Final Report

Project code: **B.GSM.0002**

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Date published: **September 2012**

PUBLISHED BY
Meat & Livestock Australia Limited
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NORTH SYDNEY NSW 2059

Economic Evaluation of Investment in EverGraze

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

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INTRODUCTION

EverGraze is a partnership between Australian Wool Innovation (AWI), Meat and Livestock Australia (MLA), the CRC for Plant based Management of Dryland Salinity and regional catchment management agencies. From 2008 the CRC became the Future Farm Industries CRC (FFI CRC).

EverGraze focuses on farming systems in different environments across the high rainfall zone of southern Australia (EverGraze website, 2011). This report provides the results of an analysis of the costs and benefits of the investment in the EverGraze initiative.

BACKGROUND

At the beginning of the 2000s, MLA, the CRC for Plant Based Management for Dryland Salinity and AWI with Land and Water Australia (LWA) were all pursuing joint productivity and environmental benefits through various land and water management R, D & E programs.

Also, the $1.4 billion National Action Plan for Salinity and Water Quality had commenced in 2000/01. This plan, delivered through 56 regional natural resource management bodies, saw the Australian Government and State/Territory Governments working together to repair and conserve the natural environment and ensure the sustainable use of the nation's natural resources.

Use of perennial pastures in the higher rainfall recharge areas was seen as a focus for change and had the potential to deliver both economic and environmental benefits in the form of improved animal productivity, enhanced water quality in waterways, and reduced water accessions to groundwater.

Original Investment: Phases I to III

The original investment in EverGraze was a project called "Profitable Animal Production from Perennial Pastures" or PAPP, initially a joint initiative of MLA and the CRC. Subsequently the initiative was known as the EverGraze Project. AWI joined the funding effort in 2007.

The EverGraze initiative has been developing and testing new farming systems in different environments of the high rainfall zone (>550mm average annual rainfall) of southern Australia. The initiative involves combining different perennial pastures designed to meet the nutritional needs throughout the year of high performance prime lamb and wool production systems. Apart from increasing productivity and profitability on a whole farm basis, the pastures were envisaged to use excess water in the soil profile, so lowering water tables and the threat of salinity in some regions, as well as improving water quality in waterways.

EverGraze has progressed through a number of phases since its commencement. The first two phases produced detailed processes for catchment selection, methods for producer engagement and pre-experimental modelling in order to establish the first implementation stage of the investment (Phase III).

The catchments selected initially were:

1. South Coast Western Australia (Albany Eastern Hinterland Catchment)
2. South West Victoria (Glenelg Hopkins Catchment)
3. Southern NSW (Murrumbidgee Catchment)

A number of farm management scenarios were designed for each catchment that covered current, best and new livestock and pasture systems. The pre-experimental modelling task was to undertake bio-economic and hydrologic modelling of the typical farms and farm management scenarios and have the results reviewed and validated by stakeholders. The first implementation stage (Phase III) was to enable the modelled future farming systems to be further researched, validated and demonstrated in the field. This aimed to produce innovative and profitable animal production enterprises that utilised perennial pastures (mostly improved pastures at this stage) and that also contributed to reduced recharge at the catchment scale.

Specific objectives were:

(a) a reduction in recharge by 50% (or an appropriate amount for the region) over current farming systems
(b) an increase in profitability by 50% (above best practice animal enterprises).

Phase IV

In this phase (2007-2010), AWI contributed to an expanded EverGraze project where research was conducted at 3 additional sites (Albury /Wodonga, Orange and Tamworth).

Phase IV continued the implementation stage and included the extension to a native pasture focus (as opposed to improved pasture) and increased emphasis on adoption. Also, a network of 55 demonstration sites or Supporting Sites was established. The increased emphasis on extension included new investment by DPI Vic and DPI NSW.

Phase V

Phase V (2008-2011) consisted of validation and interpretation of the improved farming systems. Due to drought the Proof Sites for improved pasture were continued for another two years. There was strong support for the continuation of the Native Proof Sites due to the impact of drought and also to achieve a better understanding of the ability to manipulate native pastures for profit and natural resource outcomes.

Phase VI

Phase VI is the current phase (2011-2014). It is an adaption phase including packaging of national research outcomes to make them more accessible and regionally relevant. It includes development and delivery of training for service providers and producers, finalisation of native sites, and modelling to improve understanding of the potential impact of decisions within the farming systems designed on the Proof Sites.

A diagrammatic representation of EverGraze showing the targets, the various Proof and Supporting Site locations and the research/extension split is shown in Figure 1.

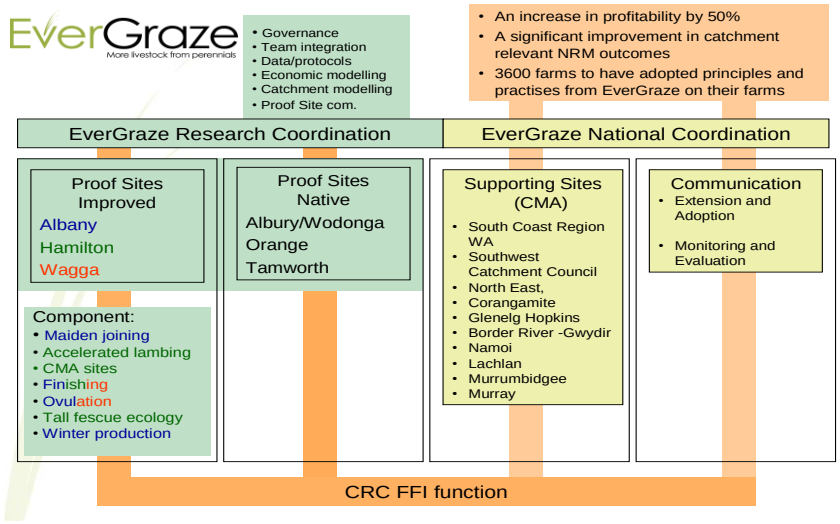

Figure 1: A Diagrammatic Representation of EverGraze
(Source: EverGraze, 2011)

Target Market

The target market for the investment were livestock producers in the high rainfall zone (HRZ), defined as >550 mm average annual rainfall. According to ABARES, the number of broadacre farms has declined in this zone over the past decade, continuing the decline exhibited in the decade before. The number of farms in the past ten years is shown in Table 1 for each of the southern states and for Australia.

Table 1: Number of Broadacre Farms in the High Rainfall Zone

Year ending June	NSW	VIC	SA	TAS	WA	Total for S States	Total for Australia
2001	8,136	8,774	2,593	1,440	1,932	22,875	26,635
2002	7,758	8,444	2,642	1,202	1,684	21,730	25,296
2003	8,934	9,305	2,943	1,439	2,136	24,757	28,846
2004	9,050	8,792	2,938	1,567	2,025	24,372	28,598
2005	8,070	8,857	2,829	1,456	2,057	23,269	27,578
2006	6,932	7,277	2,407	1,121	1,719	19,456	22,884
2007	5,919	7,530	2,205	1,095	1,630	18,379	21,830
2008	6,146	6,417	1,959	1,007	1,670	17,199	20,026
2009	5,924	6,743	2,022	1,171	1,741	17,601	20,502
2010	5,443	7,534	1,909	900	1,457	17,243	20,182
Average past 10 years	7,231	7,967	2,445	1,240	1,805	20,688	24,238
Average past 5 years	6,073	7,100	2,100	1,059	1,643	17,976	21,085

Changes in Emphasis

The context and NRM objectives of EverGraze originally placed an emphasis on water management and the reduction of groundwater recharge and salinity. Due to the 2005 to 2009 drought this emphasis on reducing recharge lessened. Overtime a greater emphasis was given to wider NRM outcomes such as improved ground cover, water quality and biodiversity and the performance of farming systems during poor climatic years.

The emphasis on productivity and profitability remained but it was realised that the objective of achieving a 50% increase in profitability was optimistic, particularly given the drought conditions existing for a large part of the investment period that impacted differentially on various locations.

Greater emphasis in 2008-2011 was given to the validation of systems. Also, in 2007/08 the additional AWI support extended the initiative to native pastures and a greater emphasis on extension with regard to both profit and the wider NRM outcomes via operational funding for state agencies.

Also in 2007/08, the CRC was successful in a rebid to become the Future Farming Industries CRC. This continuation of funding also reignited an emphasis on farming systems and planning to increase adoption. Increased extension capacity was available from the CRC via in-kind agency extension specialists in Victoria and NSW and Evergreen in WA. Separate contracts were established between the agencies and AWI for extension operating funds.

PRINCIPAL OUTPUTS

Proof Sites

The improved pasture sites focused on a range of systems including existing and new perennial pasture species, increased pasture production and utilisation, improved grazing management and reproductive performance of animals in the system.

Both systems and component research were carried out at each site with an overall objective of increasing profit and natural resource outcomes in the six regions of the high rainfall zone of temperate Australia.

The systems developed at the sites were implemented at a scale of approximately 70 hectares in each of the regions. The systems all used similar high-performance sheep genetics. Standard measurement protocols were established and the experiments were measured within this framework under the guidance of the EverGraze Regional Group (ERG) in each Proof Site region. The EverGraze Proof Sites were strongly focussed towards research but with a coordinated communication program.

Examples of component research were increasing winter feed from summer active perennial pastures; hedge and shrub rows to improve lamb survival; use of rotational grazing and fertilisers to improve the production and persistence of native pastures, and the use of perennials to increase ovulation rates.

Apart from the Proof Sites, there was a series of on-farm demonstrations supported by EverGraze; these involved the CMAs and tested elements of perennial based livestock farming systems that were aimed at profit as well as delivering natural resource outcomes.

Information being produced from the Proof Sites and on–farm demonstrations was supported by field days, workshops, producer training as well as training for consultants, researchers and natural resource managers. A series of fact sheets (EverGraze Actions and Exchanges) were produced, as well as a newsletter and various other publications. The EverGraze website also provided an information resource.

Apart from direct contact with producers, engagement with personnel who in turn could influence producers in their decisions was an important part of the EverGraze extension strategy. This included the Proof Site teams themselves and associated producers, extension personnel (both private consultants and state agency personnel including those in both primary industry and NRM departments), Landmark agronomists and others.

Supporting sites

There were 55 Supporting Sites that performed a demonstration role and that were associated with components of the farming systems at the Proof Sites. These were implemented by local producer groups in conjunction with catchment management authorities. Examples of topics covered included: perennial species compared to annuals; alternative (summer active) perennials compared to traditional species; and grazing management of native pastures.

Issues addressed

Some of the issues addressed by EverGraze included:

- Native vegetation including understanding its identification, role, utilisation and integration into the farming system
- Integration of native and improved pastures
- Role of improved pastures including use of lucerne to ameliorate a failed spring and role of kikuyu grass to replace annual ryegrass in WA
- Improvement of (improved) degraded pastures
- Role of rotational grazing and changes to pasture utilisation rates
- Availability of green perennials to increase ovulation rates and increase lamb survival
- Benefits of shelter systems
- Compilation and integration of current knowledge (farming system design) so as to match soil, genetics, pasture species, grazing management, enterprise type and farmer type

Extension outputs

A range of extension activities took place and associated outputs were produced:

- Regional extension plans linked to the national EverGraze plan and its targets were developed for each Proof Site region with the plans being updated each year
- Training programs and courses were developed and implemented.

- Demonstrations were held in association with Supporting Sites in collaboration with CMAs, state agencies or private consultants.
- Field days and farm walks were associated with both Proof and Supporting Sites; these were initially focused on awareness raising (2000 events held and 5,500 people participated).
- In 2009-10 emphasis shifted to communicating results and encouraging adoption; 290 events were held, attended by 8,200 people; also major forums were held on specific topics (e.g. the role of lucerne and kikuyu) at specific sites.
- A number of decision support tools were developed; for example, a Pasture Improvement Calculator that estimates the profitability of resowing pastures and tools on rotational grazing and lamb survival.
- A range of Fact Sheets have been produced including many on management and use of sown perennial grasses, management of native grasses, and management of livestock.
- EverGraze Exchange sheets have been produced that discuss a variety of management options based on the latest research findings rather than providing a 'how to do it' sheet.
- These published information documents have been used widely at courses, field days and other events.
- Catchment management groups (e.g. Central West CMA) have produced useful publications as part of EverGraze.
- A large number of case studies (including financial case studies) has been produced by the state agencies operating in each state.
- A training program "EverGraze Whole Farm Grazing Strategies" has been developed and piloted. This program assists farmers to make whole-of-farm strategic investment decisions (based on EverGraze principles) and overcome challenges with implementation. It will also be delivered to service providers online in Phase VI.
- A number of short workshops suitable for delivery to producer groups and service providers (e.g. Feed Budgeting, EverGraze Grazing Management Principles).
- Future extension outputs will include regional packages, modelling and a new website.

Capacity building outputs

- Increased research capacity has been built including data produced for farm to catchment scale modelling, large scale system research and agricultural practice change.
- EverGraze has supported the training of a number of PhD students.
- Industry leadership capacity has been enhanced through the National Advisory Committee and involvement of producers and other community members across a range of EverGraze Regional Groups.
- EverGraze has facilitated the building of productive research, extension and NRM partnerships and collaboration between three RDCs, state agencies and a range of CMAs. For example (Geoffrey Saul, pers. comm., 2011):
    - In central NSW, the Lachlan CMA helped organise and provided and paid for all catering and support to field days at the Orange Proof Sites.
    - In northern NSW, the Namoi and Border Rivers/Gwydir CMA ran joint field days and had DPI speakers at on-farm events.
    - WA scientists and producers visited Kangaroo Island in SA twice to promote the use of kikuyu on the island.

- The Central Highland Agribusiness Forum applied on behalf of EverGraze to secure Caring for Our Country funding for Supporting Sites across Victoria.
- The knowledge about the use of summer active perennials undertaken at Wagga Wagga was picked up and discussed across the project.

PRINCIPAL OUTCOMES AND BENEFITS

The key outcomes from the investment have been practice changes by HRZ producers with regard to the pastures used and the systems and management practices in which they are embedded. These practice changes have led to profitability and NRM improvements in HRZ grazing systems as well as enhanced wellbeing of producers through decreased complexity, workload and stress. Some of these improvements have been captured by the one practice change, for example, rotational grazing to increase ground cover, reductions in the number of mobs of sheep for easier management, and increased profits.

The practice changes vary considerably as demonstrated in the variation among the individual producer case studies that have been reported by EverGraze.

Examples of practice changes reported in narratives and case studies of individual farms that referred to specific practice changes and impacts include:

- Strategic grazing of the annuals and perennials
- Use of chicory, lucerne, phalaris, tall fescue, kikuyu and cocksfoot to increase stocking rates and improve animal performance
- Use of rotational grazing and feed budgeting
- Use of merino ovulation techniques (flushing on lucerne)
- Increased persistence of native perennial pastures
- Reduced supplementary feeding
- Matching management to species
- Earlier weaning
- Better allocation of fertiliser inputs
- Moved from set stocking to late start deferred grazing and rotational grazing on native pastures in steep hilly country, increased persistence of native perennial pastures and increased ground cover
- Whole farm grazing strategies resulting in increased total production, more growth and less wastage, increased utilisation, increased flexibility in management, and increased confidence to buy trade stock
- Increased carrying capacity and pasture quality
- Lower animal health costs (due to reduced parasites)
- Higher wool quality and quantity and higher lambing percentages
- Improved condition score
- Reduced wind erosion
- Reduced water logging
- Less undesirable species

- Less impact of stock camps
- Reduced erosion and salinity
- Reduced run-off erosion, improved ground cover and less weeds
- Increased quality/density of phalaris and improved pasture composition

BENEFITS ASSOCIATED WITH THE INVESTMENT

A summary of the benefits identified from the EverGraze investment is provided in Table 2. In the main these reflect the practice changes identified in the outcomes section.

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

Benefit Type	Levy Paying livestock industries	Spillovers	
		Other Industries	Public
Economic	Increased farm profits by HRZ grazing enterprises More informed risk-profit balance and decision making under uncertainty Reduced soil loss by water erosion through use of perennials and increased ground cover	Crop industries and mixed farming industries	Enhanced ability of producers to support and sustain rural communities
Environmental	Reduced potential loss of productive land (acidity salinity, waterlogging, soil loss by water erosion)	Crop industries and mixed farming industries	Reduced recharge to groundwater and reduced salinity and other contaminants in catchment waterways (e.g. nutrients, sediments)
Social	Practice change that reduces producer stress and increases producer well being Increased research, advisory and leadership capacity of the industry Increased industry capacity to change and enhancement of industry licence to operate	Crop industries and mixed farming industries	Increased institutional collaboration and coordination of public resource expenditure Increased national research capacity Potential animal welfare benefits from strategies that emerged regarding interaction of lamb survival with vegetation Greater satisfaction by the wider community regarding industry concern for the landscape

Public versus Private Benefits

The potentially improved farming systems emanating from this investment will lead to both private and public benefits. The private benefit will take the form of improved productivity and profitability through reduced soil loss and an improved feedbase and grazing management via the improved farming systems. The principal public benefits will be exhibited in reduced groundwater recharge, reduced erosion and degraded land, improved water quality downstream in the catchments from reduced erosion and nutrient export, and reduced chances of future salinity impacts. Smaller public benefits may be captured in the area of animal welfare through improved vegetation management for shelter, increased research capacity and an enhanced capacity of rural based institutions to work together.

Match with National Priorities

The Australian Government's national and rural R&D priorities are reproduced in Table 3.

Table 3: National and Rural R&D Research Priorities 2007-08

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

The EverGraze investment has contributed to National Research Priorities 1 (through improved land management and water quality) as well as Priority 3. The investment also made a contribution to Rural Research Priorities 1 and 3 and the two Supporting Priorities.

PREVIOUS BENEFIT-COST ANALYSES

2005 Analysis

A benefit-cost analysis was carried out on the EverGraze investment in late 2005 (Young, 2005). The analysis estimated a benefit cost ratio of 3.2 to 1

2007 analysis

A 2006/07 analysis (Agtrans Research, 2009) used some of the assumptions in Young (2005) but included the value of water quality benefits. The net present value for the total investment and including water quality benefits was estimated at 6.2 to 1. However, when the benefits included were only those derived from profit increases, this analysis produced similar results to those found by Young (2005).

THE CURRENT BENEFIT-COST ANALYSES

Terms of Reference

The terms of reference (TOR) for the current analysis identify three separate analyses. The TOR state:

I. An ex post BCA 2008-2011(Extension phase) – a time where AWI made commitments to 3 native pasture Proof Sites and MLA continued its work in high input demonstration sites. AWI and MLA funded co-ordination and implementation of a network of producer demonstration sites.
II. An ex post BCA 2006-2011 (Research phase) – covering the whole EverGraze project plus the more recent farming systems research.
III. An ex ante BCA 2011-2013 based on the project proposal for two further years of investment as contained in the proposal submitted by the FFI CRC.

It is noted that the investment in EverGraze in the years earlier than 2006 need to be accommodated in the analysis as these earlier investments would have contributed to the later impacts of EverGraze. Also, it has now been confirmed that the EverGraze investment will continue to 2013-14.

The approach taken for the ex-post analyses (I and II in the terms of reference) is that all benefits from EverGraze from the investment up to 2011 are estimated. This interpretation of the terms of reference was made as it would have been difficult to attribute the benefits gained to research versus extension as the two strongly interact. The only way this could be done usefully would be to assume some level of adoption from the research (without extension) and then estimate the additional adoption due to extension. As extension was also carried out in the research phase, the assumptions necessary would be quite arbitrary.

Investment

The annual investment in EverGraze commenced in the year ended June 2005. Annual investments are shown in Table 4.

Table 4: Resources Invested by Year for MLA, AWI, CRC, and Other Funding Partners (nominal $)

Year ending June	MLA funds	AWI funds	CRC (Cash) (c)	CMAs (Cash)	CRC (in-kind)	CRC and CMAs (in kind)	Total
2005	1,163,000	0	300,000	95,000	1,780,011	0	3,338,011
2006	613,000	0	300,000	155,000	2,213,772	0	3,281,772
2007	911,000	800,000	300,000	100,000	2,280,185	0	4,391,185
2008	924,000	800,000	300,000	122,000	2,348,590	0	4,494,590
2009	200,000	800,000	300,000	328,000	992,000	0	2,620,000
2010	200,000	800,000	300,000	309,000	1,020,000	0	2,629,000
Total to 2010	4,011,000	3,200,000	1,800,000	1,109,000	10,634,558	0	20,754,558
2011	305,000	161,600	950,000	0	0	0	1,416,600
Total to 2011	4,316,000	3,361,000	2,750,000	1,109,000	10,634,558	0	22,171158
2012	715,000	675,000	0	0	2,481,000	1,553,500	5,424,500
2013	385,000	675,000	0	0	2,782,000	1,228,500	5,070,500
2014	0	0	0	0	230.000	0	230,000
Total to 2013	5,416,000	4,711,600	2,750,000	1,109,000	16,127,558	2,782,000	32,896,158

Sources: EverGraze Cash Flow Spreadsheet for 2005 to 2010; EverGraze Budget Spreadsheet for 2011; Project Proposal 2011-2014; Discussions between Russell Pattinson, MLA and AWI in November 2011.
Note: MLA, AWI and CRC cash contributions for 2011 sourced from CRC, as were CRC in-kind contributions for 2012, 2013 and 2014.

Approach to Developing Assumptions

A project advisory group was formed to assist with the assumptions to be used in the analyses. The group was Russell Pattinson (Convenor), Chris Mirams, Cam Nicholson and Geoff Symes. The group was selected based on their knowledge of HRZ pastoral systems, and their familiarity with the EverGraze investment, outputs and outcomes. Russel Pattinson provided access for Agtrans to much of the relevant EverGraze printed material for use in the definition of the logical framework and for the development of assumptions for quantification of benefits required in the benefit cost analyses. The advisory group also made input to the assumptions used in the analyses and this input is gratefully acknowledged. However, many assumptions had to be made where there was a scarcity of relevant information. In that regard responsibility of the final assumptions made are those of the authors and not the advisory group.

Benefits Valued

The benefit valued in this analysis is the increases in aggregate farm profit that can be attributed to EverGraze.

Benefits Not Valued

1. Economic benefits not valued included more informed risk-profit balance and decision making under uncertainty. Data was not available to make any estimates of the average and variability of net income associated with particular management changes. This could be achieved however via modelling such as that carried out by Nicholson (2011). Information on the trade-off between the average and the variability of returns between two alternatives could then be used by the

individual producer to make decisions more in line with personal preferences, so increasing their personal utility.

2. Environmental benefits not valued include improved ground cover, reduced soil acidity, and reduced sediment and nutrient reduction in waterways

3. Social benefits not valued include reduced farmer stress, improved well-being, and easier management; increased industry capacity to change (this would be in addition to the increased profits attributable to EverGraze and would apply to learning capacity and better appreciation of interactions between components that may be useful for other future innovations and technologies); increased institutional capacity to cooperate and work together; and increased research capacity from the higher degrees supported and completed.

   The main reason for not valuing these benefits was the difficulty of making credible assumptions about the extent of change, and difficulties in estimating financial values for such benefit types. Improved ground cover benefits could be a candidate for valuation with regards to soil and nutrient loss from the farm and reduced nutrient contamination of off-farm waterways. However, this would be a sizeable valuation exercise and was not possible within the current analysis (see later).

Aggregation

While a strong case could be made for disaggregation of the practice changes made across regions, suitable data was not available. In a similar manner, profit increase would have varied by region as well as for the particular practice changes that would have been made on different groups of farms. Hence the key assumptions (extent of change and value of change) are made for HRZ farms as a whole.

KEY ASSUMPTIONS FOR THE EX POST ANALYSIS

The key essentials of the analysis framework to value the increase in farm profits benefits were:

- the extent of practice change for each year due to the EverGraze investment
- the value of practice change
- lags between when changes made and the receipt of benefits
- the longevity of benefits from a practice change

Numbers of Farms Changing Practices

Commendable attempts by the EverGraze project have been made to measure and report the involvement of producers and other stakeholders with EverGraze as well as the impact of EverGraze on producers. These results have been used in the assumptions to value aggregate impact.

EverGraze data on producers adopting practice change for the 2006-2011 period have been reported based on a telephone survey of EverGraze participants and non-participants in April

2010. Information on intentions to adopt practice change was collected from participants during EverGraze events.

The telephone survey was used also to gauge understanding of key practices around EverGraze and to provide guidance on the future direction of research and extension in EverGraze. The survey included producers who had participated in EverGraze, Next Users (State agency, CMA and Landcare personnel), as well as non-participants in EverGraze.

Two methods were used to estimate from the survey data a range of 2,300 to 4,200 producers making changes due to EverGraze over the five year period for years ending June 2006 to June 2010 (EverGraze, 2010).

Two methods were used to estimate the number of producers that made changes as a result of the EverGraze project. The first method estimated that 4,200 made changes as a result of EverGraze, this method ignored the fact that some of those stating they had changed management due to EverGraze may still have made changes anyway. The second method estimated that 2,300 made changes as a result of EverGraze; this figure was estimated by assessing the stated adoption differences between those participating in EverGraze compared to those not participating. However, this method ignored the possibility that some of the non-participants may have obtained information unknowingly from other sources such as CMA and state agency personnel who had been influenced by participating in EverGraze. The mean of these two estimates is 3,250 producers which would be an average of about 600 per annum assuming equal annual adoption over each year.

Another study estimated that 600 producers adopted practice changes due to the 2010-2011 EverGraze activities. This estimate was based on the assumption that 50% of the 1,200 participants in that year would have made practice changes (EverGraze, 2011). The report states:

"Approximately1,200 producers were involved in demonstration or training activities similar to those from which the "intentions" were reported. It was estimated that in the order of 720 (60%) of these have had similar intentions for practice change. If we assume that even only 50% actually go through and make a change – then practice change potential from the activities would be in the order of 600 producers over that period." (EverGraze, 2011, p29).

Higher levels of EverGraze adoption were reported to be in SW or NE Victoria and in WA, with levels of adoption on the NSW HRZ farms being the lowest. As indicated earlier these differences were not accommodated in the present benefit cost analysis.

Other factors affecting adoption estimates

Other influence pathways

The above estimates did not directly include any allowance for the change on farm that may have been precipitated by the attendance at EverGraze events over the past four years by 4,000 individuals from groups such as CMAs, Landcare, state agricultural agency staff, and private consultants or agronomists (e.g. from Landmark). Most management changes cannot usually be attributed to one source and it is possible that many additional changes have occurred via pathways that indirectly can be traced back to other producers or advisers who

were influenced by EverGraze. It is also interesting to note that from a survey of non-participants (i.e. people who had never attended an EverGraze event or activity), 30% said they were aware of the project (Geoffrey Saul, pers. comm., 2011).

However, these other learning/influence pathways have been accommodated to some extent by averaging the two estimated figures of producers making changes using the two methods, as discussed in the previous subsection.

Drivers of change other than profit

A number of practice changes were made on farms principally due to reasons other than profit as described previously: for example, lifestyle improvements, increased management flexibility, adjusting risk levels more suited to the individual's preference, and to pursue environmental benefits. While some of these changes may have also resulted in increased profit, it is assumed that there were others that did not. As the benefit to producers making changes that result in profit is being valued, there is an argument for adjusting the above numbers downwards to address this issue with the benefits from achieving the other objectives remaining as qualitative benefits.

Failure to make profit

It is likely that a number of those making management changes for profit may not have realised the average profit that is assumed in this analysis. In fact, it is possible that some may have made losses. As there is little information available on these scenarios, this factor has not been addressed in the present analysis. Follow up on those stating they have made management changes would provide evidence of such failures.

It is concluded that the number of 600 producers per annum making management changes as a result of participation in EverGraze needs to be adjusted downwards to accommodate the other drivers of change (20% downwards adjustment) and failure to make profit (25% downwards adjustment) and then would provide a reasonable and probably conservative estimate.

Investment legacy

The current ex post analysis assumes EverGraze investment ceases in June 2011. It is likely that if investment had ceased then, there would still be some adoption occurring post June 2011 that could be attributed to the investment up to June 2011. While this would not occur through direct participation, further adoption would rely on activities in 2011, and increasing knowledge of public and private advisers and previously available residual EverGraze literature.

Hence, it is assumed that 25% and 10% of the number of producers changing in 2010-11 would make changes in 2011/12 and 2012/13 respectively without any further investment in EverGraze.

Summary of Adoption Assumptions 2006 to 2011

A summary of the estimated numbers assumed to adopt for profit and who successfully achieve profits is provided in Table 5.

Table 5: Estimated Number of Farms Making Practice Changes due to EverGraze Investment 2005 to 2011

Year ended June	Numbers making practice changes	Numbers making practice changes for profit that result in profit increases
2006	600	360
2007	600	360
2008	600	360
2009	600	360
2010	600	360
2011	600	360
2012	150	90
2013	60	36

Future adoption

It is noted that many HRZ producers (particularly in southern NSW) were badly affected by a lengthy drought period and this factor would have significantly reduced adoption. In one survey, two of the major limitations to adoption were limited capital and drought (Geoffrey Saul, pers. comm., 2011). This suggests that there may be some potential adoption capacity remaining in the industry now that seasons have improved and a swing back to sheep and cattle in marginal cropping regions is apparent. This is important in terms of assumptions regarding the impact of EverGraze investment in 2012 and 2013 on future adoption.

As time passes, reliance on surveys of producers to recall what influenced their management changes will become less reliable as EverGraze outputs and principles become increasingly mainstream. An option then would be to identify the total investment in relevant R, D & E that may have been made each year (EverGraze plus other) against all practice changes made or identify specific EverGraze outputs from which change can be traced.

Adoption Tool

An Adoptability Planning Tool is currently being developed and trialed by a team associated with the FFI CRC. The tool focuses on practice change and how it might be systematically predicted to assist with guiding ex ante investment in research and extension as well as assisting ex-post R, D and E evaluation where assumptions are not well supported by real adoption data. With regard to EverGraze, the tool may have useful applications in relation to guiding future extension efforts of EverGraze findings.

One comment is that the tool could work most effectively when there is a simple new technology or innovation and prediction of its adoptability is being made over its lifetime. The tool works on both the innovation (potential advantage etc) and the characteristics and perceptions of the target audience.

Where the innovation builds on existing technologies that are already partially adopted, it may be difficult to separate the adoption of the innovation being tested from the adoption that is

already in place. In these situations therefore it would be essential to ascertain detail on the current practices before applying the tool.

Where there are many specific technologies and systems being promoted (as with EverGraze) and a range of target audiences, there may be numerous populations and innovations (and combinations of innovations) to assess through the tool. Reducing this number may require grouping of populations and innovations which would require efforts to become familiar with the frequency of the existing practices and systems. The effective design of R&D investment requires knowledge of the target audience. Achieving a more systematic approach through the use of the Adoptability Planning Tool is probably its greatest benefit. Even many extension programs, for example, are still not planned with specific target audiences and their current practices in mind.

Financial impacts of practice change

Two key assumptions are necessary to estimate the aggregate financial impacts per farm from changes attributed to EverGraze: the area of the farm and the net profit gained per ha.

Area of farm

The ABARES annual survey provides statistics for the number and area of broadacre farms in the HRZ (Table 6).

Table 6: Average Broadacre Farm Numbers and Areas in the High Rainfall Zone of Southern Australia (excluding Tasmania) (2001 to 2010)

Region	WA	SA	VIC	NSW	Aust
Average farm numbers	1,805	2,448	7,967	7,231	19,451
Average area (ha)	667	1,309	484	836	787 (a)

(a) Weighted average for the four states

The average area of the farms where changes were made due to EverGraze was 860 ha (EverGraze, 2010); this is consistent with the weighted average in Table 7. The median size of the farm changing practices was 540 ha. The decision was made to use the median farm size data rather than the average, despite the EverGraze finding that it would be producers with larger farms who are most likely to adopt information from EverGraze (EverGraze, 2010).

Profit gain per ha

The relationship between the change made and the impact on whole farm productivity and profit is pivotal and is being modelled currently by EverGraze.

In the meantime, some of the narratives and case studies reported by EverGraze refer to financial impacts but most refer to specific components and are not in a form that can be directly interpreted in a whole farm or whole farm per hectare scale.

While the median farm area was 540 ha, the median area on which changes due to EverGraze were made was assumed to be 100 ha. The profit estimated is $50/ha of the area subject to management changes. This is supported as a conservative estimate by inspection of some of the case studies where profits are reported. This represents approximately $10 per ha over the whole farm area. As the $50 per ha is considered an approximate estimate, this assumption is subject to sensitivity testing in the later analysis.

This annual profit assumption is considered net profit and would allow for any increase in annual variable costs as well as the amortised value of any additional capital investment (e.g. increases in perennial pasture sowing, increased stock numbers). The types of benefits associated with the changes are numerous and ranged from direct cost reductions to increased carrying capacity, animal performance and product quality.

It would have been useful to follow up on a sample of those stating they made or intended to make practice changes to assess:

(a) If the changes had been made
(b) If the change had resulted in benefits, particularly net profit
(c) The value of the increased profits in $ per whole farm ha.

Lag between practice change and benefits

In order to accommodate the nature of many of the changes (e.g. sowing an increased area of perennial pasture and increasing the stocking rate), a lag of two years is assumed between the year of practice change and the first year of benefits received. The maximum level of benefits is conservatively assumed to be reached one year after the first year of benefits. These assumptions are supported by Saul et al (2011) where it is reported that it took 3 years for the full benefit of pasture improvement at five locations in south-western Victoria to become apparent.

Longevity of benefits

It is assumed that once benefits commence for a given farm they extend for 20 years. There are no foreseen technical issues that would curtail benefits. Where an improved technology post EverGraze becomes available, any new benefits are attributed to the new investment; the old technology, as long as it is technically available and feasible, continues to be assigned benefits and the new technology is compared with it and attracts the added benefits. A viable argument against extending the benefits for 20 years is that the farm's ownership and management may change and the new regime may not continue with the existing improved systems.

Social and NRM benefits

As described previously, a number of practice changes were made on farms principally due to reasons other than profit and have been excluded from the aggregate profit estimated. The issue is that these non-profit benefits have not been valued in the current analysis.

It may be possible to value lowered stress and increased well-being and job satisfaction. Increased information in the numbers benefitting in this regard and some estimates of the extent of the improvement in well-being eventuating would be helpful if this was attempted.

NRM benefits were mainly associated with increased ground cover, reduced erosion, decreases in sediment and nutrient export, and potentially reduced waterlogging and salinity impacts.
Again, while some of these benefits can be valued, measurements on the extent of impact are not readily available for EverGraze.

A major benefit from EverGraze is the reduction in soil erosion from increasing ground cover. It is well known that the impacts of both wind and water erosion are reduced by additional ground cover, with reduced water erosion one of the principal outcomes provided by EverGraze. The loss of the fertile topsoil removes organic matter and plant nutrients and this can reduce future pasture production, so benefits to the farm are also achieved as well as reduced export of sediment and nutrients.

While not formally included in the quantitative analysis, the following provides some indication of the potential benefits to the producer of increasing ground cover.

The average soil loss through surface runoff during the SGS national experiment was reported by McCaskill et al (2003) at 14 tonnes per ha for 1 mm of top soil (as the mean bulk density was 1.4). If the average ground cover increased from 60% to 70% on some farms due to EverGraze, Figure 2 suggests that soil loss (expressed in tonnes per ha) may be reduced by at least 50%. At 50%, the soil loss averted may be about 7 tonnes per ha.

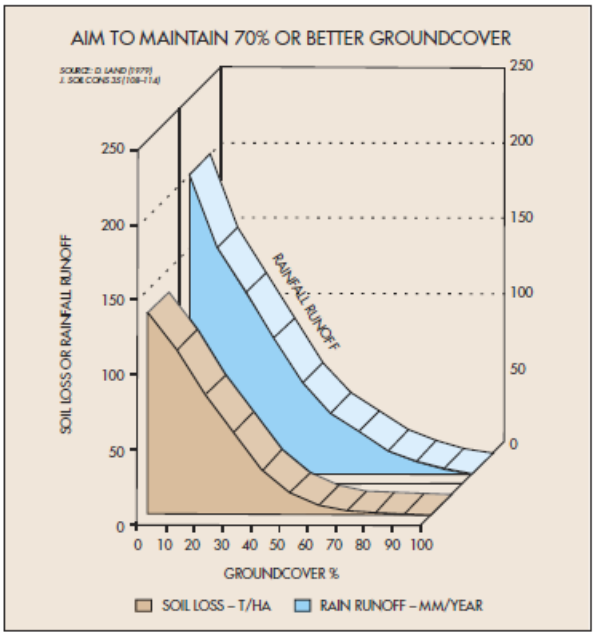

Figure 2: Effect of Groundcover on the amount of soil loss and water runoff from pastures (Source: Lang and McDonald (2005) adapted from Lang (1979))

An estimate of the cost of fertiliser to replace the nitrogen, phosphorus and trace element loss from one tonne of eroded soil has been estimated in the range of $3.50 to $7 (Anon, undated). At the lower end of this value range, the value of 7 tonnes of soil therefore may be over $20 per ha.

Another estimate derived from a nutrient audit of the Long Term Phosphate trial at Hamilton was that the top 1 mm of soil contains about 12 kg/ha of P; with P valued at about $3.00/kg, the loss of 1 mm of soil is therefore equal to a loss of about $36/ha just in P and not counting N, K S or trace elements (Malcolm McCaskill, personal communication to Geoffrey Saul, 2010).

Wind erosion is another matter. In Western Australia soil erosion from wind from grazed paddocks throughout the wheat belt has been estimated to cost between $20-$60 per ha in lost income from the next crop (Marsh, 1982). While the impact of wind erosion is probably significantly less than this in the HRZ, these numbers illustrate the severity of wind erosion in some circumstances.

There are obviously critical assumptions in this area that would need measurement and verification if such estimates were to be viewed as credible in relation to the impact of EverGraze. However, the above historical literature suggests the potential value of such an impact from EverGraze could be significant relative to the estimated profit that EverGraze may capture from other means. It is surprising therefore that soil loss has not been measured in the EverGraze investment. Improved and more detailed and authoritative estimates to those above could also be attempted by those with soil and nutrient knowledge.

For purposes of the present analyses, it is assumed that the current profit estimate includes an element of the value of soil loss averted.

Summary of Assumptions for Ex Post Analysis

A summary of the key assumptions made is given in Table 7.

Table 7: Assumptions for the Valuation of Increased Profits from Investment in EverGraze from 2006 to 2011

Variable	Value	Source
Investment costs	See Table 4	
Number of farms changing practices due to EverGraze	See Table 5	Agtrans Research based on EverGraze surveys and reports
Median size of farms changing practices	540 ha	
Median area benefiting due to EverGraze	100 ha	
Net profit assumed	$50 per ha	Agtrans Research based on input from Advisory Group
Lag between practice change and year of first benefits	2 years	
Lag between practice change and year of maximum benefits	3 years	

KEY ASSUMPTIONS FOR THE EX ANTE ANALYSIS

EverGraze Investment 2011-12 to 2013-2014

The annual investment in EverGraze for each of the three years investment was provided earlier in Table 4.

Numbers of Farms Changing Practices

In the ex-post analysis, the assumptions regarding adoption for the investment up to 2011 included the two years 2011-12 and 2012-13 after which adoption directly due to investment in EverGraze fell to zero.

While the ex-ante analysis does not have any positive data as evidence, it is likely that two further years of EverGraze investment will produce similar annual numbers of producers changing practices to the earlier years. This would be in addition to those already accounted for in the ex post analysis.

Arguments for assuming a lower number of new adoptees can be attributed to the new investment after 2011 include:

- producers most likely to change may already have been engaged in the first six years
- the legacy of the earlier investment may have been stronger than assumed in the ex post analysis

Arguments that the numbers should continue at the same level would include:

- the steep part of the sigmoid curve of adoption curve for many technologies would continue for a longer period
- the drought in the 2005 to 2009 period may have delayed early adoption by some producers
- the anticipated increasing emphasis on individual needs and whole farming systems (demonstrating profit) in the 2011-2014 period may attract a new market niche and encouraged greater adoption
- survey data from 2010 reported that 72% of EverGraze participants intended to make further changes to pasture management

It is concluded therefore that 600 producers make practice changes in each of the next three years as a result of the new investment. The combination of the non-profit and profit drivers of change, as applied in the ex-post analysis, would still be relevant.

Also, some adoption after June 2014 is assumed and can be attributed to the three year new investment. Some 25% and 10% of the number of producers changing in 2013-14 are assumed to make changes in 2014/15 and 2015/16 respectively.

While it is possible that there will be a significant adoption legacy greater than assumed here, it needs to be kept in mind that the attribution of future benefits to the research findings from EverGraze will likely diminish over time as new forms of packaging the EverGraze information are applied.

Summary of Adoption Assumptions for 2012 - 2014 investment

A summary of the number of producers making changes and of those assumed to adopt for profit and who successfully achieve profits is provided in Table 8.

Table 8: Estimated Additional Number of Farms Making Practice Changes due to EverGraze Investment 2012-2014

Year ended June	Numbers making practice changes	Numbers making practice changes for profit that resulting in profit increases
2012	600	360
2013	600	360
2014	600	360
2015	150	90
2016	60	36
2017	0	0

Financial impacts of practice change

As with the post analysis, the assumptions necessary to estimate the aggregate financial impacts per farm from changes attributed to EverGraze were the area of the farm and the net profit gained per ha. These are assumed the same as for the ex-post investment at 540 ha of which 100 ha was assumed to benefit at the profit level of $50 per ha. The lag between the practice change and the first year of benefits, the time taken to achieve maximum benefits, and the longevity of benefits were assumed the same as for the ex post analysis and are repeated in Table 9.

Summary of Assumptions for Ex Ante Analysis

Table 9: Assumptions for the Valuation of Increased Profits from Investment in EverGraze from 2012 to 2014

Variable	Value	Source
Investment costs	See Table 4	
Number of farms changing practices due to EverGraze	See Table 8	Agtrans Research based on EverGraze surveys and reports.
Median size of farms changing practices	540 ha	
Median area benefiting due to EverGraze	100 ha	
Net profit assumed	$50 per ha	Agtrans Research based on input from Advisory Group
Lag between practice change and year of first benefits	2 years	
Lag between practice change and year of maximum benefits	3 years	

RESULTS

Results for Ex Post Analyses

All past costs and benefits were expressed in 2010/11 dollar terms using the CPI. All benefits after 2011 were expressed in 2010/11 dollar terms. All costs and benefits were discounted or compounded to 2010/11 using a real discount rate of 5%. The base run used the best estimates of each variable, notwithstanding a high level of uncertainty for some of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2010/11) to the final year of benefits assumed.

Investment criteria were estimated for the total investment up to and including 2011 and each set of investment criteria were estimated for different periods of benefits. The investment criteria are reported in Table 10.

Table 10: Investment Criteria for Investment (2005 to 2011)
(discount rate 5%)

Criterion	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits (m$)	44.56	90.65	126.82	152.70	158.24	158.24	158.24
Present value of costs (m$)	29.25	29.25	29.25	29.25	29.25	29.25	29.25
Net present value (m$)	15.31	61.40	97.57	123.45	128.99	128.99	128.99
Benefit cost ratio	1.52	3.10	4.34	5.22	5.41	5.41	5.41
Internal rate of return (%)	15.0	24.5	26.3	26.7	26.7	26.7	26.7

The annual cash flow of benefits from the investment is shown in Figure 1.

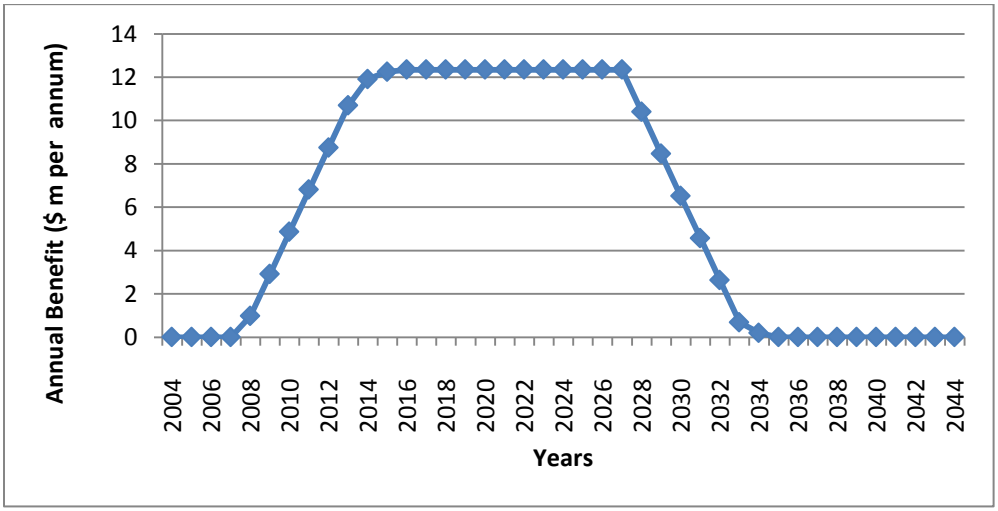

Figure 3: Annual Benefit Cash Flow

Sensitivity Analyses

The sensitivity of the investment criteria to the discount rate is shown in Table 11.

Table 11: Sensitivity of Investment Criteria to Discount Rate
(Total investment, 20 years from year of last investment)

Criterion	**Discount rate 5%**		
	0%	**5% (Base)**	**10%**
Present value of benefits ($ m)	240.72	158.24	114.30
Present value of costs ($ m)	24.58	29.25	34.77
Net present value ($ m)	216.14	128.99	79.54
Benefit-cost ratio	9.79	5.41	3.29

The sensitivity of the investment criteria to the assumption regarding the average profit increase is shown in Table 12. The break even profit increase for the investment to return 5% was $9 per ha of the practice change area.

Table 12: Sensitivity of Investment Criteria to Changes in Profit Per Hectare Undergoing Change
(Total investment, 20 years)

Criterion	**Discount rate 5%**		
	Low Value ($25 per ha)	**Base value ($50 per ha)**	**High value ($100 per ha)**
Present value of benefits ($ m)	79.12	158.24	316.48
Present value of costs ($ m)	29.25	29.25	29.25
Net present value ($ m)	49.87	128.99	287.23
Benefit-cost ratio	2.70	5.41	10.82
Internal rate of return (%)	16.0	26.7	41.1

Table 13 presents the sensitivity of the investment criteria to the producer numbers assumed making practice changes due to EverGraze. The break even total number of producers that needed to change for the investment to break even in the ex post analysis was 705, compared to the assumed number of 3,810.

Table 13: Sensitivity of Investment Criteria to Producer Numbers Assumed Changing per annum from 2006 to 2011 (Total Investment, 20 years)

Criterion	Discount rate 5%		
	300	600 (base)	900
Present value of benefits ($ m)	79.12	158.24	237.36
Present value of costs ($ m)	29.25	29.25	29.25
Net present value ($ m)	49.87	128.99	208.11
Benefit-cost ratio	2.70	5.41	8.11
Internal rate of return (%)	16.0	26.7	34.6

Results for Ex-Ante Analysis

All costs and benefits were expressed in 2010/11 dollar terms. All costs and benefits were discounted or compounded to 2010/11 using a discount rate of 5% real. The base run used the best estimates of each variable, notwithstanding a high level of uncertainty for some of the estimates. All analyses ran for the length of the investment period plus 20 years from the last year of investment (in this case 2013/14) to the final year of benefits assumed.

Investment criteria were estimated for the total investment for the three year period (years ending June 2012 to June 2014) and each set of investment criteria were estimated for different periods of benefits. The investment criteria are reported in Table 14.

Table 14: Investment Criteria for Investment (2011-12 to 2013-14) (discount rate 5%)

Criterion	0 years	5 years	10 years	15 years	20 years	25 years	30 years
Present value of benefits (m$)	0.84	20.55	39.63	54.58	62.37	62.43	62.43
Present value of costs (m$)	9.77	9.77	9.77	9.77	9.77	9.77	9.77
Net present value (m$)	-8.93	10.78	29.87	44.82	52.61	52.67	52.67
Benefit cost ratio	0.09	2.10	4.06	5.59	6.39	6.39	6.39
Internal rate of return (%)	negative	24.0	32.0	33.3	33.5	33.5	33.5

The annual cash flow of benefits from the investment is shown in Figure 4.

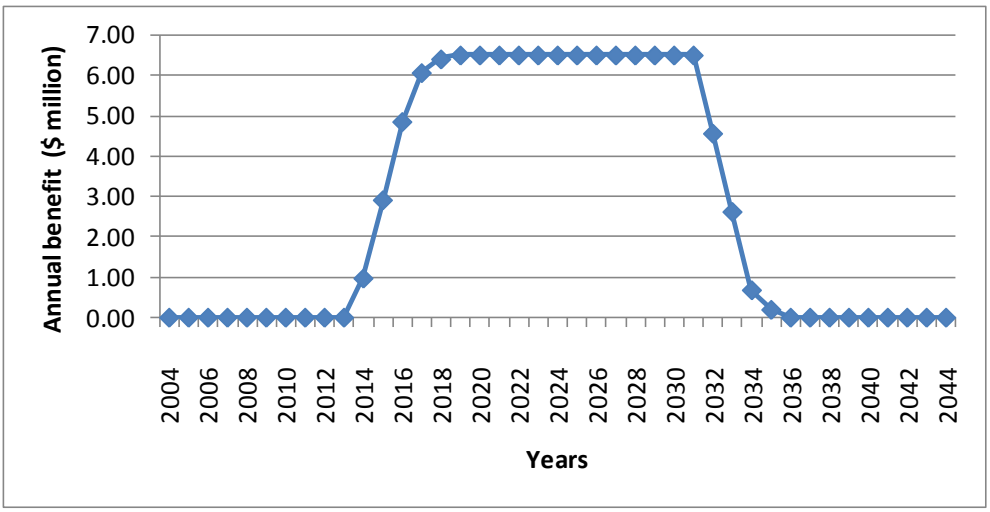

Figure 4: Annual Benefit Cash Flow

Sensitivity Analyses

The sensitivity of the investment criteria to the discount rate is shown in Table 15.

Table 15: Sensitivity of Investment Criteria to Discount Rate
(Total investment, 20 years from year of last investment)

Criterion	**Discount rate 5%**		
	0%	**5% (Base)**	**10%**
Present value of benefits ($ m)	113.77	62.37	37.22
Present value of costs ($ m)	10.50	9.77	9.12
Net present value ($ m)	103.28	52.61	28.09
Benefit-cost ratio	10.84	6.39	4.08

The sensitivity of the investment criteria to the assumption regarding the average profit increase is shown in Table 16. The break even profit increase for the investment to return 5% was $7.80 per ha undergoing change.

Table 16: Sensitivity of Investment Criteria to Changes in Profit Per Hectare Undergoing Change
(Total investment, 20 years)

Criterion	Discount rate 5%		
	Low Value ($25 per ha)	Base value ($50 per ha)	High value ($100 per ha)
Present value of benefits ($ m)	31.19	62.37	124.75
Present value of costs ($ m)	9.77	9.77	9.77
Net present value ($ m)	21.42	52.61	114.98
Benefit-cost ratio	3.19	6.39	12.77
Internal rate of return (%)	20.1	33.5	52.4

Table 17 presents the sensitivity of the investment criteria to the number of producers making management changes due to EverGraze. The break even total was 315 producers versus the assumed total of 2,010.

Table 17: Sensitivity of Investment Criteria to Producer Numbers Assumed Changing per annum from Investment in 2011-12 to 2013-2014 (Total Investment, 20 years)

Criterion	Discount rate 5%		
	300	600 (base)	900
Present value of benefits ($ m)	31.19	62.37	93.56
Present value of costs ($ m)	9.77	9.77	9.77
Net present value ($ m)	21.42	52.61	83.79
Benefit-cost ratio	3.19	6.39	9.58
Internal rate of return (%)	20.1	33.5	43.8

CONCLUSIONS

The EverGraze project is somewhat unique in that the experimental phase was preceded by a significant effort into catchment identification, system design, and modelling. The integration of the research phase with extension and involvement of state agency and other advisers, and the integration in pursuing both profit and environmental outcomes were particularly noteworthy.

Given the assumptions made, the benefit cost analysis suggests that the investment has been highly successful in economic terms. The ex post analysis estimated that a total R&D investment of $29 million (present value terms) produced benefits valued over 20 years of $158

million, giving a net present value of $129 million, a benefit cost ratio of 5.4 to 1, and an internal rate of return of 27%.

The ex ante analysis estimated a slightly higher rate of return. The ex ante analysis estimated that a total R&D investment of $9.8 million (present value terms) would produce benefits valued over 20 years of $62.4 million, giving a net present value of $52.6 million, a benefit cost ratio of 6.4 to 1 and an internal rate of return of 33%. The principal reason for the slightly higher return for the future investment was the lower R&D cost per producer changing practices driven mainly by the extension orientation of the ex ante investment. However, it should be noted that the 2012-2014 investment relied also on the earlier research phase of EverGraze. Sensitivity analyses showed that the positive results were fairly robust to lower values of the key assumptions.

The key assumptions of the number of producers changing practices due to EverGraze and the net profit achieved from the change were the most challenging in this analysis. It is possible that some of the early adoption assumed may in fact occur later than assumed in this analysis. However, the adoption profile used is based on the evidence provided by a number of EverGraze reports. Also, assumptions of adoption post EverGraze investment are associated with greater uncertainty and attribution to the EverGraze investment alone will decline as extension packages using the EverGraze results evolve and add value over time.

These results were achieved despite the fact that a number of the benefits from EverGraze, while identified, were not included in the valuation of benefits. Time and resources did not permit such valuations. To assist future attempts at such valuations, programs such as EverGraze should attempt to measure and estimate the extent of impacts such as soil loss, water quality improvements off farm and some of the social impacts such as producer wellbeing.

ACKNOWLEDGMENTS

Russell Pattinson, Miracle Dog
Malcolm McCaskill, Department of Primary Industries, Victoria
Kate Sargeant, National EverGraze Extension Leader
John McGrath, Future Farm Industries CRC

The assistance and input from the following members of the Project Advisory Group is gratefully acknowledged:

- Geoffrey Saul, former EverGraze National Extension Coordinator
- Chris Mirams, Chair, EverGraze National Advisory Committee
- Cam Nicholson, Nicon Rural Services

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