

# Biodiversity and Mixed Farming Systems

*A biodiversity proposal for the Grain & Graze Program  
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## Summary

This proposal outlines a suggested approach to biodiversity within Grain & Graze because several of the regions in the Program have asked for assistance with biodiversity. Definitions of biodiversity abound, so we propose an inclusive definition for Grain & Graze, one that involves compositional diversity (what native and exotic species are present and in what numbers), structural diversity (how is the diversity of species and ecosystems arranged on mixed farms), and functional diversity (what activities, services or functions are being carried out in the landscape).

Biodiversity is not a ‘user-friendly’ concept at farmer level, given that the subject matter itself is ambiguous, complex, often contested, value laden, science driven and usually based on native vegetation as a surrogate. To help ensure the approach taken to biodiversity is farmer-friendly, we believe that two things need to be done by Grain & Graze:

- i) Make sure the focus for biodiversity is on all the land uses and all species that make up a mixed farm, rather than concentrate solely on the conservation of remnant vegetation;
- ii) Modify the usual scientific approach of developing hypotheses, collecting data, and then communicating the results. Instead, a more inclusive process is recommended, based on collecting some data relating to biodiversity and mixed farming, leading to a dialogue between farmers and researchers, that will provide specific hypotheses for further testing.

The proposal is based on the Grain & Graze case study farms (40 across the 8 regions) and transforms these case-studies from one-off ‘snapshots’ into longitudinal studies of how mixed farming influences biodiversity and how biodiversity influences mixed farming. The strategy is to explore the relationships between site and system characteristics (climate, geography and management) and measures of farm performance and biodiversity. Four ‘paddocks’ are selected on each of the case study farms, to represent different land uses (cropping, pasture in rotation, permanent pasture and remnant vegetation), with 2 years of paddock and farm scale data collected.

The purpose of the biodiversity proposal is to provide sufficient information within a region to allow serious local engagement around the issues associated with mixed farming and biodiversity, while collectively contributing to a very broad scale understanding of how to balance the needs of mixed farming businesses and biodiversity at farm and catchment scale.

## Navigation through the document

**Section 1** (4 pages) provides an introductory discussion on biodiversity and mixed farming, including a discussion of alternative approaches and linkages with catchment targets.

**Section 2** (5 pages) outlines the approach to biodiversity we are proposing for Grain & Graze, the basic suite of measurements that are required and an indication of the costs and effort required.

**Appendix 1** provides a detailed account of the suggested measurement regime.

**Appendix 2** discusses some related biodiversity activities and possible key linkages.

**Appendix 3** discusses aligning Grain & Graze regional projects with catchment targets.

# 1. Biodiversity in an Agricultural Context

Biodiversity is becoming an increasingly important issue in agriculture. A major impetus for the formal incorporation of biodiversity conservation into national environmental policies was the United Nations Conference on the Environment held in Rio de Janeiro in 1992. Signatories to the Convention on Biological Diversity (CBD) (UNEP 1992) agreed at subsequent conferences to develop biodiversity strategies based on regional goals and targets. In Australia, a parallel process has led to the devolution of responsibility for biodiversity goals to catchment management authorities and boards. The concept of biodiversity is now being introduced to land holders who are being asked to incorporate biodiversity goals into their land management activities.

## 1.1 Biodiversity and Conservation

Biodiversity is a broad concept with many possible interpretations (Williams 2004). While the definition used in the CBD encompasses both exotic and native species, Government biodiversity policies and programs in Australia have focused on native genes, species and ecosystems (Williams *et al.* 2001). This is reflected in the increasing use of the phrases ‘native biodiversity’ or ‘indigenous biodiversity’ (eg. Wilson *et al.* 2003).

This approach has quite universal appeal and is about protecting native Australian flora and fauna for their intrinsic value. Clearing native vegetation has been extensive in the mixed farming zone, with the direct result that many of Australia’s threatened plant and animal species are found in the Grain & Graze regions. Against this background of habitat loss and modification, a major focus for biodiversity in agricultural regions must be the conservation of remaining native species if the agricultural landscape is to retain its uniquely Australian qualities.

The ‘bottom line’ for this approach is that we must prevent further loss of native species from agricultural landscapes, and landscape scale is the most appropriate level for such conservation – for example many catchment plans are based on ensuring (say) 30% of the catchment is managed for conservation purposes<sup>1</sup>. This approach is usually seen by landholders as top down, involving totally unrealistic targets based on little if any hard evidence and not farmer friendly, and it is easy to see potential for conflict between farmers and such catchment targets.

There have been, and continue to be, significant resources available to landholders who want to conserve native vegetation on their farm. For example, there is information about important practices, free advice and assistance is usually available, and (often) there are incentives to assist farmers to do such things as prepare farm plans, fence remnant vegetation, create wildlife corridors, revegetate riparian areas, improve the condition of remnants, and revegetate to expand remnants.

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<sup>1</sup> As an example, the Murrumbidgee Catchment Blueprint says “The blueprint will protect and enhance terrestrial native vegetation communities; facilitate revegetation and regeneration of priority vegetation types; enhance aquatic communities and native fish diversity and abundance; and develop a culture of stewardship of the environment”. Specifically, “By 2012, to manage for biodiversity conservation a minimum of 30% of the area of each of the remaining native vegetation communities and related habitats of the Murrumbidgee catchment.” Like other catchment blueprints, Murrumbidgee uses ‘native vegetation’ as a surrogate for biodiversity.

## **1.2 Biodiversity and Interactions with Agriculture**

Another way biodiversity is viewed takes a pragmatic or human centric approach based on the core assumption that healthy ecosystems are necessary for the services that they provide (eg fresh water, clean air, nutrient recycling, pest control, soil health, human fulfilment, sense of place etc), and that we will continue to rely on these services. This approach includes both exotic and native components of biodiversity and may therefore be more applicable across all land uses at farm scale. There is a strong element in this approach, of ‘how can we benefit from biodiversity’ rather than assigning an intrinsic value to biodiversity in its own right, and that it is the services provided that are at least as important as the particular species that are providing them.

These two approaches persevere because both have merit, and because the connections between native biodiversity and other important landscape functions and services are not always clear. Wallcott (2004) explained “*Experiments on biodiversity and ecosystem functioning are few in number, include less than 30 species and are, for the most part, relatively recent (Waide and others, 1999, Walker and others, 1999, Lawler and others, 2001). Consequently, much of the discussion on this topic is based on theoretical arguments that are often untested. This handful of experiments, mostly in either grasslands or aquatic communities, has found fairly consistent evidence for relationships between the diversity of species and ecosystem function, especially primary productivity. While it is now widely accepted that diversity may influence ecosystem functioning, it is not yet clear how important diversity is relative to other factors, how it regulates ecosystem functioning nor how this depends on the status of the system of interest (Naeem, 2002, Tilman and Lehman, 2001).*” Others (eg Grime 1997) provide a more sceptical view, concluding that the relationship between biodiversity and ecosystems function has defied generalisation.

In effect, for the Grain & Graze Program, it doesn’t matter whether the motivation behind biodiversity is to protect species for their intrinsic value, or for the contribution they make to healthy ecosystems and the farming businesses they support, or both. We should simply accept that biodiversity is a very broad concept with many possible interpretations, step past any controversy, and forge an appropriate course for the Program to take.

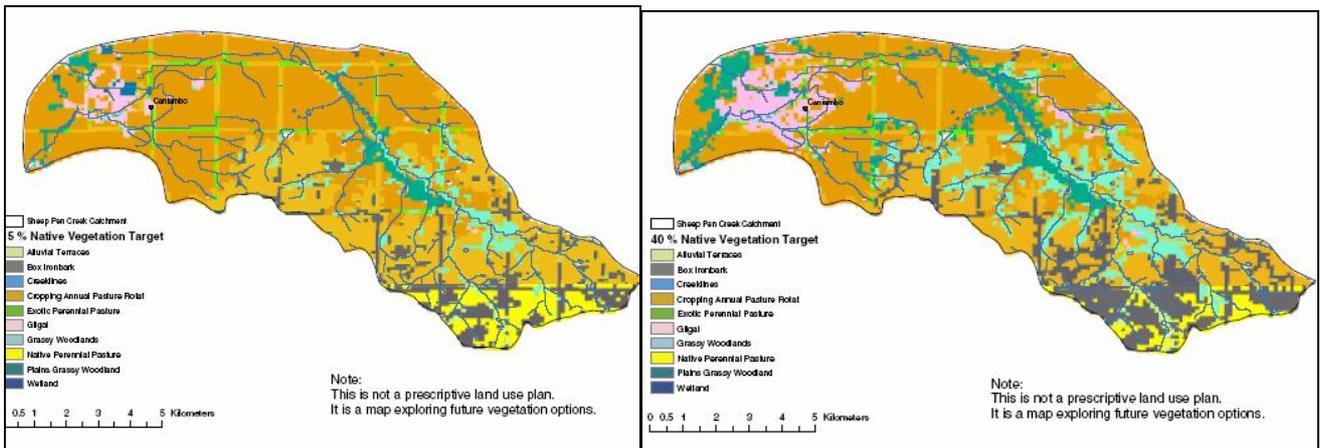
## **1.3 Addressing Catchment Targets**

The Grain & Graze Program makes several references to catchment scale resources and targets (see Appendix 3). For example, the ‘Welcome’ statement on the website reads: “*Grain & Graze is an exciting new research program which is working with farmer and catchment groups in Australia's wheat-sheep zone to improve on-farm profitability and productivity while also achieving local catchment management targets.*” Grain & Graze regions were also asked to address how their proposals would help meet catchment targets for biodiversity.

Landscape modelling, which uses native vegetation as a surrogate for biodiversity, is a commonly used approach for regions to address catchment targets, and to gain some understanding about how they could impact on individual farms. Examples are the Heartlands (Cresswell 2004), CSIRO (Abel 2003) and Landmark projects (Wilson et al. 2003) in south-eastern Australia, with a similar approach being adopted in the Lachlan/Central West Grain & Graze region.

The CSIRO Ecosystem Services project (Abel 2003) has used a set of decision rules at the sub-catchment scale to model different vegetation scenarios as a surrogate for biodiversity conservation planning. Eighteen decision rules are applied to create a pattern of vegetation

options that would enhance native biodiversity outcomes (Fig. 1). The modelling suggested that an increase from the current level of 8% vegetation in the sub-catchment to a 15% target (Fig. 1a) produces only small increases in ecosystem services as indicated by habitat configuration scores, carbon storage, shelter, shade, stream sediment load, sheet and rill erosion control, deep drainage control and control of soil acidity. At a 40% target the landscape has become relatively well connected (Fig. 1b). These sorts of analyses can be used to explore potential thresholds in ecosystem responses, although our understanding about many of the processes involved and how they interact is still quite limited.



**Figure 1a and 1b:** Modelled 15% and 40% targets for native vegetation enhancement (Abel et al 2003).

More recently, a catchment analysis tool (CAT), which simulates water–soil–plant interactions at a land management scale, has been developed and uses 6 rules to model changes to landscapes (400 ha blocks – roughly farm scale) (Wilson et al. 2003). The rules relate to ensuring there is at least one 40ha remnant in each 400ha block; that roadsides and riparian areas have 40-50m buffer zones; and that linkages (40m wide) are provided between remnants, and with roadsides and riparian areas.

These catchment scale modelling projects highlight the ‘danger’ for Grain & Graze – a Program that must achieve a high level of interaction and trust with mixed farmers. These ‘catchment targets’ are generally seen in a poor light by landholders – basically as representing the worst of top-down interference by Government in the operations of their farms. Despite the fact that these tools (such as the CAT described above) can be used to explore different catchment targets or other management goals identified by regional groups, maps such as shown in Figure 1 can ‘confirm’ landholder fears that there is a Government agenda. Grain & Graze must take an approach that is more readily recognised by landholders as working with them to meet their needs, as well as contributing to any catchment targets.

#### **1.4 A Suggested Approach for Grain & Graze**

In this complex mix, how can the Grain & Graze Program make a significant contribution to managing biodiversity, and help clarify what mixed farmers should and can do on their own farms? How can mixed farmers assist with the general and widely supported concept that we need to protect native species from further extinction while at the same time, continue to carry on the

cropping/grazing businesses that sometimes represent the greatest threats to those species? How can mixed farmers find the best balance between these sometimes competing objectives.

For Grain & Graze, we are recommending that the conceptual framework identified by Noss (1990) be adopted by the Program. Noss proposed that biodiversity be divided into three inter-related components - compositional diversity (how many), structural diversity (how arranged) and functional diversity (what they do). In the context of Grain & Graze, these components would encompass:

1. Compositional diversity – what native and exotic species are present on mixed farms, and in what numbers.
2. Structural diversity - how is the diversity of species and ecosystems arranged on mixed farms, both within remnant vegetation, and in the broader agricultural landscape. and
3. Functional diversity - what activities/services/functions are being carried out, and to what extent is the function related to or dependent on the composition and/or the structure.

In Grain & Graze, we propose looking at these three components of biodiversity (including both exotic and native species), and assessing their relationship with both production and conservation. This involves adopting the ‘definition’ of biodiversity developed by Freudenberger and Harvey (2003): *Biodiversity is the variety of life, its composition, structure and function, at a range of scales.*’

Such an approach will allow a focus on farm scale (essential if the Grain & Graze biodiversity activities are to engage with the mixed farming community) but with links to the broader landscape. The core question is how do we get the best outcome for biodiversity (composition, structure and function) on mixed farms that consist largely of crops and pastures and relative small areas of remnant vegetation?

We also need to position the Grain & Graze Program within a suite of parallel biodiversity projects. The biodiversity activities in Land Water & Wool (in the Native Vegetation and Biodiversity sub-program, and in the Sustainable Grazing on Saline Lands sub-program) and the Salinity CRC biodiversity program are briefly outlined in section 2.

### **1.5 The Current Grain & Graze Approach to Biodiversity**

A brief review of the regional Grain & Graze projects reveals that most regions are unclear about what approach to take to biodiversity and many have asked for assistance from Grain & Graze on how to address this issue. Only the Lachlan/Central West region is very clear about its approach and the links to catchment targets. It has taken a focus on biodiversity conservation in mixed farming landscapes, with the objectives of:

- 1) Assessing the status of remnant vegetation on case study farms;
- 2) Reviewing (desktop) the potential production benefits of biodiversity conservation;
- 3) Assessing the impact of pasture cropping and alley farming on biodiversity;
- 4) Determining how biodiversity is arranged across the landscape in relation to land use and other variables, and the potential to enhance conservation through landscape design.

The major focus in the Lachlan/Central west region is remnant vegetation, and its survival in mixed farming landscapes. Because Grain & Graze is about mixed farming (i.e. crops and

pastures in rotation), we are recommending that the scope of biodiversity investigations be broadened in other Grain & Graze regions to help understand the issues relating to biodiversity across the whole farm, including exotic crop/pasture paddocks and remnant native vegetation. This would require a different approach to that taken in the Lachlan/Central West region. [We see an opportunity for the Lachlan/Central West region to be used as a case study to see how, and if, the 'landscape modelling' approach can be married with the farm-level approach to biodiversity that is being proposed here. Depending on the success of this marriage a new model for approaching biodiversity targets could be developed as Grain & Graze evolves.]

## **2. A Proposed Biodiversity Strategy for Grain & Graze**

Within each Grain & Graze region, there are 5 case study farms. It is planned that these case study farms and turn them from snapshots into longitudinal studies of biodiversity on mixed farms in terms of both the biodiversity that supports the production systems and the biodiversity supported by the production system. A range of measurements is proposed in spring and autumn for a two year period, starting in spring 2005.

This approach is based on the observation that there is insufficient consensus on what biodiversity means in an agricultural setting and too little information available concerning the composition, structure and function of biodiversity on mixed farms to take the traditional scientific approach of hypothesis → data → communicate. In that approach, scientists formulate hypotheses based on observations, collect data to test the hypothesis, and then communicate the results (see Fig. 1 for an example). Given that the subject matter of biodiversity is ambiguous, complex, often contested and value laden, that approach is not sufficiently inclusive to accommodate the range of interpretations and interests. Instead we are suggesting an alternative the approach of data collection → followed by dialogue with farmers → leading to jointly developed hypotheses for testing, as described below.

### **2.1 The approach**

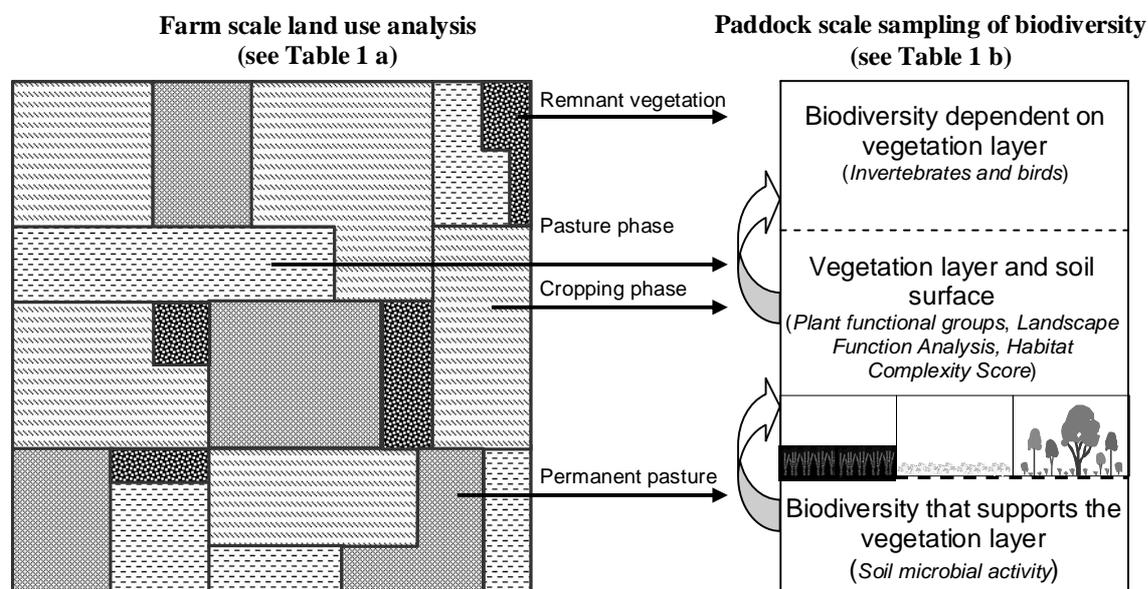
The approach in the Grain & Graze biodiversity strategy is to explore the relationships between site and system characteristics of mixed farms (climate, geography and management) and selected measures of farm performance and biodiversity. It's about starting at square one, and trying to quantify and understand the role biodiversity plays in supporting production on mixed farms and the role that farm management can play in supporting the viability of the native biota and ecosystem processes.

The data → dialogue → hypothesis approach will involve collecting information on the composition, structure and function of biodiversity on mixed farms as the basis for dialogue between landholders, scientists and natural resource managers, allowing them to jointly develop hypotheses that can be tested in greater detail. To jump to hypotheses without the participation of landholders will result in 'more of the same'. In addition, developing hypotheses (with or without farmers) up front, requires a level of information about biodiversity and mixed farms that is currently only available for remnant vegetation and not for the other land uses on mixed farms.

The dataset described below will allow the Grain & Graze Program to not only engage in a dialogue with farmers about biodiversity, but also provide sufficient data to tentatively explore relationships of interest to both farmers and those with responsibility for nature conservation at

larger scales. For example, it will be possible to examine the relationships across the 40 case study farms between the proportion of a farm under native vegetation and whole farm profit, or the number of birds recorded on farms and indices such as the Habitat Complexity.

The proposed strategy involves paddock and farm scales of measurement as illustrated in Figure 2. This figure shows a stylised mixed farm with 4 land uses (2 in crop rotation, permanent pasture and remnant vegetation). One paddock considered typical of each land use type is selected as representative of that land use. The vegetation layer is depicted as the central element of the paddock sampling as agriculture focuses on manipulating the vegetation layer – crops, pastures and remnant vegetation. Table 1 outlines suggested measurements at each paddock sampling site and at farm scale. The approach focuses on exploring relationships between measures of site and system characteristics of mixed farms (i.e. climate, geographical features and management regime) and selected measurements of biodiversity (species and functional group diversity within plants, birds and invertebrates, and landscape function) and farm physical and economic performance.



**Figure 2** – Stylised mixed farm with 4 land uses and 4 paddock based sampling sites.

**Table 1** – Proposed measurements at paddock and whole farm scale (for detail see section 2).

Paddock scale*	Whole Farm Scale
<p><b>Site and system characteristics</b></p> <ol style="list-style-type: none"> <li>1. Soil characteristics (type, P, N, K, C, pH, Ec).</li> <li>2. % cover of weeds in crop by functional group</li> <li>3. % cover grasses/legumes/others in pasture</li> <li>4. Remnant vegetation type and condition (1-3 scale)</li> <li>5. Landscape position (slope and aspect)</li> <li>6. Paddock inputs</li> </ol> <p><b>Measures of production, diversity and landscape function</b></p> <ol style="list-style-type: none"> <li>7. Paddock outputs (Gross Margin, grain yield, livestock production)</li> <li>8. Landscape Function Analysis</li> <li>9. Soil microbial biomass, microbial respiration and cellulase activity (soil DNA for analysis by others)</li> <li>10. Habitat Complexity Score</li> <li>11. Soil surface invertebrates (to the level of order, with catch available for further study to genus or species by others)</li> <li>12. Bird species</li> </ol>	<p><b>Site and system characteristics</b></p> <ol style="list-style-type: none"> <li>13. Rainfall</li> <li>14. Farm Area (+ % crop, permanent pasture, pasture in rotation, remnant vegetation, saline and 'other' land)</li> <li>15. Terrain analysis (GIS 'ruggedness' index)</li> <li>16. Land use 'patchiness' (number, size and arrangement of patches of the different land uses)</li> <li>17. Proximity of remnants &gt; 10 ha in the surrounding landscape within 5 km.</li> </ol> <p><b>Measures of production, diversity, and landscape function</b></p> <ol style="list-style-type: none"> <li>18. Whole farm profit</li> <li>19. Whole farm grain production (kg/ha)</li> <li>20. Whole farm livestock production (kg/ha)</li> <li>21. Soil surface invertebrates list.</li> <li>22. Bird species list for the farm</li> <li>23. Year-round green Leaf Area Index</li> <li>24. Area-weighted Landscape Function Analysis and Habitat Complexity Score</li> </ol>

\* Data collected in one representative example of each of 4 land use classes on each farm (crop, pasture in rotation with crop, permanent pasture and remnant vegetation)

## 2.2 Regional Effort, Co-ordination, and Synthesis

The farm scale data (land use diversity analysis and whole farm Leaf Area Index) would require an aerial photograph and farm plan for each property, plus local information on characteristics of crops, pastures and native vegetation with spatial analysis carried out centrally for all farms. Paddock scale data (vegetation assessment and soil and invertebrate sampling) would require two people visiting each property twice a year for approximately two days each in autumn and spring (8-10 days per farm per year, including data entry). It is assumed that this work be carried out by regional staff associated with each Grain & Graze region.

A training course would need to be run at the commencement of the project to train regional Grain & Graze staff in plant, invertebrate and soil sampling techniques, Landscape Function Analysis (LFA), Habitat Complexity Score, and collection of the farm-scale data. It is recommended that the bird surveys be sub-contracted to regional naturalist clubs or other local conservation groups. Based on the level of activity outlined above, regional effort would be in the order of 100 days labour per year per region (10 days on-farm data collection for vegetation, soil microbial activity, LFA and invertebrate sampling plus 40-50 days for sample preparation, sorting and data entry etc).

In addition there would be about \$12,000 for sub-contracted bird surveys per region and \$14,000 for materials and laboratory analyses per region associated with soil biological activity and soil surface invertebrates.

A full time scientist would be required to lead and co-ordinate the biodiversity component of Grain & Graze nationally. This would involve negotiating and drafting a detailed research protocol with the regions, establishing milestones, running training courses for regional staff, overseeing data collection and database maintenance, reviewing progress, carrying out analyses of data and relating results to production data collected through other components of Grain & Graze, and communicating results to the regions, industry and scientific groups. The national co-ordinator would also be required to draw the eight regional datasets together in the form of internal reports, publications and communications material on behalf of the regions and industry partners, liaise with related projects examining biodiversity in farming systems and co-ordinate preparation of papers for publication in the scientific literature.

Some input from a spatial analyst would be required to carry out the GIS analyses of topography and land use diversity for the 40 farms.

### **2.3 Adding Value to other Biodiversity Projects**

Section 1.4 introduced the need to position Grain & Graze within a suite of parallel projects and programs on biodiversity in agricultural systems. The overarching questions from each of these initiatives is summarised in Table 2, and the major measurements being taken (or proposed) for each initiative are presented in Table 3. Grain & Graze could play an important integrating role by examining impacts of site and farming systems on biodiversity across a broad range of environments and farming systems, while each of the other projects could contribute greater depth to studies of individual farming systems and parts of the landscape. There is also a significant opportunity for Grain & Graze in the Land Water & Wool Program. Firstly, the Native Vegetation and Biodiversity sub-program has (by coincidence) its major activities in the gaps between Grain & Graze regions. This may provide not only scientific opportunities (to fill in gaps), but extension opportunities as well. Secondly, the Sustainable Grazing on Saline Lands (SGSL) sub-program is collecting some similar biodiversity information from salt affected land (a land class not included in this Grain & Graze proposal but which is present on many mixed farms).

With 40 Grain & Graze farms in this biodiversity proposal, there are certain to be some that have native pastures (with potential direct links to the CRC and LWW projects), and some that have land affected by dryland salinity (can link directly to SGSL) so that much more direct interactions might be possible. For example, on a Grain & Graze farm, where the permanent pasture paddock is a native pasture, it should be possible to combine that information with the CRC project. Where there is salt affected land on the Grain & Graze farm, it should be possible to add the salt land as a 5<sup>th</sup> 'paddock' for biodiversity sampling and that data can be combined with the SGSL biodiversity theme.

It should be possible for the Grain & Graze program to 'convene' a process that brings the 4 Programs together in some way to build a stronger picture of biodiversity on southern Australia farms – indeed, we see a significant leadership role in this area for the Grain & Graze biodiversity science leader. This would be a major outcome for Grain & Graze, and great value for farmers and others with an interest in biodiversity management in agricultural landscapes.

**Table 2 - Key questions being asked by the 4 programs**

<b>Grain &amp; Graze</b>	<b>LWW Biodiversity</b>	<b>SGSL</b>	<b>Salinity CRC</b>
What impacts are current mixed farming operations having on the elements of biodiversity within the farm boundary and vice versa?	Is it possible to demonstrate the compatibility of profitable wool production and conservation of biodiversity, and to identify the specific biophysical and socio-economic links between the two?	To what extent can best practice saltland pastures restore the biodiversity and landscape function on land affected by dryland salinity?	How can the novel farming systems being developed in the CRC contribute to biodiversity goals in agricultural landscapes without significantly compromising their profitability and water use?

**Table 3 – key biodiversity related measurements**

<b>Grain &amp; Graze</b>	<b>LWW Biodiversity</b>	<b>SGSL</b>	<b>Salinity CRC</b>
<b>Whole Farm &amp; Farm Management Measurements</b>			
<b>a) Site and System Characteristics</b>			
<ul style="list-style-type: none"> <li>● Rainfall</li> <li>● Whole farm area, % land uses and patchiness</li> <li>● Topography</li> <li>● Proximity to large remnants</li> </ul>	<ul style="list-style-type: none"> <li>● Rainfall</li> <li>● All farm management activities</li> </ul>	<ul style="list-style-type: none"> <li>● Rainfall</li> </ul>	<ul style="list-style-type: none"> <li>● Rainfall</li> <li>● Farm size</li> <li>● Proportion of farm under perennial farming systems</li> <li>● Proximity to large remnants</li> </ul>
<b>b) Farm Measures of Production and Biodiversity</b>			
<ul style="list-style-type: none"> <li>● Farm profit (\$/ha)</li> <li>● Grain and livestock production (kg/ha)</li> <li>● Soil surface invertebrates</li> <li>● Bird species</li> <li>● Area weighted averages of paddock measures</li> </ul>	<ul style="list-style-type: none"> <li>● Farm Income</li> </ul>	<ul style="list-style-type: none"> <li>● Role of saltland pastures in the grazing systems</li> </ul>	<ul style="list-style-type: none"> <li>● Role of perennial farming systems on the farm</li> <li>● Conservation goals of the landholder</li> </ul>
<b>Plot or Paddock based Measurements</b>			
<b>a) Site and System Characteristics</b>			
<ul style="list-style-type: none"> <li>● Soil characteristics</li> <li>● % weeds in crops</li> <li>● % grasses etc in pasture</li> <li>● Remnant veg condition</li> <li>● Paddock inputs &amp; outputs</li> <li>● Landscape condition</li> </ul>	<ul style="list-style-type: none"> <li>● Area, botanical composition, cover and litter depth</li> <li>● Tree cover and remnant native vegetation</li> <li>● Soil type and deposition history, nutrient status and biota, depth of topsoil</li> <li>● Length of fenced and unfenced waterways</li> </ul>	<ul style="list-style-type: none"> <li>● Paddock inputs &amp; outputs</li> <li>● Site Characterisation (soil profile, fertility, salinity, waterlogging)</li> <li>● Landscape position</li> </ul>	<ul style="list-style-type: none"> <li>● Soil characteristics</li> <li>● % weeds in crops</li> <li>● % grasses etc in pasture</li> <li>● Remnant veg condition</li> <li>● Paddock inputs &amp; outputs</li> <li>● Landscape condition</li> </ul>
<b>b) Paddock Measures of Production and Biodiversity</b>			
<ul style="list-style-type: none"> <li>● Paddock outputs</li> <li>● Habitat Complexity Score</li> <li>● LFA</li> <li>● Soil microbial biomass, microbial respiration and cellulase activity</li> <li>● Invertebrates</li> <li>● Birds</li> </ul>	<ul style="list-style-type: none"> <li>● Plant diversity (exotic and native)</li> <li>● Area, botanical composition, cover and litter depth</li> <li>● Bird, reptile, mammal and amphibian diversity</li> <li>● Water quality and aquatic macro-invertebrate diversity</li> <li>● Grazing records</li> </ul>	<ul style="list-style-type: none"> <li>● Plant diversity</li> <li>● Grazing days/animal production</li> <li>● Landscape functional analysis</li> <li>● Terrestrial invertebrates</li> <li>● Soil microbial respiration</li> <li>● Modelled profitability</li> </ul>	<ul style="list-style-type: none"> <li>● Plant diversity</li> <li>● Landscape functional analysis</li> <li>● Birds</li> <li>● Reptiles</li> <li>● Soil microbial biomass</li> <li>● Soil microbial respiration</li> <li>● Soil enzyme activity</li> </ul>

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## Appendix 1 - Proposed Data Set for Biodiversity in Grain & Graze Regions

This analysis assumes that the 5 farms selected in each region for the case study project being undertaken by RMCG will participate in the on-going biodiversity study. Hopefully these will be the 5 case study farms, as the background information would be very useful in examining relationships between farm performance, location, farming practice and biodiversity. All regions would be able to include more farms, more sites per farm, or more measures at each site, depending on local interest and available resources.

The intention of the biodiversity project is to examine the relationships between site and system variables, measures of biodiversity and measures of farm performance through multivariate analyses. This makes selection of the 160 sampling sites (40 farms by 4 sites per farm) very important. Selection needs to be carried out to reflect the broad range in geography (rainfall, topography, landscape position, soil type), landscape context (eg close to and distant from remnant vegetation, high and low levels of remnant vegetation and revegetation) and farming practice (minimum and conventional tillage, set stocking and rotational grazing, high and low inputs) across Australia's mixed farming areas. While ideally the actual farms would be selected based on a number of these key variables, this is not possible because the farms are being chosen for another project – however, we expect that the case study project will automatically select a good range of different mixed farming operations

The measures below are divided into paddock and farm scale data. The farm scale data includes three measures that are scaled up from paddock scale measurements on the basis of the area of the farm under each land use type and the assumption that the sample paddocks are 'representative' of that land use type across the farm.

### Paddock scale data

The measures below are to be collected within paddocks representing the four main land management classes; crop phase of rotation, pasture phase of rotation, permanent grazing and remnant vegetation. **Spring and autumn** sampling is required unless otherwise specified.

1. **Soil characteristics.** A one-off soil type and nutrient status analysis (N, P, K, Organic Carbon, pH and Ec) from standard commercial soil tests at the beginning of the project.
2. **Percent cover of weeds in crop.** A 'general indication' of weed content, estimated by functional group (grasses, legumes and others forbs) from 20 quadrats per paddock in spring only.
3. **Percent cover grasses, legumes and other forbs in pasture.** A 'general indication' of pasture composition, estimated from 20 quadrats per paddock.
4. **Remnant vegetation type and condition.** Type is available from vegetation maps or local knowledge. Condition is assessed using a 1-3 scale condition score (Huggett *et al* 2004).
5. **Landscape position.** A one-off determination, with paddocks classified as hilltop, midslope, lower slope, or valley floor; plus aspect as one of the 16 compass points (N, NNE, NE, ENE, E etc)
6. **Paddock inputs.** An on-going record/diary of paddock inputs and operations.

7. **Paddock outputs.** Gross margins (\$/ha from grain and grazing), grain production (kg/ha) and livestock production (grazing days) calculated annually
8. **Landscape Function Analysis.** Landscape Functional Analysis (LFA, Tongway and Hindley 1995) was developed as a measure of rangeland condition and has since been used to assess the success of mining rehabilitation and revegetation in agricultural landscapes. It uses 10 measurements of soil surface condition to derive three indices of water infiltration, soil surface stability, and nutrient cycling that have been found to correlate well with direct field and laboratory measurements. These indices are integrated to produce an index of landscape function. The individual measurements are perennial basal plant cover, litter cover, cryptogam cover, crust brokenness, erosion features, deposited materials, soil microtopography, surface nature and the Slake Test.

A short course on the application of LFA could be run centrally for regional staff. Software developed by Tongway and Hindley (1995) can then be used to rapidly generate the three indices of functionality (infiltration, stability and nutrient cycling). The hypothesis is that landscapes with high functional indices as determined using the LFA technique produce higher levels of production, more tightly closed water and nutrient cycles and provide higher value habitat for species sensitive to landscape degradation than landscapes with low landscape functional indices. (Do we want to leave this hypothesis in?).

9. **Soil microbial biomass, respiration and cellulase activity.** Twenty samples are to be taken in each paddock in spring 2005 and spring 2006, bulked and sent to CSIRO Forestry and Forest Products Laboratory in Mt Gambier, South Australia for determination of soil microbial activity, soil microbial respiration and cellulase activity to provide a relative measure of the level of soil microbial activity that supports the vegetation layer. The average cost of each analysis is approximately \$100, giving a total cost of \$1,200 per farm per year (3 analyses per soil sample x 4 sites per farm) or \$12,000 total per region (5 farms by 2 years). It is also recommended that soil be retained from this survey for analysis of DNA by other soil biology programs to examine the relationship between microbial diversity and function.
10. **Habitat Complexity Score.** The Habitat Complexity Score is based on the method described by Catling and Burt (1995) and provides a measure of the state and condition of the vegetation layer. While it has been developed for the assessment of native vegetation (particularly woodlands) and its suitability as habitat for the native biota, the Habitat Complexity Score has also been used to assess a range of natural and synthetic vegetation in agricultural landscapes. Hobbs *et al* (2003) in particular showed a significant relationship between the Habitat Complexity Score for a range of vegetation types (plantation, remnant and pasture paddocks) and the diversity of bird species recorded.  
  
The Habitat Complexity Score will help assess the contribution of pastures, crops and scattered trees across the cropping and grazing areas of each farm to structural, compositional and functional diversity. The technique will need to be applied at a large scale than is normally applied to provide whole-of-paddock assessments.
11. **Soil surface invertebrates** (to the level of order, with catch available for further study to genus or species by others). The approach suggested is that adopted by the SGSL program which is to survey for invertebrates using pitfall traps and sort to the level of order recording gross differences in the number of organisms within each order (a 4 level scale is used for each order - zero, 1-10, 10-100, < 100) recorded in each vegetation type (or

treatment) using a visual identification key. This could be combined with sampling for target taxa that have known functional roles such as insects known to be predators of agricultural pest species (ladybirds) and those that play functional roles with respect to water and nutrient cycling (such as ants and termites).

The approach involves a transect of 10 pitfall traps per site (i.e. paddock or remnant) left out for two weeks in autumn and spring and bulked for each site. The cost of materials for a transect of 10 pitfall traps (cups, drift fences, fence pegs, propylene glycol) is in the order of \$100, giving a total of \$400 per farm or \$2000 per region. Sorting to the level of order would require approximately 1 day per sample after an initial training period, or 8-10 days per farm per year (40-50 days per region). The targeted survey methods would require more specialised input in terms of centralised sorting of the catch.

12. **Bird species.** Birds are influenced by both what happens on the farm and the broader landscape context - in particular, proximity to large patches of native vegetation. As representatives of the so called 'charismatic mega fauna', birds have the potential to drive conservation efforts if a) landholders identify with species that are at risk and b) it can be demonstrated that collective efforts to modify the landscape context without going out of business can have an impact on their longer term viability.

The suggested approach is that members of local naturalist clubs or bird observer groups, many of whom will be landholders, be sub-contracted to carry out the surveys. The standard Birds Australia 10 minute/5 ha survey would be used at three locations within each of the four land use classes (Remnant, Crop phase, Pasture phase and Permanent grazing) on each farm four times a year (spring, summer, autumn and winter) for two years. This amounts to 240 surveys (3 reps x 4 paddocks x 5 farms x 4 times/yr x 2 years) per region. Assuming an observer could carry out the 12 single farm surveys in a day (surveys have to be undertaken within the 2 hours post dawn, or pre dusk), this would require 1 weeks surveying per season for one observer or 4 weeks per region.

Past experience with the Birds Australia national surveys suggests that paying local observers from naturalist clubs or other conservation groups is the most reliable way to carry out these targeted surveys where specific locations are concerned. Assuming observers were to be paid \$250 per day, this would cost approximately \$6,000 per region for bird data each year for two years. The data from these surveys would then be compared to the Birds Australia national surveys to relate the results to past regional and national survey data. Across the regions, the influence of area and proximity of remnant vegetation and farming practice on observations could be examined.

## **Whole farm data**

13. **Rainfall** (Monthly)
14. **Whole farm area** (ha) **and patchiness** (number, size and arrangement of patches of the 4 land use types and any other land classes – eg saline land). The pattern of land use would be captured from an aerial photograph and farm plan for each farm indicating the areas under four broad classes of land use. As well as the total area under each land use class, the analysis would examine patch size (median and range), patch shape and edge to area ratio to account for land use exposure given that different patch shapes with the same area can lead to varying degrees of exposure to other land uses, nearest neighbour statistics to

patches of the same type (measured from patch centre and perimeter) and remnant exposure to neighbouring land use types, i.e. the proportion of boundary in common with each of the adjacent land uses. This information would be used to provide quantitative and descriptive assessments of land use patterns for each farm and region. Underlying this it would be useful to have some topographic classification of land uses. By classifying all land uses according to position in the landscape e.g. hilltop, mid slope, lower slope and valley floor, it would be possible to identify concentrations and distributions of similar land use types. In order to compare sites across the country, it would also be necessary to classify land use into broader classes (i.e. high impact, medium impact, low impact) to allow for comparisons between study sites where land uses may vary from region to region.

15. **Terrain analysis.** Describing terrain and landscape features is readily simple given access to a GIS and digital elevation model, and can be enhanced using aerial photography – ruggedness is an index of the true surface area of a property - is a standard measure on many GIS systems, or algorithms to calculate this measure are readily available. Digital elevation models (DEM) with a grid (pixel) resolution of at least one hectare are either available from government agencies or can be readily computed for Grain & Graze regions. By combining the DEM with land-tenure data or aerial photography, using a GIS, it is possible to generate boundaries and area statements for each property, as well as for land systems, crops and native vegetation communities within properties.
16. **Proximity of large remnants.** A one-off assessment of the proximity of large remnants (>10ha) in the surrounding landscape within 5 km.
17. **Whole farm profit** (\$/ha from grain and grazing) calculated on an annual basis.
18. **Whole farm grain production** (kg/ha) calculated on an annual basis.
19. **Whole farm livestock production** (kg/ha produced on a whole farm basis).
20. **Soil surface invertebrates** (aggregated list to the level of order for the whole farm).
21. **Bird species** (aggregated list for the farm).
22. **Leaf Area Index.** An estimate of seasonal green-leaf LAI, based on the proportion of each farm under the various land management units with an estimate of the year-round LAI for each land class over each season. This would provide an aggregate measure of the water management potential of the current farming system and an overall measure of percent cover with implications for soil management and general sustainability of the farming system. While the LAI of crops and pastures can be estimated fairly readily using remote sensing data, most of the native vegetation communities found in the proposed study regions are likely to be too complex to characterise reliably using satellite imagery alone. Therefore, whole farm LAI will be estimated from areas of the different land uses, and local estimates of the seasonal LAI.
23. **Area-weighted paddock scale indices.** Landscape Function Analysis and Habitat Complexity Score. This is to be based on the scores derived for each paddock type multiplied by the proportion of the farm under each land use and summed to give an average expression for the whole farm.

## **Appendix 2 – How could this approach complement other national programs?**

This section provides an analysis of the suite of projects (LWW, SGSL and CRC) that are currently focussing on biodiversity in farming systems to illustrate how they could potentially complement one another. It is suggested that Grain & Graze provide the overall farming systems context for the management of biodiversity in farming systems, with the other programs providing more detailed studies of biodiversity by land use type and enterprise, i.e. native pasture grazing systems and saline land in Land, Water & Wool, and novel perennial land use systems in the Salinity CRC.

### ***The Approach Being Taken to Biodiversity in Land Water & Wool***

Land, Water & Wool has a Native Vegetation and Biodiversity sub-program which is developing, testing and promoting options for integrating wool production with the protection, management and restoration of native vegetation and its associated biodiversity. The sub-program has five regional projects, spread across the high rainfall and sheep-cereal zones of south-eastern Australia, that are undertaking research on the links between commercial wool production and biodiversity in native pastures and bushland. By coincidence, the LWW projects tend to be located in the gaps between Grain & Graze catchments, which could create some collaborative opportunities if this were explored.

A major focus for LWW is examining the financial implications of different biodiversity management options on farm business profitability. Consequently, each of the projects is collecting a range of biophysical and financial data, principally at the farm scale. Social data is being collected either as part of surveys of woolgrowers, or using techniques such as photographs to explore the perceptions that woolgrowers have of biodiversity.

- **Traprock region, South-east Queensland**

This project, which started in April 2004, has three phases:

1. to research and evaluate the key social, economic and ecological values and management approaches that underpins successful wool production using the Traprock region of southern Queensland as a case study;
2. to develop integrated landscape management practices for profitable and sustainable wool production that links property to sub-catchment scales and coordinates with broader catchment and regional planning objectives; and
3. to develop a toolkit for monitoring productivity and biodiversity for profitable and ecologically sustainable wool production, and establish a coordinated monitoring and reporting program applicable to other wool growing regions.

The biodiversity component measures aspects of the flora (e.g. plant species and relative abundance; exotic and native grass cover-abundance), habitat complexity, condition of vegetation and soils, birds, reptiles and invertebrates. The QMDC is a partner in this project, so there is potential for collaboration with the Border Rivers Grain & Graze project.

- **Northern Tablelands, NSW**

The project underway in the Armidale region of NSW aims to demonstrate the compatibility of profitable wool production and conservation of biodiversity by testing 10 hypotheses relating to the specific biophysical and socio-economic links between wool production and biodiversity conservation on monitor farms. An example of the hypotheses is “that retention of native pastures

for wool production reduces costs (compared to sown pasture development); improves wool quality, prices and wool profits; and sustains a greater diversity of native plants and dependent native fauna than sown pastures.”

Field sampling of biophysical resources and land and water management is being undertaken on each monitor farm, conducted by specialist professional teams from UNE. The data are to be analysed by: (a) modelling of the production and biophysical data to test specific hypotheses; (b) whole-farm modelling to generalise the results from the sample of monitor farms.

- **Hill Country, Central Victoria**

This project is working with nine commercial wool properties across three regions of central Victoria – the Ararat Hills, Maryborough-Lexton and Springhurst. Detailed financial, agronomic and biodiversity data has been collected on the nine properties, with the latter measures focusing on native plant species and vegetation types. Based on this data, detailed property reports have been developed that identify production/conservation options, based on farmer's goals over a 10-15 year time frame. Modelling has been undertaken on the probability of natural regeneration of eucalypts across agricultural landscapes as a low cost option for revegetating large areas.

- **Clare region, South Australia**

The focus of this project is to help wool growers conserve and improve native pasture biodiversity by rotational grazing and to lift profits through increased production. Specifically the research is evaluating the effect of grazing management of native pastures on sheep productivity, farm financial returns and ecosystem function of native pastures. A range of plant, soil and sheep measurements are being taken including pasture growth rates, change in native and annual pasture species, species diversity, water use efficiency, water infiltration rates and soil biological data. Farm level economic data is collected as part of the project, using the ProfitProbe approach.

- **Midlands region, Tasmania**

The Tasmanian regional project is examining how woolgrowers currently manage their native vegetation for conservation and production purposes on-farm. This includes working with woolgrowers to conduct grazing trials on native pastures, survey on-farm biodiversity (native plant and animal species) throughout the Midlands region and develop key performance indicators for environmental best practice. A tool has been developed that calculates the opportunity costs of conserving native species and vegetation types at the farm and catchment scale. Researchers from the University of Tasmania have a number of student projects underway that are addressing questions identified by woolgrowers about managing native systems for production and conservation outcomes.

The ambitious nature of these projects are both a strength and weakness. For example, given the data available, it will be challenging to answer the complex hypotheses being addressed in the NSW project. Different projects are collecting different sets of biodiversity and production data, partly because of the different issues being addressed across the regions, but also because of the different resources and skills available to each project. Having a University associated with a project (such as in the Tasmanian, NSW and Queensland projects) can add considerable resources to a project through the use of student projects or in-house technical expertise.

## ***The Approach to Biodiversity in Sustainable Grazing on Saline Lands (SGSL)***

SGSL (a sub-program of Land Water & Wool) has a series of National research sites investigating best practice saltland pasture systems in WA (2 sites), SA, Vic and NSW. These sites collectively contribute to a Biodiversity and Landscape Function Theme that is focussed around a suite of measurements in three plant communities: untreated saltland, best practice saltland pasture, and relevant remnant vegetation.

Summary of the minimum data sets for the biodiversity and landscape function protocol

Measurement	Frequency and Comments
Plant diversity	Three times a year (prior to grazing, after grazing and at peak biomass), based on full composition analysis of the Botanical quadrants
Landscape Functional Analysis	Once or twice a year (prior to grazing and just after grazing) as recommended by David Tongway for each site
Soil microbial respiration	Four times a year (spring, summer, autumn and winter), with all samples analysed in Armidale
Disturbance regime	Record of the timing and degree of disturbance (fertilisers, pesticides, grazing, flooding, fire and major weather events)
Diversity of above ground invertebrates	Pitfall traps with drift fences - the pitfall traps are 'open' for one week at a time, with collections in late spring (peak biomass) and post-grazing in autumn. The 'catch' is sent to WA for sorting and identification
Pasture and animal production measurements are contained in other protocols and are available to the biodiversity theme via the SGSL databases.	

### **Biodiversity Theme questions**

The biodiversity theme is addressing the following questions relating to biodiversity systems.

- How do saltland pastures influence ecosystem function (Landscape Functional Analysis and Soil Microbial Respiration)?
- Are there any relationships between the measures of ecosystem function and pasture and animal productivity?
- What are the effects of revegetating saltland on the diversity of plants and soil surface invertebrates?
- Are there any relationships between the measures of plant and invertebrate diversity and pasture and animal productivity?
- Are there any relationships between the measures of plant and invertebrate diversity and measures of ecosystem function?

The strength of the SGSL approach is that it will draw information from saline sites across the 4 southern, mainland states and combine that information with the suite of other pasture and animal performance data. In addition, SGSL is attempting to combine below ground, vegetation and above ground measurements relating to biodiversity. A weakness of the SGSL approach is that for the invertebrate diversity study, the samples are only sorted down to Order (eg thrips, ants, flies etc) which is relatively easy to do, but does not provide information on function. This is fine if you subscribe to the view that diversity is valuable in and of itself, but unsatisfactory if you have an interest in understanding functional roles.

## ***The Approach Being Proposed for Biodiversity in the Salinity CRC***

The CRC for Plant Based Management of Dryland Salinity has the aim of developing farming systems based on perennial plants that contribute to the management of salinity through increased water use. The CRC's interest in biodiversity relates to ***how the novel farming systems it is developing could contribute to biodiversity goals in agricultural landscapes***, and in particular, how their composition, location, and management could contribute to those goals without significantly compromising their profitability and water use.

The following approach to enhancing biodiversity values in agricultural landscapes came out of a CRC and MLA sponsored biodiversity workshop held at Rutherglen in 2003 and has been adapted from Lefroy and Smith (2004). It is based on the premise that the landscape scale is the most appropriate level to be setting and achieving biodiversity goals.

### 1. Establish the biodiversity goals

Establishing the biodiversity goals involves answering three questions.

1. What are the regionally significant native species, communities and ecological processes whose persistence you wish to ensure?
2. What are the threats to and needs of those species, communities and ecological processes?
3. In what ways could management of farming systems contribute to managing the threats and achieving the needs of these species, communities and processes?

This is essentially a social process with heavy reliance on expert advice and data from existing biodiversity surveys and audits. This is the step that most ecological research in agricultural landscapes has not done well, with the consequence that the connection between research outcomes and implementation has been weak – it also suffers from the question “whose goals are we talking about?”

### 2. Identify relevant response functions

Identify evidence-based relationships between actions (such as type and location of new perennial vegetation in the landscape and its harvesting regime or grazing management) and the specified outcomes (persistence of species, communities or processes in a farming landscape). Studies will need to be set up to compare the extent to which the biodiversity ‘treatments’ achieve the goals relative to two benchmarks – the conventionally managed farming systems (the ‘normal’ control) and the most structurally or compositionally relevant remnant ecosystem (the ‘natural’ control). This is applied ecological science, and will involve establishing response functions between the location, composition, structure and management of farming systems such as agroforestry and perennial pastures and measures relating to the persistence of native species, plant communities or the processes that represent the goals.

### 3. Establish the economic implications of biodiversity interventions at the farm business level.

This involves moving down from the level most appropriate to setting and achieving biodiversity goals, the landscape scale, to that of the farm business, and attempting to identify the opportunity cost and capital cost of intervention. That intervention could range from complete displacement of agricultural activity, to a change in management such as time of grazing of native pastures or the harvest cycle of agro-forestry systems. This is economic analysis, involving assessment of the farm scale implications of applying a range of alternative biodiversity oriented strategies.

These steps then need to be repeated until it is possible to either identify achievable goals of genuine ecological merit that satisfy farm business constraints, or failing that, establish the cost of achieving biodiversity goals.

The CRC has a project application with MLA entitled “Enhancing biodiversity in native pastures on the south-west slopes of the Murray Darling Basin”. This project aims to explore the implications of grazing management for improved water use and productivity for the diversity and persistence of a suite of native species associated with native pastures, including other native plants (such as legumes, daisies, lilies and orchids), birds and reptiles. The project poses the questions whether tactical grazing (specifically shown to be useful for increasing the perennial grass content of pastures) can also enhance the viability of other native species present in native pastures.

A strength of this project is its ability to examine biodiversity in permanent pastures in greater detail than is possible in a project with broader aims such as *Grain & Graze*. The weaknesses are that it needs to be more strongly connected to measures of performance at the farm scale, it needs to be tied to other studies of the implications of grazing systems on biodiversity such as existing and proposed LWW projects, and it is dependant on the diversity of grazing management systems that currently exist, as at this scale it is not possible to impose grazing management treatments on native pastures to examine impacts on biodiversity and vice versa.

## APPENDIX 3: Addressing Catchment Targets in Grain & Graze

### The Catchment Context in Grain & Graze

In order to address the issue of biodiversity catchment targets, it is necessary to describe the 'Catchment Context' for Grain & Graze. This is done from the perspective of what Grain & Graze has 'promised' it will achieve at the catchment scale, as well as presenting the catchment targets (where available) for each of the regions as addressed in their proposals. These targets are largely aspirational, and require a whole-of-catchment approach to move forward. Until they are made spatially specific, they have little relevance at the farm scale as it is not possible to determine the impact on farm businesses of achieving these targets. The landscape modelling approach adopted by the Lachlan Central West region is one approach to bringing catchment targets down to the farm scale.

The Grain & Graze Program makes several references to catchment scale resources and targets, as indicated in the following references on the website (accessed November 22, 2004). Relevant sections have been underlined to illustrate how embedded the concept of catchments are, followed by individual catchment targets and project responses.

'Welcome' statement:

Grain & Graze is an exciting new research program which is working with farmer and catchment groups in Australia's wheat-sheep zone to improve on-farm profitability and productivity while also achieving local catchment management targets.

The catchment theme is repeated in the mission and objectives for Grain & Graze, as follows.

#### **Our mission**

*To provide mixed farming enterprises in southern Australia with new "whole-farm" knowledge, tools and capability to adopt management changes that will increase production of crops, pastures and animals while maintaining or enhancing biodiversity and the catchment resources which sustain them.*

#### **Objectives**

*Grain & Graze has three key objectives. These are:*

- *More profit for mixed farmers (especially from the pasture phase of rotations)*
- *Better water quality (eg reduced recharge via incorporation of deep-rooted pastures)*
- *Enhanced condition and diversity of plants and wildlife (on farms and across catchments).*

Catchment biodiversity targets identified in the original Grain & Graze proposals

#### Avon region

### *Biodiversity targets*

**Ecological Communities – increase in the extent, condition and security of Threatened Ecological Communities (TEC's) revise RCT**

*At least five priority key remnant habitats of threatened ecological communities to be protected and enhanced annually, according to guidelines developed*

**Landscapes – Special values, including ‘endemism’ and ‘areas of species richness’ are identified and conserved**

Management plan for 5 new selected priority landscapes as determined under Recovery Catchments developed and implementation commenced within 2 years

### Border Rivers region

**Relevant aspirational targets and related resource condition targets (RCTs) in the regional NRM Plan**

- Retain, regenerate or establish native vegetation in the regions by 2035.
  - 30% minimum native remnant vegetation coverage to maintain ecological processes and ecosystem linkages at bio-regional and priority sub-catchment scales by 2020.
  - No net loss of remnant vegetation coverage in mapped bioregional corridors of state significance as identified by Environment Protection Agency Bioregional Planning Assessments by 2010
- Conserve and enhance ecologically viable areas of the regions by 2035.
  - By 2010 the extent of “Endangered” regional ecosystems in subregions with less than 30% remnant vegetation will be increased to 110% of the 2001 mapped extent.
- By 2020 the extent of “Of Concern” regional ecosystems in subregions with less than 50% remnant vegetation will be increased to 110% of the 2001 mapped extent
- Conserve and enhance biological diversity by 2030
- By 2010, areas of identified high nature conservation significance are maintained in current condition and improved against Common Nature Conservation Classification System 03/04 survey benchmarks.

### Lachlan/Central West NSW region

Output 4 focuses on understanding the distribution of (native) biodiversity components across landscapes and the opportunities for improved biodiversity conservation through landscape design of mixed farming systems. Landscape modelling will be used in the Little River Catchment east of the Newell Highway and a counterpart catchment in the west of the project area to assess landscape re-design in mixed farming systems. The biodiversity status of remnant vegetation on case study farms will be assessed using measures that relate to:

- National and state scales (threatened ecological communities, threatened species, statewide conservation priorities).
- Regional/catchment scale (against regional vegetation targets, priorities for reducing fragmentation at regional scale).

- Landscape scale (degree of fragmentation around site, connectivity, total remnant size, edge to cleared land, whether incorporates riparian zone).
- Patch scale - (native plant species richness, vegetation structure, mature trees/hollows, logs, recruitment, exotic plant cover, bare ground)
- Area of site being assessed.

Landscape modelling will be used to investigate how elements of biodiversity (species, communities, condition, ecological function) are distributed across landscapes in relation to land use and other factors, and to identify how these elements can be enhanced by land use change. These studies will be conducted initially in the Little River catchment in the east of the project area, for which relevant and comprehensive data sets are already available.

These studies will involve:

- ▶ Development of current (native) biodiversity layers in a GIS, using a range of inputs including vegetation plot data, modelled vegetation data, remotely sensed condition data, and data on configuration of vegetation. (These layers are already available for the Little River sub-catchment which is the initial study area).
- ▶ Using these data sets along with cadastral, landuse, and soil capability layers to determine relationships between the status of biodiversity at property and sub-catchment scales and farm characteristics such as property size, type of farming and grazing systems, and other landscape attributes.
- ▶ Assessing the likely regional outcomes for conservation of biodiversity from actions at the property scale. These assessments will include: (i) predicting change in status of biodiversity at the sub-catchment scale under different landuse change scenarios; and (ii) assessing how to achieve the best regional outcomes for biodiversity from actions at property scales.

### Corangamite region

#### **Biodiversity targets**

- By 2007, **protect 2,500 ha of high priority EVC remnant vegetation on private land** (to a standard that can be accounted for within the Regional CAR system). (CCMA RMA 81)?
- By 2007, **improve the capacity of land managers** to be able to meet regional BMP's for native vegetation management and revegetation (CCMA, RMA 86).
- Build **capacity and knowledge of industry**..... to plan and protect biodiversity, particularly threatened species and critical habitat (GHCMA, RMA 39).

**Grain & Graze outputs** will contribute to:

- Achieving protection of the high priority remnant vegetation on private land, mainly through improved native grass protection.
- Contribute to land managers increasing the area of native vegetation on their farms, through the enhancement and establishment of vegetation habitat for pest predators.

### *Eyre Peninsula region*

The Eyre Peninsula Natural Resource Management Group (EPNRMG) have released a third draft regional integrated NRM plan and investment strategy that is shortly to be finalised and endorsed by the Commonwealth. The plan highlights the following areas as priorities across the region but has yet to set specific targets. The priorities for the region, as they relate to dryland agriculture are as follows:

- Unsustainable water extraction and use
- Pest plant and animals
- Deteriorating water quality
- Soil health decline and erosion
- Wetland degradation
- Loss of flora and fauna habitat
- Dryland salinity

Furthermore, the Eyre Peninsula Catchment Water Management Board (EPCWMB) has highlighted the following as their interim priorities across the region. It should be noted that these priorities differ between catchments and sub catchments and are variable according to hydrological features. Targets for the region have yet to be established.

- Integrating Water Resource Management
- Protecting the Water Quality
- Dryland Salinity
- Conservation Cropping
- Pasture Management
- Efficient Irrigation Practices
- Managing Ecosystem and Biodiversity
- Community Awareness and Involvement

### Mallee region

The Mallee region incorporates three states and illustrates the different approaches taken to target setting across different regions.

#### **NSW Targets**

- Retain a minimum of 80% of the pre-clearing extent of each vegetation community in the Lower Murray Darling catchment. (LMDCB)
- Increase by 171,000 ha, the area of permanent conservation reserves in the catchment by 2012. This target will contribute towards achieving the permanent reservation of 20% of each vegetation community (pre-clearing extent) by 2052. (LMDCB).

#### **SA Targets**

- Recover 30 % of quality native vegetation, habitat and agricultural production areas from pest infestation and minimize any further infestations by 2020.
- To maintain, increase and improve the condition and connectedness of indigenous terrestrial vegetation at the landscape scale in high value conservation sites to 30% by 2020.

## **Victorian Targets**

- See a net gain in the extent and condition of native vegetation on private land (Mallee Region Catchment Strategy).
- Establish market-based incentives to maintain and rehabilitate biodiversity on private land (MRCS).
- A yet to be determined percentage of native vegetation on private land covered by cooperative management agreements (MRCS).
- Strategies developed to allow the movement of farm machinery while protecting biodiversity on priority road reserves (MRCS).
- A yet to be determined number of ha of private land restored to native vegetation as habitat for native species in priority areas (as determined in Biodiversity Action Plans).

## Murrumbidgee region

The long-term goal for the Murrumbidgee project is to have producers in the mixed farming zone of the Murrumbidgee catchment in a position, both economically and philosophically, to address the goals of the Murrumbidgee Catchment Management Board. By providing farmers with the capacity to release non-arable areas of land from production, the catchment targets in relation to sustainability and biodiversity will be achieved. The project is committed to natural resource management, and this will be promoted via all education and extension activities.

## Northern Agricultural region (WA)

### **Catchment Level Targets**

The Northern Agricultural Catchments Council targets were still in development at the time of writing the proposal and therefore yet to be accredited by the Commonwealth. The most relevant (draft) objective for biodiversity was to protect biodiversity values at risk from rising ground water, waterlogging and salinity.