GRAZIERS WITH BETTER PROFITABILITY, BIODIVERSITY AND WELLBEING

Exploring the potential for improving environmental, social and economic outcomes in agriculture

Abstract

There is significant potential to simultaneously increase environmental health and biodiversity in grassy woodlands biome and improve financial and wellbeing for graziers. However, traditional methods of landholder engagement and education on their own may be insufficient to realise the opportunity. We describe some areas where further investigation should be undertaken with a view to identifying policy directions.

Sue Ogilvy, Mark Gardner, Dr Thilak Mallawaarachchi, Dr Jacki Schirmer, Kimberly Brown, Dr Elizabeth Heagney.

Corresponding author: sueogilvy@gmail.com

Copyright

Enquiries

General enquiries about the project should be directed to the Project Lead: Sue Ogilvy via sueogilvy@gmail.com. Enquiries related to regenerative grazing practice should be directed to Mark Gardner of Vanguard Business Services via mark.gardner@vbs.net.au.

Purpose of report

The report: Graziers with better profitability, biodiversity and wellbeing is provided to parties interested parties in exploring the relative profitability of grazing entities that have either maintained or are regenerating significant ecological functions and biodiversity in the grassy woodland biome of Eastern Australia.

Citation

Please cite the report as: Ogilvy, S., Gardner, M., Mallawaarachichi, T., Schirmer, J., Brown, K., Heagney, E. (2018) Report: Graziers with better profitability, biodiversity and wellbeing. Canberra Australia

Additional material and resources

Project summaries and further materials are available via Vanguard Business Services Dubbo: www.vbs.net.au.

Acknowledgements

This project was supported through funding from the Australian Government's National Environmental Science Program. It included significant contributions from NSW OEH and ABARES for econometric analysis, from and benefited from considerable in-kind support from Dr Thilak Mallawaarachchi (University of Queensland) and Emeritus Professor Stephen Dovers (ANU). Assoc. Prof. Jacki Schirmer and Ms Kimberly Brown (University of Canberra) led the wellbeing component. The team is also grateful for the substantial assistance generously provided by Dr Sue McIntyre (CSIRO) to adapt the principles for managing and conserving grassy woodlands (McIntyre et al., 2002) for use as an ecological condition classification. The project team acknowledges the influence of ABS in the metadata driven spreadsheet design used in the project for classification and compilation of financial data. We are grateful for the assistance of Mike Digby, Niilo Gobius and Phil Tickle in the use of FarmMap4D for the remote-sensing component, and Dr. Ivan Hanigan for the exploration of season quality. We thank Stuart Whitten of CSIRO, Fiona Dickson and Paula Perrett of the Department of the Environment and Energy for the opportunity to discuss the strategies and tactics of the project and benefit from their experience. Finally, the project acknowledges the insights and leadership and generosity of the regenerative graziers that have participated in this study. Their commitment to grazing practices that balance environmental and economic performance is a significant contribution to agriculture in Australia.

Disclaimer

This report has been prepared for the purpose of communicating the methods and findings of an exploratory research project. It is a working paper prepared for discussion purposes only. Whilst the authors have exercised due care, skill and diligence in preparing this report they do not warrant the accuracy of data provided to it, or the accuracy of any conclusions drawn in reliance on the data. This report does not constitute financial or investment advice and should not be relied upon for this purpose. To the extent permitted by law the authors accept no responsibility for any loss, claim or liability incurred by any party in connection with this report.

Graziers with better profitability, biodiversity and wellbeing

1 Abstract

The box gum grassy woodlands, an iconic Australian ecological community, have declined by approximately ninety-two percent from their natural extent, largely due to decades of clearing and nutrient enrichment associated with efforts to improve productivity and profitability of agriculture. However, a community of practice of producers (self-styled regenerative graziers) has persistently claimed that they have very good environmental performance and biodiversity on their properties and that they are no less profitable than other producers in their regions. Individual case studies have supported these claims. This project aimed to discover the differences in profitability between graziers whose farms exhibit healthy functional traits and biodiversity of grassy woodlands and all other sheep, sheep-beef and mixed cropping-grazing businesses in their regions. Financial performance of farm businesses was compared with industry benchmarks and the ABARES Farm Survey participants. For additional social context, the project assessed the wellbeing of the graziers and compared this to NSW producers that have contributed to the University of Canberra regional wellbeing survey. The study found that the regenerative graziers that contributed to this project are often more profitable than comparable contributors to the ABARES Farm Survey, especially in dry years, that the levels of farm profit were similar to published industry benchmarks of 'elite' producers and they experience significantly higher than average wellbeing when compared to other NSW farmers. Taken together, these findings verify the claim that some graziers are able to be profitable whilst maintaining and enhancing the biodiversity on their properties and suggests that they have a set of management capabilities, different to other producers that creates these outcomes. These findings indicate that there is the potential to increase both public and private benefits by investing to develop additional regenerative grazing capacity.

2 EXECUTIVE SUMMARY

This independent research project focused on grazing properties in regions where box gum grassy woodlands are found. The box gum grassy woodlands are an iconic Australian ecological community that was listed under the Environmental Protection and Biodiversity Act (EPBC) as endangered in 2010 (TSSC, 2010). The endangerment of this community is a result of decades of clearing and nutrient enrichment for agriculture that has resulted in their decline by approximately 92% from their pre-1750 extent. Clearing and nutrient enrichment to improve profitability and productivity of agriculture remains the dominant approach to production within these landscapes. However, a community of practice of producers (self-styled regenerative graziers) has persistently claimed that that they generate higher or more dependable profitability than other producers in their regions and that their grazing practices help to conserve valuable ecological functions of box gum grassy woodland communities. If verified, the information gained has the potential to reveal opportunities for improving environmental performances in the landscapes where these iconic and threatened ecological communities are distributed. It should be noted that this study has not specifically measured whether regenerative grazing regimes are maintaining or improving the condition of box gum remnants to the criteria set out in the EPBC Act (i.e. to high conservation values). Nonetheless, a number of key features of this endangered community have been assessed as present within these regenerative grazing production systems.

Supported by funding from the Australian Government's National Environmental Science Program (NESP-EP), this project investigated the profitability of commercial-scale producers in NSW who are using and sustaining healthy grassy woodlands as inputs to production. This report presents findings for the financial, ecological and wellbeing characteristics of fifteen regenerative graziers from three regions of NSW grassy woodland biome; Armidale – Uralla (North), Wellington – Gulgong (Central) and Holbrook – Young (South). Participants were selected on the basis that:

- they were of commercial scale and deriving their livelihood from their farm business,
- they had been applying a low or no input operations policy and using sensitive management of grazing and
- the property demonstrated characteristics consistent with established principles for managing and conserving features of healthy grassy woodlands.

Participants were asked to provide at long-term detailed financial information, describe the history of the property, their business and personal goals and current management policy and complete several questions that were identical to some of those included in the University of Canberra's annual Regional Wellbeing Survey. The characteristics of the properties relevant to grassy woodland condition and sustainability were assessed for to evaluate the adherence to published principles for the conservation and management of grassy woodlands (McIntyre et al., 2002) and describe the condition of the property as sustaining or regenerating functional and species characteristics of grassy woodlands and native pastures. Key financial performance indicators and driver variables were derived so that their profitability could be compared to industry benchmarks and to participants in the ABARES Farm Survey. Wellbeing was compared to wellbeing of other NSW graziers of similar age and gender, using standard measures of health and wellbeing.

The regenerative graziers that contributed to this study were found to be more profitable when compared to all sheep, sheep-beef and mixed industry farms in a similar geographic region especially in the dry years between 2005-06 and 2008-09. Similar mean profitability between the NESP-EP and the other farm businesses was seen in 2014-15, 2015-16 and 2016-17. In these years, the NESP-EP sample exhibited lower variance (Ogilvy et al., in preparation). Regenerative farms also displayed more stable incomes through time compared to other farms in the ABARES Farm Survey.

Although this study was not configured to identify a causal link between ecological condition and farm profitability, our observation of significant differences in the cost and profit profiles of the regenerative graziers compared to other farms establishes a strong link between different modes of management and farm profitability. We conclude that regenerative grazing can be at least as profitable, and at times more profitable, than other methods whilst maintaining and enhancing grassy woodland biodiversity on their properties.

Analysis of the wellbeing data indicates that the regenerative producers experience a meaningful and significant wellbeing advantage compared to NSW farmers matched for gender and age. Regenerative graziers also reported higher ‘farming self-efficacy’ – confidence in being able to successfully manage different aspects of their farm. Self-efficacy is an important ‘wellbeing determinant’ known to influence wellbeing levels, and this finding suggests regenerative grazing may be associated with improved self-efficacy, which in turn has a positive influence on farmer wellbeing.

Taken together, these findings are suggestive of a previously unrecognised but potentially significant set of benefits being experienced by the regenerative graziers, possibly as a result of their approach to management of their natural resource base. However, while the private benefits to producers may be enough on their own to induce individual investment in skills associated with improvements environmental condition and biodiversity, experiences in other agricultural sectors (e.g. sugarcane (Queensland CANEGROWERS Organisation, 2018)) indicate that there may be other barriers to change. This suggests a path forward to improve our understanding of factors that contribute to farm business profitability, environmental health and rural wellbeing and should enable governments to design and develop programs that build these capabilities throughout the sector.

This study is unique in that it sampled a set of livestock producers based on the environmental health and biodiversity of their properties (regenerative graziers) and compared their profitability and wellbeing to a representative sample of other producers. This gives the study its strength and reveals the opportunity for future studies.

The sample of graziers was small and the lack of data about the ecological characteristics of the broader population of graziers in the grassy woodlands biome means that it is not possible to confirm any causality between the condition of the ecosystem and profitability or with higher wellbeing. Further studies examining the ecological characteristics of a larger sample of livestock producers in the grassy woodlands and other biomes are needed to identify whether the results amongst the group examined in this study apply more broadly and to identify if, when and how improvement of biodiversity is related to positive impacts on farm profitability and producer wellbeing.

We suggest the following areas are investigated with a view to identifying policy directions:

1. Identifying the most effective strategies for raising awareness and understanding of the opportunities to improve profitability, environmental performance and wellbeing, in a whole of farm context, including:
    a. How to increase graziers’ access to high quality regenerative grazing education and consulting that allows them to emulate, adapt or innovate upon leading

regenerative graziers' management skills. This may include support for educators and consultants as well as mentoring and access to field days on farms managed by the leading regenerative graziers.

   b. How to increase understanding and acceptance of the environmental, economic benefits of regenerative grazing amongst government agencies, agronomists and government extension officers

2. Describing the market and cultural mechanisms that would ensure that financial and-or social rewards exist (and no barriers are perceived) for increasing biodiversity and landscape function. For example:
   a. The emerging efforts of the private sector to use sourcing and capital allocation decisions to increase environmental protection and biodiversity on the properties they purchase from or lend to. (This would include support for development of methods by which they can assess these attributes and recognise farm businesses that generate them.)
   b. Land valuation approaches to develop strategic pathways for 'environmentally friendly' land valuation practices.
   c. Related to b above, expansion of existing markets for biodiversity and mechanisms for financial services providers to generate returns from biodiversity investment. This may encourage biodiversity-sympathetic land valuations.
   d. Correcting misperceptions that increases in native vegetation and biodiversity may negatively impact property rights for agricultural producers and increasing understanding of obligations and restrictions under the *Environment Protection and Biodiversity Conservation Act 1999* and state and territory native vegetation/biodiversity legislation.

3 CONTENTS

4 LIST OF FIGURES

5 LIST OF TABLES

6 PROJECT OUTLINE

This project sought to investigate potential opportunities for landholders in the iconic box gum grassy woodland biome of eastern Australia to improve both biodiversity and economic performance. We sought to inform farmers who may wish to incorporate more environmentally sound practices into their commercial operations of the potential for financial benefits or disadvantages. We aimed to inform government of the magnitude and nature of private benefits of better environmental management to assist with increased private generation of public environmental benefits.

We investigated cases where commercial-scale farmers in the grassy woodland biome have, over the long term, maintained or regenerated healthy ecosystems and utilised this as the natural resource base that sustains their businesses. We collected data related to key ecological attributes, subjective wellbeing and long-term financial data of these farms and compared farm financial profitability and farmer wellbeing with outcomes in closely located farm businesses to investigate whether we could find differences in profitability and wellbeing between the two populations.

The research was undertaken in three stages (a) collection and collation of on-farm financial data as well as formal survey data relating to farmer wellbeing, and industry benchmarks against which these can be compared (b) independent assessment of grassy woodland and native pasture characteristics, and (c) formal comparative analysis of economic outcomes associated with regenerative versus conventional farming systems. Examples are provided in Mallawaarachchi and Green (2012).

This report is structured in five sections. This section (Section 6) outlines the project; the foundational concepts, the region studied, the project organisation, activities and outputs. It describes the methods to select participants and protect their privacy. Section 7 describes the findings of the project in relation to farm business profit, farmer wellbeing and environmental health of the properties. Section 8 describes the limitations of this study and outlines the opportunities it exposed. Section 9 discusses the implications of the findings as context for the recommendations (section 10). A short conclusion section closes the report. The detailed driver variables for profit are outlined in Appendix A. Appendix B provides the methods for financial data collection and transformation and ecological assessment and property condition classification.

6.1 FOUNDATIONAL CONCEPTS

Farmers manage their properties, primarily to gain a profit and support their way of life. Ongoing profitability in agricultural systems requires ongoing inputs of human, financial and natural or environmental capital. But inputs to farming from environmental capital (like forage for livestock, nutrients and moisture from soil, pollination by insects) are widely accepted to vary in response to the extent and condition of the contributing ecosystems. These in turn may be degraded, maintained, or improved, depending on the farm management practices employed at a given site.

In commercial farm management, positive ecological outcomes are produced as a ‘joint product’, or a ‘complementary good’, meaning that their production is not the farmers’ primary motive. But, as the farmers’ understanding of how ecological condition contributes to improving or sustaining production benefits, observations suggest that more farmers consciously invest in ecological improvements, such as maintaining and improving biodiversity on farms[1] (Mallawaarachchi and Szakiel, 2007). Therefore, a better understanding of how farmers gain these benefits from investment in biodiversity is an important consideration in designing public policies. For instance, public policies, such as cost sharing arrangements may be designed to encourage farmers to provide a greater proportion of these public environmental goods on farm. In designing such cost-sharing arrangements, the extent to which biodiversity assists production can be an important guide. Previous research argues that such benefits are measurable and can be positive (Mallawaarachchi and Green, 2012).

In addition to contributing to agricultural productivity, ecosystems can confer a range of additional services. Benefits from these services often accrue at a broader (local, regional or landscape) scale, and, as such, ecosystems and their attendant services are considered public goods (even where they occur on private land). Again, this has important policy implications. The balance between public and private benefits from biodiversity (or ecosystems or farm management more generally) is considered a key factor influencing the appropriateness and outcomes of alternative management options such as engagement, and positive or negative incentives[2] (Pannell 2008).

If we consider 'economics' in its broadest sense, to encompass all facets of an individual's welfare, then farmer wellbeing can also be considered an important economic outcome from farming operations. It follows that a full understanding of the economic outcomes of regenerative farming requires an investigation of the implications (if any) of regenerative farming for wellbeing. If benefits such as reduced stresses associated with land management arise from regenerative farming, then they would be considered to contribute to the overall private economic benefit arising from regenerative farming practice.

There is a need to identify, describe and statistically calibrate the functionality of the land management mode with functional analysis of the ecological and economic variables to identify the factors that maximise benefits for livestock producers while achieving conservation of iconic and endangered ecosystems. This project makes a significant contribution toward that aim.

---

[1] Mallawaarachichi, T. and Szakiel, S. 2007, *Nonbroadscale land clearing in southern Australia: economic issues in managing native vegetation on farm land,* ABARE Research Report 07.2. Prepared for the Natural Resource Management Division, Australian Government Department of Agriculture, Fisheries and Forestry, Canberra, January.

[2] Pannell, D. J. (2008) Public Benefits, Private Benefits, and Policy Mechanism Choice for Land-Use Change for Environmental Benefits. *Land Economics,* 84**,** 225-240

6.2 REGION

This study focused on the grassy woodlands biome of Eastern Australia. Many grassy box woodlands are iconic ecological communities of conservation interest to Commonwealth and State governments (DotEE, 2016). They occur west of the Great Dividing Range on an arc from Southern Queensland through NSW to central Victoria (Figure 1.) in areas where rainfall is between 400 and 1200mm per annum, on moderate to highly fertile soils (TSSC, 2010). As a result of clearing and nutrient enrichment for agriculture and subsequent grazing pressure, 'tidying up' and weed invasion (Dorrough et al., Dorrough and Moxham, 2005, Dorrough et al., 2006, McIntyre et al., 2002, Prober et al., 2002a, Prober and Thiele, 2005, Prober et al., 2002b) they have declined by approximately 92% from their pre-1750 extent of 5,011,655 (NSW Department of Environment, 2010) and were listed as critically endangered under the Commonwealth EPBC Act in 2006 (DotEE, 2018). An objective of the national recovery plan for these ecosystems is to increase grassy woodland and native pasture characteristics between remnants to preserve the extent, integrity and function of Box Gum Grassy Woodlands and to bring about enduring changes in land manager attitudes and behaviours towards environmental protection and sustainable management practices (NSW Department of Environment, 2010).

A community of practice of 'regenerative' graziers in the grassy woodlands have claimed for years that it is possible to regenerate and conserve these ecosystems whilst achieving satisfactory economic results (Ampt and Doornbos, 2011, Seis and Seis, 2003, Wright et al., 2005). These claims align well with more general research into the contribution of ecosystem inputs to extensive livestock production systems (see for example Ash et al., 2015, Lavorel et al., 2015, Walsh and Cowley, 2016) and with animal behaviour and nutrition research (Provenza et al., 2007, Villalba and Landau, 2012, Villalba and Provenza, 2009). Such studies consistently predict that improved ecosystem function and condition (especially biodiversity) can improve the resilience of the natural resource base (Lavorel et al., 2015). These claims have largely remained untested because traditional evaluations of agricultural productivity that are routinely undertaken by government agencies (in Australia by ABARES and ABS) rarely collect data on the ecological qualities of a farm property (ABARES, 2014) and other research has not incorporated long-term financial data of leading regenerative graziers alongside characterisation of the ecological functions and biodiversity of the property. Some aspects of the methods used for this project may be insightful for future development of empirical methods that may identify any causal links between economic performance and biodiversity on farms.

Figure 1: Grassy woodland biome (green). Image created by Greg Patterson.

6.3 Project organisation

This project was directed by Sue Ogilvy at the Fenner School of Environment & Society Australian National University (ANU) who had overall responsibility for management of strategies and resources to achieve delivery of the project outputs. The ANU Enterprise provided liaison with the Department for all matters pertaining to administration, auditing, and reporting of the project. Prof. Stephen Dovers provided academic supervision and oversight of Human Research Ethics. Dr Thilak Mallawaarachchi, School of Economics, University of Queensland, provided economic methods supervision and oversight of data collection specification, methods, and analysis techniques. Dr Mallawaarachichi also contributed to the reporting of the project and development of publications. NSW OEH provided econometric expertise for definition, collection and analysis of ecological and economic data, project communications and is a key user of the project outputs. ABARES enabled the financial performance of the regenerative graziers to be compared to other comparable producers that have contributed to the ABARES Farm Survey.

Vanguard Business Services managed farmer recruitment and farmer engagement with the project and operationalised the collection, confidentialisation and security of farm financial data in line with the protocols approved by ANU Human Ethics Committee (protocol 2017/011). Vanguard also participated in the economic and ecological data specification and analysis and continues to collaborate with the development of project communications outputs. The project benefited from the incorporation of the experience and expertise of producers considered leaders in 'regenerative' grazing and whose involvement in design and use of project communications will improve the impact of the project.

Dr Sue McIntyre assisted the project team to adapt the principles of conservation and management of grassy woodlands (McIntyre et al., 2002) to assess the condition of the participating properties in terms of grassy woodland health and sustainability.

Associate Professor Jacki Schirmer and Ms Kimberly Brown adapted the University of Canberra Regional Wellbeing Survey to compare the subjective wellbeing of the participants with other NSW farmers.

The project organisation is illustrated below.

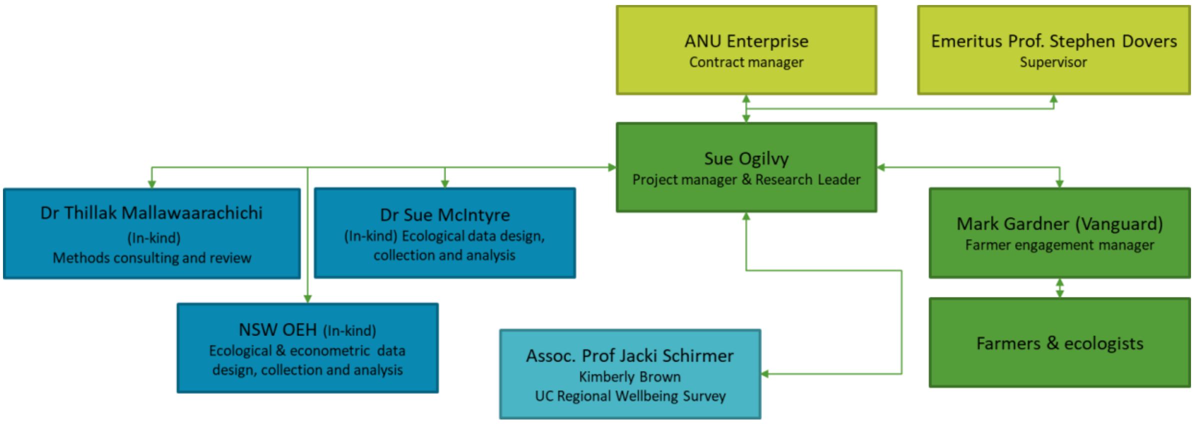

Figure 2: NESP-EP Farm profitability and biodiversity project organisation

6.4 Summary of activities, progress and outputs

The project established an interdisciplinary working group comprising the producers, farm consultants, ecologists, and economists to appropriately inform elements of the project. Methods to identify a relevant sample of regenerative producers and sources of comparative data were designed and executed to produce a database of ecological, economic, and financial data relating to regenerative farmers.

Ethics approval for the research was obtained from ANU (protocol number 2017/011) and sixteen producers were successfully recruited. Under this protocol, financial data comprising profit & loss and balance sheets was obtained from accounting statements, livestock records, bank valuations and landholder valuations of assets. Eleven participants supplied more than ten years of financial data, one producer supplied 9 years of data. The remaining four participants supplied between four and eight years of data. All participants completed a section of the University of Canberra Regional Wellbeing survey and a semi-structured interview that elicited information about producer goals and their attribution of the strategies that help them to achieve their goals.

Financial performance benchmarks from leading benchmarking organisations (AgInsights and MLA) were obtained to allow comparison of financial performance of the participating producers and the industry leaders. Comparison to representative performance of closely located farms is being conducted by ABARES in collaboration with NSW OEH.

6.5 Methods overview

The project used a case study approach. The NESP-EP sample of participating graziers were drawn from a community who have consciously invested in ecological functions to improve the productive capacity and biodiversity of their natural resource base. They were selected on the basis that they have ceased the practices thought to be threatening to grassy woodlands and native pastures and are using grazing[3] and other practices thought to assist with their conservation and regeneration. Accordingly, this project describes the population of regenerative graziers (in the grassy woodlands biome) as livestock producers who are maintaining or regenerating many of the ecological characteristics associated with healthy grassy woodlands and derived native pastures.

The criteria for inclusion in the project were:

- The properties used in production were observed as part of the recruitment process to demonstrate the characteristics of healthy, sustainable grassy woodlands and native pastures. The property had not been subject to recent (within 10 years) nutrient enrichment.
- The landholder described a long-term low-input, regenerative grazing regime and that their management goals included high levels of landscape function (consistent with Tongway and Hindley, 2004) and biodiversity. Their practices don't include the activities commonly associated with grazing that are regarded as threats to grassy woodlands (NSW Department of Environment, 2010).

[3] Typical regenerative grazing regimes involved grazing durations of 3 to 7 days with usually more than 180 days (sometimes more than a year) rest between grazing. The regenerative grazing policy is to observe recovery rates of pastures, estimate how to retain sufficient annual pasture growth for replenishment of soil and vegetation resources and match stock numbers to resources available.

- The farm business has been producing wool and livestock at commercial scale for more than 10 years and was prepared to provide multiple years of detailed financial data.

Properties and landholders were identified using word of mouth and referral techniques via the communities of practice in this industry and invited to participate in the project under ANU Ethics Protocol 2017/011 approved by ANU Human Ethics Committee. Sixteen producers and landholders confirmed their willingness to participate and the capacity of the properties to sustain or regenerate characteristics of healthy grassy woodlands and native pastures on their properties was assessed.

To do this, the project team adapted the principles of conservation and management of grassy woodlands (McIntyre et al., 2002) for a property-wide condition assessment of grassy woodland and native pasture characteristics. The method incorporated satellite imagery to estimate the extent of woodland and forest areas and fractional vegetation data from Landsat obtained through FarmMap 4D enabled estimation of bare ground. Woodland condition and ground-layer condition of woodlands and pastures was assessed via field observations by a suitably qualified ecologist who also gathered information about past and current management to judge whether the property is likely to improve condition or not. Section 13 – Appendix B provides more detail about the methods used.

Field observations for twelve properties were made during December 2017 following some summer rain. Field observations for four properties were made in May and June 2018. As a result of the non-ideal timing of these observations, we expect that the observations of the ground-layer may underestimate the range of species present on the properties.

Following the ecological assessment, one property was judged to not meet the long-term management criteria for sustainable or regenerating grassy woodlands and financial and wellbeing data for this participant was removed from the financial results. A second property that had, over the long term applied no nutrient enrichment to grassy woodlands and derived pastures was discovered to have added chicken manure to these areas in the final year of the study. This means that these areas are most likely to be unsustained in the future as grassy woodlands and native pastures. However, the financial information for this farm business was retained in the profitability analysis because the effect on production of the changed management practices occurs after the study period. The findings of the ecological assessment of the properties is described in section 7.1 Ecological characteristics.

The fifteen enterprises included in the financial analysis comprise wool flocks, cattle herds, mixed wool and cattle operations and some properties include agistment services as part of their enterprise. Some participants are taking advantage of opportunities to expand their businesses and have purchased properties in the period of the study. The significant outlays for stock purchases have affected the profitability in those years. Some participants have introduced other enterprises or have vertically integrated into direct processing and sales of meat. As a result of very good environmental management of the property over the long-term, one participant is part of the Environmental Stewardship Program (ESP) run by the Department of the Environment and their financial performance reflects the income and expenses related to this contract. While in future studies it would be desirable to analyse profitability with and without this type of income stream, the changes to capital and resource allocation decisions the farmer has made to the enterprise in response to this contract cannot be removed and consequently, the profitability of this business in the absence of the ESP contract can't be determined. This is consistent with the treatment of this type of income by ABARES and allows a like for like comparison with this dataset. Since no other

NESP-EP participants receive income from environmental stewardship-type payments or ecosystem services-type payments we judge that the inclusion of this participant didn't compromise achievement of the purpose of this study. The proportion of ESP (or like) payments to total income for the whole cohort of NESP-EP participants is 2.2%.

The participants were able to contribute multiple years of detailed financial data. Eleven of the fifteen farm businesses were able to contribute more than ten years of detailed financial data. One farm supplied nine years of data and four farms were able to supply financial data for between four and eight years[4].

Fourteen producers participated in the wellbeing survey component and their wellbeing was compared to NSW respondents to the University of Canberra Regional Wellbeing Survey (http://www.canberra.edu.au/research/faculty-research-centres/ceraph/regional-wellbeing). The methods for wellbeing are included at the start of the section describing the wellbeing findings.

Multiple strategies were employed concurrently to reduce the chances of a participant being identified as a contributor of data to the project. Contributions of financial data related to a farm business were coded by Vanguard Business Services, the collector of the data. Only coded data was shared with other members of the project team.

The profitability of the NESP-EP sample was compared to contributors to the ABARES Farm Survey (ABARES, 2018) and to financial indicators published in the Holmes & Sackett AgInsights[5] benchmarking series (Holmes Sackett, 2018). The approach to profitability analysis is summarised at the start of section 7.2 with the details of data collection and analysis described in Section 13 Appendix B – methods.

[4] due to changes of accountants or accountant policies not to store long-term data

[5] Holmes & Sackett AgInsights farm benchmarking measures financial and production performance of farm managers and like ABARES doesn't report on the qualities of the ecosystems used for production. Unlike ABARES, the data presented is not drawn from a representative sample of farms but are thought to represent the best of the producers using the conventional (common) best practice which is typically characterised by soil nutrient enrichment and preference for exotic pastures. While the AgInsights data may include some regenerative graziers, the bias towards benchmarking conventional producers is demonstrated in the significantly higher use of pasture amendments (Section 12 Appendix A 12.3 Pasture costs per DSE).

7 FINDINGS

We present the findings in the following order; ecological characteristics, farm business profitability and then wellbeing. The wellbeing section includes a brief introduction to wellbeing research and the methods used for this study before the findings are described. The detailed methods for ecological assessment and financial analysis are described in Section 13 Appendix B.

7.1 ECOLOGICAL CHARACTERISTICS

Each property was classified as either sustainable grassy woodland, regenerating grassy woodland or reducing grassy woodland by judgement of the degree to which all or some principles were in evidence and whether the property was below threshold as a legacy of past management. Table 1 describes the six classifications used. We found that, while all the regenerative graziers in the NESP-EP sample are achieving good environmental performance, not all of them demonstrated complete adherence to the principles of conservation and management of grassy woodlands and derived pastures (McIntyre et al., 2002). In addition, despite good management, some properties remain below threshold for some ecological elements as a legacy of past management (before regenerative practices were adopted).

Table 1: descriptions of different condition classifications of properties in the grassy woodlands

Threshold status	***Not managing for grassy woodland persistence (high input, import of nutrient)***	***Managing for production and ecosystem function (low input)***	***Managing for production, ecosystem function and native biodiversity***
Landscape condition above ecological thresholds	Landscape unsustainable as grassy woodland, native biodiversity being eliminated. A property with grassy woodland characteristics in which intensification (nutrient enrichment, exotic vegetation) is being used to maximise production.	Landscape sustainable as grassy woodland, some native biodiversity absent. Management principles relevant to woodland, pasture and soil function being applied to a property with sustainable grassy woodland characteristics. May deplete or maintain conservation values (habitat for native species.	Landscape sustainable as grassy woodland, high levels of biodiversity. All six management principles are applied to a property with sustainable grassy woodland characteristics. Grassy woodland biodiversity and conservation values are expected to be maintained or improved.
Landscape condition below ecological thresholds	Landscape unsustainable as grassy woodland, native biodiversity largely eliminated. A property with depleted grassy woodland characteristics which is continuing to be managed for maximum production.	Landscape regenerating, but biodiversity may remain limited. Management principles relevant to pasture and soil function applied to a property with depleted natural capital. No specific restoration of conservation values or native habitat.	Landscape regenerating. All six management principles are applied to a property with depleted grassy woodland characteristics. Active restoration of native habitat is occurring. Grassy woodland biodiversity and conservation values are expected to be maintained or improved.

Using the method described in Section 16: Appendix B, we classified each property as sustaining, regenerating or reducing the ecological characteristics and biodiversity of grassy woodlands and native pastures. As described in the overview of the methods, fifteen properties were assessed as meeting the criteria for the sustainable management of grassy woodlands during the study period;

managing for production and ecosystem function and/or native biodiversity. Most properties were below threshold for one or two principles and this was judged to be a legacy of past management rather than reflecting the continued presence of threatening processes. (The reasons for excluding two properties are provided in the methods overview.)

While all producers that are managing for production and ecosystem function are demonstrating the principles of conservation and management of grassy woodlands, even if they are below threshold for some elements, a distinction between those who are also managing for grazing-sensitive and conservation-important native biodiversity (species described in Appendix 1 of the National Recovery Plan for this biome (NSW Department of Environment, 2010)) would, in future, enable useful secondary analysis of whether this extra investment was positive or negative to their profitability. As a result of the ecological assessment, we judged that some producers were using sensitive-enough management that they could be assessed as applying conservation principles across the whole property. Observations of grazing-sensitive species including of more than one of the Appendix 1 species on some of the properties corroborates this assessment. This does not mean that these properties have been assessed as having grassy woodlands and native grasslands in the condition that would be consistent with their identification as threatened ecological communities under the EPBC Act. *Nonetheless, a number of key features of this endangered community have been assessed as present within these regenerative grazing production systems.* A separate condition: 7 – Reference condition (Figure 3) communicates this.

The classification of the properties is shown in Figure 3. Nine properties were found to be applying all the principles for conservation and management of grassy woodlands. Two of these demonstrated they were above the thresholds for woodland proportion and quality as well as dominance and quality of native vegetation in the ground layer. They demonstrated abundant natural regeneration of trees and shrubs and standing and fallen dead timber as well as a normal distribution of tree ages. The ground layer of woodlands and cleared pastures demonstrated the presence of non-grass species listed in appendix 1 of the grassy woodlands recovery plan as important species for healthy grassy woodlands. The landscape function of these properties was very high with less than 15% bare ground as measured via the seasonal ground-cover statistics produced by FarmMap4D (FarmMap4D, 2017), healthy riparian areas and large and medium tussock sizes throughout the ground layer of woodlands and pastures. These were classified as '*sustainable as grassy woodland with high biodiversity*'. Seven properties were classified as regenerating. They also demonstrated application of all principles of management but were found to be below threshold for grassy woodland proportion or tussock size or quality of ground-layer in that they exhibited presence of perennial exotic invasive weeds such as St John's Wort or Coolatai grass. It is anticipated that, over time the management principles being demonstrated will allow these properties to move above the thresholds.

Five properties were classified as '*regenerating grassy woodland, but with limited biodiversity*' judged to be using less sensitive grazing (recovery periods between 28 and 180 days) and weed management and to therefore be unlikely to regenerate the more grazing sensitive species associated with grassy woodlands. All were also found to be below threshold on one or two of the sub-principles (usually grassy woodland proportion, native dominance of the ground layer, size of tussock grasses and presence of weeds). Appendix 1 species were observed on all but one of the properties, most of the observations were in the cleared pasture areas. Details of findings related to ground-cover proportion and ground-layer quality are provided in Section 12 Appendix A.

Two properties were classified as not sustaining or regenerating grassy woodlands. One property had in the final year of the study period, on the advice of the local agronomist, added chicken manure to pastures with significant scattered trees. This is a threatening process for grassy woodland and native pastures and will significantly inhibit the health and regeneration of these ecological communities for some time. However, because this occurred in the final year of the study and prior to that the property had not used inputs for more than 20 years, we judged that the effect of the fertilisation would only be seen in a negative impact on profit in the final year. Accordingly, we decided to retain the long-term financial data in the profitability analysis for the NESP-EP sample.

One property, a mixed grazing cropping enterprise had exceeded the threshold of 30% intensive use for the period of the study, so their financial results were excluded from the study despite the grazed grassy woodlands being judged to be healthy. This exposed the need for future assessments of sustainability of ecosystems on a property to be able to consider the connectivity of ecosystems within the property to the current and prospective condition of ecosystems beyond the property boundary.

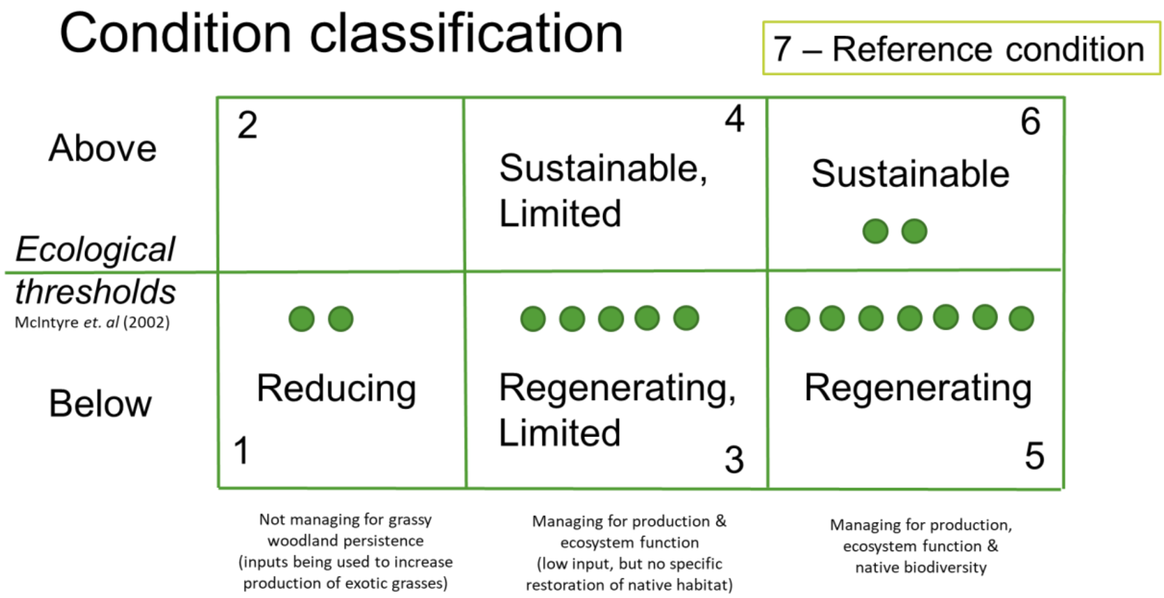

Figure 3: property condition classifications. Each property was classified as using all or some the principles and being above or below the thresholds described as being associated with management and conservation of grassy woodlands

7.2 PROFITABILITY

This section describes the profitability of the NESP-EP sample of producers and compares them to the industry benchmarks described in the methods section. At the date of reporting, further econometric analysis was still in progress. Findings will be published in appropriate professional journals and general audience communications. Financial values are nominal values, not adjusted for inflation.

Profitability can be examined several ways. In this report we present Earnings before income and tax per dry sheep equivalent (EBIT/DSE) for the regenerative graziers and a comparison of this with the Holmes & Sackett Aginsights benchmark participants (Holmes Sackett, 2018). We also provide a comparison of the drivers of profitability including income/DSE, supplementary feed/DSE, pasture costs/DSE, animal health and breeding. Preliminary findings of the comparison of ROAM and EBIT per sheep equivalent (SE) for the NESP-EP sample with ABARES Farm Survey contributors in the region follow.

More detailed comparisons with the AgInsights benchmarks are provided in Section 12, Appendix A. The methods for collection, compilation and calculation of profitability and driver variables are described in the methods section (Section 13, Appendix B). For the definitions of income and expenses and analytical methodologies used in this comparison, please refer to the descriptions provided in AgInsights (Holmes Sackett, 2018). We applied these definitions to the NESP-EP sample so that comparisons are as ‘like-for-like’ as possible.

7.2.1 Comparison to industry benchmark – Holmes & Sackett AgInsights

The enterprises participating in the NESP-EP were compared with commercial benchmarks reported from the AgInsights survey in each year from 2007. We compare the EBIT/DSE of the NESP-EP sample with the Holmes and Sackett AgInsights benchmarks and present the comparisons of the Top 20%, Average and Bottom 20% of the NESP-EP sample (ranked by EBIT/DSE) for the key driver variables on a per DSE basis; income, supplementary feed, pasture expenses, animal health and breeding, variable costs and fixed costs. The enterprises in the NESP_EP sample have similarities with the AgInsights group, and there is an overlap in geographical location. The NESP-EP group consisted mainly of mixed grazing farms (Beef, Wool, Beef/Wool with some cropping) with some farms being vertically integrated with direct marking and other forms of livestock. However, the sample size was too small to allow NESP-EP data to be distinguished by their enterprise type and the data presented reflect a mix of enterprises, so some care needs to be taken in the interpretation of comparisons between the two groups. It may be possible in future to align the datasets to allow a closer match of enterprises and locations and gather the ecological data necessary to test the assumption that the AgInsights contributors are not sustaining or regenerating grassy woodlands as the productive natural resource base.

7.2.1.1 EBIT/DSE

The NESP-EP sample for EBIT/DSE was compared to the Holmes & Sackett AgInsights benchmark[6] performance EBIT/DSE for each year of our study. The results are presented in Figure 4 with the data in Table 2. The exact method of ranking used in Holmes & Sackett AgInsights is not published.

[6] Note: the participants in the AgInsight benchmark are generally regarded to represent the top twenty percent of agricultural businesses.

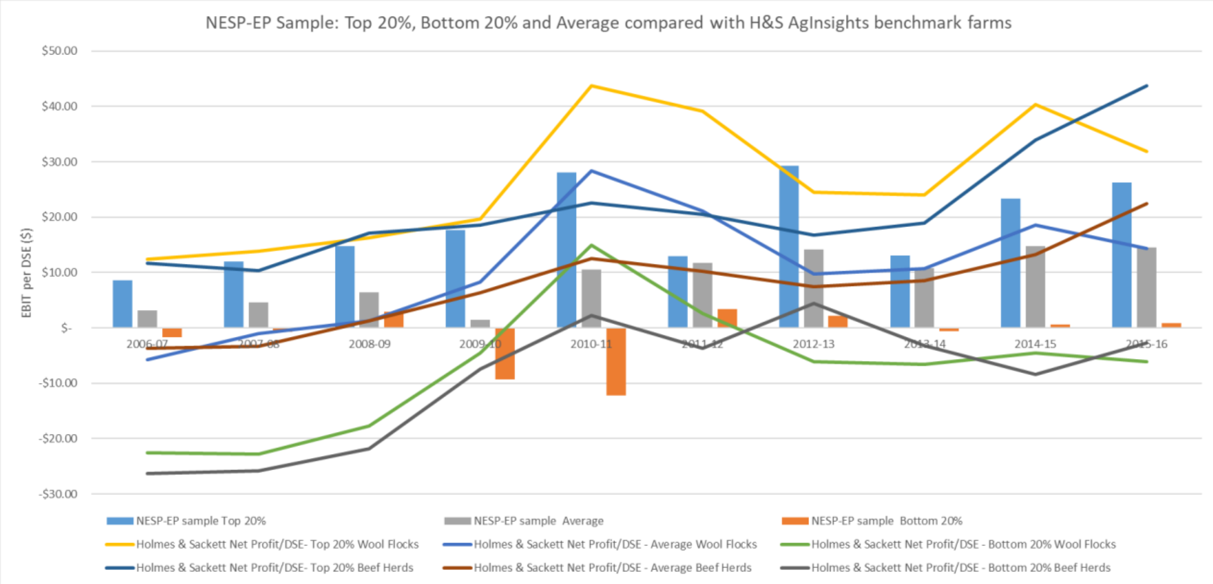

Figure 4: Chart of comparative EBIT/DSE for the NESP-EP sample (columns) and the Holmes & Sackett AgInsights database (lines). The Top 20% of the NESP-EP sample is the average of the two farms in the top 20% (percentile.inc(array,0.8)) of EBIT/DSE. The Bottom 20% is the average of the two farms in the bottom 20% (percentile.inc(array,0.2)) of EBIT/DSE. The average is the average of the remainder. This may not exactly match the method used in AgInsights and so the results should be used with caution.

Table 2: EBIT/DSE data table.

EBIT per DSE **Producers ranked by ROAM**	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**
NESP-EP sample - Top 20%	8.55	12.04	14.79	17.62	28.12	12.90	29.30	13.09	23.38	26.23
NESP-EP sample - Average	3.18	4.55	6.40	1.50	10.55	11.80	14.13	10.73	14.77	14.51
NESP-EP sample - Bottom 20%	-1.65	-0.74	2.95	-9.31	-12.27	3.44	2.16	-0.57	0.66	0.83
Holmes & Sackett Wool Flocks Net Profit/DSE- Top 20%	12.44	13.81	16.31	19.64	43.69	39.21	24.51	24.02	40.31	31.91
Holmes & Sackett Wool Flocks Net Profit/DSE - Average	-5.72	-0.97	1.22	8.27	28.42	21.13	9.74	10.71	18.62	14.34
Holmes & Sackett Wool Flocks Net Profit/DSE - Bottom 20%	-22.59	-22.80	-17.77	-4.53	14.98	2.60	-6.16	-6.63	-4.55	-6.10
Holmes & Sackett Beef Herds Net Profit/DSE- Top 20%	11.65	10.35	17.09	18.53	22.56	20.57	16.71	18.93	33.98	43.79
Holmes & Sackett Beef Herds Net Profit/DSE - Average	-3.74	-3.37	1.29	6.31	12.54	10.29	7.43	8.58	13.27	22.46
Holmes & Sackett Beef Herds Net Profit/DSE - Bottom 20%	-26.28	-25.77	-21.82	-7.49	2.21	-3.70	4.43	-3.22	-8.38	-2.69

Note that the NESP-EP sample is comprised of Wool Flocks, Beef Herds and mixed sheep/cattle enterprises and financial results presented here for this group will be affected to different degrees by the quality of markets for wool and beef. More than half the NESP-EP group of 16 have purchased additional land within the last 5 years, with 7 participants also commencing value adding businesses. This means that in this sample some businesses are in a growth phase (also reflected in the optimism in the wellbeing findings). The impacts of these investments, in many cases, are yet to fully flow through the business. The negative EBIT in 2009-10 and 2010-11 for the NESP-EP sample reflects the large investment in cattle due to a change in enterprise for one contributor. The increase in profitability from 2010-11 for the top 20% of NESP-EP may partly reflect the commencement of an ESP contract for one contributor.

7.2.1.2 Ten-year average EBIT/DSE

The ten-year average EBIT/DSE provides insights into the comparative profitability over a range of seasons and markets. Over a ten-year period, the average EBIT/DSE of the NESP-EP sample is below the average of the AgInsights benchmark groups for Wool Flocks and above the average for Beef Herds. The top 20% of NESP-EP is below the AgInsights group for both Wool Flocks and Beef Herds and the ten-year average for the bottom 20% of NESP-EP is above the ten-year average for the bottom 20% of AgInsights contributors.

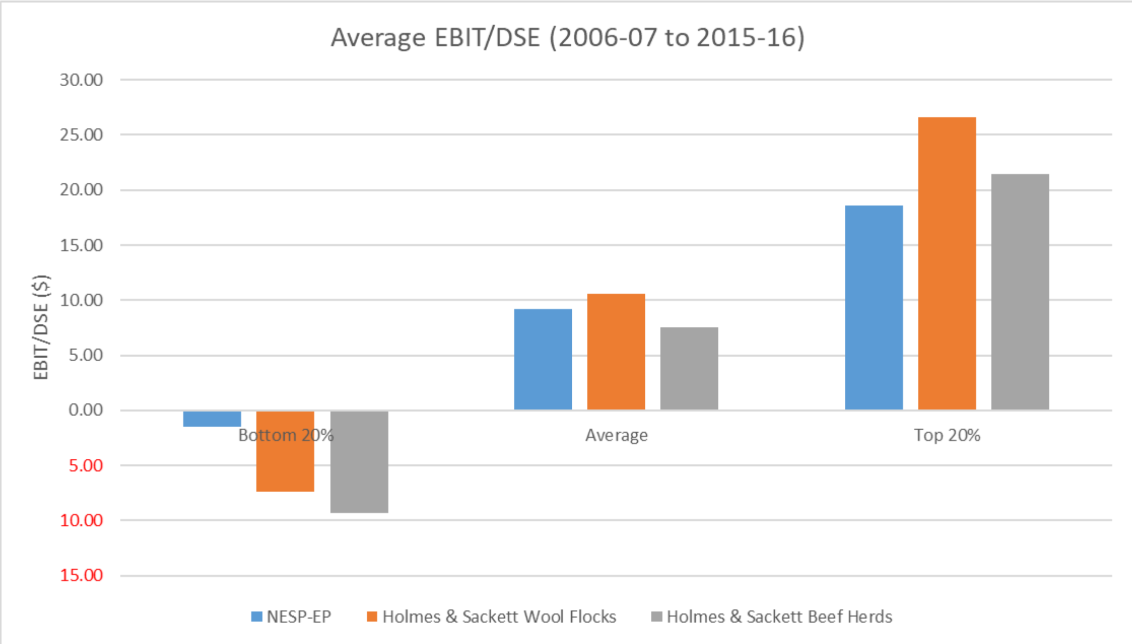

Figure 5: Chart of EBIT/DSE ten-year average (2006-07 to 2015-16) of top 20%, average and bottom 20% of producers.

Table 3: Data table for EBIT/DSE ten-year average chart (Figure 5.)

Ten-year average EBIT/DSE ($)	*Bottom 20%*	*Average*	*Top 20%*
NESP-EP	1.45	9.21	18.60
Holmes & Sackett Wool Flocks	7.36	10.58	26.59
Holmes & Sackett Beef Herds	9.27	7.51	21.42

7.2.1.3 Driver variables

The NESP-EP group were ranked on EBIT/DSE (described earlier) to present Average, Top 20% and Bottom 20%, to compare with the AgInsights contributors. Comparison of the ten-year average of the driver variables commonly considered to affect profitability are presented. Annual values for the study period are available in charts and data tables in Appendix A of this report.

7.2.1.4 Income/DSE

There is no obvious reduction in Income/DSE compared to the industry benchmark.

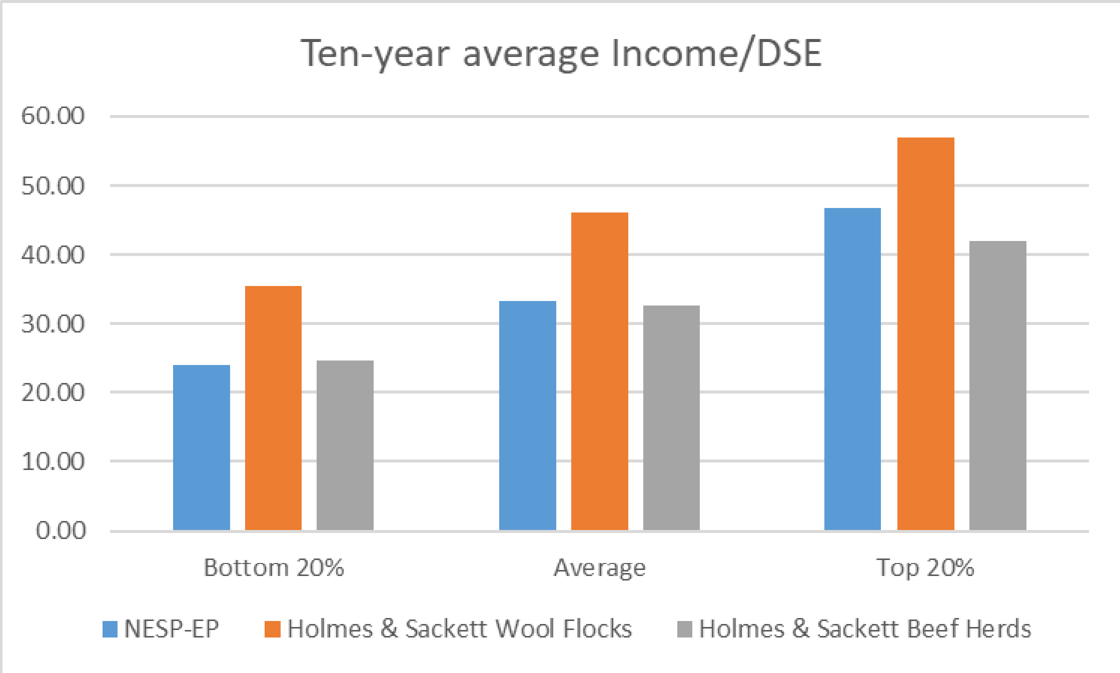

Figure 6: Chart of Income/DSE ten-year average (2006-07 to 2015-16) of top 20%, average and bottom 20% of producers

Table 4: Data table for Income/DSE ten-year average chart (Figure 6.)

Ten-year average Income/DSE ($)	*Bottom 20%*	*Average*	*Top 20%*
NESP-EP	23.97	33.37	46.68
Holmes & Sackett Wool Flocks	35.52	46.15	56.94
Holmes & Sackett Beef Herds	24.68	32.70	41.89

7.2.1.5 Supplementary Feed/DSE

The NESP-EP sample spends significantly less on supplementary feed than the industry benchmark. Supplementary feed (hay and grain) costs are generally regarded by the agricultural benchmarking organisations as a key driver variable distinguishing the more profitable conventional producers from others by increasing stock numbers per hectare. Supplementary feeding is not a common practice in the NESP-EP sample. Evidence from the semi-structured interviews (this study) suggests that the NESP-EP sample apply a different strategy. They commonly adjust (reduce) stock numbers in response to their foresight of declining resource capacity in adverse seasonal conditions. They rarely feed animals, and then only for short and tightly targeted durations. Maintaining stock numbers for long periods with purchased feed is not a characteristic of their management. This strategy may also confer significant social and ecological benefits to their farms as well as lowering the cost base.

The slightly higher expenditure on supplementary feed in good seasons (in time-series presented in Appendix A) may reflect some NESP-EP producers opportunistically in a countercyclical strategy purchasing feed in good seasons when prices are low.

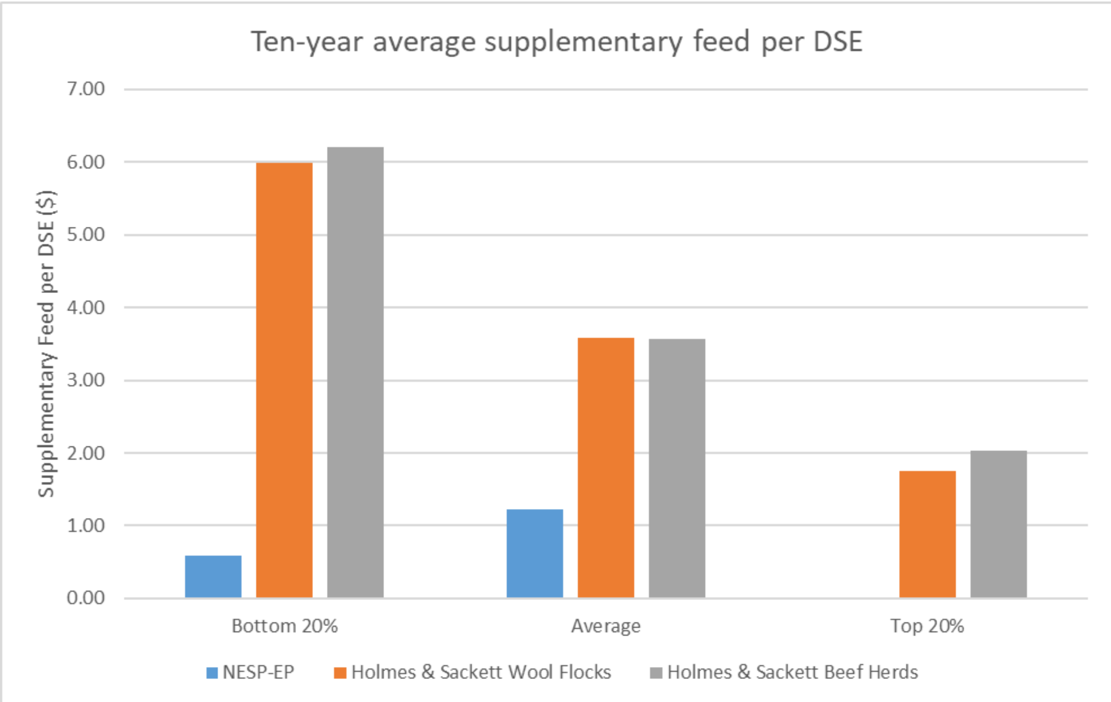

Figure 7: Chart of supplementary feed per DSE ten-year average (2006-07 to 2015-16) of top 20%, average and bottom 20% of producers

Table 5: Data table for supplementary feed per DSE ten-year average (2006-07 to 2015-16) of top 20%, average and bottom 20% of producers (Figure 7)

Ten-year average supplementary feed per DSE ($)	*Bottom 20%*	*Average*	*Top 20%*
NESP-EP	0.59	1.22	0.00
Holmes & Sackett Wool Flocks	6.00	3.58	1.76
Holmes & Sackett Beef Herds	6.21	3.56	2.03

7.2.1.6 Pasture costs per DSE

The NESP-EP sample spends significantly less on pasture and soil amendments than the industry benchmark. Amendments to soil, cultivation, sowing and/or fertilisation of pastures to improve productivity have been classified as pasture costs. To assemble an equivalent dataset to allow comparisons with the AgInsights benchmark participants, we used the fertiliser expenses, any identified seed/chemical costs plus costs for lime/gypsum from the NESP-EP participants. The NESP-EP sample use low levels of traditional inputs for pastures, relying on their planned grazing management techniques to assure availability of ecological functions provided by plants and animals to capture, store and cycle nutrients and other resources. Many of the NESP-EP sample provide livestock with free access to complex mineral supplements. A range of amendments such as compost teas, biological preparations, or very low rates of fertiliser (such as for pasture cropping) have been used by some NESP-EP participants in some years. These are low cost pasture inputs. These, plus the evidence for high ecological function (from the ecological assessment) may indicate no or very low net reduction of soil minerals via export of wool and livestock, despite the low or no use of artificial inputs (as suggested in Filippi, unpublished). The detailed tables in Appendix B indicate some significant investment in pasture costs in some years. Information from the interviews suggests these reflect the application of biodynamic inputs and chicken manure for some farms. The ecological implications of chicken manure to the future health of grassy woodlands are discussed in the section of this report describing the grassy woodlands condition.

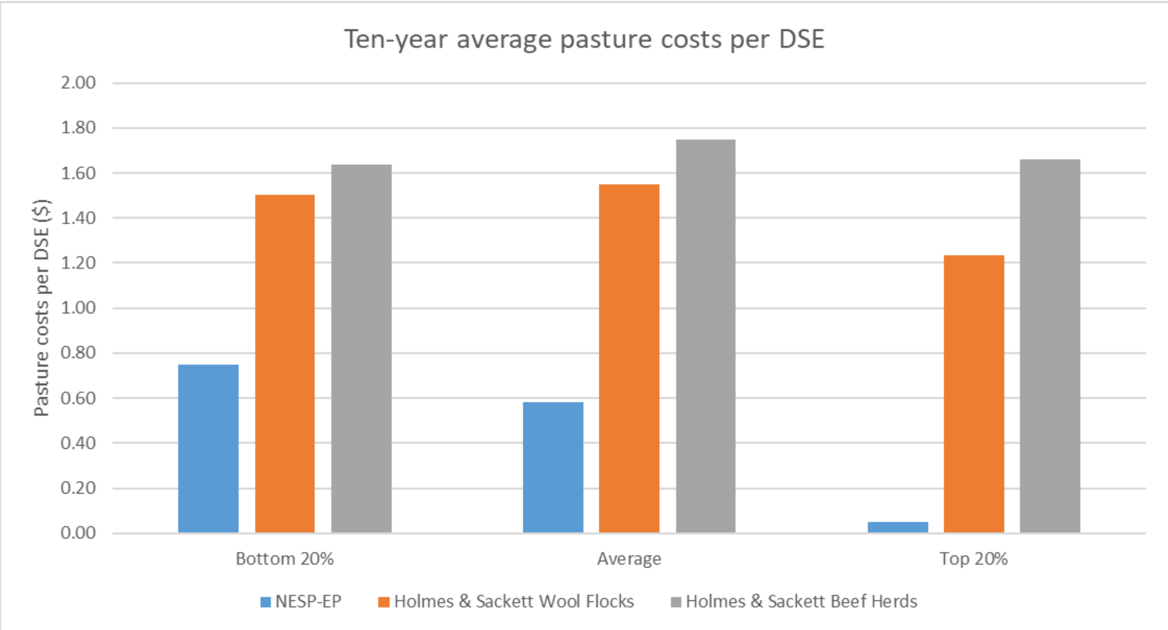

Figure 8: Chart of pasture costs (fertiliser) per DSE ten-year average (2006-07 to 2015-16) of top 20%, average and bottom 20% of producers

Table 6: Data table for pasture costs (fertiliser) per DSE ten-year average (2006-07 to 2015-16) of top 20%, average and bottom 20% of producers (Figure 8)

Ten-year average pasture costs (fertiliser) per DSE ($)	*Bottom 20%*	*Average*	*Top 20%*
NESP-EP	0.75	0.58	0.05
Holmes & Sackett Wool Flocks	1.51	1.55	1.24
Holmes & Sackett Beef Herds	1.64	1.75	1.66

7.2.1.7 Animal health and breeding per DSE

The NESP-EP sample spends significantly less on animal health and breeding costs than the industry benchmark. The semi-structured interviews with the NESP-EP participants indicated that their animals were usually healthy and required low levels of inputs to sustain their health. The animal health expenses may reflect the proportion of wool flocks that have invested in a long-term genetic solution to blowfly and now don't need to mules or treat the sheep for fly protection. Reduction in need for fly treatment and other inputs may also be a result of more frequent shearing (under 12 months) was also common, reducing the need for many animal inputs. The NESP-EP sample believe that they generally see relatively high reproductive levels of stock which may due to the management of grazing that reduces the chances of nutritional deficiency in ewes.

The detailed tables in Appendix A demonstrate that in some years the NESP expenditure was quite high. This can be tracked to the investment in the genetic solution that largely eliminates the requirement for mulesing and is an investment in the future productive capacity of the flock or herd.

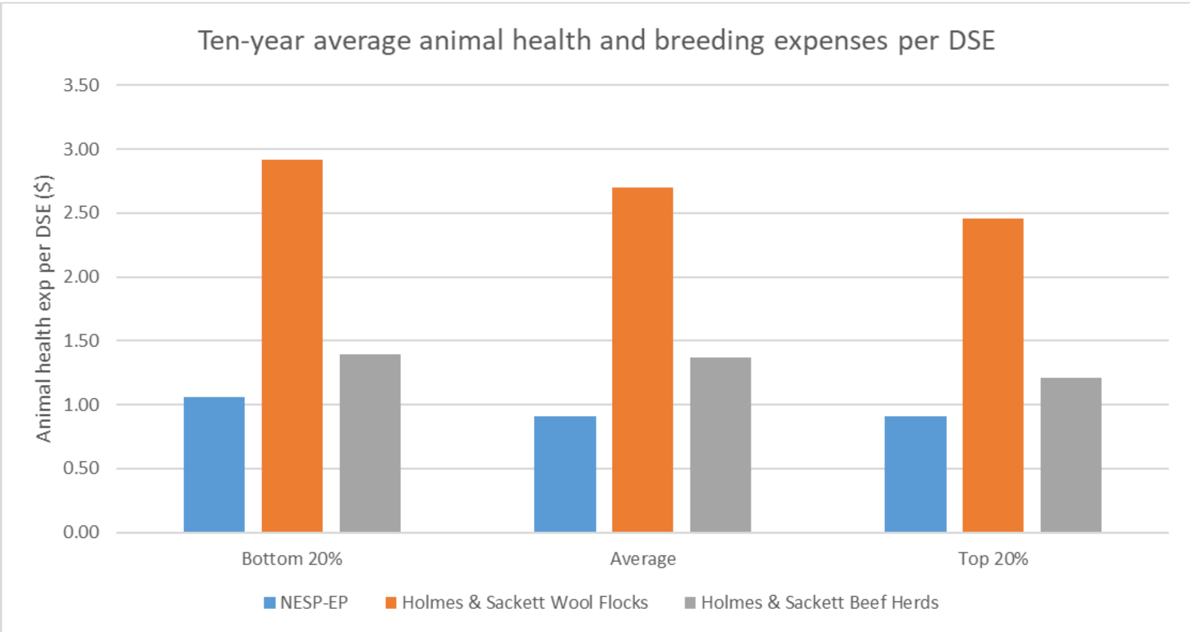

Figure 9: Chart of animal health and breeding expenses per DSE ten-year average (2006-07 to 2015-16) of top 20%, average and bottom 20% of producers

Table 7: Data table for animal health and breeding expenses per DSE ten-year average (2006-07 to 2015-16) of top 20%, average and bottom 20% of producers (Figure 9)

Ten-year average animal health and breeding expenses per DSE ($)	*Bottom 20%*	*Average*	*Top 20%*
NESP-EP	1.06	0.91	0.91
Holmes & Sackett Wool Flocks	2.92	2.70	2.46
Holmes & Sackett Beef Herds	1.40	1.37	1.21

7.2.1.8 Variable costs per DSE

Variable costs for the NESP-EP sample were compared to AgInsights. In general, variable expenses for the NESP-EP sample are lower than the AgInsights benchmark participants for all categories, except for the AgInisght Top 20% of cattle herds. The NESP participants had lower levels of expenditure across a wide range of input categories, preferring less reliance on purchased inputs. In structured discussions the techniques used to manage their farms were strongly based around the use of planned grazing for pasture and livestock management (including feed budgeting), weed management and to provide information about the quality of the season. This appeared to confer a lower cost base right through many expense categories in the farm business.

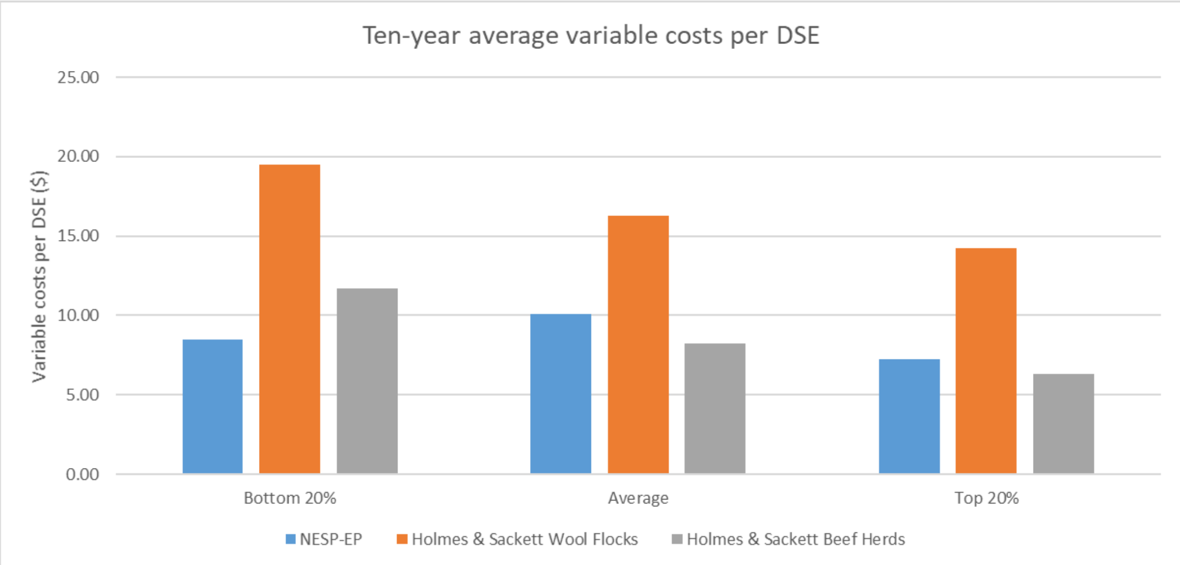

Figure 10: Chart of variable costs per DSE ten-year average (2006-07 to 2015-16) of top 20%, average and bottom 20% of producers

Table 8: Data table for animal health and breeding expenses per DSE ten-year average (2006-07 to 2015-16) of top 20%, average and bottom 20% of producers (Figure 10)

Ten-year average variable costs per DSE ($)	*Bottom 20%*	*Average*	*Top 20%*
NESP-EP	8.48	10.06	7.25
Holmes & Sackett Wool Flocks	19.52	16.25	14.26
Holmes & Sackett Beef Herds	11.73	8.23	6.31

7.3.1.1 Fixed costs per DSE

Fixed (overhead) costs are those farm business costs which are rarely able to be varied, for example council rates. Fixed (overhead) expenses show the least difference between the two samples. The top 20% and average of NESP-EP groups had slightly higher fixed costs, while the top 20% had slightly lower costs per DSE. Some NESP-EP participants had slightly higher overhead costs than others. These were commonly associated with businesses within the group purchasing land to expand their operation. In tracking the financial performance of these businesses, a time lag appears evident between the costs of expansion and the benefits (data in Appendix A). Some of the NESP-EP group has purchased additional land within the last 5 years, with a few participants also commencing new value adding businesses in this time. This may help explain some of the higher fixed costs for the NESP-EP group.

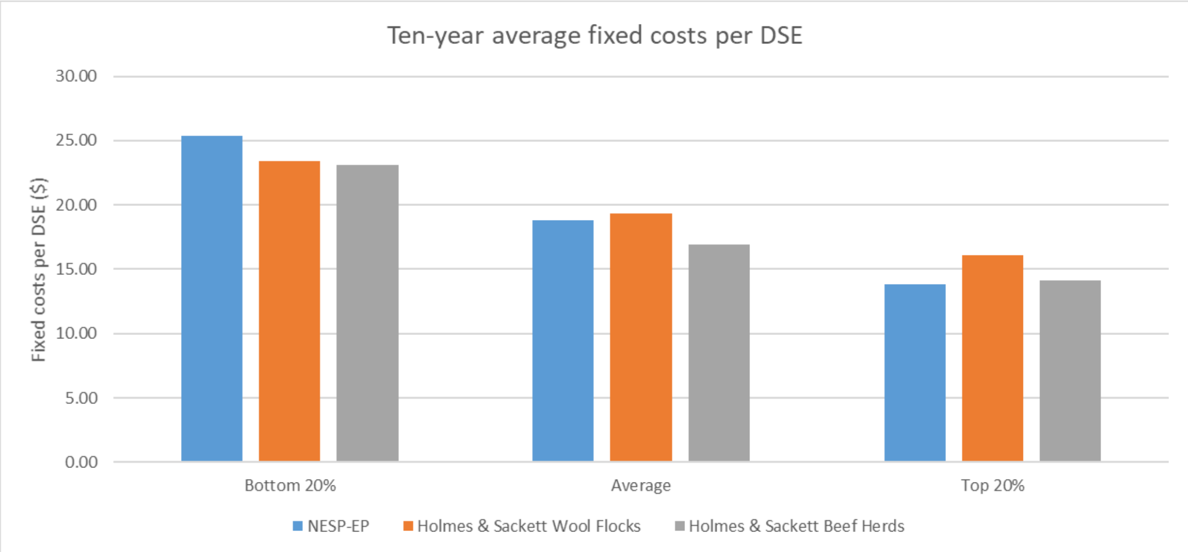

Figure 11: Chart of fixed costs per DSE ten-year average (2006-07 to 2015-16) of top 20%, average and bottom 20% of producers

Table 9: Data table for fixed costs per DSE ten-year average (2006-07 to 2015-16) of top 20%, average and bottom 20% of producers (Figure 11)

Ten-year average fixed costs per DSE ($)	*Bottom 20%*	*Average*	*Top 20%*
NESP-EP	25.40	18.84	13.85
Holmes & Sackett Wool Flocks	23.40	19.32	16.10
Holmes & Sackett Beef Herds	23.10	16.95	14.16

7.3.2 Comparison to ABARES Farm Survey contributors

This section presents the preliminary results from comparison of the NESP-EP sample (Type 1) with farms from ABARES farm survey (Type 2). Preliminary analyses for return on assets management (ROAM) and earnings before interest and tax (EBIT) per sheep equivalent (SE) are shown in Figures 12 & 13. These indicate that the NESP-EP sample has performed at least as well as the farms surveyed by ABARES over this period particularly in dry years. Regenerative farms also appear to have an increased degree of inter-annual stability, returning consistent financial returns with significantly reduced variability compared to conventional farms.

The preliminary results also show significant differences between regenerative and conventional farms in terms of both cost and profit profiles. These mirror the differences in key income and expenditure categories reported for NESP-EP farms versus AgInsights benchmarks and provide statistical confirmation of the differences inferred from those comparisons. Our statistical analysis identifies differences in income to expenditure profiles at a very high significance level ($p<0.001$), despite our small sample size (which would usually gear analyses towards a Type II error). Cost and profit profiles will be explored further to elucidate the mechanisms through which regenerative farms achieve strong financial performance and stability. We anticipate this analysis will be complete by the end of October and submitted for publication in a peer-reviewed journal in by the end of 2018.

ROAM for the NESP-EP sample (red) and ABARES Farm Survey (blue).

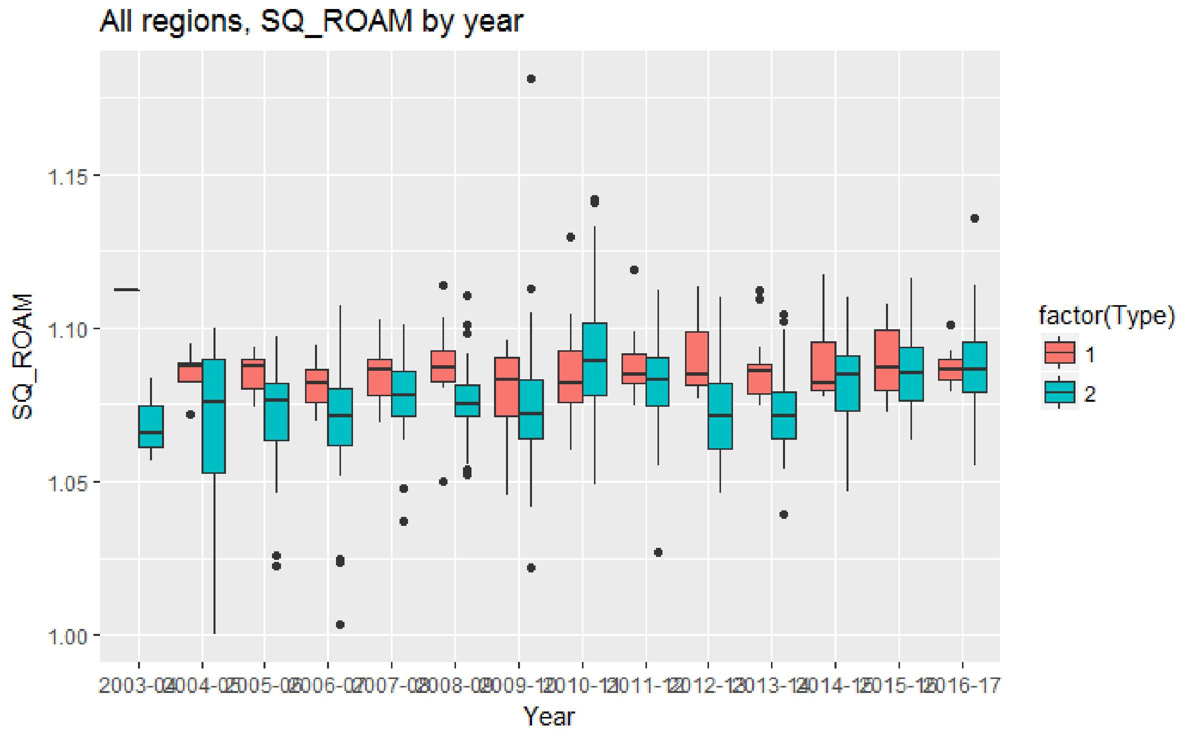

Figure 12: Return on assets managed - EBIT divided by the value of all assets under management (including land and livestock)

EBIT per sheep equivalent (SE) NESP-EP sample (red) and ABARES Farm Survey (blue).

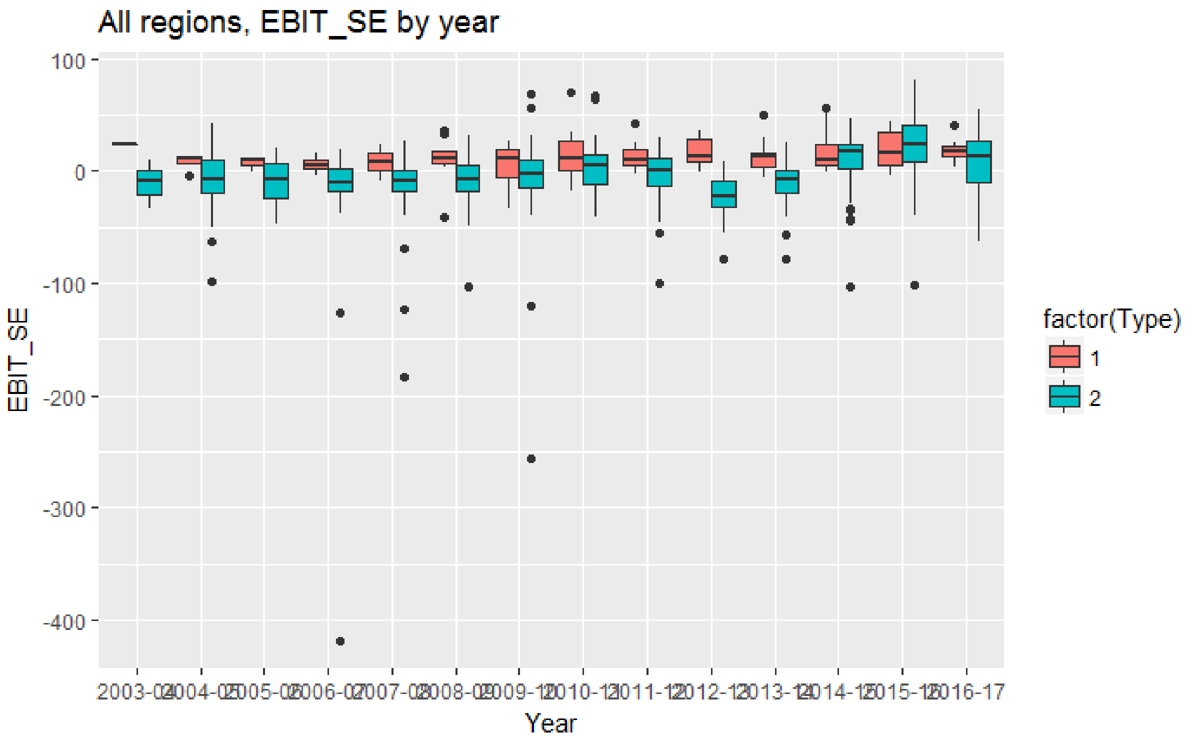

Figure 13: EBIT per sheep equivalent

7.4 Wellbeing

The wellbeing of farmers is important for several reasons. A person with high levels of wellbeing – broadly defined as a high quality of life and positive mental health – is better able to cope with challenges (such as drought or market changes often experienced by farmers), more likely to embrace change (such as technological innovation common in agriculture), better able to contribute to their community, and less likely to access support services. More specifically, farming is an occupation associated with a range of known occupational stressors that can threaten wellbeing. In particular, farmers often lack access to health support services due both to living in rural areas and social stigma associated with seeking support and are regularly exposed to challenges such as drought and market change that can threaten wellbeing (Schirmer et al., 2013).

There is growing interest in identifying strategies that can better protect the wellbeing of farmers and reduce the risk of poor mental health. In addition to traditional health interventions, the potential of non-traditional interventions delivered outside the health sector is increasingly recognised as an important part of supporting farmer wellbeing (Schirmer, 2017, Schirmer et al., 2013).

Natural resource management activities have been proposed as potential non-traditional health interventions in past studies (Schirmer, 2017, Schirmer et al., 2013), as they are argued to provide avenues by which stresses associated with land management can be reduced, and by which confidence in farm decision making can be increased, both factors supporting wellbeing.

Regenerative farming represents a system of land management that changes how farmers think about and make decisions about land management, and the resulting environmental, economic and social outcomes of their farming. Proponents of regenerative farming often claim it has benefits for wellbeing of those who engage in it, but there is currently little evidence to support this claim (Brown et al., in preparation, Schirmer and Brown, in preparation).

If regenerative farming has the benefits for wellbeing that proponents claim, it has significant potential as a wellbeing intervention that can reduce risk of poor mental health amongst farmers and improve the social sustainability of farming communities through supporting wellbeing in those communities. The wellbeing benefits of regenerative farming therefore should be examined to better understand if regenerative farming does have the wellbeing benefits its proponents claim.

This study examined whether best practice regenerative graziers (BPRG) have different levels of wellbeing compared to other farmers, as a first step in evaluating the claims of proponents. Higher wellbeing levels would indicate potential for regenerative farming to act as a preventative health measure that reduces the risk of a person experiencing poor mental health. It is important to distinguish here between preventative measures – which reduce risk of health problems occurring – and health interventions implemented to address health problems when they occur. Regenerative farming is not proposed as a way of addressing existing health issues here and does not replace interventions that support farmers experiencing these problems. Rather, if there is evidence of improved wellbeing amongst regenerative farmers, this indicates that encouraging wider adoption of regenerative farming could over the longer term reduce demands for these services by reducing the numbers of farmers who reach a point at which they have mental health or other wellbeing associated problems that require intervention.

7.4.1 What is wellbeing?

The wellbeing of individual people can be defined as a state in which a person is able to realise their potential, cope with normal stresses, and contribute to their household, community, and workplace. People with high levels of wellbeing have a high quality of life, and more likely to cope with challenges and embrace change. Many things contribute to a person's overall wellbeing. These include their safety and security, their physical and mental health, their relationships and social networks, their access to goods and services, and the fairness of the society they live in, amongst others.

Wellbeing can be measured objectively or subjectively. Objective measures of wellbeing are measured through societal indicators of progress, such as level of income and education. Alternatively, subjective measures comprise individual cognitive evaluations about the various aspects of one's life. Measuring subjective wellbeing provides real insight into a person's life, and often provides very accurate reflections of objective indicators of wellbeing. It also provides insights into areas that cannot be measured objectively, such as the quality of a person's relationships, their inner world of beliefs and emotions, and their confidence in their ability to achieve what they desire to in life. It is for this reason that there has been increasing interest and recognition of the use of subjective measures of wellbeing, particularly when concerning policy development (Dolan et al., 2011).

This report uses three indicators to examine the wellbeing of people: Global Life Satisfaction (GLS), the Personal Wellbeing Index (PWI) and Worthwhileness. The GLS and PWI measures are 'hedonic' measures that examine how pleasurable people find life, whereas the Worthwhileness measure examines how meaningful people find their life, in the form of feeling the things they are doing in their lives are worthwhile.

Global Life Satisfaction (GLS)

GLS is recognised internationally as a key indicator of the overall wellbeing of individual people (Cheung and Lucas, 2014), and comprises of a single question whereby a person is asked to rate their life as whole.

Thinking about your own life and personal circumstances, how satisfied are you with your life as a whole?	Scale from 0 (completely dissatisfied), to 10 (completely satisfied).

Personal Wellbeing Index (PWI)

This multiple-item measure is recognised internationally as a valid and reliable measure of subjective wellbeing, comprising an aggregated score of seven items which assess satisfaction across numerous life domains (The International Well Being Group, 2013). Results from both the aggregated score of the seven items, along with scores from each individual domain are used in this report.

PWI score	Score was calculated on the combined mean score of individual PWI domain items. Scale was multiplied by 10 to produce a score between 1 (lowest possible wellbeing) to 99 (highest possible personal wellbeing)
Individual PWI domains	***Each item measured on a scale from 0 (completely dissatisfied), to 10 (completely satisfied).***
Standard of living	How satisfied are you with your standard of living?
Health	How satisfied are you with your health?
Achieving	How satisfied are you with what you are currently achieving in life?
Personal relationships	How satisfied are you with your personal relationships
Safety	How satisfied are you with how safe you feel?
Community	How satisfied are you with feeling part of your community?
Future security	How satisfied are you with your future security?

Worthwhileness

This single-item measure was developed by the UK Office of National Statistics and used to assess how worthwhile people feel their lives are. This measure has been used in the UK Integrated Household Survey and the annual Subjective Well-Being Annual Population Survey dataset (Oates et al., 2017).

Overall, to what extent do you feel the things you do in your life are worthwhile?	Participants responded on a scale from 0 (not at all), to 10 (completely worthwhile).

7.4.2 Methods

Both qualitative and quantitative research methods were used to examine whether best practice regenerative graziers (BPRG) have different levels of wellbeing compared to other farmers. There were three components to data collection and these are outlined below.

7.4.2.1 Survey data from BPRG

Our sample of BPRG were asked to complete an anonymous paper survey. The survey asked participants about their subjective wellbeing using various measures (Life Satisfaction, Personal Wellbeing Index and Worthwhileness), along with known wellbeing determinants such as farming self-efficacy and self-reported farm financial performance. Measures used in this survey were identical to measures used in the Regional Wellbeing Survey 2016 (RWS). Average scores from this group were then compared with samples of graziers drawn from the RWS.

7.4.2.2 Regional Wellbeing Survey 2016 (RWS) data from NSW graziers

The Regional Wellbeing Survey is a large survey of 13,000 Australians, conducted every year since 2013. In 2016, approximately 4,000 farmers participated in the survey. The survey is unique in that is focuses on the experiences of Australians living in regional, rural and remote areas of Australia, while also including a small sample of residents living in Australia’s capital cities. The survey is described in detail in reports available at www.regionalwellbeing.org.au.

7.4.2.2.1 Semi-structured interviews with BPRG

Given the exploratory nature of this research, semi-structured interviews with our sample of BPRG’s were conducted. Interviews aimed to explore the perspectives of the BPRG group of how regenerative farming had impacted on their wellbeing and wellbeing determinants. Thematic analysis of notes from interviews with 9 participating BPRG’s was conducted, and results helped interpret findings from survey data analysis.

7.4.3 Understanding the goals of Regenerative Farmers:

While the concept of Regenerative Grazing is commonly discussed from an ecological perspective, focusing just on the biophysical neglects the impact of the approach on the people living and working on the land as well as the impacts on farm profit. The widening out of the concept of Regenerative Grazing to encompass Social and Financial aspects is a feature of this project.

To date there has been little work done on the social aspects of Regenerative Grazing. A component of the project examined the priorities (goals) of Regenerative Farmers. In this part of the study 27 Regenerative Farmers in the Grassy Woodlands of NSW were surveyed to ascertain their goals. The survey tool used was extracted from the Vanguard Business Services On Track Farm Family Social Indicators, which have been in wide commercial use for over 15 years. Each decision maker was asked to select the most important goals from the list of 24 options (see Table 10), and then asked to prioritise these choices in importance from 5 to 1.

Table 10: Possible goals for farm businesses

1	Maximum income
2	Satisfactory income
3	Keeping out of debt
4	Safeguarding income
5	Gaining recognition
6	Family tradition
7	Being own boss
8	Children in worthwhile occupations
9	Farm in the family
10	Working with family members
11	Pride of land ownership
12	Self-respect
13	Good crops, pastures, and stock
14	Farm as a business
15	Important to the community
16	Leaving farm in good/better condition
17	Improving biodiversity
18	Special abilities and aptitudes
19	Meeting a challenge
20	Enjoyment of work
21	Making farm productive
22	Healthy outdoor life
23	Working hard
24	Independence

7.4.4 Producer goals

The results from the survey is presented in Figure 14 below and gives an insight as to the goals (priorities) of the sample of regenerative graziers in the project.

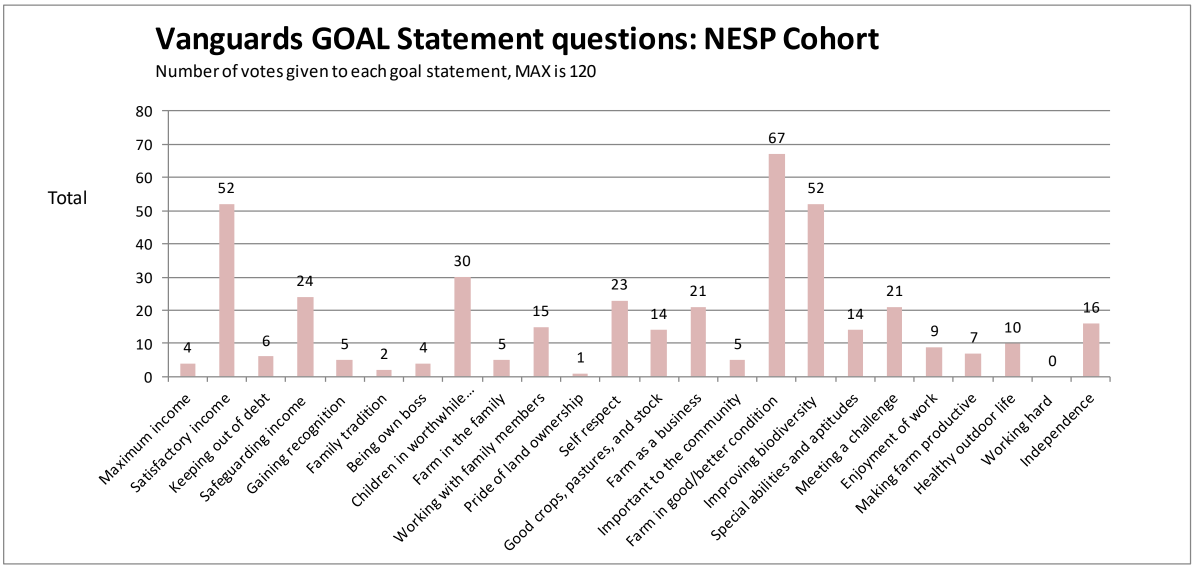

Figure 14: aggregated responses to questions about goals

It is interesting to note that the three most common goal statements were:

- Leaving farm in good or better condition (67)
- Improving biodiversity (52)
- Achieving a Satisfactory level of income (52)

Not surprisingly the highest priorities of the regenerative graziers were to “Leave their Farm in good or better condition” and to “Improve biodiversity”. The ecological reports contained within this project indicate that substantial and measurable gains are being made towards these two goals.

The most important financial goal was to achieve a “Satisfactory level of income” (52). It is interesting to note that “Maximizing Income” scored only 4. The surveyed information was reinforced in the facilitated conversations, as the participants spoke about achieving “enough” profit to sustain their requirements (social, physical and financial) rather than to extract the maximum profit from the resources (and hence potentially conflict with their two highest goals).

This is an important distinction between regenerative graziers and the conventional commercial approaches to farming where a greater emphasis is placed on *profit maximization.* Given the regenerative graziers clear management emphasis on Landscape Health, it could be reasonably expected that the magnitude of farm profit may be lower. Presented in the Profitability section, the measured level of profit achieved in this study period from the regenerative graziers was broadly comparable with the producers working with the Holmes and Sackett Benchmarking group over the same period. These producers, as described in the Holmes and Sackett report, are highly profit motivated.

This is of great interest as the regenerative graziers, despite not having the same focus on profit, were able to achieve a comparable level of profit *as a by-product of their land management approach.*

7.4.5 Producer wellbeing

This section examines whether best practice regenerative graziers (BPRG) have better wellbeing than other comparable graziers. To do this, the subjective wellbeing of the 14 BPRG was measured using identical measures to those used in the Regional Wellbeing Survey (RWS). This enabled the subjective wellbeing of the BRPG to be compared to similar graziers who completed the RWS. As noted earlier, in addition to measuring overall wellbeing, measures of farming self-efficacy were also examined. This was done as a person's self-efficacy – their confidence in their ability to achieve desired outcomes in life – has been demonstrated to have a significant influence on their wellbeing, and because regenerative farmers often argue that adopting regenerative farming practices and processes improves their confidence in making decisions on the farm (indicative of higher self-efficacy). Finally, some measures of self-rated farm financial performance were also compared, as financial wellbeing is a known determinant of a person's overall wellbeing and is also argued by regenerative farmers to be improved by engaging in regenerative farming.

This section examines findings in three parts:

- Subjective health and wellbeing. The subjective health and wellbeing of BPRG is compared to other farmers, using multiple standard measures.
- Farming self-efficacy. Whether and when BPRG report higher self-efficacy than other farmers is examined using questions developed for the Regional Wellbeing Survey. This helps identify whether any differences in wellbeing of BPRG compared to other farmers is likely to be due to improvements in confidence in farm decision making that improve farm-related self-efficacy.
- Self-assessed farm financial performance. The farm financial performance reported by BPRG is compared to other farmers, to better identify if there are differences in self-reported farm financial performance. This again can provide insight into the processes that may be contributed to differences observed in the wellbeing of BPRG compared to other farmers.

To meaningfully compare the subjective wellbeing of BPRG to other graziers, it was necessary to ensure there was an 'apples and apples' rather than 'apples and oranges' comparison. Wellbeing is well documented to change throughout a person's lifespan and in association with characteristics such as gender. Given this, it was important to ensure that similar age groups of farmers were compared. We compared BPRG to other NSW farmers who were:

- Graziers: All the BPRG engaged in grazing. When identifying a comparison sample, only graziers were included in the comparison sample, as past studies have shown differences in wellbeing and farm financial performance between those engaged in grazing and cropping (Schirmer et al., 2015).
- Gender: Farmers of different genders are known to have differing subjective wellbeing (Schirmer et al., 2015). All the BPRG were male, suggesting a need to compare the BPRG to other male farmers. However, as other projects are likely to also include female BPRG, we have also included some comparisons that include all farmers (male and female).
- Age: Wellbeing has been shown to typically change with age, with people aged 65 and over often reporting much higher levels of subjective wellbeing compared to those who are younger. The general population of farmers includes many older farmers, with farmers having an older average age compared to other people in the workforce (Monaghan et al., 2017). This means that data from the RWS will be influenced by the large cohort of farmers aged 65 and older. The 14 BPRG were almost all aged between 40 and 60 (with two

exceptions, both in their 60s). This suggested a need to ensure wellbeing of BPRG was compared to the best possible age comparison group (40 to 60, into which almost all the 14 fell), while also comparing to the general farming population (which includes those aged 65 and older).

Subjective health and wellbeing

The group of BRPG examined in this study had significantly higher wellbeing than other similar farmers. This section explains these findings.

Subjective wellbeing measures are typically highly stable over time. To give an example of how stable they are, when measuring subjective wellbeing from 0 to 100, across an entire adult population, it is common to see the average score across the population stay within a range of two to three points over many years, with no variation outside that small range. For example, the Global Life Satisfaction (GLS) measure we examined, together with the Australian Unity Personal Wellbeing Index (PWI, also measured in this study), have both been measured for many years using a representative sample of the Australian adult population. Between 2002 and 2017, the GLS average score across the population ranged between 75.9 and 79.1 – a range of 3.2, despite the underlying measure being measured from 0 to 100. The average PWI score during the same period ranged from 74.1 to 76.6, an even smaller range (Capic. T. et al., 2017). Similarly, the Regional Wellbeing Survey shows very little variation in average subjective wellbeing scores, with a range of 2 to 3 points in the average across years (Schirmer et al., 2016).

This means that in general, a group that has mean wellbeing scores more than 3 points different to the average has significantly higher wellbeing than the average. As can be seen in Figure 15, the 14 BPRG had average wellbeing scores for the three key subjective wellbeing measures that were more than three points higher than the average wellbeing scores of the two most comparable groups (other male graziers aged 40 to 60, and all other graziers aged 40 to 60). This was the case for the Personal Wellbeing Index, Global Life Satisfaction (satisfaction with life as a whole), and feeling their lives were worthwhile. The difference was greatest for the eudaimonic[7] measure of wellbeing, with the BPRG significantly more likely to feel their lives were meaningful than other comparable farmers.

These findings show that the group of BPRG had wellbeing significantly higher than average. Whether this result would apply to regenerative farmers more broadly depends on how representative the 14 BPRG examined in this study are of the broader population of regenerative farmers, something not examined in this study.

[7] Purpose, meaningfulness and success is wellbeing.

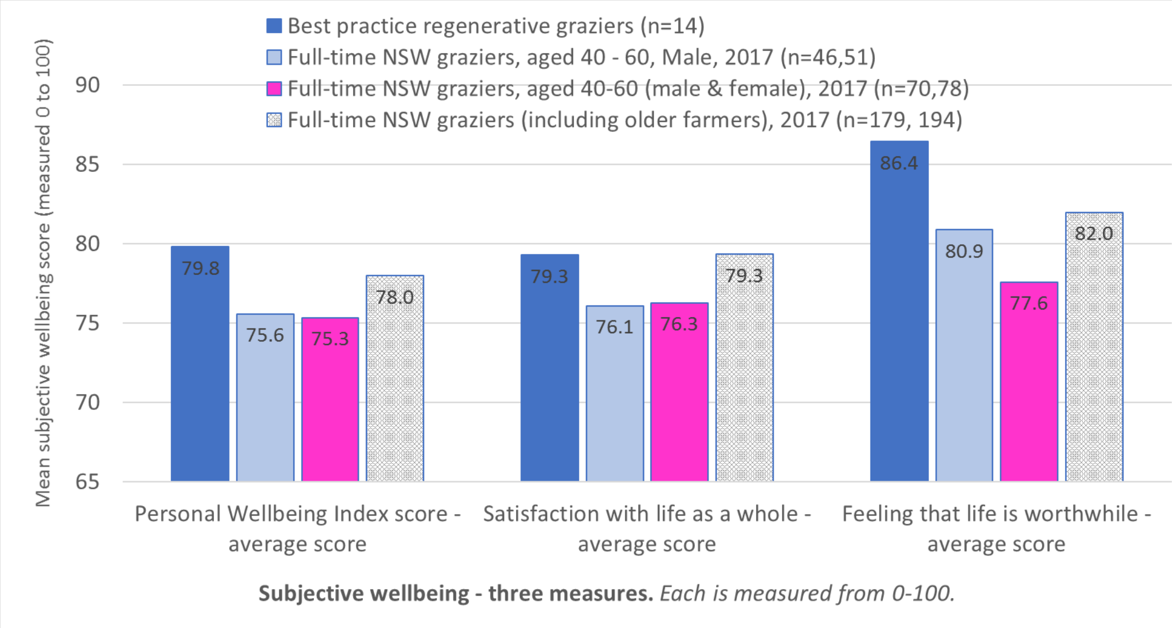

Figure 15 Subjective wellbeing of best practice regenerative graziers compared to other graziers

The Personal Wellbeing Index is made up of several individual measures, each measuring different dimensions of wellbeing. Each of these was examined, to identify whether it shows the wellbeing of regenerative farmers differing more on some measures than others when compared to other graziers of similar age. As shown in Figure 16, BPRG were much more satisfied with their health, and significantly more satisfied with their future security, what they were achieving in life, and their personal relationships. They were also slightly more satisfied with their standard of living. Their level of satisfaction with how safe they felt and feeling part of their community was similar to other graziers. This suggests that regenerative grazing may contribute to wellbeing via some specific pathways (improved health, satisfaction with achievements, feeling secure about the future, and personal relationships).

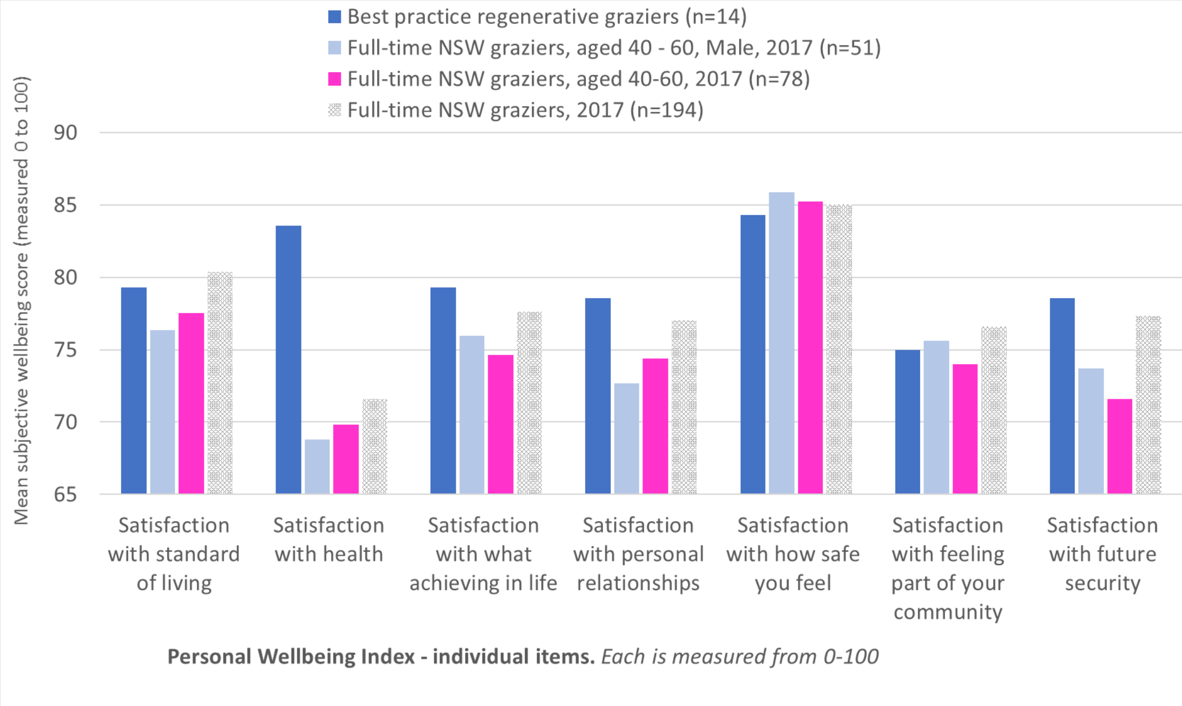

Figure 16 Personal Wellbeing Index – individual measures, comparison of best practice regenerative graziers and other graziers

To further examine the large difference in satisfaction with health, we examined the 'general health' measure. This is a measure used in many surveys, which asks participants to self-rate their health as being excellent, very good, good, fair or poor. It has been shown to be a robust predictor of objectively measured health outcomes (De Salvo et al, 2006). Shown in Figure 17, BPRG were much less likely to report being in fair or poor health (none reported this, compared to 13.7% of full-time mail NSW graziers aged 40 to 60), and much more likely to report being in very good or excellent health than average (64.3% compared to 39.2% of full-time male graziers aged 40 to 60). This again suggests better health amongst BPRG compared to other graziers of similar age.

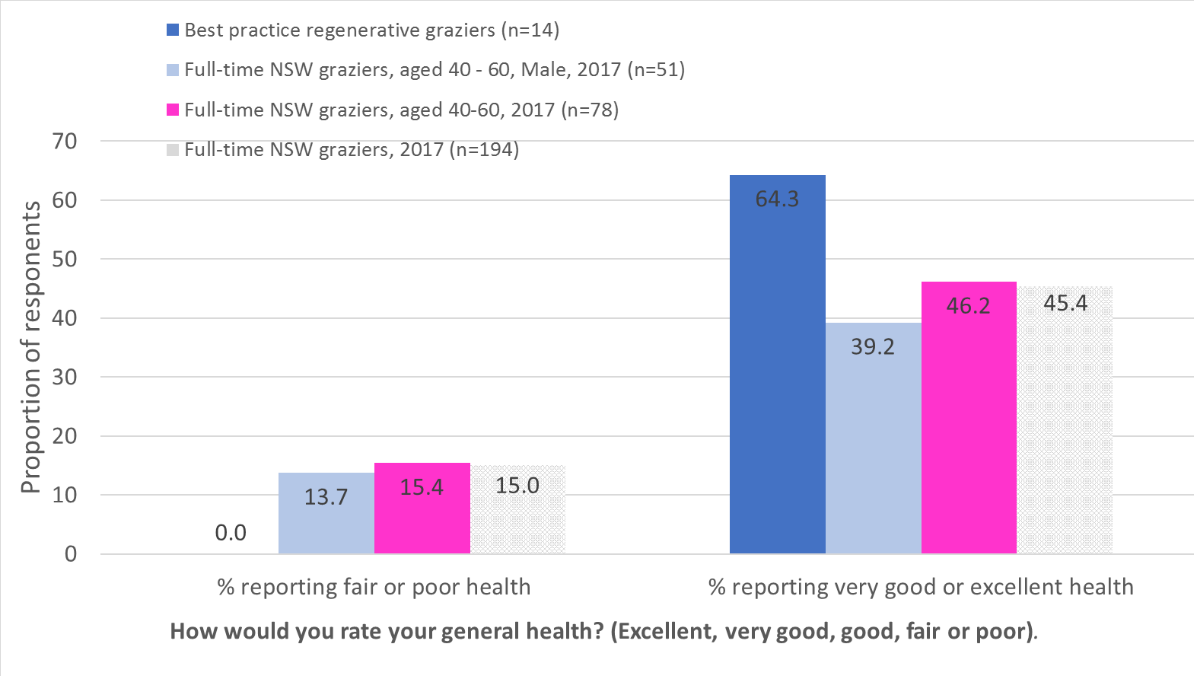

Figure 17 General health of best practice regenerative graziers compared to other graziers

Finally, we examined psychological distress levels amongst BPRG compared to other farmers (Figure 18. Psychological distress is a measure of what is sometimes termed ‘illbeing’. ‘Wellbeing’ and psychological distress are not a continuum: while highly correlated, a person can simultaneously experience some types of illbeing (e.g. psychological distress or major physical illness) and wellbeing (high work satisfaction, or positive overall ratings of quality of life) (Massé et al. 1998). BPRG reported slightly but not significantly lower levels of distress compared to other groups.

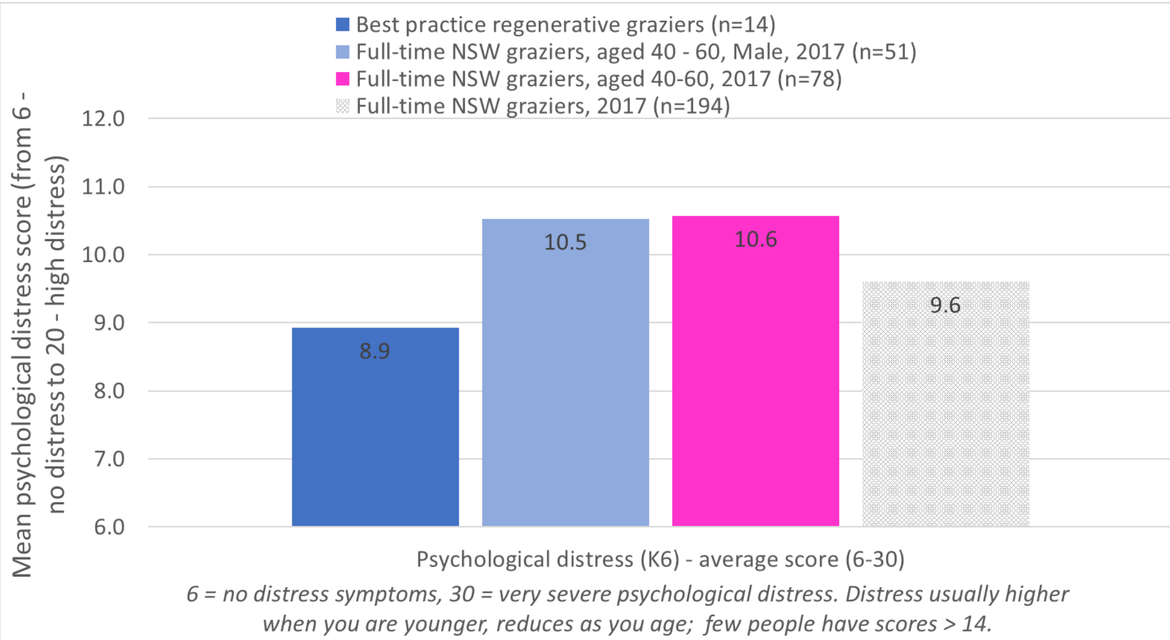

Figure 18 Psychological distress of best practice regenerative graziers compared to other graziers

Overall, the results show that BPRG had significantly higher wellbeing than comparison groups of graziers, consistent with the argument made by proponents that engaging in regenerative grazing is positive for their wellbeing.

Farming self-efficacy

To better understand why regenerative farmers might have better wellbeing, we examined two common ‘wellbeing pathways’ that have been suggested in past work to be ways that improved natural resource management may improve farmer wellbeing (Schirmer et al. 2013). The first (examined in this section) was farming self-efficacy, meaning the confidence farmers have that they can achieve their farming goals. Self-efficacy is a well-established predictor of overall wellbeing: people who are more confident in being able to achieve desired life outcomes in general report much higher levels of wellbeing (Hobfoll, 2002). In the case of regenerative farming, proponents often argue that they feel more confident in being able to achieve farming goals, particularly those related to land and water management and production decisions. This was measured using a ‘farm self-efficacy’ scale that examined the extent to which farmers felt confident about their ability to engage in different aspects of their farm management.

As shown in Figures 19 and 20, BPRG reported higher farming self-efficacy than all other groups of farmers they were compared to. They were more confident in being able to achieve the things they wanted to on their farm, being able to handle market conditions, and meeting farm business objectives, although for these three the differences were smaller than for others. They were much more likely than other farmers to feel confident they could make the right decisions about farm management, cope well with difficult conditions on the farm, maintain and improve health of vegetation, land and water. They also felt much more optimistic about their farming future than other farmers. These findings all suggest that regenerative farming is improving self-efficacy of farmers, and in particular better enabling them to cope with challenging conditions and make effective decisions on the farm, all things which are known to have positive effects for overall wellbeing.

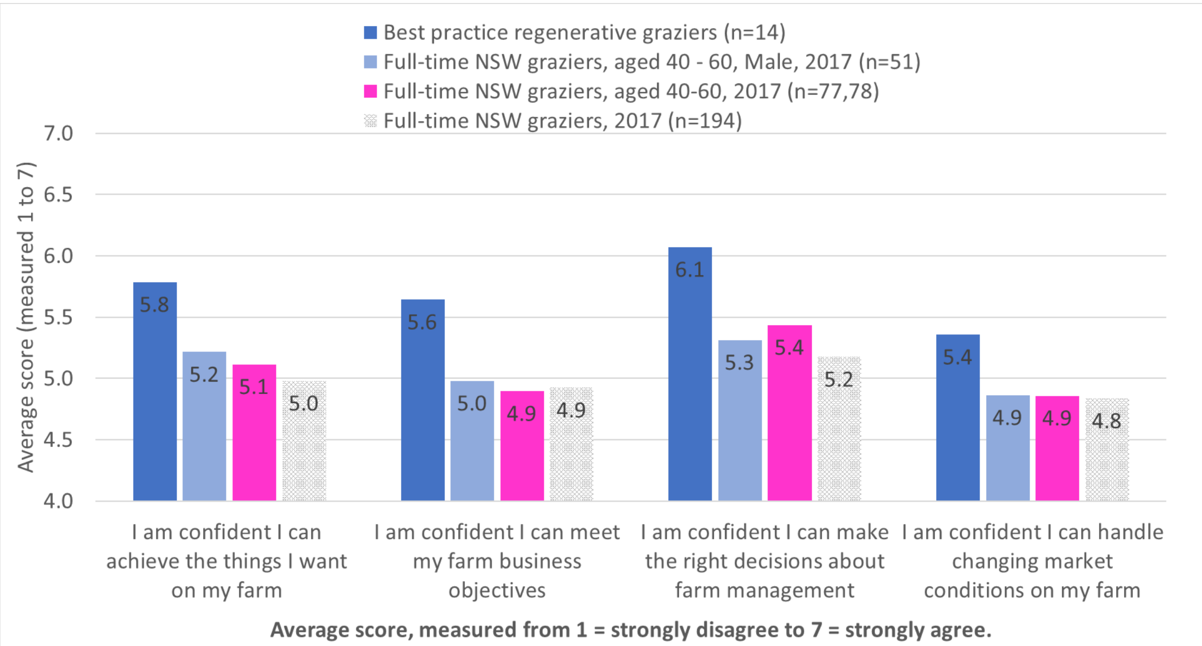

Figure 19 Farming self-efficacy – Part 1

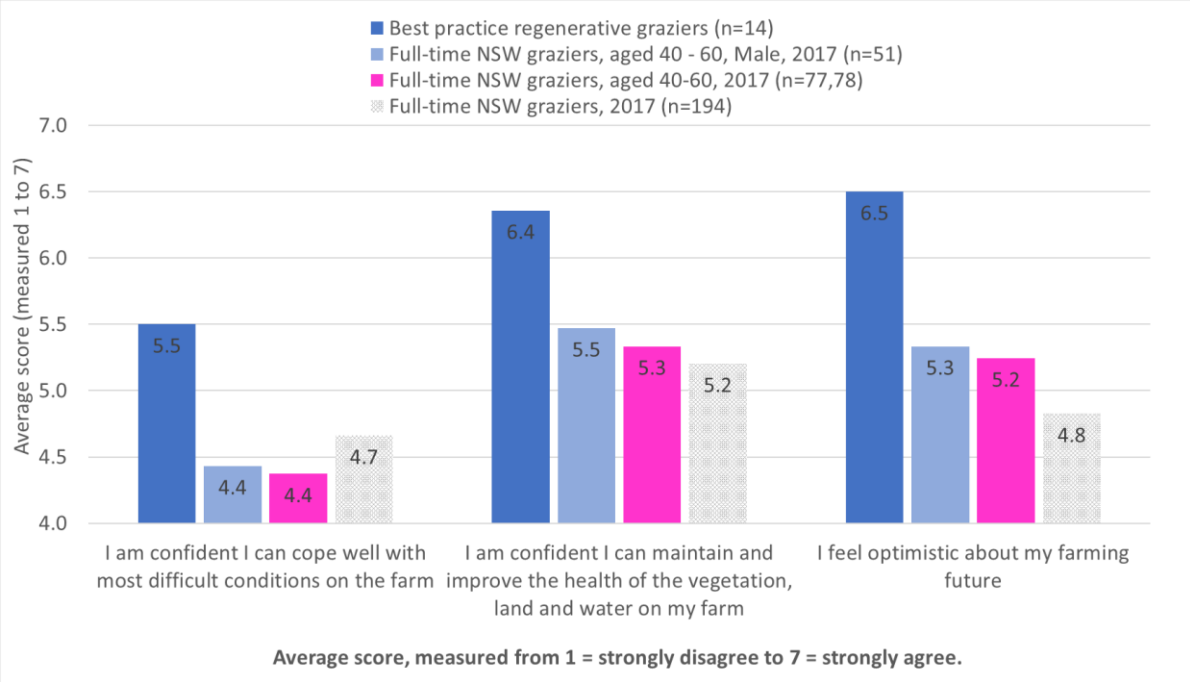

Figure 20 Farming self-efficacy – Part 2

Self-assessed farm financial performance

The second 'wellbeing pathway' we examined was self-assessed farm financial performance. A person's financial status is a known predictor of wellbeing and has also been identified in previous studies as a pathway by which engaging in improved natural resource management may contribute positively to farmer wellbeing (Schirmer et al. 2013).

Farmers were asked to identify whether their farm had, on average over the last three years, made a loss or profit on the farm (Figure 21). BPRG were much more likely to report making a moderate to large profit (64.3% compared to 39.2% of full-time male graziers aged 40 to 60). They were, however, slightly more likely to report experiencing farm financial stress (Figure 22), although differences were small. They were more likely than other farmers to report being satisfied with their farm financial performance (Figure 23), and to report having very good cash flow. Overall, this indicates that BPRG report better farm financial performance compared to other graziers, which may be contributing to the higher levels of wellbeing observed amongst BPRG.

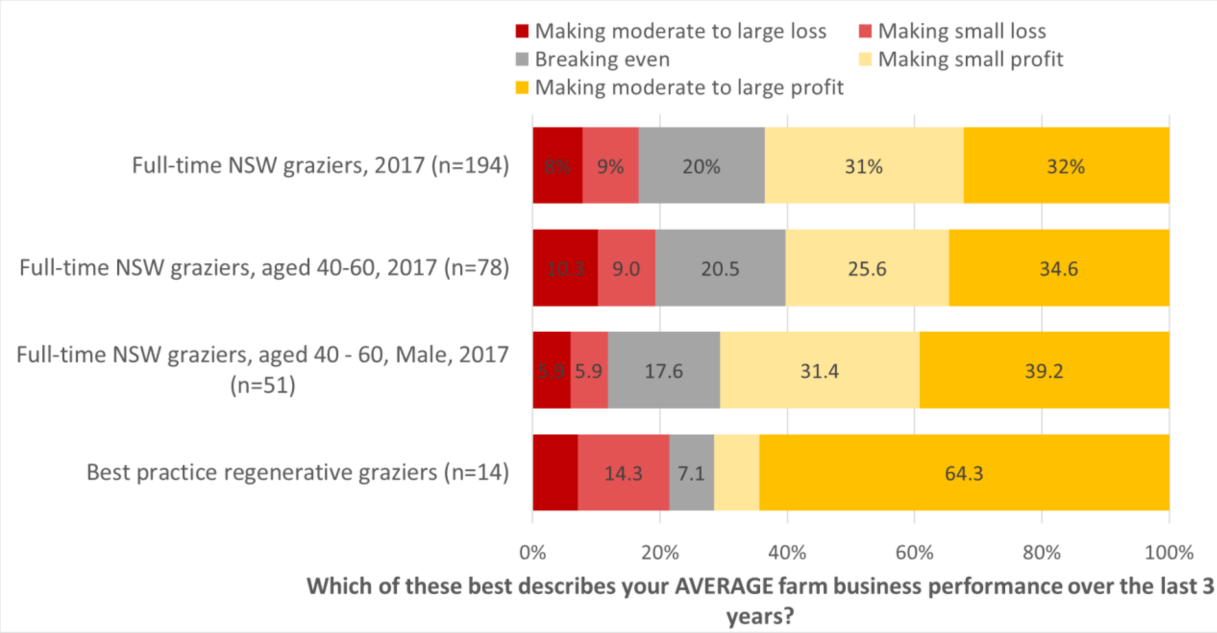

Figure 21 Average farm business performance in last three years, self-reported

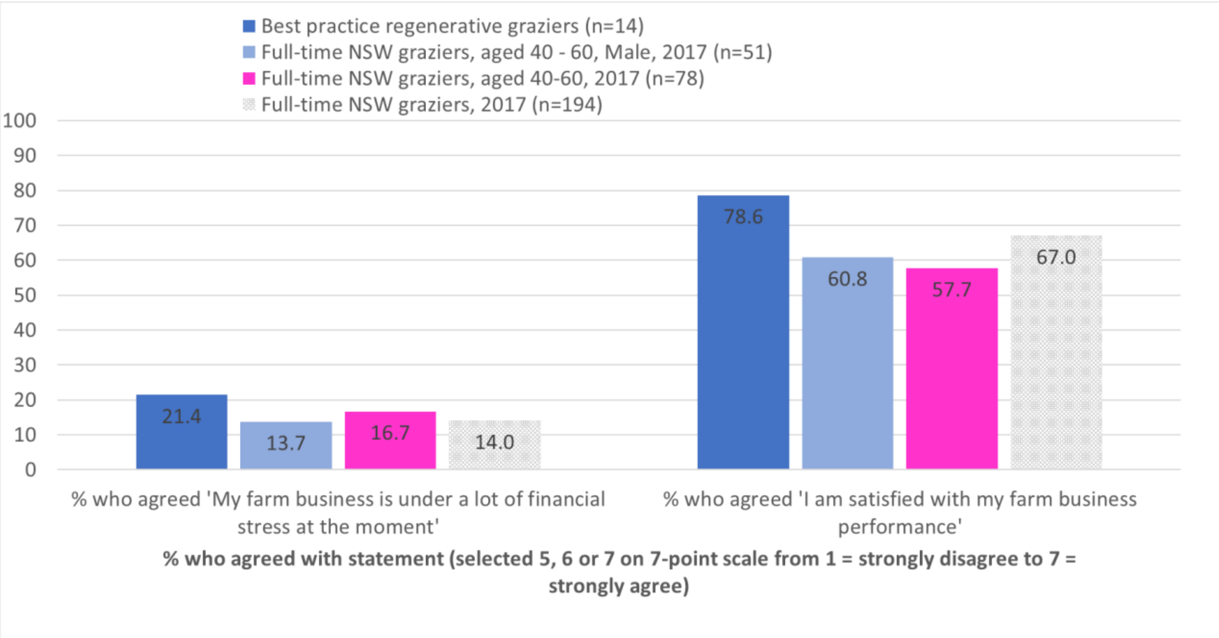

Figure 22 Farm financial stress and satisfaction with farm business performance

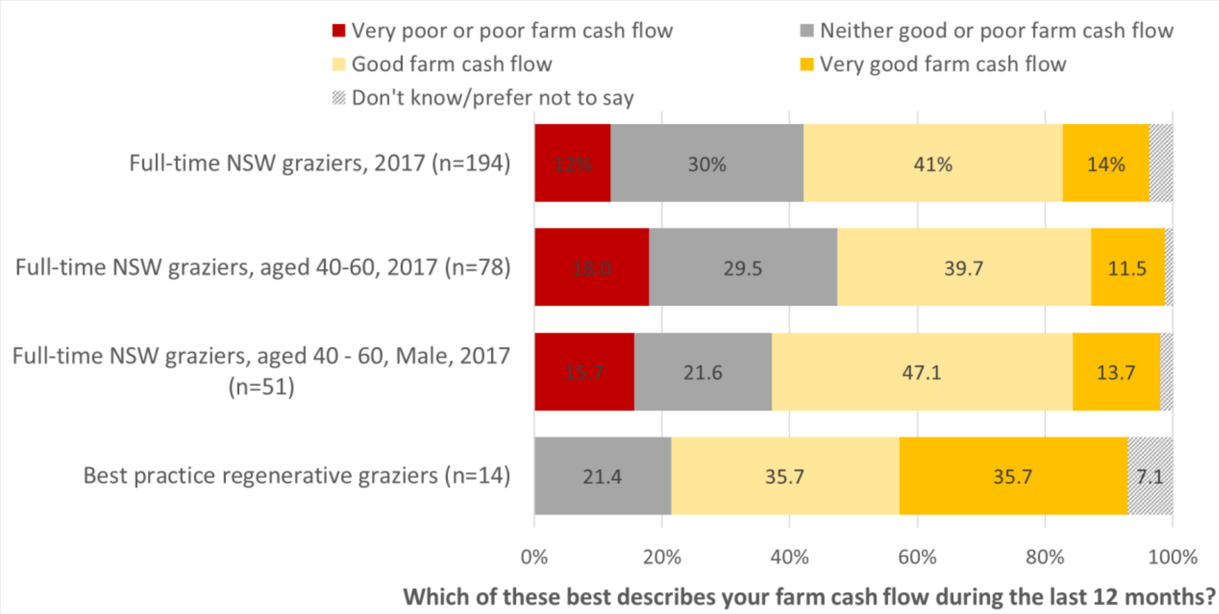

Figure 23 Self-reported farm cash flow status in last 12 months

Findings – semi-structured interviews

Thematic analysis of notes from semi-structured interviews with 9 BPRG's identified four main themes; (1) self-efficacy, (2) feeling good, (3) relationships and (4) financial stability. These are outlined in Diagram 1. The majority of farmers spoke about the positive benefits regenerative farming has had on their wellbeing and identified potential pathways for wellbeing as being related to increased self-efficacy, increased financial resilience, and more available time off-farm to spend with family and friends. Additionally, some farmers spoke about psycho-social benefits related to regenerative farming, including increased optimisms, reduced stress and the pride and enjoyment they experienced from seeing improvements to their landscape. A small number of farmers spoke about being more aware of healthy behaviours since adopting regenerative farming, such as being more aware of the types of food they and their family ate, and the importance of physical activity.

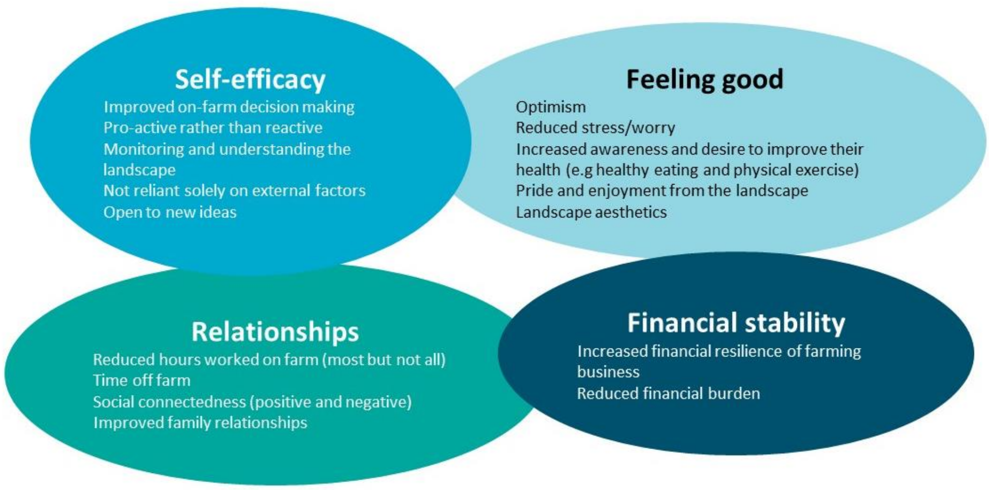

Diagram 1: four main themes identified from semi-structured interviews with NESP-EP study participants

The four themes identified from the semi-structured interviews reflect some of the findings from the analysis of survey data. Interviews with BPRG identified self-efficacy and reduced financial stress as wellbeing determinants that have been improved since implementing regenerative agriculture. This was also reflected in higher average scores on questions relating to self-efficacy, financial performance, and future security. Health related self-efficacy was also identified by several participants in semi-structured interviews which may also explain the high average scores BPRG reported for satisfaction with health. Although BPRG spoke about some of the negative impacts of regenerative farming had on relationships with the broader farming community, this was not reflected in the survey data analysis.

7.5 Season Quality

Agriculture is greatly impacted by variability in the quality of seasons and the project sought to include this as a variable in analysis of comparative profitability. An aspirational goal for the project was to associate the financial profitability of each participant with the quality of the season experienced by each producer in each year of the study. At the time of the study NSW DPI were running a very informative natural resource management newsletter that included appropriate information about the quality of the season. We requested assistance from the team to compile this information over the study period to use as a classification of quality. Whilst initial agreement was obtained, personnel changes occurred, and we were not successful in getting the information. NSW DPI has been engaged again on this topic and we are optimistic that a subsequent study may allow a robust analysis of associations between profitability and season quality.

To provide a prototype to inform the direction of this analysis, Dr Ivan Hanigan generously provided a Hutchinson Drought Index for each participating property so that the intensity and duration of rainfall deficiency could be investigated as a proxy for season quality. In an experimental approach using these indices, each financial year was classified as favourable or unfavourable based on whether a rainfall deficiency in the financial year was observed. Feedback from participants about the usefulness of the season quality classifications was sought. Since they found this useful, we produced a simple chart to indicate the quality of seasons for each participant location. Great caution should be taken with interpretations of apparent associations from these simple indicators.

The team considered using the Southern Oscillation Index (SOI) as a proxy for season quality should we be unable to access other sources. The SOI gives an indication of the development and intensity of El Nino or La Nina events in the Pacific Ocean. Sustained negative values are usually accompanied by a reduction in winter and spring rainfall over much of eastern Australia and the Top End. Sustained positive values are associated with stronger Pacific trade winds. Together these give an increased probability that eastern and northern Australia will be wetter than normal. It has been used successfully by NSW OEH in similar work and is regarded as appropriate for this project as well (Heagney, L., in preparation).

The southern oscillation index (SOI) for the period is shown in Figure 24. It shows negative values during 2005, 2007, 2009 and 2015. Incorporation of season quality as a variable in the analysis is an aim for a journal article later this year.

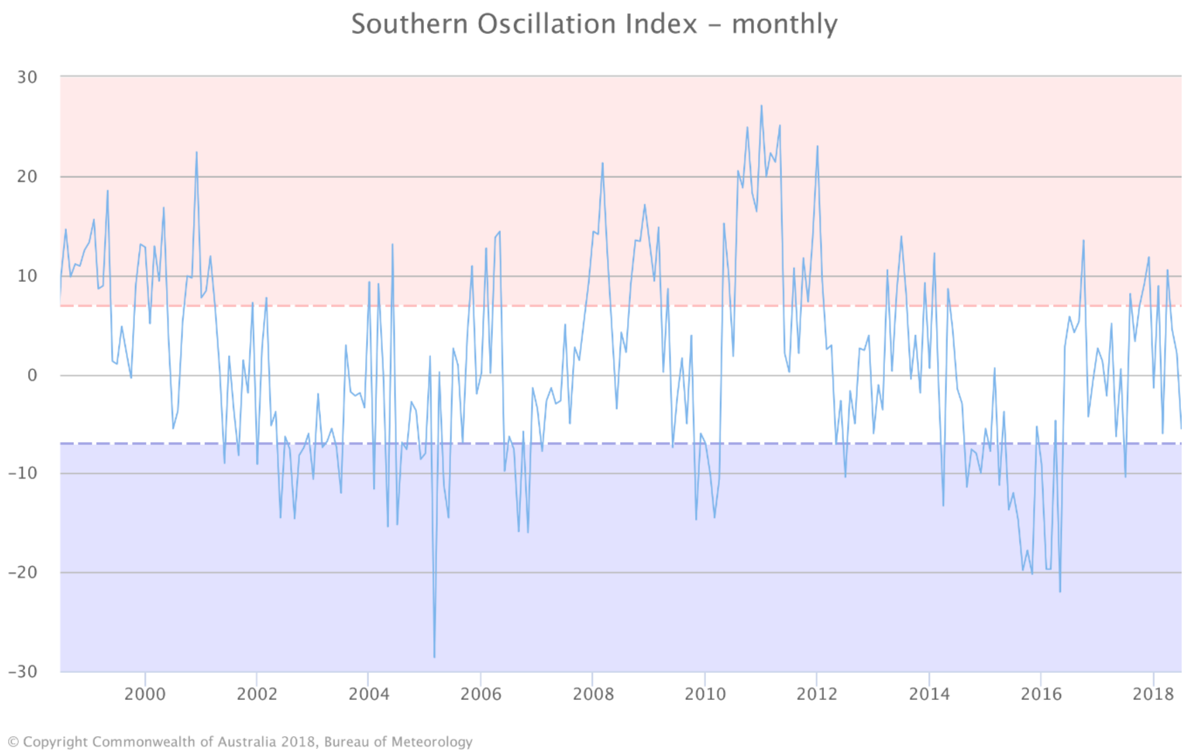

Figure 24: SOI for the period of interest for the NESP-EP farm profitability and biodiversity project. Source: Australian Bureau of Meteorology, Canberra Australia accessed July 13, 2018.

The output of the experimental development of season quality 'indices' (based on the Hutchinson drought index), classified favourable if no rainfall deficit emerged in a financial year or unfavourable if it did is shown in figure 25. Feedback from participants and attendees at a farmer conference indicated the value of this information was high. It is provided here for interest but has not been used in the analysis. It indicates that for most of the participants, eleven of the past 15 years shown some degree of deficit in rainfall from long term averages. This was interpreted by the participants as meaning they should avoid making production choices that require good seasons or even average seasons to yield the required outputs.

Farm Code	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Farm 1														
Farm 2	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Favourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Favourable	Unfavourable
Farm 3	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Favourable	Favourable	Unfavourable	Unfavourable	Unfavourable	Favourable	Unfavourable	Unfavourable
Farm 4	Unfavourable	Unfavourable	Unfavourable	Favourable	Unfavourable	Unfavourable	Unfavourabl e	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Favourable	Favourable	Unfavourable
Farm 5														
Farm 6	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Favourable	Unfavourable	Unfavourable	Unfavourable	Favourable	Unfavourable	Favourable	Unfavourable
Farm 7	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Favourable	Favourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Favourable	Unfavourable
Farm 8	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Favourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Favourable	Unfavourable	Unfavourable
Farm 9	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Favourable	Favourable	Unfavourable	Unfavourable	Unfavourable	Favourable	Unfavourable	Unfavourable
Farm 10	Unfavourable	Unfavourable	Unfavourable	Favourable	Unfavourable	Unfavourable	Favourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Favourable	Unfavourable	Unfavourable
Farm 11	Unfavourable	Unfavourable	Unfavourable	Favourable	Unfavourable	Unfavourable	Unfavourabl e	Favourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Favourable	Unfavourable
Farm 12	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Favourable	Favourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Favourable	Unfavourable
Farm 13	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Favourable	Favourable	Unfavourable	Unfavourable	Unfavourable	Favourable	Favourable	Unfavourable
Farm 15	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Unfavourable	Favourable	Favourable	Unfavourable	Unfavourable	Unfavourable	Favourable	Unfavourable	Unfavourable

Figure 25: Classification of financial years as being favourable or unfavourable seasons based on the Hutchinson Drought Index.

8 LIMITATIONS AND OPPORTUNITIES

The limitations and opportunities presented by the study.

8.1 UNDERSTANDING ENVIRONMENTAL FACTORS OF FARM PROFITABILITY

This study has uniquely examined the profitability of regenerative graziers selected for the ecological characteristics of the property, not by the description of the grazing practice or a self-assessment of management quality. By selecting participants based on the ecological characteristics of the property it has removed the possible sampling bias of including low-function landscapes in studies of profitability and wellbeing. This gives the study its strength, but the small size of the sample and the absence of information about the characteristics of the agricultural ecosystems in the AgInsights and ABARES datasets means it is not possible to confirm that the ecological characteristics are the dominant part of the causal pathway. In addition, it was not possible in this study to analyse the significance of ESP income on profitability in either the NESP-EP, or contributors to AgInsights or ABARES datasets used for comparison. It would be desirable to understand the significance of this on profitability in comparison to the effect of the ecological functions and other factors of production. Finally, the recruitment methods may have a selection bias in that unprofitable farm businesses with highly biodiverse properties may have been unwilling to participate.

The evidence collected in this study suggests that a consistent, strong financial performance is possible when regenerative techniques are employed on grazing properties within the study region. The presence of the ecological characteristics associated with a greater range and more dependable production of ecosystem services (e.g. Lavorel et al., 2015) is consistent with a causal pathway in which regenerative grazing leads to improved profitability. However, it is possible that profitability and ecological characteristics are both an output of many other factors, including managers with better skills. There remains a strong need for a larger dataset to discover if higher profitability is due to ecological characteristics and if so what the ecological-economic gradient ('dose-response') is and what other factors, such as management skill are significant. There is an opportunity to use the methods for financial data collection, confidentialisation, compilation and analysis developed in this study to collect the larger and longitudinal datasets required to understand the relative strength and gradient of ecological characteristics for profitability.

Secondary analysis of the relationship of profitability with seasonal ground-cover and season quality is planned. These will use classifications (composite indices) obtained from the experimental methods described. The results will contribute to the development of methods for total factor productivity decomposition that will include ecology and climate as factors of production (using data envelopment analysis).

Although this study was not configured to identify a causal link between ecological condition and farm profitability, we believe that the study establishes a causal link between different modes of farming (via our observation of significant differences in the cost and profit profiles of regenerative vs. other farms) and farm profitability. We conclude that regenerative farming can be at least as profitable, and possibly more profitable, than other farming methods.

Next steps

The data on key profitability indicators and driver variables collected in this study will be further analysed including secondary analysis of associations of profit magnitude and quality of seasons and markets. Two journal articles are being prepared to publish the findings and to discuss the policy implications of the study to contribute to ecological economics and agricultural resource economics literature. General audience (landholder) communications pieces are being prepared to communicate the findings and implications of the study for landholders. These will be made available on the Vanguard Business Services Website. Negotiations have commenced about preparing a webpage for this project as part of the Sustainable Farms initiative at Fenner, ANU.

8.2 GRASSY WOODLAND CONDITION CLASSIFICATION

This study was unique in that it used a classification of grazing properties as sustainable, regenerating, or unsustainable for its basis of landholder selection. An objective alternative to asking landholders about the type (name) of the grazing practice being used is more specific and has greater potential to enable larger and longitudinal studies to better understand the ecological-economic gradient ('dose-response') necessary for profitability and conservation. The integration of the combination of vegetation characteristics and management policy in the classification is scientifically coherent with the literature describing the mechanisms for how ecological inputs reduce cost and maintain yields. It also allows the incorporation of management policy as a factor in judging the future extent and condition of grassy woodlands.

The method was relatively inexpensive and appeared to be reliable. However, the study recognises that there are existing structured field validated ecological assessment methods already in use by state and territory jurisdictions, government programs and NGOs. These can be rolled up or down in complexity to enable a range of expertise to apply methods and can be further explored with respect to alignment with classification of sustainable, regenerating or unsustainable. There was not the capacity to undertake this approach in this study. In addition, searches for key ground layer species to assess representative areas of the property were somewhat ad-hoc, as they were not intended to establish a formal assessment of species richness or abundance, but to form part of a professional judgement of the quality of the ground-layer. It is therefore not possible to use these assessments to determine whether the nationally threatened ecological communities were present on farm with respect to condition thresholds identified in the EPBC Act.

The thresholds that were used as a basis for the condition classification of grassy woodlands rely on proportions of woodlands, native pastures, conservation zones and intensive uses. This may exclude landholders who are maintaining remnants of grassy woodlands in very good condition from recognition of their efforts and this may reduce their motivation for this management. We recommend that future work in condition classifications consider the motivational impact as well as the ecological parameters.

Another consideration for future development of condition classifications of ecosystems being used for agriculture is the incorporation of exotic plants. Exotic plants can provide significant locally beneficial regulating services as well as provisioning services but are not valued in the conservation-focused classification we've used in this study. In addition, agro-forestry plantations, including exotic trees are significant producers of public ecosystem services over a large region (regulation of wind speed and air moisture, carbon storage and cultural services) and not valued in the classification in this study. We suggest that a three-dimensional classification be developed that values provisioning services (e.g. production values of plants), conservation values (e.g. native species conservation quality) and regulating services (e.g. ability to stabilise soil and filter and infiltrate water flows).

The condition classifications developed through this project may be applicable in environmental-economic accounting. As suggested above, the alignment of these concepts with existing, well-established ecological condition methodologies can be tested through workshopping with relevant expertise in order to build community consensus of a more refined approach and refine the understanding of sustainability and biodiversity retention relative to different land use practices.

The fractional vegetation statistics of FarmMap4D provided a satisfactory way of estimating the bare ground proportion of the property. As described in the findings, it also yielded some interesting observations about the difference in seasonal ground-cover between the participating properties and the properties within a 10km radius. This is an experimental use of these statistics which requires further exploration and testing.

8.3 RELATED TO THIS PROJECT'S APPROACH TO WELLBEING RESEARCH

This study is unique in that it examines best practice regenerative graziers (BPRG) who represent a sizable community of practice that has departed from the mainstream conventional commercial grazing practices. While this gives the study its strength, it also creates limitations, as the sample of BPRG was small. The results presented in this chapter show that amongst this small group of graziers, wellbeing was significantly higher than the average male farmer aged 40 to 60. However, while this conclusion can be confidently drawn for the 14 BPRG studied, with their wellbeing significantly better on several fronts than the average, the small sample size and lack of available data about the broader population of BPRG means it is not possible to confirm that this sample is representative of all BPRG in Australia. Further studies examining a larger sample of regenerative farmers are needed to identify whether the results amongst the group examined in this study apply more broadly.

The second key limitation of this study is that while it shows that a key group of BPRG have significantly higher wellbeing, the study was cross-sectional in nature. This means that while the evidence is consistent with the hypothesis that engaging in regenerative farming leads to improved wellbeing, it is possible that some other factor caused *both* the engagement in best practice regenerative grazing and the higher levels of wellbeing. The presence of improved farming self-efficacy and farm financial performance is consistent with a causal pathway in which regenerative farming leads to improved self-efficacy and farm performance, and through this to improved wellbeing. Nevertheless, there remains a strong need for a wider range of evidence to more conclusively demonstrate that the higher wellbeing of the BPRG is due to their engagement in regenerative farming.

There is also a possibility that the method of collecting data for BPRG – via face to face discussions with questions completed on a paper survey – led to some positive bias in responses, with the participants reporting more positive outcomes to the interviewer than the comparison groups of farmers (who completed their survey online without an interviewer present). However, it is considered unlikely this would result in differences of the size observed in the results, while pointing to a need for comparison studies that use identical methods for all stages of data collection.

The evidence collected in this study suggests there is likely to be validity in current claims being made about the effect of regenerative farming on wellbeing. There is an opportunity to establish larger studies that can better identify when and how adopting regenerative farming has positive effects on wellbeing. In particular, longitudinal studies that track the wellbeing of farmers over time would provide a better understanding of causality and be able to better demonstrate the relevant adaptation pathways and whether it is in fact adoption of regenerative farming causing the higher wellbeing observed in this sample of BPRG.

Larger studies, both longitudinal and cross sectional, can also be used to better identify the mechanisms by which engaging in regenerative farming improves wellbeing, something which can then be used to better understand how to support wellbeing amongst farmers through the design of farming systems.

Future studies should also develop definitions of best practice regenerative farming that can apply to a range of land types and locations (including but not limited to box gum grassy woodlands), enabling larger samples of farmers to be examined and assessed for verification of these preliminary results.

Next steps

The data on wellbeing and wellbeing determinants collected in this study will be further analysed. Key next steps being undertaken are:

- Preparation of a journal paper examining the small sample of BPRG and comparing them to the sample of farmers from the Regional Wellbeing Survey
- Identifying lessons to be learned about defining best practice regenerative farming and applying these to better define different types of regenerative farming in future surveys.

A range of further potential work has also been identified, however work beyond the two steps above would require successfully achieving additional funding to examine this topic in more depth.

8.4 Pathways to regenerative grazing

The type of education and support that is most helpful to the most successful regenerative graziers needs to be determined. Many of the more environmentally sensitive regenerative producers whose properties nominated the education and coaching they've received through the holistic planning (Savory and Butterfield, 1999) and related management frameworks (see Resource Consulting Services http://www.rcsaustralia.com.au/) as significant influences of their current practice. These frameworks have been available in Australia since 2000 and the effect on profitability (and wellbeing) is mediated by the producer's ability to develop expertise and by the capacity of the landscape to improve biodiversity and landscape function (Tongway and Hindley, 2004) in response to management change. This may have been a bias introduced by the recruitment process and needs to be confirmed or contradicted with a larger sample.

8.5 Season quality

The quality of the season; the timing, amount, and duration of rainfall, temperatures and wind speed are all important factors of production in agriculture. In the absence of a more appropriate product from the Bureau of Meteorology, the secondary analysis uses the SOI as a mechanism to classify the quality of the season. While this is appropriate, participant responses to our experimentation with adaptation of the Hutchinson drought index indicates that more detailed information about the quality of the seasons would be useful to producers to help them evaluate the effectiveness of their management choices.

9 DISCUSSION

In addition to the need to replicate and expand this study, this section discusses future areas of investigation with a view to identifying policy directions.

This study suggests that regenerative grazing of properties in the grassy woodlands biome of NSW is delivering public environmental benefits in the form of regeneration and maintenance of ecological characteristics and biodiversity of grassy woodlands and native pastures. It also suggests that there may be private benefits in the form of profitability, income stability, and personal wellbeing for participating landholders. Pannell's public-private investment framework suggests that, where an environmental scheme or behaviour delivers both public and private benefits, landholder education and engagement should be sufficient to secure participation or uptake of those behaviours (Pannell, 1999, Pannell et al., 2006). Landholder education and engagement, building on the training and consulting that was found to be influential for the regenerative graziers is essential to achieve wider and successful adoption of the practices, but for the following reasons may not be enough, on its own to overcome all of the barriers to change.

1. There is a common perception amongst landholders and government and private extension agents that native pastures (as part of grassy woodlands) are not as profitable as a grazing resource, as exotic pastures despite the lack of contemporary or empirical evidence. The findings of this project will challenge these perceptions, and additional verification and explanation will be needed as there may be other factors influencing the productivity of these farmers.
2. The wellbeing study demonstrated that some regenerative farmers in our study feel less safe in and less a part of their community (Figure 16, page 43). Most of the participants in this study have reported being excluded and criticised by their neighbours who follow conventional farming practices. Some reported being singled out for personal insults from a range of sources, not just other landholders. The study participants surmise that making a change to regenerative grazing is somehow perceived as a criticism of those landholders continuing to use conventional methods. This was commonly identified as the largest single drawback to regenerative grazing. For some individuals this social cost may outweigh any financial benefit associated with implementing regenerative farming practices. These challenges to the commercial legitimacy and social acceptability of regenerative agriculture may also be reflected in the negative effect on financial value of increasing the conservation values of a property.
3. There is concern amongst landholders that land use restrictions will be imposed if properties are discovered to be supporting rare or endangered species on their property. The colloquial advice is [sic] 'shoot, shovel and shut-up'. Hence, these will be significant barriers to realising the public and private benefits of regenerative grazing.

10 RECOMMENDATIONS

Greater uptake of regenerative grazing must navigate these deeply held beliefs among landholders, bank-valuers, scientists, extension agents and policy-designers and recognise they may act as strong barriers to adoption. We have been reflecting on strategies that could be investigated for their effectiveness alongside landholder engagement and education to accelerate adoption, proficiency, and further development of regenerative grazing practices. We list some interrelated strategies and explain them more fully below:

1. Increasing motivation to learn more about regenerative grazing practices
    a. Raising awareness and understanding of opportunities to improve profitability, environmental performance and wellbeing
    b. Ensure financial and social rewards exist for increasing biodiversity. For example, supporting producers to access emerging sustainability-conscious markets which regenerative graziers are well-placed to serve
2. Improving the effectiveness of education and consulting available to assist graziers to develop the ecological literacy and adaptive planning skills that are the foundation of regenerative grazing practices.
3. Demonstrating the overall economic viability of regenerative farm management practices, taking full account of the value of both positive and negative externalities in conventional and regenerative practices.
4. Reducing drought related distress

10.1 INCREASING MOTIVATION TO LEARN MORE ABOUT REGENERATIVE PRACTICES

10.1.1 Raising awareness and understanding of the opportunities to improve profitability, environmental performance and wellbeing

Increasing the motivation to develop skills and capacity for regenerative grazing throughout Australia requires confirming and explaining the comparative profitability of regenerative graziers in a larger study, including those in biomes other than the grassy woodlands. To do this, future studies would aim to establish the ecological-economic gradient (how much ecosystem condition improvement is required to improve profit) and the financial transition (the magnitude and sign of the impact on profitability while environmental change is occurring).

Also required are answers to questions that may act as barriers to adoption by conventional farmers who, like regenerative graziers, also want to make sure they leave their land in good condition for future generations. These questions include whether nutrients are being mined from landscapes, whether risk of invasive weeds and fire is increased by having a regenerative neighbour and whether the practices are labour-intensive. To our knowledge there are few empirical studies that have addressed these questions, but many untested assumptions about what the answers would be.

Agriculture is notoriously subject to interannual variability of seasons, markets, and production. Adaptive capacity appears to be essential. Further study of whether the regenerative grazing community demonstrates more adaptive capacity and therefore drought resilience compared to conventional practice and whether this is a strong factor on the causal pathway would be valuable. If so, exploration of the best methods to help landholders develop adaptive capacity would inform strategies for landholder engagement and education.

10.1.2 Ensure financial and social rewards exist for increasing biodiversity

To improve the influence that the regenerative graziers of this study have over the motivation of others to emulate and adapt their practices, it may be necessary to increase the general acceptability of these practices. The framework provided by behavioural insights should be investigated to address the social acceptability of regenerative practices and to assist change enablers to support skills development for producers and people involved in agricultural science and extension.

Markets are emerging for agricultural products that are differentiated by their environmental attributes. European markets in particular are demanding higher levels of environmental (and animal welfare) performance and so there is an opportunity for Australia to improve its export opportunities by expanding adoption of regenerative grazing methods. In response to demands by consumers for agricultural products that demonstrate better environmental, animal welfare and farmer wellbeing performance, a number of brands including Kering (Kering, 2013) are already applying selective sourcing policies to improve agricultural performance on these attributes (Ogilvy et al., 2015). Two of the authors (Ogilvy and Gardner) coordinated a visit by Kering Global Head of Sustainability Innovation to wool producers in NSW, some of whom were participants in this study. Following this visit some producers have secured supply contracts with Kering because they meet their quality requirements as well as their environmental and animal welfare criteria.

The growing commercial recognition and associated premiums paid for produce in the marketplace creates a powerful statement of the legitimacy of regenerative grazing. The red meat industry in Australia has recently acknowledged the threat posed by consumer concerns about environmental and animal welfare performance to its social licence to operate. It recommends collaborative investment to improve consumer perceptions of the environmental performance of red meat (The CIE, 2015). Supporting sustainability-conscious markets to share the conservation and environmental objectives of the government and supporting regenerative graziers to access them is likely to be a positive influence on motivation and capacity building for regenerative grazing.

In addition, to supplement these efforts governments should continue to invest in markets for biodiversity as supplements to public and philanthropic investment, even if they are modest and limited to increasing the transitional areas around and between remnants. These may also provide mechanisms for investors, including banks, to consider conservation and biodiversity objectives alongside other criteria for land valuation.

10.2 Improving the effectiveness of engagement and education

While the common perception is that engagement and education of farmers to improve environmental outcomes should be based on improving their knowledge of grazing practices or of ecology, we observe that a distinguishing feature of the influential educational programs nominated by our producers as being highly beneficial is they have a strong focus on creating adaptive capacity; setting goals that accommodate environmental, profitability and family aspirations, supporting option analysis and decision-making, creating broad ecological literacy and developing and supporting capacity for foresight, planning and tactical response in their overall decision-making.

The influential educational programs nominated by the regenerative producers assisted them to manage their complex, dynamic systems and make transformational changes in a way that the ‘single-issue’ training programs were unable. It would appear there is a need for development of education founded on systems thinking rather than single issue management. Careful consideration should be given to programs that accredit the quality of educators and farm consultants to reduce the risk to producers.

Research that compares the effectiveness of different forms of farm consulting (including rural financial counselling and government extension) on the development of regenerative grazier capability would be valuable to understand barriers to adoption of regenerative grazing. In line with this, program pilots that test the capacity of holistic farm management education and consulting alongside investment in high conservation value lands could enable government to develop insights that improve outcomes related to private land conservation across the grassy woodland biome.

10.3 Demonstrating the overall economic viability of regenerative and conventional farm management practices

The implementation of the system of environmental-economic accounting (EEA) by the Department of the Environment & Energy in partnership with ABS and ABARES provides an opportunity to establish ecological-economic statistics for agriculture. The compilation of environmental accounts linked to financial accounts provides more complete and robust information for use by governments aiming to assure sufficiency of primary production as well as conserve biodiversity, stabilise soils and maintain healthy waterways. These may enable statistics for development of a sustainable agriculture index, following comparable methods to total factor productivity, but including the full complement of costs and benefits. Signals that agricultural produce with better environmental, animal welfare and producer wellbeing are increasingly preferred indicate that a method of demonstrating performance is likely to be necessary for future success in global markets (Mallawaarachchi et al., in preparation).

The methods developed for use in this project offer insight into condition classification methodologies at property (and sub-property) scale that might in future be adapted for use in environmental-economic accounting and in analysis of natural capital as a factor of production in agriculture. They also provide a practical method for sustainable-sourcing programs to assess the environmental performance of producers in the informal markets for biodiversity that are emerging in response to consumer demand. Independent peer review would test these claims and suggest further development of these approaches for use in much larger and long-term statistical collections.

10.4 Reducing drought-related distress

With most of NSW in the grip of severe drought, the question of how to respond appropriately to support farmers without subsidising poor management is again being raised. Evidence from the semi-structured interviews (this study) suggests that the NESP-EP sample develop plans (months in advance) to adjust (reduce) stock numbers in response to declining seasonal conditions. They often do this with the support of the farm consultant who assists them to estimate the financial impact of different choices and develop a financial plan and livestock management strategy that will meet their goals.

Evidenced by their low feed expenditure, even during the 2006-07 to 2008-09 dry seasons, the NESP-EP sample rarely feed animals, and then only for short and tightly targeted durations. Their planning creates an opportunity to forward purchase feed when prices are low. Maintaining stock numbers for long periods with purchased feed is not a characteristic of their management. In addition to avoiding financial distress, this strategy may also confer significant social and ecological benefits to their farms as well as lowering the cost base.

If a larger study confirmed that this strategy provides economic, ecological and social benefits, it might be possible to support other graziers to emulate the planning and to proactively engage with their lenders to assure they have financial support when it is most needed.

11 CONCLUSION

This study was unique in that it directly measured ecological characteristics and long-term profitability and current wellbeing. It shows that regenerative grazing of grassy woodlands may be delivering public environmental benefits in the form of sustainable land management practices that maintain greater levels of native flora diversity in the grassy woodlands biome of NSW. It also shows that these producers enjoy higher profitability than other producers in their region, especially in dry years. However, the small sample and the lack of available data about the ecological and wellbeing performance of the Holmes & Sackett benchmark participants and the ABARES farm survey participants prevents conclusions that there are causal relationships between environmental, financial and wellbeing levels. Further investment is recommended to replicate and expand on this study.

We recommend performing the study in other similar ecological zones in other states to see if the findings of this study are confirmed or contradicted. This could include recruitment of participants who didn't meet the criteria for selection in this study to understand the strength of association and gradient of response. It is also recommended that this study is repeated in different ecological zones to see if the findings are generalisable (it has been tested in the northern rangelands (see for example Ash et al., 2015, O'Reagain and Scanlan, 2013, Walsh and Cowley, 2016). Adding measures of ecological health and biodiversity to the ABARES Farm Survey and ABS studies may enable a long-term, large statistical collection to inform productivity analysis and policy design (they are already being incorporated in the UC wellbeing surveys of graziers).

While the private benefits to producers may be enough on their own to induce individual investment in skills associated with improvements environmental condition and biodiversity, experiences in other agricultural sectors (e.g. sugarcane (Queensland CANEGROWERS Organisation, 2018)) indicate that there may be other barriers to change. Behavioural insights techniques may provide ways to understand these and to design and test cost-effective solutions to overcome them.

If the benefits are confirmed and causal pathways described to an appropriate degree of confidence, the following policy responses should be investigated:

- Understanding and addressing non-financial barriers to adoption of regenerative grazing practice
- Improve access to education and farm consulting to improve the chances of successful adoption and continued innovation of regenerative grazing practices.
- Increase understanding of the environmental, economic benefits of regenerative grazing amongst the agronomists and government extension officers
- Ensure financial and social rewards exist for increasing biodiversity including support for the efforts of the private sector to use selective sourcing and capital allocation decisions based on environmental and biodiversity attributes

12 Appendix A – Detailed financial and ecological data

This section includes the data used to compile the averages for the key driver variables presented in the body of the report. The data largely speaks for itself and we have speculated (from our knowledge of the industry) about the explanations for the differences between the NESP-EP sample and the Holmes & Sackett benchmark participants.

12.1 Income per DSE

Income from environmental stewardship is included amongst the NESP-EP sample[8]. Information about whether this is the case for the Holmes & Sackett benchmark was not available.

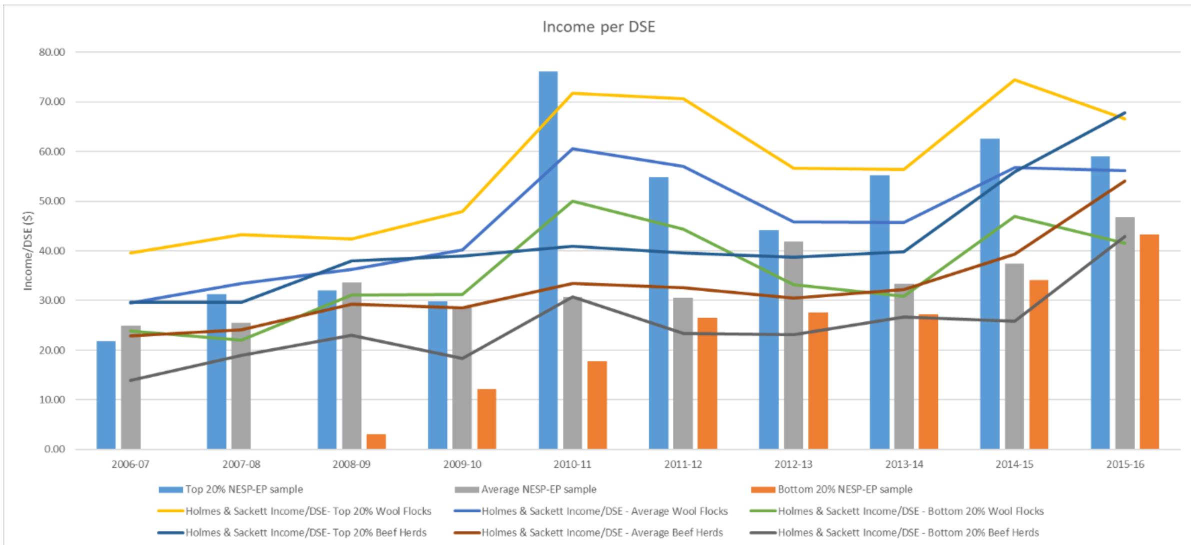

Figure 26: Chart of income per DSE. NESP-EP producers (columns), Holmes & Sackett benchmark participants (lines)

Table 11: Data table for Income per DSE chart

Income per DSE ($) **Producers ranked by EBIT per DSE**	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**
Top 20% NESP-EP sample	21.87	31.25	32.03	29.85	76.06	54.83	44.12	55.26	62.53	59.02
Average NESP-EP sample	24.92	25.50	33.62	28.89	30.72	30.58	41.84	33.43	37.39	46.80
Bottom 20% NESP-EP sample	nd	nd	3.06	12.17	17.81	26.50	27.58	27.24	34.12	43.29
Holmes & Sackett Wool Flocks Income/DSE- Top 20%	39.58	43.22	42.39	47.95	71.69	70.64	56.66	56.34	74.40	66.55
Holmes & Sackett Wool Flocks Income/DSE - Average	29.56	33.39	36.25	40.22	60.60	57.02	45.85	45.69	56.76	56.14
Holmes & Sackett Wool Flocks Income/DSE - Bottom 20%	23.89	22.07	31.08	31.26	50.03	44.37	33.16	30.89	46.98	41.49
Holmes & Sackett Beef Herds Income/DSE- Top 20%	29.64	29.58	37.92	38.94	40.96	39.60	38.71	39.82	55.85	67.83
Holmes & Sackett Beef Herds Income/DSE - Average	22.92	24.15	29.28	28.47	33.42	32.62	30.50	32.26	39.34	54.08
Holmes & Sackett Beef Herds Income/DSE - Bottom 20%	13.87	18.96	22.99	18.30	30.70	23.39	23.18	26.74	25.79	42.84

[8] One producer in the NESP sample has significant income from the Environmental Stewardship Program.

12.2 Supplementary feed per DSE

NESP-EP participants (in keeping with the general regenerative practice) commonly adjust stock numbers to meet declining resource availability in adverse seasonal conditions. They rarely feed animals, and then only for short and tightly targeted durations. Maintaining stock numbers for long periods with purchased feed is not a characteristic of their management. This helps explain some of the differences in supplementary feed costs between the NESP-EP and AgInsights groups. The slightly higher expenditure on supplementary feed in 'good' seasons may reflect some NESP-EP producers taking advantage of counter-cycle opportunities to purchase feed when prices are low.

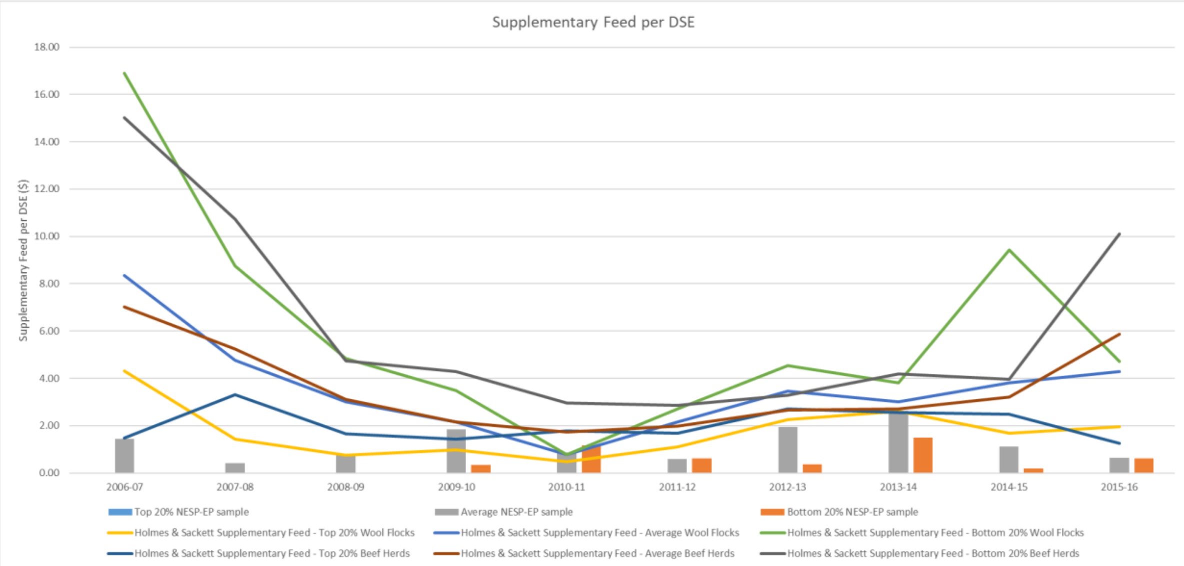

Figure 27: Chart of supplementary feed per DSE. NESP-EP producers (columns), Holmes & Sackett benchmark participants (lines)

Table 12: Data table for supplementary feed per DSE chart

Supplementary Feed per DSE Producers ranked by EBIT/DSE	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**
Top 20% NESP-EP sample	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Average NESP-EP sample	1.43	0.42	0.75	1.85	0.85	0.58	1.93	2.62	1.12	0.63
Bottom 20% NESP-EP sample	nd	nd	0.00	0.33	1.17	0.63	0.35	1.48	0.19	0.60
Holmes & Sackett Wool Flocks Net Profit/DSE-Top 20%	4.32	1.43	0.76	0.98	0.47	1.10	2.26	2.62	1.69	1.95
Holmes & Sackett Wool Flocks Net Profit/DSE - Average	8.35	4.77	3.00	2.16	0.78	2.16	3.47	3.00	3.82	4.28
Holmes & Sackett Wool Flocks Net Profit/DSE - Bottom 20%	16.90	8.75	4.84	3.48	0.77	2.72	4.54	3.81	9.43	4.72
Holmes & Sackett Beef Herds Net Profit/DSE-Top 20%	1.47	3.32	1.65	1.43	1.79	1.68	2.70	2.55	2.49	1.25
Holmes & Sackett Beef Herds Net Profit/DSE - Average	7.01	5.23	3.10	2.15	1.74	1.98	2.65	2.71	3.21	5.86
Holmes & Sackett Beef Herds Net Profit/DSE - Bottom 20%	15.01	10.72	4.73	4.28	2.95	2.85	3.28	4.19	3.95	10.11

12.3 Pasture costs per DSE

As discussed in the body of the report, one of the criteria for selection of properties for the study was that they had been low input for more than 10 years (nutrient enrichment is a key threat to grassy woodlands). One property (ranked in the bottom 20% based on EBIT/DSE) that was recruited on this basis was found to have added chicken manure to its grazing areas on advice of the agronomist to increase production. As a result, the property had to be classified as unsustainable for grassy woodlands. The financial results were retained because of the recency of this addition.

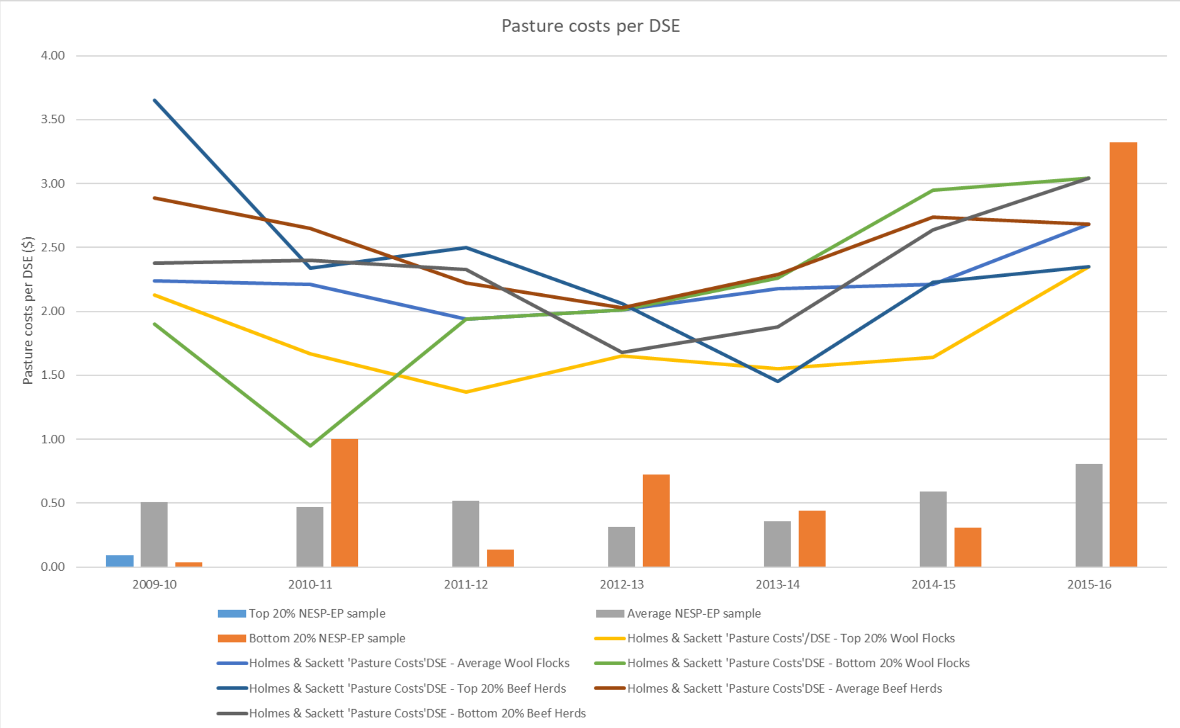

Figure 28:Chart of pasture costs per DSE. NESP-EP producers (columns), Holmes & Sackett benchmark participants (lines)

Table 13:Data table for pasture expenses per DSE chart

Pasture expenses per DSE ($) **Producers ranked by EBIT per DSE**	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**
Top 20% NESP-EP sample	0.23	0.13	0.04	0.09	0.00	0.00	0.00	0.00	0.00	0.00
Average NESP-EP sample	0.77	0.75	0.73	0.51	0.47	0.52	0.31	0.36	0.59	0.80
Bottom 20% NESP-EP sample	nd	nd	0.03	0.04	1.00	0.14	0.72	0.44	0.31	3.32
Holmes & Sackett Wool Flocks Net Profit/DSE- Top 20%	nd[9]	nd	nd	2.13	1.67	1.37	1.65	1.55	1.64	2.35
Holmes & Sackett Wool Flocks Net Profit/DSE - Average	nd	nd	nd	2.24	2.21	1.94	2.01	2.18	2.21	2.68
Holmes & Sackett Wool Flocks Net Profit/DSE - Bottom 20%	nd	nd	nd	1.90	0.95	1.94	2.01	2.26	2.95	3.04
Holmes & Sackett Beef Herds Net Profit/DSE- Top 20%	nd	nd	nd	3.65	2.34	2.50	2.06	1.45	2.23	2.35
Holmes & Sackett Beef Herds Net Profit/DSE - Average	nd	nd	nd	2.89	2.65	2.22	2.03	2.29	2.74	2.68
Holmes & Sackett Beef Herds Net Profit/DSE - Bottom 20%	nd	nd	nd	2.38	2.40	2.33	1.68	1.88	2.64	3.04

[9] Data for these years is available, but was not collected by the project due to time-constraints.

12.4 Animal health and breeding expenses

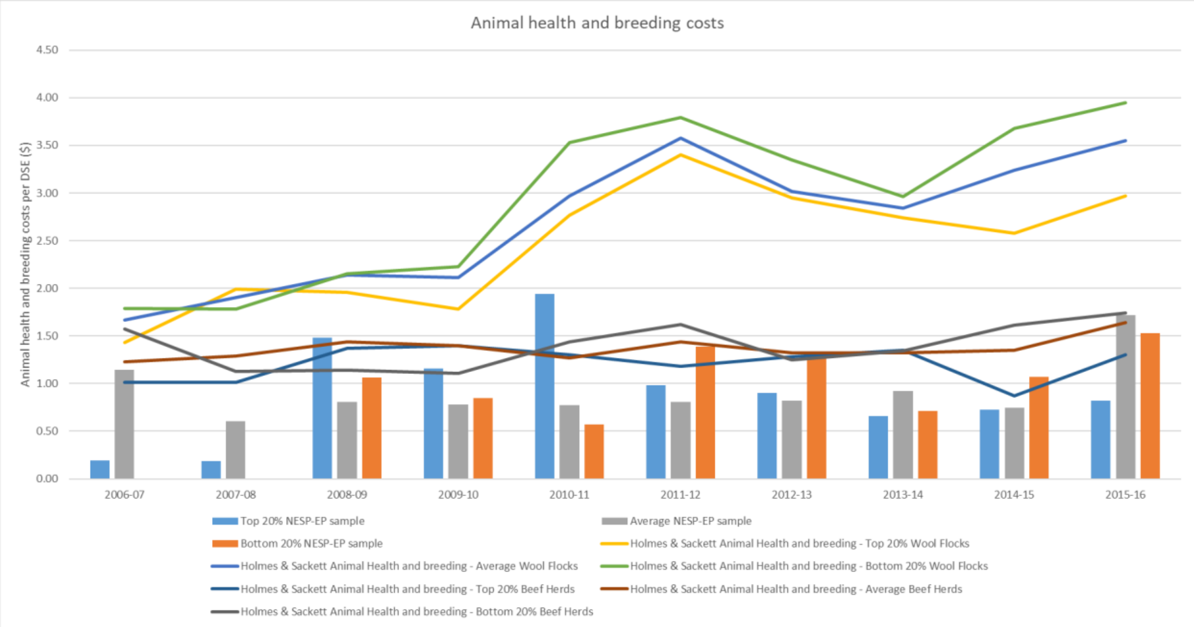

Figure 29: Chart of animal health and breeding expenses per DSE. NESP-EP producers (columns), Holmes & Sackett benchmark participants (lines)

Table 14: Data table for animal health and breeding expenses per DSE

Animal health & breeding expenses per DSE ($) Producers ranked by EBIT per DSE	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**
Top 20% NESP-EP sample	0.19	0.19	1.48	1.15	1.94	0.98	0.90	0.66	0.73	0.82
Average NESP-EP sample	1.14	0.60	0.81	0.78	0.77	0.81	0.82	0.92	0.75	1.72
Bottom 20% NESP-EP sample	nd	nd	1.06	0.85	0.57	1.39	1.29	0.71	1.07	1.53
Holmes & Sackett Wool Flocks Net Profit/DSE-Top 20%	1.43	1.99	1.96	1.78	2.77	3.40	2.95	2.74	2.58	2.97
Holmes & Sackett Wool Flocks Net Profit/DSE - Average	1.67	1.90	2.14	2.11	2.97	3.58	3.02	2.84	3.24	3.55
Holmes & Sackett Wool Flocks Net Profit/DSE - Bottom 20%	1.79	1.78	2.15	2.23	3.53	3.79	3.35	2.96	3.68	3.95
Holmes & Sackett Beef Herds Net Profit/DSE-Top 20%	1.01	1.01	1.37	1.40	1.30	1.18	1.28	1.35	0.87	1.30
Holmes & Sackett Beef Herds Net Profit/DSE - Average	1.23	1.29	1.44	1.40	1.27	1.44	1.32	1.32	1.35	1.64
Holmes & Sackett Beef Herds Net Profit/DSE - Bottom 20%	1.57	1.13	1.14	1.11	1.44	1.62	1.25	1.34	1.61	1.74

12.5 Variable costs per DSE

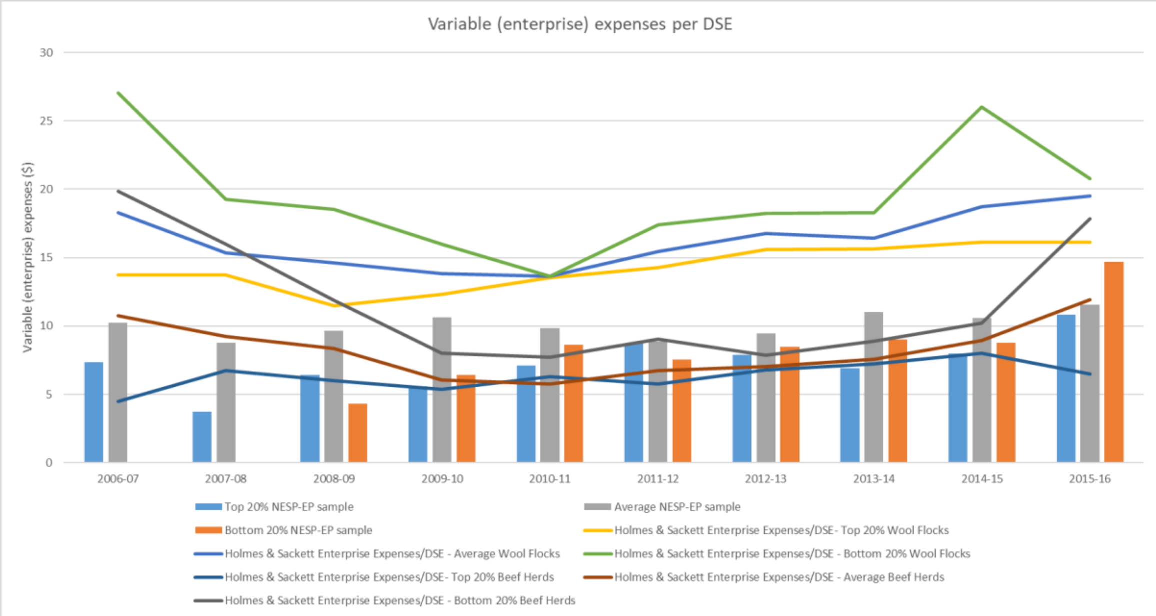

Figure 30: Chart of variable costs per DSE. NESP-EP producers (columns), Holmes & Sackett benchmark participants (lines)

Table 15: Data table for variable costs per DSE

Variable expenses per DSE ($) **Producers ranked by EBIT per DSE**	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**
Top 20% NESP-EP sample	7.4	3.7	6.4	5.6	7.1	8.7	7.9	6.9	8.0	10.8
Average NESP-EP sample	10.2	8.8	9.6	10.6	9.8	8.9	9.5	11.0	10.6	11.6
Bottom 20% NESP-EP sample	nd	nd	4.3	6.4	8.6	7.5	8.5	9.0	8.8	14.7
Holmes & Sackett Wool Flocks Net Profit/DSE-Top 20%	13.73	13.73	11.48	12.32	13.54	14.26	15.61	15.64	16.14	16.13
Holmes & Sackett Wool Flocks Net Profit/DSE - Average	18.26	15.37	14.59	13.82	13.63	15.42	16.77	16.43	18.74	19.51
Holmes & Sackett Wool Flocks Net Profit/DSE - Bottom 20%	27.06	19.28	18.53	16	13.65	17.42	18.24	18.26	26	20.76
Holmes & Sackett Beef Herds Net Profit/DSE- Top 20%	4.48	6.73	6.02	5.37	6.27	5.75	6.8	7.2	8.01	6.47
Holmes & Sackett Beef Herds Net Profit/DSE - Average	10.73	9.22	8.34	6.03	5.77	6.73	7.03	7.58	8.92	11.94
Holmes & Sackett Beef Herds Net Profit/DSE - Bottom 20%	19.85	16	11.89	8	7.69	9.01	7.86	8.91	10.23	17.83

12.6 Fixed costs per DSE

Significant fixed costs per DSE in 2008-09 to 2010-11 in the NESP-EP sample (bottom 20%) are attributed to large entries for repairs and maintenance for one farm for those years.

Figure 31: Chart of fixed costs per DSE. NESP-EP producers (columns), Holmes & Sackett benchmark participants (lines)

Table 16: Data table for fixed costs per DSE

Fixed (overhead) expenses per DSE	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Top 20% NESP-EP sample	16.0	13.6	14.6	17.2	19.0	13.7	8.7	10.0	13.1	12.7
Average NESP-EP sample	14.4	17.6	15.9	21.3	18.4	16.4	21.3	17.5	18.2	27.5
Bottom 20% NESP-EP sample	nd	nd	48.0	37.9	26.5	14.2	15.9	18.9	22.6	19.2
Holmes & Sackett Wool Flocks Net Profit/DSE- Top 20%	13.41	15.68	14.61	15.99	14.46	17.17	16.54	16.68	17.96	18.52
Holmes & Sackett Wool Flocks Net Profit/DSE - Average	17.02	18.99	20.44	18.13	18.6	20.46	19.34	18.56	19.4	22.29
Holmes & Sackett Wool Flocks Net Profit/DSE - Bottom 20%	19.42	25.59	30.32	20.19	21.4	24.35	21.08	19.26	25.51	26.83
Holmes & Sackett Beef Herds Net Profit/DSE- Top 20%	13.52	12.5	14.81	15.05	12.13	13.28	15.2	13.7	13.86	17.57
Holmes & Sackett Beef Herds Net Profit/DSE - Average	15.93	18.3	19.4	16.13	15.11	15.6	16.05	16.1	17.15	19.68
Holmes & Sackett Beef Herds Net Profit/DSE - Bottom 20%	20.3	28.72	32.91	17.78	20.81	18.08	19.74	21.05	23.94	27.7

12.7 Ground-cover

All properties exceeded the threshold for bare ground (<30% bare ground) and were found to be managing successfully to prevent soil erosion or compromise of waterway quality. They were all varying their grazing impact to improve biodiversity on their properties. The average bare ground proportion observed through all seasons was approximately 10%. Most properties exhibited the legacy of high input use and clearing and are therefore regenerating grassy woodland and native pasture characteristics from quite a degraded base.

Shown in figure 32, the seasonal ground-cover statistics (from FarmMap4D) showed that the NESP-EP participants in the study (the regenerative graziers) have had an average of about 3% more ground-cover than the properties within a 10km radius of the centre of the property over the term of the study.

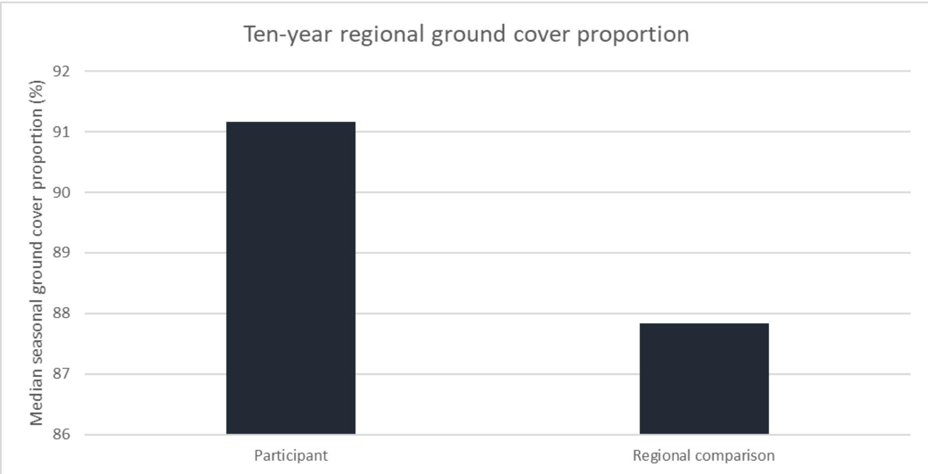

Figure 32: Average difference in ground-cover between the participants and properties within 10km radius. (Statistical output of FarmMap4D. Average from 2006-07 to 2015-16.)

Shown in Figure 33 the differences were greatest in dry years with the years 2006-07 to 2008-19 demonstrating a difference of around 16% and 2013-14 to 2015-16 a difference of about 13%. The least difference in seasonal ground cover was observed in 2010-11 which we had classified (in our experimental method described in Section 7.6) as a favourable season.

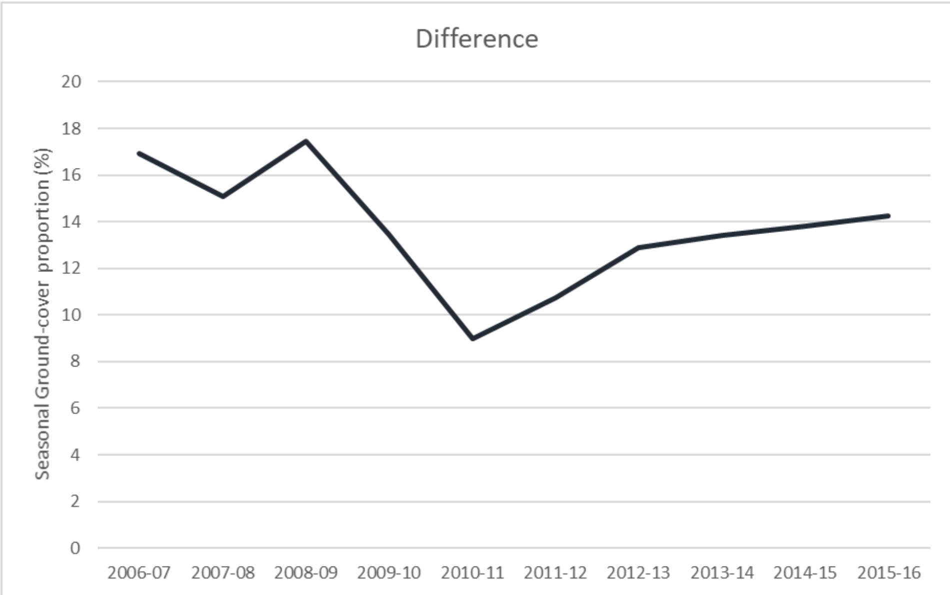

Figure 33: Average difference in ground-cover between the participants and properties within 10km radius for each year of the study. (Statistical output of FarmMap4D.)

Secondary analysis of associations between profitability and seasonal ground-cover and season quality planned for journal articles and general communications is expected to be informative.

12.8 Ground layer quality

The ecological assessment observed species listed as important to grassy woodlands in Appendix 1 of Box Gum Grassy Woodland Recovery Plan (NSW Department of Environment, 2010)). Table 2 provides a list of non-grass Appendix 1 species and the number of observations made of these species.

Table 17: non-grass species observations (total across properties)

Non-grass (Appendix 1)	Number of observations
Dianella spp.	7
Asperula conferte	1
Dichopogon fimbriatus	8
Tricoryne elatior	16
Stypandra glauca	1
Glycine spp. or Desmodium spp.	19
Rutidosis letorrhynchoides	12
Chrysocephalum spp.	6
Swansonii spp.	1
Goodenia hederaceae	5
Thysanotus tuberosus	3
Craspedia spp.	2

The frequency of observations of these species in the grassy woodland areas of the farms is shown in figure 34. Observations were made at several sites on each property and the average of them used as an indication of observations for the property.

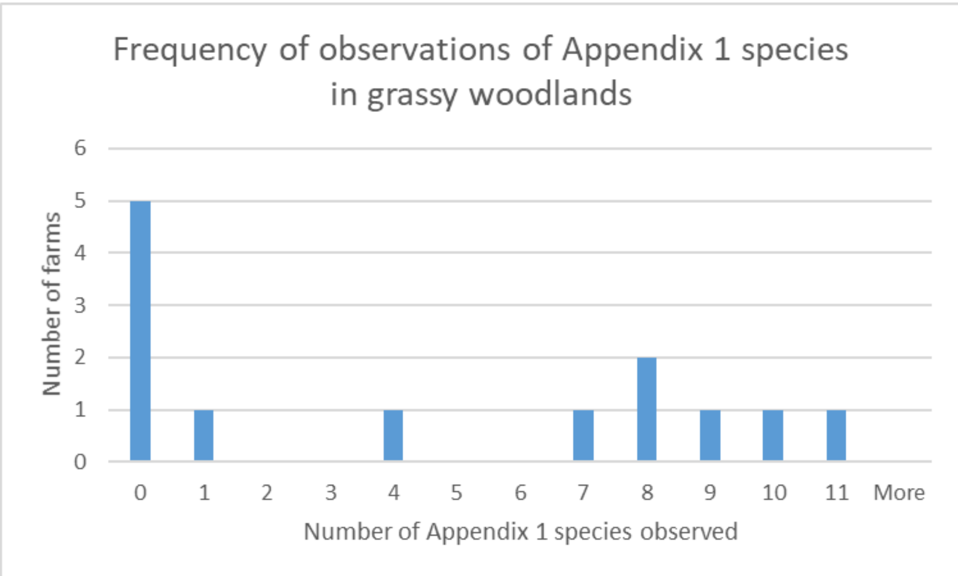

Figure 34: frequency of observations of non-grass species in grassy woodlands.

Observations of the Appendix 1 species in the cleared pastures of the properties is shown in figure 35.

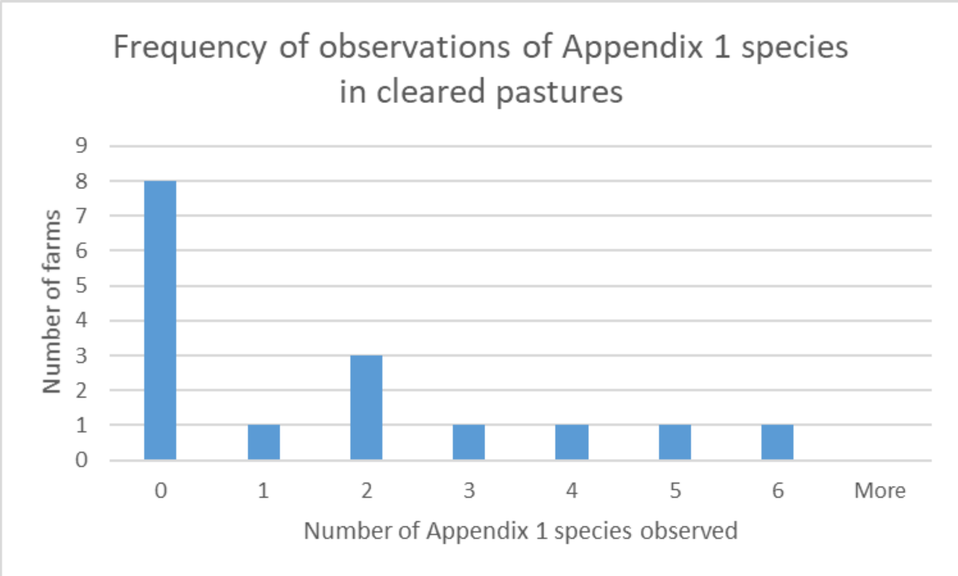

Figure 35: frequency of observations of Appendix 1 species in cleared pastures

A wide range of grass species were observed in the cleared pastures as well as in the grassy woodlands. These are listed in table 18 and many of the species are judged to be valuable pasture species (for livestock production).

Table 18: grass and sedge species observed on subject properties

Grass and sedge species observed

Paspalidium jubiflorum	Poa lab./sieb.
Elymus scaber	Carex appressa
Panicum effusum	Juncus
Agrostis spp	Lomandra multiflora
Dichanthuim sericeum	Bracteantha viscosa
Bothriochloa macra/decipiens	Bracaria milliformus
Themeda spp.	Sorghum leiocladum
Eragrositis brownii/leptostachya	Trifolium arvense
Sporobolus creber	Eulalia aurea
Cymbopogon refractus	Wahlenbergia spp.
Chloris truncata	Sanguisorba minor
Aristida spp	Imperata cylindrical
Echinopogon ovatus	Crassula spp.
Joycea pallida	Erodium spp.
Enteropogon acicularis	Pimela linifolia
Microleana	Austrostipa bigeniculata & densiflora & scabra
Rytidosperma spp	Pennisetum alopecuroides

13 APPENDIX B - METHODS

This section describes the methods used to collect and interpret financial, ecological, and social data for profitability analysis.

13.1 FINANCIAL DATA

This section describes the methods used to collect, confidentialise, curate, compile and compare the financial data for the project.

The project aimed to compare the financial performance of the producers in our sample population relative to other local wool, beef, or mixed cropping-grazing producers. Two sources of appropriate comparison data were identified; industry benchmarking studies and the ABARES farm survey. Industry benchmarking studies measure the production and financial performance of farm managers to establish the features of the most profitable cohort of managers that distinguishes them from the remainder. The ABARES farm survey has been conducted since the 1940s and provides a wide range of information on the economic performance of farm business units in the rural sector (ABARES, 2018).

The benchmarking studies and ABARES all use slightly different definitions, variables, and calculations of profit. Our design for data compilation enabled the project to be able to compare its sample population to each of these datasets despite their differing premises and objectives.

13.1.1 Collection and management of participant data

The financial data for the sample population was collated from profit & loss statements, livestock trading accounts, balance sheets, bank valuations and landholder valuations obtained from the participants' accountants. It is customary for producers to regularly review financial, operational, and social performance with their accountants or farm consultants and Mark Gardner of Vanguard Business Services is an experienced Farm Consultant who routinely collects and reviews such data as part of the service Vanguard offers to farmers. To assure the commitment to confidentiality was met, financial data was de-identified by Vanguard by replacing property names with numbers and entered into a spreadsheet for collation and compilation for analysis. The coded data was then made available to other project team members for transformation and analysis. The process, roles and responsibilities for financial (and wellbeing) data collection, classification, compilation, calculation and analysis is illustrated in Figure 36.

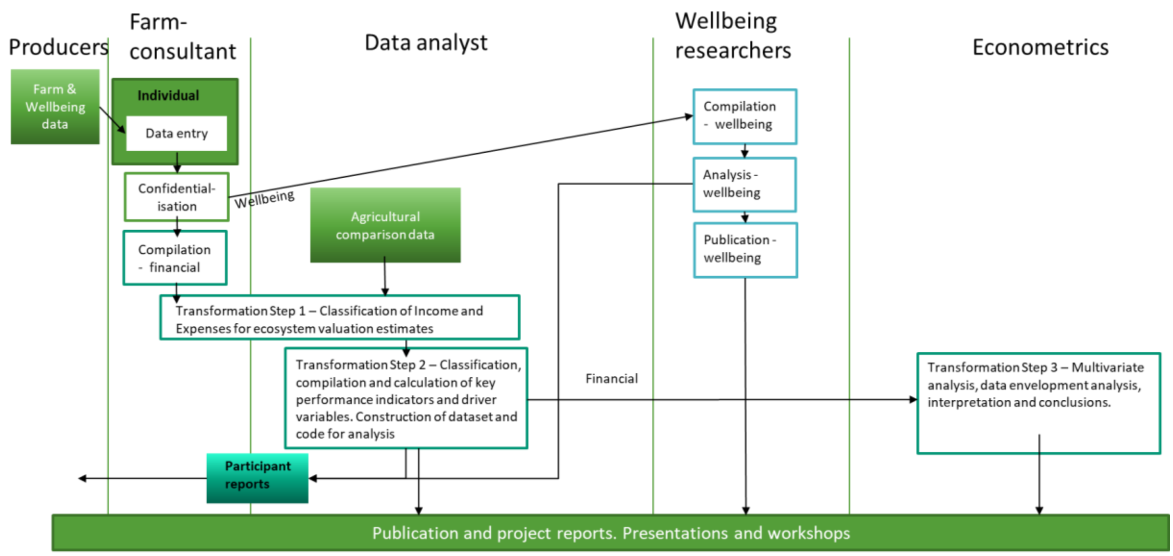

Figure 36: Process, roles and responsibilities for collection and processing of financial (and wellbeing data).

To allow the compilation and calculation for financial analysis to be reliable, simple, and flexible, the project used a metadata-driven design used by the Australian Bureau of Statistics (ABS) for management of large statistical collections. A metadata-driven design uses metadata to classify data for the required range of analytical purposes. It separates data entry from data transformation and compiles individual classifications and calculations in separate worksheets so that only simple spreadsheet operations are required, and each stage of analysis is separately distinguished to reduce the chance of errors.

While this project was not a large collection, the design provided a range of advantages. It enabled the producer's description of financial transactions to be classified into standardised terms for analysis and comparison with datasets compiled for different purposes and using different variables. The datasets used to compare profitability of the NESP-EP sample farms use different definitions of farm income, off-farm income and other farm income as well as different approaches to classification of expenses classes. The metadata-driven approach provided the required flexibility and made the task of assembling datasets for like-for like comparison to both, different data sets simple and fast. The ability to track a value through the classification strata to the original entry provided a way to audit data to assure accuracy.

13.1.2 Comparison to industry benchmarks

Two industry benchmarking studies were identified that describe multi-year financial performance of wool and beef producers in the grassy woodland biome of Australia. These were the AgInsights benchmarking publication series produced by Holmes Sackett Pty Ltd since 2003 (Holmes Sackett, 2017) and a benchmarking study of profitable integration of cropping and livestock management published by MLA (MLA and Rural Directions, 2018).

Since 2003, Holmes Sackett research into agricultural productivity and profitability has described the profitability of different enterprise strategies and identified a range of variables associated with profitability that are possible drivers of better performance. This research is published annually in a series entitled AgInsights: Knowing the past: Shaping the future. AgInsights participants are generally regarded as the elite of Australian agricultural producers, the Bottom 20% of the benchmark is considered to be similar to the ABARES average (Holmes Sackett, 2017) and are commonly (but not exclusively) comprised of producers in the grassy woodland biome.

Industry knowledge and descriptions of the enterprise operations strategies used by participants indicate that AgInsights participants can be described as 'conventional' producers using the current good practice techniques for agricultural productivity; significant quantities of inputs to elevate soil nutrients and cultivation, livestock supplementation and a preference for exotic vegetation. These practices are also described as contributing to key threatening processes for grassy woodlands (McIntyre et al., 2002, Prober and Thiele, 2005, TSSC, 2010). They are therefore suitable as counter-factual comparisons of profitability for this study.

Benchmarking data from the AgInsights publications were obtained from the National Library of Australia (Canberra) and used to compare the profitability of the sample population with the performance being achieved by the AgInsights participants. To allow comparisons of profitability across farms of different sizes and in different rainfall zones, profit is commonly estimated on a per head of livestock, per hectare or per hectare per millimetre of rainfall. There are two 'units' of livestock used in this study; dry sheep equivalent[10] (DSE) used commonly in the industry and sheep equivalent[11] (SE) used by ABARES.

A national Meat & Livestock Australia project recently compiled 100 multi-year (three years; 2014 to 2017) datasets from southern Australia to identify drivers of profitability in each agro-ecological zone (MLA and Rural Directions, 2018). While the project focused on how cropping and livestock can be successfully integrated to achieve win-win outcomes, it produced data for return on assets managed (ROAM) and other variables useful for comparison of profitability of alternative enterprises.

Holmes & Sackett benchmarking uses Return on Assets Managed (ROAM) and Net Profit (calculated as EBIT) as key indicators of whole farm profitability. ROAM is calculated by dividing the earnings before interest and tax (EBIT)[12] for a farm and dividing this by the total assets under management (including the value of livestock holdings). It therefore considers the value of all resources engaged to generate farm business profit. The Holmes & Sackett AgInsights database is ranked on net profit per DSE and per hectare at the whole farm level. In the final benchmarking report used in this study, the AgInsights Volume 19 benchmark included 159 participants with 31 farms making up the top 20% of performers. Most participants are located in the grassy woodland biome. Eighty-nine farms were from NSW, thirty-six from Tasmania, twenty-one from Victoria, twelve from South Australia and one from Queensland. Most (650,000ha) of the area benchmarked (720,000ha) is used for grazing (Holmes Sackett, 2017). Profits in 2015-16 were above average by historical standards.

While there are many variables that lead to differences in financial performance, in general, Holmes & Sackett finds that profitability of the top 20% of wool producers is driven by some key driver variables including income/DSE and cost of production/DSE. For beef producers, cost of production is a key factor, but producers that use supplementary feed to increase income when markets are good and feed costs are low tended to have better overall financial performance. Key components of

[10] A DSE reflects the size and forage requirements of a (approximately) 45kg castrated male sheep. Cattle are regarded in this study to be roughly equal to 10 DSE.

[11] The formula for calculation of sheep equivalents (se) is: sheep_equivalents = sheep_at_30 June + (beef_cattle_at_30_June * 8) + (dairy_cattle_at _30_June * 12) + (total_area_of crop_for year * 12); Livestock numbers include all types and ages. For example sheep includes sheep and lambs. Crop area is the total area planted to crops harvested during the financial year.

[12] Holmes & Sackett use the term Net Profit for EBIT.

cost of production in livestock systems are supplementary feed, pasture costs, animal health and breeding costs. Management of enterprise expenses (that contribute to variable costs) and overhead costs is also important.

We gathered AgInsights benchmark results for the period from 2006 to 2017 for these indicators and variables from volumes held at the National Library in Canberra. We ranked the NESP-EP sample by EBIT into top 20%, average and bottom 20% so performance on key performance indicators and driver variables could be compared. These are presented in 14 Findings.

13.1.3 Comparison to ABARES farm survey

An objective of the project was to collect data that would allow comparison of financial performance under different seasonal conditions. This required selection of comparison farms in very similar climate and geological regions to reduce the chances that differences in financial performance between ABARES data and the participants in this study were due to these influences.

ABARES publishes data from its Farm Survey at SA4 level to preserve privacy and confidentiality of farm data. This is too coarse to support the goals of the project. To overcome this issue, ABARES proposed to perform the analysis in-house and produce the results for further analysis. To locate appropriate Farm Survey participants, we provided the latitude and longitude of the centre of the sample properties and a description of the enterprise type to ABARES. To ensure that NESP participants were not also in the ABARES dataset, we gained permission from the study participants to provide ABARES with information about whether they had participated in the Farm Survey in the past. The de-identified NESP-EP dataset compiled to compare financial variables matched to ABARES definitions and coded for confidentiality was provided to ABARES along with R-code for the analysis.

The classification strategy is illustrated in Figure 37.

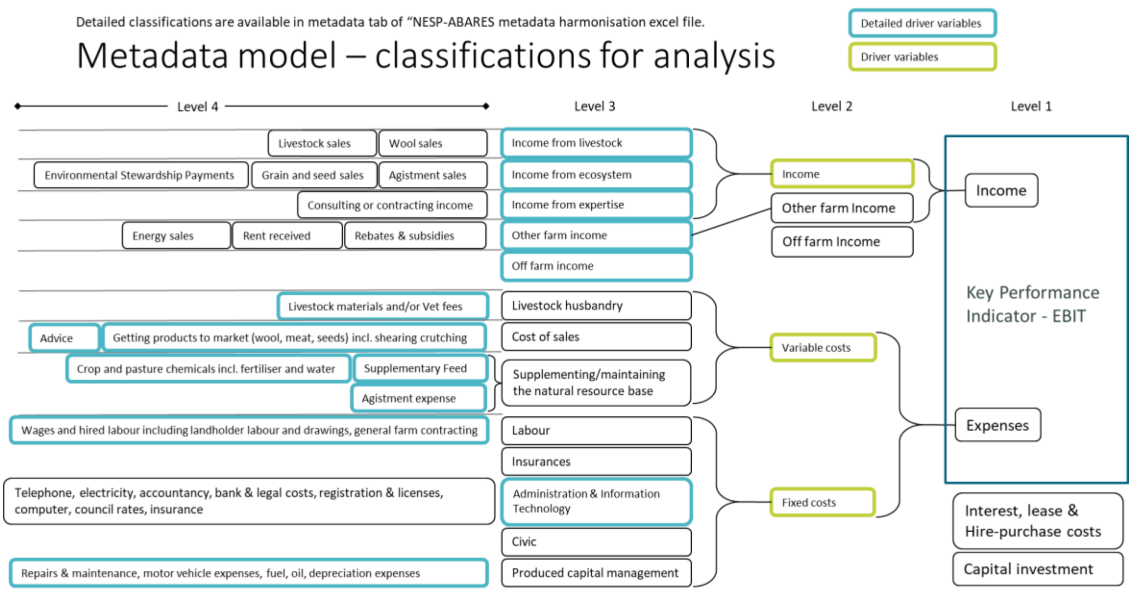

Figure 37: metadata model - classifications for analysis

At the time of writing (18 July 2018) issues with code functions were still being resolved and only a limited set of data was available for inclusion in this report (see findings).

13.1.4 Basic and econometric analysis

The project will report findings of comparative profitability in two ways; via comparison of raw data with benchmarking reports and via econometric analysis. The econometric analysis used linear mixed effects models to determine whether or not farming mode (regenerative versus other farms) has a statistically significant effect on key performance metrics (EBIT/DSE, ROAM). We also compare cost and profit profiles associated with each farming mode using non-parametric multivariate techniques. Taken together, the results of these analyses are used to establish a link between farming practice and associated financial outcomes. A number of secondary analyses have also been undertaken to consider implications for farm efficiency, quality of season and future climate effects.

The preliminary analyses contained in this report capture key outcomes of our econometric comparison. Our final results will be submitted for peer-review and publication prior to the end of 2018.

13.2 Ecological classification

The aim of the study was to study the profitability (and wellbeing) of producers using or regenerating healthy grassy woodlands as their natural capital. To confirm claims that properties of the selected participants are sustainable or regenerating grassy woodlands we needed to develop a method to classify them[13]. *Note: these property owners don't explicitly have restoration and conservation of grassy woodlands as a personal goal and so the condition of the grassy woodlands should be regarded as an emergent property of their management.*

We sought to classify condition at property scale in order to provide an overall view of the environmental performance and biodiversity of the property and chose to do this by combining the condition of different ecological communities within the property to form the overall assessment. This is illustrated in figure 38.

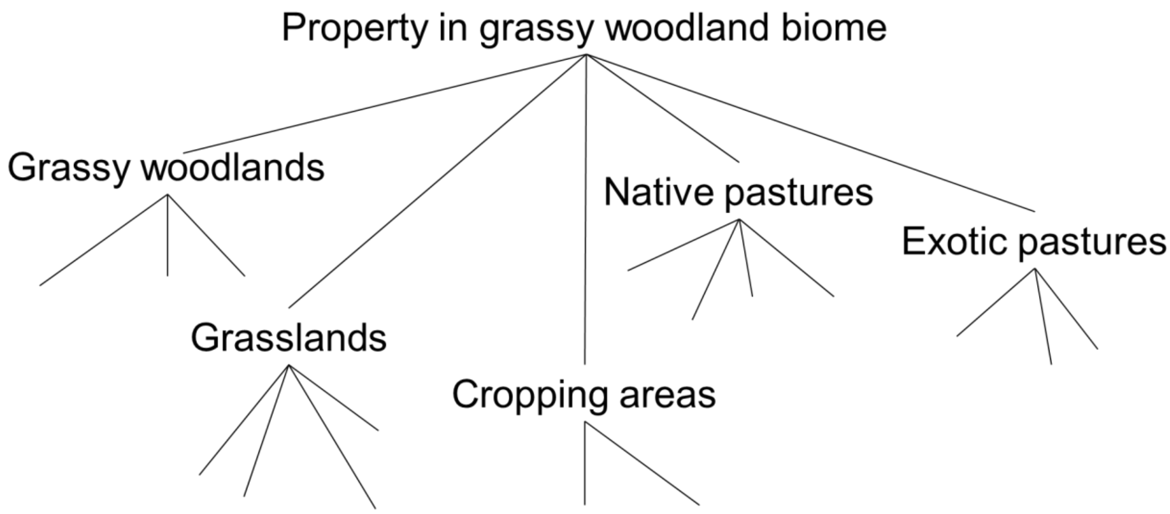

Figure 38: illustration of different types of agro-ecological communities comprising the natural resource base of a grazing business.

13.2.1 Classification method for sustainable, regenerating or reducing grassy woodlands.

A literature review revealed several candidate methods to achieve the classification (rating) required. These were examined for their fitness for purpose, cost-effectiveness and fit to the skillset of the project team. Methods that emerged as the most appropriate included the state & transition model (Rawlings et al., 2010, Prober et al., 2002a), the principles for management and conservation of grassy woodlands (McIntyre et al., 2002), the biodiversity assessment method (BAM) recently adopted by the NSW government for offsets for development (NSW Government, 2014) or using NSW vegetation maps (Keith and Simpson, 2017). To reduce the cost of data collection, we investigated the use of remotely-sensed data, including the fractional vegetation statistics now available from landsat (Guerschman et al., 2015).

The BAM was judged unsuitable for our purposes because it did not enable the classification of grassy woodlands as we required. It required that assessors were trained in the method which the project was not resourced for and as the participating producers were not likely to participate in the BAM, there was no incentive for them to contribute to the cost of assessing their properties using

[13] *It should be noted that this study has not specifically measured whether regenerative grazing regimes are maintaining or improving the condition of box gum remnants to the criteria set out in the EPBC Act (i.e. to high conservation values). Nonetheless, a number of key features of this endangered community have been assessed as present within these regenerative grazing production systems.*

this method. The NSW vegetation maps are at too coarse a scale to meet the project's purpose but were incorporated into the remote sensing as part of the evidence for classification of grassy woodland health.

The method for classification of the participating properties used the principles of management and conservation of grassy woodlands (McIntyre et al., 2002) as the organising framework. These principles were developed using a modified Delphi approach involving a panel of eleven experts representing a range of disciplines (McIntyre et al., 2002). They incorporate a series of six, clear ecological principles for grazing properties for which some thresholds[14] were identified. The principles are aimed at property scale with the premise that if all properties demonstrated the principles, grassy woodlands would be conserved.

They are summarised below:

1. Property planning, and management should include a long-term vision which considers the whole of property and its place in the catchment
2. Soils should be managed to prevent erosion and to maintain productive capacity and water quality
3. Pastures should be managed for production and to maintain a variety of plants and animals
4. Local trees should be maintained for the long-term ecological health of the property and the catchment
5. All properties should have core conservation areas for species that are sensitive to agricultural land uses
6. Watercourses and riparian areas are particularly important to the ecosystem and grazing enterprise and require special management.

Each principle has subprinciples that describe thresholds and management in more detail. These are summarised:

- Thresholds:
    a. Greater than 30 percent of the property has woodlands or forests
    b. Each woodland/forest patch is greater than 10 hectares
    c. There is less than 30% bare ground
    d. The pastures are dominated by large native grass tussocks
    e. Less than 30 percent of the property is subject to intensive use (addition of nutrients and fertilisers)
    f. A minimum of 10 percent of the property is managed for conservation of grazing-sensitive species
- Management policy includes

[14] Thresholds refer to general principles of property management in the grassy woodland biome and not to assessment and management of threatened ecological communities under the EPBC Act.

- Low (no) input of nutrients including chicken manure or other ‘soft’ inputs
- Sensitive grazing management of all areas (esp. vulnerable soils and riparian areas)
- Management goals include native habitat and biodiversity
- There is evidence of natural regeneration and maturation of local trees
- Abundant fallen timber, standing dead trees

We used a combination of management interview, remotely-sensed observations and data (spatial data) and field observations by an ecologist to assess the degree to which the properties exhibited these thresholds and principles and classify the condition of the property. This is illustrated in figure 39.

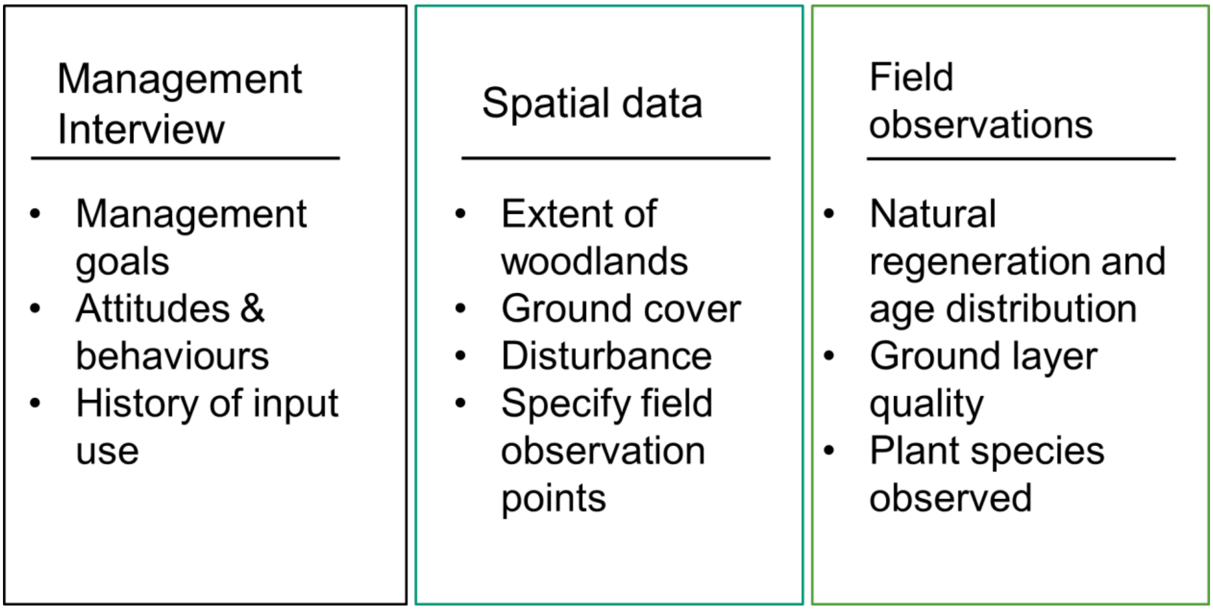

Figure 39: illustration of methods used in combination for property condition assessment

To estimate the area of woodland or forest and the size of woodland patches (thresholds a. and b.) we used the mapping and capability for remotely sensed data functionality provided by FarmMap4D[15] (FarmMap4D, 2017) and NSW vegetation maps (Keith and Simpson, 2017). To estimate the proportion of bare ground on the property (threshold c.) and to detect the area and timing of cultivation or significant disturbance (corroborating or contradicting the findings of the management interview and field observations for threshold e) we used the fractional vegetation statistics products of FarmMap4D. The remotely-sensed observations and mapping functionality allowed priority areas or areas of interest to be nominated to prioritise the field observations.

Data to estimate thresholds d. and f. and whether the management policies indicated satisfaction of the principles were obtained by interviews and field observations. The quality of the ground-layer in woodlands and cleared pastures was assessed via field observations made by a suitably qualified ecologist familiar with grassy woodlands and grazing systems performed the field observations. The field observations were guided by a protocol and data collection sheet populated with the remotely-

[15] A subscription to FarmMap4D was obtained for each participating property.

sensed information and a history of the property. The roles and sequence of data collection is illustrated in figure 40.

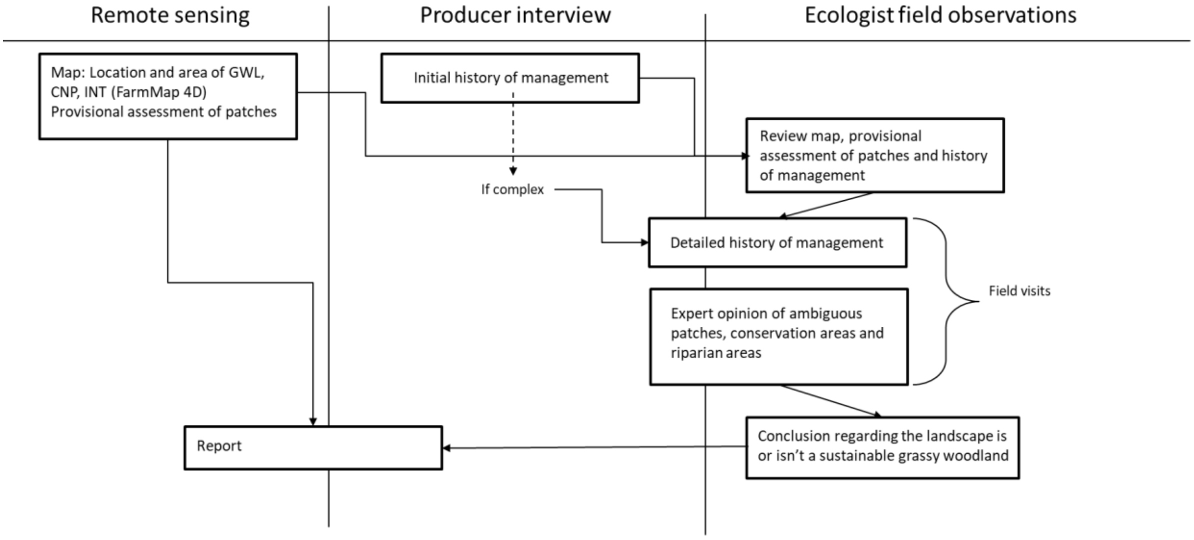

Figure 40: process, roles and responsibilities for collection of data for classification of grassy woodland status of properties

13.2.1.1 Spatial data collection

This table below summarises these characteristics and describes how the FarmMap4D was used. Supplementary information is available from the FarmMap4D User Guide V6 (FarmMap4D, 2017)

Characteristics necessary for BGGW	**Methods for using FarmMap4D outputs to confirm these characteristics**
More than 30% of the property area comprises patches of minimum 5ha of woodland (ideally 35 trees per hectare) or forest cover	Areas that are visually recognisable as trees had fences or polygons drawn around them, so the area could be estimated and expressed as a proportion of the total property. A count of the number of trees per hectare or a visual estimate of number of canopy distances between trees was used to classify woodlands from forests and from scattered paddock trees. A visual match of the area to the classification by NSW of grassy woodland or sclerophyll forest (Keith and Simpson, 2017) was made using a kml file loaded into Google earth and matching this to patches of trees or forests on the subject property. Where overstory was remotely-sensed, but not mapped as grassy woodland, field observations were used to assess whether the wooded areas were classifiable as grassy woodland or other.
No more than 30% of the ground surface of the grazing areas comprises bare soil (areas vulnerable to erosion or frequently exposed to heavy disturbance should have 100% cover).	The basic statistics product of FarmMap4D was used to estimate the percentage of bare ground since 1989 for the whole property.
If grain and forage cropping (e.g. high input cultivation of annual plants) is part of the system, it is less than 30% of the property area.	Indications of cultivation or significant disturbance such as overgrazing is provided by the Decile product. Where lowest decile ground cover with a clear fence line effect was observed, we suspected cultivation and inputs. This information was used to corroborate or contradict the management history and to direct the ecological to sites of interest. Size of cultivation area as output to estimate intensified proportion.

Characteristics necessary for BGGW	Methods for using FarmMap4D outputs to confirm these characteristics
At least 10% of the property (including on good quality soil types and riparian areas) is comprised of habitat including mature trees, understory vegetation, fallen timber and standing dead timber maintained weed free as habitat for native flora and fauna.	From Farm Maps (if formal conservation zones, information provided by farmers) corroborated by field observation.
Vegetation at the edges of watercourses is managed to prevent soil erosion, nutrient entry to watercourses and invasion by exotic plants.	Locations of riparian areas from images from FarmMap4D. Condition of riparian areas from expert ecologist observation.

13.2.1.2 Field observations

Field observations by a suitably qualified ecologist were used to assess woodland condition and ground-layer condition with respect to the principles for conservation and management of BGGW and to judge whether the current management is likely to improve condition or not.

The ecologist was briefed that the purpose of the ecological assessment was to assess the extent to which the selected farms meet criteria for the sustainable management of grassy woodlands as described in McIntyre et al. 2002. The farms were selected as being the closest to best-practice management in this respect, and the assessments aimed to confirm (or otherwise) that there is sufficient grassy woodland and derived native grasslands in appropriate condition to expect that, under current management, their condition and extent will be maintained or improved. The aim of the farm visit was to gather the information that is not provided by the spatial data or well-being interview e.g. management histories, woodland condition, ground layer condition.

As much information as possible from remotely collected data was provided to the assessor prior to the farm visit. This was studied by the assessor to understand as much as possible about the property, so that, in discussion with the landholder, the assessor could confirm what is known and clarify any ambiguities. We organised a briefing meeting before the visit to go through the special data and identify issues.

In general, in addition to the land use histories identified above, the assessor was expected to need to discuss with the landholder:

- Any places of interest noted from the spatial data that we need assistance to interpret.
- The best route to take through the farm to cover representative areas and places in which ground truthing is required.
- Places not identified by the spatial analysis that could be considered to have high conservation values and/or that are under conservation management. (In other words, ‘can you show us your best bits’.)

At each location (identified from spatial analysis or by the landholder) the assessor was required to wander around for a few minutes and observe each area to provide the information listed for each type of community. An assessment of whether an observed species was dominate, significant or minor for each area was recorded. In the data collection sheet provided to the assessor, the following prompts for each area were made to assure observation quality.

13.2.1.3 Assessment of woodlands

- Are they grassy woodlands or sclerophyll forests? Y/N
- Are there a range of ages of trees? Y/N
- Are there many mature trees? Y/N
- Is natural regeneration observed?
- Is fallen timber present and abundant?
- Is the area grazed Y/N
- Is native vegetation dominant[2] Y/N
- Is there greater than 90% ground cover[16] Y/N
- List species identified and other observations

13.2.1.4 Assessment of riparian areas

- Are there signs of erosion? Y/N Is the current water clear? Y/N
- What is the potential for erosion with fast flows? H/L
- Is there quality habitat? Y/N
- Are there signs of salinity? Y/N
- Is the area grazed Y/N
- Is native vegetation dominant Y/N
- Are the banks well-grassed? Y/N
- Are significant weeds observed? Y/N

13.2.1.5 Assessment of cleared pasture

- Is the area grazed Y/N
- Is native vegetation dominant Y/N
- Are significant weeds observed Y/N
- Is there greater than 90% ground cover Y/N
- List species identified and other observations

13.2.2 Classifications

The classification of the property as either sustainable grassy woodland, regenerating grassy woodland or reducing grassy woodland was derived by judgement of the degree to which all or some principles were in evidence and whether the property was below threshold as a legacy of past management. A six-box classification (already presented as Table 1 in the document) that combines these principles was derived for use in secondary analysis of profitability implications associated with the classification. While all producers that are managing for production and ecosystem function are demonstrating the principles of conservation and management of grassy woodlands, even if they are below threshold for some elements, we felt the distinction between those who are also managing for native biodiversity would enable useful secondary analysis of whether this extra investment was positive or negative to their profitability. Accordingly, we judged that some producers were using sensitive-enough management that some grazing-sensitive species may survive in their production landscapes. This was confirmed by observations of more than one of the Appendix 1 species on some of the properties.

[16] Based on crown cover of ground plants

Threshold status	Not managing for grassy woodland persistence (high input, import of nutrient)	Managing for production and ecosystem function (low input)	Managing for production, ecosystem function and native biodiversity
Landscape condition above ecological thresholds	Landscape unsustainable as grassy woodland, native biodiversity being eliminated. A property with grassy woodland characteristics in which intensification (nutrient enrichment, exotic vegetation) is being used to maximise production.	Landscape sustainable as grassy woodland, some native biodiversity absent. Management principles relevant to woodland, pasture and soil function being applied to a property with sustainable grassy woodland characteristics. May deplete or maintain conservation values (habitat for native species.	Landscape sustainable as grassy woodland, biodiversity largely complete. All six management principles are applied to a property with sustainable grassy woodland characteristics. Grassy woodland biodiversity and conservation values are expected to be maintained or improved.
Landscape condition below ecological thresholds	Landscape unsustainable as grassy woodland, native biodiversity largely eliminated. A property with depleted grassy woodland characteristics which is continuing to be managed for maximum production.	Landscape regenerating, but biodiversity may remain incomplete. Management principles relevant to pasture and soil function applied to a property with depleted natural capital. No specific restoration of conservation values or native habitat.	Landscape regenerating. All six management principles are applied to a property with depleted grassy woodland characteristics. Active restoration of native habitat is occurring. Grassy woodland biodiversity and conservation values are expected to be maintained or improved.

The details of the principles, sub-principles and the type of data used to assess whether they were being applied are shown via an example in Table 19. The degree of demonstration of each sub-principle was assessed using management interview, spatial data or field observations, or a combination. The assessment of demonstration of each principle was judged by the assessment of its sub-principles and these were considered together to decide the final classification of the condition of the property.

Table 19: Principles, subprinciples, example assessment and data sources for classification (rating) of property grassy woodland condition

Principle number	Description	Assessment for condition classification	Data source(s)
Principle 1: *Not used in this study*	Property planning and management should include a long-term vision which considers the whole of the property and its place in the catchment.	*Not used in this study.*	*Not used in this study.*
Subprinciples 1.1 to 1.5	This principle applies to areas which have not been developed but which will be. The properties in this project were developed decades ago. All the landholders contributing data to this project apply low input, ecologically sensitive grazing management and aim to avoid any negative impacts offsite from their management or production methods.	*Not used in this study.*	*Not used in this study.*

Principle number	Description	Assessment for condition classification	Data source(s)
Principle 2:	**Manage soils to prevent erosion and to maintain productive capacity and water quality.**	**Satisfied**	**Overall judgement of this principle made by considering the assessment of the sub-principles**
2.1	Keep the amount of bare ground exposed to no more than 30-40% of the ground surface in pastures	Satisfied	Fractional ground cover statistics (output of FarmMap4D) described further in 13.5.2 below and verified by field observation described in 13.2.1.5 above
2.2 Not used in this study.	Place infrastructure in stable locations on the landscape to avoid erosion.	Not used in this study.	Not used in this study.
2.3 *Adapted for this study.*	Some soil types require particular attention to avoid erosion and salt problems. Riparian area soils always require particular attention because of their important function in regulating water quality and weed movement.	Satisfied	Management interview exposing attitudes and behaviours sympathetic to soil protection. Complemented with fractional ground cover statistics (output of FarmMap4D) for evidence of bare ground with quality of riparian vegetation assessed in field observation particularly for riparian areas and drainage lines where low ground cover was observed remotely.
Principle 3:	**Manage pastures for production and to maintain the variety of plants and animals**	**Satisfied**	**Overall judgement from sub-principle assessment**
3.1	Graze conservatively to maintain dominance of large and medium tussock grasses over 60 – 70% of the native pastures.	Not satisfied. Short tussock grasses dominate	Field observations of native dominance and tussock size described in 13.2.1.5 above
3.2 *Adapted to accommodate the prior, usually extensive land use during the last century.*	Limit the extent of intensive land use (grain and forage cropping, sown pastures) to a maximum of 30% of the property area. 70% of the property area is dominated by native perennial grasses (includes forest, woodland, and grassland)	Satisfied	Assessed by combination of management interview about practices complemented with fractional ground cover statistics (decile product of FarmMap4D) to identify heavily disturbed areas that might have been subject to cultivation and therefore fertilisers. Any suspect zones were assessed in field observation. Field observations used to assess the quality and native-dominance of the ground-layer described in 13.2.1.5 above.
3.3	Vary the management of native pastures to provide for a variety of species and a diverse range of fodder sources.	Satisfied	Sensitive grazing that varies the timing, duration and intensity of grazing to promote biodiversity is a basic tenet of holistic

Principle number	Description	Assessment for condition classification	Data source(s)
			management and planned grazing and therefore part of the recruitment criteria. Minimum recovery times for regenerative graziers are typically six months and maximums can exceed 12 months.
Principle 4:	**Maintain local native trees for the long-term ecological health of the property and catchment**	**Satisfied**	**Overall judgement from sub-principles**
4.1	There should be a minimum of 30% woodland or forest cover on properties.	Satisfied	Remotely sensed using FarmMap 4D using visual inspection and area estimation. Woodland quality (overstory and ground-layer quality) were assessed via field observations.
4.2	Always favour natural regeneration of existing trees over planting and recreating habitat	Satisfied	Field observation were used to assess natural regeneration and a normal distribution of tree ages described in 13.2.1.3 above.
4.3	To be viable in the long term, woodland patches should be a minimum of 5 – 10 ha.	Satisfied	Remotely sensed using FarmMap 4D using visual inspection and area estimation.
4.4	Retain trees of different ages within stands to retain the long-term viability of tree populations. The presence of mature trees (with nesting hollows) is particularly important.	Satisfied	Field observation Field observation were used to assess the distribution of tree ages and confirm the presence of mature trees described in 13.2.1.3 above.
4.5 *Not used in this study*	Maintain or regenerate trees in appropriate places to minimise degradation, enhance livestock production and enhance diversity.	*Not used in this study*	*Not used in this study*
Principle 5:	**All properties require core conservation areas for species that are sensitive to agricultural land uses.**	**Satisfied. Core conservation areas not distinguished – sensitive management applied over whole property**	**Overall judgement from sub-principles.**
5.1 *Not used in this study*	Where possible choose areas with existing flora and fauna values for ongoing management and include areas on good quality soils.	*Not used in this study*	*Not used in this study*
5.2	Retain critical habitat areas such as mature trees, understorey vegetation and standing dead and fallen timber for fauna.	Satisfied	Field observation were used to confirm the presence of mature trees and standing and fallen dead timber and assess the quality of the

Principle number	Description	Assessment for condition classification	Data source(s)
			ground layer described in 13.2.1.3 above.
5.3	Core conservation areas need protection from heavy or continuous grazing.	Satisfied	Field observation and general interview
5.4	Ongoing management of exotic plants and fire may be required in core conservation areas	Satisfied	Field observation and general interview
5.5 *Not used in this study*	Core conservation areas should be connected to others on the property and in the district.	*Not used in this study*	*Not used in this study*
5.6	Manage at least 10% of the property as core conservation area.	Core conservation areas not distinguished. Sensitive management applied across whole property.	Property maps providing extent of conservation-specific areas or management of grazing indicates the whole property is being managed with conservation of biodiversity as an objective.
Principle 6:	**Watercourses and riparian areas are particularly important to the ecosystem and grazing enterprise and require special management**	**Satisfied**	**Overall judgement from sub-principles**
6.1	Vegetation should not be cleared up to the edges of watercourses. Riparian areas should have good quality native habitat.	Satisfied	Field observation and general interview to establish the goals of management of riparian areas and the quality of riparian habitat described in 13.2.1.4 above
6.2	As a general principle, livestock should be excluded from watercourses to reduce soil erosion and maintain the quality of the water	Satisfied	Field observation and general interview to establish the goals of management of riparian areas and the quality of riparian habitat described in 13.2.1.4 above.
6.3	Control of exotic plants in riparian areas is important.	Satisfied	Field observation and general interview to establish the goals of management of riparian areas and the quality of riparian habitat described in 13.2.1.4 above.

13.2.3 Methods for estimating ground-cover proportion

To estimate the proportion of ground-cover since 2005 which reflects the change to management practices for the participants. Seasonal ground-cover statistics were extracted from the Imagery Analysis product of FarmMap4D via the regional comparison analysis. The comparison region was selected to include properties that looked like the participant properties (i.e. not forests). In most cases this was 5km or 10km radius from the centre of the participant property. In cases where participating properties were closely located, a larger 20km radius was used to reduce the effect of the other participant(s) on the regional comparison.

13.2.4 Methods for assessing the quality of forage for grazing

The quality (nutritional value and diversity) of a pasture is an important driver of financial and environmental performance in grazing systems. To allow the project and to classify the quality of pastures to explain financial outcomes, we collected information about the species and abundance of grasses and forbs on the property.

The participants in the project have excellent knowledge and skills to correctly identify native grasses and forbs. The project provided each participant with a species list and asked them to nominate which species they have observed on the property and whether the species is minor, significant, or dominant in the pastures. These observations were corroborated during field visits. Expert opinion from the producers in the project team was used to assign a quality value to each species. This was observed to align well with judgements of grazing quality published in Grassland Flora: a field guide for the Southern Tablelands (2007) authored by David Eddy, Dave Mallinson, Rainer Rehwinkel and Sarah Sharp.

14 REFERENCES

ABARES 2014. Australian farm survey results 2011- 12 to 2013 - 14. Canberra Australia: Australian Government Department of Agriculture Bureau of Agricultural and Resource Economics and Sciences.

ABARES. 2018. *Farm surveys and analysis* [Online]. Canberra Australia: Australian government. [Accessed 1 July 2018].

AMPT, P. & DOORNBOS, S. 2011. Communities in Landscapes project Benchmark Study of Innovators. Wyong: Landcare NSW.

ASH, A., HUNT, L., MCDONALD, C., SCANLAN, J., BELL, L., COWLEY, R., WATSON, I., MCIVOR, J. & MACLEOD, N. 2015. Boosting the productivity and profitability of northern Australian beef enterprises: Exploring innovation options using simulation modelling and systems analysis. *Agricultural Systems,* 139**,** 50-65.

BROWN, K., SCHIRMER, J. & UPTON, P. in preparation. Do regenerative farmers have higher wellbeing than their peers? Exploring associations between different measures of subjective wellbeing and engagement in regenerative farming practices. .

CAPIC. T. ET AL. 2017. Australian Unity Wellbeing Index Survey 34: Summary report August 2017. Australian Centre on Quality of Life, Melbourne. Melbourne, Australia.

DORROUGH, J., DORROUGH, J., MCINTYRE, S., BROWN, G. & STOL, J. Differential responses of plants, reptiles and birds to grazing management, fertilizer and tree clearing. *Austral ecology,* 37**,** 569-582.

DORROUGH, J. & MOXHAM, C. 2005. Eucalypt establishment in agricultural landscapes and implications for landscape-scale restoration. *Biological Conservation,* 123**,** 55-66.

DORROUGH, J., MOXHAM, C., TURNER, V. & SUTTER, G. 2006. Soil phosphorus and tree cover modify the effects of livestock grazing on plant species richness in Australian grassy woodland. *Biological Conservation,* 130**,** 394-405.

DOTEE. 2016. *Grey Box (Eucalyptus microcarpa) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia SPRAT Profile* [Online]. Canberra, Australia: Commonwealth Department of the Environment & Energy. Available: http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=86#status [Accessed 28 March 2016].

DOTEE. 2018. *EPBC Act List of Threatened Ecological Communities* [Online]. Australian Government Department of the Environment and Energy. Available: http://www.environment.gov.au/cgi-bin/sprat/public/publiclookupcommunities.pl [Accessed 2018].

FARMMAP4D 2017. FarmMap 4D User Guide V6. Canberra Australia.

FILIPPI, P. unpublished. Plant productivity, litter accumulation and phosphorus loss in a diverse perennial grassland under unfertilised cell grazing. *AFNR4102 Research Project B / Research Paper.* University of Sydney.

GUERSCHMAN, J. P., SCARTH, P. F., MCVICAR, T. R., RENZULLO, L. J., MALTHUS, T. J., STEWART, J. B., RICKARDS, J. E. & TREVITHICK, R. 2015. Assessing the effects of site heterogeneity and soil properties when unmixing photosynthetic vegetation, non-photosynthetic vegetation and bare soil fractions from Landsat and MODIS data. *Remote Sensing of Environment,* 161**,** 12-26.

HOLMES SACKETT 2017. AgInsights Volume 19. Wagga Wagga, NSW Australia.

HOLMES SACKETT 2018. AgInsights: A HOLMES SACKETT PUBLICATION. KNOWING THE PAST: SHAPING THE FUTURE. Wagga Wagga, NSW Australia.

KEITH, D. A. & SIMPSON, C. C. 2017. Vegetation Formations and Classes of NSW (version 3.03 - 200m Raster) - David A. Keith and Christopher C. Simpson. VIS_ID 3848. Syndey, Australia.

KERING 2013. Kering Environmental Profit & Loss (E P&L). Paris, France.

LAVOREL, S., COLLOFF, M. J., MCINTYRE, S., DOHERTY, M. D., MURPHY, H. T., METCALFE, D. J., DUNLOP, M., WILLIAMS, R. J., WISE, R. M. & WILLIAMS, K. J. 2015. Ecological mechanisms underpinning climate adaptation services. *Global Change Biology,* 21**,** 12-31.

MALLAWAARACHCHI, T., OGILVY, S., HEAGNEY, L., SCHIRMER, J., GARDNER, M. & OLIVER... in preparation. Addressing sources of unsustainability in Australian Agriculture: some insights from regenerative grazing.

MCINTYRE, S., MCIVOR, J. G. & HEARD, K. M. 2002. *Managing & Conserving Grassy Woodlands,* Canberra, CSIRO Publishing.

MLA & RURAL DIRECTIONS 2018. Profitable integration of cropping and livestock management guideline. New South Wales - Central West. Central West New South Wales. Sydney, Australia.

MONAGHAN, N., LOWER, T. & ROLFE, M. 2017. Fatal Incidents in Australia's Older Farmers (2001–2015). *Journal of Agromedicine,* 22**,** 100-108.

NSW DEPARTMENT OF ENVIRONMENT, C. C. A. W. 2010. National Recovery Plan. White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Dative Grassland. A critically endangered community. . Sydney Australia: Department of the Environment, Comate Change and Water NSW.

NSW GOVERNMENT 2014. BioBanking Assessment Methodology 2014. Sydney Australia: State of NSW and Office of Environment and Heritage.

O'REAGAIN, P. J. & SCANLAN, J. C. 2013. Sustainable management for rangelands in a variable climate: evidence and insights from northern Australia. *animal,* 7**,** 68-78.

OGILVY, S., HEAGNEY, L., MALLAWAARACHCHI, T., ASHTON, D., GARDNER, M., SCHIRMER, J., BROWN, K. & MCINTYRE, S. in preparation.

OGILVY, S., KULKANI, A., HURLEY, S. & MACLEOD, T. 2015. From Vicious to Virtuous Cycles: a sustainable future for Australian Agriculture. Carlton, Victoria Australia: CPD.

PANNELL, D. J. 1999. Economics, extension and the adoption of land conservation innovations in agriculture. *International Journal of Social Economics,* 26**,** 999-1014.

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**,** 1407-1324.

PROBER, S. M., LUNT, I. D. & THIELE, K. R. 2002a. Determining reference conditions for management and restoration of temperate grassy woodlands: relationships among trees, topsoils and understorey flora in little-grazed remnants. *Australian Journal of Botany,* 50**,** 687-697.

PROBER, S. M. & THIELE, K. R. 2005. Restoring Australia's temperate grasslands and grassy woodlands: integrating function and diversity. *Ecological Management & Restoration,* 6**,** 16-27.

PROBER, S. M., THIELE, K. R. & LUNT, I. D. 2002b. Identifying ecological barriers to restoration in temperate grassy woodlands: soil changes associated with different degradation states. *Australian Journal of Botany,* 50**,** 699-712.

PROVENZA, F. D., VILLALBA, J. J., HASKELL, J., MACADAM, J. W., GRIGGS, T. C. & WIEDMEIER, R. D. 2007. The Value to Herbivores of Plant Physical and Chemical Diversity in Time and Space. *Crop Science,* 47**,** 382.

QUEENSLAND CANEGROWERS ORGANISATION. 2018. *Project Cane Changer* [Online]. Queensland CANEGROWERS Organisation. Available: https://www.canechanger.com/ [Accessed 19 October 2018].

RAWLINGS, K., FREUDENBERGER, D. O. & CARR, D. 2010. A guide to managing Box Gum Grassy Woodlands. Canberra Australia: Department of the Environment, Water, Heritage and the Arts.

SAVORY, A. & BUTTERFIELD, J. 1999. *Holistic Management: A New Framework for Decision Making,* Washington DC, Island Press.

SCHIRMER, J. 2017. Riverina Local Land Services natural resource management activities: Evaluation of socio-economic benefits and costs. Report prepared for Riverina Local Land Services, August 2017. Canberra, Australia: University of Canberra.

SCHIRMER, J., BERRY, H. L. & O'BRIEN, L. V. 2013. Healthier land, healthier farmers: Considering the potential of natural resource management as a place-focused farmer health intervention. *Health & Place,* 24**,** 97-109.

SCHIRMER, J. & BROWN, K. in preparation. Are alternative agricultural systems good for farmer wellbeing as well as environmental sustainability? Evidence from Australian farmers. .

SCHIRMER, J., PEEL, D. & MYLEK, M. 2015. Farmers and agriculture: The 2014 Regional Wellbeing Survey. Canberra, Australia.

SCHIRMER, J., YABSLEY, B., MYLEK, M. & PEEL, D. 2016. Wellbeing, resilience and liveability in rural and regional Australia: the 2015 Regional Wellbeing Survey. Camberra, Australia.

SEIS, C. & SEIS, N. 2003. "Pasture Cropping" a profitable & sustainable approach for mixed farming systems. Mudgee, NSW Australia: CWCMA.

THE CIE 2015. Meat Industry Strategic Plan 2015-20: Quantifying the payoffs from collaborative investments by the red meat industry. Canberra, Australia.

TONGWAY, D. J. & HINDLEY, N. L. 2004. *Landscape Function Analysis: Procedures for monitoring and assessing landscapes,* Canberra, CSIRO Sustainable Ecosystems.

TSSC 2010. Advice to the Minister for the Environment and Heritage from the Threatened Species Scientific Committee (TSSC) on Amendments to the List of Ecological Communities under the Environment Protection and Biodiversity Conservation Act 1999 (APBC Act). . Canberra, Australia: Department of the Environment and Energy.

VILLALBA, J. J. & LANDAU, S. Y. 2012. Host behavior, environment and ability to self-medicate. *Small Ruminant Research,* 103**,** 50-59.

VILLALBA, J. J. & PROVENZA, F. D. 2009. Learning and Dietary Choice in Herbivores. *Rangeland Ecology & Management,* 62**,** 399-406.

WALSH, D. & COWLEY, R. 2016. Optimising beef business performance in northern Australia: what can 30 years of commercial innovation teach us? *The Rangeland Journal,* 38**,** 291-305.

WRIGHT, T., WRIGHT, K. & REID, N. 2005. Case Study: Wool production & biodiversity working together for Tim & Karen Wright - 'Lana'. Armidale, NSW Australia.