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Biodiversity-smart, profitable meat production: An update - Developing R&D recommendations arising from an updated review of the impacts of red meat production on biodiversity

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Abstract

All food production systems are under pressure to comply with societal expectations that the food is not only of good nutritional value but is sustainably produced. The reputation of the Australian redmeat industry is intrinsically tied to the management practices and policies of former generations of producers and policy makers, as well as to current unsustainable practices evident in some other parts of the world. Meat & Livestock Australia has invested considerably in environmental issues such as biodiversity and has sought to identify opportunities for potential future investment in biodiversity management in the context of profitable grazing enterprises.

This report updates a 2009 review that compared the biodiversity management performance of the red meat industry vis-à-vis the performance of white meat, plant-protein and other protein production systems. Precedence in this update is given to advances in knowledge specifically in relation to red meat production.

Recommendations for industry level R&D investment are outlined.

Executive Summary

Purpose

Meat & Livestock Australia (MLA) is a significant investor in sustainable agriculture, including the development and improvement of grazing systems designed to minimise or reverse the impact of red meat production on biodiversity.

In 2009 MLA commissioned a report (B.CCH.2023) that compared the biodiversity management performance of the red meat industry vis-a-vis white meat, plant-protein and other protein production systems.

This project updates the knowledge accrued since 2009 specifically in relation to the red meat industry and makes recommendations on potential future MLA investment in biodiversity related R&D. The study was conducted between May and July 2013.

Methods

The methods associated with this study focused on an analysis of contemporary literature to update knowledge about the biodiversity management performance of the red meat industry.

While analysis of the literature has been used to identify R&D investment opportunities, this study also involved surveying key research and management practice informants about R&D priorities on the relationship between biodiversity and grazing.

Findings

The report deals with two aspects of the available literature: 1) the non-peer reviewed literature largely dealing with shifts in the operating environment within which red-meat industry co-investment in biodiversity research takes place; and 2) the peer reviewed literature updating the technical knowledge base about the relationships between red meat production and biodiversity. In addition, the report relates 3) the views expressed in interviews with and surveys of researchers and graziers. The key findings for each follow:

1) Shifts in the operating and investment environment

- Natural Resource Management R&D investment priorities have shifted significantly towards climate change other issues often need to integrate with this;
- Various government initiatives now place biodiversity in the context of building ecosystem resilience;
- Closer scrutiny of rural R&D arrangements, including co-investment, continues;
- Increasing industry productivity is a national priority that will influence future government and industry policy frameworks;
- A raft of recent Australian Government policies support inter-related issues such as food security, supply-chain relationships and Asian market opportunities;
- Public perception of the industry has been adversely influenced by animal welfare issues;

• The speed and reach in which information can be conveyed provides new opportunities but can expose industry to greater public scrutiny.

2) The emergence of new knowledge

Relatively few peer-reviewed publications regarding the relationship between grazing and biodiversity have been released since 2009. What has been published generally focuses on the negative impacts of grazing on biodiversity, either directly or through related pressures such as introduced pasture grasses.

To date, virtually no published research has been found in the peer-reviewed Australian ecological literature since 2009 on the potentially positive benefits that biodiversity can bring to livestock production systems.

From the literature that has been published, the main findings include:

- The usefulness of vegetation cover thresholds as a tool for biodiversity conservation is now being discounted by some authors;
- While overall, stock exclusion was found to be beneficial for biodiversity, considerable variation in response was identified;
- Invasive pasture species continue to have an impact on biodiversity, particularly in northern and central Australia;
- The importance of interactions between grazing and other potential pressures on biodiversity has been demonstrated across a number of studies;
- Considerably more publications have appeared about biodiversity and climate change in the last 3-4 years. These are mostly based on modelling and expert opinion, and often at the 'bigger picture' level than just on their relationships to grazing;
- There is a growing focus on the resilience of ecosystems and farming communities;
- The concept of 'novel ecosystems' has gained greater attention and promoted some heated debate in the scientific community;
- The novel ecosystem debate is part of the broader research and extension focus on restoration and regeneration of degraded systems;
- Another ongoing 'big picture' debate is the relative contribution of land sparing and land sharing to biodiversity conservation in production landscapes.
- Stewardship payments to farmers for managing for conservation outcomes/delivery of ecosystem services still seem to be considered a useful incentive model.

3) The views of key informants

Consensus among researchers was found on the following:

- Environmental, social and economic complexity can make it challenging to identify generic rules for biodiversity conservation on grazing lands;
- A greater understanding is required of the local/regional variation in grazing systems and the interactions with biodiversity;

- There is a need to evaluate alternative approaches to grazing management such as pasture cropping, holistic grazing and stress-free stock management and compare them with mainstream practices;
- The role of more diverse pasture mixes for production (including livestock health and wellbeing) and biodiversity outcomes needs further evaluation across environments;
- The importance of local, management oriented research building on existing longterm and/or baseline research was emphasised.

Interviews responses from graziers highlighted a need to marry landscape production with health, including farmers' physical and mental health, consumer health and animal health.

Recommendations

In summary, the current study found that while grazier interest in sustainability had not declined since 2009, investment in the biodiversity component of it had. This has led to a reduction in research that examines the integration of biodiversity with profitable farming systems.

Most of the recommendations of the 2009 study have yet to be implemented. The role of this study has been to place these and more contemporary recommendations arising from new findings into the context of MLA's overall investment strategy. To this end, the report places the top 12 R&D recommendations into a conceptual framework that starts with MLA's Strategic Plan 2010-15 (see Figure 1 and Table 1).

Without exception, these recommendations have been contextualised by the need to deal with biodiversity within production systems that are profitable. The report adopts the term "biodiversity smart', implying that biodiversity management is not an end to itself but rather something that can support profitable production.

Moreover, the recommendations are delineated by their relationship to critical elements of management decision making (the 'biodiversity smarts'): smarter decision framing, smarter capacity to make decisions, and smarter implementation and review of decisions. In effect, this provides a framework that could see MLA investments in biodiversity integrate under a single program, with relationships formed with other MLA initiatives as necessary.

Translating investment into biodiversity smart land management as a means of securing markets is difficult to value quantitatively. Yet taking seriously the burden of proof principle underpinning claims of sustainable beef and lamb production valued off farm at \$11.6 billion and \$3.8 billion is in itself a reasonably compelling business case.

After undertaking this project, the authors' priorities for biodiversity R&D would be 1) to undertake a systematic regional scale review as recommended previously, as well as 2) more rigorously assess alternative grazing systems such as holistic management, pasture cropping and self-medication compared to mainstream practices. The ecosystem services and resilience provided by these systems could potentially be explored at the same time.

The reviewers commend this report's recommendations to MLA and recommend that Figure 1 and Table 2 be used as a workshop primer for industry participants to discuss and flesh out into

actionable investments. This would enable the recommendations to be tested by a broader audience and create a sense of ownership of the findings.

Figure i: The Biodiversity Smart Profitable Production Framework



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Table i: The Biodiversity Smart Profitable Production Framework (including report recommendations)

B.ERM.0095 - Biodiversity-smart, profitable red meat production: An update

The biodivers smarts	ity The key management questions	The R&D priorities (Authors' Recommendations)	Key R&D outputs	Essential links to other strategic imperatives
Smarter framing of decisions	 What are the risks? What are the benefits? What are the opportunities? How can risks and benefits be combined and managed to create business value, healthy properties and improved wellbeing? 	 Describe and value the variation in space and time of the impacts of grazing regimes on biodiversity and the responses to them; Describe and value the biodiversity and production benefits of diverse pastures mixes and alternative grazing systems; Describe and value the benefits of productive management versus 'locking land away' for biodiversity outcomes; Explore equitable ways for society to pay for ecosystem services specific to red-meat production; Develop an assessment tool to guide incremental, systems or transformative changes to ensure land use matches land capability; Examine the link between healthy landscapes and grazier well-being. 	 Systematised risk assessment account; Upgraded property management assessment tools; Economic frameworks for sensibly comparing traditional and novel grazing systems; Government, industry and corporate agriculture policy recommendations for capturing natural capital benefits; Grazier and adviser tools for capturing natural capital benefits; Input into a corporate social responsibility statement of MLA 	 Market access Increasing industry and people capacity
Smarter capacity to make decisions	 What are the management options and resource requirements? What do resilient meat production systems look like? What should be monitored and how? 	 Develop Risk Indexes for different regions to define ecosystem thresholds, underpin response indicators and act as a tool for management planning; Explore how remote sensing and smart technologies can be used to deliver multiple, including biodiversity, benefits; Explore what a biodiversity module of the Cattle Council's Pasturefed Cattle Assurance System (PCAS) might look like and how it would be perceived. 	 Risk indexes and threshold indicators; Adaptive management options to avoid crossing thresholds or to respond if hitting them; Feasibility assessment for a potential biodiversity module of PCAS. 	 Increasing productivity across the supply chain Increasing industry and people capacity Market access
Smarter implemen- tation of decisions	 What is best practice to match particular conditions? How can best practice be managed adaptively? How can landscapes regenerate under profitable management? 	 Describe for each grazing region how to restore / regenerate functioning ecological communities instead of simply fencing remnants or planting lines of trees; Develop new ways to improve integration of farm forestry and other complementary farming systems with grazing management and on-farm biodiversity conservation; Identify fire regimes that encourage woodland regeneration in grazing landscapes. 	 Regionally-specific best practices based on natural capital; Contextualised best practices for the grazing component of mixed farming (not just grain and grazing) systems; Best practice fire management regimes. 	 Increasing productivity across the supply chain Increasing industry and people capacity

Essential links to other

B.ERM.0095 - Biodiversity-smart, profitable red meat production: An update

Glossary

Biodiversity

The variety of life, its composition, structure and function, at a range of scales. For the purposes of this report, biodiversity management focuses at the farm and paddock scale, within a regional framework.

Extensive

Industries that utilise native vegetation as the resource base and have relatively low stocking rates. Principally corresponds to the rangelands and savannas in the centre and the north of Australia (covering around two-thirds of the country), but also on native pastures in south-eastern Australia. External inputs to these systems are low or zero.

Intensive

Industries where native vegetation has been cleared and converted to another land use, principally exotic pastures or crops. Pastures are often irrigated and fertilisers added to accelerate plant growth.

Land sharing

Also referred to as integration and wildlife friendly farming. This approach integrates goals for food production and biodiversity protection on the same land. A relevant example for the red meat industry is utilizing native pastures as part of production systems. Extensive industries fall within this category.

Land sparing

Also referred to as separation. This approach separates intensive farming from protected ecosystems, often at large scales. A relevant example for the red meat industry is replacing native pastures with exotic pastures while fencing off areas of remnant vegetation. Intensive industries fall within this category.

Meat

Most people use the term 'meat' to refer to animal flesh, mostly skeletal muscle. However, Food Standards Australia and New Zealand has a broader definition that also includes offal ('meat other than meat flesh' e.g. brain, liver, kidney, tripe).

Red Meat (MLA)

In Australia, the term 'red meat' is used by the meat industry to refer to meat from cattle, sheep and goat (i.e. beef, veal, lamb, mutton and goat meat). It does not include meat from pigs (e.g. pork, ham, bacon) or kangaroo. In many other parts of the world, including the US, UK and Europe, the term 'red meat' includes pig meat. Pig meat is also now included in the definition of red meat by the NHMRC) – see below.

Red meat (Byron 2011, NHMRC 2013)

The latest definition of red meat used by the National Health and Medical Research Council (NHMRC) now includes pork, ham or bacon as well as the muscle meat from cattle, sheep, deer and kangaroo. Pig meat has been added because it is referred to as red meat in other parts of the world and in epidemiological studies.

Total grazing pressure (Fisher et al. 2005)

The combined grazing pressure exerted by all stock – domestic and wild, native and feral – on the vegetation, soil and water resources of rangeland landscapes.

Resilience (sensu Walker et al. 2004)

The capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks. Disturbances of sufficient magnitude or duration can profoundly affect an ecosystem and may force it to reach a threshold beyond which a different regime of processes and structures predominates. This can cause shifts in ecosystems, often to less desirable and degraded conditions. Interdisciplinary discussions on resilience now includes consideration of the interactions of humans and ecosystems via socio-ecological systems.

Value

The term value in this report principally refers to the economic (monetary) value of a good or service based on individual preferences and choices. Non-monetary values are also included where relevant, such as the aesthetic or cultural value of a good or service.

Acronyms

ANU	Australian National University
BIGG	Biodiversity in Grain and Graze
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities (Commonwealth)
DPIPWE	Department of Primary Industries, Parks, Water and the Environment
MLA	Meat & Livestock Australia
NCCARF	National Climate Change Adaptation Research Facility
NHMRC	National Health and Medical Research Council
NLWRA	National Land and Water Resources Audit
OECD Organis	ation for Economic Co-operation and Development
PCAS	The Pasturefed Cattle Assurance System
PSR	Pressure-State-Response
R&D	Research and Development
RDC	Research and Development Corporation

SOE State of the Environment

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1 Background

This review updates and builds upon a previous Meat & Livestock Australia (MLA) project (B.CCH.2023), *Review of the impacts of red meat production and alternative sources of protein on biodiversity* (Williams and Price 2009, Williams and Price 2010). The conclusions of that project provide Box 1.

B.CCH.2013 focussed largely on Australia's red-meat industries, particularly cattle and sheep, with attention paid to their comparative performance to other protein sources. It acknowledged the conceptual challenges in comparing different industries' performance in respect to biodiversity (water and greenhouse gases are more readily quantifiable). Despite these challenges, the results demonstrated that the beef industry had the largest relative potential contribution to the impact on terrestrial biodiversity in Australia, by both the area covered and the nature of the impacts. This impact includes the area of native vegetation cleared for grazing, the impacts of over-grazing and trampling, the amount of grain used in high density feedlots, and the quantity of greenhouse gases emitted.

Even if current management practices incorporate biodiversity conservation into their objectives, the legacy of past land use practices casts a long shadow over the beef and sheep industries in Australia. This has led to widespread and persistently held perceptions that these industries have had a major and negative impact on the nation's biodiversity, with ongoing calls to reduce the number of stock and replace them with an industry based on kangaroos (e.g. Wilson and Edwards 2008). On a global scale, the impact of meat production on natural systems through clearing (for both pastures and grain to feed cattle in feedlots), overgrazing, over-use and pollution of waterways, and greenhouse gas emissions has seen similar calls to review red meat consumption and hence the number of stock (e.g. Stehfest *et al.* 2009, Hoekstra 2012).

Many industry initiatives in Australia, including those of the beef and sheep industries, have the potential to improve the management of biodiversity. As always, the challenge comes in terms of their implementation. In order to minimise the impact of beef and sheep meat systems on biodiversity, the conservation of natural resources has to become a core and integral part of production systems rather than perceived as an optional extra if times are good. The practices of innovative land managers implementing sustainable land and water management can be used as examples to others and applied more widely.

Box 1: 2009 Review Revisited

Williams and Price (2009) reviewed the state of knowledge of the relationships between 10 protein sources and the major pressures on biodiversity. It was found that beef production made the most significant contribution to altered grazing regimes and the associated pressures on biodiversity in Australia, as it does across the globe (Steinfeld *et al.* 2010). This is due to the extensive nature of production of much of the industry. For example, in Australia, nearly 56% of the land surface is used for livestock grazing (Leslie and Mewett 2013). Much of this is for meat production. While in many cases it was difficult to quantify the exact contribution cattle and sheep made to the pressures on biodiversity, overall they were found to have a range of impacts on soil and water health and the structure, function and composition of native plants and animals (Williams and Price 2009, 2010). In addition to grazing, these impacts were related to vegetation clearance and modification, trampling and soil compaction, extraction, modification and pollution of waterways and the introduction of invasive pasture species. Livestock were also found to contribute to greenhouse gas emissions and consequently climate change.

2 Project Objectives

2.1 Meat & Livestock Australia's expectations

Meat & Livestock Australia (MLA) is a significant investor in sustainable agriculture, including the development and improvement of grazing systems designed to minimise or reverse the impact of meat production on biodiversity (MLA 2006). MLA seeks to gather the most accurate, scientifically robust information to establish the evidence base for its performance, inform better land management, enlighten public debate and help shape future conservation programs. Consistent with this approach, in 2009 MLA commissioned a report (B.CCH.2023) that compared the biodiversity management performance of the red meat industry vis-a-vis white meat, plant-protein and other protein production systems.

This report updates B.CCH.2023, giving precedence to advances in knowledge in respect to red meat production since 2009. In doing so, MLA seeks to consider the case for future R&D investment in biodiversity management in the context of profitable grazing systems.

2.2 The aims of the project

As per the project terms-of-reference (Appendix 1), this report provides to MLA:

- an assessment of the current knowledge of livestock production systems impacting on biodiversity (composition, structure and function) and how improving biodiversity can assist livestock production;
- an assessment of the opportunities available to the grazing industries through a better understanding of biodiversity on farm; and
- identification of research activities required to provide enabling knowledge and technologies with which to take advantage of the opportunities (region by production system developed from B.CCH.2023).

2.3 The project team

The research team associated with this study includes Adjunct Professor Jann Williams, one of Australia's leading ecologists and biodiversity researchers, and Adjunct Professor Richard Price, a prominent environmental research leader, sociologist and political scientist.

The combination of these skills is intended to ensure that MLA's desire for scientifically robust analysis is met and that the integrity of the research is not compromised by factors other than those needed to underpin continuous improvement in biodiversity management across red meat production systems.

3 Methodology

3.1 Building on Project B.CCH.2023

This study builds on a project commissioned by MLA in 2009 that compared the red meat industry's biodiversity management performance with that of competing protein production systems. Two key outputs were associated with the project, including:

- a comprehensive final report (Williams and Price 2009: http://www.kiriganai.com.au/publications_5.php)
- a technical summary published as a peer reviewed journal article in *Animal Production Science* (Williams and Price 2010).

The emphasis of both of these documents was on the technical comparison of biodiversity management performance, with some but lesser emphasis on how MLA should respond to the findings in terms of future R&D investment.

This current project revisits the study with the priority now being on identifying the investment case and subsequently the specific investment opportunities for MLA to pursue within the context of its environment and natural resource management portfolio. With this in mind, along with limited timeframe and resources vis-à-vis B.CCH.2023, the methods associated with this study focus on:

- an analysis of contemporary literature to update knowledge about the biodiversity management performance specifically of the red meat industry. There was no requirement to bring up to date the knowledge of the performance of other protein production industries, and as a consequence the update does not include a comparative analysis, which was a feature of the original work; and
- an analysis of interviews and feedback from the research and grazier communities involved with red meat production systems.

The definition of red meat used by Meat & Livestock Australia includes cattle, sheep and goats. The National Health and Medical Research Council (NHMRC) (Byron 2011, NHMRC 2013) includes the muscle meat from cattle, sheep, deer, pig and kangaroo in their definition of red meat. The latest NHMRC definition has added pork, ham and bacon because pig meat is referred to as red meat in other parts of the world and in epidemiological studies. For the purposes of this review, the focus is on cattle and sheep as these represent the main production systems and levy-base relevant to MLA.

The study was conducted over 18 days between May and July 2013.

3.2 Literature review

The analysis undertaken in this update is largely based on the contemporary literature concerning red meat production systems and biodiversity condition of Australian landscapes (including terrestrial and aquatic features). Most of the literature is of necessity Australian, again distinguishing this report from B.CCH.2023 that in addressing non-red meat industries had a greater reliance on overseas literature. Key words were used to search relevant journals for papers on biodiversity and cattle/sheep grazing published since 2009. Recent publications of research scientists with a history of working in this area were also assessed.

The updated report gives precedence to peer-reviewed scientific literature or official statistics in the public domain. This is in line with MLA preference to promote rigorous evidence-based decision-making. As discovered for the original review however, the authors again found that the relative paucity of biodiversity impact studies meant some reliance on the grey literature, including industry publications and conference papers where these were presented by researchers related to the field of biodiversity.

In addition, the authors have made reference to emerging concepts and findings discussed in interviews with key Australian biodiversity researchers (see 3.3 below), reflecting the short period of time that has

transpired since the B.CCH.2023 was undertaken, particularly in terms of time available for contemporary research findings to be formally published.

The continuing paucity of literature reflects the still fledgling interest in studies that aim to integrate biodiversity into agriculture systems. Much of the biodiversity literature in agricultural landscapes has focused on the patches of native vegetation that remain in the landscape, rather than examining biodiversity as part of the farming system. There is also limited research on the human dimensions of grazing systems such as how decision-making is influenced by ecosystem health. These gaps underline the importance of MLA's initiative to invest in this report and also points towards the kinds of R&D investment opportunities that immediately identifiable.

3.3 Interviews with key informants

While analysis of the literature has been used to identify R&D investment opportunities, this study also involved surveying key research and management practice informants about R&D priorities on the relationship between biodiversity and grazing. The survey, which is provided in Appendix 2, was sent to 25 research scientists. Four recipients provided a written response to the survey, two were interviewed by phone for an hour each and one was interviewed in person for around 30 minutes.

In addition to the survey, a simple question seeking graziers' ideas about potential biodiversity R&D investment was circulated via Twitter to graziers with Twitter accounts. Discussions with four well-respected levy-paying graziers were also held, taking advantage of their participation alongside one of the authors at a workshop on landscape health.

The insights arising from the surveys, interviews and discussions is detailed in Section 5, while a list of the key informants is provided in Appendix 3.

As suggested in the terms of reference, the outputs of this study may potentially become the subject of a workshop involving these and other key informants to provide further strategic guidance to MLA.

3.4 Analysis

The original study used the Pressure-State-Response (PSR) model developed by the Organisation for Economic Co-operation and Development (OECD 1993) and used in Australia for environmental reporting at the local, state and national level (e.g. SOE 2011). 'Indicators' are the essential components of these models, but often data are often lacking to demonstrate trends over time (Williams *et al.* 2001). This report broadly uses the pressure-state-response model with modifications to reflect changes that have occurred since 2009.

The same ten broad pressures selected for examination in the original study were used as a starting point for this report. These pressures are based on a number of national and major publications on pressures on biodiversity (e.g. Williams *et al.* 2001, NLWRA 2002, Beeton *et al.* 2006, SOE 2011):

- Vegetation clearance and modification
- Altered fire regimes
- Altered grazing regimes
- Altered hydrology

- Trampling and soil compaction
- Invasive species
- Pollution
- Disease and pathogens
- Climate change
- Other pressures

Where possible, an attempt was made to put these pressures into a regional framework to explore potential differences in R&D priorities.

The responses of organisations such as MLA to these pressures, and what they mean for the current state of biodiversity, have been influenced by some significant changes in the broad operating environment since 2009. As such, the next section of the report analyses the landscape in which the red meat industry now operates. This increasingly complex environment – with a greater focus on issues such a climate change, food safety and security, animal welfare and the Asian market, as well as new technologies - has implications for the red meat industry and how the public perceive its environmental performance.

4 Findings: the changing landscape since 2009

This section deals with two elements. The first element relates to changes in the operating environment since 2009 in which R&D investment decisions are made, acknowledging this project's emphasis on making recommendations in respect to future biodiversity investment. Since the original report, a number of changes have occurred in the broader environment in which the red meat industry operates. These changes can have an impact on the sector in a variety of ways, as illustrated at the international level by Steinfeld *et al.* (2010). One of the impacts is on the nature and amount of R&D undertaken and the uptake of the research findings. Hence it is important to cover the major developments that have occurred since Williams and Price (2009) was written.

The second element deals with the provision of new information to emerge since 2009 on grazing's impact on biodiversity. No attempt has been made to repeat detailed information provided in the original report as:

- this was not requested, as the information is easily accessible from the B.CCH.2023 report (Williams and Price 2009, available at http://www.kiri-ganai.com.au/publications_5.php) and its accompanying journal paper (Williams and Price 2010);
- ii. perhaps owing to the first point, the budget did not allow for this, and
- iii. the provision of such detail would potentially distract from the purpose this report serves, which is to present a case for future MLA investment in biodiversity R&D.

4.1 Shifts in the operating and investment environment

4.1.1 R&D funding for industry related biodiversity issues

Since 2009, Natural Resource Management R&D investment priorities have shifted significantly towards climate change. This is reflected in the need for publicly funded research in biodiversity R&D to demonstrate its link to climate change and the carbon economy. This shift is in response to a number of new policies, programs and strategies released by governments since 2009. Section 4.1.2 describes a number of recent Australian Government biodiversity initiatives that specifically refer to climate change. These in turn are mirrored by changes at the State and regional level.

Due to these changes, considerable human and financial resources have been channelled into climate change policy and research over the last 3-4 years. Much of the change in resource allocation has come at the expense of investment in other environmental issues (Price 2008). In many cases, these other environmental issues are intended to be addressed in more integrated, whole of landscape initiatives (Price 2012). Examples relevant to biodiversity include the National Climate Change Adaptation Research Facility (e.g. NCCARF 2012) and the carbon farming component of the Biodiversity Fund, where biodiversity is expected to be investigated within the context of climate change.

While the integration of environmental themes is attractive from a management perspective, it can mean that important issues become lost in the integration process to the point where they disappear. In the case of Grain & Graze, for example, the investigation of biodiversity was well integrated with investigations into mixed farming systems that included grazing. However, such integration is not so apparent in the second phase of Grain & Graze. Certainly specific investments that directly examined the relationships between biodiversity and grazing have ended (e.g. Biodiversity in Grain & Graze; Bridle *et al.* 2009; Bridle and Price 2009).

The Grain & Graze example is a microcosm of a broader shift in agricultural R&D investment where the focus is being placed on ways to increase production. This is reinforced by the findings of the Productivity Commission's review of the rural R&D model (Productivity Commission 2010). In this review, the Commission highlighted a need to counter the falling productivity levels being experienced across most agricultural industries, suggesting that this ought to be the highest priority of the RDCs.

Following consideration of the Productivity Commission's review of the RDC model, the Minister for Agriculture, Fisheries and Forestry, released the Rural Research and Development Policy Statement (Ludwig 2012). The statement was intended to instil greater confidence in the rural R&D model and set out the Australian Government's priorities and expectations, these being:

- Increased transparency and accountability
- Improved coordination and priority setting
- Increased productivity growth
- Increased operational efficiencies and
- Increased value for money from investments.

Significant in these priorities is the emphasis on process, with only the expectation of improved productivity growth setting out the government's expectations for outcomes. While other aspects of the Statement support the need for investment in sustainable agriculture, the emphasis on productivity growth is a salutatory message that the contribution of biodiversity to productivity growth needs to be convincingly demonstrated.

4.1.2 Key Australian government biodiversity policies, strategies and reports

A number of biodiversity related policies and reports have been released by the Australian Government since 2009. Policies relevant to the red meat industry, that can impact directly and indirectly on graziers and influence funding priorities, include:

- Australia's Biodiversity Conservation Plan 2010-2030 (NRMMC 2010a);
- Australia's Strategy for the National Reserve System 2009-2030 (NRMMC 2010b);
- 2011 State of the Environment Report (State of the Environment Committee 2011);
- National Wildlife Corridor Plan (DSEWPac 2012);
- Australian Native Vegetation Framework (COAG Standing Council on Environment and Water 2012); and
- the Biodiversity Fund and Carbon Farming initiatives established under the Clean Energy Future package.

One of the major changes since 2009, which is reflected in the preceding list, is the increased focus placed on climate change in Australia as an over-arching and accelerating pressure on biodiversity that interacts with other threats (Dunlop *et al.* 2012, Doerr *et al.* 2013, Kitching *et al.* 2013, Maggini *et al.* 2013, NCCARF 2012). Internationally, mitigating and adapting to climate change is also starting to get attention from conservative institutions such as the World Bank who released their second 'Turn up the Heat' report in June 2013 (Schellnhuber *et al.* 2013). Reference to maintaining and strengthening the resilience of both natural systems and human communities has also increased (e.g. Walker and Salt 2012, Norton and Reid 2013).

Climate change is identified as one of the three main drivers of change in the Australian environment in the 2011 SOE report (State of the Environment Committee 2011). The other two main drivers are population growth and economic growth. These drivers frame the key findings of the SoE report. The increased importance given to climate change as a pressure on biodiversity is also reflected in Australia's new Biodiversity Conservation Plan which covers the period 2010-2030 (NRMMC 2010). The priorities for action that deal directly with biodiversity are to build ecosystem resilience in a changing climate *by*:

- protecting diversity;
- maintaining and re-establishing ecosystem functions; and
- reducing threats to biodiversity.

The Plan states that climate change will magnify the impacts of existing threats, as well as directly threaten some species and ecological communities. As noted by Williams and Price (2009) the key message from ecologists is that climate change needs to be examined in the context of other ongoing pressures on natural systems and interactive effects considered.

In the context of climate change, conservation goals are increasingly becoming more process-oriented. This is reflected in both the National Wildlife Corridor Plan (DSEWPac 2012, Fitzsimons *et al.* 2013) and the Australian Native Vegetation Framework (COAG Standing Council on Environment and Water 2012). Both of these national initiatives focus measures to combat climate change such as increasing connectivity at the landscape scale and improving the functioning of native ecosystems. The implications of climate change for the National Reserve System has also been reviewed (Dunlop *et al.* 2012). Prober

and Dunlop (2011) note that in this newly emerging policy environment it is important not to lose sight of what we value about Australia's biodiversity and the continuing relevance of current biodiversity conservation tools.

4.1.3 MLA / Cattle Council relationship

The repercussions of the temporary closure of the live cattle export trade to Indonesia in 2011 have extended beyond the political and public advocacy debates about the pros and cons of live export trade. In particular, the closure became an impetus for the industry to review its preparedness and capacity to defend and promote its interests in an effective and coordinated way (Inovact 2013). As the Inovact review into industry structures suggests, the live export crisis "provided momentum for levy payers to question the need for changes to current strategies, structures, roles and responsibilities, and the allocations and return on investment from levy funds."

The Cattle Council's response was to develop a new strategy for the grassfed cattle industry (*Beef 2015 and Beyond*). Despite this strategy making no reference to biodiversity, one important outcome from the strategy and the associated MLA and Cattle Council discussions leading up to it, has been the clarification of the respective roles of the two organisations, in particular emphasising MLA's role as a knowledge investor. While extension is an important part of what MLA does, it seeks to share this role with the Cattle Council as a means of maximising its own investment in R&D.

In April 2013 MLA and the Cattle Council released a voluntary certification system for pasturefed cattle called 'The Pasturefed Cattle Assurance System' (PCAS). This is an assurance program that enables the industry to prove claims relating to pasturefed or grassfed production methods. Underpinning PCAS are standards which govern the on-farm feed requirements and traceability of the cattle as well as pre-slaughter handling practices which influence eating quality. The PCAS Standards also include two optional modules to support claims relating to the freedom from antibiotics and hormone growth promotants. A biodiversity module could potentially be added to such a scheme to allay consumer concern about environmental impacts of red meat production in addition to animal and human health.

4.1.4 NFF Blueprint for Agriculture

The NFF Blueprint for Australian Agriculture (NFF 2013) reflects the broader shift in recent discourse on agricultural priorities with its emphasis on food security, reversing declining productivity levels, improving supply chain relationships and securing the R&D investment base for agricultural industries. The main Blueprint report gives cursory consideration to environmental issues, with any mention framed in terms of economic outcomes, i.e. either in terms of Australia's natural environment contributing to competitive advantage, or in terms of the cost to industry of environmental regulatory compliance. The term 'biodiversity' receives some mention, but not in terms of strategies agricultural industries should pursue.

If anything, the document reinforces traditional agricultural perspectives that government ought to be responsible for environmental and biodiversity investment allowing industry to focus on productivity investment with some regard to environmental compliance. An accentuated paragraph in the Blueprint goes so far as to suggest that profitable agriculture will enable industry investment in the environment to follow; with one interpretation being that making a profit and environmental stewardship has a linear rather than an inter-dependent relationship.

Such positions suggest there is an urgent need for quantitative analyses to better define the contribution of biodiversity to agricultural productivity, particularly the economic and social dimensions.

4.1.5 National Food Plan and Australia in the Asian Century

The release of the National Food Plan Green Paper in 2012 (DAFF 2012) provided the opportunity to consider the paddock to plate relationships of agriculture and the role of food policy to support the economic, environmental and social benefits arising from these. Past food policies have been guided by "the principle that government should minimise interventions in the economy, environment and society except where a strong rationale exists to do otherwise." (Inovact 2013). The emphasis in the new Food Plan will be to ensure that there is sufficient flexibility in the institutions of agriculture to adapt to changing circumstances. The document stresses the relationship between food, food security, food affordability and nutrition. In this respect, the social dimension of agriculture is taken into account, though particularly with respect to consumers. This position presents some potential conflicts with environmental outcomes, for example where achieving food affordability is at the cost of industry investment in the environment and biodiversity.

The Australia in the Asian Century white paper focuses future environmental policy on meeting the following aspiration: "Australia will be a world leader in implementing sustainable food production methods, in sustainable energy and water use, and in biodiversity conservation." (Australian Government 2013). The paper recognises that the future opportunities for Australian industries, including its agricultural industries, lies in Asia, while cautioning that to meet the rapidly growing demand associated with increasing wealth may place adverse pressures on our resources. The paper suggests that the current policy approach of relying on markets and other incentives, such as environmental stewardship payments, for managing biodiversity and ecosystem services will continue into the foreseeable future. This approach, however, will be reviewed as part of an assessment of Australia's Biodiversity Conservation Strategy 2010–2030.

Biodiversity is also considered in the paper in respect to the potential impact of foreign investment applications involving agriculture. With such investment growing in Australian agriculture, pressure will be placed on government to ensure that biodiversity considerations are dealt with equitably in respect to both foreign and domestic compliance.

The National Food Plan shares a connection with the Asia Century report in that both highlight the opportunities for Asian trade, including from further development of northern Australia's contribution. In other words, despite many decades of rhetoric about the northern Australia's potential role in economic development, we are beginning to see a convergence of specific strategic and policies that may see this eventuate.

This will place the resources of the north under further development pressure as well as shine the public spotlight on what is happening in this part of the country. Concepts such as a cultural and conservation economies have been put forward as alternative development models for the north (e.g. Woinarksi *et al.* 2007, Hill *et al.* 2008).

4.1.6 Public perception and pressure

Australian agricultural industries, including the grazing industry, continue to suffer from negative perceptions from the public and within some non-government organisations (e.g. Birdlife Australia 2013, PeTA 2013, Friends of the Pinnacle no date). Notwithstanding that negative perceptions are articulated more frequently, more publicly and more emotively than positive ones, these negative perceptions come

together to make a narrative that is not only divisive (between farmers/graziers and citizens/consumers) but potentially enduringly so.

A negative perception of one aspect of industry performance can lead to and reinforce negative perceptions of other aspects. An example can be the negative perception of an industry's environmental performance may discourage people from seeking employment or becoming educated in that industry, leading to lowering education levels of the workforce, leading to a smaller and lower paid workforce which can then reinforce a range of negative views about the industry (and agriculture as a whole) (Australian Senate 2012). Ultimately, this can reduce industry capacity to address both productivity and environmental challenges.

Dealing with negative perceptions is not easy, particularly when they become blurred in the minds of consumers, such as in the case of confusing animal welfare issues and environmental sustainability or summarily dismissing an industry's performance in respect to one because the other is viewed poorly. For such reasons, the Senate Education, Employment and Workplace Relations References Committee suggests that Australian agriculture needs to rewrite its narrative as a positive one (Australian Senate 2012). This however requires that all aspects of an industry's performance can reinforce the positive narrative.

The message for the grazing industry is that any perceived stain in its biodiversity performance bleeds into other aspects of its performance.

4.1.7 The emergence of new technologies

Another part of the changing landscape since 2009 is the accessibility of new technologies and ways of communicating. The examples provided here relate to uses of technology in the grazing sector, illustrating some of the opportunities provided by these developments.

- New technologies are being trialled for the beef industry in remote Australia (Leigo *et al.* 2012). These mainly centre around remote monitoring, mapping programs and modelling tools for pasture and herds.
- Mobile technology has changed the way the world accesses information and communicates. Smart phone apps such as CliMate, which was launched in May 2012 for iPhones and iPads, makes information such as recent weather data available to farmers to support on-ground observations. Other relatively recent apps such as 'Bird in hand' and 'Frog log', both developed in Tasmania, are useful identification guides in the field and can be used to record survey data to add to state and national databases. Tablets have also made the collection of data in the field by researchers more efficient which can influence the amount and type of information they collect.
- Graziers now have access to social media such as Twitter to share their views and experiences. Many currently participate in Twitter forums such as AgchatOz.
- The recent ability to examine changes over time at specific sites using Google Earth should open up new areas of investigation.

4.2 Advances in knowledge and understanding

Williams and Price (2009) reviewed over 500 papers on the impact of protein sources on biodiversity. Since then, the number of papers published on the relationship between biodiversity and production in

the red meat industry has been limited. Our review suggests there is less experimental research being undertaken in this area in Australia than previously.

Research questions and funding are influenced by the broader operating landscape, as noted above. In this context, new developments, directions and findings arising in the last 3-4 years from papers and reports directly addressing the relationship between grazing and biodiversity are summarised below. Where possible research topics have been presented against the 10 pressures used in the original review, as well as being regionalised (Table 1). The 2011 State of the Environment (SoE) report demonstrates that the pressures identified by Williams and Price (2009) still represent major threats to biodiversity.

Region →	Rangelands	Savanna	Crop-pasture	Native/exotic HRZ
↓ Pressure				
Vegetation clearance and modification			 Vegetation cover thresholds Land sparing vs land sharing Stock exclusion 	 Vegetation cover thresholds Land sparing vs land sharing Stock exclusion
Altered fire regimes		 Interactions with grazing 		
Altered grazing regimes	 Impacts of stock exclusion Dingoes 		 Stock exclusion Dingoes 	
Altered hydrology				
Trampling and soil compaction	 Impacts of stock exclusion 			
Invasive species	 Buffel grass dispersal 	 Impacts of introduced pasture grasses 		
Pollution				
Disease and pathogens				

Table 1: Main research topics examined since 2009 within a regional framework

Climate change	Generally at a level that is relevant to all regions.
Other pressures	Dingoes

The usefulness of allocating individual pressures against different regions may be limited as many of the recently published papers address themes relevant to all or many regions, or discuss the interactions between grazing and other pressures on biodiversity. The dot points below therefore summarise the principal themes covered in the recent literature.

- The usefulness of vegetation cover thresholds as a tool for biodiversity conservation is now being discounted by some authors (e.g. Lindenmayer pers. comm., Kirkpatrick pers. com, Maron *et al.* 2012), although this view is contested. For example, the 30% landscape cover threshold is still being promoted in guidelines for landscape restoration (e.g. Gardiner and Reid 2010 and Doerr *et al.* 2013). This subject was also explored with the key research informants, as described below. Other research on the biodiversity of vegetation patches within production landscapes continues, particularly on revegetation and regrowth (e.g. Seabrook *et al.* 2011, Lindenmayer *et al.* 2012a, Lindenmayer *et al.* 2013).
- The importance of areas for biodiversity where grazing has been excluded or minimised is highlighted in several recent publications such as Prober *et al.* (2011), Schultz *et al.* (2011, 2012) and Lindenmayer *et al.* (2012b). While overall, stock exclusion was found to be beneficial for biodiversity, considerable variation in response was identified. At some sites intervention was required, for example to remove dominant exotic weeds from the fenced remnants.
- Invasive pasture species continue to have an impact on biodiversity, particularly in northern and central Australia. For example, research by Kutt and Fisher (2010, 2011) found that the increasing dominance of an exotic pasture grass (Indian Couch) effects habitat and the species composition of both vertebrates and invertebrates in tropical savanna woodland. Some new insights have been published into the spread of buffel grass in grazing landscapes (e.g. Fensham and Silcock 2013). It appears that the invasion of this grass has far less to do with fire and more with drought and propagule pressure than previously thought.
- The importance of interactions between grazing and other potential pressures on biodiversity has been demonstrated across a number of studies including Read and Cunningham (2010) in the arid zone, Lunt et al. (2012) and Dorrough *et al.* (2012) in south-eastern Australia and Kutt (2009) in savanna country. These and other studies show variation in the response of species (both within and between) to grazing and its interaction with other pressures such as flood, fertilisers and fire. This variability makes it challenging to develop generic findings about the impact of grazing on biodiversity.
- Research has been undertaken through the CRC for Future Farming on rehabilitating native perrenial grass pastures (Thapa *et al.* 2011) and the potential of Australian shrub species for grazing systems, landscape health and profitability.
- Fred Provenza has influenced grazing management in, at least, Tasmania (DPIPWE 2012) and Western Australia where he has recently spoken at field days. Provenza's research has focused on influencing productivity and natural resource management by understanding animal nutrition and social behaviour (Howery *et al.* 2010). In Tasmania, a sheep grazier that adopted his approach reported increases in productivity, animal health and biodiversity when her sheep were kept in

family groups and allowed to self-medicate by selecting from a diversity of pasture species (DPIPWE 2012).

Considerably more publications have appeared about biodiversity and climate change in the last 3-4 years (see NCCARF 2012 for a review of publications between 2009-2012). These are mostly based on modelling and expert opinion, and often at the 'bigger picture' level than just on their relationships to grazing (Doerr *et al.* 2013, Kitching *et al.* 2013, Maggini *et al.* 2013). An exception is Bradshaw et al. (2013) who wrote about both the big picture (the potential implications of a carbon economy on the conservation of Australian biodiversity) and its relevance to land use practices such as grazing. This paper noted that carbon price-based modifications to agriculture that would benefit biodiversity include reductions in livestock density and fertiliser use and retention and regeneration of native shrubs; anticipated shifts to exotic perennial grass species such as buffel grass and kikuyu (both used for cattle grazing) were identified as potentially having net negative implications for native biodiversity.

Other 'big picture' publications, which have broader relevance to grazing enterprises, are mostly desk-top reviews, based on modelling or are theoretical or policy-oriented in nature. Some of the topics covered under this banner follow.

- Recently there has been a greater focus on the resilience of ecosystems and farming communities. Publications that refer to this framework are generally more policy than research based. An exception is the recent book by Walker and Salt (2012) that gives examples, including in Australia, where resilience theory is being used in the 'real world'. Reid *et al.* (in press) refer to the 'newly emerging paradigm of resilience-based ecosystem stewardship' as a way forward in beef production landscapes. This approach acknowledges change as an inherent part of socio-ecological systems and reframes management units such as farms as ecosystems that provide a suite of ecosystem services, not just a single resource like beef or wool.
- The concept of 'novel ecosystems' has gained greater attention and promoted some heated debate in the scientific community (Hobbs *et al.* 2013). Some fear that, by raising the issue of novel ecosystems (those without historical precedence and that are self-sustaining), the way is being paved for a more laissez-faire attitude to conservation. It has been argued however that these altered systems are overdue for careful analysis to determine how to intervene in them responsibly.
- The novel ecosystem debate is part of the broader research and extension focus on restoration and regeneration of degraded systems, both native (e.g. Seabrook *et al.* 2011, Menz *et al.* 2013) and agricultural (e.g. regenerative and holistic grazing management; Outcomes Australia 2012; Sherren *et al.* 2012). With the uncertain impacts of climate change on the structure, function and composition of native species, some authors argue that more focus should be placed on ecosystem structure and function than on composition. This has implications for both policy and R&D in the grazing sector.
- Another ongoing 'big picture' debate is the relative contribution of land sparing and land sharing to biodiversity conservation in production landscapes (Fischer *et al.* 2011, Lindenmayer *et al.* 2012c). Some researchers argue that it is not a case of one or the other on any property (Nick Reid, pers. comm.) and that it's a question of obtaining whatever and everything on offer for biodiversity. In his words, diversity in land use begets biodiversity. In a similar vein, Benton (2012) writes that

extensive systems (land sharing) may the best option in one place and intensive systems in another. As with most things in life, the conclusion is 'it depends'.

• Stewardship payments to farmers for managing for conservation outcomes/delivery of ecosystem services (as recommended by Williams and Price in 2010) still seem to be considered a useful model (NRMMC 2010, Harris-Adams *et al.* 2012, the new Midlands Stewardship program in Tasmania being managed by Bush Heritage Australia). As noted above, Reid *et al.* (in press) refer to the newly emerging paradigm of 'resilience-based ecosystem stewardship'. This is a phrase that we are likely to see and hear more of.

In summary, the research that has been published on the relationship between grazing and biodiversity since 2009 generally focuses on the negative impacts of grazing on biodiversity, either directly or through related pressures such as introduced pasture grasses. To date, virtually no published research has been found in the peer-reviewed Australian ecological literature since 2009 on the potentially positive benefits that biodiversity can bring to livestock production systems. The paper by Sherren et al. (2012) touches on this relationship in relation to alternative grazing systems, but only anecdotally, as does DPIPWE (2012). This type of integrated research appears to have finished with the end of programs such as BIGG. The CRC for Future Farm Industries has filled some of this gap from an agricultural perspective. Research on the establishment of native pastures and increased diversity of perennial forage species in grazing landscapes are two areas the CRC has invested in (e.g. Thapa *et al.* 2011). These management practices should have some biodiversity benefits, even if they were not fully measured.

Research on ecosystem services is one area where you could expect to see relationships between biodiversity and grazing being examined. Recent publications such as Barral *et al.* (2013) map a range of ecosystem services associated with different land uses in south-eastern Australia, including forage production. Because the pastures in this example are exotic, a negative relationship between pasture production and biodiversity is assumed. The inverse relationship of biodiversity on production values is not explored. In contrast, Cork *et al.* (2012) examined the relationship between soil characteristics (including soil biodiversity and ground cover) and production outcomes in agricultural landscapes in Australia. These authors found that better managing soil condition, including through improved grazing practices, can lead to increased production of food and other commodities through the enhancement of a number of soil properties.

5 Key informant responses

5.1 Research scientists

While a limited response was received to the survey questions, the six researchers who did respond bought perspectives from northern and southern Australia, from Universities, government agencies and a non-government organisation and from scientists with backgrounds in agriculture and ecology. No responses were elicited from social scientists, which may explain the emphasis on biophysical research identified by the respondents. That said, the social scientist co-author of this report brought a social and institutional perspective to section 4.1 in particular and into the analysis in other sections.

The first stage of the analysis was to see if there was general agreement amongst researchers. Consensus was found on the following topics:

- The complexity of the systems being studied environmental, social and economic. This complexity can make it challenging to identify generic rules for biodiversity conservation on grazing lands. It was agreed that aspects such as management history, vegetation type and environment will have an impact on rare species conservation and retention and restoration of habitat. Social scientists would add that variation in economic and social circumstances will also have an impact. Understanding and exploring this variation in space and time is important to both the R&D undertaken and how it is implemented.
- A greater understanding is required of the local/regional variation in grazing systems and the interactions with biodiversity, using more rigorous descriptions of the grazing regime. In the first instance this could be kick-started by a systematic and comprehensive review of the positive and negative interactions between biodiversity and grazing across Australia. This review would include contacting researchers to access unpublished research. Such a study, which was a major recommendation of Williams and Price (2009), would allow the identification of gaps and recommendations for targeted research.
- The need to scientifically evaluate some of the 'new' (or at least alternative) approaches to grazing management such as pasture cropping, holistic grazing and stress-free stock management and what they mean for both production (especially the economics) and biodiversity outcomes. This could build on studies such as Sherren *et al.* (2012) that surveyed a number of holistic grazing managers (amongst others) in Australia and found that they viewed the stewardship of biodiversity as fundamental to their long-term production system. Comparing these approaches with more mainstream management practices would provide a comprehensive analysis of grazing enterprises across Australia.
- The role of more diverse pasture mixes for production (including for livestock health and wellbeing) and biodiversity outcomes needs further evaluation across a range of environments.
- Both of the points above point to non-mainstream grazing systems that appear to have benefits for both biodiversity and production. Some of the evidence is anecdotal, especially in Australia, so more rigorous studies could identify the pros and cons of these approaches.
- Two highly respected and experienced scientists concluded that landscape scale vegetation thresholds were not useful tools for biodiversity conservation in agricultural landscapes, whereas a third one still recommends them. This reflects the ongoing debate in the literature with some authors considering thresholds to be spurious (Maron *et al.* 2012) whereas other still endorsed their use (Gardiner and Reid 2010, Doerr *et al.* 2013). In the mind of one prominent researcher, it was felt that the concept could be discarded and no further R&D was required. This was based on the findings of a soon to be published study testing the concept of thresholds with a large, comprehensive data set.
- Opportunities for R&D on the biodiversity and production benefits of revegetation/ regrowth on farms, particularly at the whole paddock or larger scale, were still identified including its contribution to the carbon economy.
- The importance of local, management oriented, long-term research was identified where relationships can be built with the farming community. Opportunities are available to build on existing long-term or baseline research programs involving graziers and researchers, such as that undertaken at ANU and through BIGG.

5.2 Graziers

The question posed to graziers on Twitter about what they see as biodiversity investment priorities did not elicit any meaningful response. Other twitter chatter around this time largely covered issues such as the dominance of the retail sector in agriculture in general and concern for the lack of rainfall over much of the country so far this year.

The short interviews and discussions with four well-respected graziers drew out broad investment ideas rather than specific project level priorities. These ideas centred around the need to marry landscape production with not just landscape ecology and but also health. Farmer health, including mental health, consumer health and animal health). The graziers suggested that when it comes to biodiversity investment, they would prefer to define the outcome (i.e. increased profit, better landscapes and healthier people/stock) and leave it to the researchers to define specific projects to get there.

Interestingly, the graziers interviewed also suggested a need to redefine 'participatory research' to cover not just farmers, but also participants in the supply chain, policy makers and representatives of consumer organisations. One made mention of the need for MLA to "get back into participatory programs that bring investors as well as graziers together," a point that was quickly agreed to by the other graziers. The same grazier also stated that it was important MLA and other "traditional institutions of agriculture" diversify the types of graziers they are willing to work with and invest in. There was some suggestion here that holistic management graziers were often excluded from investments or made to feel uneasy if attending events.

5.3 Other observations

A few recommendations were only made by one individual based on their research area and experience. For example, only one researcher explicitly identified the importance of better understanding the dynamics of weed invasion and how it interacts with management.

None of the researchers who responded to the survey explicitly identified the value of additional research on fire regimes and their interactions with grazing. This may reflect the fact that most of the respondents were from SE Australia where recent fire research has focused on biodiversity conservation in forests, woodlands and native grasslands (e.g. Lunt *et al.* 2012, Nimmo *et al.* 2013, Pharo *et al.* 2013). While fire regimes were not identified as a specific research priority, a better understanding of the interactions between different pressures on biodiversity was seen as important by researchers.

There still appears to be a gap between researchers working in the rangelands compared to the intensive land use zone. For example, the concept of land sparing (intensive systems where production and conservation are separated spatially) compared to land sharing (integrating biodiversity and production on the same land) was treated differently by researchers from different regions. The comparison has more resonance in southern than northern Australia where less land clearing has occurred.

As expected, the emphasis on research priorities is in the biophysical sphere, apart from reference to a better understanding of the economics of different grazing systems by at least two researchers. This contrasts from the feedback received for the graziers whose priority was to undertake research on the relationship between landscape ecology and farmer health. Having said that, several researchers stress the importance of the human dimension of managing production landscapes (Kirkpatrick *et al.* 2007, Norton and Reid 2013, Lindenmayer pers. comm.). This did not translate however to undertaking

research in this area. Observations such as these emphasise the importance of collaborations between different disciplines when undertaking research (as demonstrated in Lefroy *et al.* 2008).

6 Research gaps and recommendations

The sustainable management of Australia's land resources remains a priority in the eyes of governments, consumers and landholders themselves, despite growing pressure to improve productivity levels to enhance profitability, as well as to lift total industry production to supply growing markets, particularly in Asia. The voice of the consumer is growing louder, and courtesy of social networks, it is spreading quicker. Moreover, the technologies for monitoring and identifying sources of land degradation are improving. Decreasing government investment in biodiversity research does not amount to tacit approval for increasing productivity without regard to environmental impact.

If anything, there is likely in future to be enhanced public and consumer interest in whether the rhetoric that Australia's natural assets contribute to the comparative advantage of Australian beef and lamb translates into grazing practice consistent with this. As highly lucrative and consumer savvy markets such as Japan open (or reopen) their doors to U.S and other sources of beef in particular, living up to our comparative advantage will become even more important.

Translating investment into biodiversity sensitive land management as a means of securing markets (including against non-red meat competitors) is difficult to value quantitatively, yet taking seriously the burden of proof principle underpinning claims of sustainable beef and lamb production valued, off farm, at \$11.6 billion and \$3.8 billion is in itself a reasonably compelling business case.

As with any business case, it is important any investment by MLA in biodiversity-related R&D be established such that each investment has the best chance of maximising the return on investment. This will mean investments should include:

- an outcome focus with clear measurable goals;
- sound investment analysis at the conceptual stage, likely meaning the involvement of economists and possibly social scientists at the problem definition phase (later phases may not require their ongoing involvement);
- participatory research models that maximise likelihood of adoption;
- possible support for long term, locally-based research so that graziers recognise both its relevance and endurance
- communication of results in a way the end users relate to.

The following sections outline the research gaps and the specific recommendations for MLA consideration. During the next phase of this study, the recommendations will be further developed so as to more closely address how each might take into account each of the five points raised above.

6.1 Research gaps

The limited data, both Australian and international, on the impact of specific industries on biodiversity reflects the dearth of research that has been undertaken, for many industries at least. While the red meat industry has improved its environmental stewardship in recent years using evidence-based

research, there are still some research gaps to be filled. The main recommendation in Williams and Price (2009) was that:

MLA immediately invest in pulling together as much information on grazing regimes, vegetation condition and management history as could be found for the livestock grazing industry. This would help better understand the interactions between domestic stock grazing and biodiversity in Australia.

Importantly, such a review should help elevate the concept of total grazing pressure and grazing regimes into the language of grazing and hence enable a better understanding of impacts of grazing on biodiversity.

This primary recommendation is still to be acted upon. In undertaking this review, this recommendation would be strengthened by explicitly including an assessment of the biodiversity and production/economic benefits of mainstream and 'alternative' grazing systems such as holistic management and pasture cropping. This was a strong message from both the research and grazier communities.

A number of other potential areas for research investment were identified by Williams and Price (2009, 2010). In particular, they drew on recommendations made by various authors associated with the publication Ten Commitments: Reshaping the Lucky Country's Environment (Lindenmayer *et al.* 2008). These research gaps are reproduced below together with additional gaps arising from the current review. They have been grouped into broad areas for ease of reading and to compare with the conceptual framework and recommendations for the red-meat industry in the next section.

Biodiversity-grazing interactions

Previously identified but still relevant

- Describe the variation in space and time of the impacts of grazing regimes on biodiversity and the responses to them (*this would be covered in the systematic review*);
- Describe the benefits of land management versus 'locking land away' (or land sparing versus land sharing) for biodiversity outcomes;
- Intensify the research effort to improve our knowledge about the biodiversity-ecosystem functioning-ecosystem services relationship;
- Develop a better understanding of the interactions between grazing and other potential threats to biodiversity such as altered fire regimes and weeds;
- Finding better ways of dealing with the pervasive threat of feral predators.

Newly identified

- Examine the biodiversity and production benefits of diverse pastures mixes, holistic management, pasture cropping etc;
- > Identify the economic factors associated with realizing the benefits above.

Grazing management

Previously identified but still relevant

Facilitate the transformation of grazing activity to ensure land use matches land capability;

- Improve seasonal climate forecasts to help deal with the variability of Australia's climate, and translating these into appropriate grazing management responses;
- Invest in labour-saving innovations that enable graziers to focus on the social and environmental elements of the triple bottom line.

Woody native vegetation management

Previously identified but still relevant

- Describe how to restore functioning ecological communities instead of simply fencing stagnating remnants or planting lines of trees;
- Develop new ways to improve integration of farm forestry with grazing management and on-farm biodiversity conservation;
- > Identify fire regimes that encourage woodland regeneration in grazing landscapes.

Monitoring

Previously identified but still relevant

- Find out what the different monitoring programs across protein production landscapes (both for production and biodiversity outcomes) tell us about management systems;
- Adapting comprehensive and robust biodiversity monitoring programs, linked to measurement of the efficacy of management.

Social research

Previously identified but still relevant

Develop an understanding of the way people perceive different protein based industries and their impact on biodiversity (for example, dairy farms in high rainfall zones compared to grazing in the arid zone), based on some of the techniques used in social research; (this research is less relevant to a report focusing on the red meat industry – however - research could be undertaken on how people perceive different sectors of the industry (such as rangelands grazing compared to feed lots) and their impact on biodiversity).

Newly identified

Examine the two-way relationship between physical/mental health and environmental health.

Policy

Previously identified but still relevant

- Identify how best to enhance the adoption of perennial production systems as rapidly as possible, including through policy initiatives that can be conveyed with credibility by industry, and ensuring graziers have the skills to manage these systems;
- Explore equitable ways for society to pay for ecosystem services specific to red-meat production.

6.2 Recommendations for the red meat industry

6.2.1 Being 'biodiversity smart'

Most of the R&D recommendations of the 2009 study (Williams and Price 2009; Section 6.2.1) are yet to be implemented. The role of this review has been to place these and more contemporary recommendations arising from new findings into the context of MLA's overall investment strategy.

To this end, the report places the top 12 R&D recommendations into a conceptual framework that starts with MLA's Strategic Plan 2010-15 (see Figure 1 and Table 2).

Without exception, these recommendations have been contextualised by the need to deal with biodiversity within production systems that are profitable. The report adopts the term "biodiversity smart', implying that biodiversity management is not an end to itself but rather something that can support profitable production.

Moreover, the recommendations are delineated by their relationship to critical elements of management decision-making (the 'biodiversity smarts'): smarter decision framing, smarter capacity to make decisions, and smarter implementation and review of decisions. In effect, this provides a framework that could see

MLA investments in biodiversity integrate under a single program, with relationships formed with other MLA initiatives as necessary.

This new framework is complimented by the industry and enterprise recommendations in Williams and Price (2009) that were designed to assist better integration of biodiversity management into grazing systems. The recommendations covered the following topics, with the details available in the original report.

Industry:

- Improve conversion efficiency
- Reduce the hoof-print
- Match land use to land capability
- Embed a biodiversity culture into grazing (demythologise biodiversity)
- Breakdown institutional silos
- Acknowledge and reward good management
- Collaborate
- Monitoring

Enterprise:

- Planning
- On-ground management
- Monitoring

6.2.2 Priority areas for investment

After undertaking this project, the authors' priorities would be 1) to undertake the systematic review as recommended previously, as well as 2) more rigorously assess alternative grazing systems such as holistic management, pasture cropping and self-medication compared to mainstream practices. The ecosystem services and resilience provided by these systems could be explored at the same time potentially.

The authors strongly recommend that a follow-up workshop with industry participants be supported to consider this report (particularly Figure 1 and Table 2), together with its predecessor, as a means of prioritising potential future MLA investments and to reframe such investments in terms of outcomes at the industry and individual grazier level. Such a workshop would enable the recommendations to be tested by a broader audience and create a sense of ownership of the findings.

We also recommend that future investments build grazier capacity to adaptively manage their businesses based on monitoring economic, production, social, and environmental (including biodiversity) thresholds of concern. Moreover, we suggest that wherever possible, new investments build on baseline studies such as BIGG and long-term studies such as those being undertaken by Professor David Lindenmayer and his research group at the ANU.

Figure 1: The Biodiversity Smart Profitable Production Framework



Table 2: The Biodiversity Smart Profitable Production Framework (including report recommendations)

The biodiversi smarts	ity The key management questions	The R&D priorities (Authors' Recommendations)	Key R&D outputs	Essential links to other strategic imperatives
Smarter framing of decisions	 > What are the risks? > What are the benefits? > What are the opportunities? > How can risks and benefits be combined and managed to create business value, healthy properties and improved wellbeing? 	 Describe and value the variation in space and time of the impacts of grazing regimes on biodiversity and the responses to them; Describe and value the biodiversity and production benefits of diverse pastures mixes and alternative grazing systems; Describe and value the benefits of productive management versus 'locking land away' for biodiversity outcomes; Explore equitable ways for society to pay for ecosystem services specific to red-meat production; Develop an assessment tool to guide incremental, systems or transformative changes to ensure land use matches land capability; Examine the link between healthy landscapes and grazier well-being. 	 > Systematised risk assessment account; > Upgraded property management assessment tools; > Economic frameworks for sensibly comparing traditional and novel grazing systems; > Government, industry and corporate agriculture policy recommendations for capturing natural capital benefits; > Grazier and adviser tools for capturing natural capital benefits; > Input into a corporate social responsibility statement of MLA 	 Market access Increasing industry and people capacity
Smarter capacity to make decisions	 What are the management options and resource requirements? What do resilient meat production systems look like? What should be monitored and how? 	 Develop Risk Indexes for different regions to define ecosystem thresholds, underpin response indicators and act as a tool for management planning; Explore how remote sensing and smart technologies can be used to deliver multiple, including biodiversity, benefits; Explore what a biodiversity module of the Cattle Council's Pasturefed Cattle Assurance System (PCAS) might look like and how it would be perceived. 	 Risk indexes and threshold indicators; Adaptive management options to avoid crossing thresholds or to respond if hitting them; Feasibility assessment for a potential biodiversity module of PCAS. 	 Increasing productivity across the supply chain Increasing industry and people capacity Market access
Smarter implemen- tation of decisions	 What is best practice to match particular conditions? How can best practice be managed adaptively? How can landscapes regenerate under profitable management? 	 Describe for each grazing region how to restore / regenerate functioning ecological communities instead of simply fencing remnants or planting lines of trees; Develop new ways to improve integration of farm forestry and other complementary farming systems with grazing management and on-farm biodiversity conservation; Identify fire regimes that encourage woodland regeneration in grazing landscapes. 	 Regionally-specific best practices based on natural capital; Contextualised best practices for the grazing component of mixed farming (not just grain and grazing) systems; Best practice fire management regimes. 	 Increasing productivity across the supply chain Increasing industry and people capacity

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Appendices

Appendix 1 Terms of Reference

Project No.	B.ERM.0095		
Project Title	Developing biodiversity I	R&D recommendations	08-Aug-2013
Start date	03-May-2013	Completion date	

Purpose and description

Purpose

To update and refine recommendation for research in biodiversity R&D based on the 2009 MLA project B.CCH.2023

Description

The authors of a major report and refereed journal article for MLA (B.CCH.2023) on the impact of meat production systems on biodiversity will update the knowledge in the report and develop the recommendations. This will be done in consultation with technical experts (by phone and email) with a view to providing a sound basis for future research investments for MLA.

Objectives

The Consultant will achieve the following objective(s) to MLA's reasonable satisfaction:

Objectives

By 5 July, 2013 to have provided to MLA:

- An assessment of the current knowledge of livestock production systems impacting on biodiversity (composition, structure and function) and how improving biodiversity can assist livestock production.
- An assessment of the opportunities available to the grazing industries through a better understanding of biodiversity on farm.
- Identification of research activities required to provide enabling knowledge and technologies with which to take advantage of the opportunities (region by production system - developed from B.CCH.2023)

Additional details

Three main tasks will be progressed by the project team:

Task 1: Assessment of current knowledge (literature review and consultation with experts)

Task 2: Identifying options for improving the management of biodiversity within grazing systems

Task 3: Development of detailed recommendations that can become the basis for a project call

A desk top approach will inform the detail as well as communications by phone and email to key technical experts.

A workshop with producers and researchers would enhance the project but require additional funding and can be considered as a stage 2 process.

1. With a view to providing a sound basis for future research investments, update a recent review (MLA project B.CCH.2023, 2009) following consultation with technical experts to report on an assessment of the current knowledge of:

a. the impacts (positive and negative) of livestock production systems on biodiversity (across habitat, vegetation and soil) as it relates to the major regional Australian livestock production systems.

b. the potential for biodiversity improvement in grazing systems and the contribution of biodiversity to increase pasture and livestock production/profitability. This can form the basis of a compelling case to improve management of biodiversity

2. Describe the current and potential options for improving the management of biodiversity within a grazing system as it may relate to regional production systems (eg rangelands, verses crop - pasture systems verse native / exotic pasture dominated high rainfall zone systems), providing commentary on the impacts, any clear tradeoffs, and the associated opportunities for pasture and livestock production.

3. Develop the detail of the pasture / grazing focused recommendations from MLA report B.CCH.2023, that could become the basis for a project call targeting regions / livestock production systems of need with a specific emphasis on southern Australia (as fire and grazing recommendations will be addressed elsewhere). In addressing the recommendations this could include:

a. new / novel research technologies and processes in researching biodiversity on farm, which represent opportunities to provide a "breakthrough" in understanding biodiversity and improve productivity of grazing systems.

b. filling research gaps in the knowledge base around:

 i. pasture / livestock production and its impacts on biodiversity
 ii. how improving biodiversity, can improve pasture / livestock production
 iii. how pasture / livestock production can be managed to improve biodiversity

iv. spatial arrangement of land-use (integration v separation) and v. development of "lead indicators" or "thresholds" that will inform decision tools for livestock producers.

A workshop with producers / researchers can be supported outside the project costs.

Outputs

- Assessment of the current knowledge of livestock production systems impacting on biodiversity (composition, structure and function) and how improving biodiversity can assist livestock production.
- Assessment of the opportunities available to the grazing industries through a better understanding of biodiversity on farm.
- Identification of research activities required to provide enabling knowledge and technologies with which to take advantage of the opportunities (region by production system - developed from B.CCH.2023)

Relationship between grazing and biodiversity

Key-informant survey

Please return BY 12 JUNE 2013 to: submissions@kiri-ganai.com.au

Please bear in mind:

- The relationship between grazing and biodiversity can be two-way (impact and benefit)
- While MLA is specifically interested in cattle and sheep meat (and goat) production systems, lessons from grazing by wool sheep are also of interest
- It would be helpful to know which form of livestock you are referring to in your responses.

Question	Response
1. In your view, what has been	
the most significant	
contribution made by research	
over the past five years towards	
understanding:	
1a. pasture / livestock	
production and its	
impacts on biodiversity	
biodiversity can improve	
pasture / livestock	
production	
1c. how pasture / livestock	
production can be	
managed to improve	
biodiversity	
1d. spatial arrangement of	
land-use (Integration V	
sparing vs land sharing)	
1e. development of "lead	
indicators" or	
"thresholds" that will	
inform decision tools for	
livestock producers.	
2. In terms of future research	
investment, what more do we	
heed to know in order to	
2a pasture / livestock	
production and its	
impacts on biodiversity	
2b. how improving	
biodiversity can improve	
pasture / livestock	
production	

Question	Response
2c. how pasture / livestock production can be	
managed to improve biodiversity	
2d. spatial arrangement of land-use (integration v	
separation or land	
2e. development of "lead	
indicators" or "thresholds" that will	
inform decision tools for	
3. In particular, are there any	
new/novel research	
technologies and processes in	
researching biodiversity on	
farm which represent	
opportunities to provide a	
"breakthrough" in	
understanding biodiversity and	
improve productivity of grazing	
systems	
4. Do you have any further	
comments to make in respect	
to high priority R&D activities	
on the relationship between	
biodiversity and grazing?	

Appendix 3: Key informants involved in this project

Researchers

Warwick Badgery Professor Steve Cork Dr David Freudenberger Professor Jamie Kirkpatrick Professor David Lindenmayer Ms Sue Ogilvy Associate Professor Richard Thackway Professor Nick Reid Dr Sally Leigo Graziers

Mr Charlie Massy

Mr David Marsh

Mr Tony Coote