal relative to soybean meal is given in Table 21.

Another important source of stock feed can be harnessed from the processing of animals (tallow) and re-processed cooking oil. The conversion of these feedstocks to biodiesel undermines the availability of an important energy source especially for poultry and pigs.

The WA stockfeed manufacturing sector is concerned by the potential lack of the supply and use of tallow for animal feeding because of competition with the biodiesel manufacturers. The stockfeed industry has traditionally used lower grade tallow and reprocessed cooking oils. The conversion of these to biodiesel reduces a lower cost source of energy for pig and poultry feeding.

Table 21. Nutrient composition of canola meal relative to soybean meal

Component	Canola meal*		Soybean meal
	Canada[a]	Australia[bc]	US[de]
Moisture	10.0	11.0	12.0
Crude protein % (N x 6.25)	35.0	37.0	47.0
Rumen bypass (% of prot.)	35.0	-	(14.0)
Oil %	3.5	2.9	(3.0)
Linoleic acid %	0.6	0.58	(0.6)
Ash %	6.1		6.02
Sugar %	8.0		9.17
Starch %	5.2		5.46
Cellulose %	4.6		
Oligosaccharides	2.3		
Non-starch polygosaccharides %	16.1		
Soluble NSP %	1.4		
Insoluble NSP %	14.7		
Crude fibre %	12.0	11.9	5.40
Acid detergent fibre %	17.2	16.9	7.05
Neutral detergent fibre %	21.2	26.6	11.79
Total dietary fibre %	33.0		
Tannins %	1.5		
Sinapine %	1.0	1.5	Nil
Phytic acid %	4.0	(2.0)	(1.55)
Glucosinolates (u mol/g)	16.0	11.0	Nil

* Refers to solvent extracted meal. Expeller and cold press meals have higher oil content with concurrent dilution of their other components.

a = Canola Council of Canada – Feed Industry guide.
b = Perez-Maldonado 2003.
c = Department of Primary Industry.
d = American Soybean Association.
e = National Research Council (NRC).

Source: ACE Livestock Consulting Pty Ltd.

Canola meal is mainly sold as a protein source for a variety of livestock that have different digestive capacities and nutrient requirements.

5.3.1 Cattle and sheep

Canola meal can be mixed into a full ration at 10 to 15 per cent for cattle and sheep. Based on the high methionine and cystine amino acid content of canola meal, it can be a valuable supplement for sheep feed. Lupin seeds which are often fed to sheep in Western Australia have lower methionine and cystine levels in comparison.

5.3.2 Dairy cattle

Canola meal is used in dairy diets because it possesses an excellent amino acid profile for rumen microbes. It is also used in the dairy ration because it has a good balance of rumen degradable and by-pass proteins which aids in maximising milk production. Daily intake of canola meal is 1-2 kg per day for dairy cattle in WA.

5.3.3 Pigs and poultry

Protein content and quality (amino acid profile) is important in poultry and pig diets. Pigs and poultry rations typically consist of five per cent canola meal. The pig and poultry industries are not receptive to using canola meal for full protein supplementation because of some anti-nutritional factors (ANF) in canola meal. One of the ANF is phenolics. Phenolics are unwanted and undesirable in animal feed material. They are considered to hinder animal nutrition in at least two ways: they are associated with poor palatability due to bitterness or astringency, thus affecting feed intake; secondly, they interfere with nutrient uptake in the digestive system.

In canola, sinapine is the most abundant of all small phenolics. Sinapine causes issues with egg laying chickens because the eggs have a ‘fishy’ or ‘crabby’ smell. Hens can not metabolise sinapine fully and trimethylamine, an intermediate, is leached into the eggs which causes the fishy odour. Even though there are low sinapine canola varieties, the poultry industry generally only uses canola meal for protein supplementation at low levels.

Crude fibre is present in larger amounts in the hulls of oilseeds and limits their use in diets for poultry and young pigs. Removal of hulls and indigestible fibres enhances the digestible and metabolisable energy of the meal. The easiest way to address this problem is through plant breeding to make the seed coat thinner.

Another ANF found in canola meal is phytate, a form of phosphorus generally not bio-available to non-ruminant animals and fish, because they lack the digestive enzyme, phytase, required to separate phosphorus from the phytate molecule. The unabsorbed phytate increases the amount of phosphorus in the manure. Excess phosphorus excretion is known to lead to environmental problems.

5.4 POTENTIAL IMPACT OF CANOLA MEAL ON THE LIVESTOCK INDUSTRY IN WA

The current annual canola meal consumption for each livestock sector is shown in Table 22.

Table 22. Estimated inclusion rates (%) and consumption of canola meal by livestock sector in WA (‘000 tonnes)

	Cattle	Sheep	Pigs	Goats	Poultry	Dairy	Total
% inclusion rate	5-15 (10)	5-15 (10)	15	5-15 (10)	15	5-15(10)	
Canola meal intake	11.1	15.0	24.3	neg	23.1	11.1	84.6

Source: Spragg J.: Australian Stockfeed Manufacturers Association, Executive Officer, 2006.

Given an average annual canola crop of 500 000 tonnes and assuming all of this production was used in the local biodiesel market, there would be 350 000 tonnes of canola meal available. However currently, the total requirement of canola meal consumed by the Western Australian livestock industry is theoretically 84 600 tonnes. This would mean that there would be 265 400 tonnes of canola meal surplus in WA. Due to the small livestock industry in WA, biodiesel manufacturers would have to seek other markets for the meal, such as the export market or to the Eastern States, or develop alternative uses for it like fertiliser.

Some analysis of feed grain products, prices, suppliers, availability, protein percentage and end users for the WA livestock feeding sector has been done and is summarised in Table 23.

Table 23. Competing protein materials available to the WA Livestock Feed Industry

Material	Suppliers	Price range AUD$	Crude protein (%)	Price equivalent AUD$ per % protein***	Availability MT	Livestock type
Soybean meal	US	450-600	44-48	10.22-12.50	Bulk shipment 5 000–15 000	Poultry Pig Equine
Canola meal	Riverland Kojonup Oils	280-400	35-37	8.00-10.80	15k-20k 2 000-3 000	Poultry Pig Dairy Beef Sheep Equine
Lupins	WA growers	160-300	28-32	5.70-9.40	200 000+	Pig Dairy Beef Sheep Equine
Dehulled lupins	Kalgrains Coorow Seed Cleaners Macco Feeds CBH/Westons T and Redwood	260-400	38-42	6.80-9.50	8 000-10 000 2 000 6 000-10 000 100 000+* 2 000	Poultry Pig Dairy Equine
Field peas	WA growers	180-350	22-24	7.50-14.60	3 000-10 000	Poultry Pig
Faba beans	WA growers	180-300	24-26	7.50-11.55	1 000-2 000	Poultry Pig
Copra expeller	Indonesia/Fiji Philippines	280-400	22-24	12.75-15.65	Container shipments	Equine
Urea	Fertiliser importers	300-400	42 (N)	7.15-9.50	Unlimited	Dairy Beef Sheep
DDG**	Local		30-32		100 000	All

Source: Rory Coffey, Canola Market Analysis, November 2005.

Another issue to consider is the major factor influencing the energy value of canola meal is the amount of residual oil. The Eastern States processing plants use a solvent extraction method, which leaves only 2 per cent oil in the meal. The crushing plants in WA use an expeller, which leaves 7-8 per cent oil in the meal. The higher oil content increases the available energy value in the canola meal which means the Western Australian livestock industry has a comparative advantage over the Eastern States. In a normal season, Western Australian canola meal receives a premium between $10-$25 per tonne compared to the Eastern States canola meal; due to the higher oil content. In drought years such as 2006/07, there is no premium between the different States due to the increased demand for protein.

6. CONCLUSIONS

Overall, the proposed ethanol production in WA will impact to the Western Australian livestock by competing for cheap ASW, AGP and Feed wheat grades. There could be up to 2 million tonnes of grain consumed by the ethanol industry in WA and up to 500 000 tonnes of canola utilised by the biodiesel industry which could be seen as increased competition for the livestock industry for feed grains. There would however be large supplies of cheap DDG and canola meal available to the livestock industry. Demand for low grade wheat generated by an ethanol industry could benefit the livestock sector by the resulting production of industrial wheat, where previously demand did not justify the investment.

Access to affordable grain in WA underpins the capacity of livestock industries to remain reliable suppliers to global meat markets while various highly managed feeding regimes allows Western Australian beef and milk cattle, sheep, pig, goat and chicken producers to distinguish themselves from the low cost producers such as South America.

WA is however ideally suited for a biofuels industry due to its significant grain production, particularly for ethanol production and to a lesser degree for biodiesel. WA has many comparative advantages for a future biofuels industry including efficient and low-cost production of grain, relatively small population and a large exportable grain surplus.

Wheat is the major grain crop produced in WA and offers WA many opportunities for the ethanol industry. Furthermore, the petrol market is significantly smaller compared to the Eastern States so there will be less ethanol required in WA and consequently the impact on the food and/or livestock sectors will not be as dramatic. Furthermore, with further research and development, new industrial wheat varieties could assist the livestock industries by providing more suitable grains that have higher starch content and, therefore, energy. These new varieties could also assist with climate change and salinity constraints in the future because they could be bred for drought conditions. These new varieties are likely to require less inputs and be suitable for growing on marginal land.

From a biodiesel perspective, there are more impedients in the system. Oilseed production in the State is limited currently to approximately 500 000 tonnes of canola which would only supply about five per cent of the total diesel market. Other local feedstocks are also limited such as tallow and used cooking oil. Therefore alternative oilseeds and other feedstocks need to be developed both in the short and longer term to supply biodiesel into the large diesel market.

In conclusion, the development of a biofuels industry will increase competition for feed grain with the livestock industry in WA; particularly grains utilised for its energy. Investments in breeding programs for industrial grains and alternative oilseeds are essential.

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