final report

Project code: **B.ERM.0102**

Prepared by: **Paul Ryan**

Interface NRM

Date published: **March 2010**

ISBN: **9781741913682**

PUBLISHED BY
Meat & Livestock Australia Limited
Locked Bag 991
NORTH SYDNEY NSW 2059

Biodiversity in the Landscape

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

Abstract

Approaches to managing grazing systems that incorporate natural resource management issues, including biodiversity, are urgently required. The integration of biodiversity information into a suite of past and present research projects and agency programs was assessed using interviews with production and biodiversity researchers, an online survey and literature reviews. The research projects and agency programs have a range of objectives ranging from minor integration of biodiversity with production through to full integrated approaches. Results suggest the degree of integration of biodiversity information into the projects examined is influenced by a range of factors including: personal constructs, project funding and objectives and origin and institutional factors. Strategies and specific methods, models and tools used to integrate were identified, but these were mostly context or project specific with limited general application. A range of strategies relating to funding and bridging activities are suggested to improve the integration of production and biodiversity research and extension in the future.

Executive summary

Calls to improve the profitability and sustainability of production systems are likely to increase under climate change. A key challenge for the sustainability of grazing industries is their capacity to deliver a range of natural resource management benefits, including biodiversity, while remaining profitable.

Biodiversity in the Landscape is a scoping project to document current approaches and explore new strategies for integrating production and biodiversity in perennial pasture systems through research and extension processes. The project focused on production grazing systems research undertaken within the eastern states Proof Sites of the Evergraze project. Additionally, other research and extension activities addressing integration of production and biodiversity in south-eastern perennial grazing systems were examined. The project objectives were to:

1. Analyse the degree to which biodiversity knowledge is currently integrated into production research and extension, and the strategies used.
2. Evaluate new strategies through which integration could be significantly improved, including the ecosystem benefits (now termed System Benefits) concept currently under development within the FFI CRC.
3. Identify information and research needs required to implement the most useful strategies arising from (2).

Data collection consisted of semi-structured interviews, an online survey, review of project reports, communication products and extension material and a review of wider literature relevant to integration.

In total 20 research and extension staff from state agencies, catchment management authorities and R&D organisations were interviewed, with a further 13 people responding to the email survey, a response rate approximately 50% of that expected. Respondents used their experience from current and past projects and more generally from their previous experience as the basis for responses.

Results suggest there is currently limited integration of biodiversity knowledge into some of the Evergraze projects examined. This is not surprising as the objectives for these particular projects relate primarily to productivity and reductions in leakage of water through increased perenniality which may include exotic species, with biodiversity outcomes being a minor component. The interviews revealed, however, a range of factors influencing the potential for integration between production and biodiversity in the research and extension phase. Even where objectives are focused on integration, the degree of integration is often limited. These factors include personal constructs, funding, organisational/institutional factors, project factors, mismatch of objectives and scales, skills/resources required, terminology and perceptions, and lack of evaluation tools or criteria for integrated research. Common strategies for integration were identified These included problem framing, research design and planning, analysis, and communication and extension. Similarly various methods, models or tools used by research and extension staff to develop integrated projects were also identified. Apart from cost benefit analysis, however, most of these were context or project specific.

Awareness of traditional ecosystem services approaches among researchers and extension staff was often limited to higher level concepts rather than detailed practical understanding. Many respondents identified limitations or concerns about using an ecosystem services approach, suggesting that as it currently stands, there is limited scope for using the traditional approach as an integration tool.

The ‘System Benefits’ approach currently being developed by the FFI CRC, which is a major advancement on the traditional ecosystem services concept, has potential to improve the outcomes of integrated research by supporting development of integrated funding programs, improving understanding and communication between funders, researchers and their stakeholders, planning, analysing and evaluating research and communicating research findings. For this to be achieved however, a major communication effort is required to articulate and differentiate the System Benefits approach from ‘traditional’ ecosystem services and overcome some of the negative perceptions about this traditional approach. Further development of the System Benefits approach is addressing some of the issues identified through this project.

Production and biodiversity researchers (and extension staff) differ greatly in the way they conceptualise the systems they operate in. Many of the issues identified by this scoping study stem from deeply held personal constructs and entrenched cultural and institutional factors. Differences in understanding extend to: differences in how systems are organised and function, awareness of key theories and concepts that underpin the different disciplines, language and terminology. The two groups appear to operate for the most part in relative isolation from each other. The result is policy and extension messages that align strongly with either production or biodiversity (or natural resource management) and that often contradict each other.

Strategies to address this schism are urgently required. The lack of integrated research including biodiversity has the potential to hamper the meat and livestock industries capacity to deal with future profitability and sustainability challenges. The results of this study suggest there is unlikely to be significant change in this situation without specific activity and investment to generate more integrated research and extension.

Specific evaluation criteria for integrated research that includes biodiversity should be considered. Traditional evaluation criteria such as adoption rates may be poor indicators of the success of research with high public benefits.

Two key areas for investment and further activities were identified. Innovative funding arrangements and specific integrated objectives at the project level are the most direct mechanisms to drive integrated research in the short term. In the longer term, however, a more productive approach will be to invest in ‘bridging activities’ that build the capacity of researchers and institutions to undertake integrated research.

Contents

1 Background

Land managers, rural industries and governments are all confronted by farm profitability and land degradation issues. These result from complex interactions between social, economic and ecological factors and as such, they require integrated solutions. Single-focused solutions have been applied in the past and these typically fail to address complex problems and may result in perverse outcomes. Complex drivers are creating demand for integrated information to underpin decision-making and allow managers to evaluate options for land use and practices that deliver multiple outcomes.

With limited resources available for research and development, one approach to generate this information is to integrate economic and environmental objectives into single research projects. This approach is taken in the EverGraze project of the Future Farm Industries Cooperative Research Centre (FFI CRC). In this case, the aim is to meet the challenge of producing integrated information that addresses profitability of grazing enterprises and a suite of natural resource management problems.

Biodiversity in the Landscape is a scoping project to document current approaches and explore new strategies for integrating production and biodiversity in perennial pasture systems through the research and extension process. This work focused on research undertaken within the production grazing systems of the Evergraze project. Only eastern states Proof Sites are addressed here. Additionally, other research and extension activities addressing integration of production and biodiversity in south eastern perennial grazing systems were examined.

2 Project objectives

With particular reference to production grazing systems incorporating native species, the project objectives were to:

- Analyse the degree to which biodiversity knowledge is currently integrated into production research and extension, and the strategies used.
- Evaluate new strategies through which integration could be significantly improved, including the ecosystem benefits (now termed system benefits) concept currently under development within the FFI CRC.
- Identify information and research needs required to implement the most useful strategies arising from (2).

It should be stressed that the intent of this scoping project was not to assess or evaluate how well or otherwise these projects address biodiversity issues. The projects examined were developed to meet a wide range of objectives of which biodiversity (or other natural resource management issues) is just one, sometimes minor, objective. Rather, the intent was to understand how these current projects approach integration, what factors contribute or hinder integration and in doing so develop strategies for improving integration in the future.

3 Methodology

3.1 Project methodology

Data collection consisted of semi-structured interviews; an online survey; review of published reports, communication products and extension material and a review of wider literature relevant to integration.

3.1.1 Interviews

Semi-structured interviews were conducted in person or over the phone with twenty individuals from a range of research organisations and agencies including the FFI CRC Evergraze project, CSIRO, various state primary industry and environment departments, Universities, and catchment management authorities (Appendix 1). Interview questions were formulated from the review of literature and drawing on advice from experts about the format and content of semi-structured interview questions. The resultant survey (Appendix 2) was trialled with appropriate colleagues (results discarded) and revised before the formal interview process commenced. Each interview took between one to two hours to complete. Key points were documented and each interview was taped on a digital recorder (with consent and assurance regarding privacy) for later review.

Respondents were not asked specifically about the systems benefits approach currently being developed by FFI CRC, but rather about the broader concept of ecosystem services. This was because the system benefits approach was still under development and providing an explanation or background about a new approach would take considerable time. Therefore, it was felt that asking about the broader traditional approach to ecosystem services[1] would provide insights against which the potential system benefits approach could be judged.

3.1.2 Online survey

An online survey (Appendix 3) was developed to complement and expand on the interview process. Questions were drawn from responses from the first 10 interviews, by which stage response categories were becoming evident. The online survey and background project information were circulated via email to individuals known to be connected to large networks in research organisations, state agencies and catchment management authorities. They were asked to complete the survey and forward the survey link onto their network. A reminder email was sent two weeks later.

3.1.3 Literature review

Reports and specific 'grey' literature such as communication, extension material and newsletters were reviewed (Appendix 4) to determine how production and biodiversity issues are presented and communicated. A broader review of literature relating to integration research was also conducted. Specific literature mentioned by interviewees was also examined and key publications are listed in section eight.

[1] Such services are defined in the Millennium Ecosystem Assessment (2005 page 1) as "the benefits people obtain from ecosystems." These benefits include food, water, timber, leisure, spiritual benefits, etc.

3.1.4 Analysis

A modified Grounded Theory approach was used to analyse the data. It is an inductive method, in that information from a variety of sources (in this case interviews, online surveys and project literature) are 'coded' and codes are then grouped into 'categories' from which themes or underlying trends can be identified (Ward 1993, Pandit 1996).

A subset of the interview questions were designed to elicit discussion regarding the interviewee's personal constructs about how production and natural resource management (including biodiversity) issues interact in the landscape. Personal constructs are built from personal values and beliefs, and the observations and experiences of individuals. As such, they provide a deep insight into the motivations behind behaviour. Although results from this approach are not conclusive, they provide insight and context for the underlying paradigm on which the interviewee's responses to other questions were founded.

The response rate to the online survey was low (13 individuals). Given the low response rate, the results of the online survey are not presented in detail, although consistent messages and key findings are incorporated into the discussion. The online survey results are summarised in Appendix 5.

3.1.5 Limitations and terminology

The project was a preliminary investigation to understand the current approaches to integrating production and biodiversity. It is acknowledged that many of the researchers and extension staff interviewed are participating in existing projects that may *or may not* have integration of production and biodiversity as an objective. In particular, Evergraze projects have a specific overarching goal to improve production and reduce water leakage at the farm scale, while only some projects have specific objectives relating to biodiversity and native plant species. The intent of the project is to understand approaches to integrating multiple outcomes into research and extension and learn from these for future application.

For the purposes of this scoping project we define the term biodiversity as to be native species (and their genes), the ecosystems they form and the processes that sustain these ecosystems. It is important to acknowledge that many people interviewed for this scoping project have or may have different interpretations or definitions of biodiversity. In particular, the term 'biodiversity' can be defined to include all biota, both native and culturally derived (eg domestic crops and stock). Where used in this sense below, this is explicitly stated. Differences in its use underline how important it is to define the term at the outset of projects and in publications to ensure that there is no uncertainty as to the meaning intended.

The sample size for interviews was limited to 20 individuals. The response to the online survey was approximately half of what was expected. Future research into this issue should consider including researchers from other natural resource management fields, including social and economic research (only one researcher interviewed in this scoping project was an economist).

4 Results and discussion

4.1 Results

4.1.1 Strategies currently used for integration

Four key strategies for integration were evident from the responses:

1. Problem framing – integration was based on 'big picture' conceptual thinking about the conflicts and synergies between production outcomes and NRM and biodiversity outcomes. Hypotheses or research questions were based on system wide issues and/or consideration of multiple scales. There was often evidence of a pathway of past projects or activities through which the researchers had gained experience and understanding of the issues, the systems they were researching and how best to undertake the research. This approach was more evident in projects with a strong biodiversity element.

2. Research design and planning – this is a 'technical' approach to integration, and was implemented by adding additional research activities (some researchers described 'bolting on' other objectives) to existing research or approaches. These projects were often a minor evolution of previous projects and some researchers openly discussed the pragmatic need to recast existing research to meet new funding opportunities. In most cases this had occurred without substantially modifying the overarching conceptual framework.

3. Analysis – these projects rely on *post hoc* 'regression' type analysis to examine the interaction between different variables that contribute to production and biodiversity (or NRM outcomes) without necessarily framing the problem or designing the research as integrated research *a priori*. For example, a project may measure a range of production variables (eg live weight, fleece weight, pasture utilisation rates, fertiliser inputs) and range of biophysical variables (ground cover, species diversity and abundance, soil attributes, leakage) and the data are analysed to explore the relationship between these variables without testing specific questions or hypotheses formulated before the research commenced. Some researchers expressed the challenge this approach presented as teasing out and understanding the drivers of change or responses. This can be difficult, as also can the translation of these results to different landscapes or production systems.

4. Communication and extension – respondents using this strategy frequently mentioned that land managers already integrate large amounts of information to make management decisions that best suit them, so rather than presenting pre-packaged information about integration issues, research outputs and messages are presented as a range of options that highlight the benefits, synergies and conflicts between possible actions and the land managers select and integrate the information relevant to them.

Observations about these strategies
While it is impossible to undertake integrated research without incorporating all these strategies to some degree, it was usually evident for each project that one of the four strategies outlined above was the predominant approach to exploring integration of production and NRM and/or biodiversity issues. This may be related to the origin of the projects (ie continuation of existing Evergraze projects may use strategies 2, 3, and 4 rather than redesigning the whole project implied in 1) or the experience or career stage of the researcher.

Strategies 3 and 4 also appear more opportunistic and adaptable, respondents using these approaches discussed being able to change direction or explore interesting results in more detail.

Some respondents identified the risks and challenge with Strategy 3 in that relying on analysis to integrate information is very challenging.

> "there is also the difficulty quite often you might have this idea conceptually about how you are going to integrate it and then the reality is when you get down to it, it's much much harder to do than what you thought, in terms of integrating the data." – researcher.

How do these strategies affect the degree to which biodiversity is integrated?
The strategies outlined above heavily influence the degree to which production and biodiversity are integrated in research and extension. All respondents recognised the need for integration to occur at all stages from research design through to extension and adoption, however a range of factors (eg funding, time frames, organisational factors) were identified that often prevent this. There also appears to be a lack of conceptual frameworks or tools to assist researchers to plan and implement integrated projects. Further, as some Evergraze projects examined were extensions of previous projects, there was obviously limited scope for those projects to be redesigned (ie Strategy 1 and 2 above) so some of these projects are relying on Strategies 3 and 4 to achieve some level of integration of biodiversity outcomes, while still achieving the higher level objectives for the Evergraze project.

Clearly projects that commence with well developed problem framing and questions, and then develop research designs to test these, are more likely to address integration objectives. However, it was clear that most projects had a large element of adaptation and modification as they evolved. This may reflect the challenging and uncertain nature of integrated research, which places a lot of emphasis on personal and organisational factors to cope with and manage the uncertainty of this type of research.

> "it was a process that evolved over time, although we did have a pretty clear idea of what we wanted to do from the beginning…….a lot of it got nutted out at the beginning, but then a lot of it evolved as we went because things came up….we were all learning….a lot of things come up that we never would have expected." – researcher.

4.1.2 Factors that influence the degree to which biodiversity is integrated into production research

There are a range of other factors determining the degree to which biodiversity knowledge is incorporated into production research and extension. These factors can be summarised as follows:

Personal factors
There were marked differences in the personal constructs of production and biodiversity researchers. These personal constructs could be described as:

- Production-focused – whereby research and extension are aimed at identifying the optimal or most efficient use of available resources to maximise production at the farm or smaller scales, while minimising other impacts.
- Biodiversity-focused – research and extension are aimed at understanding the patterns and processes that drive the distribution of species across the landscape and managing the interactions and trade offs between production and various other land uses to achieve biodiversity persistence.

Extension and agency staff from regional organisations tended to align to these constructs so there were clear divisions from research through to the extension phase in how individuals

perceived problems and solutions to the challenge of integration. Other factors such as the organisational context or funding appear to have a secondary influence.

There were also a range of personal motivating factors cited by researchers and extension staff for engaging in more integrated projects. These included learning new skills, tackling new challenges and developing close connection with and respect for land managers.

Funding
Availability of funding and the objectives attached to funding opportunities were the overwhelming factor mentioned by researchers for undertaking integrated research. This suggests that in the short term, funding and the associated objectives are the most influential 'lever' for driving integrated research.

Organisational/institutional factors
After funding, organisational/institutional factors (including support, culture, mission, structure, institutional and collaborative arrangements) of the organisation in which the respondent worked were the next most important factors mentioned. No specific organisational or institutional arrangements were identified as being better than another model, however, it's clear that important factors are:

- internal support from the organisation
- support from immediate colleagues
- access to resources and skills at an organisational level

Researchers mentioned the importance of organisational and collegial support or hindrance when trying to design or undertake integrated research.

> "we are a long way from the production focused people (research group) and closer to (another research group)…….so being lumped in with them is actually quite good because they are quite comfortable with the concepts and terminology." – researcher.

> "we're still in silos we are all still pulling against each other, within our organisation and between organisations." – agency person.

There were clear differences in the experiences between researchers and extension staff from different States suggesting that the specific institutional arrangements, culture, and history of the way agencies interact may be important. For example, some researchers and agency staff in Victoria discussed how changes to organisational structure (eg amalgamation, then later separation of production and land management agencies) had impacted on their capacity to undertake integrated work. Integration was more difficult following separation of the agencies.

Many respondents identified organisational and team leadership or internal advocacy to higher levels in the organisation as being critical to success.

> "it comes from the Board, a few thinkers on the Board, they drive it all." – agency person.

Specific project factors
Many respondents identified the immediate context of the project, including other staff or research team members and case study farmers as being personally important.

> "you get a lot of personal satisfaction from the interactions with people, a lot of the motivation to do integrated work comes from the farming families that you work with." – researcher.

> "even though we came at it from very different perspectives, we had a lot of respect for each other's knowledge, we used to challenge each other a lot and we had more than a few arguments and disagreements, but it was really great working as a team and we learnt a lot from each other." – researcher.

Some respondents discussed the need to have the right combinations of personalities for a project to be successful.

> "I mean you can't really say it, but you almost need to socially engineer your research team if you are going to engage the different disciplines, but it usually doesn't happen that way." – agency person

Most researchers and extension staff working in projects with a steering committee or reference group commented on how important these structures were in shaping their research, challenging the thinking or assumptions that researchers used, and guiding the development of key messages and communication material. This highlights the importance of careful selection and diversity of membership of these committees/groups and the role they could play in improving integration through diverse membership.

Mismatch of objectives at different scales

The farm, either physically or as a business unit, is the key scale around which production researchers and extension staff structure much of their thinking when discussing results, adoption and/or evaluation. At this scale, research questions or extension material focus on objectives about the best options to maximise output or efficient resource use for a given set of inputs and management practices.

In contrast, biodiversity researchers and extension staff refer to landscapes, tenures and land uses and the differences and trade offs between these as being important. This stems primarily from the fact that ecological processes (and many natural resource management issues) that drive patterns of biodiversity typically operate over larger scales. Research questions and extension messages are frequently focused on objectives about understanding the difference between the biodiversity values of different land units under different management regimes and their spatial arrangement.

> "we keep coming up against this fundamental trade off between production and conservation where by a happy outcome is always a compromise for conservation and production, the group think is that we should have a win-win all the time, I think that has been really difficult for industry to come to terms with." – researcher.

Competing or conflicting government policy within or between organisations was mentioned by a number of interviewees as influencing how they approached issues of integration, either in research or extension. The complexity of information and competing messages produced by the range of agencies was identified as a barrier to integration and contributing to negative perceptions held by researchers, extension staff and land managers alike.

> "I often get asked [by other agencies] to make it simple and don't make it complex and I struggle with talking about a system that is innately complex and how you simplify that down to one or two sentences or whatever they want." – agency person.

> "some of the things they are out there promoting or funding, it's a disgrace….I refuse to have anything to do with them." – researcher.

Mismatch of scales of inquiry or analysis
Related to the mismatch of objectives is the mismatch of scales of inquiry. The scale at which production research is most often undertaken (paddocks to farm) is in contrast to the scale at which much biodiversity research is undertaken (from patches to landscape). Biodiversity research is also often specifically interested in issues across scales (eg 'nestedness' of occurrence of species).

Scaling up results from a plot or paddock scale experiment to the landscape scale is not always feasible or necessarily valid so results from research undertaken at a different scale frequently has a limited 'domain of application' and makes comparison of results difficult. Matching scales, controlling for variation in landscape factors and management represent major challenges for research design and in some instances increase the resources required.

Given these underlying differences, clear communication and clarification of terminology about objectives, scale and context are essential if integrated projects are to be developed.

Skills/resources required
Many researchers commented on the lack of skills, students or resources required to undertake specialist research as major barriers to undertaking more integrated work. Some respondents suggested training in multidisciplinary approaches to production and biodiversity management should be included in natural resource management courses.

Terminology and perceptions
Terms such as 'ecosystem services', 'biodiversity' and 'nature conservation' were considered by many production researchers and extension staff to be viewed negatively by land managers and hence there is some reluctance to use that terminology in both the research and communication phase.

> "biodiversity is a dirty word." – production researcher.

> "I think (the term) biodiversity is much more commonly used than understood." – agency person.

Other respondents discussed the confusion the term biodiversity generates.

> "whenever the term biodiversity comes up, people have different inbuilt meanings of what it's talking about." – researcher.

> "people thinking that they have done it anyway or included biodiversity and it might just be because there is perennials, it might just be that there are perennial pastures there and there are a few different species there, so that's it, tick it off.' – agency person

Researchers and extension staff also talked about the pressure for projects to be successful in terms of adoption (ie one of the key criteria frequently mentioned for 'successful' projects is adoption or uptake of research findings). Given the perceived negativity of land managers towards biodiversity issues, some researchers and extension staff commented on the need to 'dress up' or 'disguise' biodiversity messages in more production-orientated language. Few respondents discussed the need to challenge the negative perceptions of land managers but those that did suggested that negative perceptions stem from confusion over terminology, etc. rather than negative perceptions about the issues *per se*.

> "so once you get past that, they (land managers) realise you are actually talking about things they are concerned about as well so you quickly have some common ground that you both agree on." – agency person.

Lack of evaluation tools or criteria for integrated research
No specific criteria for evaluating the effectiveness of integration of production and biodiversity in research were identified by researchers or extension staff with the most common criteria cited being those used for traditional research, such as scientific publications and adoption of results.

Publication may not be a useful measure for evaluating integrated research. Traditionally, integrated research has been difficult to publish and some researchers commented on this as a disincentive. There are an increasing number of applied journals and publications that focus on integrated research so this barrier may be diminishing, although the quality (i.e. impact factor) of these journals will still influence researcher's perceptions about the value of integrated research from a career development perspective.

Using adoption rates as an evaluation criterion raises a critical issue about how integrated research is evaluated compared with straight production research. In many cases the NRM or biodiversity benefit is a public good benefit (ie accruing beyond the farm scale) in which case adoption is likely to be low unless the practice or technology is implemented via government programs using incentives.

Adoption, particularly the total numbers of land managers or area of adoption, may also be less important for integrated research findings if it relates to specific contexts (eg location in the landscape, within specific vegetation types). Although it is still feasible to have adoption targets for the context specific issues it means greater recognition from funders about that specific context and hence, likely adoption rates.

4.1.3 Methods, models or tools used to assist in the development of projects that integrate production and natural resource management issues (including biodiversity).

There were a range of methods, models and tools used by researchers and extension staff to aid in the development of integrated projects, including those addressing production and natural resource management issues. These include:

- principles or organising frameworks
- process models
- planning approaches
- GIS tools and information
- specific analysis techniques such as cost-benefit analysis
- evaluation and adoption information

The approaches to integration currently used by research and extension staff are specific to the context and problems being addressed. With the exception of cost-benefit analysis approaches there was no single method, model or tool highlighted that could be more generally applied.

4.2 Discussion

There is very limited integration of production and biodiversity knowledge into the range of projects examined in this scoping study. This is not surprising, particularly for the Evergraze projects undertaken by some researchers included in the interviews for this scoping project. The high level objective for Evergraze focuses on increases in productivity and minimisation of leakage to ground water through the increasing perenniality of pastures. This obviously narrows the scope biodiversity comprises in most projects to a limited suite of native species, primarily perennial native grasses. This 'functional' view of biodiversity (ie its role in performing certain functions such as water use and soil protection) was highly consistent within the production-focused research and extension staff. Some production-focused researchers also questioned current definitions of biodiversity as often being too narrowly focused on native species, suggesting instead that a more global definition of biodiversity that incorporates native and introduced species may be more appropriate when researching production and NRM outcomes.

This was in sharp contrast to the biodiversity-focused research and extension staff who had more developed constructs about biodiversity that included notions of how biodiversity is organised across the landscape and using concepts such as composition (ie the mix of different species) and structure (ie the diversity of life forms and connectivity) in addition to more developed understandings of function (eg dispersal, regeneration). This more developed construct is consistent with formal definitions of biodiversity. Research undertaken by biodiversity-focused researchers (ie in non Evergraze projects) typically had limited production elements included.

In research projects where biodiversity outcomes were a specific objective, the research was generally undertaken by people with specialist biodiversity knowledge suggesting that access to those skills internally or through partnerships may be an important factor in developing (or not) integrated projects. In the case of some Evergraze projects, because of differences in approaches to studying production and biodiversity (eg biodiversity is often studied across a range of scales) components of these projects were being effectively run as parallel sub-projects with results brought together in secondary analysis. This approach was highlighted by some Evergraze researchers as very challenging and some had previous experience using this approach where projects had failed to meet their objectives.

Few projects had well-developed frameworks to assess the role of native species in delivering production outcomes, with native species diversity and cover typically measured as an outcome (ie as response variables) to particular management inputs. While this is useful information, the focus on a small suite of native species that are reasonably tolerant of grazing and fertiliser inputs (and hence already common and widespread) means that many of the potential benefits and costs of biodiversity to production under different management systems and at different scales are being overlooked. This exacerbates one of the key issues consistently highlighted by many research and extension staff – the difficulty of articulating to land managers the benefits of biodiversity to production.

The issues encountered in this scoping study are not new or unexpected. There is an extensive literature documenting the failure of research to address complex problems that span different disciplines or domains. Improving return on investment in inter- or trans-disciplinary research is a major challenge for R&D funders worldwide. What is surprising, however, is the *degree* to which production and biodiversity researchers (and extension staff) differ in the way they conceptualise the systems they operate in (See Appendix 6 for a summary of the key differences).

Many of the issues identified by this scoping study stem from deeply held personal constructs and entrenched 'cultural' and institutional factors. Differences in understanding extend to how

production and biodiversity systems are organised and the key processes that support them, awareness about key theories and concepts that underpin the different fields, language and terminology, etc. Organisational and disciplinary cultures appear to reinforce these constructs. The two groups appear for the most part to operate in relative isolation from each other. The result is policy and extension messages that align strongly with either production or biodiversity (or natural resource management) and that often contradict the other. For example the role of fertilizer in increasing production from semi native pastures and simultaneous negative impacts on biodiversity is one issue where strongly held opposing views are creating tension and some confusion for agency extension staff.

Without active intervention from government agencies, funders and R&D organisations this situation will continue as the 'cultures' are perpetuated by self-selecting research teams and relatively closed communication within disciplines and organisational cultures. For example, many production researchers and extension staff interviewed have a strong perception that landholders are turned off by terms like 'biodiversity' or 'conservation' and that messages must be couched in production terms if they are to be received by land managers. Consequently, participatory approaches such as those used by Evergraze, where researchers talked openly about the pressure to have 'real time' research results that are rapidly adopted, could be reluctant to engage in integrated research with a strong biodiversity focus or communicate messages that highlight some of the negative trade offs between production and biodiversity. While this is understandable, it means that important opportunities to communicate integrated messages that include biodiversity may be missed or integrating organisations such as Catchment Management Authorities or landholders looking for biodiversity related information may not engage with outputs from such projects.

In contrast biodiversity researchers and extension staff appear to be less driven by stakeholder demand for information, they 'push' extension material rather than respond to 'pull' from stakeholders. Consequently, much of their extension material may not put issues in the right context, format or language that can be used by other researchers, agency staff or land managers and so adds little value towards bridging this gap. Examples given by respondents include biodiversity research that failed to include or explore the economic impacts of the recommendation to increase the cover of native vegetation:

> "they then recommended that land managers in the ….region adopt this recommendation without any recognition that if they did, every single land manager would go broke." – researcher.

4.2.1 Potential for the ecosystem services/benefits concept to improve integration

As the traditional ecosystem services concept is currently understood and communicated by research and extension staff there appears to be little scope for it to be used as a tool for integrating biodiversity and production in the short term. While almost all respondents were aware of the concept of ecosystem services many highlighted the fact that the concept appeared to have 'dropped of the radar' and had not been developed into a usable concepts or that the actual 'guts' of the concepts was vague.

Many production-focused researchers interpreted ecosystem services to be an extension of or part of a broader biodiversity conservation issue, and hence although land managers might understand the concept they might be reluctant to engage closely with it because of the perceived link with biodiversity conservation.

Biodiversity focused respondents often had a better understanding of the concept but were the most negative about its applicability to integration, some citing a lack of technical knowledge to

take the concept forward, others highlighting the lack of awareness or understanding in the community or lack of adequate institutional arrangements to implement the concept in an effective manner.

There is some interest in the concept as a communication tool, however, many respondents commented that it also implied that landholders would or should expect to be paid to deliver ecosystem services and so could have possible negative effects if those payments were not on offer.

Combined, the above perceptions about the 'traditional' ecosystem services concept means that considerable effort would be required to engage researchers and extension staff in the concept, deal with the concerns raised and communicate how the concept would add value to planning, implementing or communicating integrated research outputs to land managers and agency staff, with an uncertain outcome.

Using different terminology or classification systems or developing tools to assist researchers, agencies and land managers to implement the concept in more practical ways may provide a way forward. The System Benefit approach being developed by the FFI CRC has considerable potential to overcome many of the issues raised by respondents. The System Benefits approach provides a clearer definition and classification of benefits, an issue identified by many respondents as hampering development of the traditional ecosystem services concept. The System Benefits approach also allows the beneficiaries (and losers) from any change in land cover, such as those implied in some of the research examined during this scoping project, to be more readily identified.

The Mallee case study of the System Benefits concept (Wallace unpublished) demonstrates how the benefits and dis-benefits can be apportioned at different scales and in doing so could assist researchers and extension staff to target and communicate research outputs to relevant (beneficiary) audiences at different scales. It may also assist to address one of the major conceptual divides between production and biodiversity focused research, specifically the mis-match of focal scales of research in these different domains. It may also assist to tease out the difference between biodiversity conservation as an ethical objective (a strongly held value by many of the biodiversity researchers interviewed) and the role of biodiversity (using the term in its broadest sense of cultural and native biodiversity) more generally in delivery of a wider range of ecosystem services that may not be dependent on the presence of indigenous species.

Currently there are no evaluation criteria used by researchers and extension staff that relate specifically to integration of biodiversity with production outcomes. Cost benefit analysis was identified by some researchers as an integration tool they used although it was unclear how biodiversity (or in most cases specifically plant species) were included. The System Benefits concept has potential to provide a framework for evaluating different research outputs or helping agency staff and land managers to assess different options, but it will require a concerted communication effort to overcome the current negative perceptions about the traditional ecosystem services approach.

Some biodiversity researchers did identify the potential role of ecosystem services or benefits approaches in land use planning at local to regional scales and as a concept for engaging in policy debate.

4.2.2 Strategies and research needs to improve integration of production and biodiversity

Short-term strategies to improve integration (< 5 years) include:

New funding arrangements – the majority of researchers said that funding was a key driver for undertaking integrated research. Funding approaches to improve integration could include:

- developing programs with *specific integration objectives* as this is likely to be the most effective strategy to improve the return on investment in integrated research in the short term
- exploring alternative funding models (market based tender and/or performance based approaches) to drive improved return on R&D investment in integrated projects. For example funding could reward development of multi-disciplinary teams or integrated research outcomes over more traditional approaches
- funding for scholarships/PhD projects could specifically target integration skills and projects
- recognising the specific challenges of integrated research and structure funding programs accordingly – researchers interviewed for this project said integrated research took longer to plan, required specialist skills and was more resource intensive
- developing guidelines for membership of steering committees/reference groups that oversee integrated research to include integration specialists and encourage a diversity of perspectives
- developing evaluation criteria for integrated research projects that reflect the specific nature of the research

Bridging activities – the substantial gap between production and biodiversity researchers will not be bridged without deliberate investment. This investment could include:

- dedicated positions or projects to facilitate development of integration projects prior to funding calls
- training and information sessions regarding integration prior to funding calls
- production of communication material aimed at researchers and extension staff to highlight the specific challenges and solutions to undertaking integrated research
- development of a Community of Practice to connect or support researchers and extension staff working in this field
- engagement with state agencies and other institutions such as Catchment Management Authorities to provide leadership, encourage and support integrated research and extension activities
- engagement with relevant tertiary education providers to improve integration skills in graduate and post-graduate courses

An outline of the steps to undertaking an integrated project is provided at Appendix 7.

5 Success in achieving objectives

5.1 Objective 1

The scoping project achieved objective one and determined there was very limited incorporation of biodiversity knowledge into production research and extension. This was established through interviews with production and biodiversity research and extension staff, an online survey and a review of published and grey literature.

Factors that influence the degree to which biodiversity is integrated into production research were identified. In summary, these were: personal factors, funding, organisational/institutional factors, project factors, mismatch of objectives at different scales, mismatch of scales of inquiry, skills/resources required, terminology and perceptions, lack of evaluation tools or criteria for integrated research.

Four strategies for integration were identified by the researchers. These were evident at various project phases including problem framing, research design and planning, analysis, and communication and extension.

Various methods, models or tools used by research and extension staff to develop integrated projects were also identified. Apart from cost benefit analysis most of these methods, models or tools were context or project specific.

5.2 Objective 2

Objectives 2 and 3 were achieved with strategies to improve integration identified and evaluated to the extent possible within the scope of this project.

While the potential for the System Benefits concept and other strategies to improve integration were examined, the challenge of overcoming the cultural, conceptual and institutional barriers identified are considerable and are unlikely without deliberate intervention and investment.

6 Impact on the meat and livestock industry – now and in five years time

This scoping project has shown that biodiversity and production are generally not well integrated in current research projects. Whether integration of these two outcomes is an important issue for the meat and livestock industry depends on the response to two questions:

1. Does the industry view biodiversity as an outcome[2] that they wish to deliver; a means to industry profitability; or a constraint on activity to be overcome?
2. Looking forward, is the national and global environment changing in ways that requires a re-thinking of the response to (1) above?

Each of these questions is considered briefly below.

The level of research and extension integration required will be driven ultimately by the goal(s) of the meat and livestock industry with regard to biodiversity. If biodiversity is an outcome that the industry wishes to pursue in parallel with other system benefits such as food production, then it is critical that there is better integration of biodiversity and production research. Particular forms of research will also be important. For example, as outlined by Dorrough *et al.* 2008[3], if biodiversity is important, then it is essential to scale up site and paddock level information to landscape scales.

Alternatively, meat and livestock industries may only be interested in the beneficial impacts on production of native biodiversity, for example through pest control. Or biodiversity research may only be of interest to avoid socio-political constraints on activity. In each case, the need for integrated research will be different, and this emphasises the importance of clarifying goals.

Turning to the second question above, a number of changing circumstances have implications for the meat and livestock industry in the longer term. For example, there has been a dramatic shift in the way landscapes are viewed, from a relatively static view of landscapes as primarily 'farming' land to one of landscapes as dynamic multi-use systems that produce a range of goods and services whose values are determined by rural *and* non-rural communities (eg production, lifestyle, aesthetic, water catchment, habitat, fire risk, utilities, mining, etc). At the same time national and state practices and policies relating to emissions and carbon sequestration, drought and exceptional circumstances, water, biodiversity conservation and native vegetation are likely to come under increasing scrutiny. There are also new institutions and stakeholders in rural landscapes and substantial knowledge gaps about the combined economic, social and biophysical implications of these issues and how they will play out under a changing climate.

Consequently, how questions (1) and (2) above are answered by the meat and livestock industry will have important implications for future research, including the integration of biodiversity and production research. The barriers to undertaking integrated research, and hence developing integrated solutions, identified by this research will require deliberate intervention if they are to be overcome.

[2] Strictly speaking biodiversity is a measure – for example, number of species or other taxonomic group in a given area – not an outcome. There is a need for those working in the field to be more explicit about what specific outcome is intended by use of the term biodiversity.

[3] Most explicit in the final paragraph of their report on page 63, but also implicit in the first two conclusions on page 4. Where is this reference?

7 Conclusions and recommendations

7.1 Conclusions

- Results from interviews, an online survey and review of literature suggest there is limited integration of biodiversity information into the production research projects examined during this scoping study.

- A range of factors limiting integration between production and biodiversity research and extension were identified. These include: personal factors, funding, organisational/institutional factors, project factors, mismatches of objectives and scales, skills/resources required, terminology and perceptions, lack of evaluation tools or criteria for integrated research.

- Strategies currently used by research and extension staff to integrate production and biodiversity issues were identified. These were evident at various project phases including during problem framing, research design and planning, analysis, and communication and extension. Specific methods, models or tools used by research and extension staff to develop integrated projects were also identified. Apart from cost benefit analysis most of these were context or project specific.

- There is unlikely to be significant change in this situation without specific activity and investment to generate more integrated research and extension. The lack of integrated research has the potential to hamper the meat and livestock industries' capacity to deal with future profitability and sustainability challenges.

7.2 Recommendations

- The lack of integration of biodiversity information into production research should be recognised as a future risk for the meat and livestock industry.

- New funding approaches and institutional arrangements to drive integration in the shorter term should be further explored and trialled.

- Bridging activities that build capacity in integrative research and extension in the longer term should be further explored and trialled.

8 Bibliography

Abel N., Ross H., Herbert A., Manning M., Walker P. & Wheeler H. (1998) *Mental Models & Communication in Agriculture*. Rural Industries Research & Development Corporation, Canberra.

Day P. *et al.* (2008) *Managing Complex Systems: Preliminary Findings from Grain & Graze*. Land & Water Australia, Canberra.

Dorrough,J., McIntyre, S., Stol, J., Brown, G., and Barrett, G. 2008. ER.101 - Understanding the interactions between biodiversity and the management of native pastures in the Murray Darling Basin. Meat & Livestock Australia Limited, North Sydney.

Ferguson J. (2005) Bridging the gap between research and practice. *Bridging the gap between research and practice* **1**, 46-54, www.km4dev.org/journal.

Fischer A. & Young J.C. (2007) Understanding mental constructs of biodiversity: implications for biodiversity and conservation. *Biological Conservation* **136**, 271-282.

Haugaard Jakobsen C., Hels T. & McLaughlin W.J. (2004) Barriers and facilitators to integration among scientists in transdisciplinary landscape analyses: a cross-country comparison. *Forest Policy and Economics* **6**, 13-31.

Land & Water Australia (2004) *Integration Symposium Proceedings*. Land & Water Australia, Canberra.

Millennium Ecosystem Assessment (2005) Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute, Washington, DC.

Pandit, Naresh R. (1996) The creation of theory: a recent application of the grounded theory method. Qualitative Report, 2(4).

Pannell, D.J., Marshall G.R., Barr N., Curtis A., Vanclay F. & Wilkinson R. (2006) Understanding and promoting adoption of conservation practices by rural landholders. *Australian Journal of Experimental Agriculture* **46**, 1407-1424.

Perez Vazquez A. & Ruiz Rosado O. (2005) Interdisciplinary research: A SWOT analysis and its role in agricultural research in Mexico. *Tropical and Subtropical Agroecosystems* **5**, 91-99.

Scherr S.J. & McNeely J.A. (2008) Biodiversity conservation and agricultural sustainability: towards a new paradigm of 'ecoagriculture' landscapes. *Philosophical Transactions of the Royal Society* **363**, 477-494.

Vanclay F. (2004) Social principles for agricultural extension to assist in the promotion of natural resource management. *Australian Journal of Experimental Agriculture*, **44**, 213-222.

Ward, John (1993) How to research community issues: the grounded community development research method: a resource learning manual with case studies. Partnership Press and Deakin University, Victoria.

9 Appendices

9.1 Appendix 1 List of interviewees who completed semi-structured interviews

Category	Interviewee
Evergraze	Meredith Mitchell (DPI Vic) Angela Avery (DPI Vic) Steve Clark (DPI Vic) Warwick Badgery (DPI NSW) Jim Virgona (CSU) Kate Sergeant (DPI Vic) Lachlan Rowling (DPI NSW) Nick Reid (UNE)
State agencies, R&D corporations, other research institutions	Sue McIntyre (CSIRO) Jim Crosthwaite (DSE Vic) Josh Dorrough (previously DSE Vic) Cathy Waters (DPI NSW) Julian Seddon (DECC NSW) Kate Stothers (DPI Vic) Ian Packer (LCMA) Carla Miles (GBCMA) Tim Barlow (GBCMA) Nathan Heath (MCMA) Ian Lunt (CSU) Jann Williams (UTAS)

9.2 Appendix 2 Semi-structured interview questions Is there any analysis of this to be presented, or is it only as captured above?

Definitions and terminology

1. Is the integration of biodiversity and production an objective of your current (or past) work?

2. How do you define integration in this context?

3. For the purposes of your work, how do you define biodiversity?

4. What elements or levels of biodiversity are included in your work? (ie ecosystem, community, species, genetic).

Which of these levels of biodiversity are the main focus in your work? Why?

5. Does your work have implications for other natural resource management issues? Which issues?

6. At what spatial scales is your work applicable? (ie paddock, farm, landscape, region, national, etc).

Approach to integration

7. What methods (conceptual frameworks, approaches, tools) do you use to assist you to integrate biodiversity and production?

8. At what phase in the process - from research through to on-ground adoption (see table) - do you attempt to integrate biodiversity and production issues? How?

(ask about relevant phases)

Phase	Method of integration
Problem definition/ conceptualisation	
Literature/background info	
Research design	
Field site/study site selection	
Data collection	
Data analysis	
Key findings	
Communication	
Extension & adoption	
Program/Project design	
Monitoring and evaluation	

9. Do you think the ecosystem services concept is useful for integrating biodiversity and production? Why?

If useful or currently using - Which ecosystem service approaches or classifications are you aware of?

Drivers and operating environment

10. Where does the main motivation for integration in your work come from – funders, your agency/organisation, colleagues/discipline/field, stakeholders, general public?

11. Who do you think benefits from efforts to integrate biodiversity and production in the type of work you do? How do they benefit?

12. Do you think there are any negatives or drawbacks from integration of biodiversity and production issues?

13. What factors enable or support you to integrate biodiversity and production in your work?

14. What factors do you perceive as barriers to integration of biodiversity and production in your work?

15. How do you evaluate the success or otherwise of efforts to integrate biodiversity and production? What measures/indicators do you use?

Other projects/approaches

16. Are you aware of any other projects or approaches that have successfully integrated biodiversity and production issues?

10 Appendix 3 Online survey questions

Understanding current practice for integrating production and biodiversity in research and adoption

Thank you for taking part in this survey. The purpose of the survey is to improve understanding of how and why researchers, extension, agency and catchment management staff integrate production and biodiversity issues.

This survey is part of larger scoping project funded by the Future Farm Industries CRC with support from Meat and Livestock Australia examining approaches, barriers and opportunities for integrating production and biodiversity to improve on ground outcomes. The scoping project has a particular emphasis on perennial plant based grazing systems, however, experiences and approaches from people integrating production and biodiversity for other outcomes are extremely valuable to improve our understanding.

The survey consists of multiple choice questions and should take less than 10 minutes to complete.

For more information please contact:
Paul Ryan
Interface NRM
paulryan@internode.on.net

For more information about the Future Farm Industies CRC see www.futurefarmcrc.com.au

Important things you should know:
Your responses will be kept strictly confidential. Responses or comments collected during this survey will be aggregated for analysis and communication purposes. The privacy of individual respondents will be protected at all times. Results from the survey may be used in future publications.

1. **How would you best describe your current role?**
   Research and development
   Catchment/program manager
   Extension/catchment officer
   Communication/education officer
   Agribusiness adviser
   Land manager
   Other (please specify)

2. **Is integrating production and biodiversity information an objective of your work?**
   Yes
   No
   Unsure

3. **Does your work have implications for natural resource management issues other than biodiversity management?**
   Yes
   No
   Unsure

4. **If you answered yes to Q3 above, which of the following issues does your work include:**
   Water quality
   Water quantity
   Irrigated salinity
   Dryland salinity
   Soil management/health
   Erosion control
   Pest plants
   Pest animals
   Climate change
   Other (please specify)

5. **What levels of biodiversity are included in your work?**
   Genetic
   Species
   Community
   Ecosystem

6. **At what spatial scale is your work applicable?**
   Patch/site
   Paddock
   Farm
   Local landscape
   Region
   National

7. **Are there any particular approaches, tools, models or methods you use to integrate production and biodiversity information together?**
   Yes
   No
   Unsure

8. **If you answered yes to Q7 above, can you please name or describe the approach, tools, models or methods you use to integrate production and biodiversity information together?**

9. **At what stage(s) in the process from research through to on ground action do you think integration of production and biodiversity issues should occur?**
   Problem definition
   Literature review/background
   Research design
   Study site selection
   Data collection
   Data analysis
   Key findings
   Communication
   Extension activities
   Catchment program/project design
   Catchment program/project implementation
   Monitoring and evaluation
   All
   Other (please specify)

10. How familiar are you with the ecosystem services concept?
Unfamiliar
Somewhat familiar
Familiar
Very familiar
Unsure

11. Do you think the ecosystem services concept is a useful framework for integrating production and biodiversity information?
Yes
No
Unsure

12. What are the main drivers for the integration of production and biodiversity in the work that you do?
Funding arrangements
Organisational mission
Program/project goals and objectives
Colleagues
Stakeholders
General public
Personal beliefs/values
Other (please specify)

13. Who do you think benefits from efforts to integrate production and biodiversity?
Funders
Organisation/agency
Researchers
Program/project officers
Stakeholders
General public
Industry groups
Land managers
All
Other (please specify)

14. What factors enable or support you to integrate biodiversity and production in the type of work that you do?
Clear terminology or definitions
Good communication networks
Good linkages between researchers and end users of information
Availability of approaches, tools, methods
Low transaction costs
Sufficient funding
Aligned organisational/agency mission or goals
Good organisational structure
Complementary needs of stakeholders/clients
Other (please specify)

15. What factors are barriers to integrating biodiversity and production in the type of work that you do?
Unclear terminology or definitions
Poor communication networks

Poor linkages between researchers and end users of information
Lack of approaches, tools, methods
High transaction costs
Lack of funding
Conflicting organisational/agency mission or goals
Poor organisational structure
Competing needs of stakeholders/clients
Other (please specify)

16. Do you have any comments or suggestions about improving the integration of production and biodiversity information?

10.1 Appendix 4 List of reviewed grey literature

Dorrough J., Stol J and McIntyre S. (2008) Biodiversity in the paddock: a land managers guide. Future Farm Industries CRC.

Evergraze (2008) Hamilton proof site field day 16th May, 2008. Evergraze field day brochure.

Evergraze (undated) Evergraze - right plant, right place, right purpose. Evergraze brouchure.

Evergraze (undated) Evergraze background and contact information. Evergraze brochure.

Evergraze (undated) Grazing management systems explained. Ervergraze brochure.

Evergraze (undated) Indentifying native pastures of eastern Namoi. Evergraze brochure.

Evergraze (undated) Management of native pastures in Victoria. Evergraze brochure.

Evergraze (undated) Native pastures for sustainable agriculture. Evergraze brochure.

Evergraze (undated) South West Victoria – Corangamite and Glenelg Hopkins catchments. Evergraze brochure.

Moll K., Miles C., Dorrough J. & Crosthwaite J. (2007) Green Graze Pilot Program Final Report. Goulburn Broken Catchment Management Authority and Department of Sustainability and Environment, Victoria.

Schultz N.L., Reid N. & Lodge G.M. (2008) Studies of plant biodiversity on properties grazing sheep on the north–west slopes of New South Wales. Pages 135–136 in: Boschma, S.P., Serafin, L.M., Ayres, J.F. (eds) 'Proceedings of the 23rd Annual Conference of the Grassland Society of NSW (Grassland Society of NSW Inc: Orange)'.

10.2 Appendix 5 Summary of online survey

Only thirteen people participated in the online survey. Given the low response rate the results are summarised below but are not presented graphically.

1. **How would you best describe your current role?**
   Seven of the 13 survey respondents identified their current role as an extension/catchment officer. Four respondents selected the research and development role, and the land manager and catchment/program manager roles were selected once each.

2. **Is integrating production and biodiversity information an objective of your work?**
   Twelve of the thirteen respondents indicated that integrating production and biodiversity information is an objective of their work.

3. **Does your work have implications for natural resource management issues other than biodiversity management?**
   All respondents nominated 'yes' to this question.

3. **If you answered yes to Q3 above, which of the following issues does your work include:**
   Erosion control and pest plants were nominated by over 90% of participants. The next most common NRM issues were water quality and soil management/health and pest animals and climate change Water quantity and dryland salinity were each selected eight times and irrigated salinity was selected as an NRM issue encountered by three respondents. Only one participant nominated an additional unlisted issue, this was monitoring, evaluating and reporting, plus socio-economic and capacity issues.

5. **What levels of biodiversity are included in your work?**
   All 13 respondents nominated the ecosystem level, 11 selected community, nine species, and four the genetic level.

6. **At what spatial scale is your work applicable?**
   Region was the most selected spatial scale and was nominated by 12 participants. Patch/site, farm and local landscape were selected nine times each. Paddock was chosen nine times and five participants selected the national scale.

7. **Are there any particular approaches, tools, models or methods you use to integrate production and biodiversity information together?**
   Twelve respondents nominated yes to this question.

8. **If you answered yes to Q7 above, can you please name or describe the approach, tools, models or methods you use to integrate production and biodiversity information together?**
   Eleven people responded to this question. The approaches, tools, models or methods described were: INFFER, whole farm planning, landscape planning, native pasture systems, ecological grazing for weed control, AG MERI framework, NSW MER framework, ecosystem services, cost-benefit analyses, and multi-scale biodiversity assessment methods.

9. **At what stage(s) in the process from research through to on ground action do you think integration of production and biodiversity issues should occur?**
   Eleven of the 13 respondents selected 'all' stages although each item was also selected separately between five to seven times.

10. **How familiar are you with the ecosystem services concept?**
    Less than half (six) of the respondents said they were very familiar with the ecosystem services concept. Three were familiar with the concept; two somewhat familiar and two were unfamiliar.

11. Do you think the ecosystem services concept is a useful framework for integrating production and biodiversity information?

Nine respondents thought the ecosystem services concept was a useful framework for integration, two said it wasn't and two were unsure.

12. What are the main drivers for the integration of production and biodiversity in the work that you do?

Of the available options personal beliefs/values was the most selected by the survey participants (eight). Funding arrangements and stakeholders were each selected seven times, organisational mission and program/project goals and objectives were each selected six times. Colleagues and general public were selected less often; four and two times, respectively.

13. Who do you think benefits from efforts to integrate production and biodiversity?

'All' and 'land managers' were selected most often at eight times each. Stakeholders and the general public were both selected seven times; industry groups six times; funders and researchers five times and organisation/agency and program/project officers four times each.

14. What factors enable or support you to integrate biodiversity and production in the type of work that you do?

Complementary needs of stakeholders/clients were nominated by nine of the survey respondents.

Good communication networks, sufficient funding and aligned organisational/agency mission or goals were each selected eight times. Two items were selected seven times: good linkages between researchers and end users of information, and availability of approaches, tools, methods. Clear terminology or definitions and good organisational structure were selected four and three times, respectively. An additional factor was nominated by one participant: 'consistency of funding and approaches over long time periods'.

15. What factors are barriers to integrating biodiversity and production in the type of work that you do?

Poor linkages between researchers and end users of information and lack of funding were the barriers selected most often (nine times each). Other selected barriers were competing needs of stakeholders/clients (eight times); plus lack of approaches, tools, methods, and conflicting organisational/agency mission or goals (seven times each); unclear terminology or definitions, poor communication networks and high transaction costs (six times each). Poor organisational structure was selected twice. Two respondents offered other barriers; these were 'clear goals between producers and agency are not established', and 'lack of scientific research to prove the benefits and differing core values/beliefs for landholders'.

16. Do you have any comments or suggestions about improving the integration of production and biodiversity information?

Seven participants offered comments or suggestions. These were:

- 'There has to be strong financial or legal incentives before it will be successful because it is not in the interests of individual producers to compromise productivity by investing in biodiversity outcomes. That is, I do not believe there is strong evidence that farm-scale biodiversity conservation results in farm-scale production benefits.'
- 'Better conceptual framework needed including examples of integration'
- 'Improved cross disciplinary understanding or terminology and theory for both researchers and stakeholders'
- 'Greater emphasis and understanding of truly 'sustainable production'

- ‘Helping the "green end" (usually NRM biodiversity professionals) understand the practical realities arising from farm production economics better so that programs developed are more likely to fly’
- ‘More scientific research to prove or disprove the benefits to the landholder, and products to help educate extension officers and landholders’
- ‘Improved governance structures/arrangements at all levels/scales and stronger cooperative arrangements across government levels, research organisations, NGOs and agencies’
- ‘Biodiversity and production are presented as opposites, suggesting you can’t have both. Ecosystem Services approach allows them to be presented as complementary and on a spectrum. The culture of many state government agencies is the biggest barrier to incorporating better biodiversity management into production systems’
- ‘Solid science - that presents well and simply the cost benefits or ecosystem services of biodiversity in a production context’

10.3 Appendix 6 Summary of differences between how production and biodiversity researchers conceptualise the research problem.

	Production view	Ecosystem view
Important scales	Paddock to farm	Patch to landscape
Problem definition	Efficiency or optimisation to deliver maximum production while minimising off and on site impacts. System seen as robust to manipulation.	Comparison (trade offs) between different land uses in relation to their contribution to maximising biodiversity in the landscape. System seen as fragile to inappropriate disturbance.
Role of biodiversity in the system	Role in supporting production, often not restricted to native biodiversity (ie included exotic species). Often interested in common species.	Structural and compositional role of biodiversity in providing wide range of benefits. Restricted to native biodiversity, exotic species seen as highly negative in this context. Often interested in uncommon or rare species.
Role of livestock production in the system	Primary purpose of land use with natural resources and inputs managed to maximise output with minimal on or off site impacts.	One type of land use within a mosaic, often equated with ‘disturbance’ with positive or negative impacts on any particular unit of land depending on the goal, regime and site factors.
Role of management in the system	Tactical decisions to improve efficiency or optimise production outcomes.	Implemented to deliver a wide range of outcomes depending on management goal.
Communicating research	Presented as advice or guidelines to assist land managers and extension staff to determine the best course of action to achieve the production goal.	Presented as trade offs or negative/positive outcomes for biodiversity conservation arising from particular management regimes of which production may be one.
Key evaluation question for assessing success of research?	Has the research developed advice/options that land managers can use to make better decisions and improve management of their operation?	Has understanding of processes that drive patterns of species and vegetation communities across the landscape improved?

10.4 Appendix 7 Draft template for establishing a project integrating biodiversity and production outcomes

Funding body perspective

Step 1: Clarify project outcomes

- For the project, define what is meant by biodiversity. One definition is provided in the Glossary below.

- State specifically what element(s) of biodiversity are the focus of the project, including whether native or cultural, names of taxa, etc. Throughout the remainder of the statements below the term 'biodiversity' is referring to native biodiversity unless otherwise stated.

- Does the project group view biodiversity as an outcome[4] that they wish to deliver; a means to industry profitability; or a constraint on activity to be overcome?

Step 2: Write project objective(s)

- Based on the above, and assuming that the project is to deliver both a biodiversity ethic (see Glossary) and production outcome, clearly state the project objective(s).

- In line with standard definitions of an objective, it is useful to include the spatial scale over which the objective will apply, as well as the timescale.

- If integration is an objective, ensure that this is stated in the objective(s). Develop evaluation criteria for the integrated research component that reflect the specific nature of the research.

Step 3: Determine resource requirements

Funding

- Explore alternative funding models (market based tender and/or performance based approaches) to drive improved return on R&D investment in integrated projects. For example, funding could reward development of multi-disciplinary teams or integrated research outcomes over more traditional approaches.

- Consider funding scholarships/PhD projects that specifically target integration skills and projects.

- Recognise the specific challenges of integrated research and structure funding programs accordingly – integrated research takes longer to plan, requires specialist skills and is more resource intensive to implement.

Personnel (including steering committees)

[4] Strictly speaking biodiversity is a measure – for example, number of species or other taxonomic group in a given area – not an outcome. There is a need for those working in the field to be more explicit about what specific outcome is intended by use of the term biodiversity. The classification of system benefits under development by the FFI CRC will provide a mechanism for doing this. In this regard, the definition of biodiversity ethic in the glossary covers most views represented in the "conserve biodiversity for its own sake" group of views.

- Develop guidelines for membership of the steering committee/reference group that oversees the integrated research to include integration specialists, and encourage membership that provides a diversity of perspectives.

- Develop selection guidelines that ensure the project personnel will include a mix of mental models, conceptual frameworks and approaches conducive to a successful integrated project.

In addition, consider:

- Dedicated positions or projects to facilitate development of integration projects prior to funding calls.

- Training and information sessions regarding integration prior to funding calls.

- Production of communication material aimed at researchers and extension staff to highlight the specific challenges and solutions to undertaking integrated research.

- Development of a Community of Practice to connect or support researchers and extension staff working in this field.

- Engagement with state agencies and other institutions such as Catchment Management Authorities to provide leadership, encourage and support integrated research and extension activities.

- Engagement with relevant tertiary education providers to improve integration skills in graduate and post-graduate courses.

Step 4

Taking into consideration all the above, develop the request for quotation or other means required to advertise and contract the project.

Glossary

Term	Definition
Biodiversity	It is recommended that the following definition is adopted: The variety of life forms including the different plants, animals, fungi, microorganisms, etc. Use of the term is restricted to living things; therefore, the diversity of ecosystems is excluded in contrast to many current definitions. Biodiversity is generally separated into genetic, taxonomic (eg species and sub-species), community (or assemblage) and structural diversity (see Wallace 2007 for a more complete explanation, including further reading). This definition includes both natural (or native) biodiversity and cultural biodiversity (ie farm stock, domesticated cereal crops, domesticated pastures, cats, dogs, etc).
Biodiversity ethic	Many people consider that natural biodiversity should be conserved in its own right and/or that humans should not cause the extinctions of species. Such a position can be reached by various paths including: a. Religious beliefs; b. Philosophical beliefs c. A view that all natural life forms have intrinsic value quite separate from humans, and should be conserved in its own right. Items (a) and (b) above clearly belong in the spiritual/philosophical category; however, there is debate as to whether (c) is a belief and therefore part of the spiritual/philosophical category, or is a separate type of category. Here, these different views are captured as a biodiversity ethic. Note that measures for this need to be developed and more tightly linked to perennial systems and their extent. It will generally be some combination of: taxonomic composition and structure together with a measure of the probability of increased persistence of native biota. (Taken from draft documentation on the System Benefits approach under preparation by the Future Farm Industries Cooperative Research Centre.)

Reference

Wallace, K.J. (2007) Classification of ecosystem services: problems and solutions. *Biological Conservation* **139**:235-246.