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Measuring and Communicating the Value of R&D Programs within Livestock Production Innovation
Volume 1: Main Report

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Abstract

Fifty randomly selected individual projects funded by MLA from July 2001 to June 2006 have been evaluated. Benefits for each project are described and summarised in a triple bottom line format (economic, environmental and social).

Thirty of these projects have been subjected to a benefit-cost analysis with the remainder evaluated qualitatively. As some selected projects have been grouped together for the purpose of estimating the value of benefits, there are 24 rather than 30 individual quantitative analyses in the report.

All analyses demonstrate that a wide range of outcomes and benefit types are being delivered by Livestock Production Innovation. The 24 quantitative evaluations result in an average benefit-cost ratio of 9 to 1 with benefits being shared between the industry and consumers.

Executive Summary

Rationale

The rationale for this evaluation was that MLA required some measure as to how well their R&D investment portfolio was performing.

The initiative was to provide accountability to MLA investors (industry and government) that investments were being made wisely and were retuning financial/economic gain to industry and the wider society. Another principal requirement was the provision of information in a triple bottom line format on the range and nature of benefits being produced.

Project objectives

The objectives of the evaluation were:

1. To complete and report on a randomly sampled, stratified evaluation of the Livestock Production Innovation (LPI) investment portfolio, including quantitative cost-benefit analyses, of projects funded during July 2001 to June 2006.
2. To complete and report on a quantitative and qualitative evaluation of the OJD R&D program including benefit-cost analysis (see Volume 8).

While the major objective of the study was in measuring the value of its R&D programs within LPI, other objectives were:

- To learn from analyses of past investments in order to improve current and future investment decisions.
- To describe and communicate a spread of successful research investments to stakeholders.

Approach

The analysis was established by 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.

Results

Each of the twenty evaluations not valuing benefits included a description of the rationale for each investment, the amount of investment, and the objectives of the project. The outputs, outcomes and benefits were then described. There were 19 qualitative analyses for the 20 projects, two projects having been combined as they both referred to the same subject matter.

Benefit types

Economic benefits were identified in all 43 analyses and were valued in all 24 quantitative analyses. Environmental benefits were identified in 30 of the 43 analyses. No valuation of environmental benefits was applied but in many cases the economic benefits valued also captured an

environmental or resource condition benefit (e.g. reduced soil loss from earlier destocking). A total of 30 of the 43 analyses identified social benefits arising from the investments. As with the environmental benefits, no social benefits were valued in the 24 benefit-cost analyses.

Investment criteria
The 30 projects analysed in a quantitative manner were subjected to the same process as for the qualitative analyses. However, for these 30 projects an attempt was made to value some of the benefits that had been defined. In addition, details of the financial investment that produced these benefits were assembled. This allowed a benefit-cost analysis to be performed for each of these 30 projects. However, for some analyses, more than one of the 30 selected projects contributed to the benefit set that was defined. This meant that 24 analyses represented the 30 projects.

A summary of the results for the 24 analyses are provided in the following table:

Investment Criteria for MLA Investment into the Selected Project
(discount rate = 5%; present values as of 2005/06 in 2005/06 $ terms)

	MLA investment into Selected Project (s)			B/C Ratio	IRR (%)
Investment	**PVB ($M)**	**PVC ($M)**	**NPV ($M)**		
1. BeefPlan Group No. 1	0.08	0.03	0.05	2.3	12.6
2. BeefPlan Group No. 2	0.05	0.11	-0.06	0.49	Negative
3. Bullpower	3.66	0.19	3.47	19.4	51.0
4. Grazing Land Management	12.65	0.36	12.29	35.4	26.6
5. Eradicating rejected forage plants	1.57	0.15	1.42	10.6	25.5
6. NIRS: calibration and delivery (two projects)	6.75	0.86	5.89	7.9	38.3
7. Whole-Flock Vaccination for OJD	0.19	0.03	0.15	5.5	41.2
8. Gene silencing in parasitic nematodes	2.04	0.26	1.79	7.99	18.2
9. Prime Time Campaign	3.10	0.49	2.62	6.40	24.3
10. Pathogenesis of OJD	2.45	0.87	1.58	2.82	10.7
11. CBX herd	1.68	0.11	1.56	14.8	39.7
12. Tagasaste	4.69	0.73	3.97	6.5	29.1
13. EDGE*network*® (four projects)	5.44	1.25	4.19	4.4	13.5
14. Beef Genetics Research	2.92	0.82	2.10	3.55	No solution
15. Meeting Market Specifications	6.91	0.78	6.13	8.9	22.9
16. Heat Load in feedlots (two projects)	0.98	0.46	0.53	2.16	13.7
17. ALFA contribution to the CRC	11.12	0.76	10.35	14.5	39.9
18. Saudi Arabia Trade Resumption	4.71	0.25	4.46	18.7	Very high
19. Heat Stress Model	5.01	0.28	4.73	18.2	Very high
20. SGS (two projects)	1.43	0.37	1.06	3.85	No solution
21. Grain & Graze	1.03	0.17	0.86	6.0	21.6
22. Buffalo Fly trap	1.00	0.24	0.76	4.1	10.2
23. Biological control of weeds	22.48	0.55	21.93	40.8	94.3
24. EverGraze	1.40	0.43	0.96	3.22	12.6

The investment criteria produced are highly dependent on the assumptions made in each analysis. Where there are multiple types of benefits it is often not possible to quantify all the benefits that may be linked to the investment. Further, assumptions were required that related to the difference that the investment has made. Some of these assumptions can be contentious and many made in the analyses are a matter of judgement. To address the uncertain assumptions, some sensitivity analyses have been conducted, where the investment criteria are recalculated with variations of some of the uncertain assumptions. In addition, a rating has been given to the confidence in the results. The confidence ratings address the coverage of benefits and the degree of certainty in the assumptions.

Overall, the distribution of investment criteria for the MLA projects in the table above is not dissimilar to those observed in other recent studies carried out by Agtrans Research for other R&D organisations.

A key outcome for the assessment was the aggregate performance of the MLA investment in the 30 projects drawn in the sample where benefits were valued quantitatively.

As the analyses for these 30 projects also drew in other MLA investment from the population, an assessment was also made of what is termed the 'extended sample'. The following table describes the resulting investment criteria for both the 30 projects and the extended sample, that is all projects in the population where benefits had been valued. Results are expressed in 2005/06 $ terms as of 2005/06.

Aggregate Investment Criteria for 30 Projects and for the Extended Sample
(discount rate 5%)

Discount rate	30 Projects	Extended sample
Present Value of Benefits ($M)	104.50	163.50
Present Value of Costs ($M)	11.17	23.53
Net Present Value ($M)	93.33	139.97
Benefit-Cost Ratio	9.35 to 1	6.95 to 1

The reason for the fall in the benefit–cost ratio for the extended sample is that the extension drew in many more projects from two large programs (SGS and EDGE*network*) both of which had benefit–cost ratios lower than the average.

The aggregate benefits from the 30 projects can be compared with the cost of investment in the sample of 50 projects in order to generate aggregate investment criteria for the entire sample. This provides investment criteria that should be considered only as a minimum as it assumes there are no benefits from the 20 projects where benefits were not valued. However, these minimum investment criteria can be applied to the entire population of projects as they are based on a random sample of the total investment.

The following table provides the investment criteria for the entire sample of 50 projects as well as for the extended sample. These investment criteria can be extrapolated to the population as the original sample of 50 projects made up 27% of the population of projects and the extended sample made up 45% in terms of the present value of costs.

Aggregate Investment Criteria for Entire Sample of 50 Projects and their Extensions
(discount rate 5%)

Discount rate	Sample of 50 projects	Extended sample
Present Value of Benefits ($M)	104.50	163.50
Present Value of Costs ($M)	19.46 (a)	31.81
Net Present Value ($M)	85.04	131.68
Benefit-Cost Ratio	5.37 to 1	5.14 to 1

(a) The Present Value of Costs for the 20 qualitatively analysed projects was $8.28 M and this is added to the Present Value of Costs for the quantitatively analysed projects of $11.17 M.

The B/C Ratio of 5.4 to 1 should apply to the investment of $57.010 M in the population, that is, the present value of benefits produced from the LPI investment of $57 M is estimated as at least $308 M. This will be a conservative estimate as benefits were not valued at all for a part of the sample. Also, the identified environmental or social benefits were not valued for any projects.

Distribution of benefits
It needs to be recognised that livestock producers do not always capture all the benefits from R&D investment. Consumers and other parts of the industry along the value chain will also share in the benefits. However, in general producers are likely to capture a considerable proportion of the benefits estimated in the current analyses.

Ovine Johne's Disease (OJD) program
A separate economic analysis of the OJD R&D Program was undertaken. The Program consisted of 45 projects funded over the period from July 1998 to December 2007. Based on the assumptions made, the investment returns were positive. The investment achieved a net present value of $18.7 million at a 5% discount rate. The benefit-cost ratio was 1.8 to 1 and the internal rate of return just under 14%.

The benefits estimated are probably an underestimate of the true benefits since any benefits from a large strategic research component of the program have not been included in this analysis and could well lead to prospective future benefits.

There is no question that the results of the R&D investment provided valuable direction to all concerned and that the vaccine and grazing management technologies that were developed have given sheep producers options for management that they would not have had without the R&D investment. These management tools also underpinned the policy developments that have been made in the area of risk management and reduced regulation regarding OJD. The evaluation of the OJD program is presented Volume 8 of this report.

Conclusions

The findings from the qualitative and quantitative analyses demonstrate that:

- A range of benefit types (economic, environmental and social) are being delivered by LPI investment with the most frequent benefit delivered being on-farm productivity improvements.
- For the 30 projects where benefits were valued, the aggregate benefit-cost ratio was 9.4 to 1 at a discount rate of 5%.

- The total LPI investment over the period 2001 to 2006 has delivered (or is expected to deliver) a positive return on investment, with an estimated benefit–cost ratio of at least 5.4 to 1.
- As a large number of environmental and social benefits were identified as emanating from these investments without being valued, the results above are likely to be an underestimate of the performance of the sample and the portfolio.

Recommendations

1. Information on the magnitude of investment by year and by project should be maintained by MLA so that all partner contributions to an investment can be more easily identified by year and by contributing organisation.
2. The specification of the value of the researcher contribution to projects (in kind) is not always in contracts. It is recommended that such specification should be made mandatory.
3. MLA should consider giving greater encouragement to principal project teams and program and project review team to devote greater attention to the economic aspects of project investment when reporting and evaluating projects.

Contents

1 Background

Meat and Livestock Australia (MLA) was established in 1999 and assumed the R&D investment and management role of the former Meat Research Corporation. Restructuring led to the formation of Livestock Production Innovation (LPI) as a business unit within the new organisation.

LPI invests in R&D activities to deliver production, environmental and social benefits to MLA's stakeholders. These stakeholders include sheep and beef producers, feedlotters, live exporters and the Australian government. Funding to produce these benefits comes from industry transaction levies and matching funds from the Australian government.

Previous approaches to economic evaluation of MLA's portfolio of investment in R&D were not regular, were carried out through different methods and were usually based on selected projects. The pending introduction of an investment and evaluation framework by MLA through an approach arising from a MLA consultancy with the Centre for International Economics (CIE) has stimulated thinking along the lines of a more coordinated and ongoing approach to evaluation.

The rationale for this study was that MLA required some gauge as to how well the R&D investment portfolio is performing. The study was established by selecting a representative set of projects funded by LPI over the five years from July 2001 to June 2006. These projects were each described in terms of their outputs, outcomes and triple bottom line benefits. Thirty of the fifty projects were subject to quantitative economic evaluation. 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. The approach was to provide accountability to MLA investors (industry and government) that investments were being made wisely and to demonstrate financial/economic gain to industry and the wider society. Another requirement was the provision of information in a triple bottom line format on the range and nature of benefits being produced.

2 Project Objectives

The objectives of the consultancy are:

1. By 15 May 2006, complete and report on a quantitative and qualitative evaluation of the OJD R&D program including benefit-cost analysis.
2. By 31 July 2006, complete and report on a randomly sampled, stratified evaluation of LPI's investment portfolio, including quantitative cost-benefit analyses, of projects funded during July 2001 to June 2006.

The primary objective for MLA in measuring the value of its R&D programs within LPI is accountability. That is, to demonstrate the nature and size of the impacts and benefits resulting from the research investment.

Secondary objectives of the study are:

- To learn from analyses of past investments in order to improve current and future investment decisions.
- To describe and communicate a spread of successful research investments to stakeholders.

3 Methodology

3.1 Definition of Project Population

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 broad 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. The steps undertaken included:

- removing the GST for those years where appropriate to give actual expenditures.
- decreasing the values of those projects identified as including funding other than that from MLA. The values were decreased according to percentages provided by MLA.
- identifying the appropriate cost data for the year 2005/06 as both actual and budgeted figures were provided for that year. The highest figure for each project from the actual or budget columns was selected.

At the completion of this step, the total value of the broad population of projects was $89.601 M (888 projects) and covered funding of projects from 1998/99 to 2007/08.

The next steps on further refining the population were:

- excluding any project that received no funding in the five year period 2001/02 to 2005/06.
- excluding any project that had greater than 10% of its budget occurring after June 06.
- excluding any project that received total funding of less than $25,000.

The rationale for the above exclusions was to ensure that the population of projects related to the time period of interest and also to ensure that projects selected for analysis were largely completed at the time of the analysis. This was to ensure greater confidence in the assumptions made regarding the outcomes and benefits of the investment. Projects that commenced prior to the time period of interest (that is, before June 2001) and only have one year of funding in the time period of interest are still included in the population. This is for continuity purposes if further five year time periods are evaluated in the future, and to ensure every project is eligible for inclusion in at least one five year period. For example, a project that is excluded from the analysis for the five year period ending June 2006 due to the project not being substantially completed, may also be excluded from an analysis for the five years starting July 2006 if a rule were implemented that a certain proportion of its funding could not be prior to the five year period.

The decision was made to exclude any project receiving funding of less than $25,000 to ensure that very small projects did not dominate the sample. The purpose of this was to ensure a sufficient sample of the population of dollars invested was achieved.

A total of 164 projects received no funding in the five year period of 2001/02 to 2005/06. These projects had a total value of $8.968 M. A further 76 projects had greater than 10% of their budget occurring after June 2006. These projects had a total value of $27.035 M. The total number of projects remaining in the population at this point was 648 with a total value of $53.599 M.

A total of 245 projects received total funding of less than $25,000, however these projects had a combined value of only $3 M (5.6% of the total funding of projects included in the population at this point).

The next step was the exclusion of some of the following types of project that remained in the population. The identification of projects for exclusion was undertaken by MLA staff:

- Company Managed Activities (CMAs)
- Consultancies of an operational nature, market research, workshops
- Coordinators

Finally, the remaining population was scanned to consolidate where contract variations had resulted in a project having two entries for the same contract. The investment was rationalised into one entry for that project where this was observed.

At the completion of all of the above exclusions and adjustments by MLA staff, the total LPI investment being 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.

3.2 Defining the Size of the Sample

The number of projects to be included in the sample depended on:

- the variation expected between individual project investment criteria,
- the number of projects in the population, and
- the confidence limits required around the aggregate investment criteria produced.

Due to the lack of information on the expected variation of the investment criteria in the population of MLA projects, use was made of known variation across investment criteria for other R&D projects. The variation in the B/C Ratios from a recent evaluation study for the Sugar R&D Corporation (24 projects quantified) was used as a proxy for the expected MLA B/C variation. The simple average B/C Ratio across the 24 projects was 7.5 for the sugar study, with a 95% confidence interval of +/- 2.8 either side of this mean estimate for the population mean. At 90% confidence the interval was +/- 2.4.

As the sample size changes an estimate of the confidence intervals is presented in Table 3.1.

Table 3.1: Confidence Intervals at a Range of Sample Sizes

Sample size	Confidence interval (+/-) for the B/C Ratio
12	4.0
18	3.3
24	2.8
30	2.5
36	2.3

In another study of selected projects (not random) over three years for Land & Water Australia, the simple average B/C Ratio was 6.8 (weighted average of 3.5). The individual projects had a similar variation in their B/C Ratios to the SRDC evaluation.

Experience with other RDCs (pigs, dairy, sugar, land and water) has demonstrated that generally about 50% of all projects selected in a random sample are usually able to have their benefits quantified satisfactorily. If say 25 projects were quantified for MLA, then it estimated that 50 projects have to be selected in the random sample. A quantified sample of 25 would provide a confidence interval of approximately 2.8 in the B/C Ratio. Further projects quantified would give only a small and declining reduction in the confidence interval (see Table 3.1).

If 50 projects were selected in the sample, it would provide also a significant part of the MLA population (as defined) being quantified. By project number it would be 50/361 (14%) and most likely a higher proportion by dollar value is the sample was stratified by financial value. Given the broad assumptions and indications provided above, the 50 projects appear statistically efficient as well as being sufficient to represent the population from a non-statistical viewpoint.

Therefore, the total number of projects (or project equivalents) that could be analysed, given the resources available and the other requirements of the evaluation was set at 50, with an objective of quantifying 25.

3.3 Sampling

In order to ensure the 50 projects were randomly selected but so that they formed a representative sample of the population, some pre-stratification was applied in the selection process. Two variables were considered important in the stratification:

- the program; and
- the size of the project investment (greater than or less than the mean value of projects in the population).

Ideally, the population would be stratified based on the five programs representing the five types of levy payers to LPI. These are:

- Southern Beef Producers
- Northern Beef Producers
- Lamb, Sheepmeat & Goat Producers
- Live Exporters
- Feedlotters.

However, there are a number of areas of funding which receive contributions from two or more of the above levy groups. These include projects related to animal health & welfare and the environment. Therefore these projects could not be easily allocated to one of the five programs above. Options considered included placing the project in the program from which it received the majority of its funding, or having the project appear in each of the programs in which it received funding. The decision was taken that both of these options would bias the selection process for or against the projects. Therefore for the purposes of the stratification, the projects receiving funding from multiple programs were kept in separate groups. As the proportions of funding received from various programs are known, some distribution of benefits from these projects to the original five programs has been possible when aggregating investment criteria. The additional categories included for pre-stratification were:

- Environment

- Animal Health & Welfare (AH&W)
- Strategic Science
- Adoption & Capacity

In addition, two projects were unable to be clearly assigned to any program including the four additional programs above. Therefore they were each included as separate strata.

The population of projects in terms of size (by value) is specified for the two strata in Table 3.2.

Table 3.2 Description of the Project Population in terms of Number & Value by Group and by Size

Group	a (< mean)		b (> mean)		Total	
	Value (and % of total)	No. of projects	Value (and % of total)	No. of projects	Value (and % of total)	No. of projects
Southern Beef (SB)	$1.339m (2.79%)	23	$7.039m (14.61%)	14	$8.378m (17.38%)	37
Northern Beef (NB)	$2.762m (5.73%)	49	$9.161m (19.06%)	27	$11.923m (24.74%)	76
Lamb, Sheepmeat & Goats (LSG)	$3.886m (8.06%)	67	$5.378m (11.16%)	18	$9.264m (19.22%)	85
Live Export	$0.862m (1.79%)	20	$1.738m (3.61%)	10	$2.600m (5.39%)	30
Feedlots	$1.338m (2.78%)	22	$3.815m (7.90%)	10	$5.153m (10.69%)	32
Environment (SB & LSG)	$2.598m (5.39%)	38	$5.278m (10.95%)	20	$7.876m (16.34%)	58
AH&W (NB, SB & LSG)	$0.380m (0.79%)	7	$0.300m (0.62%)	1	$0.680m (1.41%)	8
Strategic Science	$0.774m (1.60%)	14	$0.160m (0.33%)	1	$0.934m (1.94%)	15
Adoption & Capacity (NB, SB & LSG)	$0.745m (1.55%)	15	$0.515m (1.07%)	3	$1.26m (2.61%)	18
DAV.094	$0.097m (0.20%)	1	0	0	$0.097m (0.20%)	1
PRD.1997	$0.029m (0.06%)	1	0	0	$0.029m (0.06%)	1
Total	$14.808m (30.73%)	257	$33.381m (69.27%)	104	$48.191m	361

The sample of projects was selected pro rata according to the percentages in Table 3.2, resulting, after rounding, in 50 projects being selected according to the project numbers in Table 3.3. The numbers in brackets represent the number of projects to be selected in each strata, after rounding.

Table 3.3 Number of Projects Selected in Each Group

Group	**Size**	
	a (< mean)	**b (> mean)**
Southern Beef	1.39 (1)	7.30 (7)
Northern Beef	2.87 (3)	9.51 (9)
Lamb, Sheepmeat & Goats	4.03 (4)	5.58 (6)
Live Export	0.89 (1)	1.80 (2)
Feedlots	1.39 (1)	3.96 (4)
Environment (SB & LSG)	2.70 (3)	5.48 (5)
AH&W (NB, SB & LSG)	0.70 (1)	
Strategic Science	0.8 (1)	0.17 (0)
Adoption & Capacity (NB, SB & LSG)	0.77 (1)	0.53 (1)
DAV.094	0.10 (0)	
PRD.1997	0.03 (0)	
Total	15	35

All projects in the population were placed in an Excel spreadsheet, and a random number between 0 and 1 was generated by the Excel program and assigned to each project. The projects were then arranged into ascending order based on the random number assigned. Each of the projects was then considered in turn from the beginning of the list until the quota of projects for each cell of the stratification above was filled. Where a cell was full and the next project drawn was for that cell, the project was discarded and the next project drawn.

One of the 50 projects was replaced later due to it being found ineligible.

The final sample of projects is presented in Table 3.4. The total value of MLA funding for the 50 randomly selected projects was $12.335 M, which was 26% of the total population of relevant projects of $48.191 M (nominal terms). The replacement project is included in Table 3.4 (SFG.014)

Table 3.4: Sample of 50 LPI Projects

Project code	Project title	Total MLA funding ($)	Start date	End date
Northern Beef				
NBP.215	Beefplan Group No. 1	30,000	2003/04	2006/07
NAP3.310	Beefplan Group No. 2	41,513	1999/00	2001/02
NAP3.117	Bullpower: Delivery of adequate normal sperm to site of fertilisation	92,625	1999/00	2002/03
NAP3.325	Grazing Land Management: Education Package Technical Manual	174,455	2000/01	2002/03
NBP.316	Assessing the Value of Trees in Sustainable Grazing Systems	175,345	2002/03	2005/06
NBP.327	Protecting North Australian Grasslands from Rejected Forage Plants of High Weed Potential	136,580	2002/03	2005/06
NAP3.222	Incorporation of Practical Measures to Assist conservation of biodiversity within sustainable beef production in Northern Australia	175,611	1998/99	2001/02
NBP.303 V1	Delivery of NIRS to improve cattle nutrition	200,772	2001/02	2004/05
NAP3.121	Improving nutritional management of grazing cattle: Improving reliability of faecal NIRS calibration equations	242,650	2000/01	2003/04
NAP3.326	Rangelands Australia	245,454	2000/01	2002/03
NBP.325	Neighbourhood Catchments- Minimising the Impacts of Grazing in the Fitzroy Catchment	460,000	2002/03	2005/06
NBP.326	Fluoroacetate Toxicity Protection Trial on Cattle	133,684	2003/04	2003/04

Table 3.4: Sample of 50 LPI Projects (continued)

Project code	Project title	Total MLA funding ($)	Start date	End date
Lamb, Sheepmeat & Goats				
OJD.020	Individual animal tests for Ovine Johne's Disease	46,303	2001/02	2003/04
SFG.014 (SG.109)	Understanding Genetics of Muscle Hypertrophy and Leanness in Sheep	245,079	2003/04	2006/07
AHW.099	Periparturient relation of immunity to sheep worms: causes, control and implications for development of immunity in lambs	55,310	2004/05	2005/06
OJD.015	Effects of Whole-Flock Vaccination at Merrill	25,870	2000/01	2004/05
AHW.031	Development of Gene Silencing in the Parasitic Nematode Haemonchus contortus (Research Organisation and Project Management)	271,212	2003/04	2005/06
COMP.001	Commercialising Flockcare	298,970	1999/00	2001/02
LAMB.139	Improving Consistency of Lamb Supply - Victoria	320,160	1999/00	2001/02
AHW.025 V1	Development of Non-Injectable Vaccine Delivery Technologies for Red Meat Industries	373,600	2002/03	2005/06
SCSB.065 V	Prime Time Campaign Implementation and Management of Farmer Forums	421,235	2004/05	2005/06
OJD.031 V2	Pathogenesis of OJD - Strategic Research for Diagnosis and Prevention	387,500	2002/03	2004/05
Southern Beef				
BFGEN.012	Consolidation of data - CBX herd	30,000	2002/03	2002/03
SBEF.015	Intake Studies and Supplementary Feeding in Tagasaste	269,076	1998/99	2002/03
EDGE.4.024	Kondinin (WA) EDGE*network*® (Delivery Agreement)	350,000	2001/02	2003/04
EDGE.4.015	RIST (VIC/TAS) EDGE*network*® (Delivery Agreement)	398,524	2000/01	2003/04
BFGEN.002	Quantitative Genetics Research - Beef Industry	499,150	1999/00	2001/02
SBP.006 V2	Regional Systems to Meet Market Specifications	667,000	2002/03	2005/06
SBP.015	Development of Spatial Toolsets for Managing Climate Risk in the Livestock Industry of Southern Australia (Software Licence and Development agreement)	779,049	2003/04	2005/06
SBEF.006	The Development of Multi-Breed EBVs	847,346	1998/99	2002/03

Table 3.4: Sample of 50 LPI Projects (continued)

Project code	Project title	Total MLA funding ($)	Start date	End date
Feedlots				
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 Estrn Austn Feedlots	223,456	2001/02	2002/03
FLOT.124	Devitalisation of Imported Feed Grain by Fumigation	450,000	2003/04	2004/05
FLOT.215	ALFA contribution to the Cattle & Beef Quality CRC	630,000	2000/01	2005/06
Live Export				
LIVE.114	Best Practice in the Use of Veterinary Chemicals and Drugs in Exporting Livestock	49,400	2003/04	2003/04
LIVE.103	Saudi Arabia Live Sheep Trade Resumption Trial	164,168	1999/00	2001/02
LIVE.116	Development of a Heat Stress Risk Management Model	224,200	2002/03	2003/04
Strategic Science				
STU.134	Undergraduate Scholarship Program.	25,955	1999/00	2002/03
Environment				
HRZ.120	Updating Modules of the SGS Pasture Model	30,000	2003/01	2004/05
SGS.009B	SGS Science Theme Reporting Leader	68,199	2000/01	2001/02
HRZ.121 V1	Improving the SGS Pasture Model, and scoping drought risk analysis	65,000	2004/05	2005/06
GG.010	Grain & Graze Operations Coordinator	149,189	2003/04	2004/05
SGS.115	Western Australia (Albany) SGS Research Site	175,293	1998/99	2001/02
TR.062	Non-insecticidal Control of Buffalo Fly	198,500	1998/99	2001/02
WEED.400 A	Delivery of Biological Control Agents for Broad-Leafed Weeds in Temperate Pastures	252,835	2003/04	2005/06
HRZ.201	Profitable Animal Production from Perennial Pastures (PAPP): Phase 3 - Establishment	400,000	2004/05	2004/05
Adoption & Capacity				
EDGE.2.041	Daniels - design, formatting and editing of EDGE*network* workshop materials (Umbrella)	80,951	2003/04	2005/06
EDGE.4.063	Western Australia licensee agreement	188,091	2004/05	2005/06
Animal Health & Welfare				
AHW.036	Improved Diagnosis of Reproductive Disease in Cattle	299,828	2003/04	2005/06

The total funding for the 50 projects was found to be somewhat different to the $12.335 M reported earlier. The reason for this difference was due mainly to some incorrect assumptions made concerning a number of projects in the population. These related mainly to how co-funding with partners was treated (e.g. the inclusion or non-inclusion of partnering money in the payments made by MLA). This created some errors in both the total for the sample of 50 projects as well as the total for the population ($48.191 M))[1].

3.4 Qualitative Assessment Process

Each selected project was evaluated through the following steps:

1. Information from the original project proposal, milestone reports, final reports and relevant correspondence was extracted from the appropriate MLA files. Relevant published papers and reports and other material was assembled with assistance from MLA personnel, Principal Investigators and others.
2. An initial description of the project background, objectives, activities, costs, outputs, and outcomes and benefits was drafted. Additional information needs were identified.
3. Telephone contact was made with the Principal Investigator (or an alternative researcher in some cases) and the draft sent to that person for perusal and comment, together with specific information requests. In the main, telephone and email mechanisms were used for communication.
4. In a number of instances the Principal Investigator had left the organisation. In these cases people were contacted in other organisations or another person in the original organisation who was familiar with the project was sought for comment.
5. Further information was assembled from statistical and industry sources, particularly for those projects where benefits were deemed to be quantifiable (see later).
6. Some analyses proceeded through several drafts, both internally within the project team as well as externally via Principal Investigators and some MLA program managers and coordinators.
7. Final drafts were passed by Principal Investigators for any final comments.

Projects were assessed as to whether they:

- had produced benefits before 2005/06 (benefits thought to be captured already)
- were likely to produce benefits at some future time; and
- had produced, or were likely to produce, economic, social or environmental benefits.

[1] The new totals used for projects are used with confidence and the differences will not be overly significant. The aggregate total for funding of the 50 projects (expressed in the analysis as the prevent value of MLAs investment in the sample) will be the most accurate estimate available. As it is likely that the population will vary by a similar proportion (due to the sample being random), it has been decided not to go through the entire population of projects to make further adjustments where they are likely to exist. Instead, the difference between the original total for the sample and the revised total for the sample has been determined. The revised total for the sample in nominal dollar terms is $14.597 M. This is an increase of 18.3%. The population ($48.191 M) could then be adjusted by a similar proportion, resulting in an estimated total value of the population (nominal dollars) of $57.010 M. This results in 25.6% of the population of projects being included in the sample (in value terms).

During the analysis of individual projects, some projects were analysed with other projects in the sample. For the 20 projects that were analysed only qualitatively, two projects (HRZ.120 and HRZ.121) were analysed together and hence only one qualitative report was prepared for the combined projects.

The benefits identified for each project were assessed as to whether they could be credibly valued in monetary terms. Benefits were valued in 30 of the 50 projects. Benefits for another 2 or 3 projects could possibly have been valued but the total resources available prevented this. The result is that the most appropriate investments have been chosen for valuation of benefits. Reasons for not being able to quantify benefits from the other twenty projects included:

- outputs were mainly in the form of knowledge that could not be currently used to deliver improvements to industry or the community;
- specific positive outcomes of the R&D were difficult to define and attribute to the R&D investment; and
- outcomes were particularly difficult to value.

Those projects subjected to quantitative analysis are marked in Table 3.5.

Table 3.5: Sampled Projects where Benefits were Quantified

Project code	Quantitative analysis (Q)	Project title
Northern Beef		
NBP.215	Q	Beefplan Group No. 1
NAP3.310	Q	Beefplan Group No. 2
NAP3.117	Q	Bullpower: Delivery of adequate normal sperm to site of fertilisation
NAP3.325	Q	Grazing Land Management: Education Package Technical Manual
NBP.316		Assessing the Value of Trees in Sustainable Grazing Systems
NBP.327	Q	Protecting North Australian Grasslands from Rejected Forage Plants of High Weed Potential
NAP3.222		Incorporation of Practical Measures to Assist conservation of biodiversity within sustainable beef production in Northern Australia
NBP.303 V1	Q	Delivery of NIRS to improve cattle nutrition
NAP3.121	Q	Improving nutritional management of grazing cattle: Improving reliability of faecal NIRS calibration equations
NAP3.326		Rangelands Australia
NBP.325		Neighbourhood Catchments- Minimising the Impacts of Grazing in the Fitzroy Catchment
NBP.326		Fluoroacetate Toxicity Protection Trial on Cattle
Lamb, Sheepmeat & Goats		
OJD.020		Individual animal tests for Ovine Johne's Disease
SFG.014 (SG.109)		Understanding Genetics of Muscle Hypertrophy and Leanness in Sheep
AHW.099		Periparturient relation of immunity to sheep worms: causes, control and implications for development of immunity in lambs
OJD.015	Q	Effects of Whole-Flock Vaccination at Merrill
AHW.031	Q	Development of Gene Silencing in the Parasitic Nematode Haemonchus contortus (Research Organisation and Project Management)
COMP.001		Commercialising Flockcare
LAMB.139		Improving Consistency of Lamb Supply - Victoria
AHW.025 V1		Development of Non-Injectable Vaccine Delivery Technologies for Red Meat Industries
SCSB.065 V	Q	Prime Time Campaign Implementation and Management of Farmer Forums
OJD.031 V2	Q	Pathogenesis of OJD - Strategic Research for Diagnosis and Prevention
Southern Beef		
BFGEN.012	Q	Consolidation of data - CBX herd
SBEF.015	Q	Intake Studies and Supplementary Feeding in Tagasaste
EDGE.4.024	Q	Kondinin (WA) EDGE*network*® (Delivery Agreement)
EDGE.4.015	Q	RIST (VIC/TAS) EDGE*network*® (Delivery Agreement)
BFGEN.002	Q	Quantitative Genetics Research - Beef Industry
SBP.006 V2	Q	Regional Systems to Meet Market Specifications
SBP.015		Development of Spatial Toolsets for Managing Climate Risk in the Livestock Industry of Southern Australia (Software Licence and Development agreement)
SBEF.006		The Development of Multi-Breed EBVs

Table 3.5: Sampled Projects where Benefits were Quantified (continued)

Project code	Quantitative analysis (Q)	Project title
Feedlots		
FLOT.123		Review of Options to Reduce Feedstuff Supply Variability in Australia
FLOT.327	Q	Reducing the Risk of Heat Load for the Australian Feedlot Industry
FLOT.317	Q	Measuring the microclimate of Estrn Austn Feedlots
FLOT.124		Devitalisation of Imported Feed Grain by Fumigation
FLOT.215	Q	ALFA contribution to the Cattle & Beef Quality CRC
Live Export		
LIVE.114		Best Practice in the Use of Veterinary Chemicals and Drugs in Exporting Livestock
LIVE.103	Q	Saudi Arabia Live Sheep Trade Resumption Trial
LIVE.116	Q	Development of a Heat Stress Risk Management Model
Strategic Science		
STU.134		Undergraduate Scholarship Program.
Environment		
HRZ.120		Updating Modules of the SGS Pasture Model
SGS.009B	Q	SGS Science Theme Reporting Leader
HRZ.121 V1		Improving the SGS Pasture Model, and scoping drought risk analysis
GG.010	Q	Grain & Graze Operations Coordinator
SGS.115	Q	Western Australia (Albany) SGS Research Site
TR.062	Q	Non-insecticidal Control of Buffalo Fly
WEED.400A	Q	Delivery of Biological Control Agents for Broad-Leafed Weeds in Temperate Pastures
HRZ.201	Q	Profitable Animal Production from Perennial Pastures (PAPP): Phase 3 - Establishment
Adoption & Capacity		
EDGE.2.041	Q	Daniels - design, formatting and editing of EDGE*network* workshop materials (Umbrella)
EDGE.4.063	Q	Western Australia licensee agreement
Animal Health and Welfare		
AHW.036		Improved Diagnosis of Reproductive Disease in Cattle

3.5 Quantitative Assessment Process

Where project benefits were quantitatively evaluated, investment criteria of Net Present Value (NPV), Benefit-Cost Ratio (B/C Ratio) and Internal Rate of Return (IRR) were estimated at discount rates of both 5% and 10%. All dollar costs and benefits were expressed in 2005/06 dollar terms and discounted to the year 2005/06. A 30-year time frame was used in all analyses, with the first year being the initial year of investment in the R&D project. 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.

The NPV is the difference between the Present Value of Benefits (PVB) and the Present Value of Costs (PVC). Present values are the sum of discounted streams of benefits and/or costs. The B/C Ratio is the ratio of the PVB to the PVC. The IRR is the discount rate that would equate the PVB

and the PVC, thus making the NPV zero and the B/C Ratio 1:1. For a fuller explanation of the terms used in the investment analyses, please see the Glossary of Terms in Appendix 1.

In some cases individual projects in the group of 30 were evaluated as part of a wider set of projects or in some cases, an entire program (e.g. Grain and Graze, Sustainable Grazing Systems, EDGE*network*). This was required as the selected project on its own did not itself produce individual benefits but contributed to an outcome with other projects. The benefits valued for the program or wider set of projects were then attributed to an individual project on the basis of its relative cost contribution.

The randomly selected projects that were evaluated together included:

- Two Near Infrared Reflectance Spectroscopy (NIRS) projects (NBP.303 and NAP3.121) with another two projects relating to NIRS
- Four EDGE projects (EDGE 4.015; EDGE 4.024; EDGE 2.041; and EDGE 4.063) via the entire investment in EDGE (47 projects)
- Two feedlot heat stress projects (FLOT.317 and FLOT.327) via a set of 16 projects
- Two Sustainable Grazing Systems (SGS) projects (SGS.115 and SGS.009B) via the entire SGS program (93 projects)

This resulted in 24 benefit–cost analyses being conducted and reported.

In addition:

- GG.010 was evaluated as part of the whole Grain and Graze program.
- A number of the other 50 selected projects were evaluated in conjunction with other MLA projects, some of which were in the population and some which were not (e.g. excluded on the grounds of size or timing).
- For some analyses, the valuation of benefits was based on the assumptions in previous analyses carried out by other authors. These previous analyses included:
  - the economic analysis carried out by the Beef CRC for CRC III.
  - the economic analysis carried out by CIE for the Weeds CRC on Pattersons curse (CIE, 2001).
  - the economic analysis carried out by Farquharson et al (2002) on beef genetics research.

The fact that more then the 50 MLA projects were included in the analyses meant that a far greater proportion of the population was included than the 26% by value reported earlier. In addition to the $14.597 M reported earlier, additional MLA money was included in other projects. Some of these projects were in the defined population of projects, while others were outside of the population due to their size or timing. Many of the additional projects were included due to wider evaluations being undertaken for SGS, Prime Time, EverGraze, Grain and Graze, the Feedlot Heat Stress group of projects and EDGE*network*. An extension from the randomly selected 50 MLA projects to the wider set of projects allowed a higher proportion of the total population to be analysed. In terms of the total nominal value of investment analysed, the 50 projects represented 26% of the population whereas they represented 27% of the population in terms of the present value of costs (PVC). The extended set of 114 projects represented 45% of the population in terms of PVC.

Assumptions were made in a consistently conservative manner when valuing benefits. Analyses were undertaken for total benefits that included future expected 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 for the 5% discount rate.

In a number of cases other R&D projects (not drawn in the sample and in some case not even MLA projects) had to be included in the analysis in order for benefits and costs to be matched appropriately. Also, in some cases the cost of some further R&D was required to be included in the analysis, with appropriate probabilities included to produce expected benefits (probabilities on additional investment being funded or for its success).

For projects that were quantitatively evaluated, it was not always possible to quantify all benefits that may have been associated with the particular investment. For example, identified environmental and social benefits were sometimes particularly difficult to quantify.

Descriptions of all 43 analyses (19 qualitative and 24 quantitative) that cover the 50 selected projects and their extensions are provided in Volumes 2 to 7.

4 Results and Discussion

4.1 Summary of Benefits for Individual Innovations

A summary of the benefits produced by the 50 projects is presented in Table 4.1 showing the nature of the benefits produced (economic, environmental and social benefits).

Table 4.1: Summary of Principal Benefits for the 50 Sampled Projects

Project	Economic benefits	Environmental benefits	Social benefit
Beefplan Group No. 1	Application of information gleaned from nutrition workshop to on-farm practices Changes in herd/breed composition, breeding aims and marketing strategies on some enterprises Adoption of a simple temperament rating for weaners More aware of bull breeding fertility and soundness and putting more emphasis on rotating bulls	Changes to property layouts following Environmental Management Systems input Improved grazing management skills Adoption of farm forestry practices and trials of silvicultural treatments on some members' properties Adoption of reduced tillage following the biodynamic field tour	Group declaration to improve management practices More overt involvement of all family members in decision-making processes and work practices Increase in computer ownership and skills as well as utilisation in property management decision making e.g. climate information
Beefplan Group No. 2	Changed management practices in both the short term and long term leading to increased net farm cash income	Increased awareness of Environmental Management Systems Reduced sediment export to waterways and enhanced biodiversity via improved grazing practices	Enhanced confidence and social networking skills Improved communication skills among members
Bullpower	Decreased capital cost of bulls per calf sired Greater rate of genetic gain for bulls produced in the herd		Increased confidence in decision making ability with respect to bull mating percentages

Table 4.1: Summary of Principal Benefits for the 50 Sampled Projects (continued)

Project	Economic benefits	Environmental benefits	Social benefit
Grazing Land Management	Enhanced productivity of northern Australia meat and livestock production through improved management decision making Increased net farm income of producers	Reduced soil erosion and reduced sediment export to waterways resulting in improved water quality	Increased personal capacity to manage and cope so reducing stress and improving quality of life Enhanced effectiveness of participation in regional and industry affairs
Value of trees in sustainable grazing systems	Changed pasture growth and nutritional quality due to microclimatic factors Reduced deaths due to heat stress Value of timber for harvesting	Long-term sustainability of the resource base Carbon sequestration	Potential for reduced social conflict over impacts of vegetation clearance
Eradicating rejected forage plants	Prevention or delay in the four legumes becoming weeds, so reducing the negative economic impact of control costs for land holders and loss in productivity Reduced costs to government of control of the potential weeds in public and conservation areas	Reduced environmental damage from potential weeds including loss of biodiversity and natural resource management impacts	The Acacia species could possibly elicit some negative human reaction at flowering time
Conservation of biodiversity	Improved productive capacity of land due to improved water and nutrient cycling, shelter and shade, pollination and pest control Potential for income from timber harvesting and carbon credits Cost of reduced productivity of land	Improved biodiversity (both flora and fauna) Potential for improved water quality (riparian zone protection and water cycle improvements)	
NIRS: calibration and delivery	Greater efficiency in provision of diet supplements Increased ability to meet requirements of target markets Cost-effective weight gain in cattle	Reduced likelihood of overgrazing through earlier destocking with potential implications for erosion, sediment export and biodiversity loss	Educational and research tool

Table 4.1: Summary of Principal Benefits for the 50 Sampled Projects (continued)

Project	Economic benefits	Environmental benefits	Social benefit
Rangelands Australia	Increased average profits for grazing properties from improved management Reduced variability in income for grazing properties Increased contribution from income from diversification e.g. outback tourism Improved private sector and government services for those living in the rangelands	Enhanced biodiversity from improved grazing management Improved water quality in waterways from reduced sediment export due to grazing management changes Improved natural resource management services for those living in the rangelands	Enhance personal capacity to seek out information and make improved decisions in both business and personal areas Higher level of engagement in the community and enhanced community and industry leadership in the rangelands Improved flexibility for making career changes
Neighbourhood catchments	Increase in productivity of land used for grazing Reduced sediment loss from property Reduced gully erosion on property Improved water quality on property	Improved water quality in local catchment waterways (reduced export of sediment and other pollutants) Potential for widespread use of the model to improve water quality and impact positively on the GBR	Increased social interaction within catchment landholders Increased capacity of participants with respect to adoption of new practices Increased capacity of rural communities to deal with reducing the impact of land management on the environment
Fluoroacetate Toxicity Protection	Potential for reduced cattle mortality due to fluoroacetate poisoning		
Individual tests for OJD	Knowledge that the known tests are not particularly sensitive to OJD Knowledge that some sheep can recover from an early infection of OJD so avoiding flock management strategies based on early-age testing and associated culling, as such a strategy may remove some genetically resistant sheep		

Table 4.1: Summary of Principal Benefits for the 50 Sampled Projects (continued)

Project	Economic benefits	Environmental benefits	Social benefit
Muscle hypertrophy and leanness	Higher productivity on-farm due to higher lamb weights at a given age and higher carcase yields Potentially enhanced demand for sheepmeat due to generally higher levels of leanness	Increased feed conversion efficiency can lead to less stress on native vegetation in drought periods	Potential for human medical applications from the knowledge being generated
Immunity to sheep worms	Potentially new sheep nutrition strategies to better manage internal parasites around the time of lambing (peri-parturient period) Potential for reduced neonatal mortality		
Whole-flock vaccination for OJD	Lowered death rates Lowered production losses within infected flocks Improved worm control due to OJD driven grazing management improvements within infected flocks Lowered rate of spread of OJD to new flocks Contributed to reduced trading losses of producers via the replacement of quarantining and zoning policies with a risk management system of trading Contributed to reduced costs of regulation	Some fencing of riparian areas due to control measures assisted with enhancing water quality and protecting biodiversity The control policy of rotational grazing of native perennials will have enhanced biodiversity The contribution to increased trading of sheep allowed the avoidance of degraded pastures and soil erosion	Contributed to reduced community anxiety via the replacement of quarantining and zoning policies with a risk management system of trading

Table 4.1: Summary of Principal Benefits for the 50 Sampled Projects (continued)

Project	Economic benefits	Environmental benefits	Social benefit
Gene silencing in parasitic nematodes	More effective control of internal parasites of sheep Reduced costs of internal parasite control in sheep	Improved health of sheep increases productivity per head and can therefore decrease environmental impact.	Enhanced welfare and well being of agricultural animals Improved social welfare due to reduced use of conventional drugs in livestock production Capacity building in biotechnology and a strengthening of linkages between fundamental and applied research Support discovery of new antiparasitic agents to treat serious human diseases
Commercialising Flockcare	Improved meat yield due to less trimming Time efficiencies in record keeping Improved market access and market opportunities	Reduced chemical impact on the environment	Improved health and safety, including chemical usage Improved animal welfare Increased capacity to manage
Consistency of lamb supply	Higher and more consistent lamb products produced, processed and delivered to consumers. Higher average lamb prices achieved by producers, higher margins by processors and marketers and higher levels of satisfaction by consumers		Increased knowledge of lamb markets with greater control of marketing leading to higher levels of confidence and personal pride in their business
Non-Injectable vaccine delivery	If this technology were proven to be efficient, and Potential cost reductions through reduced labour Reduced product quality downgrade costs. Lowered productivity impact from diseases		Reduction in needle stick injuries to livestock handlers

Table 4.1: Summary of Principal Benefits for the 50 Sampled Projects (continued)

Project	Economic benefits	Environmental benefits	Social benefit
Prime Time Campaign	Higher productivity per hectare for the group of lamb producers changing management practices as a result of the campaign, leading to higher profitability and lowered cost of production More lamb producers meeting market specifications Partial benefits from increased use of other lamb and sheepmeat services provided by MLA Potential market and trade benefits from maintaining lamb and sheepmeat supply		Individual capacity building in that many producers now have increased confidence to change management practices Industry capacity building in that networks of producers and private sector agencies have been developed and strengthened
Pathogenesis of OJD	Vaccine or drug: Lowered death rates compared to use of Gudair provide a new drug or vaccine is more cost-effective and would be used by producers Vaccine or drug: If more effective may reduce spread of OJD disease Differential test: Reduce risk of infection when trading sheep of high value Differential test: Depending how used, may reduce rate of spread of OJD in Australia Overseas sales of differential test, vaccine or drug Spinoff benefits to BJD management and control in Australia and worldwide		Vaccine or drug: Less human injury risk with use of new vaccine or drug compared to use of Gudair Contribution toward risk management for Crohn's disease

Table 4.1: Summary of Principal Benefits for the 50 Sampled Projects (continued)

Project	Economic benefits	Environmental benefits	Social benefit
CBX herd	Increased productivity of beef production systems through increased rate of genetic gain (via traits such as resistance to ticks, worms, heat stress and seasonally poor nutrition) Product enhancement to better meet market demand and consumer requirements (e.g. breeding for meat quality)		
Tagasaste	Expansion of tagasaste based grazing systems, increasing the productive capacity of that land Increased liveweight gain from cattle grazing on tagasaste systems	Reduced recharge from deep sandy soils Stabilisation and erosion control	
EDGE*network*®	Enhanced productivity of meat and livestock production through improved management decision making Increased net farm income of producers	Sustainable management of biodiversity, weeds, water and soil health, and overcoming soil erosion and salinity,	Increased personal capacity to manage and cope so reducing stress and improving quality of life Enhanced effectiveness of participation in regional and industry affairs Increase in knowledge, skills and confidence to change and adapt to industry and personal needs.
Beef Genetics Research	More efficient and effective industry servicing and faster rates of genetic progress in both southern and northern beef cattle herds		
Meeting Market Specifications	Increased efficiency of utilisation of pasture resource leading to higher productivity Reduced cost of production for beef	Increased farm incomes could lead to improved management of environmental resources	Increased confidence and capacity in integrating technologies across breeding, nutrition and market requirements

Table 4.1: Summary of Principal Benefits for the 50 Sampled Projects (continued)

Project	Economic benefits	Environmental benefits	Social benefit
Spatial Toolsets for Managing Climate Risk	Improved grazing management decisions resulting in higher productivity and enhanced incomes Stocking rates closer to the optimum can minimise pasture wastage and stimulate regrowth of better quality pastures More effective feed budgeting by better assessment of current pasture availability and likely growth in the season ahead	Improved pasture management can lead to lowered rates of land degradation and reduced soil erosion and export of sediment to waterways	
Multi-Breed EBVs	Increased rate of genetic gain by crossbreeders		
Feedstuff Supply Variability	Likelihood of strategies that will reduce the supply variability of feedgrains 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 Superior phytosanitary standards applying to imported feedstuffs – due to superiority of devitalisation over QA practices such as inspection and random audits	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

Table 4.1: Summary of Principal Benefits for the 50 Sampled Projects (continued)

Project	Economic benefits	Environmental benefits	Social benefit
Heat Load in feedlots	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 costs 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 Enhanced capacity of feedlot managers to understand and react to options of lowering heat load stress.
Devitalisation of Imported feed grain	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 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

Table 4.1: Summary of Principal Benefits for the 50 Sampled Projects (continued)

Project	Economic benefits	Environmental benefits	Social benefit
ALFA contribution to the CRC	Increased productivity of beef production systems through increased rate of genetic gain Product enhancement to better meet market demand and consumer requirements		
Veterinary chemicals	Application of best practice should mean reduced mortalities and weight loss. Accurate diagnosis and treatment should also minimise costs resulting in better returns for exporters and more repeat business from importers Improved access to technical knowledge will help to attract veterinarians and stockmen to the livestock export industry as these people are required to demonstrate their competence on a regular basis	Best practices will assist the environment by minimising chemical usage and disposal of carcasses. It would also extend to responsible disposal of containers.	Development of best practice manuals and systems demonstrates to government the industry's commitment to proper care of the animals. This should lead to greater understanding and acceptance of live animal exporting within government ranks if not the wider community.
Saudi Arabia Trade Resumption	Re-opening of the Saudi Arabia market increased competition for live sheep with positive implications for value adding The re-opened Saudi market required younger sheep than previously sent. Reducing the average age of the flock (through earlier culling) will usually raise the flock's productivity	The existence of the live export market allows stock numbers to be reduced quickly in response to drought with beneficial implications for pastures and soil	The live export industry helps to maintain the viability and social infrastructure of the sheep industry. This is particularly important to remote areas of WA The new protocol has had positive implications for animal welfare. The trials reported virtually no mortalities during transportation
Heat Stress Model	Protection of the live export trade from the threat of closure Higher export operating costs might be passed back to producers but added value still higher than would be the case without the trade Continuation of the trade allows the average age of the flock to be reduced resulting in productivity gains	Capacity to export livestock despite vagaries of the climate and future changes Reduced risk of mortalities and the associated disposal issues	Capacity to protect the welfare of animals in the face of long haul climatic risk Continuation of the trade likely to result in less paddock mortality – that might have had negative welfare connotations

Table 4.1: Summary of Principal Benefits for the 50 Sampled Projects (continued)

Project	Economic benefits	Environmental benefits	Social benefit
Undergraduate Scholarship			Capacity building within the agricultural sciences
Updating SGS model	Increase in average level of profits for farm businesses Long-term analysis using 100 year climate records will provide a quantitative understanding of economic variability in pasture management for different regions More efficient and effective government policies for delivery of drought support	Improved sustainability of land and pasture resources Provides complete nutrient balance for N, P, K, S, including leaching and runoff Improved understanding of the patterns of climate variability to inform natural resource management decisions including pasture management Greenhouse gas emissions from pastures. The model calculates gas emissions of nitrous oxide and methane, as well as the full carbon balance	Reduced stress for land and water managers due to more objective processes in decision making and being able to plan ahead Greater equity between landholders in drought support decisions Improved personal capacity of land managers to manage climatic variability resulting in less stress in the community
SGS	Increased productivity of pastures Higher stocking rates and increased productivity of animals Profitability gains for producers Gains in efficiencies and effectiveness among consultants and agency personnel	Increased water utilisation by pastures from rotational grazing and from wider use of perennial species Reduced water accessions to groundwater resulting in potentially less waterlogging and less chance of salinity outbreak on the property	Increased capacity building in producer regions through the networking and improved capacity of individuals to seek change and learn

Table 4.1: Summary of Principal Benefits for the 50 Sampled Projects (continued)

Project	Economic benefits	Environmental benefits	Social benefit
Grain & Graze	Increase in average farm income Reduced variability in average farm income	Improved natural resource condition on-farm Improved regional natural resource condition	Increased capacity to act on a whole-farm basis
Buffalo Fly trap	Lower cost control method for buffalo fly including reduced chemical and labour costs	Reduced level of chemical use and impact in the environment	
Biological control of weeds	Reduced cost of weeds to producers in southern Australia from higher pasture productivity and ensuing increased stocking rates Reduction in control costs (including chemicals) of dense infestations Reduction in losses of pigs and horses from poisoning from Paterson's curse Reduced downgrading of wool due to vegetable matter contamination from thistles Cost to apiarists from reduced utilisation of Paterson's curse	Reduced chemical use for control may benefit the environment	Reduced incidence of skin irritations and allergies from Paterson's curse and a reduced social nuisance value of thistle infestation Increased capacity of landholders to work together
EverGraze	Increase in net farm profit per ha for farms in the three catchments Increase in net farm profit for farms in other high rainfall zone catchments Reduced economic impact of salinity in waterways	Reduced recharge to groundwater and reduced salinity in catchment waterways Improved aquatic biodiversity	Potential animal welfare benefits from strategies that emerge regarding interaction of lamb survival with vegetation (e.g. break of slope shrub plantings)
Reproductive disease testing	Improved reproductive performance in beef and dairy herds leading to higher herd productivity and profitability Potential for enhanced domestic trading opportunities from being able to ensure disease free status of breeding stock Potential for improved trade and market access		Reduced risk of infection with leptospirosis for farm and abattoir workers

Economic benefits were identified in all 43 analyses and were valued in all 24 quantitative analyses. Environmental benefits were identified in 30 of the 43 analyses. No valuation of environmental benefits was applied but in many cases the economic benefits valued also captured an environmental or resource condition benefit (e.g. reduced soil loss from earlier destocking). A total of 30 of the 43 analyses identified social benefits arising from the investments. As with the environmental benefits no social benefits were valued in the 24 benefit-cost analyses.

4.2 Investment Criteria

In only 30 of the 50 sampled projects were benefits valued (24 analyses). Also, some of the benefits identified in Table 4.1 were not valued due to lack of information and the time available. In all evaluations an attempt was made to err on the conservative side when formulating assumptions, although it was sometimes difficult to ensure an equal degree of conservatism across all analyses. Economic benefits were more commonly valued than environmental and social benefits largely due to:

- their being easier to value than environmental and social benefits when the resources for analysis were restrictive
- stronger and more purposive linkages between the investments and economic outcomes

The primary sets of individual investment criteria are presented in Tables 4.2 and 4.3. Table 4.2 provides the results for the whole investment around the selected project or projects. The whole investment may be a single project, several or more projects or a whole program. In addition to MLA resources for the selected project or projects, there may be other resources included:

- from partners and researchers involved in the selected project or projects
- from MLA and partners/researchers via other projects
- from other projects where MLA is not involved

The objective of providing this first set of results is to demonstrate the magnitude of the wider investment that has been used in the analysis. In most cases this wider investment has been defined in order to best match the defined benefits, as often benefits from an individual project can not be isolated effectively. Where necessary, the approach has been to estimate the benefits from the wider investment and then ascribe a portion of these benefits to an individual project of interest based on the relative investment contributions.

Table 4.2 shows that the investments with the largest benefits as defined by the PVBs were:

- CRC II
- Biological control of weeds
- SGS
- Grain and Graze

These investments also have the four largest PVCs and had B/C Ratios of around 15, 18, 4 and 7 respectively.

Table 4.2: Investment Criteria for All Investment into the Selected Projects
(discount rate = 5%; present values as of 2005/06 in 2005/06 $ terms)

	All investment			B/C Ratio	IRR (%)
Investment	**PVB ($M)**	**PVC ($M)**	**NPV ($M)**		
1. Beefplan Group No. 1	0.17	0.07	0.10	2.3	12.8
2. Beefplan Group No. 2	0.10	0.21	-0.10	0.5	Negative
3. Bullpower	28.96	1.74	27.22	16.6	29.3
4. Grazing Land Management	28.68	0.81	27.87	35.4	26.6
5. Eradicating rejected forage plants	16.43	1.00	15.44	16.5	28.4
6. NIRS: calibration and delivery	25.84	3.29	22.56	7.9	38.0
7. Whole-Flock Vaccination for OJD	43.86	7.42	36.44	5.9	59.1
8. Gene silencing in parasitic nematodes	76.03	9.64	66.38	7.9	17.8
9. Prime Time Campaign	13.83	2.11	11.72	6.6	25.7
10. Pathogenesis of OJD	14.00	4.97	9.03	2.8	10.7
11. CRC II (CBX Herd)	1,735.6	113.6	1,622.0	15.3	50.9
12. Tagasaste	15.20	2.35	12.85	6.5	29.1
13. EDGE*network*®	59.2	14.7	44.5	4.0	12.4
14. Beef Genetics Research	16.74	4.71	12.03	3.6	no solution
15. Meeting Market Specifications	83.34	9.87	73.67	8.5	20.9
16. Heat Load in feedlots	3.49	1.65	1.83	2.11	12.8
17. CRC II (ALFA contribution)	1668.8	113.6	1555.1	14.7	50.9
18. Saudi Arabia Trade Resumption	4.71	0.25	4.46	18.7	Very high
19. Heat Stress Model	5.01	0.28	4.73	18.2	Very high
20. SGS	174.5	49.2	125.3	3.6	25.5
21. Grain & Graze	196.49	29.63	166.9	6.6	27.8
22. Buffalo Fly trap	5.13	1.28	3.9	4.0	10.0
23. Biological control of weeds	999.9	55.6	944.4	18.0	15.1
24. EverGraze	47.06	13.63	33.43	3.4	13.8

The next table (Table 4.3) provides the investment criteria for the MLA only investment in the 30 selected projects (24 analyses). The investments with the highest NPVs were:

- Biological control of weeds

- ALFA contribution to the CRC
- Grazing Land Management

The investments with the highest B/C Ratios were:

- Biological control of weeds
- Grazing Land Management
- Heat stress model (Live export)
- Bullpower

It should be noted that a number of the investment analyses relied on previous BCAs and where benefits had been estimated by others (Numbers 11, 14, 17, and 23).

Table 4.3: Investment Criteria for MLA Investment into the Selected Projects
(discount rate = 5%; present values as of 2005/06 in 2005/06 $ terms)

	MLA investment into selected project (s)			B/C Ratio	IRR (%)
Investment	**PVB ($M)**	**PVC ($M)**	**NPV ($M)**		
1. Beefplan Group No. 1	0.08	0.03	0.05	2.3	12.6
2. Beefplan Group No. 2	0.05	0.11	-0.06	0.49	Negative
3. Bullpower	3.66	0.19	3.47	19.4	51.0
4. Grazing Land Management	12.65	0.36	12.29	35.4	26.6
5. Eradicating rejected forage plants	1.57	0.15	1.42	10.6	25.5
6. NIRS: calibration and delivery (two projects)	6.75	0.86	5.89	7.9	38.3
7. Whole-Flock Vaccination for OJD	0.19	0.03	0.15	5.5	41.2
8. Gene silencing in parasitic nematodes	2.04	0.26	1.79	8.0	18.2
9. Prime Time Campaign	3.10	0.49	2.62	6.4	24.3
10. Pathogenesis of OJD	2.45	0.87	1.58	2.8	10.7
11. CBX herd	1.68	0.11	1.56	14.8	39.7
12. Tagasaste	4.69	0.73	3.97	6.5	29.1
13. EDGE*network*® (4 projects)	5.44	1.25	4.19	4.4	13.5
14. Beef Genetics Research	2.92	0.82	2.10	3.6	No result
15. Meeting Market Specifications	6.91	0.78	6.13	8.9	15.6
16. Heat Load in feedlots (2 projects)	0.98	0.46	0.53	2.2	22.9
17. ALFA contribution to the CRC	11.1	0.76	10.35	14.5	39.9
18. Saudi Arabia Trade Resumption	4.71	0.25	4.46	18.7	Very high
19. Heat Stress Model	5.01	0.28	4.73	18.2	Very high
20. SGS (two projects)	2.96	0.83	2.13	3.6	25.5
21. Grain & Graze	1.03	0.17	0.86	6.0	21.6
22. Buffalo Fly trap	1.00	0.24	0.76	4.1	10.2
23. Biological control of weeds	22.48	0.55	21.93	40.8	94.3
24. EverGraze	1.40	0.43	0.96	3.2	12.6

The factors that usually drive the investment criteria for an R&D investment include:

- The cost of the R&D.
- The magnitude of the net benefit per unit of production; this net benefit per unit also takes into account the costs of implementation.
- The quantity of production affected by the R&D, in turn a function of the size of the target audience and the level of maximum adoption ultimately expected.
- The discount rate.
- The time elapsed between the R&D investment and the accrual of benefits.
- The time taken from first adoption to maximum adoption.
- An attribution factor applies when the specific project or investment being considered is only one of several pieces of research or activity that have contributed to the outcome being valued. This is sometimes accounted for by including the costs of the additional R&D with the costs of the project being considered. However where specific costs may not be available an estimate of the percent contribution is often made and applied to the benefits.
- Probabilities may be applied when the research is not complete or when some further investment is required before the outputs of the research are translated into adoptable outcomes and extended to the industry. Sometimes the probabilities can be applied to the "without" scenarios as there is uncertainty as to what would have happened without the research.

Assumptions for these factors have been made in the quantitative analyses where appropriate and are reported in the individual project analyses in Volumes 2 to 7 of this report.

Various combinations of these factors can combine to produce a high NPV or rate of return.

4.3 Confidence in Analyses

The investment criteria produced and presented in Tables 4.2 and 4.3 are highly dependent on the assumptions made in each analysis. There are two areas of potential concern with regards to confidence in the analyses. The first is the coverage of benefits. Where there are multiple types of benefits it is often not possible to quantify all the benefits that may be linked to the investment. The second involves the assumptions relating to the difference that the investment has made. Some of these assumptions can be contentious and many made in the analyses are a matter of judgement. To address the uncertain assumptions, some sensitivity analyses have been conducted, where the investment criteria are recalculated with variations of some of the uncertain assumptions.

In addition, a rating has been given to the confidence in the results of the investment analyses. The confidence is made up of two factors including the coverage of benefits and the degree of certainty in the assumptions. The rating categories used are High, Medium and Low, where:

- High: denotes a good coverage of benefits or reasonable confidence in the assumptions made
- Medium: denotes only a reasonable coverage of benefits and/or some significant uncertainties in assumptions
- Low: denotes a poor coverage of benefits or many uncertainties in assumptions

Table 4.4 presents an estimate of the confidence in each of the analyses, expressed via the rating categories defined above.

Table 4.4: Confidence in Each Analysis

Project	Coverage of benefits	Confidence in assumptions
1. Beefplan Group No. 1	High	Medium
2. Beefplan Group No. 2	High	Medium
3. Bullpower	High	Medium
4. Grazing Land Management	High	Medium
5. Eradicating rejected forage plants	Medium	Low
6. NIRS: calibration and delivery (two projects)	High	Medium
7. Whole-Flock Vaccination for OJD	High	Medium
8. Gene silencing in parasitic nematodes	Medium	Low
9. Prime Time Campaign	Medium	Medium
10. Pathogenesis of OJD	High	Low
11. CBX herd	High	Low
12. Tagasaste	Medium	High
13. EDGE*network*® (4 projects)	Medium	Medium
14. Beef Genetics Research	High	Medium
15. Meeting Market Specifications	Medium	Medium
16. Heat Load in feedlots (2 projects)	High	High
17. ALFA contribution to the CRC	High	Low
18. Saudi Arabia Trade Resumption	Medium	Medium
19. Heat Stress Model	Medium	Medium
20. SGS (two projects)	Medium	High
21. Grain & Graze	Medium	Medium
22. Buffalo Fly trap	Medium	Medium
23. Biological control of weeds	Medium	Low
24. EverGraze	Medium	Medium

4.4 Comparison of Investment Criteria with Other RDCs

Tables 4.5 and 4.6 present a comparison of the distribution of the investment criteria calculated for the present analyses with the investment criteria calculated in similar analyses undertaken in the past few years by Agtrans Research. Only those studies that have been based on random samples are presented.

Table 4.5: Comparison of MLA NPVs with Other Analyses of Random Samples of Projects

Range of NPV ($M)	MLA (2006)	FWPRDC (a)	SRDC, BSES, SRI (b)	SRDC and BSES (c)
Discount rate (%)	5	5	5	5
Negative	1	0	0	0
0-5	18	7	6	11
5-10	2	2	5	0
10-15	2	2	0	2
15-50	1	2	3	1
50-100	0	0	0	0
100-300	0	1	0	0
>300	0	0	0	0
Total	24	14	14	14

(a) FWPRDC (2001)
(b) Agtrans Research (1998)
(c) Agtrans Research (2004)

Table 4.5 shows that for MLA, 75% of the investments quantified have NPVs of between 0 and $5 million. Only one investment had an NPV of greater than $15 million. The range of NPVs for MLA was $-0.07 million to $21.9 million. This comparison with other studies disadvantages MLA as the MLA analyses are reduced to individual projects and MLA funding only whereas the other studies have included other investments and hence reflect larger parcels of both benefits and costs. The comparison in Table 4.6 is more meaningful.

Table 4.6: Comparison of MLA B/C Ratios with Other Analyses

Range of B/C	MLA (2006)	FWPRDC	SRDC, BSES, SRI	SRDC and BSES
Discount rate (%)	5	5	5	5
Negative	0	0	0	0
0-5	11	8	3	9
5-10	5	2	4	1
10-20	5	1	3	3
20-50	3	1	1	1
50-100	0	2	3	0
>100	0	0	0	0
Total	24	14	14	14

Sources: As for Table 4.5

Table 4.6 shows that 33% of the analyses for MLA had a B/C Ratio of over 10 to 1. This compares with the average of the other studies of 34% (29% column 3, 50% column 4 and 29% column 5).

Overall, the distribution of investment criteria for the MLA projects is not dissimilar to those observed in other similar studies carried out by Agtrans Research.

4.5 Analysis of Investment Characteristics

The objective of this analysis was to identify relationships between the investment criteria for the 24 case studies and specific characteristics of the investments. The idea was to identify relationships that pointed to what might constitute success factors in investing in R&D. Although the investment criteria were estimates made with only a moderate degree of confidence, they were all estimated using a consistent method and conservative assumptions.

Data on the three principal investment criteria were compiled (NPV, B/C Ratio and IRR), along with the components of NPV, namely PVB and PVC. Present values had been produced using a 5% discount rate, were all expressed in the same dollar terms (2005/06) and referred to the 2005/06 financial year. Investment criteria were included only for the MLA benefits and costs for the individual MLA projects drawn in the sample.

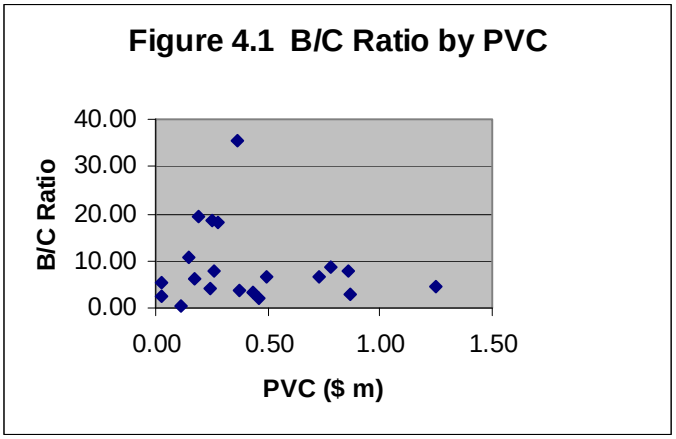
Other information compiled was:

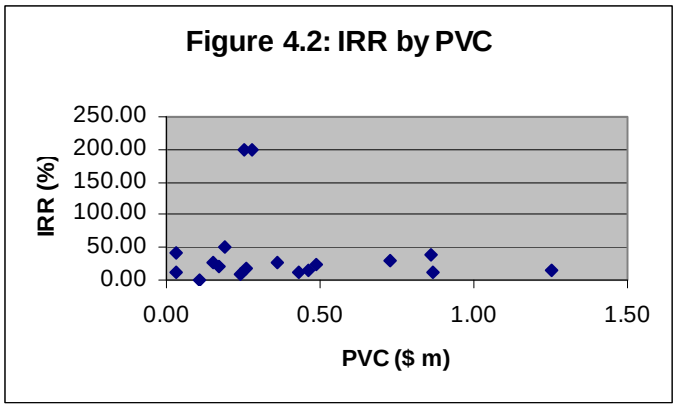
- Start year for the investment
- Number of years for which the MLA investment continued
- The number of years from the first year of investment until benefits commenced to accrue

Only 21 of the 24 case studies were subjected to the analysis. Three case studies were omitted as they relied heavily on assumptions in investment analyses that had been carried out by other organisations.

The distributions of the three investment criteria for the 21 investments (MLA investment only) in relation to PVC are shown in Figures 4.1, 4.2 and 4.3.

Figure 4.1 B/C Ratio by PVC





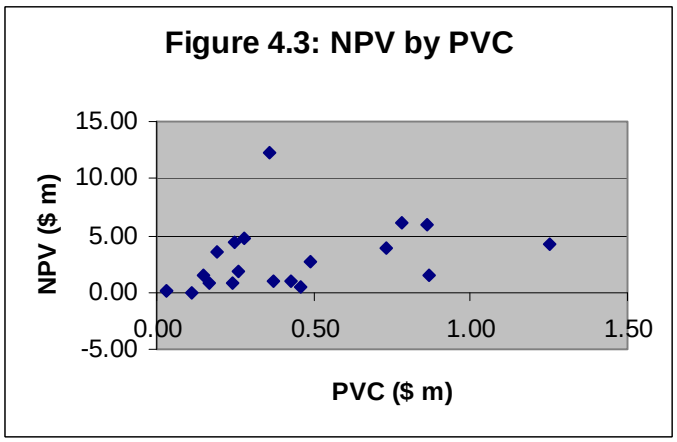
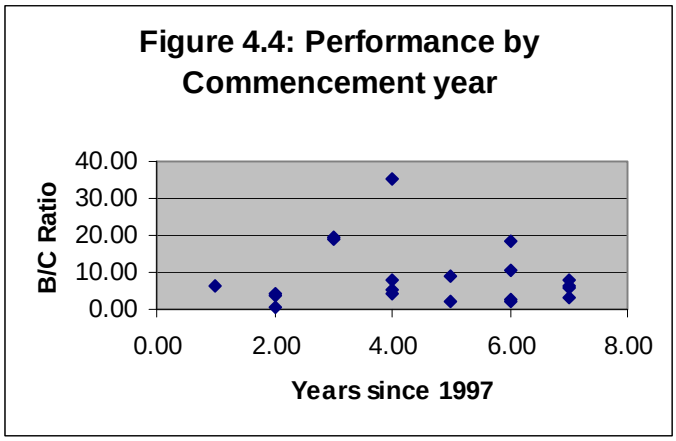


Figure 4.1 and Figure 4.2 suggest that the rate of return may decrease slightly as the PVC increases, but the relationship does not appear to be strong. Figure 4.3 suggests that the NPV increases with increases in the size of the MLA investment, a relationship that would be expected. Although not shown here, there is strong relationship between PVB and PVC.

Each case study was assigned to the year in which investment in that case study commenced. Each year was then assigned a number with 1998 being year 1, 1999 being year 2 and so on. There appeared no clear relationship between time and investment performance as measured by the estimated B/C Ratio (Figure 4.4).



As may have been expected, the B/C Ratio was weakly negatively related to the length of the investment, that is, the longer the investment period the lower the B/C Ratio (Figure 4.5).

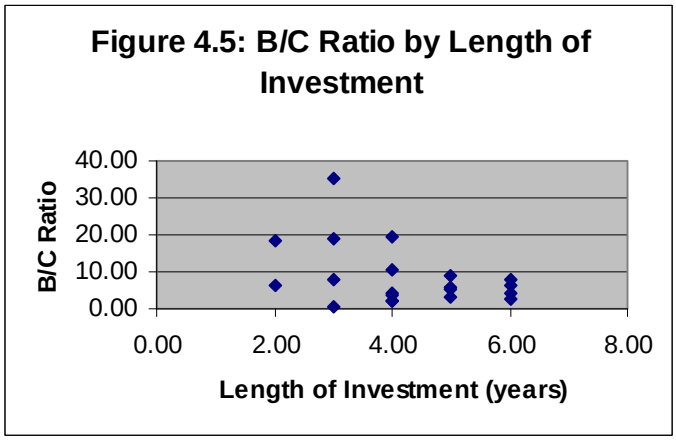
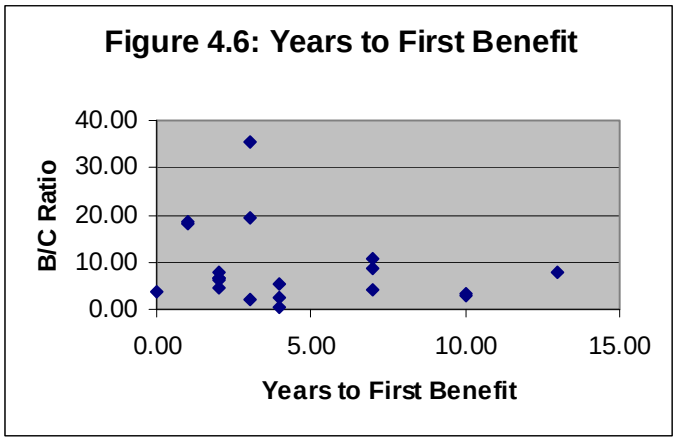


Figure 4.6 shows a weak relationship between the B/C Ratio and the number of years between the initial investment and when the first benefit is captured.



The above findings relate only to the 21 case studies analysed. Whether these findings relate to the remainder of the MLA population of investments is unknown. However, most of the relationships identified were weak. None were tested statistically.

4.6 Distribution of Benefits

Expressing benefits in the form of a cost reduction is usually the preferred way to value benefits as reductions can be directly related to a shift in the supply curve to the right. With a static demand curve, this shift allows the additional economic surplus to be estimated, with producers and consumers sharing the surplus according to the slopes of the supply and demand curves. Cost reduction estimates are not always possible or simple from specific R&D investments. In the analyses conducted in the present study a range of benefit types, including cost reductions are valued. Some benefits, for example, are based on net profit increases which could be translated into a cost reduction for a specific commodity.

The total benefits estimated in each analysis will be shared between both producers and consumers. Producers refer to those industry sectors involved along the value chain. Consumers refer to both domestic and overseas consumers. There can also be leakage of benefits to producers in other countries where the technology produced is transferable and often costless to those producers.

There has been no attempt to estimate the relative distribution of benefits in the current analyses between different types of producers, between producers and consumers, or along the industry sector chain.

A first simple step to do this would be to estimate the producer/consumer shares according to the elasticity of supply and demand where a specific commodity is involved. Cost reductions in Australian on-farm production usually result in a favourable distribution for the on-farm sectors, at least in the short term. If the cost reduction or gain is large enough then farm production of the commodity may increase in the longer term and the additional supply may drive the farm gate price downwards. Production of other commodities may decrease and their price may rise. Likewise there may be other ramifications from the demand side and consumers may switch from one commodity to another. Exporters may take advantage of lower prices and change the export mix, depending on international markets and relative product availabilities. The relative importance of

drivers for and responses to price changes along the value chain will depend also on the input-output relationships between stages of the chain. The response to a cost reduction on farm is therefore complex with a whole range of sectors responding to an initial shift in one variable. This complexity may be tackled through modelling and this approach is appropriate.

Freebairn et al (1982) concluded that in a multistage production system, research induced cost reductions in one part of the system provides benefits to consumers and all other members of the production system. They concluded that the distribution of the research benefits is the same whether the cost reduction occurs at the non-farm input, farm or marketing sectors. The relative distribution between sectors depends on the elasticity of retail demand and the supply elasticities of value added at each stage of the production chain. The aggregate gains are affected little by changes in the various price elasticities. Further they concluded that the cost of research will be distributed in the same way as the benefits, implying that it does not really matter who pays for the research. The model used by Freebairn et al relies on constant input–output coefficients for the product as it moves through the value chain.

Previous work for MLA (CIE and ACIL, 1991) determined that off–farm productivity improvements were more beneficial to farmers than on-farm improvements involving increased product supply. This result appeared to contradict the main finding in Freebairn et al. This was explained as a result of more complex economic models being able to relax the assumptions on fixed input-output coefficients along the production chain.

An economic model of the red meat value chain is part of the evaluation framework developed for MLA by CIE. The model is constructed around a detailed set of input–output accounts and details the red meat value chains from farm production to feedlots, processing, wholesaling, retailing, domestic consumption and exports. The model allows estimates of economic impacts from changes in supply and demand factors and calculates the benefits to the red meat industry and for Australia after tracing through all flow on or secondary effects. It also provides estimates of how the benefits are distributed among different parts of the red meat industry and the rest of the economy. Such a model may be useful in prospective assessments of future investments involved in different types of R&D and in determining the relative effort in marketing investment versus R&D.

However, the question may need to be asked whether it is worthwhile utilising a large inter-sectoral economy wide model for ex-poste analyses when:

(i) R&D projects may have individually only a marginal impact on cost reductions and some apply to only a small part of one industry.
(ii) Sometimes it is difficult to express all impacts in the form of a cost reduction for one or more commodities.
(iii) There are impacts occurring for other commodities from R&D initiatives and other factors impacting on supply and demand and input-output relationships.
(iv) When time and resources are scarce, the time spent on sophisticated modelling may be better spent on collecting information on actual impacts and especially on adoption.
(v) The communication of, and providing simple explanations about, the results from a complex model are sometimes difficult.

On the other hand it may be argued that

(i) If an appropriate and updated model is already available, it may be worthwhile using it for individual investment analyses where appropriate.

(ii) Where an industry sector is particularly interested in the return to its own investment only, modelling with all flow on secondary impacts may be appropriate.

The following provides some description of the potential distribution of benefits by groups of projects organised by the different levy payers of northern beef, lamb sheepmeat and goats, southern beef, feedlots, and live export, as well as environment and adoption and capacity. The approach does not directly use the distributional impacts from the CIE economic model (CIE, 2006) due mainly to its currently available measures being in value added terms and the difficulty of communicating the results to levy payers. Instead, some references are made to the multi-sectoral equilibrium displacement model developed by Griffith and others (Zhao et al, 2000) for guidance on the potential distributional effects of benefits measured largely at the farm gate.

Northern Beef
Of the six analyses in this program, three analyses valued benefits in the form of increased net farm income from non-specific productivity changes and three from productivity improvements and cost reductions in the areas of bull costs, feed supplements and weed control costs. It may be possible to translate all of these benefits into cost reductions per kg beef produced, largely because many northern beef systems are single enterprise.

In general domestic and export consumers together may capture up to about 60% of the total benefits estimated from cost reduction in the Australian beef industry (Zhao et al, 2001). However, for northern beef, it is likely that consumers would have captured a lesser proportion than 60% as a high proportion of northern beef is destined for export markets where the own price demand elasticity is higher than for the local market. Also, the elasticity of supply in the northern industry is probably lower than that usually considered for the Australian beef industry as a whole. Hence any increased production and therefore any price reduction impacts are likely to be small. Producers would dominate benefits along the value chain compared with feedlotters, processors, retailers and exporters (Zhao et al, 2001).

Southern Beef
Two of the four analyses in the southern beef program were associated with an increase in productivity due to genetic improvement, another due to improved tradeoffs between genetics and feeding costs, and another due to lowered costs of production of beef. At least two of these analyses also contained some aspects of better meeting market specifications which could provide higher farm gate prices. One other analysis in southern beef (two EDGE projects) is discussed in the Adoption and Capacity sector below. Again consumers may capture up to about 60% of the total benefits estimated. Of the proportion captured by industry, producers are likely to have captured most of the benefits along the value chain (Zhao et al, 2001).

Lamb, Sheepmeat and Goats
Of the four economic analyses, three were concerned with cost reductions from improved disease control of OJD and one with an increase in net income emanating from productivity changes and on-farm cost reductions from the Prime Time campaign. Although lamb exports have risen in recent years, the proportion of lamb exported is still lower than for beef. Assuming the elasticity of demand for lamb is lower than for beef, and the own price elasticity of supply is about the same as for beef, it is possible that a higher proportion of the benefits (than for beef) from these cost reductions will be passed onto consumers.

Feedlots
The two analyses in the feedlot program were both associated with cost reduction (reduced death rates) and improved productivity through genetic improvement. Again consumers may gain up to 60% of the benefits estimated, feedlotters themselves may gain minimally (a few percent of the benefits only) with producers likely to gain the remainder (Zhao et al, 2001).

Live export
Benefits from the two analyses here were associated respectively with risk management and increased live sheep exports with their associated higher margins to producers. Neither of these benefits can be claimed as a cost reduction and one benefit jointly applied to both sheep and cattle. No estimates of elasticity of supply or demand for live exports were readily available. Intuitively, it is likely that most of the estimated benefits were captured by industry, particularly the sheep industry, rather than consumers. Within industry, producers have probably captured a high proportion of benefits.

Environment
Of the five analyses, benefit estimates for three (SGS, G&G, EverGraze) related to increased farm profits on high rainfall grazing (sheep and cattle) and medium rainfall mixed farms (sheep, cattle and cropping). It would be difficult to reduce these profits to cost reductions for specific commodities and make informed comment concerning the distribution of benefits along the value chain. For the other two analyses, one benefit was expressed in the form of a cost reduction (Buffalo Fly) and was related to the northern beef industry. The same comment applies to this analysis as for the earlier northern beef industry investments. The fifth analysis (weeds in temperate pastures) was related to productivity improvements and cost reductions from controlling weeds in temperate pastures. This could be translated (with some difficulty) into a cost reduction by apportioning total cost savings to different commodities produced in temperate areas

Adoption and capacity
The one analysis in this category (EDGE*network*) used increased profits per farm as the key benefit valued. It would require further assumptions to simulate these cost reductions for specific commodities from these profit increases.

4.7 Comments on Process

Overall the process followed in the assessments proceeded smoothly. Cooperation with principal investigators and researchers was cordial and most understood and respected the process that MLA was following. Assistance from MLA personnel was constructive and timely.

For several of the older projects (such as those finishing in 2001/02) both records and corporate memory were inadequate.

The major constraint faced was the dearth of information on the funding of projects from sources other than from MLA. Even where financial records were available from MLA, the division between MLA money and money from partners often was not clear. Further, researcher contribution (cash or in-kind) were not always specified in contracts so that for a number of projects, gross assumptions needed to be made. Researchers contacted often contributed their own estimates of in-kind contributions for some analyses.

5 Aggregate Criteria

5.1 Aggregate Criteria for the Sample

An aggregate NPV and a B/C Ratio are estimated for the 30 projects where benefits were valued quantitatively. These broader investment parameters are estimated by aggregating the benefit and cost streams for each of the 30 projects (24 analyses).

Table 5.1 presents the aggregate investment criteria for the 30 projects analysed. As for the individual analyses, results are expressed in 2005/06 $ terms. Investment criteria were calculated using discount rates of both 5% and 10% (all costs and benefits discounted to the year ending June 2006).

Table 5.1: Aggregate Investment Criteria for 30 Projects

Discount rate	5%	10%
Present Value of Benefits ($M)	104.50	67.53
Present Value of Costs ($M)	11.17	12.68
Net Present Value ($M)	93.33	54.85
Benefit-Cost Ratio	9.35 to 1	5.31 to 1
Internal Rate of Return (%)	50.02	50.02

A sample of 50 projects was drawn from the population in order to achieve a target of quantifying and generating investment criteria for about 50% of the sample (about 25 projects). In fact, 30 projects were analysed quantitatively.

It was then possible to compare the benefits from the 30 projects with the investment in the 50 projects in order to generate aggregate investment criteria for the entire sample. These aggregate results are presented in Table 5.2. Results are expressed in 2005/06 $ terms as of 2005/06, for discount rates of both 5% and 10%.

Table 5.2: Aggregate Investment Criteria for Entire Sample of 50 Projects

Discount rate	5%	10%
Present Value of Benefits ($M)	104.50	67.53
Present Value of Costs ($M)	19.46 (a)	22.74
Net Present Value ($M)	85.04	44.80
Benefit-Cost Ratio	5.37 to 1	2.97 to 1
Internal Rate of Return (%)	35.52	35.52

(a) The PVC for the 20 qualitatively analysed projects was $8.28 M and this is added to the PVC of the quantitatively analysed projects of $11.17 M

The resulting NPV and B/C Ratio in Table 5.2 then reflect a situation that assumes the other 20 projects analysed qualitatively have not produced benefits. While this is not true, these two criteria do provide a minimum performance for the 50 projects drawn at random. Extrapolation to the population of projects from the sample of 50 drawn is then valid. For example the B/C Ratio of 5.4

to 1 should apply to the investment of $57.010 M in the population over that period, that is, the present value of benefits produced from LPI investment is estimated as at least $308 M.

5.2 Aggregate Criteria for the Extended Sample

The total investment for the 24 individual analyses sometimes included other funding of MLA projects that were not directly drawn in the sample. This was because benefits were defined in terms of specific outcomes and all investment contributing to those outcomes was included in the initial analysis. It was then possible to attribute a proportion of the benefits to the specific MLA funding of the project or projects drawn in the sample. This is how the results in Table 5.1 were estimated. The attribution was based on the proportion of total costs contributed by the projects. However, this method also allowed additional benefits to be estimated for any MLA funding of projects in the population that were in the analyses.

It was deemed appropriate to use the 30 projects where benefits were quantified to "seed" or "define" a wider set of MLA investments that were also included in the population as the additional MLA investment so covered could also be considered to be chosen at random. This allowed a larger proportion of the population to be analysed. This allowed even greater credibility to the use of sample results to reporting on the likely performance of the total MLA population. In fact, the original sample of 50 projects made up 27% of the population of projects and the extended sample made up 45% in terms of the present value of costs.

Table 5.3 presents the investment criteria for the 30 projects including the investment in the additional projects (the extended sample).

Table 5.3: Aggregate Investment Criteria for Extended Sample Based on 24 Analyses and the 30 Projects

Discount rate	5%	10%
Present Value of Benefits ($M)	163.50	107.29
Present Value of Costs ($M)	23.53	27.09
Net Present Value ($M)	139.97	80.21
Benefit-Cost Ratio	6.95 to 1	3.96 to 1
Internal Rate of Return (%)	46.16	46.16

While the total benefits and costs increase compared to those in Table 5.1, the aggregate B/C Ratio falls (9.35 to 6.95). The reason for the fall for the extended sample is that the extension drew in many more projects from two large programs (SGS and EDGE*network*) both of which had B/C Ratios lower than the average.

Table 5.4 shows the aggregate investment criteria for the extended sample for the 50 projects.

Table 5.4: Aggregate Investment Criteria for Extended Sample Based on 24 Analyses and the 50 Projects

Discount rate	5%	10%
Present Value of Benefits ($M)	163.50	107.29
Present Value of Costs ($M)	31.81 (a)	37.14
Net Present Value ($M)	131.68	70.15
Benefit-Cost Ratio	5.14 to 1	2.89 to 1
Internal Rate of Return (%)	34.34	34.34

(a) The PVC for the 20 qualitatively analysed projects was $8.28 M and this is added to the PVC of the quantitatively analysed projects of $23.53 M.

5.3 MLA Investment for the period from July 2001 to June 2006

While the investment criteria presented in Tables 5.1 and 5.2 refer to the selected projects that were funded over the above period (July 2001 to June 2006), some projects included years of funding outside this period. For example, of the $14.6 million (nominal terms) invested by MLA in the 50 selected investments, only 72% of this occurred within that five year period.

It was possible to re-estimate the benefits and costs for each analysis using only the investment in the specific five year period. As an increasing number of projects are analysed, this would allow future five year periods to be compared within say five year blocks on a discrete or rolling five or three year basis. The value of this is that it would allow the tracking of the investment performance of MLA over time.

The corresponding investment criteria to those in Tables 5.1 and 5.2 are shown in Tables 5.5 and 5.6. These additional tables provide results for that part of the investment in the 30 projects that actually took place within the five year period July 2001 to June 2006.

Table 5.5: Aggregate Investment Criteria for 30 Projects with Investment Limited to the Specific Five Year Period

Discount rate	5%	10%
Present Value of Benefits ($M)	66.18	41.03
Present Value of Costs ($M)	7.65	8.46
Net Present Value ($M)	58.53	32.57
Benefit-Cost Ratio	8.65 to 1	4.85 to 1
Internal Rate of Return (%)	34.71	34.71

Table 5.6: Aggregate Investment Criteria for 50 Projects with Investment Limited to the Specific Five Year Period

Discount rate	5%	10%
Present Value of Benefits ($M)	66.18	41.03
Present Value of Costs ($M)	12.30	13.55
Net Present Value ($M)	53.88	27.48
Benefit-Cost Ratio	5.38 to 1	3.03 to 1
Internal Rate of Return (%)	27.08	27.08

5.4 Aggregation of Results by Levy Group

Aggregate investment criteria (similar to those presented in Tables 5.1 and 5.2) were calculated for funding of projects categorised by levy payer group (Northern Beef, Southern Beef, Lamb & Sheepmeat, Feedlots, Live Exports). Some projects were funded 100% by one of these groups. Other projects were jointly funded by more than one group. The benefits of each of the multi-funded projects were distributed to each of the five levy paying groups based on the contribution to investment in each. This information was provided by MLA at the population definition and stratification stage of the project.

The aggregate investment criteria estimated for each levy payer group are reported in Tables 5.7 and 5.8

Table 5.7: Aggregate Investment Criteria for 30 Projects by Levy Payer Group

Discount rate	5%	10%
Northern Beef		
Present Value of Benefits ($M)	26.89	15.39
Present Value of Costs ($M)	2.07	2.49
Net Present Value ($M)	24.83	12.90
Benefit-Cost Ratio	13.02 to 1	6.19 to 1
Internal Rate of Return (%)	27.13	27.13
Southern Beef		
Present Value of Benefits ($M)	28.83	18.41
Present Value of Costs ($M)	4.13	4.71
Net Present Value ($M)	24.69	13.70
Benefit-Cost Ratio	6.97 to 1	3.91 to 1
Internal Rate of Return (%)	24.21	24.21
Lamb and Sheepmeat		
Present Value of Benefits ($M)	26.96	15.23
Present Value of Costs ($M)	3.23	3.46
Net Present Value ($M)	23.73	11.77
Benefit-Cost Ratio	8.36 to 1	4.40 to 1
Internal Rate of Return (%)	28.90	28.90
Feedlots		
Present Value of Benefits ($M)	12.10	7.88
Present Value of Costs ($M)	1.22	1.38
Net Present Value ($M)	10.88	6.50
Benefit-Cost Ratio	9.93	5.70
Internal Rate of Return (%)	34.15	34.15
Live Exports		
Present Value of Benefits ($M)	9.72	10.62
Present Value of Costs ($M)	0.53	0.64
Net Present Value ($M)	9.19	9.98
Benefit-Cost Ratio	18.40	16.6 to 1
Internal Rate of Return (%)	No solution	No solution

Table 5.8: Aggregate Investment Criteria for 50 Projects by Levy Payer Group

Discount rate	5%	10%
Northern Beef		
Present Value of Benefits ($M)	26.89	15.39
Present Value of Costs ($M)	4.33	5.13
Net Present Value ($M)	22.56	10.25
Benefit-Cost Ratio	6.21 to 1	3.00 to 1
Internal Rate of Return (%)	19.45	19.45
Southern Beef		
Present Value of Benefits ($M)	28.83	18.41
Present Value of Costs ($M)	7.59	9.16
Net Present Value ($M)	21.23	9.25
Benefit-Cost Ratio	3.80 to 1	2.01 to 1
Internal Rate of Return (%)	15.04	15.04
Lamb and Sheepmeat		
Present Value of Benefits ($M)	26.96	15.23
Present Value of Costs ($M)	5.07	5.64
Net Present Value ($M)	21.89	9.59
Benefit-Cost Ratio	5.32 to 1	2.70 to 1
Internal Rate of Return (%)	19.73	19.73
Feedlots		
Present Value of Benefits ($M)	12.10	7.88
Present Value of Costs ($M)	1.87	2.10
Net Present Value ($M)	10.23	5.79
Benefit-Cost Ratio	6.46 to 1	3.76
Internal Rate of Return (%)	27.83	27.83
Live Exports		
Present Value of Benefits ($M)	9.72	10.62
Present Value of Costs ($M)	0.59	0.71
Net Present Value ($M)	9.13	9.91
Benefit-Cost Ratio	16.47 to 1	14.92 to 1
Internal Rate of Return (%)	No solution	No solution

Northern Beef
The Northern Beef Program contributed to 14 of the 50 projects in the sample. This investment covered 23% of the total PVC in the Northern Beef population. Aggregate benefits for the group were dominated to a large extent by GLM which contributed 17% of the total PVC for the levy group across the seven analyses but 47% of the benefits for the levy group.

Southern Beef
The Southern Beef Program contributed to 18 of the 50 projects in the sample and covered 42% of the total PVC in the Southern Beef population. This program made a significant investment in EDGE projects and this has contributed to a relatively low B/C Ratio for both the 30 the 50 sampled projects. The performance of the program has been enhanced by the performance of the biocontrol weeds project where benefits were high.

Lamb and sheepmeat
The Lamb and Sheepmeat program performance also was buoyed by the biocontrol weeds project where benefits contributed were high. The program contributed to 20 of the 50 projects in the sample and its investment covered 22% of the total PVC in the Lamb and Sheepmeat population.

Feedlots
The Feedlots program contributed to 5 of the 50 projects in the sample and covered 24% of the PVC in the Feedlots population. The Feedlots program performance was pushed up by the ALFA contribution to the CRC where benefits were high.

Live Export
The Live Exports program contributed to 3 of the 50 projects in the sample and covered 16% of the total PVC in the Live Exports population. For this program note that the investment criteria increase with an increase in the discount rate as most benefits were obtained before the year of the analysis. Of the three projects drawn in the sample, two had their benefits quantified which led to only a relatively small fall in the investment criteria for the 50 projects compared to the 30 projects.

Care needs to be taken in any comparisons made between the investment criteria for levy payer groups due to the small number of projects involved in some groups and the different proportions of sampled projects that were quantitatively analysed for each levy payer group. Some characteristics of the analysis for each group are provided in Table 5.9.

Table 5.9: Characteristics of the Investment Analysis for the 50 Project Sample for Each Levy Group (5% discount rate)

Group	Total investment by group in population (PVC $ M)	Total investment by group in sample of 50 (PVC $ M)	Group B/C Ratio	Proportion of investment in group population represented by group projects in the sample of 50
Northern Beef	18.87	4.33	6.21 to 1	22.9
Southern Beef	17.98	7.59	3.80 to 1	42.2
Lamb and sheepmeat	23.42	5.07	5.32 to 1	21.6
Feedlots	7.72	1.87	6.46 to 1	24.4
Live Exports	3.70	0.59	16.47 to 1	15.9

6 Conclusions and Recommendations

6.1 Conclusions

The findings from the qualitative and quantitative analyses demonstrate that:

- A range of benefit types (economic, environmental and social) are being delivered by LPI investment with the most frequent benefit delivered being on-farm productivity improvements.
- For the 30 projects where benefits were valued, the aggregate benefit-cost ratio was 9.4 to 1 at a discount rate of 5%.
- The total LPI investment over the period 2001 to 2006 has delivered (or is expected to deliver) a positive return on investment, with an estimated benefit–cost ratio of at least 5.4 to 1.
- As a large number of environmental and social benefits were identified as emanating from these investments without being valued, the results above are likely to be an underestimate of the performance of the sample and the portfolio.

6.2 Recommendations

1. Information on the magnitude of investment by year and by project should be maintained by MLA so that all partner contributions to an investment can be more easily identified by year and by contributing organisation.
2. The specification of the value of the researcher contribution to projects (in kind) is not always in contracts. It is recommended that such specification should be made mandatory.
3. MLA should consider giving greater encouragement to principal project teams and program and project review team to devote greater attention to the economic aspects of project investment when reporting and evaluating projects.

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Appendices

Appendix 1: Glossary of Economic Terms

Benefit-cost analysis (BCA) - A conceptual framework for the economic evaluation of projects and programs in the public sector. It differs from a financial appraisal or evaluation in that it considers all gains (benefits) and losses (costs), regardless of to whom they accrue.

Benefit-cost ratio (B/C Ratio) - The ratio of the present value of investment benefits to the present value of investment costs.

Benefit Transfer - The transfer of estimated benefits from an original source site to a new or target site.

Discounting - The process of relating the costs and benefits of an investment to a base year using a stated discount rate.

Ex-ante or prospective analysis - Evaluates a potential investment based on a number of assumptions of the likely level of inputs and outputs (and their values) that will occur as the investment proceeds.

Ex-post or historical analysis - Occurs after the research investment has been completed. It analyses the investment after completion with respect to benefit and cost outcomes attributable to the investment.

Internal Rate of Return (IRR) - The discount rate at which an investment has a net present value of zero, i.e. where present value of benefits = present value of costs.

Investment criteria - Measures of the economic worth of an investment such as Net Present Value, Benefit-Cost Ratio, and Internal Rate of Return.

Net Present Value (NPV) - The discounted value of the benefits of an investment less the discounted value of the costs, i.e. present value of benefits - present value of costs.

Present Value of Benefits (PVB) - The discounted value of benefits.

Present Value of Costs (PVC) - The discounted value of costs.

Willingness to pay (WTP) – The amount an individual is willing to pay to acquire a good or service, often elicited from stated or revealed preference approaches.

Appendix 2: Contents of Volumes 2 to 7

Volume 2: Northern Beef Case Studies
(See separate volume)

BeefPlan Group No. 1 (NBP.215)

Beefplan Group No. 2 (NAP3.310)

Bullpower - Delivery of Adequate Normal Sperm to Site of Fertilisation (NAP3.117)

Grazing Land Management: Education Package Technical Manual (NAP3.325)

Assessing the Value of Trees in Sustainable Grazing Systems (NBP.316)

Protecting North Australian Grasslands from Rejected Forage Plants of High Weed Potential (NBP.327)

Incorporation of Practical Measures to Assist Conservation of Biodiversity within Sustainable Beef Production in Northern Australia (NAP3.222)

Faecal NIRS: A Tool for Predicting Diet Quality in Grazing Cattle (NAP3.121, NBP.303, NAP3.116, NBP.302)

Rangelands Australia (NAP3.326 and includes NBP.217)

Neighbourhood Catchments – Minimising the Impacts of Grazing in the Fitzroy Catchment (NBP.325)

Fluoroacetate Toxicity Protection Trial on Cattle (NBP.326)

Volume 3: Lamb and Sheepmeat Case Studies
(See separate volume)

Individual Animal Tests for OJD (OJD.020)

Understanding Genetics of Muscle Hypertrophy and Leanness in Sheep (SFG.014)

Periparturient Relaxation (PPR) of Immunity to Sheep Worms: Causes, Control and Implications for the Development of Immunity in Lambs (AHW.099)

Whole Flock Vaccination at Merrill (OJD.015)

Development of Gene Silencing in the Parasitic Nematode Haemonchus contortus (AHW.031)

Commercialising Flockcare (COMP.001)

Consistency of Lamb Supply – Victoria (LAMB.139)

Development of Non-injectable Vaccine Delivery Technologies For Red Meat Industries (AHW.025)

MLA Prime Time Campaign: Implementation and Management of Farmer Forums (SCSB.065)

Pathogenesis of OJD: Strategic Research for Diagnosis and Prevention (OJD.031)

Volume 4: Southern Beef Case Studies
(See separate volume)

Consolidation of Molecular and Phenotypic Data from the Belmont CBX herd into the CRC Database (BFGEN.012)

Intake Studies and Supplementary Feeding in Tagasaste Browsing Systems (SBEF.015)

EDGE*network*®

Quantitative Genetics Research for the Beef Industry (BFGEN.002 including SBF.014)

Regional Systems to Meet Market Specifications (SBP.006V2)

Development of Spatial Toolsets for Managing Climate Risk in the Livestock Industries of Southern Australia (SBP.015)

The Development of Multi-Breed EBVs (SBEF.006)

Volume 5: Feedlot Case Studies
(See separate volume)

Review of options to reduce feedstuff supply variability (FLOT.123)

Measuring the Microclimate of Eastern Australian Feedlots and Reducing the Heat Load for the Australian Feedlot Industry (FLOT.317 and FLOT.327)

Devitalisation of Imported Feedgrain by Fumigation (FLOT.124 and FLOT.127)

ALFA Contribution to the Cattle and Beef Quality CRC (FLOT.215)

Volume 6: Live Export Case Studies
(See separate volume)

Best practice in the use of veterinary chemical and drugs in exporting livestock (LIVE.114)

Saudi Arabia Live Sheep Trade Resumption Trial (LIVE.103)

Development of Heat Stress Risk Management Model (LIVE.116)

Volume 7: Environment and Other Case Studies

(See separate volume)

Undergraduate Scholarship Program (STU.134)

Updating Modules of the SGS Pasture Model (HRZ.120) and Improving the SGS Pasture Model and Scoping Drought Risk Analysis (HRZ.121 and HRZ.121V)

The Sustainable Grazing Systems Program (Including SGS.009B and SGS.115)

Grain & Graze (GG.010)

Non-insecticidal Control of Buffalo Fly Using Behaviour-Modifying Systems (TR.062)

Delivery of Biological Control Agents for Broad-Leafed Weeds in Temperate Pasture (WEED.400A)

Profitable Animal Production from Perennial Pastures (PAPP) Phase 3- Establishment (HRZ.201)

Improved Diagnosis of Reproductive Diseases in Cattle (AHW.036)