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Economic Evaluation of MLA Feedlot Investment 2001-2006

Executive Summary

The original analyses

The set of analyses reported here for the MLA investment in Feedlot R&D builds on a set of economic evaluations carried out by Agtrans Research for Meat and Livestock Australia (MLA) in 2006. The 2006 analysis was effected by randomly selecting a representative sample of 50 projects funded by Livestock Production Innovation (LPI) that received funding over the five years from July 2001 to June 2006.

Five Feedlot projects were drawn in the sample and, through linkages to other projects, led to a total of 15 projects that were analysed in the Feedlot sample. The 2006 evaluation for the Feedlot investment was then modified according to the ACIL-Tasman guidelines to meet the requirements of the pooled sample. The Feedlot report, together with that for Lamb and Sheepmeat and the Environment investments were submitted by MLA in April 2008. The current feedlot report is based on the Feedlot report to ACIL-Tasman.

The sample

The population and final sample of Feedlot projects and the financial investment in them is specified in Table 1.

Table 1: Description of the Feedlot Project Population in terms of Number & Value

	No of projects	Total MLA funding (nominal $M)
Population	32	5.153
Sample	15	2.292

The sample of Feedlot projects is presented in Table 2. The additional ten heat stress projects analysed are not included in this table. There were two quantitative analyses:

- Reducing the Heat Load for the Australian Feedlot Industry
- Grainfed Investment in Beef CRC II

The first was based on FLOT.327, FLOT317 and the other ten heat stress projects; the second was FLOT 215. FLOT.123 and FLOT.124 were analysed only in a qualitative manner.

Table 2: Sample of Feedlot Projects

Project code	Project title	Total MLA funding ($)	Start date	End date
FLOT.123	Review of Options to Reduce Feedstuff Supply Variability in Australia	117,603	2002/03	2003/04
FLOT.327	Reducing the Risk of Heat Load for the Australian Feedlot Industry	149,008	2004/05	2004/05
FLOT.317	Measuring the microclimate of Eastern Australia Feedlots	223,456	2001/02	2002/03
FLOT.124	Devitalisation of Imported Feed Grain by Fumigation	450,000	2003/04	2004/05
FLOT.215	MLA contribution to the Cattle & Beef Quality CRC	630,000	2000/01	2005/06

Benefits

The benefits identified from most of the investments analysed are predominantly private industry benefits in the form of productivity improvements. The predominant initial beneficiaries of the research have been feedlot operators but a large proportion of the benefits will ultimately accrue to cattle producers and beef consumers. Consumers will also benefit from improved beef quality. There will be substantial public spillover benefits in the form of enhanced animal welfare gains for the heat stress investments as well as some environmental benefits from reduced odour, enhanced biosecurity and reduced soil degradation.

Quantitative Analyses

In carrying the evaluations, all past costs and benefits were expressed in 2007/08 dollar terms using the CPI. All benefits after 2007/08 were expressed in 2007/08 dollar terms. All costs and benefits were discounted or compounded to the year 2007/08 using a discount rate of 5%. All analyses ran for the length of the investment period plus different periods from the last year of investment, up to a maximum period of 25 years.

Costs for the initial R&D project included those for MLA as well as contributions (dollar and in-kind) from other funding organisations as well as the participating R&D group. Assumptions were made in a consistently conservative manner when valuing benefits.

Sensitivity analyses were undertaken in most cases for those variables where there was greatest uncertainty or for those that were thought to be key drivers of the investment criteria. The sensitivity analyses were conducted only at the 5% discount rate.

Results for Individual Investments

Investment criteria were estimated for both total investment and for the MLA investment alone. The investment criteria for each of the two quantitative analyses for the 25 year period are reported in Tables 3 and 4.

Table 3: Investment Criteria for Total Investment and Total Benefits
(discount rate 5%, 25 years)

Criterion	**Heat Loads in Feedlots**	**Grainfed Investment in Beef CRC II**
Present value of benefits (m$)	5.09	332.21
Present value of costs (m$)	1.93	54.37
Net present value (m$)	3.15	277.84
Benefit cost ratio	2.63	6.11
Internal rate of return (%)	15.5	19.5

Table 4: Investment Criteria for MLA Invest*ment and MLA Benefits
(discount rate 5%)

Criterion	Heat Loads in Feedlots	Grainfed Investment in Beef CRC II
Present value of benefits (m$)	4.29	5.62
Present value of costs (m$)	1.64	0.89
Net present value (m$)	2.66	4.73
Benefit cost ratio	2.62	6.31
Internal rate of return (%)	15.3	20.8

Results for Aggregate Investment

Tables 5 show the investment criteria for the two investments combined for different benefit periods for the MLA investment.

Table 5: Aggregate Investment Criteria for MLA Investment
(discount rate 5%)

Criterion	0 years	5 years	10 years	15 years	20 years	25 years
Present value of benefits (m$)	0.55	2.49	5.07	7.09	8.68	9.92
Present value of costs (m$)	2.30	2.30	2.30	2.30	2.30	2.30
Net present value (m$)	-1.76	0.19	2.77	4.79	6.37	7.61
Benefit cost ratio	0.24	1.08	2.20	3.08	3.76	4.30
Internal rate of return (%)	Negative	6.4	15.9	18.2	18.9	19.2

Table 6 shows the aggregate investment criteria for the MLA investment when the benefits from the two investments (13 projects) are placed against the total costs of all Feedlot projects drawn in the sample (15 projects).

Table 6: Aggregate Investment Criteria for MLA Benefits from the Two Investments Compared with the MLA Investment in All Feedlot Projects Drawn in the Sample
(discount rate 5%, 25 year benefit period)

Present value of benefits (m$)	9.92
Present value of costs (m$)	3.07
Net present value (m$)	6.85
Benefit cost ratio	3.23
Internal rate of return (%)	16.1

Conclusion

The investment by MLA in the Feedlot cluster was $5.2 million in nominal dollar terms. The MLA investment in the 15 projects included in the sample reported here totalled $2.3 million in nominal dollar terms and had a present value of costs of $3.1 m in 2007/08 dollar terms as of 2007/08. This investment by MLA was estimated to produce a present value of benefits of $9.92 m, giving a benefit-cost ratio of 3.2 to 1 and an internal rate of return of 16% per annum over a 25 year benefit period. Given that the sample of projects analysed made up nearly 50% of the population, there can be some confidence that the performance of the overall population would have been similar.

A range of types of benefit was evident. The predominant group of benefits was private in nature and captured predominantly by cattle producers and feedlotters with some benefits being passed along the marketing chain to processors and consumers. Consumers will also benefit from improved beef quality. However, significant social benefits were evident in the form of animal welfare benefits and improved biosecurity management.

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1. Introduction and Background

The original analyses

The set of analyses reported here for the MLA investment in Feedlot R&D builds on a set of economic evaluations carried out by Agtrans Research for Meat and Livestock Australia (MLA) in 2006. The 2006 analysis was effected by randomly selecting a representative sample of 50 projects funded by Livestock Production Innovation (LPI) that received funding over the five years from July 2001 to June 2006. Each of these projects was described in terms of their objectives, outputs, outcomes and economic, environmental and social benefits they had produced.

Thirty of the fifty projects were selected for quantitative economic evaluation and their benefits valued in monetary terms. The value of benefits for each project was then compared to the investment made in each project. As all projects were selected at random across a stratified population of projects, this allowed the aggregate performance of the sampled projects to be extrapolated to the entire population of projects funded by LPI.

The stratification process resulted in five Feedlot projects being drawn in the sample.

Two of these feedlot projects were in the area of heat stress. There were ten other heat stress projects added to the two drawn in the sample and the twelve projects were evaluated as one investment. This was required as the selected projects on their own did not produce individual benefits that could be isolated but contributed to an outcome with other neat stress projects. This expanded the proportion of the total Feedlot Investment that was analysed.

A third project drawn in the five was the contribution that MLA made to Beef CRC and this project was subject to an economic evaluation on its own. The two other projects drawn in the sample were analysed in a qualitative manner and no benefits were valued.

The pooled sample approach

The Council of Chairs of Rural R&D Corporations (CCRRDC) pooled sample approach required evaluation of a set of research area clusters that spanned the portfolio of all RDCs. For MLA's part this was delivered through use of the original analyses described above. Seven LPI clusters were submitted by MLA to ACIL Tasman (on behalf of the CCRRDC) who subsequently randomly chose three clusters to be evaluated. These were Lamb and Sheepmeat, Feedlots, and Environment clusters.

The 2006 evaluation for the Feedlot investment was then modified according to the ACIL-Tasman guidelines to meet the requirements of the pooled sample. The Feedlot report, together with that for Lamb and Sheepmeat and the Environment investments were submitted by MLA in April 2008.

The current report

The current feedlot report is based on the Feedlot report to ACIL-Tasman. The $ terms have been changed to from 2006/07 to 2007/08 as has the year to which all cash flows are discounted.

2. Methods

For the original analyses, a list of LPI projects active during the period July 2001 to June 2006 was provided to Agtrans Research by MLA. This list was the population of projects to be considered and had been developed from MLA's project management system. A number of steps were undertaken to ensure the data used to define the specific population was appropriate. These steps are described in the report to MLA in 2006/07.

The total LPI investment (the population) considered by this analysis was $48.191 M across 361 projects. The total funding over the five year period from July 2001 to June 2006 was $38.270 M, the difference being funding of projects in the population before July 2001 and after 2005/06.

The population and final sample of Feedlot projects and the financial investment in them is specified in Table 1.

Table 1: Description of the Feedlot Project Population in terms of Number & Value

	No of projects	Total MLA funding (nominal $M)
Population	32	5.153
Sample	15	2.292

The sample of Feedlot projects is presented in Table 2. The additional ten heat stress projects analysed are not included in this table. There were two quantitative analyses:

- Reducing the Heat Load for the Australian Feedlot Industry
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Table 2: Sample of Feedlot Projects

Project code	Project title	Total MLA funding ($)	Start date	End date
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For projects that were quantitatively evaluated, it was not always possible to quantify all benefits that may have been associated with the particular investments. For example, identified environmental and social benefits were sometimes particularly difficult to quantify.

3. Investment Description and Costs

A description of the investments analysed and their outputs and outcomes are provided in the individual project analyses (Appendices 1 to 4).

Estimates of the resources invested by MLA by year in the Feedlot R&D population and the projects analysed are provided in Table 3. In nominal terms the value of the projects analysed was 44% of the value of the population. In terms of numbers of projects the percentage was 47%.

Table 3: Resources Invested by Year for MLA in Feedlot R&D (nominal $)

Year	MLA Investment in Population (32 projects)	MLA Investment in 15 projects analysed
1998/99	135,600	0
1999/00	232,577	0
2000/01	654,517	296,082
2001/02	890,986	383,453
2002/03	960,622	505,973
2003/04	1,117,025	541,896
2004/05	843,881	435,735
2005/06	317,291	129,350
2006/07	0	0
Total	5,152,500	2,292,488

Source: MLA

4. Benefits Associated with the Investments Analysed

A summary of the benefits that have emerged from the investment in feedlot R&D is provided in Table 4. This shows the nature of the benefits produced (economic, environmental and social) from the 15 projects.

Table 4: Summary of Principal Benefits for the Sampled Projects

Project	Economic benefits	Environmental benefits	Social benefits
Feedstuff Supply Variability (1 project)	Likelihood of strategies that will reduce the supply variability of feed grains to end users Integration of climatic and economic models to generate more timely and accurate predictions of grain supply outlook Greater cognizance of market failure and the need to look for solutions beyond the micro scale Development of a structurally sound industry that will be sustainable over the long term A larger intensive animal industry with correspondingly larger dividends for operators and associated communities	The natural environment will be 'saved' during drought events to the extent that feedlots and intensive feeding generally remain economic because of less price variability and a more rapid supply-side response to the needs of the livestock feeding industry. Cattle will move quicker to intensive feeding and thereby save pasture and reduce soil degradation	Scope for industry expansion leading to flow-on benefits to regional communities especially jobs Job and income security for people working directly in the feed processing and delivery industry Animal welfare during drought events due to greater confidence that intensive feeding will be relatively durable in the face of drought Enhancement of industry's understanding of how markets work to address severe events
Heat Load in feedlots (12 projects)	Lowered mortality rates in feedlots, particularly from extreme events Lowered probability of uneconomic mandatory regulations industry (e.g. to increase shade in feedlots to 100% capacity without any significant risk improvement) with a higher probability of a lower cost risk management approach to addressing heat stress events	Reduced odours emanating from feedlots via reduced cattle concentrations and improved pad management	Delivery of a higher level of animal welfare by feedlot managers resulting in reduced loss of animal life and stress

Devitalisation of imported feed grain (1 project)	Ability to import feed grain during supply shortages will provide confidence and continuity to intensive animal industries and lower input prices. This could lead to potentially larger intensive animal industries. Any financial benefit needs to be offset against any losses imposed on the Australian feed grains producing sector Potentially a reduced risk to agricultural industries of weed seeds and diseases entering Australia through imported feedstuffs Development of structurally sound intensive animal industries which are sustainable over the long term	Reduced risk to the environment from superior phytosanitary standards applying to imported feedstuffs – due to the superiority of devitalisation over QA practices such as inspection and random audits The natural environment will be 'saved' during drought events to the extent that feedlots and intensive feeding generally remain economic because of less price variability and a more rapid supply-side response to the needs of the livestock feeding industry. Cattle will move quicker to intensive feeding and thereby save pasture and reduce soil degradation	Scope for industry expansion leading to flow-on benefits to regional communities especially jobs Job and income security for people working directly in the feed processing and delivery industry Improved animal welfare during drought events due to greater confidence that intensive feeding will be relatively durable in the face of drought
Grainfed Investment in CRC II (1 project)	Increased productivity of beef production systems through increased rate of genetic gain Product enhancement to better meet market demand and consumer requirements	Improved effectiveness of feed utilisation with a lowering of methane outputs	Delivery and training initiatives have enhanced the capacity of the industry

The benefits identified from most of the investments analysed are predominantly private industry benefits in the form of productivity improvements. The predominant initial beneficiaries of the research have been feedlot operators but a large proportion of the benefits will ultimately accrue to cattle producers and beef consumers. Consumers will also benefit from improved beef quality. There will be substantial public spillover benefits in the form of enhanced animal welfare gains for the heat stress investments as well as some environmental benefits from reduced odour, enhanced biosecurity and reduced soil degradation.

The Australian Government's national and rural R&D priorities are reproduced in Table 5.

Table 5: National and Rural R&D Research Priorities 2007-08

Australian Government	
National Research Priorities	**Rural Research Priorities**
1. An environmentally sustainable Australia 2. Promoting and maintaining good health 3. Frontier technologies for building and transforming Australian industries 4. Safeguarding Australia	1. Productivity and adding value 2. Supply chain and markets 3. Natural resource management 4. Climate variability and climate change 5. Biosecurity Supporting the priorities: 1. Innovation skills 2. Technology

The heat stress investment has made a major contribution to Rural Research Priority 1 through its impact of reducing death rates in feedlot cattle. The investment has made a significant contribution to innovation skills and technology for ensuring the sustainability of Australian industries (National Research Priority 3 and Supporting Rural Research priorities).

The grainfed contribution to the CRC has made a major contribution to Rural Research Priority 1 through its impact on the rate of genetic gain. In addition, the investment would have contributed to maintaining or increasing demand by consumers through contributing to meat quality improvements such as marbling (Rural Research Priority 2). The CRC investment has made a significant contribution to the use of frontier technologies and innovation skills and technology for ensuring the sustainability of Australian industries (National Research Priority 3 and Supporting Rural Research priorities).

The two projects analysed qualitatively will contribute to increased productivity (Rural Research Priority 1) through a higher level of security of supply of feedstuffs, as well as National Research Priority 4 and Rural Research Priority 5 through improved phytosanitary standards applying to imported feedstuffs.

The assessment of the relative contribution to each of the five Rural Research Priorities is:
Rural Research Priority 1 (60%)
Rural Research Priority 2 (20%)
Rural Research Priority 3 (10%)
Rural Research Priority 5 (10%)

5. Quantitative Investment Evaluation

The individual investments where benefits were quantified were:

- Reducing the Heat Load for the Australian Feedlot Industry
- Grainfed Investment in Beef CRC II

In carrying out these evaluations, all past costs and benefits were expressed in 2007/08 dollar terms using the CPI. All benefits after 2007/08 were expressed in 2007/08 dollar terms. All costs and benefits were discounted or compounded to 2007/08 using a discount rate of 5%. All analyses ran for the length of the investment period plus different periods from the last year of investment, up to a maximum period of 25 years. The results specific to each of the two analyses are reported in the next two sections.

Costs for the initial R&D project included those for MLA as well as contributions (dollar and in-kind) from other funding organisations as well as the participating R&D group. Assumptions were made in a consistently conservative manner when valuing benefits. The specific assumptions used in the analysis can be found in Appendices 1 and 2.

Sensitivity analyses were undertaken in most cases for those variables where there was greatest uncertainty or for those that were thought to be key drivers of the investment criteria. The sensitivity analyses were conducted only at the 5% discount rate.

6. Investment Criteria Results

Investment criteria were estimated for both total investment and for the MLA investment alone. The investment criteria for each of the two quantitative analyses for the 25 year period are reported in Tables 6 and 7. Table 6 summarises the results for investment from all sources including the MLA funding while Table 7 summarise results for the MLA investment alone.

Table 6: Investment Criteria for Total Investment and Total Benefits
(discount rate 5%, 25 years)

Criterion	Heat Loads in Feedlots	Grainfed Investment in Beef CRC II
Present value of benefits (m$)	5.09	332.21
Present value of costs (m$)	1.93	54.37
Net present value (m$)	3.15	277.84
Benefit cost ratio	2.63	6.11
Internal rate of return (%)	15.5	19.5

Table 7: Investment Criteria for MLA Investment and MLA Benefits
(discount rate 5%)

Criterion	Heat Loads in Feedlots	Grainfed Investment in Beef CRC II
Present value of benefits (m$)	4.29	5.62
Present value of costs (m$)	1.64	0.89
Net present value (m$)	2.66	4.73
Benefit cost ratio	2.62	6.31
Internal rate of return (%)	15.3	20.8

Results for Aggregate Investment

Tables 8 and 9 show the investment criteria for the two investments combined for different benefit periods and for both the total and MLA investment.

Table 8: Aggregate Investment Criteria for Total Investment
(discount rate 5%)

Criterion	0 years	5 years	10 years	15 years	20 years	25 years
Present value of benefits (m$)	0.65	48.94	149.12	227.61	289.11	337.30
Present value of costs (m$)	56.30	56.30	56.30	56.30	56.30	56.30
Net present value (m$)	-55.66	-7.37	92.81	171.30	232.80	280.99
Benefit cost ratio	0.01	0.87	2.65	4.04	5.13	5.99
Internal rate of return (%)	negative	3.1	15.7	18.3	19.1	19.4

Table 9: Aggregate Investment Criteria for MLA Investment
(discount rate 5%)

Criterion	0 years	5 years	10 years	15 years	20 years	25 years
Present value of benefits (m$)	0.55	2.49	5.07	7.09	8.68	9.92
Present value of costs (m$)	2.30	2.30	2.30	2.30	2.30	2.30
Net present value (m$)	-1.76	0.19	2.77	4.79	6.37	7.61
Benefit cost ratio	0.24	1.08	2.20	3.08	3.76	4.30
Internal rate of return (%)	negative	6.4	15.9	18.2	18.9	19.2

As mentioned earlier, there were 32 projects in the population of the Feedlot cluster. Five of these were drawn in the sample. Three of the five were analysed quantitatively, together with another 10 projects associated with heat stress in feedlots to which both of the original projects was clearly linked. Thirteen projects were therefore analysed in the two quantitative analyses. Each of the other two projects that made up the 15 projects were analysed qualitatively.

Table 10 shows the aggregate investment criteria for the MLA investment when the benefits from the two investments (13 projects) are placed against the total costs of all Feedlot projects drawn in the sample (15 projects).

Table 10: Aggregate Investment Criteria for MLA Benefits from the Two Investments Compared with the MLA Investment in All Feedlot Projects Drawn in the Sample

(discount rate 5%, 25 year benefit period)

Present value of benefits (m$)	9.92
Present value of costs (m$)	3.07
Net present value (m$)	6.85
Benefit cost ratio	3.23
Internal rate of return (%)	16.1

The population of projects from which the sample of 15 Feedlot projects was drawn numbered 32. On a nominal cost basis the sample total investment was $2.3 million from a population of $5.2 million.

Sensitivity Analyses

Sensitivity analyses were carried out on the discount rate used for the aggregate analysis and results are reported in Table 11. Sensitivity analyses for the individual investments are provided in Appendices 1 and 2.

Table 11: Sensitivity of Investment Criteria to Discount Rate

Criterion	**2.5%**	**5% (Base)**	**10%**	**15%**
Present value of benefits ($ m)	12.52	9.92	6.84	5.23
Present value of costs ($ m)	2.74	3.07	3.83	4.76
Net present value ($ m)	9.78	6.85	3.01	0.47
Benefit-cost ratio	4.57	3.23	1.78	1.10
Internal rate of return (%)	16.1	16.1	16.1	16.1

7. Conclusion

The investment by MLA in the Feedlot cluster $5.2 million in nominal dollar terms. The MLA investment in the 15 projects included in the sample reported here totalled $2.3 million in nominal dollar terms and had a present value of costs of $3.1 m in 2007/08 dollar terms as of 2007/08. This investment by MLA was estimated to produce a present value of benefits of $9.92 m, giving a benefit-cost ratio of 3.1 to 1 and an internal rate of return of 16% per annum over a 25 year benefit period. Given that the sample of projects analysed made up nearly 50% of the population, there can be some confidence that the performance of the overall population would have been similar.

A range of types of benefit was evident. The predominant group of benefits was private in nature and captured predominantly by cattle producers and feedlotters with some benefits being passed along the marketing chain to processors and consumers. Consumers will also benefit from improved beef quality. However, significant social benefits were evident in the form of animal welfare benefits and improved job security for people working directly in the feed processing and delivery industry. Environmental and natural resource management benefits were also captured through reduced soil and pasture degradation and improved biosecurity management.

8.Appendices

8.1 Appendix 1: Reducing the Heat Load for the Australian Feedlot Industry

Introduction

Excess body heat in feedlot cattle can impact on animal welfare and productivity of animals while being managed under feedlot conditions.

In 1991 a number of feedlots in Queensland and northern NSW experienced deaths of feedlot cattle due to a severe and sudden heat wave preceded by rainfall, high humidity, high temperatures and low wind speed. The losses included over 2,000 feedlot cattle near Texas in southern Queensland.

The National Feedlot Accreditation Scheme (NFAS) was established in 1994. NFAS incorporates a feedlot animal welfare code of practice and also requires compliance with the code through maintenance of an animal care statement. Independent third party auditing ensures the integrity of the scheme. NFAS is co-regulated by linkages to State government feedlot approval and licensing legislation and Australian Quarantine and Inspection Service (AQIS) administered export regulations (ALFA, 2005).

In the year 2000 over 1,000 feedlot cattle perished due to heat stress in a number of feedlots in southern NSW. Since 2002 NFAS has included a provision that feedlots notify the Australian Lot Feeders' Association (ALFA) of significant incidents of morbidity or mortality of cattle.

Since this heat stress event in 2000, the Australian lot-feeding industry via MLA has invested significant funding into research to understand the microclimate of the feedlot environment, develop indicators of heat stress and a heat load index, a forecasting system for advising feedlot operators of heat stress, a risk assessment process, and the design of new generations of shade structures (ALFA, 2005; EA Systems, 2004). Most of this research has been undertaken by three organisations: E.A. Systems Pty Limited, The University of Queensland and Katestone Environmental.

Investment Description

The overall investment by MLA into heat stress in feedlots commenced with literature reviews. After funding a set of literature review projects (FLOT.307), MLA funded FLOT.310 which was undertaken in the 2000/01 summer period and measured microclimate variations within two Australian feedlots. The findings from the literature review projects and the final report from FLOT.310 prompted MLA to fund a series of integrated projects that pursued a holistic approach to addressing heat stress issues in the industry:

All of the 16 heat stress projects funded by MLA are identified in Table 1.

Table 1: Feedlot Heat Stress Projects Funded by MLA

MLA project code	Project title
FLOT.307	Heat Load in Feedlot Cattle (series of literature reviews)
FLOT.310	Measuring Microclimate Variations In Two Australian Feedlots
FLOT.312	Risk Assessment of Occurrence of Excessive Heat Load
FLOT.313	Development and Trial of a Weather Forecasting Service for Feedlots
FLOT.314	Investigations of dietary manipulations as mechanism for minimising the impact of excessive heat load events on feedlot cattle
FLOT.315	Applied evaluation of feedlot shade design
FLOT.316	Development of an excessive heat load index for the Australian Feedlot Industry
FLOT.317	Measuring the microclimate of Eastern Australian Feedlots
FLOT.319	Refinement of the Heat Load Index Based on Animal Factors
FLOT.320	Development and Trial Operation of a Website-Based Weather Forecast Service for the Australian Feedlot Industry
FLOT.321	Risk Assessment of the Occurrence of Excessive Heat Load Events for the Major Feedlot Regions of Australia (Phase 2)
FLOT.322	Cooling water for lot-fed cattle
FLOT.324	Refined Website-based Weather Forecast Service for the Australian Feedlot Industry
FLOT.327	Reducing the Risk of Heat Load for the Australian Feedlot Industry
FLOT.329	Cattle Heat Load stress forecasting Summer 2004/2005
FLOT.330	Validation of the Heat Load Index for use in the feedlot industry

Investment Costs

The total investment costs in these projects are shown in Table 2.

Table 2: Resources Invested by Year by MLA in Other Heat Stress Projects (a) (nominal $)

Project	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	Total
FLOT.307 to FLOT.309	30,000	33,624					63,624
FLOT.310	176,082	48,144					224,226
FLOT.312		6,680	38,320				45,000
FLOT.313		20,741	33,400				54,141
FLOT.314					18,000		18,000
FLOT.315		13,400	10,500				23,900
FLOT.316		31,414	15,586				47,000
FLOT 317		134,850	88,606				223,456
FLOT.319			37,700	45,039			82,739
FLOT.320			24,670	14,820			39,490
FLOT.321			84,645				84,645
FLOT.322			30,346	1,134			31,480
FLOT.324				11,000	7,647		18,647
FLOT 327					149,008		149,008
FLOT.329					35,202		35,202
FLOT.330					28,727	21,350	50,077
Total	206,082	288,853	363,773	71,993	238,585	21,350	1,190,635

(a) As most of these projects were undertaken by private companies, the in-kind level of contribution was small. The contribution is assumed in the economic analysis to be 10% of the MLA contribution.

Principal Outputs

One of the earlier projects (FLOT.310) determined that cattle stress events in feedlots were determined by a number of variables including:

- Constant high ambient temperatures
- Significant radiant heat loads
- Low wind speeds
- Elevated ammonia levels

The investment in FLOT.317 confirmed that significant variations occurred between the external and internal microenvironments in the feedlot. Temperature differences in unshaded pens were higher than the external environment. While shade provided a minor reduction in temperature, humidity levels were higher under shade and wind speeds were reduced in shaded pens. Shade structure and overall geographic aspects of the feedlot tempered these conclusions.

Most feedlot weather stations are located outside the feedlot environment so that any stress index calculated from such observations may not be representative of those inside the feedlot. The project demonstrated that stress index equations can be adjusted accordingly so that external data can be used to calculate conditions in both shaded and unshaded areas inside the feedlot. The study also found that the best means of lowering water trough temperatures was to reduce the temperature of the water supply. Recommendations from the study were that the equations used to estimate stress indices should be modified and mechanisms for keeping trough water cooler should be examined.

After this project had been completed, in the summer of 2003/04, further heat stress events occurred in central NSW feedlots. There was some confusion over the new heat load indices, there were some errors detected in the web-advisory system, and some weather stations were not capable of computing the index within the central processor in the data loggers (EA Systems, 2004).

Project FLOT.327 went on to refine and validate the heat stress index. This process was based on a wider range of data sets from both Australia and the USA. The statistical methods used in the revised calculations were validated by an independent expert. The new index took into account the relative humidity, black globe temperature, and wind speed.

A second output from the investment in FLOT.327 was the development of a computer program to assess the risk of high heat load events occurring at individual feedlots. The risk is expressed as the probability of a high risk event and an extreme risk event occurring on a regional basis and includes individual feedlot management variables such as the provision of shade and water troughs. A heat load index calculator has been included in the program to assist feedlot operators to calculate spot measures of the index.

The final objective of FLOT.327 was to conduct a series of workshops to communicate the results of the project to the wider industry. The four workshops were held in November 2004 in Moana, Tamworth, Dalby and Wagga. The workshops covered the refined heat load indices, heat load mitigation measures and a new risk assessment program.

Other projects funded by MLA in the heat stress area focused on shade design, the development of a weather forecasting service for feedlots, and risk assessment process for high stress head load events.

The heat stress projects have contributed to a series of Tips and Tools produced by MLA. These include:

- Managing heat load in feedlot cattle - an overview
- Understanding excessive heat load in feedlot cattle
- Recognising excessive heat load in feedlot cattle
- Summer feeding of feedlot cattle
- Feedlot shade structures
- Weather monitoring in feedlots

These six Tips and Tools have been aggregated into a booklet called “Heat Load in Feedlot Cattle”. The booklet provides a comprehensive guide to understanding, recognising and managing heat load in feedlot cattle. This publication was first printed in 2004, has been reprinted once since then due to high demand and is now being revised and reprinted again in 2006.

Principal Outcomes

A principal outcome of the investment in heat stress R&D has been the raising of awareness of the feedlot operators of the issue. This has led to a higher level of interest and attention to feedlot management practices in summer periods. For example, all larger feedlots have summer management plans in place.

A web-based forecasting service now predicts a heat load index (HLI) and a cumulative heat load out for 6 days ahead. The forecasts are updated daily. The forecasts are specific to a range of regions throughout Australia (see www.katestone.com.au/mla). The service operates from December to the end of March each summer. The development of the service to date has been supported financially by MLA via the projects being evaluated. In future it is likely to cost about $20,000 per annum to continue to operate the service. The service is used by a large number of operators, particularly by the larger feedlot operators (Des Rinehart, pers. comm., June 2006).

Shade structures are now commonly used throughout the industry to alleviate the impacts of hot weather events. A feedlot shade survey conducted in mid calendar 2005 estimated that the feedlot capacity under shade represented about 60% of the total surveyed AUS-MEAT feedlot capacity (ALFA, 2005). This estimate was 124% higher than the capacity under shade in February 2000.

The increase in shade has probably been partly driven by the increased awareness and the recognition of increased shade as a risk management strategy for ameliorating heat stress events. Shade does not make a very large difference to heat stress. However, It does reduce the radiant heat loading and this reduction can be sufficient at times to avoid tipping over into a heat stress event. Even with 100% shade there still will be deaths but the incidence will be less frequent

The increased investment in shade has been in part a reaction to the potential for increased regulation/prosecution that could be implemented by governments.

In a medium sized Australian feedlot (say 15,000 head capacity), most of the losses from a heat stress event would most likely be British breed cattle destined for the export market on a 120-200 days feeding regime. With 60% shade in the feedlots on average most feedlots would be able to manage to shade the cattle that are most likely to be badly affected. The additional 40% of shading that could occur would not likely to be of great value in terms of reducing deaths or producing productivity gains. Brahman cattle or crossbreeds have higher heat thresholds and shade would be of limited benefit. The majority of long fed cattle now have access to shade (Des Rinehart, pers. comm., June 2006).

It has been difficult to show a large cattle productivity response to shade. There has been some recent evidence coming from the USA that suggests there may be some benefits. MLA is planning experiments to asses the impacts of different areas of shade on productivity and costs. Experience in Australia has shown that while feedlot weight gain may drop off for some animals in some circumstances in summer, there can be some compensating weight gains after summer. It is difficult therefore to justify the capital investment in shade on productivity grounds alone.

Apart from the capital investment required, shade does have some negative heat load impacts through generally increasing humidity. Shade generally concentrates cattle together with a build up of manure and urine concentrations creating an artificial humid environment. This can create problems also for maintaining the pad surface and this can be costly.

Key management practice changes being practiced by a large number of operators in summer include (Des Rinehart, pers. comm., June 2006):

- Not handling, moving, drafting or trucking cattle when the heat load index is high or expected to be high
- Introducing additional water troughs
- Changing feed management regimes concerning timing of feeding and composition (less grain and more high quality roughage)
- Maintaining a controlled manure pad to reduce humidity

The larger feedlot operators do have their own weather stations from where they collect information allowing them to calculate their own heat load index. This can then be calibrated against the nearest HLI forecast to provide an indication of expected heat loading in their own feedlot. It is estimated that 50% of all feedlot capacity would be subject to such management at present (Des Rinehart, pers. comm., June 2006).

The 67 feedback sheets from attendees at the four workshops described earlier for FLOT.327 indicated that most thought the workshops were good or very good. The majority of respondents seemed to be willing to integrate the heat load mitigation strategies into their management strategies.

Benefits Associated with the Investment

Benefits from the investment in the 16 heat stress projects are described here as being economic, environmental or social.

Economic

Economic benefits from this investment include a lower probability of a heat load event occurring in future due to the management changes that can be attributed to the R&D investment. Also, productivity improvements could occur. Except for shade, there may be only minimal additional investment required to capture these benefits and these will depend on the specific management changes made.

Environmental

The major environmental implications of this investment are associated with improved pad and manure management resulting in less odour emanating from the feedlots.

Social

The investment has produced a deeper understanding of the heat and humidity environment under which feedlot cattle are raised. It has therefore built capacity among researchers and feedlot managers to manage heat stress. In particular the investment has provided a stronger guard against heat stress events and suitable preparation options for their management. This will improve animal welfare considerably.

A summary of the type of benefits emanating from this investment is given in Table 3.

Table 3: Summary of the Economic, Environmental and Social Benefits from the Investment

Economic	Environmental	Social
Lowered mortality rates in feedlots, particularly from extreme events	Reduced odours emanating from feedlots via reduced cattle concentrations and improved pad management	Delivery of a higher level of animal welfare by feedlot managers resulting in reduced loss of animal life and stress
Lowered probability of uneconomic mandatory regulations industry (e.g. to increase shade in feedlots to 100% capacity without any significant risk improvement) with a higher probability of a lower costs risk management approach to addressing heat stress events		Enhanced capacity of feedlot managers to understand and react to options of lowering heat load stress.

Public versus Private Benefits

The benefits identified from the investment in the feedlot heat stress projects are a mix of private and community benefits. The majority of the private economic benefits will be captured by cattle producers. However, some of the benefits of the productivity gains will be passed along the supply chain to Australian processors and consumers. Public benefits have been captured through delivery of a higher level of animal welfare by feedlot managers resulting in reduced loss of animal life and stress. Some odour reduction has also been delivered.

Match with National Priorities

The Australian Government's national and rural R&D priorities are reproduced in Table 4.

Table 4: National and Rural R&D Research Priorities 2007-08

Australian Government	
National Research Priorities	**Rural Research Priorities**
1. An environmentally sustainable Australia 2. Promoting and maintaining good health 3. Frontier technologies for building and transforming Australian industries 4. Safeguarding Australia	1. Productivity and adding value 2. Supply chain and markets 3. Natural resource management 4. Climate variability and climate change 5.Biosecurity Supporting the priorities: 1. Innovation skills 2. Technology

The program has made a major contribution to Rural Research Priority 1 through its impact of reducing death rates in feedlot cattle. The investment has made a significant contribution to innovation skills and technology for ensuring the sustainability of Australian industries (National Research Priority 3 and Supporting Rural Research priorities).

Quantification of Benefits

Where there are cattle deaths from heat stress they are usually spectacular in number. Deaths are event driven rather than a linear response to an increasing heat load. The financial costs to the individual feedlot and the animal welfare impacts are serious when such an event occurs but it does not occur to an individual feedlot very often. However, this may change in the future with climate change.

Loss of profits

Even if a heat stress event triggering death occurred only once every ten years for an individual feedlot, it would decimate profits for that year. For example, a 20,000 head capacity feedlot might lose 2,000 head of cattle worth $2.2 m (with cattle valued say at $1,100 per head). The total throughput for the year may be say 40,000 head per year (2.5 times 80% of 20,000). If the margin on each head averaged $120, the total profit for the year would be about $4.8 m to cover fixed and overhead costs. The heat stress event would therefore reduce profit by about 40% for that year. A serious heat stress event such as this would result also in reduced productivity for the surviving cattle in the feedlot so profit losses could even be greater (Des Rinehart, pers.comm., June 2006).

It is assumed that the impact of the R&D investment has been to reduce the frequency of a heat load stress event occurring in the industry. Without the R&D investment it is assumed that an event will occur every five years. This is based on three severe events occurring in the Australian industry since 1991 (1991, 2000 and 2004). It is assumed that with the R&D program and the management changes it has developed and encouraged, this frequency will be reduced to one in every ten years.

Welfare benefits

Animal welfare benefits are estimated in terms of decreased heat stress levels. The value of a human life is assumed to be $2.5 million (Abelson, 2003). This is based on the willingness to pay studies of a middle aged person of 40 years with 40 years to live. On an annual basis this is equivalent to $150,000 per year at a 5% discount rate.

A major assumption in the current analysis is that for a small proportion of the community, the value of an animal's life is assumed to be similar to that of a human.

It should be noted that any intrinsic value of an animal's life has not been valued in the current evaluation. Society supports the killing of animals for food purposes. However, most people do not like animals suffering. In order to value the animal welfare loss due to suffering, some estimate of an animal's life has to be made in order to value suffering on some relative scale.

The proportion of the community that would value the life of the animal and hence the quality of life of the animal is assumed to be equivalent to the estimate of the proportion of the Australian population that are vegetarian. While there is little information available about the number of vegetarians in Australia, perusal of some statistics from Australia and the United Kingdom (Vegetarian Network Victoria, 2007) indicate that a rough estimate is about 10%.

Not all vegetarians would be strong supporters of animal rights as there are other reasons why vegetarianism is practiced. Likewise, there would be people in society who are not vegetarians but who would strongly support animal rights.

If the expected life of a feedlot bovine animal is assumed to be 2 years, then the value of life to the bovine is $300,000 (2 x $150,000). If 10% of the population view an animal life this way, then the value of a bovine life is $30,000. Dividing by 2 x 365, the value of life per day of a bovine is $41.10 per day.

It is assumed that the quality of life of a heat stressed animal is reduced by 50%, so each day of heat stress is valued at $20.55 per animal ($41.10 x 50%). The heat stress period is assumed to last for 4 days so the stress cost per animal is $82.19 per head (4 x $20.55).

The number of animals affected in a heat stress event is assumed to be 4 times those that die (inclusive), that is, 2,000 x 4 = 8,000 animals in each event. The welfare loss is therefore estimated at about $658,000 per heat stress event.

Summary of Assumptions

A summary of all assumptions made is given in Table 5.

Table 5: Assumptions for the Valuation of Benefits from the 16 Heat Stress Projects

Variable	**Value**	**Source**
Without R&D investment		
Productivity		
Frequency of heat stress events	Every five years	Agtrans Research based on discussions with Des Rinehart
Cattle lost	2,000 head	Agtrans Research
Value of cattle	$1,100 per head	Des Rinehart
Animal welfare		
Cattle affected by heat stress	Four times the number that die = 8,000	Agtrans Research based on discussions with Des Rinehart
Proportion of Australian population that values the life and suffering of an animal similar to a human life	10%	Agtrans Research, based on various estimates of vegetarianism in Vegetarian Network Victoria (2007)
Value of a bovine life	$41.10 per animal per day	Derived as in text
Quality of life reduction during heat stress period	50%	Agtrans Research
Length of heat stress period	4 days	Agtrans Research based on discussions with Des Rinehart
Value of loss of quality of life	$82.19 per animal affected in each event	$41.10 x 50% x 4

With R&D investment		
Frequency of heat stress events	Every ten years	Agtrans Research based on discussions with Des Rinehart
First year of benefits for both profits and improved animal welfare	2004/05	Agtrans Research
Cattle lost	2,000 head	Agtrans Research
Cattle suffering heat stress	8,000 head	2,000 x 4
Value of cattle	$1,100 per head	Des Rinehart
Animal welfare costs	Same as the without R&D investment, that is, $82.19 per animal affected in each event	Agtrans Research

Results

All past costs and benefits were expressed in 2007/08 dollar terms using the CPI. All benefits after 2007/08 were expressed in 2007/08 dollar terms. All costs and benefits were discounted or compounded to 2006/07 using a discount rate of 5%. The base run used the best estimates of each variable, notwithstanding a high level of uncertainty for many of the estimates. All analyses ran for the length of the investment period plus 25 years from the last year of investment (2005/06) to the final year of benefits assumed (2030/31).

Investment criteria were estimated for both total investment and for the MLA investment alone. Each set of investment criteria were estimated for different periods of benefits. The investment criteria are reported in Tables 5 and 6.

Table 5 shows the results for investment from all sources including the MLA funding for the sixteen projects. Table 6 shows the investment criteria for MLA funding. This MLA investment is limited to twelve of the sixteen projects that were in the population of projects from which the sample was drawn.

Table 5: Investment Criteria for Total Investment and Total Benefits for the Sixteen Projects (discount rate 5%)

Criterion	0 years	5 years	10 years	15 years	20 years	25 years
Present value of benefits (m$)	0.65	2.01	3.08	3.92	4.57	5.09
Present value of costs (m$)	1.93	1.93	1.93	1.93	1.93	1.93
Net present value (m$)	-1.29	0.08	1.15	1.98	2.64	3.15
Benefit cost ratio	0.33	1.04	1.59	2.03	2.37	2.63
Internal rate of return (%)	negative	5.8	12.4	14.4	15.2	15.5

Table 6: Investment Criteria for MLA Investment in Twelve Projects in population[1]
(discount rate 5%)

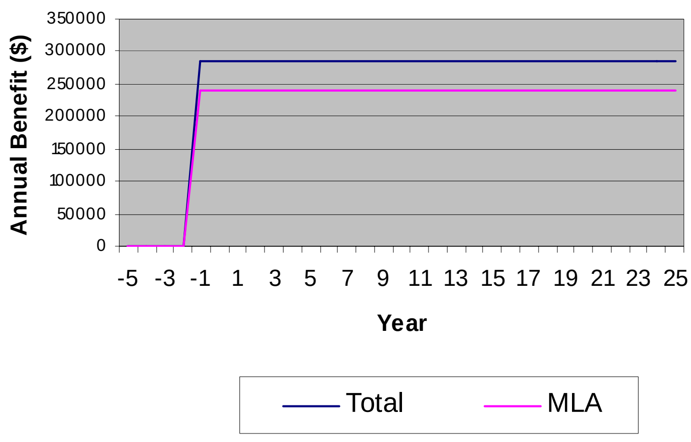
Criterion	0 years	5 years	10 years	15 years	20 years	25 years
Present value of benefits (m$)	0.55	1.70	2.60	3.31	3.86	4.29
Present value of costs (m$)	1.64	1.64	1.64	1.64	1.64	1.64
Net present value (m$)	-1.09	0.06	0.96	1.67	2.22	2.66
Benefit cost ratio	0.33	1.04	1.59	2.02	2.36	2.62
Internal rate of return (%)	negative	5.7	12.2	14.3	15.0	15.3

[1] Includes FLOT.307, FLOT.310, FLOT.312, FLOT.313, FLOT.316, FLOT.317, FLOT.319, FLOT.320, FLOT.321, FLOT.322, FLOT.327, FLOT.330

In terms of the quantified benefits, 77% could be attributed to the productivity component of the rural research priorities while the animal welfare benefits contributed 23% and could be placed in the categories of contributing to an environmentally sustainable Australia or promoting and maintaining good health.

The cash flow of benefits is shown in Figure 1 for both the total investment and for the MLA investment.

Figure 1: Benefit Cash Flow



Sensitivity Analyses

Sensitivity analyses were carried out on a range of variables and results are reported in Tables 7 and 8. All sensitivity analyses were performed using a 5% discount rate for the MLA investment only.

Benefits were estimated over the life of the investment plus 25 years from the year of last investment. All other parameters were held at their base values.

Results of a sensitivity analysis varying the period between heat stress events with the R&D program are shown in Table 7.

Table 7: Sensitivity of Investment Criteria to Period Between Heat Stress Events
(Benefits and Costs for MLA investment in the twelve projects)

Criterion	Discount rate 5%		
	Low value 7 years	**Base value 10 years**	**High value 13 years**
Present value of benefits ($ m)	2.45	4.29	5.28
Present value of costs ($ m)	1.64	1.64	1.64
Net present value ($ m)	0.82	2.66	3.65
Benefit-cost ratio	1.50	2.62	3.23
Internal rate of return (%)	8.7	15.3	18.4

The break-even heat stress frequency change for the benefit-cost ratio to be 1 was a reduction from a five year frequency without the research to a six year frequency with the research investment.

Table 8 shows the changes in investment criteria with different assumptions regarding the number of deaths and affected animals in a heat stress event. The break even number of cattle deaths in a heat stress event to provide a benefit cost ratio of 1 is 763.

Table 8: Sensitivity to Animal Deaths in a Heat Stress Event (a)
(MLA investment, 5% discount rate; 25 years)

Criterion	1,000	2,000(Base)	4,000
Present value of benefits (m$)	2.15	4.29	8.59
Present value of costs (m$)	1.64	1.64	1.64
Net present value (m$)	0.51	2.66	6.95
Benefit cost ratio	1.31	2.62	5.24
Internal rate of return (%)	7.4	15.3	27.0

(a) The ratio assumed of 3 stressed animals in addition to each death remains the same and is included the results in the table

Table 9 shows the changes in investment criteria with different assumptions regarding the intrinsic value of a feedlot animal's life. The results show that the sensitivity is not high due to the predominant benefits being those associated with commercial values.

Table 9: Sensitivity to Value of Life of a Bovine (MLA investment, 5% discount rate; 25 years)

Criterion	$20.55 per head	$41.10 per head (Base)	$82 per head
Present value of benefits (m$)	3.80	4.29	5.28
Present value of costs (m$)	1.64	1.64	1.64
Net present value (m$)	2.16	2.66	3.64
Benefit cost ratio	2.32	2.62	3.22
Internal rate of return (%)	13.7	15.3	18.4

No sensitivity to adoption (high, medium, low) has been presented as the assumptions made did not lend themselves to such an analysis.

Conclusions

The investment in the heat stress projects by MLA has increased the awareness of heat stress among feedlot managers. Also, a number of practices to manage heat stress in the summer period have been adopted by a high proportion of feedlot managers. Many of these practices have relied on information and products being produced from the investments. These changes will reduce the incidence of heat stress events in the future.

Given the assumptions made in the economic analysis, the investment has provided positive returns. For all investment in the 16 projects, the net present value is estimated at $3.15 m with a benefit cost ratio of 2.6 to 1.

Acknowledgements

Des Rinehart, Feedlot Project Manager, Meat and Livestock Australia, Brisbane

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8.2 Appendix 2: Grainfed Investment in Beef CRC II

Introduction

The Australian Lot Feeders' Association (ALFA) represents Australian feedlots. Its mission is to lead the industry in a manner that fosters excellence and integrity; improve the feedlot business environment; and ensure its community standing. The Australian government collects a levy on the sale of all grainfed cattle on behalf of industry. The levy is provided to MLA to fund marketing and research and development.

MLA has worked closely with the Cattle and Beef Quality CRC since 1993. Projects completed have had a significant impact on the feedlot industry and this association with the CRC has continued through one MLA project (Project FLOT.215) in the form of funding over the period 2000/01 to 2005/06.

Members of the CRC in 2000/01 were the University of New England, NSW Department of Agriculture, Queensland Department of Primary Industries, and CSIRO.

Investment Description

The objective of the project was to provide outcomes for the feedlot industry, in line with the objectives of the CRC. The contribution of MLA grainfed R&D funds was to be distributed to individual projects by the CRC in consultation with ALFA/MLA and MLA had the right to veto the distribution of funds to individual projects. Also, ALFA maintained a representative on the CRC Board and the CRC Advisory Committee. MLA maintained a seat on the Research Committee of the CRC.

The CRC provides MLA with an annual financial report documenting the allocation and proposed future allocation of the MLA funds to individual projects as well as a report detailing progress of relevant projects, and their outcomes, impacts and benefits to the Australian cattle feedlot industry. Hence, while MLA had some indirect control over the allocation of the granted funds within the CRC, these resources were spread across CRC projects that had outputs relevant to the feedlot industry.

An example of the distribution of grainfed funds provided by MLA is given in Table 1. This was sourced from the CRC annual report to ALFA for 2004/05. The projects listed were those to which the MLA annual contribution of $108,000 flowed in 2004/05 and 2005/06.

Table 1: Example of Projects Funded by the MLA Grainfed Funds to the CRC for Two Years of the Six Years of Investment

CRC Project	Area of Research	2004/05 ($)	2005/06 ($)
Project 1.3	Regulation of intramuscular fat Development	38,000	10,000
Project 1.4	Functional Genomics of Marbling	10,000	10,000
Project 2.1	Discovery of genetic markers … for Marbling, Tenderness and Efficiency of Feed Utilisation	15,000	25,000
Project 2.2	Improving the Efficiency of Feed Utilisation	15,000	0
Project 4.2	Information Delivery Systems	0	30,000
Project 4.4	Integration and Delivery of CRC technologies and information	15,000	0
Project 4.4	Industry Training and Technology Transfer	0	33,000
New project	Rumen inoculum for the efficient use of high grain diets	15,000	0
Total		108,000	108,000

Investment Costs

The total investment costs in FLOT.215 are shown in Table 2.

Table 2: Resources Invested by Year for MLA, the Researchers and Funding Partners for Project FLOT.215 (nominal $)

Year	MLA funds	Total CRC expenditure (a)	MLA as % CRC funding
1999/00	0	12,700,000	
2000/01	90,000	12,700,000	
2001/02	108,000	12,700,000	
2002/03	108,000	12,700,000	
2003/04	108,000	12,700,000	
2004/05	108,000	12,700,000	
2005/06 (b)	108,000	12,700,000	
Total	630,000	88,900,000	0.71

(a) DEST (2004)
(b) Funds assigned to the new CRC for Beef Genetic Technologies

Principal Outputs, Outcomes and Benefits

A range of outputs has been produced over the five years from the MLA investment. Because of the distribution of the MLA funds to different CRC projects in six different years, defining the outputs and outcomes and then identifying the associated benefits from all MLA grainfed supported projects is beyond the scope of this current investment analysis.

MLA grainfed funds have been co-invested in areas of relevance to the feedlot sector and the CRC has simply acknowledged MLA's role in a very wide range of outputs and outcomes including (Heather Burrow, pers.comm., June 2006):

- DNA markers for feed efficiency and marbling;
- development of IGF-I tests to speed up genetic improvement of feed efficiency;
- development of EBVs for Net Feed Intake to assist in genetic improvement of feed efficiency;
- non-genetic knowledge relating to achievement of marbling;
- a new algorithm to measure marbling content and distribution in the carcase on-line using video image analysis techniques;
- post-graduate student education focusing on feedlot-related topics;
- educational activities specifically designed for feedlot end-users; and
- improved profitability and productivity resulting from greater achievement of market specifications.

The benefits for the CRC investment as a whole and the specific contribution from MLA grainfed funds ultimately fall in the economic area. The most prominent benefit will be an increase in the rate of genetic gain by Australian beef producers. Such gains may be expressed in the form of productivity gains (more product per input) or products more suited to market demand and consumer tastes. These gains will be translated into income gains for the industry as well as benefit consumers. Limited environmental and social benefits will be delivered.

A summary of the benefits emanating from the investment in FLOT.215 is given in Table 3.

Table 3: Economic, Environmental and Social Benefits from the Investment

Economic	Environmental	Social
Increased productivity of beef production systems through increased rate of genetic gain	Improved effectiveness of feed utilisation with a lowering of methane outputs	Delivery and training initiatives have enhanced the capacity of the industry
Product enhancement to better meet market demand and consumer requirements		

Public versus Private Benefits

The benefits identified from the investment in the MLA support of the CRC are predominantly private benefits. The majority of the private economic benefits will be captured by cattle producers. However, some of the benefits of the productivity gains and a majority of the demand-enhancing gains will be passed along the supply chain to Australian processors and domestic and overseas beef consumers.

Match with National Priorities

The Australian Government's national and rural R&D priorities are reproduced in Table 4.

Table 4: National and Rural R&D Research Priorities 2007-08

Australian Government	
National Research Priorities	**Rural Research Priorities**
1. An environmentally sustainable Australia 2. Promoting and maintaining good health 3. Frontier technologies for building and transforming Australian industries 4. Safeguarding Australia	1. Productivity and adding value 2. Supply chain and markets 3. Natural resource management 4. Climate variability and climate change 5.Biosecurity Supporting the priorities: 1. Innovation skills 2. Technology

The program has made a major contribution to Rural Research Priority 1 through its impact on the rate of genetic gain. In addition, the investment would have contributed to maintaining or increasing demand by consumers through contributing to meat quality improvements such as marbling (Rural Research Priority 2).

The investment has made a significant contribution to the use of frontier technologies and innovation skills and technology for ensuring the sustainability of Australian industries (National Research Priority 3 and Supporting Rural Research priorities).

Quantification of Benefits

The six years of funding of FLOT.215 (2000/01 to 2005/06) mainly contributed to CRC II, except for the last year when the funding was allocated to CRC III (CRC for Beef Genetic Technologies). Because of the wide range of projects that were supported by FLOT.215, it was not possible to identify and quantify the benefits from each individual project supported. The approach originally intended was to use the overall benefits defined for CRC II and assign a proportion of those benefits to the FLOT.215. The proportion would be based on the financial contribution made by FLOT.215 to CRC II funding as a proportion of total CRC II funding. This proportion was small, less than 1% based on MLA grainfed funding of $108,000 per year for six years and total CRC II expenditure of about $12.7 m per year for seven years.

An economic analysis of the investment in CRC II had not been undertaken at the time of this evaluation report. However, a prospective economic analysis for CRC III had been undertaken. There was sufficient information in the analysis to satisfactorily reproduce the cash flows that led to the investment criteria presented for CRC III. These results were based on a 4% productivity gain due to CRC III over no CRC III. The assumption was made that CRC II would have produced similar productivity gains with similar benefits, R&D lags and adoption lags.

The Prospective Economic Analysis for CRC III

This analysis focused on the difference that funding CRC III would make to productivity growth in the beef industry. The increased productivity growth rate was translated into annual benefits from both demand enhancing and cost reducing outcomes. Appropriate R&D lags, adoption lags and adoption rates for both with and without CRC III were defined. Some of the key assumptions used in the economic analysis for CRC III are shown in Table 5.

Table 5: Key Assumptions Used in Economic Analysis for CRC III

	Potential rate of productivity improvement	**R&D lag**	**Adoption rate**	**Adoption lag**
	(%)	(years)	(%)	(years)
With-CRC	9	5	35	2
Without-CRC	5	7	25	5

(Source: Prospective Economic Analysis for CRC for Beef Genetic Technologies)

The results of the economic analysis for CRC III are shown in Table 6.

Table 6: Results of Economic Analysis for CRC III

Scenario	**Present value of total benefits (m$)**	**Present value of total costs (m$)**	**Net present value (m$)**	**Benefit to cost ratio**
With-CRC	1,930	98	1,832	19.69
Without-CRC	516	58	458	8.89
Difference	1,414	40	1,374	35.35

(Source: Prospective Economic Analysis for CRC for Beef Genetic Technologies)

The Simulated Analysis for CRC II

The same economic framework used for CRC III was assumed to apply for CRC II. This approach was supported by the CRC (Heather Burrow, pers. comm., July 2006). This approach was considered reasonable since:

- The method used for analysis of benefits from CRC III was a top down approach, rather than a bottom up approach that identified specific projects
- Much genetic research is of a "building block" nature, that is the scientific progress made in CRC II will be utilised in CRC III and some outcomes during the life of CRC III will be from R&D funded earlier; hence there is a continuum of outcomes that can be attributed back to a number of specific earlier investments.
- CRC I and II produced a range of products and packages, for example DNA markers; two vaccines for bovine respiratory disease, BREEDPLAN enhancements for feed efficiency and carcase and beef quality; enhancements to retail beef yield; marbling and feed efficiency as stand alone traits; pre-boosting and yard weaning to enhance subsequent feedlot performance (Heather Burrow, pers. comm., July 2006).

However, a significant change made for the analysis was a more conservative estimate of benefits than was made in the CRC III ex-ante evaluation. Firstly, the adoption lag for CRC III was assumed to fall from 5 years to 2 years with the advent of CRC III. This was due to the accelerated adoption component of CRC III. However, it was assumed that there would be no difference in the adoption lag with and without CRC II. Secondly the R&D lag for the 'with' CRC situation was assumed to be six years instead of five years as assumed for CRC III. Thirdly, the productivity gains for CRC II were scaled back to 50% of the original assumption made for CRC III. This resulted in a more conservative estimate of benefits than for the CRC as a whole and took into account the uncertain linkages between the CRC performance and its implications for the feedlot industry.

Summary of Assumptions

A summary of all assumptions made for the analysis is given in Table 7.

Table 7: Summary of Assumptions for the Valuation of Benefits from the Investment

Variable	Value	Source
Investment		
Total CRC II investment over seven years from 1999/00 to 2005/06 ($12.7 m per year)	$88.9 m	DEST (2004); also, estimate by Heather Burrow (pers.comm., July 2006) was $88.2 m
Total likely beef genetic investment over this period without CRC	59% of the "with CRC scenario" ($52.45 m)	Proportion from CRC III economic analysis
Benefits without CRC II		
Benefits at adoption rate below without CRC	$63 m per annum	CRC III economic analysis
R&D lag	7 years	CRC III economic analysis
Adoption lag	5 years	CRC III economic analysis
Adoption rate	25%	CRC III economic analysis
First year of benefits	2009/10	Agtrans Research
Benefits with CRC II		
Benefits at adoption level below with CRC	$89.5 m per annum	Based on 50% of that assumed in the CRC III economic analysis
R&D lag	6 years	CRC III economic analysis
Adoption lag	5 years	Agtrans Research
Adoption rate	35%	CRC III economic analysis
First year of benefits	2008/09	Agtrans Research

Results

Past costs and benefits were expressed in 2007/08 dollar terms using the CPI. All benefits after 2007/08 were expressed in 2007/08 dollar terms. All costs and benefits were discounted or compounded to 2007/08 using a discount rate of 5%. The base run used the best estimates of each variable, notwithstanding a high level of uncertainty for many of the estimates. All analyses ran for the length of the investment period plus 25 years from the last year of investment (2005/06) to the final year of benefits assumed (2030/31).

Investment criteria were estimated for both total investment and for the MLA investment alone. Each set of investment criteria were estimated for different periods of benefits. The investment criteria are reported in Tables 8 and 9.

Table 8 shows the results for the additional investment by the CRC including the MLA funding for FLOT 215. Table 9 shows the investment criteria for MLA funding for FLOT 215.

Table 8: Investment Criteria for Total Investment and Total Benefits for CRCII (discount rate 5%)

Criterion	0 years	5 years	10 years	15 years	20 years	25 years
Present value of benefits (m$)	0	46.93	146.04	223.69	284.54	332.21
Present value of costs (m$)	54.37	54.37	54.37	54.37	54.37	54.37
Net present value (m$)	-54.37	-7.44	91.67	169.32	230.16	277.84
Benefit cost ratio	0	0.86	2.69	4.11	5.23	6.11
Internal rate of return (%)	negative	3.0	15.8	18.4	19.2	19.5

Note: These results refer to the additional benefits and costs attributable to the CRC

Table 9: Investment Criteria for MLA Investment in FLOT 215 (discount rate 5%)

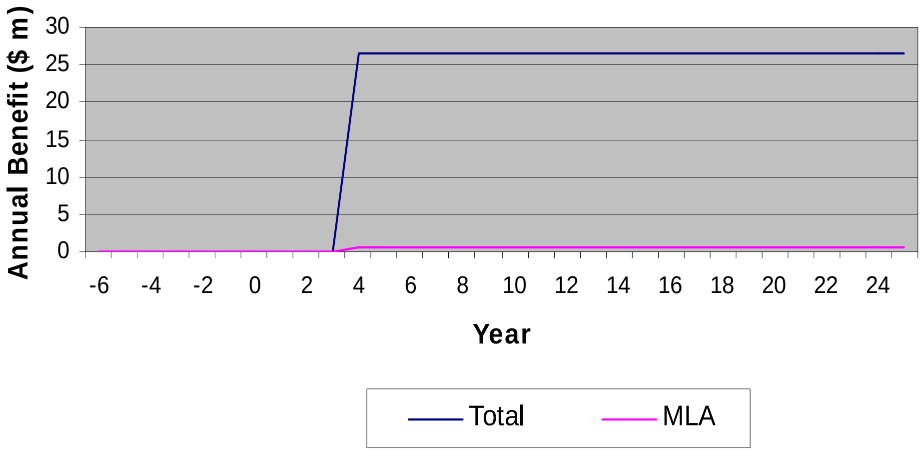
Criterion	0 years	5 years	10 years	15 years	20 years	25 years
Present value of benefits (m$)	0	0.79	2.47	3.79	4.82	5.62
Present value of costs (m$)	0.89	0.89	0.89	0.89	0.89	0.89
Net present value (m$)	-0.89	-0.10	1.58	2.89	3.92	4.73
Benefit cost ratio	0	0.89	2.77	4.25	5.40	6.31
Internal rate of return (%)	negative	3.3	17.0	19.7	20.5	20.8

Note: These results refer to the additional benefits attributable to the FLOT 215 estimated as the proportion that FLOT 215 funding made to the additional costs attributable to the CRC.

In terms of the quantified benefits, all of the benefits could be attributed to the productivity and enhancing demand components of the rural research priorities.

The cash flow of benefits is shown in Figure 1 for both the total investment and for the MLA investment.

Figure 1: Benefit Cash Flow



Sensitivity Analysis

Sensitivity analyses were carried out on a range of variables and results are reported in Tables 10 and 11. All sensitivity analyses were performed using a 5% discount rate for the MLA investment only. Benefits were estimated over the life of the investment plus 25 years from the year of last investment. All other parameters were held at their base values.

Results of a sensitivity analysis to the magnitude of the assumed likely benefits from CRC II are shown in Table 10. The results show that if the benefits were only 10% of those assumed, the investment would still more than break even.

Table 10: Sensitivity of Investment Criteria to Assumed Magnitude of Likely Benefits (MLA Benefits and Costs for FLOT.215, 5% discount rate)

Criterion	Likely benefits are 75% of current scenario	Current Scenario	Likely benefits are 125 % of current scenario
Present value of benefits ($ m)	0.87	5.62	10.37
Present value of costs ($ m)	0.89	0.89	0.89
Net present value ($ m)	-0.02	4.73	9.48
Benefit-cost ratio	0.98	6.31	11.63
Internal rate of return (%)	4.9	20.8	27.7

Table 11 shows the changes in investment criteria with different assumptions regarding the assumed adoption lag periods for research findings.

Table 11: Sensitivity to Adoption Lag Periods
(MLA investment, 5% discount rate; 25 years)

Criterion	Adoption Lag period 7 years	Adoption Lag period 5 years (base)	Adoption Lag period 3 years
Present value of benefits (m$)	2.94	5.62	8.58
Present value of costs (m$)	0.89	0.89	0.89
Net present value (m$)	2.05	4.73	7.69
Benefit cost ratio	3.30	6.31	9.60
Internal rate of return (%)	10.3	20.8	37.8

No sensitivity to adoption (high, medium, low) has been presented as the framework did not lend itself to such an analysis.

Conclusions

The MLA grainfed contribution to CRC II has been applied to a range of projects that will benefit feedlot operators as well as other sectors of the beef industry. The economic analysis has demonstrated high positive returns. The Net Present Value of the investment in FLOT.215 is estimated at $4.7 m with a benefit to cost ratio of 6 to 1 at a 5% discount rate.

Acknowledgements

Heather Burrow, Cooperative Research Centre for Beef Genetic Technologies
Des Rinehart, Feedlot Project Manager, Meat and Livestock Australia, Brisbane

References

ALFA (2002) “An Australian Lot Feeding Industry: Overview”, Sydney.

CRC for Cattle and Beef Quality (2005) “Milestone Report No 5: The ALFA contribution to the CRC for Cattle and Beef Quality “, Report to MLA.

Department of Education Science and Training (2004) “Cooperative Research Centres’ Program: CRC Directory”, Canberra.

8.3 Appendix 3: Review of Options to Reduce Feedstuff Supply Variability

Organisations: Macarthur Consulting and Rural Action
Start Date: February 2003
Completion Date: June 2003
Principal Investigator: Warwick Yates (Macarthur Consulting)

Introduction
Meat and Livestock Australia (MLA), Australian Pork Limited, Dairy Australia and Australian Wool Innovation Limited commissioned this study. The project arose from concerns raised by the National Feedgrain Action Group[1] about the ongoing feedstuff security for the target industries in the face of feed shortages brought about by the 2002-2003 drought. Studies of this nature surface in response to severe drought events and associated grassroots political pressure to 'find answers'.

The issue of feedstuff security and growth of a feedgrains industry has been the subject of many studies. Throughout the 1990s several reports examined supply and demand, alternative feedstuffs, regional supply demand models, and State-based examinations of feedstuff industries to underpin intensive livestock industries. To some extent, these studies have attempted to explain (and sometimes resolve) an apparent paradox. Australia is among the top five exporters of wheat and coarse grains in the world, with infrastructure to match, yet feedgrain users perceive difficulties in meeting their needs, which are normally less than one quarter of the total grain harvest.

The study examined the perceived inability of the agricultural sector to supply the intensive livestock feeding industries within the context of price variability (that is a natural response to periodic drought) and the livestock industry's difficulties with sourcing alternative supplies – most particularly imports – that might be used to ameliorate price variability. However, the capacity to source supplies from overseas is limited because there exists little free suitable milling capacity that could be utilised to comply with the current AQIS grain importing protocols.

Compounding these supply difficulties has been a relative lack of R&D aimed at boosting the yields of coarse grain crops. As noted in the report "…investment in grains R&D had achieved a three-fold increase in wheat yields" but "...the same could not be said for the coarse grains that are preferred by the intensive livestock industries". Furthermore, the Australian grains industry had been primarily focused on the production and export of milling wheats with much less focus on the feed requirements of the intensive livestock industries.

In summary, the periodic squeeze on feedgrain suppliers could be explained thus:

- The supply of feedgrains for domestic users was more limited and variable than aggregate statistics suggested.
- To a significant extent a few large companies owned the feedgrain supply (e.g. Australian Wheat Board and Australian Barely Board) and substantial tonnage was committed to export

[1] This group was convened by the Grains Council and should not to be confused with the 'Livestock Feedgrain Users Group' formed after this study was completed. The former was essentially production driven and does not exist today. The Feedgrain Users group is by its nature 'market driven' and can act as a vehicle for promoting grain user concerns. It now has ongoing lines of communication with the Grain Research and Development Corporation (pers. comm. Kathleen Plowman, Australian Pork Ltd).

customers. The duopoly enjoyed by the cereal grains industry allowed it to sell ‘opportunistically’ to the intensive livestock industries.

- Freight costs from Western Australia to eastern states, where the shortages occur, were inflated by coastal shipping regulations.
- In a developing drought event, grain vendors regarded grain stocks as appreciating assets. From this point the problem for domestic grain users became one of escalating prices and difficulty in being able to purchase large parcels of grain.
- Limited capacity to import grain due to quarantine stipulations in combination with a lack of portside milling capacity.

Investment Description

The current study is packaged into two volumes. Volume 2 contains a statistical compendium and seven commissioned papers that deal with key issues. The titles and authors of the commissioned papers are detailed below.

Review of feedgrain requirements of feedlots	Matthew H George, Nutrition Services Associates
Grain demand and economic cost of drought to the grass fed ruminant sector multivariable model from a national perspective	Dan Hogan, Keringal P/L
Feed grain and the Australian dairy industry	Whitehall DBC
Pork industry feedstuff security management strategies	Macarthur Agribusiness
Fodder supply and demand scenarios and risk management options for livestock industries	Colin Pearce, Jumbuck Consulting
Variability in supply of feedgrains associated with climatic variability in Australia (This study incorporated modelling by ABARE)	Graeme Hammer (formerly APSRU/QDPI, now UQ) & Andries Potgieter, APSRU/QDPI
AQIS conditions for the import of various grains	AQIS and AFFA

Volume 1 summarises, integrates and supplements the issue papers. Several chapters are focused on future grain supply security associated with drought (the short-term security problem) and projected growth in demand (the long-term security problem). The recommendations implicit in several chapters (e.g. chapter 9: *Future feedstuff supply security options*) are designed to serve as targets for policymaking.

The study examined global and Australian trends in feedgrain production and utilisation, impacts of drought and increasing intensive livestock industry demand. Options were defined that could possibly meet feedstuff requirements in drought and the feedstuff requirements associated with various intensive livestock industry growth scenarios. Initially the study was prompted by the severity of the 2002-2003 drought and the difficulties intensive livestock feeders were having in obtaining feedstuffs at prices that would enable their operations to maintain profitability[2]. At the same time as the study was being carried out, a number of other issues emerged with implications for feedgrain security including:

- The importation of feedgrains from the US and UK into eastern sea board ports with resultant domestic feedgrain price falls; imports included grain equivalent cassava based feedstuffs and palm kernel meals imported from Indonesia and imported pelleted mill run and corn gluten feed pellets;
- The high cost of transporting grain from WA and SA to the eastern states because of prevailing coastal shipping arrangements;
- Other initiatives of the Feedgrains Action Group including updating and enhancement of the Australian Bureau of Agricultural and Resource Economics (ABARE) regional feedgrain supply demand model, and an Australian Bureau of Statistics (ABS) survey of grain and fodder stocks;
- The emergence of possible technology solutions for grain and fodder treatment of imported feedstuffs;
- The outcomes of the GRDC Premium Grains For Livestock Program including better nutritional profiling of feedgrain suitability to livestock performance characteristics and the projected pilot trial of infrared spectroscopy technology to enable feedgrains to be segregated to best livestock end use and a quantitative basis for feedgrain trading; and
- New competition for feedgrain supplies from the fledgling grain based ethanol industry and increased grain feeding to dairy cattle.

The feedgrain shortage induced by drought in 2003-2003 impacted on the profitability of livestock feeding but access to feedstuffs continued. However, as the drought progressed it became evident that operation of the intensive livestock feeding industries could be significantly constrained by recurrent drought. In the longer term there appeared to be a forecast supply demand deficit for feedstuffs that, unless addressed collectively by the grains and livestock industries, could cap the growth potential of the intensive animal industries. Accordingly, the study examined:

- World and Australian feedstuff supply and demand trends;
- Current and forecast feedgrain production and use by the feedlot, pork, dairy and sheep sectors in Australia on a regional basis;
- The frequency and impact of drought on feedstuff production and availability;
- Key issues on feedstuff security seen by key intensive livestock feeders;
- Key issues impacting on the feedstuff security issue in Australia;
- Impediments to feedstuff access either through international imports or ‘internal imports’ from other States of Australia; and
- Practical options to resolve feedstuff shortages in drought or intensive livestock industry growth scenarios.

[2] This statement suggests that the underlying concern of the intensive livestock industries is with price levels during periods of grain shortage – rather than a physical inability to secure supplies. Clearly higher feed prices impact on profitability and could put producers already operating at the margin out of business. Such events are ‘characteristic’ of agriculture since periodic production and price shocks are ‘normal’ but the possibility of market failure is still relevant.

Associated Projects

The subject of 'feed grain security' has been extensively researched in response to periodic drought events and perceived shortages of product. The study included a comprehensive bibliography that included the MLA references cited below.

Meat & Livestock Australia (2003). "Australian Cattle and Sheep Industry Projections", Canberra.

Meat & Livestock Australia (2003). "High-energy feed alternatives for the feedlot industry", Feedlot FL04

Meat & Livestock Australia (December 2002). "The Impact of Feedlot Investment in Australia". MLA project FLOT.404, Sydney.

Meat & Livestock Australia (May 1999). "A Review of AQIS's March 1999 Draft Import Risk Analysis for the Import of Bulk Maize from the USA".

Meat & Livestock Australia, April 1997). "Alternative Energy Dense Feedstuffs for the Cattle Industry". MLA project FLOT.101, Sydney.

Meat Research Corporation (February 1995). "Input Requirements for Cattle Feedlot Industry. MRC Project Number: M.544.

Investment Costs

The investment by MLA in the project is shown in Table 1.

Table 1: Resources Invested by MLA, in Project FLOT.123 (nominal $)

Year	MLA funds	Partners funds (a)	Researcher Contribution	Total
2002/03	44,700	8,297	0	52,997
2003/04	72,903	0	0	72,903
Total	117,603	8,297	0	125,900

(a) Australian Wool Innovation, Dairy Australia and Australian Pork Limited but the contract was between the consultant and MLA.

Principal Outputs

The findings or outputs emanating from the research included the following:

Key features of feedgrain supply and demand

- The demand for feedstuffs in 2003 was approximately 10.8 million tonnes (MT). An ABARE analysis (conducted specifically for this study but incorporated in the APSRU study) indicated demand was expected to grow to 12.4 MT by 2007 (assuming the then current rates of growth in intensive livestock feeding industries) implying an overall 14% increase in total feed demand (see Table 2).

  The ABARE feedstuff supply / demand model included wheat, barley, oats, maize, sorghum, triticale, lupins, peas, faba bean, cotton seed, canola meal, soymeal, cotton seed meal, sunflower meal, roughages, millmix (bran and pollard), rice pollard and animal proteins. The intensive livestock industries included in the ABARE model were poultry broilers and layers, pigs, feedlot, dairy, sheep, grazing ruminants, and others including horses, aquaculture and various sunrise livestock industries[3].

Table 2: Australian Total Feed Demand in 2003 and 2007 (kt)

Feed	QLD	NSW	VIC	SA	WA	Total
Total Feed Demand (2003)	2,731	3,317	2,982	935	877	10,841
Total Feed Demand (2007 estimate)	3,200	3,848	3,288	1,051	982	12,369
% Growth	17%	16%	10%	12%	12%	14%
Source: ABARE model, 2003						

The strongest demand growth was projected in Queensland and NSW, the states where supply shortages had been the most acute and where intensive animal production for meat purposes was concentrated;

- Drought was a key component of cyclical grain and feedstuff shortages in Australia. The severity of droughts is not consistent across Australia and in most years there are sufficient supplies of feedgrains at current usage rates. The decision cycles in drought and industry growth scenarios are different and require different approaches for their resolution;
- The feed use profile consists of various dimensions governed by either drought or the need for continued industry growth. A decision cycle comes into play when there is restricted feedstuff supply in drought;
- Water was the input in shortest supply during the 2002-2003 drought event and this forced many operations to curtail activities. Water supplies are relevant to feedstuff security when and where they become more limiting (to intensive feeding generally) than feed supplies. Clearly reduced activity due to water supply constraints cannot be 'blamed' on shortages of feed or associated prices;
- The Australian intensive livestock industries were still growing and would require increased quantities of feedstuffs in the future;
- Each intensive livestock industry had its own demand profile driven by nutrition requirements, ration formulation and pricing considerations and geographic availability of certain feedstuffs;
- The principal feedstuffs required were predicted to be primarily cereal grains, pulses and some roughages;
- There were no easy solutions to feedstuff security now or in the future. The new CSIRO Stored Grains fumigation technology promised to kill pathogens and insects and devitalise the grain itself. However, the study concluded that more R&D was needed to ensure the technology complied with AQIS quarantine protocols for imported grains;
- Alternative feedstuffs to cereal grains (such as copra and cassava meal) were unlikely to be used in significant quantities because of limited availability, nutritional constraints,

[3] Prior to this study, the ABARE regional grain model assumed average yields and subsequently determined the likely transfer of grain between regions. The ABARE model was run in real time for the current study taking into account the climatic projections emanating from the Agricultural Production Systems Unit (APSRU) model. Steps towards integrating the two models have now been taken and represent an important outcome from this study.

possible anti-nutrition factors, export competition issues, real cost of energy and concerns about possible contamination with residues;

- The Eastern States, where the majority of intensive livestock industries are located, would form the greater part of the future domestic market for feedgrains and it is likely that there will be increasingly fewer exports of feedgrains from these States. But as the domestic intensive livestock industries grew, demand would be met in part by interstate transfers from WA and SA. This, in turn, would add to the importance of reducing the cost of coastal shipping, which is still regulated;
- In the event of severe and recurrent droughts, it was foreseen that substantial quantities of feedgrains would need to be imported. Because of AQIS quarantine provisions, imported grains would be used principally in metropolitan areas to service poultry and compound stockfeed manufacturers. In the 1994-1995 and 2002-2003 droughts, 440,506 and 430,431 tonnes of feedstuffs were imported respectively. There is limited scope to import higher tonnages based on portside milling facilities given existing obligations to domestic market clients. Milling capacity at the time was 1,040,000 tonnes per annum. Industry observers note that there was little free capacity available that could be utilised to comply with current AQIS grain import protocols;
- When the export parity price exceeds the import parity price, imports tend to stem further price rises for feedgrains. Imported grain can be processed at portside metropolitan areas and used primarily by the poultry and feed milling industries. The imported grain then causes up-country grain, normally destined for export, to be retained and made available for intensive livestock industries in those areas;
- One effect of drought has been constrained supply causing prices for winter and summer grains to increase as shown in Figure 1.

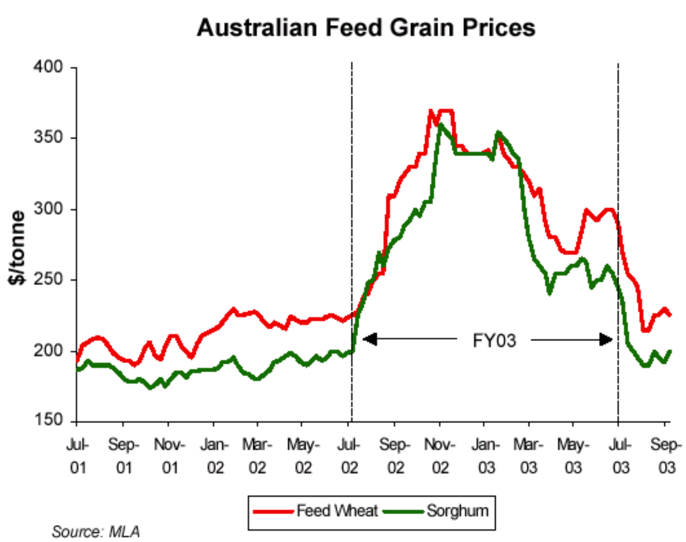


Figure 1: Effect of drought on feed grain prices (source: Meat & Livestock Australia (2003). "Australian Cattle and Sheep Industry Projections")

Domestic and Export Pricing of Feed Wheat

The drought in 2002-2003 forced the traditional gap between the export market price and the domestic market price for feedgrains to narrow as shown in Figure 2. As the drought persisted the domestic price in some cases exceeded export parity price triggering the import of feedgrains from the USA and UK. A similar price trend and triggering of imports also occurred in the 1994-1995 drought.

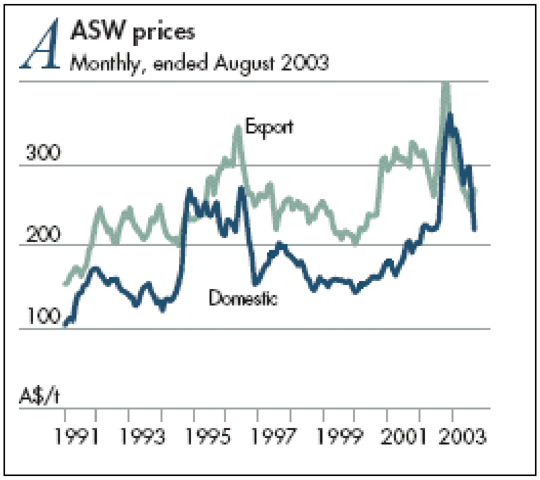


Figure 2: Comparison of export and domestic grain prices during drought (source: Australian Bureau of Agricultural and Resource Economics (2003). "Australian Grains Industry 2003 – Grain and Fodder Stocks". Canberra.)
(Note that figures 1 and 2 were not generated by the study but were included in its report to demonstrate the effect of periodic drought on domestic grain prices).

Outputs of climatic modelling

- Climate based seasonal forecasts can be made with a reasonable level of accuracy in May and September each year. At these times it is realistic for both the grains and intensive livestock industries to update and revise the Agricultural Production Systems Unit (APSRU) model (based on ABARE statistical regions) if there are concerns about feedstuff supply and demand;
- The study suggested that integrated modelling would enable the intensive livestock industries and the feedgrains industry to come together to examine likely feedgrain supply demand scenarios each year. From this point, it is up to individual operators to make their own strategic and commercial decisions. The options chosen by individual operators will depend on the nature of their industry dynamics, geographic location, enterprise size, attitude to risk, level of on-farm stocks, existing contract supply relationships and supply chain contract commitments;
- The options available to domestic grain users during drought events are affected by:
  - Nutrition and prevailing industry practices
  - Regulations
  - Infrastructure utilisation

Long Term Feedstuff Security Preparedness Options

Following are the long-term drought preparedness options recommended by the study:

- Increase grain and fodder storage on farm;
- Bring about more efficient coastal shipping;
- Improve access to imported grain;

- Encourage adoption of the testing service that predicts the digestible energy of cereal grains for pigs using infrared spectroscopy. This technology has been released by Australian Pork Limited (APL), the Grains Research and Development Corporation and the South Australian Research and Development Corporation (SARDI);
- Make an ongoing commitment to feedgrain research; and
- Consider taxation concessions for grain and water storage as drought preparedness assistance.

Short-Term Feedstuff Emergency Supply Options

Following are the short–term supply options recommended by the study:

- Waive import inspection fees;
- Allow international flag vessels to ship grain from WA to the eastern seaboard;
- Release stocks held by Government owned or empowered agencies; and
- Create a Peak Decision Making Body to initiate feed security options. This body would comprise the Chief Executives of key stakeholder groups with a focus on developing realistic action plans to address future feedstuff security supply constrictions.

The study suggested that exercise of both short-term and long-term options would depend in part on:

- Government preparedness to develop contingency planning options to mitigate the cost of exceptional circumstance funding in extreme drought events;
- The intensive livestock feeding industry's ability to negotiate preferred changes in government policies,
- Better engagement with the grain growing and marketing sectors to achieve mutually beneficial outcomes;
- The willingness for the intensive livestock feeding industries to secure feedstuff security on a contractual basis as opposed to being spot market buyers; and
- The development of better information programs to enable those players who want to utilise risk management tools depending on their enterprise size, nature of business and attitude to risk.

Principal Outcomes

One measure of a study's quality is the benefits it bestows on industry once it is tabled and evaluated for usefulness. By such criteria, FLOT.123 has generated high quality outcomes. The report was officially launched at Parliament House, Canberra and since this time it has been embraced by industry and extensively used as a basic reference, both for facts about feedgrains and for strategic direction when looking for 'solutions' (pers. comm., Kathleen Plowman, Chairperson of the Livestock Feedgrain Users Group).

According to the feedlot sector's project manager, stakeholders have made extensive use of the report. Potential for the report to be used has been enhanced in the first instance because it has been released by MLA and is available on various websites. Notwithstanding the possibility of bias, the report is said by the project manager to exhibit comprehensive coverage of the subject and clear recommendations.

Since release of the report, a 'Livestock Feedgrain Users Group' comprising representatives from the principal grain users has been formed and is now positioned to act on the recommendations.

Also, anecdotal evidence has emerged that decision makers within the wheat and barley marketing bodies are now more aware of the intensive livestock industries as a viable alternative to exporting.

Some of the recommendations from the investment in FLOT.123 have direct application to intensive livestock feeding operations. It was stated in the report that during severe drought "…grain is scarcer than money". This observation highlights the desirability of on-site storage and recommendations for encouraging increased storage. The technology applicable to safe grain storage already exists but remains to be complemented by changes in federal government policy that would make construction and usage of grain storage more financially attractive. On-farm storage of grain is seen as the risk-management strategy most relevant to smaller-scale users.

The adoption characteristics of this project will be mostly 'high-level'. Thus the target market is federal and state government agencies, peak industry bodies, industry associations and corporations as well as individual operators wanting to better understand the 'feedgrain paradox' and plan for future contingencies. Based on the report's recommendations a research program has been developed to take the pertinent issues forward (pers. comm., Kathleen Plowman).

Benefits Associated with the Investment

Large-scale studies of this type are needed periodically to update and inform the industry about the trends, issues and implications surrounding complex subjects. For Australian agriculture, there is possibly no better example of a complex subject than satisfactorily resourcing the intensive livestock industries.

The most tangible evidence of a positive response to the report rests with formation of the Livestock Feedgrain Users Group.

Given that the report is being acted upon, it will generate benefits of the following nature:

- Greater likelihood that supply capacity within Australia will be used to soften price movements in response to drought and other interruptions to the supply of grain.
- More overt competition among cereal grain sellers in the face of periodic drought and price movements.
- Further implications from the report will materialise through policy and strategy development aimed at protecting the future viability of the intensive livestock feeding industries. For example, future R&D recently commissioned by MLA is likely to make extensive use of FLOT.123 especially in respect to feed and water constraints.
- To the extent that the above changes reduce uncertainty, the intensive livestock industries will lift production. This will generate important secondary benefits in the form of jobs in regional centres. Another secondary benefit due to a larger feeding sector would be enhanced animal welfare during drought events. A feeding sector that is more economically stable in the face of drought will allow livestock to move to the safety of intensive feeding and thereby protect both animal welfare and the natural environment.

The report's immediate benefit lies in giving the feedgrain-using industries detailed factual information (e.g. about feedgrain requirements by industry, variability in supplies associated with climatic variability and AQIS import conditions, etc) and conceptual understanding of how markets work to address physical needs. A more enduring, and possibly greater benefit lies in setting goals for policy makers, industry leaders and corporations with a stake in making the grain-based livestock industries economically sustainable. The key to economic sustainability will be higher margins linked to less feedgrain supply and price volatility.

Summaries of the benefits that have arisen and that are likely to emanate from this investment are provided in Table 3.

Table 3: Economic, Environmental and Social Benefits from the Investment

Economic	Environmental	Social
Likelihood of strategies that will reduce the supply variability of feedgrains to end users	The natural environment will be 'saved' during drought events to the extent that feedlots and intensive feeding generally remain economic because of less price variability and a more rapid supply-side response to the needs of the livestock feeding industry. Cattle will move quicker to intensive feeding and thereby save pasture and reduce soil degradation.	Scope for industry expansion leading to flow-on benefits to regional communities especially jobs.
Integration of climatic and economic models to generate more timely and accurate predictions of grain supply outlook.		Job and income security for people working directly in the feed processing and delivery industry.
Greater cognizance of market failure and the need to look for solutions beyond the micro scale.	Real time modelling and more accurate predictions of drought should lead to better preparation and hence less land degradation.	Animal welfare during drought events due to greater confidence that intensive feeding will be relatively durable in the face of drought.
Development of a structurally sound industry that will be sustainable over the long term.	Superior pyhtosanitary standards applying to imported feedstuffs – due to superiority of devitalisation over QA practices such as inspection and random audits.	Enhancement of industry's understanding of how markets work to address severe events
A larger intensive animal industry with correspondingly larger dividends for operators and associated communities.		

Conclusions

It is concluded that FLOT.123 already represents good value for money with the promise of further dividends provided the report continues to be used. A major change already in the pipeline is formation of a coalition among feedgrain users that will give clearer expression to demand-side imperatives. While progress regarding changes in policies and strategies has been slow, the potential payoff ranges all the way from improved strategies and policies on grain storage to greater competition among grain suppliers to meet the needs of the intensive animal production sector.

MLA is clearly mindful of the occasional need for large-scale strategic studies that do not fit conveniently into any of the on-going programs. The risk with commissioning such studies is that they come up with recommendations that are seen to demand ‘too much’ of governments and industry bodies. Such risks notwithstanding, studies with a strong economic orientation are needed from time to time to remind people of the ‘power of the market’ and the difficulties that must be surmounted to correct market failures when and where these are found to occur.

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Graeme Hammer, University of Queensland
Vince O’Donnell, ABARE
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8.4 Appendix 4: Devitalisation of Imported Feedgrain by Fumigation

Devitalisation of Imported Feedgrain by Fumigation (FLOT.124 and FLOT.127)
Organisation: CSIRO Division of Entomology
Start Date: October 2003
Completion Date: August 2004, extended to January 2007 when FLOT.127 funded
Principal Investigator: Colin Waterford

Introduction

Australian livestock industries (both intensive and grazing industries) use about 8 to 9 million tonnes of grain representing about one third of the total Australian grain production in an average season. In 2002/03 Australian grain production fell to low levels due to the seasonal conditions and grain prices rose to about $350 per tonne ex silo for wheat and supply also became limited. During this crisis some 500,000 tonnes of grain was imported by metropolitan based chicken and stockfeed manufacturers. This activity for the mainstream livestock industries in rural areas was inhibited by the potential presence of weed seeds, pathogens and insects of quarantine concern. The capacity to source supplies from overseas was therefore limited because there existed little free milling capacity in metropolitan areas that could be utilised.

A few large companies owned the majority of the feedgrain supply (e.g. Australian Wheat Board and Australian Barley Board) and substantial tonnage was committed to export customers. The duopoly enjoyed by the cereal grains industry allowed it to sell 'opportunistically' to the intensive livestock industries.

The only fumigant that was registered to treat imported grain was methyl bromide which was being phased out due to its greenhouse gas implications. Further, methyl bromide would only be effective in very high concentrations.

CSIRO had developed a new fumigant that showed potential in devitalising grain and weed seeds and controlling pathogens and insects in imported feed grain. The main aim of project FLOT.124 was to evaluate the potential for the new fumigant gas 'ethanedintrile' (EDN) to act as a cost-effective quarantine treatment for grain so that devitalised imported grain could be transported safely to rural areas.

Investment Description

The project sought to establish the suitability of EDN as a potential solution for devitalisation of grain and associated weed seeds and pathogens to a level acceptable to quarantine authorities. This was to be achieved using a dose and method of application likely to be commercially viable and at a cost of no greater than $10 per tonne of grain treated.

The specific objectives of the project FLOT.124 were:

1. Develop a set of surrogate pathogens which can be used for study instead of the pathogens incursion risk list.
2 Furnish details as required by the Australian Quarantine and Inspection Service (AQIS) for the development of an incursion risk list for the commodities proposed for importation.
3. Produce a complete list of weeds of quarantine concern from the UK and US.

4. Classify weeds into ‘testable’ (seed available) and ‘not testable’ (seed not available).
5 Develop treatment schedules for discriminating, one off treatments of all testable weed species, and the four grains, wheat, barley, sorghum and maize, including relative humidity (RH) (water activity), dose exposure time, application technique, filling ratio.
6. Assess compatibility of materials against EDN.
7. Refine techniques for study of spore survival of surrogate pathogens.
8. Determine effective dosage for target surrogate pathogens for EDN with RH equivalent 10-14% moisture content cereals.
9. Assess one off exposure of testable weeds and the four grains, wheat, barley, sorghum and maize at constant RH, filing ratio, temperature, dose, exposure time, application followed by germination testing
10. Develop absolute maximum dose schedule that can be applied to commodities, weeds, insects, pathogens, materials.
11. Develop a treatment schedule that completely devitalises commodities according to International Seed Testing Association (ISTA) germination tests.

FLOT.127 extended the research carried out in FLOT.124 and gave particular emphasis to the level of EDN required to devitalise the weed seeds and actual pathogens of quarantine concern, rather than the surrogates tested in FLOT.124.

The specific objectives of FLOT.127 were:
1. Evaluate the feasibility of devitalisation of grain and specified insect, weed seed and pathogen contaminants of imported feed grain (maize, barley and wheat) using EDN.
2. Define the most cost-effective treatment protocols for devitalisation of grain and
specified insect, weed seed and pathogen contaminants of imported feed grain (maize, barley and wheat) using EDN and draft these in a format suitable for submission to Biosecurity Australia to initiate an import risk assessment.
3. Demonstrate the effectiveness of the EDN protocol to devitalise commercial scale
quantities (2000-5000 t) of maize (or another grain nominated by MLA) and specified insect, weed seed and pathogen contaminants.

In brief FLOT.127 was developed to

- Carry out tests on the real pathogens of concern, not surrogates
- Provide Biosecurity Australia more information for any prospective Import Risk Assessment they would carry out
- Further refine the required dosages and protocol for commercial applications

FLOT.124 was the project drawn in the sample. However, FLOT.127 continued from FLOT.124 and hence the two projects were evaluated together.

Investment Costs

The total investment costs in the project are shown in Table 1.

Table 1: Resources Invested by Year for MLA, the Researchers and Funding Partners for Projects FLOT.124 and FLOT.127
(nominal $)

Year	MLA funds	Partner (Australian Pork Limited)	Researcher (a)	Total
FLOT.124				
2003/04	300,000	300,000	0	600,000
2004/05	150,000	150,000	0	300,000
Total	450,000	450,000	0	900,000
FLOT.127				
2004/05	100,000	100,000	0	200,000
2005/06	160,000	160,000	0	320,000
2006/07	275,000	275,000	0	550,000
Total	535,000	535,000	0	1,070,000

(a) Based on interest of researcher in contracts being set at 0%

Principal Outputs

A key output of FLOT.124 was the identification of the target organisms (pathogens and weeds) associated with the commodities to be potentially imported. This process benefited from an earlier incursion risk assessment for maize carried out prior to the project. Information on targeted pathogens and weed seeds for the other grains were compiled for potential imports from the UK and USA.

Fungal pathogens were identified by Biosecurity Australia and surrogates identified for study. Experimental techniques needed to assess the viability of smut spores were developed.

An assessment of the compatibility of the fumigant with other materials was completed (metal, brick, concrete). The data were built into fumigation protocols.

A discriminating dose of the fumigant that could be applied to weeds and commodities was developed. This was to identify the most difficult weeds for further study.

Testing for the surrogate pathogens (smut, Fusarium, and Phytophthora) identified the smut fungi as being more tolerant than Fusarium and lethal doses for smut spores were defined. The devitalising dose for the smut surrogate was somewhat higher than for the commodities. Effective doses for the surrogate pathogens were found to be lower than the final recommended doses to kill all weeds and commodities.

The weeds seeds were equilibrated to the 70% RH requirement and testing of seed germinations as per objective 9 completed. The identification of the efficacy of different doses was completed. The Milestone 2 report for FLOT.124 reported:

“The discriminating dose proved very effective in identifying a subset of very tolerant weeds for further study. However the results also identified a substantial proportion of the weeds as untestable due to the germination failure of untreated control seeds. This has increased the numbers of weeds in the “non-testable” category. This will have negative implications for quarantine importation, and control measures additional to fumigation will certainly need to be considered (e.g. nil tolerance, risk of contamination at source/in transit and from structures and machinery, presence or absence of the quarantine risk at source, seed screening, assessment of risk of contamination and establishment at the end point)”.

Testing on commodities (wheat, barley, sorghum and maize) showed that EDN was more effective than methyl bromide by a factor exceeding six times. Wheat had the least variability in response to EDN treatment and barley was the most difficult to kill. However, at EDN levels necessary to control exotic weeds, barley could be completely controlled.

Preliminary estimates of the possible costs of application of EDN indicated that the cost was likely to be over $10 US per tonne, largely because of the sorption of the gas by the commodities, particularly sorghum and wheat. The final doses required to kill all potential weed seeds will be much higher than that needed for the commodities alone. Rapid sorption of the chemical by the commodities reduced the exposure of the weed seeds.

Project FLOT.127 is focussing on the actual pathogens of quarantine concern rather than surrogates. Arrangements for importing the target pathogens to Australia were being explored with AQIS at the time of the second last milestone report. However, it is apparent now that negotiations with the United States Department of Agriculture (USDA) are progressing more quickly and it is most likely that the work on the actual pathogens will be conducted in the USA rather than Australia.

Small scale trials (50kg) in FLOT.127 have indicated that it is feasible to apply the maximum target dose of 13,800 mg h/L of EDN over approximately five days to maize, wheat and barley. This has also been demonstrated for the 500 kg of maize treated for a weaner pig palatability trial, and the first of one tonne trials. At the time of this evaluation, trials have demonstrated the efficacy of EDN up to a lot size of one tonne. Preparations are being made to fumigate lot sizes up to 50 tonnes (Des Rinehart, pers.comm., July 2006).

Principal Outcomes

EDN was successful in devitalising all four grains, all surrogate pathogens and the majority of testable weed seeds. FLOT.124 concluded that maize would be the most suitable grain to import in terms of its feed value and fumigant consumption for development of large scale application of EDN for importing feedgrains. Such importation and use would be subject to registration of EDN and successful development of an import protocol based on EDN satisfying Australian quarantine requirements.

During the course of the project, the controlling committee for the project waived the $10 per tonne target for EDN treatment, presumably on the grounds that it may be an unrealistic constraint on the overall feasibility of a fumigant solution.

FLOT.124 recommended that further work on a larger scale was essential to demonstrate the practical application of an import protocol. At the time of completion of FLOT.124, EDN had not been registered but registration was being pursued by a commercial partner of CSIRO. It is understood that an application for registration has been submitted to the Australian Pesticides and Veterinary Medicines Authority (APVMA) (Des Rinehart, pers. comm., July 2006).

It is likely that an application to import will be made in order to ascertain the key information required by Biosecurity Australia in any import risk assessment (IRA). In the meantime the protocol for fumigant treatment will be further developed when the information is available from the tests on the real pathogens to be carried out in the USA (Des Rinehart, pers.comm., July 2006).

The cost of fumigating with EDN will depend to some extent on the price of EDN. EDN is manufactured only in experimental quantities at present. The commercial cost of EDN will depend to a large extent on other markets for fumigation such as for timber and soil.

Benefits Associated with the Investment

If the use of EDN for fumigating imported grain for use in rural areas eventuates, it would provide significant benefits to the intensive animal industries in rural areas. However, there are still a number of factors that need resolution before such use will be permitted. These include:

- The registration of EDN as a fumigant
- An import risk assessment and conditions that may be imposed by that assessment
- The cost of fumigating imported grain given the import risk assessment and the concentrations, amounts, and costs of EDN required

While intensive feeding animal industries (namely pig and beef feedlots) will benefit principally, there also may be some benefits accruing to other animal industries in rural areas through reduced costs of animal feed supplements in drought periods.

Potential benefits, conditional on the above factors, are described here as being economic, environmental or social. The principal potential benefit from the investment is the ability to import grain into rural areas in times of Australian supply shortages, providing confidence to intensive animal industry operators and reducing price variability.

The reduction in feed grain prices to animal industries in rural areas resulting from the ability to import may be offset to some extent by lowered revenue to the Australian grain producing industries.

A summary of the type of benefits emanating from this investment is given in Table 2.

Table 2: Economic, Environmental and Social Benefits from the Investment

<table>
<tr><th>Economic</th><th>Environmental</th><th>Social</th></tr>
<tr><td>Ability to import feed grain during supply shortages will provide confidence and continuity to intensive animal industries and lower input prices. This could lead to a potentially larger intensive animal industries. Any financial benefit needs to be offset against any losses imposed on the Australian feed grains producing sector.</td><td>Reduced risk to the environment from superior phytosanitary standards applying to imported feedstuffs – due to the superiority of devitalisation over QA practices such as inspection and random audits.</td><td>Scope for industry expansion leading to flow-on benefits to regional communities especially jobs.</td></tr>
<tr><td>Potentially a reduced risk to agricultural industries of weed seeds and diseases entering Australia through imported feedstuffs.</td><td rowspan="2">The natural environment will be ‘saved’ during drought events to the extent that feedlots and intensive feeding generally remain economic because of less price variability and a more rapid supply-side response to the needs of the livestock feeding industry. Cattle will move quicker to intensive feeding and thereby save pasture and reduce soil degradation.</td><td>Job and income security for people working directly in the feed processing and delivery industry.</td></tr>
<tr><td>Development of structurally sound intensive animal industries which are sustainable over the long term.</td><td>Improved animal welfare during drought events due to greater confidence that intensive feeding will be relatively durable in the face of drought.</td></tr>
</table>

Conclusions

The study proved the concept of using EDN to fumigate imported grain is feasible. However, at the end of FLOT.124 there were still considerable hurdles to overcome in moving to a situation where imports to rural areas would be allowable under quarantine regulations and economic for users. FLOT.127 is providing further information to assist with treatment protocols. Even then there still may be time delays in the any government IRA and uncertainties in the eventual development of import protocols for grain moving to rural areas.

Acknowledgements

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