INTEGRATING NATURAL CAPITAL ACCOUNTING INTO AGRICULTURAL DECISION-MAKING

Stuart R. Martin

Bachelor of Commerce (Land Economics)—University of Western Sydney

Master of Sustainability—University of New England

Institute for Sustainable Futures

University of Technology Sydney

Thesis submitted for a PhD in Sustainable Futures

December 2022

CERTIFICATION OF ORIGINAL AUTHORSHIP

I certify that the work in this thesis has not been submitted previously for a degree or as part of the requirements for a degree. I also certify that the thesis has been written by me. Any help that I have received in my research, or the preparation of the thesis is acknowledged in the next section. I also certify that all information sources and literature used are cited in the thesis.

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Candidate—Stuart R Martin 21 December 2022

ENDORSEMENT

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Principal Supervisor Adjunct Prof. Scott Kelly 20 December 2022

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16 December 2022

Supervisor Prof. Damien Giurco

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Supervisor Dr. Cathleen Waters 15 December 2022

ABSTRACT

There is growing interest in the critical role that natural capital plays in the supply of food, fibre, and energy, and its importance to societal well-being. This is in response to the alarming rate of decline in natural capital, and agriculture has made a significant contribution to this process. However, agriculture is also in a unique position to play a significant role in arresting this decline. To address this issue, attention has been directed towards sustainable land management practices through the measurement and monitoring of natural capital in agricultural landscapes. In recent years, the development and use of accounting frameworks for natural capital in these landscapes has been considered as a tool to deliver better natural capital outcomes and create value for farmers. Presently, there is limited evidence of their wide use.

The aims of this research, and its trans-disciplinary approach, were to investigate how natural capital is perceived by a cross-section of agricultural enterprises and stakeholders; and to Identify the value attributed to natural capital and how the obstacles to designing and integrating effective accounting frameworks may result in its wider utilization.

A mixed-methods approach was taken in this study, dominated by qualitative data. The initial stage involved the use of case studies and interviews with case study members. This provided examples of farming and government programmes that are undertaking or implementing natural capital accounting. They have been chosen to understand the value propositions and barriers that exist when there is only limited uptake of natural capital accounting. The second phase, and independent of the case studies, two focus groups collected qualitative from agricultural stakeholders to understand the perception of natural capital and its value proposition to the stakeholder and their industry or sector. Quantitative data was also gathered at this stage through a short survey conducted with focus group participants. The survey was used to overcome time constraints and as a scaffold during the sessions. Final quantitative data was also gathered through a survey of a diverse range of famers to gain a wider perspective on the importance of natural capital across the general farming population.

The case studies showed that at this stage, value propositions are more aspirational than real. The financial or economic benefits identified in cases of more-advanced natural capital accounting appeared to be based more on farming practices or methods than on the results of natural capital accounting. The wider use of natural capital accounting may be linked to a failure to develop clear links between farm productivity, financial outcomes, and environmental outcomes.

The findings from the focus groups indicated that natural capital accounting may not be the best tool with which to address the degradation of natural capital and the contribution to climate change. The focus groups highlighted the need to build strategic alliances and greater collaboration across agricultural stakeholders to develop more effective tools. A consistent message from all areas in which data were collected was that there is a general lack of knowledge and education around natural capital accounting amongst farmers and stakeholders. This was deemed to limit its wider adoption, together with an apparent lack of skill and general confusion around the language and jargon pertaining to natural capital accounting.

Given the voluntary nature of natural capital accounting without a clear value proposition and no commitment to permanency there is a risk of how effective natural capital accounting will be over the long term.

The finding from this research indicate there is a need for increased education around the role and importance of natural capital. This should occur beyond the farm gate, not only to include agriculture stakeholders, but to increase societies knowledge through the inclusion of natural capital in school curriculum and higher education.

Greater collaboration across farmers and stakeholders is required to build an improved understanding of shared values and identify opportunities to create equitable value opportunities. Equitable opportunities that will encourage wider adoption and build a longer-term focus to delivering improved natural capital outcomes. Importantly there is more work required to clearly link the economic benefits to the environmental benefits of improved natural capital and the need for long term measurement and monitoring.

Acknowledgements

I came to this thesis to unscramble balancing economic essentials of agriculture with the imperative of protecting Natural Capital. The idea was seeded from an unsuccessful attempt to create an investment product that delivered investors both economic and environmental dividends. I thank my business partners that inspired me on my journey, Tony Long, Tony Thompson and Ian Crowley.

I have been extremely fortunate to have been supervised by Scott Kelly and Damien Giurco at the Institute for Sustainable Futures and Cathy Waters from the Department of Primary Industries NSW. Without their amazing patience, guidance, and encouragement I would not have made it to the end. I will always be in their debt for their support and inspiration in fulfilling my aspirations. Without the initial connection and encouragement of Michael Bullen formerly of DPI this journey may never have begun.

It has proven an enriching if not challenging and at times frustrating journey. A journey that resulted in meeting with many extraordinary and passionate people involved in agriculture, investment, and environmental programs. A special mention to those who gave up valuable time and knowledge to assist in the journey. From those involved with the case studies, focus groups and those that completed the survey a huge thank you for the roles you have played. I feel invigorated by their kindness and willingness to give up their valuable time to assist. Of course, to Dr Alex Baumber (UTS), Dr Rebecca Cross (USYD) and Dr Elizabeth Pinkard (CSIRO) who became informal sounding boards along my journey a huge thank you. Not the least Bernie Dominiak (DPI) for his initial editing work and Janine Miller for her proof reading and editing.

I have been blessed to have been part of the Institute for Sustainable Futures (ISF) through this journey. The staff, particularly IT and Brandon Nguyen, for keeping me sane and online during COVID lockdowns. Along with fellow students who are an amazing cohort striving to deliver better outcomes for our global society. The ISF HDR program has been invaluable in smoothing the journey and guiding me through the HDR maze. I would also like to thank

the Food Agility CRC in providing both financial support, guidance and access to some of their key networks. Prof David Lamb, Dr Madeline Mitchell, Dr Mick Schaeffer and John Westgarth to name a few.

Friends and colleagues also deserve acknowledgement. Phillip Browning, Emma Leonard and Ed Leffy fellow Food Agility PHD students (the pracademicals) thank you for your encouragement and support. Phil in particular our weekly calls proved insightful and showed how interlinked research can be, not to mention, a bit of a laugh. To my fellow Orange based ISF'er Dr Simon Wright (and Stella the dog) our coffees around Orange and your continued words of encouragement were invaluable.

Of course, this would never have been possible without the immense support from my amazing wife Angela. Thank you for your love and never-ending support. Our children of who I am extraordinarily proud, Samuel and Beatrice thank you for helping me through this journey. And to Crumble (man's best friend) for his companionship, sorry you didn't quite endure the whole journey, but you were a big part of it during those long cold winter days.

Finally to my parents thank you for all your support and kindness.

This research would not have been possible without the generous funding from the Commonwealth Government Department of Education and Training scholarship.

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Date 21 December 2022

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List of Abbreviations

AFN – Accounting for Nature

CFI – Carbon Farming Initiative

CN30 – Carbon Neutral 2030

DPI – Department of Primary Industries (NSW)

DPSIR – Driving Forces – Pressures – Impact – State - Responses

EOV™ – Ecological Outcome Verification

ERF – Emissions Reduction Fund

ESG – Environmental, social, and governance

GDP – Gross domestic product

GHG – Greenhouse gases

IPCC – Intergovernmental Panel on Climate Change

IR – Integrated reporting

L2M – Land to Market™

MEA – Millennium Ecosystem Assessment

MLA – Meat and Livestock Australia

QIC – Queensland Investment Corporation

QLRF – Queensland Land Restoration Fund

SEEA – System of Experimental Environmental Accounts

SOC – Soil organic carbon

TEEB – The Economics of Ecosystems and Biodiversity

TFND – Task Force on Nature-related Financial Disclosures

OECD – Organisation for Economic Cooperation and Development

UN – United Nations

UNCCD – United Nations Convention to Combat Desertification

UTS – University of Technology Sydney

Chapter 1: Introduction

1.1 Main Problem Statement

"Natural capital" is defined as the stock of renewable and non-renewable natural resources that combine to yield a flow of benefits to people (Natural Capital Coalition, 2016). In this thesis, I examine the role that agriculture plays in managing natural capital and the risks associated with the decline in natural capital. I investigate the value that agriculture and its stakeholders place on natural capital and the obstacles that exist to designing and integrating effective frameworks to accommodate natural capital within agricultural decision-making. In this research, stakeholders are considered to be those who rely on agriculture or up on whom agriculture relies. This is important because agriculture does not operate in isolation but within a dynamic system of exchange. Freeman defined 'Stakeholders' as "those groups and individuals who can effect or be affected" by the actions associated with value creation (1984, as cited in, Hörisch et al., 2014) . They have been described in the *International <IR> Framework*, as groups or individuals that can reasonably be expected to be significantly affected by an organisation's business activities, outputs, or outcomes, or whose actions can reasonably be expected to significantly affect the ability of an organisation to create value over time (The IFRS Foundation, 2021).

In this research, I addressed the management of natural capital by agricultural enterprises in the context of their roles in the degradation of natural capital and the contribution of this degradation to climate change. I considered agriculture as both part of the solution and as a tool for reducing greenhouse gas (GHG) emissions and establishing co-benefits. Co-benefits have been acknowledged as important, environmental, social, and economic benefits and are considered additional benefits to the emission's offset or carbon stored and are not automatically priced as part of a project (Net Balance Foundation, 2013). Co-benefits in the context of this research are benefits that occur as part of a project that is designed to improve natural capital outcomes.

Importantly, the research goes beyond the farm gate to understand how agricultural stakeholder groups can influence natural capital management and outcomes, despite their

cultural and professional differences. I aimed to clarify the areas of consensus that can be used to influence and break down tensions between stakeholders. The results should allow a more integrated response to the delivery of sustainable outcomes in the management of natural capital. In this study, I examined case studies of agricultural enterprises that already undertake natural capital accounting, to identify the value propositions and the obstacles they encounter in using this approach. I used focus groups to better understand the agendas and perceptions around natural capital in key stakeholder groups. Finally, I compared these findings with a survey of a broader, more diverse group of farmers to assess how these farmers perceive their own sustainability/natural capital journey compared with those of the participants in the case studies and focus groups.

1.1.1 Background

Natural capital is required to provide the ecosystem services that are essential for agriculture. Ecosystem services have been defined as flow of benefits or value they provide to society including food, water, energy, shelter, medicine, spiritual connection. Ecosystem services also include regulating, supporting and cultural services such as clean air, flood defence, climate regulation, pollination and recreation (Natural Capital Coalition, 2016). Traditionally, natural capital was viewed through an ecological lens, effectively separating it from traditional economic considerations (Costanza & Daly, 1987). However, as Gómez-Baggethun et al. (2010) noted, ecological concerns began to be framed in economic terms in the 1970s and 1980s. This was due to the increasing recognition of society's dependence on natural capital and of its steady and alarming rate of decline.

The release of *Our Common Future,* World Commission on Environment and Development (1987), can be seen as a significant watershed in raising the issues society faces with the degradation of natural capital and ecosystem services, and the risks this degradation poses to future generations (Stoneham et al., 2003). *Our Common Future* recognised the 'value' of natural capital. However, the subsequent continued focus on economic and productivity growth ensured the prioritisation of the economy over the condition of natural capital and ecosystem services for the next 30 years.

The Millennium Ecosystem Assessment (2003) followed *Our Common Future* and was identified by Fisher et al. (2009) as a crucial milestone in identifying the need to measure, model, and map ecosystems. A key gap identified by the MEA was in the methods required to assess the interconnectedness of multiple ecosystem services (Ring et al., 2010). The *Millennium Ecosystem Assessment* emphasised that a failure to recognise the dependence of agriculture on the condition and quality of its natural capital assets will entail societal damage and threaten the future sustainability of agricultural enterprises.

Despite these publications highlighting the critical need to address the condition and management of our natural capital, Salt (2016) demonstrated that government incentive programmes have failed to produce long-term enduring environmental outcomes. As an example, Salt (2016) cites the Natural Heritage Trust, which was established after the Australian Government's sale of Telstra. The allocation of AU$1.3 billion to the Trust in 1997 gained broad community support, but despite this, the outcomes of the programme cannot be measured or readily observed (Salt, 2016). Economists, such as Partha Dasgupta and Ken Henry, increasingly stressed the importance of natural capital to economic and human well-being, but despite this, much of the recent work has been undertaken in isolation by economists or ecologists. Furthermore, problematic policy has had questionable outcomes, with a lack of clear reporting, which makes determining the success of these programmes challenging (James, 2012; Lindenmayer & Gibbons, 2012; Salt, 2016).

Nearly 40 years of research into the critical importance of natural capital has achieved only small advances in the promotion of practical natural capital accounting, particularly in agriculture. This research arose from a desire to link investment returns from agriculture with environmental dividends created through the increased measurement and monitoring of natural capital. The aim was to highlight the importance of natural capital in the delivery of agricultural returns, through the maintenance of more-resilient landscapes, based on investors' desires to strengthen their environmental, social, and governance (ESG) credentials.

In 2020, the Task Force for Nature-related Disclosures (TFND) was formed (Taskforce on Nature-related Financial Disclosures, 2020), and may be viewed as a response to the

recommendations of World Commission on Environment and Development (1987) and in *The* Millennium Ecosystem Assessment (2003). The TFND was formed in recognition that the financial world and the natural world are linked. The TFND reflects the need to internalise the links between finance and the environment through the collection of effective data on natural capital. This should allow institutions to assess and manage the risks associated with the degradation of natural capital. In 2021, Dasgupta released *The Dasgupta Review*, which aimed to put biodiversity in the centre of the debate and to combine economics and ecology to save the world (Dasgupta, 2021). It further reinforced the notion that natural capital is not a gift of nature and that its degradation and/or loss will potentially have a significant economic cost. This emphasises the need to identify how risk from natural capital loss or degradation manifests across society.

1.2 Research Context

1.2.1 Agriculture is Part of the Problem

Agriculture currently plays a prominent role in the global economic landscape, underpinned by an increasing global demand for food. This is driven by continued global population growth, expected to increase by 31%, from 7.6 billion people in mid-2017 to around 10 billion in 2050 (United Nations, 2019), in parallel with growing world affluence (Alexander et al., 2015). These factors are placing an increased demand on agricultural enterprises to increase the production of food, fuel, and shelter. The growth in demand for food, particularly meat, and the management of existing agricultural land also contributes to climate change through increased greenhouse gas (GHG) emissions due to increases in the production of methane (CH_4) from enteric fermentation and nitrous oxide (N_2O) from manure and fertilisers, both of which are attributable to livestock production.

The reduction, degradation, or destruction of natural capital faster than it can regenerate threatens agricultural productivity, and consequently other businesses and society in general. Historically, the conversion of forest land to agriculture or urban uses reflected societies' progress and development, but ignored the damage to and degradation of landscapes (Shvidenko, 2008). The conversion of forest land remains a significant source of GHG emissions, and human land use, especially intensive agricultural land use, is now an important

focus of concern. The ecological impact from deforestation and land conversion, particularly from agricultural expansion and intensification, is viewed as a major catalyst for desertification. This can lead to externalities and unintended consequences that impact the economic and social constructs of those who are dependent upon the landscapes, particularly through the loss of agricultural productivity and economic viability (Requier-Desjardins et al., 2011)

Agriculture is a leading contributor to land use change, which is associated with 8%–10% of total global GHG emissions (4.8 $GtCo_2yr^{-1}$) (Intergovernmental Panel on Climate Change, 2019; Organization for Economic Co-operation and Development, 2019). Opdam and Wascher (2004) discuss the impact of landscape fragmentation on environmental health through declines in biodiversity, ecosystem functioning, genetic diversity and ecosystem resilience, which in extreme cases can also lead to species extinction. Hobbs (1993) examined the impact of landscape fragmentation, caused by broadacre farming and grazing, on ecosystem processes in Western Australia. In particular the study considered the impacts of land clearing on water and nutrient cycling alongside growing waterlogging and salinity problems.

Soil organic carbon (SOC) is a major indicator of the condition of land-based natural capital. Soil erosion by wind, water, and tillage can rapidly deplete SOC, increasing both GHG emissions and negative economic impacts. Intergovernmental Panel on Climate Change (2019) and the Global Mechanism of the UNCCD et al. (2019) cited soil function, losses of soil carbon, and reduced biodiversity as affecting the productive potential of land. This loss of productive land is having social and political impacts through income loss and food poverty. As Orton et al. (2018, p. 3867) noted, land degradation not only affects productivity growth in agriculture, but has implications "*for the sustainability of agricultural enterprises and global food systems*".

There are additional hidden costs associated with a decline in natural capital, such as increased public costs, the loss of cultural links, the loss of amenities, and increased production costs across supply chains due to land degradation (Orton et al., 2018). In

Western Australia, the potential economic impact of lost production due to salinity across 4.5 million hectares of 'at-risk' productive agricultural land is estimated to be AU$344 million per annum (Simons et al., 2013). This report also identified the hidden public costs of salinity, which are associated with the repair of damaged infrastructure, including road, rail, and water resources (Orton et al., 2018).

The vicious cycle of landscape degradation, loss of vegetation cover, and loss of SOC are seen as contributing to climate change and extreme weather, increasing the landscape's vulnerability to climate change and extreme weather events (Middleton, 2018; United Nations Convention to Combat Desertification, 2015). As an example, in 2009, an unprecedented dust storm was caused by a combination of extreme wind and low levels of ground cover in the Lake Eyre region of South Australia and the Western region of NSW. The storm removed topsoil from fragile arid and semi-arid environments in a dust plume that was 3,000 km long and 500km wide, depositing it over 1,000 km away in Sydney and across the east coast of Australia (Leys et al., 2011). Dust reportedly even reached New Zealand, a further 2,000 km away.

1.2.2 Agriculture is Part of the Solution

In the previous section, I identified agriculture's contributions to the decline of natural capital and climate change. However, agriculture is in a unique position to play a significant role in the solution to the problems identified. Agriculture can provide a sink for GHG emissions and build resilience in agricultural enterprises, particularly by building a strong natural capital base.

The Australian Government created the Carbon Farming Initiative (CFI) in 2011, which became the Emissions Reduction Fund (ERF) in 2015. These initiatives have been key tools in Australia's commitment to reducing GHG emissions as part of the 2015 Paris Agreement. Financial incentives were also offered to encourage carbon sequestration (Fleming et al., 2019). Under the ERF, agriculture plays a significant role through its implementation of the CFI, sequestering carbon through activities such as vegetation management, the cessation of land clearing, and soil carbon sequestration. Significantly, these programmes can potentially

deliver co-benefits or additional value beyond the reduction of emissions. Co-benefits are defined as the benefits created through the implementation of policies designed to reduce GHG emissions (Intergovernmental Panel on Climate Change, 2007). Additional ecological co-benefits may include improved biodiversity, enhanced nutrient exchange, improvements in water quality, livestock shelter, and greater landscape resilience (Baumber et al., 2020). Other studies have also identified the potential co-benefits of delivering these outcomes, beyond the ecological benefits. These include economic and social benefits, such as income diversification, increased incomes, improved community resilience, and improved mental health (Cowie et al., 2019; Queensland Government, 2020).

In recognition of these opportunities, industry bodies across Australian agriculture have developed complementary initiatives, designed to increase transparency around land use and its outcomes. These initiatives address climate change, land degradation, changes in consumer preferences, the increasing need to demonstrate sustainable land management, and increased social licence requirements. These initiatives may also play an important role in delivering data and information under future reporting requirements imposed by the TFND. For example, the Queensland Government initiated the Queensland Land Restoration Fund (QLRF) in 2017, which focused on delivering carbon sequestration projects but also the co-benefits generated through the project. The Australian Beef Sustainability Framework developed by the Australian beef industry was launched in 2017 (Sustainable Australian Beef - Sustainability Steering Group, 2018). The framework was designed to track the performance of beef production with a system of indicators, including environmental and animal welfare. The Meat and Livestock Association of Australia (MLA) launched Carbon Neutral 2030 (CN30) in 2019 (Meat & Livestock Australia, 2020), which focuses on actions that deliver net-zero emissions while maintaining herd numbers. This work addresses climate change, land degradation, changing consumer preferences, and increasing societal demands to demonstrate sustainable land management.

1.3 Risk of Greenwashing

Programmes that address the management of natural capital must be rigorous, or they risk being viewed with scepticism and their legitimacy questioned and viewed as no more than

greenwashing. Poorly constructed programmes may provide little incentive for farmers to engage with or adapt to them, particularly when the outcomes and value propositions are vague and add additional costs to businesses. Greenwashing is a term originally used by environmentalist Jay Westerveld in 1986, and is defined as "*the practice of falsely promoting an organisation's environmental efforts or spending more resources to promote the organisation as green than are spent actually engaged in environmentally sound practices*" (Becker-Olsen & Potucek, 2013, p. 1318).

The Sins of Greenwashing: Home and Family Edition, TerraChoice (2010) lists seven sins of greenwashing that involve a failure to deliver on stated claims. Three risks are also important for the outcomes of natural capital management:

1) Hidden trade-offs—when programmes focus on attributes and ignore significant impacts;
2) Proof—when programs offer no verifiable evidence of their claims;
3) Vagueness—when generalised claims may cause the misinterpretation of outcomes.

Transparent, workable measurement and monitoring methods specific for natural capital are required to avoid issues of greenwashing. It could be argued that without these, the ability of agriculture to validate and account for its economic and environmental contributions is limited. Cresswell and Murphy (2017, p. v) stated that "*Australia is unable to measure the effectiveness of most of our investments in biodiversity management or management of pressures. The outcomes of management actions are rarely monitored and reported for long enough to clearly demonstrate effectiveness".* Concerns have been raised that the evidence supporting existing natural capital programmes lacks validity and that the outcomes of these programmes are both vague and deliver unintended consequences, such as increases in invasive species and feral animals.

1.4 Genuine Opportunities

Agricultural land managers who demonstrate rigour and validity in their natural capital accounting are likely to benefit from new environmental markets and financial incentives and will strengthen their social licence to operate. These opportunities are consistent with the

advantages identified in the literature with respect to participation in environmental programmes, such as carbon farming and biodiversity conservation.

Therefore, the use of measurement frameworks supports the role of agriculture in:

1) maintaining the environmental health of our ecosystems, to ensure we feed 10 billion people by 2050;

2) ensuring that agriculture does not further deplete the ecosystem upon which it depends (Henry & Tubiana, 2017);

3) identifying positive environmental and social outcomes through the improved management of natural capital and increasing social licence;

4) building stakeholder confidence in the integrity of decisions around natural capital management;

5) removing barriers to investment with evidence-based risk assessment;

6) functional and cost-effective solutions.

To deliver these benefits, the stakeholders in agriculture must understand how to adopt a land management regime and land management practices, which must be underpinned by rigorous data collection and long-term monitoring of natural capital. Ultimately, by sending signals to the market that confirm the integrity of land-use practises, agriculture can reinforce its positive economic, environmental, and social links with natural capital.

1.5 Research Objectives

The objectives of this research are to examine the obstacles to the use of natural capital accounting in agriculture and to characterise stakeholder views regarding the value propositions for adopting natural capital accounting. Additionally, I consider how greater collaboration between stakeholder groups can contribute to innovation and value creation in the management of natural capital.

This approach was chosen to identify the drivers and objectives behind stakeholders' participation in natural capital accounting programmes. I also investigated why there are

limited examples of natural capital accounting and whether this approach is the most appropriate format in which to address the issues around natural capital degradation.

1.6 Research Aims and Hypotheses

Despite the critical role of natural capital in agriculture there is little evidence of how manifests in agricultural decision making. In Australia, historical policy mechanisms around natural resource management have addressed environmental degradation through stewardship programmes. Stewardship programs that, through lack of long term measurement and monitoring, have failed to produce long-term enduring environmental outcomes (Salt, 2016). A growing number of global framework initiatives designed for natural capital accounting and monitoring the changes in natural capital provide an opportunity to influence the management and policy decisions surrounding natural capital (Leach et al., 2019). These tools vary, ranging from integrated approaches to qualitative approaches and ecological performance-based approaches.

In this thesis, I examine the obstacles to adopting new and complex natural capital pricing and valuation tools to assist in agricultural decision-making and natural capital management. Communication and collaboration between stakeholders can be used to encourage greater engagement to overcome obstacles and empower or motivate farmers to implement measurement frameworks. These obstacles are considered in parallel with the value propositions that are identified by those undertaking natural capital accounting. I explore how and why these value propositions empower stakeholders to embrace natural capital accounting.

1.6.1 Gaps in the Research

The measurement frameworks and their methodologies developed so far are complex and not yet well understood in the agricultural context. This poor understanding may reflect the current low uptake rates of application of natural capital accounting in Australian agriculture. *A clear understanding of why there has been limited uptake of natural capital accounting, and what empowers or motivates farmers to embrace and take up natural capital accounting* is the first knowledge gap addressed in my research.

There is no absolute solution to the problems around natural capital decline and how we should account for natural capital. Kallis et al. (2013) suggests there is a need to take a more pragmatic approach, one that emphasises practical circumstances and goals. This systematic change must include understanding stakeholders' beliefs and values (Martin & Verbeek, 2006; Spash, 2008). Stakeholder beliefs and value propositions can give rise to conflict or tensions between stakeholders, which are sometimes at odds with the optimal outcome in the context of natural capital. For example, how a farmer perceives the value proposition of natural capital may differ from that of a financier or to a food retailer. Freeman et al. (2007) describe the principle of stakeholder co-operation: "*value can be created, traded, and sustained because stakeholders can jointly satisfy their needs and desires by making voluntary agreements with each other that for the most part are kept*". Therefore, *stakeholder beliefs and values about natural capital, which must be understood to identify mutual benefits*, is the second knowledge gap addressed in this research.

1.7 Structure of the Thesis

An outline of the thesis structure after the Introduction is given below.

- Chapter 2 contains a review of the literature that supports the research and that has shaped my research questions and analysis.
- Chapter 3 provides the theoretical framework or scaffold upon which this thesis is built. The chapter describes the concepts used and the rationale behind the choice of applying a pragmatic world view to the research.
- Chapter 4 presents the methodology of the research and describes the approach and ethical considerations made in achieving my aims and the reasoning behind these approaches.
- Chapter 5 reviews the tools used to collect the data, why they were chosen, and how they influenced the research.
- Chapter 6 is an empirical chapter, in which I discuss the results of semi-structured interviews undertaken with case study subjects.
- Chapter 7 is an empirical chapter, in which I discuss the results of the focus groups.
- Chapter 8 is an empirical chapter, in which I discuss the results of the survey.

- Chapter 9 is the discussion chapter, in which I summarise my key findings and how they relate to the gaps in the literature identified in the Introduction.
- Chapter 10 presents a conclusion, in which I consider how this study has addressed the research questions and met the research objectives set out in the Introduction. This chapter also considers the limitations of the research and looks at further potential research opportunities in this area.

Chapter 2: Framing Natural Capital to Advance its Integration into Agricultural Decision-Making

2.1 Introduction

This chapter provides an overview of the academic and grey literature relating to natural capital and its importance to agriculture. The chapter begins with a review of the historical theories of capital in the work of classical and neo-classical economists to support an understanding of the economic principles of capital and to forge a link to contemporary theories that include natural capital.

In this chapter, I examine the birth of ecological economics and natural capital. I initially screened the Scopus data base to identify the academic literature published between 1975 and 2021 that included the term "natural capital". The time frame chosen for the search identified covers the evolution of the literature on natural capital and its integration into economic thinking. The three decades between 1990 and 2021 are recognised as the most fertile for peer-reviewed publications in this field (Aronson et al., 2006; Arrow et al., 1995; Costanza et al., 1997; Helm, 2014). The scientific literature was supplemented with the grey literature, including government reports, policy documents, reports of international organisations, technical reports, and those of other non-government organisations, to fill the gaps in the academic literature.

Finally, the chapter uses the grey literature identified during the initial search for "natural capital" as the foundation upon which to examine the development of measurement and monitoring frameworks for natural capital including (*Environmental Economic Accounting: A Common National Approach Strategy and Action Plan*, 2018; Leach et al., 2019; Natural Capital Coalition, 2016; WWF, 2019). This allowed the role played by these frameworks in influencing decision-making around natural capital management to be considered and pathways provided by which to integrate natural capital into agricultural decision-making (addressing research questions RQ1 and RQ2, see below).

2.2 The Contribution of Economic Theory and the Emergence of Natural Capital

This section examines the historical development of the concept of capital through classic and neo-classical economists. The purpose is to establish the basis of the historic concepts of capital, from "value in exchange" (classical) to "value in use" (neo-classical). In this section, I also consider the work of classical economists, such as Adam Smith and Thomas Malthus, together with those of neo-classical economists, such William Jevons and Harold Hotelling. Finally, I examine the contributions of Herfindahl and Kneese, and more recently, *The Dasgupta Review* (2021), in recognising the environment as a sink for waste, and the failure to account for the economic cost of these externalities. Where externalities can be described as unaccounted for consequences or costs of actions taken by one or more persons (Dasgupta, 2021). Figure 1 Charts some of the early evolution around the theories of capital

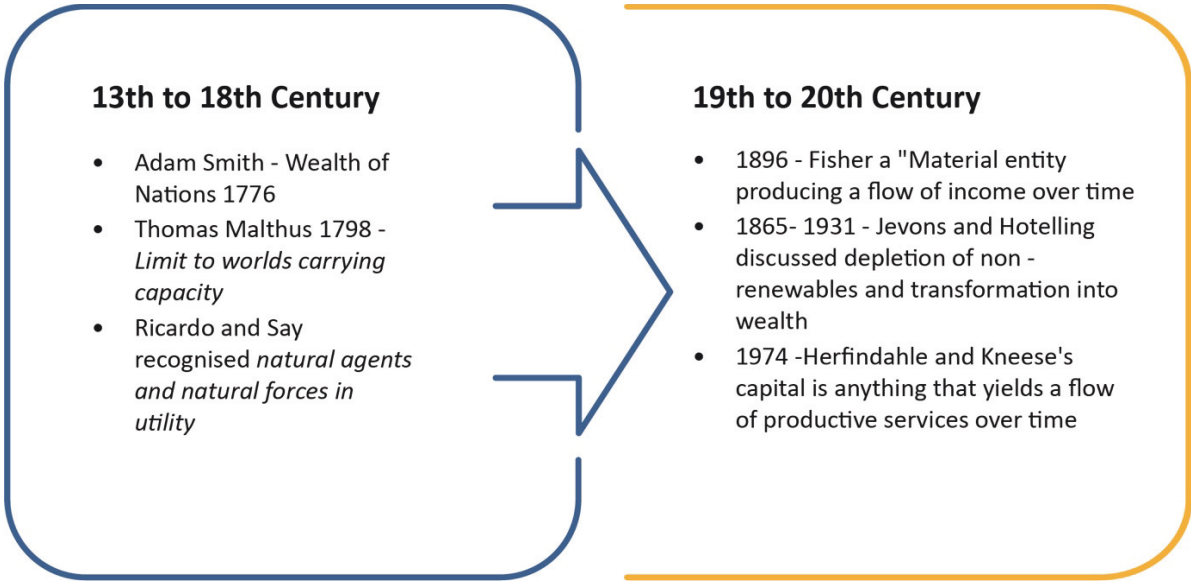


Figure 1 Classical and Neoclassical view of Capital

2.2.1 Contribution of Classical Economic Theory to the Concept of Natural Capital

The literature around the theories of capital has deep historical foundations. The evolution of these theories includes the significant writings of classical economists around the time of the Industrial Revolution, followed by those of the neo-classical economists in the 19th and 20th centuries. From the 13th century to the 18th century, "capital" was usually used in the

context of "*money advanced by owners or shareholders to establish a business*" (Hodgson (2014, p. 1065).

In the *Wealth of Nations* originally published in 1776, the classical economist Adam Smith (1723–1790) strongly influenced the development of the concept of capital (Smith, 2007). Smith recognised capital as being produced and circulated in the form of money (including lending), and as resulting in economic growth (Hodgson, 2014; Parkin, 2014). Smith's description of capital as a physical thing that holds intrinsic value or a productive resource included, somewhat controversially, human capital (Hodgson, 2014; Parkin, 2014). This controversy centred around: 1) the ability to own or trade human capital; and 2) the ability of human capital to be collateralised (Lewin & Cachanosky, 2018). Smith also considered money as indicating value in exchange, rather than as holding value (Hodgson, 2014; Parkin, 2014).

In 1798, Thomas Malthus introduced the role of the environment in the consideration of natural capital, noting that there is a limit to the world's carrying capacity because nature has limits or scarcities (Malthus, 2001). Despite this, in agricultural terms, land and labour were considered to be instruments or productive resources, producing revenue or profit (Smith, 1909). Other classical economists, such as Riccardo and Say, recognised "*natural agents"* or *"natural forces*", but did so only in relation to their value in use (utility). They did not attribute them any role in the creation of exchange or utility value. These economists viewed "natural agents" as essentially free gifts of nature (Gómez-Baggethun et al., 2010). Thus, nature was excluded from the definitions of "capital" formulated by classical economists.

2.2.2 The Contribution of Neo-classical Economic Theory to the Concept of Natural Capital

Subsequently, neo-classical economists moved away from the classical view of "value in use" (utility of a good) to "value in exchange" (an item produced for sale at a price). Reflecting this value in exchange, Böhm-Bawerk (1891 Book 1 Chapter II) described capital as "*nothing but the complex of intermediate products which appear on the several stages of the roundabout journey*". Fisher (1896) broadly defined capital as *a* "material" entity that produces a flow of income over time, and included people (Hodgson, 2014). In contrast Hobson (1926) focused

on the business world in his definition, in which capital was seen as "*money or control of money, sometimes called credit or all forms of marketable matter which embodied labour*" (Hodgson, 2014, p. 1067). These definitions focused on producible, exchangeable goods.

In their works on resource depletion (e.g., non-renewable natural capital), the neo-classical economists William Jevons and Harold Hotelling developed an early conceptual economic link to natural capital. In 1865, Jevons, discussed the depletion of non-renewable resources (coal) in terms of intergenerational compensation. He noted that the present generation used non-renewable resources to transform them into wealth (exchange) for future generations (Franco et al., 2019; Klitgaard, 2022; Missemer, 2012). Jevons also established the foundations of the "rebound effect", in which energy-efficient technology is implemented in place of inefficient technologies, thus increasing energy consumption. Reducing energy costs by introducing new more-efficient technology drives increased demand, amplifying energy security (Missemer, 2012).

Hotelling, in 1931, developed the "Hotelling rule", which, in its simplest form, outlines the socially optimal depletion of a non-renewable resource (i.e., a mine), which results (assuming no extraction costs) in maximum economic rent derived from control of a scarce resource (Hotelling, 1991). The rule implies that the price of the resource increases over time by the discount rate as the quantity of the resource depletes and demand reduces. The social value or benefit to society is no more or less than the total private cost of depleting the resource (Arrow & Chang, 1982; Devarajan & Fisher, 1981; Franco et al., 2019; Hotelling, 1991; Livernois, 2009). This should lead to the optimal extraction of the resource over time, providing equal benefits to future generations as the resource is depleted at a socially optimal rate. Hotelling has been criticised as failure to correctly predicted future prices which can result in over or under extraction of resources, the marginal cost of extraction does not remain constant and the change in the discount rate will lead to volatility in markets.

Victor (1991, p. 193) cited Herfindahl and Kneese definition of capital of 1974 as "*anything which yields a flow of productive services over time, and which is subject to control in production processes*". This definition does not restrict capital to man-made production but

includes land. The Herfindahl and Kneese's considered the environment to be both a source of services and a sink for waste products (Victor, 1991). Ayres and Kneese (1969) noted that returning transformed materials back to the biosphere is generally ignored as an economic cost, as is the environment's capacity to absorb the waste and regenerate itself. Daly et al. (1989) later wrote that the global economy is constrained by the capacities of the biosphere to regenerate itself and absorb waste. Herfindahl and Kneese noted that contrary to Malthusian theory and Jevons' "rebound principle", a constrained resource supply can be overcome by technological progress (Victor, 1991).

Dasgupta is another significant contributor to neo-classical theory and ecological economics, who has recently noted that the "ecological footprint" includes the biosphere and transformed material, including recycled waste ((Dasgupta, 2021). Some residual waste can be transformed or reused, but large pools of waste remain to be absorbed or disposed of in and by the environment. Failing to account for these externalities, risking adverse consequences for food systems, climate regulation through increased food poverty, land degradation and increased extreme climatic events (Dasgupta, 2021). A summary of the classical and neo-classical views of natural capital is shown in
Figure 2.

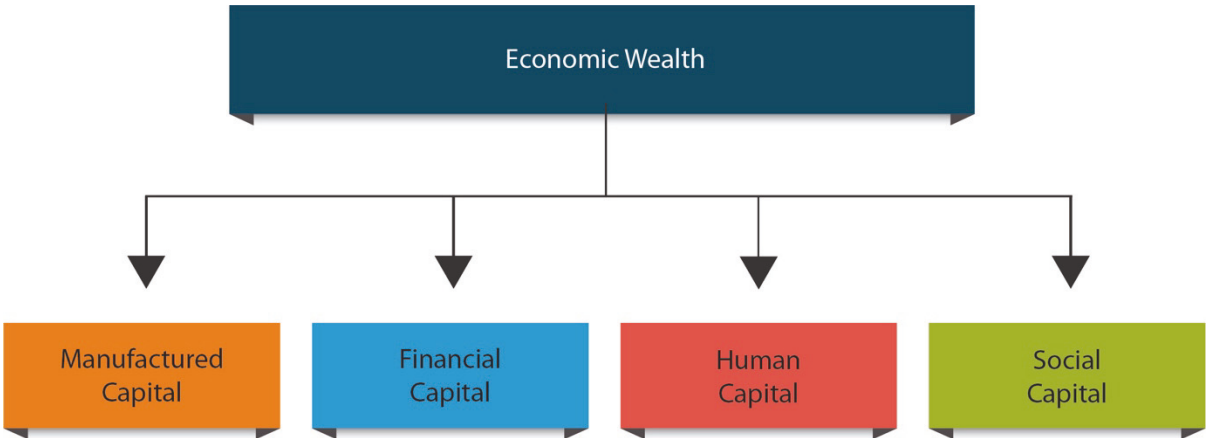


Figure 2 Economic capital—early concepts, adapted from (Barbier, 2019)

2.3 Birth of Ecological Economics

This section examines the development of ecological economics and natural capital theory, with the purpose of introducing the relevant concepts and key authors. The section considers the evolution of the literature, based on a search of the Scopus database and google scholar for papers published between 1975 and 1990. It highlights the importance of ecosystems and the link to economics with the release of *Our Common Future* and the publication of *The Value of the World's Ecosystem Services and Natural Capital*.

Figure 3 charts some of the early evolution of the key literature around natural capital.

Figure 3 Catalysts that link economics and natural capital 1970s to 1990s

2.3.1 Early Stages in the Development of Natural Capital Theory

Until the 1990s, neo-classical economists traditionally viewed natural capital as an asset to be exploited, and as its value in exchange (Costanza & Daly, 1987). Early contributions to the literature around natural capital can be viewed as pioneering. For example, the Scopus search of the literature identified limited publications (seven) that included the term "natural capital" between 1977 and 1990[1]. The search had several limitations and did not detect several notable publications from before 1990. It was also noted that during this period the term natural capital was not widely used in publications with alternative terms such as

[1] The Scopus search included only those documents in Environmental Sciences, Earth and Planetary Sciences, Economics, Econometrics and Finance and Agricultural and Biological Sciences.

ecological capital, natural resources and natural environment used. A supplementary Google Scholar search was used to detect additional papers not included in the Scopus search. Highly cited documents identified in the Google Scholar search but not in the Scopus search included Freeman et al. (1973), cited 413 times; Westman (1977), cited 293 times; and Costanza and Daly (1987), cited 76 times.

2.3.2 Expansion of Capital to Include Natural Capital

It is difficult to accurately pinpoint who first considered natural capital an economic concept, but examples of early economists who acknowledged nature's existence include Jevons and Hotelling. In 1909, Alvin S. Johnson (as cited in Missemer, 2018) distinguished between artificial capital and natural capital by considering how nature produces and provides for humans.

In 1973, Freeman (as cited in Barbier, 2019, p. 16) introduced the notion that the environment should be considered capital: "*the environment as an asset or kind of non-reproducible capital good that produces a stream of various services for man*". A further early contribution to the discussion was made by Westman (1977), who recognised the importance of accounting for Nature's services, particularly the flow of benefits to society. In this paper, he highlighted the relationship between the damage to ecosystem services and human welfare, drawing direct links between nature and human society.

Pearce (1988, p. 599), consolidated the views of Freeman and Westman by referring to the natural environment as "*a stock of natural assets serving economic functions"* and stressing the economic importance of natural capital. Pearce also introduced the concept of "sustainable development", noting that "*sustainable development is categorized by economic change subject to 'constancy of the natural capital stock'—the stock of environmental assets is held constant while the economy is allowed whatever social goals are deemed appropriate*" (Pearce, 1988, p. 598). Pearce allowed society to exploit or use Nature's resources within the bounds of its ability to renew them and with consideration of their availability for future generations. Pearce argued that consumption should be limited because not all-natural capital is the same, noting that when non-renewable assets, such as oil, minerals, and gas,

are depleted, they are no longer available to future generations. Unlike Pearce, economists such Herfindahl and Kneese (cited in Victor, 1991) advocated weak sustainability, which allows some environmental assets to exploited and eventually substituted by other forms of capital (Helm, 2016). Solow (1974) and Stiglitz (1974) were also early proponents of this concept, recommending that land be removed from a production function in the belief that Nature's input can be replaced by other capital, such as manufactured capital, or technological advances (Gómez-Baggethun et al., 2010). In contrast, the strong sustainability approach of Pearce presents natural capital as essential and its preservation paramount because it cannot be replaced or replicated. Helm (2016), maintained that natural capital is a core building block, and its preservation is essential for economic growth.

Although *Our Common Future*, released by the United Nations in 1987, does not specifically use the term "natural capital", it highlights the vital role of Nature in societal well-being, noting that "*species and natural ecosystems make many important contributions to human welfare*". Importantly, this report recommends that the condition of ecosystems must be considered with long-term measurements and monitoring, and raises the following issues:

- The maintenance of food security requires the systematic attention to the renewal of natural resources.
- The measurement of economic development must take full account of the improvement or deterioration of the stock of natural resources (introducing the case for strong sustainability).
- Priority should be given to the interconnections between economic development and environmental assessment.
- A sustainable society must meet "*the needs of the present without compromising the ability of future generations to meet their own needs*" (World Commission on Environment and Development, 1987).

Despite the release of *Our Common Future*, research publications addressing the importance of natural capital and ecosystem services remained sparse. At present, publications continued to focus on Nature's contribution to humanity, with little emphasis on the practical actions required to address the issues around natural capital degradation.

Around the release of *Our Common Future*, Costanza and Daly (1987, p. 2) state that "*nature is the economy's life support system, ignore it and we may inadvertently damage it beyond repair*". Significant contributions to the literature were also made by Daly et al. (1989). In this book, they presented an outline of the impact a growth focused industrial economy has on the biosphere. The authors, an economist and theologian, were greatly influenced by their shared ecological concerns. These authors outlined the need to amend neo-classical economics, including the view that "*nature is not a human possession but that of which humans beings are a part*" (Daly et al., 1989, p. 256). This aligns closely with that view of *Our Common Future*, which links humanity to natural capital and its condition (World Commission on Environment and Development, 1987). This work had an anthropocentric approach, which as Daly et al. (1989, p. 203) noted "*if economists are asked to calculate the value of preserving bits of wilderness from an anthropocentric point of view, and if they discount the future, the policies they recommend will not preserve much*". The authors arguing that "nature is not a human possession", but humans are one part of nature.

2.4 Foundations of Ecological Economics

This section considers the period from 1990 to 2012 as a foundational period in the recognition of natural capital in economic theory and thinking. It examines the contributions of authors such Costanza and Daly, who noted the important link between the economy and the environment and discussed placing an economic value on natural capital. The section also considers Boulding and Arrow, and the reckless consumption and exploitive behaviour threatening the degradation of natural capital. Finally, I consider the contentions around strong and weak sustainability in managing natural capital. Despite this early research, there have been few constructive undertakings that address the depletion of natural capital, in part due to the lack of frameworks.

2.4.1 Significant Contributions to the Development of Ecological Economics

From the period between 1990 and 2012, publications that included the term natural capital began to increase steadily, from around 4 in 2002 to a peak of 28 publications in 2009 (Figure 4)[2]. The release of *The Millennium Assessment* in 2005 may be considered a further catalyst, increasing the focus on natural capital (section 2.5). In conducting the search of the literature, I noted that some authors use interchangeable terms when discussing natural capital. Once again early authors do not use the term "natural capital" (e.g., *Our Common Future*), citing natural ecosystems, natural resources, ecological capital as making important contributions to human welfare. This may have caused some publications to have been missed in the Scopus and Google Scholar searches.

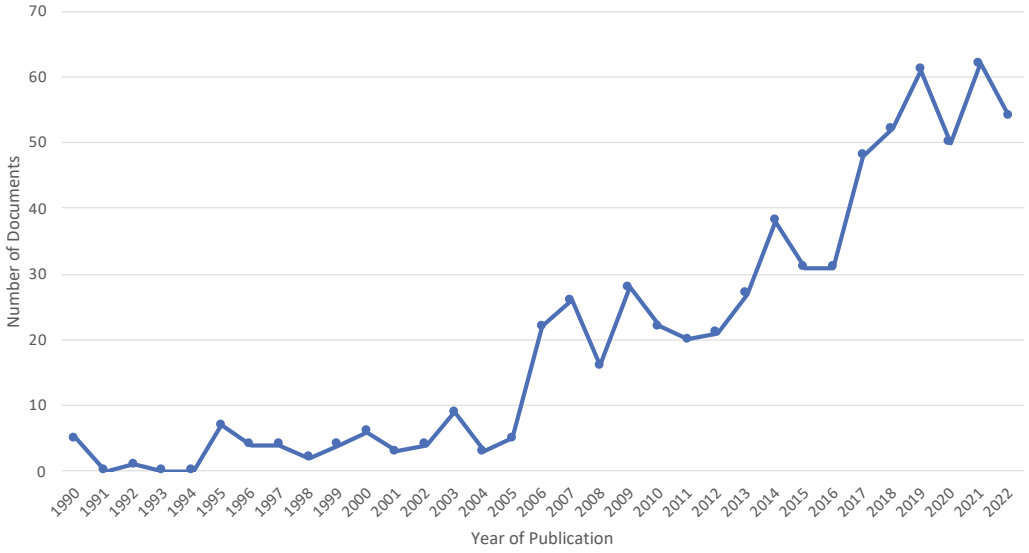


Figure 4 Scopus search for publications citing "natural capital" in 1990–2022 (Scopus, 2020)

Costanza (1992) (cited 2,249 times) is recognized as a significant early contribution, identifying the critical importance of natural capital and consolidating the thoughts of earlier authors (including El Serafy). The contribution of El Serafy (1992), introduced the need to model these systems to keep account of natural capital, in order to address the changes required to achieve sustainability. Costanza and Daly (1992), citied 870 times, took a similar approach to that of Pearce (1988). Reinforcing the need to maintain total natural capital

[2] The Scopus search included only those documents in Environmental Sciences, Earth and Planetary Sciences, Economics, Econometrics and Finance and Agricultural and Biological Sciences. The search then included only documents using the exact word "Natural Capital"

stocks at or above current levels, with a strong sustainability focus, to ensure intergenerational equity. Daly (1993, p. 811) emphasised that "*the economy lives off the environment",* and is not just as a factor of production, but the foundation of production and societal well-being.

Visualising the importance of natural capital and its role, as described above, Porritt (2007) conceptualized these considerations in a nested hierarchy (Figure 5). While Fischer et al. (2007) noted that without a functioning life-support system, societies cannot thrive; without functioning social structures and institutions, economies cannot flourish.

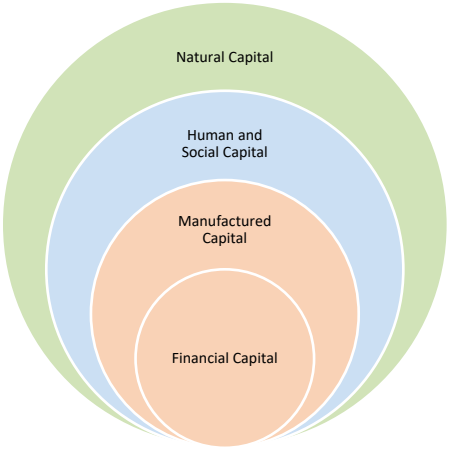


Figure 5 Nested natural capital, adapted from (Porritt, 2007)

These early authors identified the economic importance of natural capital and of a market-based approach to valuing the world's natural capital, with the aim of reflecting the scarcity value of natural capital (Arrow et al., 1995). Costanza et al. (1997) emphasised this, estimating the economic value of 17 ecosystem services across 16 biomes to be US$16–54 trillion. Although there are limitations to that study, the key message is that these services provide significant benefits to society but are essentially not valued and are seen as 'free'. The authors noted that changes to natural capital and ecosystem services, both positive and negative, directly affect human welfare, and argued that their impacts on decision-making processes must be considered.

2.4.2 Planetary Boundaries

Considering natural capital's direct impact on human welfare, some authors also began to consider the boundaries to the sustainable use of these resources (Boulding, 1966). Boulding likened the global economy to a "cowboy economy", characterised by its openness and reckless and exploitive behaviour, where consumption is viewed in a positive sense. He suggested that we must move to a closed economic system akin to a spaceship, in which consumption is minimised and in which the economy is measured as its total capital stock, with its extent, quality, and complexity the key metrics (Boulding, 1966).

Thomas Malthus and later Paul Ehrlich considered the need to constrain population growth to ensure that the needs of future generations can be met (Ehrlich, 1971; Malthus, 2001). Similarly, Arrow et al. (1995) discussed the link between economic activity and the carrying capacity and resilience of the environment. The authors reasoned that there are limits to the Earth's carrying capacity and that exploitation of environmental resources may reduce our ability to generate economic growth in the future. Their paper emphasised the need to develop appropriate indicators to promote the equitable allocation of environmental resources.

2.4.3 Critics of the Sustainable Use of Natural Capital

How far we must go to preserve natural capital and the relative utility of weak and strong approaches to sustainability are contentious issues (see section 2.3.1). For example, in a book entitled "The BET", Sabin (2013) highlighted the division and clash between biologist Paul Ehrlich and economist Julian Simon from the late 1970s to the 1980s, a debate that demonstrated how individual perspectives can become divisive and vitriolic (Sabin, 2013). The debate began with Paul Erhlich's literary piece *The Population Bomb* (1971). Erhlich claimed our inability to feed growing populations would lead to hundreds of thousands of people starving to death unless we constrained population growth. Simon countered by arguing that technology would provide a solution by alleviating protein deficiency in many countries (Sabin, 2013). Simon even proposed "*appropriating all Earth's resources to support humans*". Sabin (2013, p. 133) argued that "*food, land, natural resources and energy were all becoming more abundant, not scarcer*". Erhlich, supported by Holdron and Harte in *Bad*

news: Is it true? (Singer et al., 1980), argued that technology could not replace the services provided by ecosystems, which regulate climate, water cycles, and other essential processes Sabin (2013, p. 133). This was in response to Simon (1981) who pointed to an increase in global arable land and data indicating that there was no long run negative impact from population growth on the standard of living.

Gómez-Baggethun et al. (2010), questioned the need to take a market-based approach to natural capital and sustainability. He argued that although a market-based approach had attracted attention and political support, there were key uncertainties surrounding the outcomes of this approach. Defending the economic value of natural capital, Helm (2016) noted that there is no incentive to conserve natural capital when it has no price and there is no cost to users. Alternatively, several authors began to consider the importance of understanding the condition and/or quality of natural capital resources and the impact their condition has on the ability of these resources to renew themselves (Costanza & Daly, 1992; Pearce, 1988; World Commission on Environment and Development, 1987). In this period, the literature predominantly focused on recognising the importance of natural capital in economic terms, with limited impetus toward the implementation of these findings or the design of solutions. At this stage the authors have not considered the need to understand the signals that indicate natural capital and ecosystem services are at risk. In particular, they do not address the need for indicators that provide evidence of when exploitive behaviour is damaging natural capital and how this effects society. The following section highlights the next step in the development of the concepts in particular the need to measure and monitor.

2.5 Significant Milestones from 2000 to 2022

This section begins by considering the importance of the release of *The Millennium Ecosystem Assessment* in 2005 and examines some of the key publications that continued to focus on market-based and measurement-based solutions to arrest the decline in natural capital (

Figure 6). The literature also begins to address holistic perspectives and the human motivations that drive institutional change, and the need to break down the silos of stakeholders and undertake stakeholder discussions around natural capital. In this section, I consider the findings of *The Rockefeller Report*, particularly the need for a transdisciplinary approach to solutions and the transition of findings into actions. Finally, I discuss the release of *The Dasgupta Review* in 2021 and the conflicting opinions about its approach. I also provide a summary of the literature and key themes identified in the most recent literature.

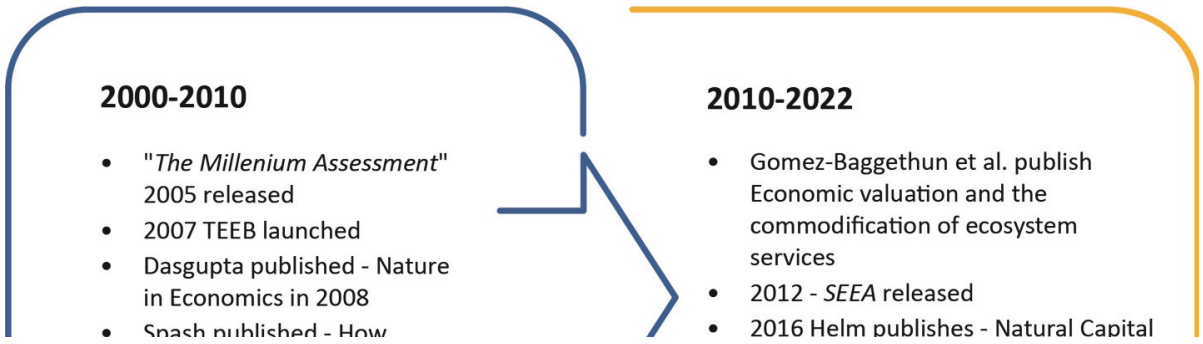


Figure 6 Significant Milestones in the literature and framework development from 2005-2022

2.5.1 Influence of *The Millennium Assessment*

The Millennium Ecosystem Assessment, released in 2005, is a crucial milestone in recognizing the need to measure, model, and map ecosystems.

The Millennium Ecosystem Assessment examined:

1) How ecosystems and their services have changed.
2) The causes of these changes.
3) How these changes have affected human well-being.
4) How ecosystems may change in the future and the implications for human well-being.
5) The options that exist to enhance the conservation of ecosystems and their contribution to human well-being.

As in *Our Common Future* (see section 2.3), the Millennium Ecosystem Assessment does not refer to the term "natural capital", although it does use the term "ecosystem services". This contrasts with the growing literature which prefers the term "natural capital". The Millennium Ecosystem Assessment identified a key gap, centred around the information available to effectively assess the conditions and trends of ecosystems and ecosystem services. This gap limits our ability to assess the economic consequence of changes in ecosystem services. Direct links between nature's ecosystem services and human well-being are also made in the Millennium Ecosystem Assessment (2005) .

The MEA has been influential in the way it has altered society views towards ecosystems and the importance they have to human well being. The MEA has also been influential in bringing a spotlight on the need to monitor the changes in ecosystem services and how these impact society. The MEA could be seen as a catalyst in the development of frameworks such as SEEA, the Natural Capital Protocol, TEEB and Accounting for Nature tools designed to monitor, manage, and value ecosystems. The integrated approach of the MEA was also innovative in its approach. In particular as threats to ecosystems can be described as wicked problems requiring not only continuous learning but a need to crossing disciplinary boundaries to develop new knowledge to address the problems.

2.5.2 Beyond the Millennium Ecosystem Assessment: 2012 to 2021

After 2012, there was a significant increase in annual publications that included "natural capital" in their content, peaking at 315 papers in 2021. The total number of publications identified in a Scopus search for the period 1990–2021 was 3,088, and notably, 71% of these were published in the 10-year period of 2012–2021) (Figure 4). The principal authors and contributors to the topic during that period included R. Costanza, J. Aronson, S. Managi, G.C. Daily, D. Helm, and E.B. Barbier. Figure 7 shows the subject areas in which natural capital was addressed, the two most prominent of which were the environmental sciences, and agriculture. Missing from the Scopus search in this period was any significant growth in the grey literature, particularly literature about the development of measurement and monitoring frameworks, which will be discussed in a later section (section 2.7).

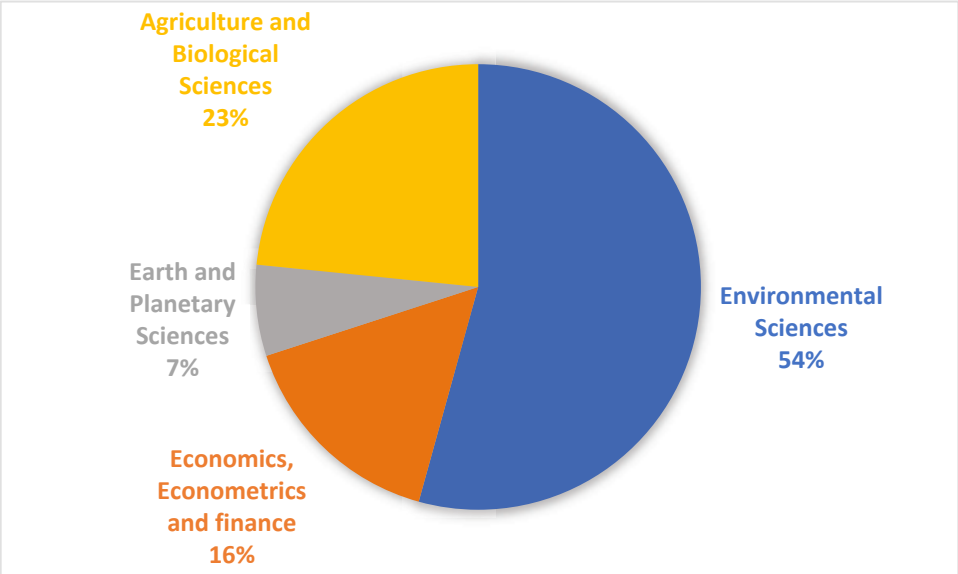


Figure 7 Scopus search results for "natural capital" documents by subject area (Scopus, 2020)

Despite the predominance of publications written since 2012, the most cited article containing "natural capital" remains Costanza et al. (1997), cited 12,011 times. This paper focused on the economic neglect of natural capital and ecosystem services, and the failure to estimate their value. It highlights how considering this value would significantly affect global pricing systems. The next most frequently cited paper Costanza et al. (2014) was cited 2,447 times, and reappraised and updated the 1997 paper. It again focused on the societal benefits provided by natural capital through the provision of ecosystem services. The paper highlighted the importance of valuing natural capital and ecosystem services, not by the

commodification of benefits or assets, but in assessing trade-offs in meeting the goal of sustainable human well-being (Costanza et al., 2014). This approach was designed to assess the impacts of policies and management decisions on natural capital and ecosystem services using a market-based approach.

Helm (2014), described a market-based approach to reversing the invisibility of natural capital, accounting for it through the creation of a balance sheet or assets register. Ideally, a balance sheet of natural capital should become a focal point for policy makers, ensuring that natural capital and the services it provides do not decrease over time and are capable of servicing future growth. However, this approach requires that a formal set of rules and standards be put into place (Helm, 2014). Because formal systems are in the early stages of their development, it can be argued that their design is not yet fit for purpose or particularly practical.

Declining natural capital is increasingly seen as a factor limiting human well-being and economic sustainability. Therefore, rebuilding natural capital must be essential in economic decision-making (Aronson et al., 2006). When addressing these issues, Aronson et al. (2006) discussed the importance of communication between ecologists and economists to establish common ground and address the urgency of the problem.

2.5.3 The Role of Human Motivation

Several authors have noted that simply placing an economic value on ecosystems assumes that we understand human motivations, such as cultural and social beliefs, around the use of natural capital (Martin & Verbeek, 2006; Seppelt et al., 2011; Spash, 2008). For example, Hein et al. (2006, p. 213) noted that "*values attributed to ecosystem services depend on the stakeholder benefiting from the services*". Moreover, an understanding of human motivations or stakeholder values can be used to drive institutional change and fill knowledge gaps, in order to reduce the human impact on natural capital (Groot et al., 2010; Mooney et al., 2004; Norgaard, 2010; Seppelt et al., 2011). Understanding these motivations requires effective communication or collaboration across all stakeholder groups, not just economists and ecologists. This view is supported by Leventon et al. (2021), who recommend that more space

be allocated for diverse knowledge systems, including engagement with stakeholders. Both Seppelt et al. (2011) and Spash (2008) also discuss the importance of stakeholder involvement in understanding the relationship between ecosystem function and human well-being. However, these authors do not address the capacity of the stakeholders to implement strategies or recognise their benefits. The Millennium Ecosystem Assessment noted that this problem goes beyond traditional academic disciplines and that theory must be applied effectively in the real world (Carpenter et al., 2009). Although the MEA failed to recommend an evidence-based framework to fill the information gap (Seppelt et al., 2011).

In 2015, the Rockefeller Foundation published a report of the concerns around the health of natural capital and the threat posed to human well-being by unsustainable exploitation of the Earth's natural capital (Whitmee et al., 2015). Several knowledge gaps were identified that must be closed to improve planetary health:

1) Collecting evidence of environmental change and understanding how it impacts or affects human health, to allow its impact to be accommodated in economic analyses.
2) The development of strategies to reduce environmental damage and harmful emissions, including the assessment of co-benefits.
3) Research strategies and technologies to promote resilience and support adaptation to environmental change, to assist policy makers in reducing risks and assessing the trade-offs between outcomes.
4) Development and use of more-robust indicators of human welfare, other than gross domestic product (GDP), and of the integrity of the underpinning natural systems.
5) Development of research that can be developed into policy and action.

The Rockefeller Foundation report differs from its predecessors in two ways. The first is its suggestion to use a transdisciplinary tool to improve outcomes. This recognises the complexity and interconnectedness of the problem and is a step beyond "*the new interdisciplinary science needed to build understanding of social–ecological systems*", mentioned in Carpenter et al. (2009, p. 1309). Second, the Rockefeller Foundation report recognised the need for research that can be developed into action. It stressed that it is not

enough to theorise about the problem, but that a pathway to action must be created (Whitmee et al., 2015). At present, this key issue remains unresolved.

In 2021, *The Dasgupta Review* was released and strengthened the crucial role of Nature in economics. Sir David Attenborough noted in the forward to *The Dasgupta Review* that "*Economics is a discipline that shapes decisions of the utmost consequence and so matters to us all*" (Dasgupta (2021, p. 2). He concluded "*The Dasgupta review at last puts biodiversity at its core*" (Dasgupta, 2021, p. 2). The review drew some criticisms for posing a neo-liberalist economic solution to the problem of natural capital decline and loss of biodiversity. Spash and Hache (2021, p. 2), noted that the review promotes an "*orthodox economic solution for loss of biodiversity*" through its recognition of the economic value of biodiversity and accounting for it. This allows business and financiers to "*recognise its existence in their accounts, capture its value and profit from trading*" (Spash & Hache, 2021, p. 2). In concluding Spash and Hache (2021, p. 20) argue against Dasgupta's neo-classical approach by claiming that turning Nature into a financial asset threatens its further destruction "*as nature that does not pay enough is liquidated as a bad investment*". As Victor (2020, p. 6) so eloquently states "*if nature as capital turns out to be worth less than the value derived from its destruction what then will proponents of natural capital say?*" and "*Paving paradise and putting up a parking lot can be very profitable*".

It is easy to dismiss the use of market-based tools in preference to a more pluralistic approach to achieve better natural capital outcomes, but a pluralistic approach can also be contested. To consider the range of perspectives around a natural capital problem requires the actors to connect, collaborate, and adapt (Hull et al., 2020). This publication contends that with a pluralistic approach, the actors are required to consider controversial topics that may be complex, polarising and dividing people rather than fostering a commitment to a solution (Hull et al., 2020). Examples of this include the conflict around water use and sharing in the Murray Darling River system, which has currently failed to deliver a satisfactory resolution that meets all stakeholders' needs, resulting in a degraded river system. A set of key foundational natural capital themes has emerged from the literature Table 1.

Table 1 Natural Capital Themes identified in the Literature

Themes	Description	References
Human Well-being/Benefit	How humans benefit from natural capital	Gómez-Baggethun et al. (2010), Johnson (1909), Westman (1977), World Commission on Environment and Development (1987), Costanza and Daly (1987), Costanza et al. (2017), Daly et al. (1989), Arrow et al. (1995), Corvalán et al. (2005), Dasgupta et al. (2021), Dasgupta (2021), Natural Capital Coalition (2016)
Cost	Choices and Trade-offs – the benefits v costs of taking or not acting in relation to natural capital	Costanza (2020)
Flow of Goods and Services	Efficient allocation of natural capital and ecosystem services as a factor of production	Helm (2016), Freeman et al. (1973)
Economics/Growth	A need to link the environment to economic development to account for degradation of natural capital	Dasgupta (2008), Pearce (1988), Costanza et al. (1997), Boulding (1966), Arrow et al. (1995), Daily et al. (2000), Daly (1993), Helm (2016), Pingali (2012), Kumar (2010), Costanza et al. (2014), Whitmee et al. (2015), Dasgupta (2021), Vardon et al. (2021)
Depletion of Natural Capital	The impact of changes socially and economically through the depletion of the environment	El Serafy (1992), Boulding (1966), Pingali (2012), Aronson et al. (2006), Dasgupta (2021)
Natural Capital is Free	Treating natural capital as a free asset risks environmental damage as it is taken for granted and exploited beyond tipping points.	Gómez-Baggethun et al. (2010), Helm (2016), Costanza et al. (1997), Costanza et al. (2014), Victor (2020), Henry and Tubiana (2017)
Substitution	Ability for natural capital and ecosystem services be substituted or replaced by technology?	Herfindahl and Kneese in (Victor, 1991), Solow (1974), Stiglitz (1974), Gómez-Baggethun et al. (2010), Sabin (2013), Ehrlich and Ehrlich (1981)
Renewable	Natural capital is seen as renewable and therefore infinite with zero cost risking over exploitation	Helm (2016), World Commission on Environment and Development (1987), Helm (2014)
Market-Based Solutions	Incentivise sustainable use of natural capital and ecosystem services through financial incentives	(Helm, 2016), (Costanza et al., 1997), Kumar (2010), Costanza et al. (2014), Helm (2014); Dasgupta (2021), Victor (2020), Vardon et al. (2021), Kallis et al. (2013)
Human Motivation	What driving influences behind humans' relationship with natural capital?	Boulding (1993), Martin and Verbeek (2006), Seppelt et al. (2011), Spash (2008), Hein et al. (2006), Groot et al. (2010), Mooney et al. (2004), Norgaard (2010), Kumar (2010), Costanza et al. (2017), Martinez-Alier et al. (2010), Dasgupta (2021)

Themes	Description	References
Externalities	Consequence of an action that affects another not directly involved. Potentially resulting in a positive or negative impact to that third party that were not intended to be impacted.	Dasgupta and Heal (1979), Daly and Cobb (1999), Orton et al. (2018)
Carrying Capacity/Thresholds	Understanding the limits of earths carrying capacity to ensure sustainable use of resources	Malthus (2001), Ehrlich (1971), Costanza (1992), Boulding (1966) , Arrow et al. (1995), Helm (2014), Dasgupta (2021)
Sustainability	The level of natural capital that should be sustained to ensure future generation needs are met.	Pearce (1988), (Ehrlich & Ehrlich, 1981); Ehrlich (1971), World Commission on Environment and Development (1987), Costanza (1992)
Condition	The quality of natural capital and how it effects societal outcomes	World Commission on Environment and Development (1987), Costanza (1992), Pearce (1988), Corvalán et al. (2005) , Helm (2014), Whitmee et al. (2015)
Communication	The exchange of information	Costanza (2020), Leventon et al. (2021), Hull et al. (2020)
Collaboration	Co-production of knowledge through mutual learning	Martin and Verbeek (2006), Seppelt et al. (2011), Spash (2008), Hein et al. (2006), Groot et al. (2010), Mooney et al. (2004), Norgaard (2010),Kumar (2010), Leventon et al. (2021), Hull et al. (2020)
Economic Incentives	Credit schemes, tradable entitlements, payments for environmental service	Helm (2014), Benayas et al. (2009), Pretty (2007), Helm (2016), Kallis et al. (2013)
Frameworks/Accounting	Measurement systems and tools designed to support decision making around natural capital	Costanza (1992), Wackernagel et al. (1999), Clark et al. (2001), Corvalán et al. (2005)), Fisher et al. (2009), Pretty (2007), Helm (2016), Costanza et al. (2017), Helm (2014), Obst et al. (2016),System of environmental-economic accounting 2012: experimental ecosystem accounting (2014) Vardon et al. (2018), Whitmee et al. (2015), Dasgupta (2021), Turner Perpetua et al. (2019), Spash (2008), Turner et al. (2019), Keith et al. (2017), Costanza (2020), Vardon et al. (2021)
Actionable/Real World	Has a practical value that can be applied in actual situations	Corvalán et al. (2005), Pretty (2007), Kumar (2010), Helm (2014), Whitmee et al. (2015), Turner et al. (2019), Keith et al. (2017), Costanza (2020), Hein et al. (2020), Natural Capital Coalition (2016)
Complexity	Complicated and intricate systems, how they interact and respond to change spatially and temporally.	Whitmee et al. (2015), Spash (2008), Martinez-Alier et al. (2010), Turner et al. (2019), Vardon et al. (2021)

2.6 Natural Capital and Agriculture

In this section, I consider the literature around the role of agriculture in valuing natural capital. The focus of agriculture on productivity ignores how natural capital shapes production outcomes. I also consider the literature that highlights the need for better data if we are to establish the link between economic outcomes and natural capital in a more integrated way. Several studies have also discussed the relationship between land degradation and its financial risk to agricultural operations. Finally, I consider food systems and discuss the negative impacts on food systems through natural capital degradation and spillover impacts in attempting to correct these externalities. The section concludes with a summary of the key literature and the themes underpinning it.

2.6.1 Agriculture and Natural Capital—A Literature Overview

The literature search of Scopus described in sections 2.3 and 2.6 was expanded to include the term "agriculture" together with "natural capital". The search identified 433 documents published between 1990 and 2022 that mentioned both agriculture and natural capital in their abstracts[3]. Of the total of these documents published up to 2022, 80% were published in the period 2014–2021.

Agriculture is a voracious user of renewable natural capital, including stocks of air, water, and soil, and ecosystem services, such the creation and replenishment of soil nutrients, pollination, and recycling air from CO_2 to O_2 (Ascui & Cojoianu, 2019a; Intergovernmental Panel on Climate Change, 2019; Muller & Sukhdev, 2018; Ramankutty et al., 2018). Poor management of natural capital can lead to permanently degraded landscapes resulting in loss of biological and economic productivity (Ajai & Bhatnagar, 2022). As highlighted by Pretty (2007) and more recently by Henry and Tubiana (2017), agriculture is unique in that it directly affects many of the assets upon which it relies for its success. Importantly, farm management practices influence how natural capital resources are used and replenished, which determines

[3] The search was limited to Environmental Science, Agricultural and Biological Sciences, Earth and Planetary Sciences, Economics, Econometrics and Finance. There were no key word exclusions applied to the search

the "*ability of future generations to generate wealth from the land resource*" (Stoneham et al., 2003, p. 197).

Key themes across the scientific and grey literature on natural capital that focus specifically on agriculture concentrate on the need to alter perspectives and change management practices if we are to deliver better environmental outcomes. Obst and Eigenraam (2017), note that the explicit incorporation of environmental considerations into agricultural productivity measures would extend our understanding of the factors that drive output and input growth, and thus support the development of more integrated policy responses. However, requiring farmers to incorporate environmental considerations into their decision-making is contentious. Problems arise when farmers consider that what they are being asked to deliver, in terms of environmental goods, encroaches upon their private property rights (Helm, 2016). This is despite these outcomes, such as improved biodiversity, water filtration, pollination, etc., deliver public benefits being non-rivalrous (unable to prevent others from its use). Notably, Helm (2014), Benayas et al. (2009), and Pretty (2007) recognise that farmers and land managers must carry out much of the work to improve environmental outcomes, which will require appropriate policies and an allocation of subsidies to compensate for this work. Failure to incentivise farmers to protect or restore "public benefits", on what may be considered private land, could mean that farmers lack the will or power to undertake these programmes, giving rise to perverse outcomes such as destruction of habitat, biodiversity loss and increased pervasiveness of invasive species. Ultimately, agricultural enterprises are commercial operations and a lack of value propositions in undertaking environmental programmes for public benefit will be a barrier to the wide acceptance of these programmes.

As discussed earlier (section 2.3), the consequences of the degradation of natural capital can result in externalities that create costs. Pretty et al. (2000), estimated that the externalities caused by UK agriculture cost £1.5 billion per year. Norse et al. (2001) estimated the externalities of pesticide use in Chinese rice systems to be USD $1.4 billion, accrued from health costs to people and the adverse effects on and off-farm biodiversity and on food quality and quantity. Recent research has also begun to consider the broader financial risks posed by the degradation of natural capital by agriculture. For example, Ascui and Cojoianu

(2019a) considered the impacts and dependence of financial institutions from natural capital degradation through loans to agriculture enterprises. Significantly, that research emphasized the link between the condition of natural capital and the economics of an agricultural enterprise. In doing so, it focused on the value proposition to both lenders and borrowers based on the condition of the natural capital, which can shape both economic and risk outcomes.

2.6.2 Transitioning to a Focus on Natural Capital in Agriculture

In Grey et al. (2011, p. viii), the authors note that the "*productivity growth in agriculture, reflecting increases in the efficiency of production process over time, is a key determinant of farm profitability*". Muller and Sukhdev (2018, p. 8) noted that "*the economy of current food and farming profusely rewards producing more volume from the same area in the cheapest way possible in order to remain competitive*". They also noted that "*the focus on productivity per hectare externalises ecological and social impacts*" (Muller & Sukhdev, 2018, p. 17). However, a focus on productivity at the expense of ecological health ignores the relationship between economic growth and the environment, risking damage to the environmental capital upon which productivity depends.

One of the key impediments to the greater recognition of natural capital in agriculture is the poor quality of on-farm economic and natural capital data, which makes the analysis of long-term trends challenging (Cojoianu & Ascui, 2018). Such analyses should identify the relationships between economic outcomes and natural capital, a knowledge gap previously discussed in section 2.5.3, by Whitmee et al. (2015) and in Millennium Ecosystem Assessment (2003). This inability to measure long-term trends may be explained by economic agendas, geopolitical instability (world wars and regional conflicts), and the significant advances made during the Green Revolution (Pingali, 2012). The Green Revolution masked the production losses caused by the degradation and loss of ecosystem functions. Arrow et al. (1995, p. 520), noted that "*growth and liberalisation have been encouraged with little regard to their environmental consequence*". As discussed earlier, the technological and other innovations made across agriculture have left the system in a state of eternal optimism, with a belief that future technologies will fix all problems.

2.6.3 Externalities of Food Production

The economics of the positive and negative externalities in food production caused by changes in natural capital are not taken into account in agriculture in any meaningful way (Sukhdev, 2018; Sukhdev et al., 2016). Pieper et al. (2020), considered the cost of food by calculating the monetary cost of the carbon footprints of foodstuffs (external cost) using German production data. They suggested that external costs should be levied on the producer (or through policy measures) to compensate for the harmful effects of production. In their discussion, the authors noted that internalising these costs would probably result in less food waste. They also suggested that consumers already pay, indirectly, for the damage caused by floods and drought through aid payments. Internalising these costs, under a polluter-pays principle ensures that consumers who demand environmentally damaging food pay for its production with higher costs. However, the paper does not address the effects of internalising these costs on food poverty and human health, as defined in the UN *Sustainable Development Goals (United Nations, 2015)* . Internalising the environmental costs of food production may cause a spillover effect that affects nutrition and health outcomes in developing countries. As access to nutritional food becomes costlier, the risk of food poverty will increase. A balance will be required as the risk of continued land degradation and damage to ecosystems will inhibit the ability of agriculture systems to produce sufficient food in the future without significant artificial inputs.

Holden and Jones (2021), published an in-depth analysis of food metrics in policy and in practice. The report evaluated the actual costs and benefits of different food systems, and the impacts and dependencies of natural systems, human systems, agriculture, and food systems. Notably, in Chapter 6, they consider an integrated approach to addressing the need for healthy agricultural systems for food production. Combining a nested approach with a polluter-pays principle, which penalises unsustainable farming practices while rewarding sustainable practices, can be an incentive to change. They also recommended greater engagement with stakeholders, such as retailers, and encouraging them to educate consumers about food provenance to support the purchase of sustainably produced foods. As Holden and Jones (2021); (Janssen & Goldsworthy, 1996) point out, we are dealing with a complex integrated system of mutually influential actors who are so closely enmeshed they

cannot be viewed through a single lens. Table 2. highlights of the key literature identified when “agriculture” was included with “natural capital” as a search term and the themes that underpin this literature.

Table 2 Key themes of the literature identified with terms "natural capital" and "agriculture"

Theme	Description	References
Economics	Linking unpriced stocks and flows of natural capital and ecosystems services into macroeconomic modelling	Benayas et al. (2008); Daily et al. (2009); Gemmill-Herren et al. (2021); Global Canopy and Vivid Economics (2020); Grey et al. (2011); Muller and Sukhdev (2018); Vardon et al. (2021), Ascui and Cojoianu (2019a)
Environment as a Free Asset	Treating natural capital as a free asset risks environmental damage as it is taken for granted and exploited beyond tipping points.	Ascui and Cojoianu (2019a); Daily et al. (2009); Helm (2016); Jackson et al. (2007)
Technology	Utilising scientific knowledge to change and manipulate environmental assets or ecosystem services	Burkhard et al. (2012)
Cost	Choices and Trade-offs - benefits of action v costs of taking or not acting with natural capital	Benayas et al. (2009); Fleming et al. (2019); Pieper et al. (2020); Pretty (2007); van Putten et al. (2021)
Externalities	Consequence of an action that affects another party not directly involved. Potentially resulting in a positive or negative impact to that third party that were not intended to be impacted.	Beder (2000); Gemmill-Herren et al. (2021); Muller and Sukhdev (2018); Norse et al. (2001); Pieper et al. (2020); Pretty et al. (2000); Sukhdev et al. (2016); Vatn (2018); Victor (2020)
Risk	Systematic risk that affects whole market. Material risk specific to individual or company	Global Canopy and Vivid Economics (2020); Pieper et al. (2020); Pretty et al. (2000),Ascui et al. (2021); Ascui and Cojoianu (2019b)
Inconsistencies	divergent views and objectives of stakeholders	Benayas et al. (2008); Grey et al. (2011); Muller and Sukhdev (2018); Salt (2016)
Measurement	Determining size, condition and extent of natural capital and ecosystem services	Burkhard et al. (2012); Cojoianu and Ascui (2018); Daily et al. (2009); Muller and Sukhdev (2018); Obst and Eigenraam (2017)
Frameworks	Measurement systems and tools designed to support decision making around natural capital	Burkhard et al. (2012); Gemmill-Herren et al. (2021); van Putten et al. (2021)
Benefits/Incentives	Credit schemes, tradable entitlements, payments for environmental services	Aronson et al. (2010); Fleming et al. (2019); van Putten et al. (2021)
Natural Capital Condition	Measurement of natural capital condition to support actions around natural capital	Benayas et al. (2008); Corvalán et al. (2005); Fleming et al. (2019); Hazell and Wood (2008); Henry and Tubiana (2017); Pretty (2007); Stoneham et al. (2003)
Climate	Prevailing long term weather conditions for a particular area	Fleming et al. (2019); Pieper et al. (2020)
Rapacious Users of Natural Capital	Excessive users of natural capital, the impact of the green revolution on natural resources	Ascui and Cojoianu (2019a); Henry and Tubiana (2017); Intergovernmental Panel on Climate Change (2019); Muller and Sukhdev (2018); Ramankutty et al. (2018); Stoneham et al. (2003)
Subsidies	Incentives provided by government to support practices and keep prices low	Benayas et al. (2009), Gómez-Baggethun et al. (2010); Gómez-Baggethun and Ruiz-Pérez (2011), Pretty (2007), Salt (2016)

2.7 Natural Capital Frameworks

In this section, I introduce the development of natural capital frameworks, their complexity and weaknesses. I also provide examples of natural capital frameworks (

Figure 8) and their key characteristics and discuss some of the challenges to adopting these frameworks, as identified in the literature. Finally, I describe where the frameworks have been applied to agricultural decision-making.

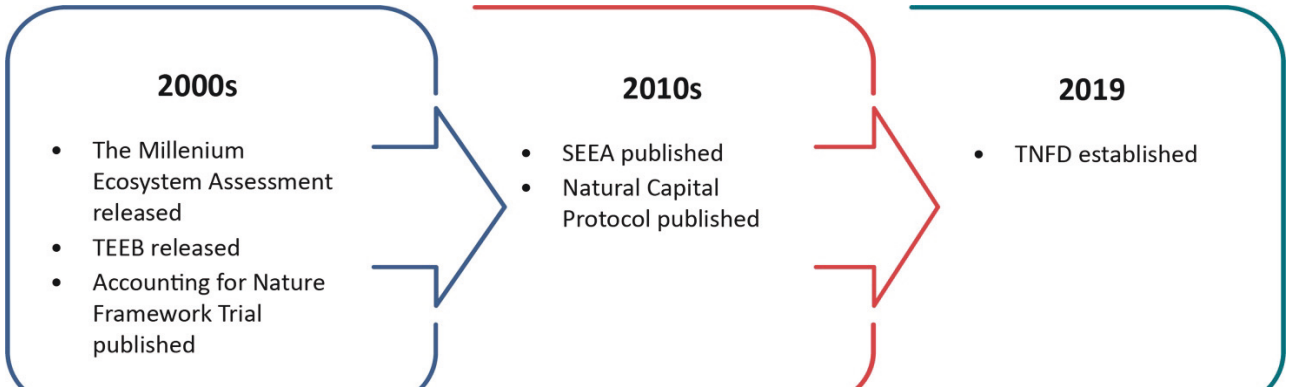


Figure 8 Natural Capital Accounting Framework Development from 2000 until 2021

Legend
TEEB – The Economics of Ecosystems and Biodiversity
SEEA – System of environmental economic accounting
MLA CN – Meat & Livestock Australia Carbon Neutral 2030
TNFD – Task Force on Nature related Financial Disclosures
NFF 2030 – National Farmers Federation 2030 Roadmap

The knowledge gaps identified in the Millennium Ecosystem Assessment and later in the Rockefeller Foundation Report include a pressing need for robust tools that deliver information that will help land managers understand the consequences of their decision-making about natural capital in the agricultural context. Frameworks that allow decisions to be made about the condition and management of natural capital can ultimately be used to reward or penalise stakeholders. They can also then be used together with public policies to increase the integrity and credibility of decision-making. As Australian economist and public servant Ken Henry argued, "*we need to manage our natural capital with the same diligence we manage our financial capital*" (Ascui & Cojoianu, 2019a, p. 1).

A period in which accounting frameworks were developed occurred between 2006 and 2021. These frameworks aim to internalise natural capital and ecosystem services by monitoring

and measuring, in order to influence management and policy decisions surrounding natural capital (Leach et al., 2019). Frameworks vary in their approach, from integrated approaches such as the System of Environmental Economic Accounting (SEEA) (*System of Environmental Economic Accounting*, 2022) and qualitative approaches, such as that used by the Natural Capital Protocol (Natural Capital Coalition, 2016), to the ecological performance-based approach used by Accounting for Nature (Wentworth Group of Concerned Scientists, 2016) .

Although frameworks are inevitably useful, one of the main challenges to their adoption is that not all approaches are the same and are sometimes established to achieve different goals. Consequently, they do not transition well into action. Turner et al. (2019), point out that differences in frameworks arise from the type of method used when building accounts, such as exchange values or welfare values. Leach et al. (2019), identified several limitations of frameworks, including the lack of a consistent classification of environmental assets, which would allow a better understanding of the links between natural capital and ecosystem services. Spash (2008) cautioned that some of the methodologies used to calculate values, such as stated-preference methods and travel-cost methods, can be criticised for their lack of robust data or agreement on methods.

2.7.1 Review of Frameworks

In 2019, WWF France produced a guidebook (WWF, 2019) to 22 tools designed to support decision-making on environmental issues. These tools included biodiversity footprint mapping, quantitative, monetary, absolute ecological performance indices, and integrated accounting tools.

In 2020, The Green Growth Knowledge Partnership released a working paper (*Natural Capital Platforms and Tools for Green Growth Planning*, 2020) to identify the gaps in the provision of natural capital data and to inform national plans for green growth through the analysis of 28 tools. These papers highlight the complexity of the problem in measuring natural capital due to the different methodologies and the diverse responses to these issues. Table 3 shows a timeline of the development of some key reports and frameworks in this research, and their characteristics.

Table 3 Examples of some key Natural capital Frameworks and publications

Year	Author	Scope	Type	Evaluation		Key References
				Benefits	Barriers	
2005	Millennium Ecosystem Assessment (MA)	Broad—assesses the consequences of ecosystem changes for human well-being. Establishes baselines for current ecosystem services.	Qualitative	+ Collaboration of scientists and scientific disciplines + Policy-driven + Science-based + Relates ecosystem services to human well-being	- Relies on policy/decision-makers to react/act - Availability of appropriate modelling and quantitative data - No new research—synthesis of existing studies - Significant complexity in delivering clear policy directives	*Millennium Ecosystem Assessment*, 2005. *Ecosystem and Human Well Being: Synthesis*, 2005) (Fisher et al., 2009; Mooney et al., 2004)
2008	Accounting for Nature – Wentworth Group of Concerned Scientists	Practical accounting framework focuses on condition accounting, for use in the agricultural context.	Ecological condition	+ Utilises SEEA framework (see below) + Condition of asset, used to interpret capacity to deliver services + Reference condition is benchmark used as a common base + Harnesses science to manage risk + Applied to agricultural context—relevant and operational	- Slow to gain political traction - Developed by a lobbyist group - Costly to implement - Current focus is Australia	(Wentworth Group of Concerned Scientists, 2016)
2012-2021	System of Environmental Accounting	Accounting framework.	Quantitative	+ Addresses technical issues of environmental accounting + Internationally agreed standards + Integrated approach links environmental data to economic data + Accounting-based system, presents data in a consistent manner, allowing interpretation, analysis, and validation + Flexibility in its use, scalable	- Slow adoption - High cost of data collection - Resource-intensive to establish - Overly technical to implement in practice - Technical challenges, e.g., deriving values for ecosystem assets, accounting for regulating services, etc.	(United Nations; et al., 2014)
2016	Natural Capital Protocol	Natural capital framework taken from a business perspective.	Qualitative	+ Flexible design + Standardised framework + Focuses on business impact and dependence on natural capital to reduce risk + Uses scenario building to assess potential outcomes	- Modelling rather than measurement - Not a formal reporting framework - Comparability across business and industries - Not stand-alone - Cost Benefit Analysis approach - Not designed for agriculture	(Natural Capital Coalition, 2016)
2018-2021	TEEB for Agriculture and food	Overarching framework for policy, business, farming, and civil society.	Qualitative	+ Considers stocks and flows and outcomes and impacts + Details how to undertake an assessment—iterative + Integrated across the value chain + Operational through natural capital protocol + Flexible	- Not specifically designed for landscape management	(Brander et al., 2012; Kumar, 2010; Ring et al., 2010)
2018	Ecological Outcome Verification (EOV)	Ecological condition	Ecological condition	+ Developed with farmers for farmers + Developed with soil scientists, ecologists, and agronomists + applied in practice + Designed for landscape management + Outcome focused	- Relatively new - Unclear how it links to economic performance - Internal verification system - Currently focuses on livestock	(Land to Market, 2022b)
2021	Wellbeing Budgets and the Environment – A Promised Land (NZ)	Well being	Living standards framework	+ Acknowledges link between environment and well-being +Cultural links to environment and well-being + Strong government support + Uses thresholds and tipping points	- Broad range of indicators - Societally based, not just agriculture - Complex	(Parlimentary Commissioner for the Environment, 2021)

By 2019, the application of these frameworks to agricultural systems in Australia remained limited. This research identified the following frameworks currently being utilised:

- The Accounting for Nature (AFN) framework—An approved framework for co-benefit assurance under the Queensland Land Restoration Fund. This is used by Kilter Rural, an investment manager of farmland assets in Australia, to quantify the improvement in natural assets on its investments with a proof-of-concept trial (Heislers et al., 2019). The AFN is also being considered by several other institutional investors in agriculture as their preferred framework for natural capital accounting.
- Ecological Outcome Verification (EOV) is being used by Land to Market (L2M), a co-operative of farmers that monitors the ecological health of farmland.
- The Tasmanian Forest Trust used the Natural Capital Protocol to present their Natural Capital Report 2021 (Forico Pty Limited, 2021).

Since 2019, and at the time of thesis preparation, several new initiatives have evolved, and steps have been taken to increase the adoption of natural capital accounting in agriculture. Examples include:

- **ImpactAg Partners**—An investment manager implementing natural capital accounting across investment projects (ImpactAg Partners, n.d.).
- **Queensland Investment Corporation (QIC)**—In conjunction with the Queensland Government, QIC is exploring opportunities to establish a natural capital investment fund.
- **AgForce Queensland**—is developing natural capital certification for landscape resilience, AgCare, an on-farm self-assessed natural capital project designed to be inexpensively implemented across a tiered system (Agforce, n.d.).
- **LandCare**—involves farming benchmarking projects. In 2021, LandCare delivered several carbon footprint and natural capital workshops across Australia to increase national alignment across themes and activities (Landcare Australia, 2021).
- **Australian Wool Innovation (AWI)**—In 2021, AWI prepared farm-level natural capital reports for 11 case studies across NSW, Victoria, and Tasmania based on SEEA (Australian Wool Innovation Limited, 2021).

- **Farming for the Future –** in partnership with the NFF is developing evidence to support the incorporation natural capital as part farming businesses (Farming for the Future, 2022)

2.7.2 Challenges in Adopting Accounting Frameworks

The application of these frameworks is not without challenges. Costanza (2020), identified several obstacles to the wider adoption of accounting frameworks, including:

- the costs of system implementation.
- inconsistent approaches to the modelling, assessment, and valuation of natural capital and ecosystem services.
- the lack of appropriate institutional frameworks.

Costanza (2020) also notes that the complexity of the systems being modelled and valued entails additional problems in terms of the skills and knowledge available to understand the systems.

Costanza (2020) states that for agriculture, the lack of clarity around the advantages or value proposition of applying these approaches becomes magnified when the expense of implementing the systems is considered. Leach et al. (2019) also stressed the challenges posed by the complexity of natural capital and ecosystem services. Similarly, the lack of standardisation in the methods of collecting natural capital data, possibly attributable in part to the spatial complexities and non-homogenous nature of natural assets, is a challenge. The frameworks listed above generally do not include methodologies for data collection or measurement approaches. Similarly, Costanza et al. (2017, p. 14) suggest that "*new approaches to data are needed*". Identifying the opportunities provided by multi-scale remotely sensed data and data collected with other types of technology should allow more interactive models that function in real time to be designed.

It is also important to recognise the significant emerging market opportunities, which will require robust frameworks to validate the outcomes of payment programmes and to

legitimise policy. As The National Farmers Federation (NFF) cautions, poorly executed policies and approaches "*could saddle farm businesses with additional costs*" (National Farmers Federation, 2019).

2.8 Conclusion

Natural capital and ecological economics are relatively new concepts in economics. Recognising and valuing natural capital will play a crucial role in advancing human health and well-being. Understanding our reliance on the environment has brought the interconnectedness of the environment and economics into increasing focus. Because natural capital is a relatively immature concept, economists and ecologists have debated the methods required to quantify its condition and global extent. The methods proposed by leading authors have centred around market-based approaches, which place an economic value on natural capital. However, not all authors agree with this approach. Some prefer a more socially constructed approach that includes human motivation when natural capital and its importance are considered. It is agreed that failing to account for natural capital poses significant risks to humanity, its well-being, and intergenerational equity.

Agriculture plays a crucial role in the management of natural capital. Its position is unique in that although it has a significant impact on natural capital and its condition, it relies heavily on natural capital for its production and output. Historically, little regard has been given to the environmental consequences of agricultural and production methods, or the externalities they generate. This has been magnified by the Green Revolution and technology that has masked the impact of agriculture on natural capital. However, this has begun to change with the recognition that the condition of natural capital is a critical factor for agriculture in the management of environmental and market access risks.

The critical nature of natural capital is being addressed, in part, by the development and application of natural capital frameworks that measure and monitor natural capital outcomes in agricultural landscapes. They are designed to provide integrity and credibility to the management of natural capital. However, these frameworks and accounting methodologies are still embryonic, and are not widely used in Australian agricultural landscapes at this stage.

As noted in the literature, not all frameworks are the same, and some are complex, with confusing language and a lack of consistency. The high cost of their application and a lack of clear value propositions for environmental and economic outcomes makes the adoption of these frameworks challenging.

2.9 The Case for this Research

Agriculture is a rapacious user of natural capital and Australian governments have identified opportunities for agriculture to make a positive contribution to improving the management of natural capital. These involve identifying the wider public (social) benefits of natural capital as well as the economic benefits to farmers and communities. Recent initiatives of state and federal governments in natural capital accounting have identified the importance of frameworks as key tools for communicating knowledge and outcomes about the management of natural capital in agriculture, while providing support for the implementation of natural capital programmes.

Although the importance of natural capital to agriculture and the need to measure and monitor natural capital are recognized, few accounting frameworks have been adopted. This is partly attributable to the complexity of natural capital systems and the relatively recent evolution of their concepts and terminology. The literature has also identified several factors as potential barriers to framework adoption, including the expense of their implementation, the availability of data, and the lack of value propositions, but has offered few actionable solutions.

A range of frameworks suitable for use in natural capital accounting in agriculture have been developed. The academic literature around these frameworks and their approach is limited and dominated by the grey literature. The guides supporting these frameworks are at times complex, lack practicality, and do not address the skills or knowledge required by practitioners to implement them. Importantly, there is also a lack of clarity around how natural capital accounting links economic and environmental outcomes, which might discourage the adoption of these frameworks by farmers.

Agriculture does not operate in isolation but is shaped by many actors and stakeholders. The literature identifies a need to engage with these stakeholders, suggesting that a transdisciplinary approach will help to define value propositions and influence natural capital outcomes. However, to date, there is limited evidence in the literature that this is occurring.

2.10 Research Questions

From the gaps identified in the research, I have formulated three key research questions.

Main Question Research Question

How can improved understanding of the views of various stakeholders be used to remove barriers to the adoption and relevance of natural capital accounting in agriculture?

Secondary-Research Questions:

- ***RQ1—How do farmers perceive the value of natural capital and the need to measure it?***
- ***RQ2—Why is the adoption of natural capital accounting so difficult? What inhibits or motivates the use of natural capital accounting frameworks and how do these factors vary between stakeholders such as retailers, financiers, accountants and investors ?***

2.10.1 Contribution to New Knowledge

Identifying the gaps in our present knowledge of the adoption of natural capital accounting will allow the identification of solutions and the removal of obstacles to the prioritisation of measuring and monitoring natural capital in agricultural systems. Clear value propositions that can deliver both economic benefits and sustainable agricultural systems must be identified to support protection of natural capital and reduce land degradation.

Chapter 3: Research Design—Theoretical Framework

In this chapter, I outline the design of my research and the underlying theoretical concepts that form the foundation of this thesis and explain why these were selected. The aim of this chapter is to inform and justify the structure of the research through a discussion of the theories and methods that were applied. The foundation for this research is my background in investment management, and in this context, and the examination of ideas about investment in agriculture that include considerations of the environmental dividends.

3.1 Introduction

As has been detailed in Chapter 2, agriculture operates within and manages large, interconnected landscapes, so those managing these landscapes are responsible for the condition of this natural capital and are stewards of its welfare. Agriculture is critical to global food security, climate regulation, and the economic and social structures within which it operates. However, it also contributes to climate change and is responsible for ecological degradation, creating significant risks to society. Agriculture does not operate in isolation but has a significant influence on or is influenced by society, and this synergy affects the way biodiversity and ecosystems are managed by agricultural land managers. The degradation of natural capital and ecosystems by poor land management decisions can translate into wider social impacts because nature-based losses can negatively affect business profitability and societal well-being (*World Economic Forum: The Global Risks Report 2020*).

These risks were raised in the World Commission on Environment and Development (1987), and reiterated in the Millennium Ecosystem Assessment (2003). The recognition of the threats posed by degraded natural capital was supported by the formation, in 2020, of the Taskforce on Nature-related Financial Disclosures (TNFD) and the release of *The Economics of Biodiversity: The Dasgupta Review* (Dasgupta, 2021). On its web site, the TNFD notes that *"the high dependency of the global economy on nature means nature loss represents significant risk to corporate and financial stability" (Taskforce on Nature-related Financial Disclosures, 2020).* However, although the importance of natural capital to agriculture is now

recognized, there are few examples of how natural capital is measured or monitored in the agricultural context.

3.2 Characteristics of the Problem

When managing landscapes and natural capital, land managers are faced with an array of complex issues on a day-to-day basis. These complexities require trade-offs and compromises, which are influenced by the belief systems, aims, knowledge, and experience of the land managers themselves (Siebrecht, 2020). These complexities are also fragmented because they involve interactions across various disciplines, including ecology/science, economics/finance, social/cultural concerns, and politics. These disciplines have different values, and involve different levels of authority, cultures, and personalities, making compromises difficult (Hull et al., 2020). Therefore, to achieve their personal and financial goals, landscape mangers must assess significant volumes of information and make many compromises. These complexities and competing interests often lead to conflict or tensions, with increasing pressure on the agricultural sector to produce more from its existing assets while simultaneously addressing environmental concerns (Foley et al., 2011). Figure 9 illustrates a conceptual system showing the key relationships and influences within a farming system.

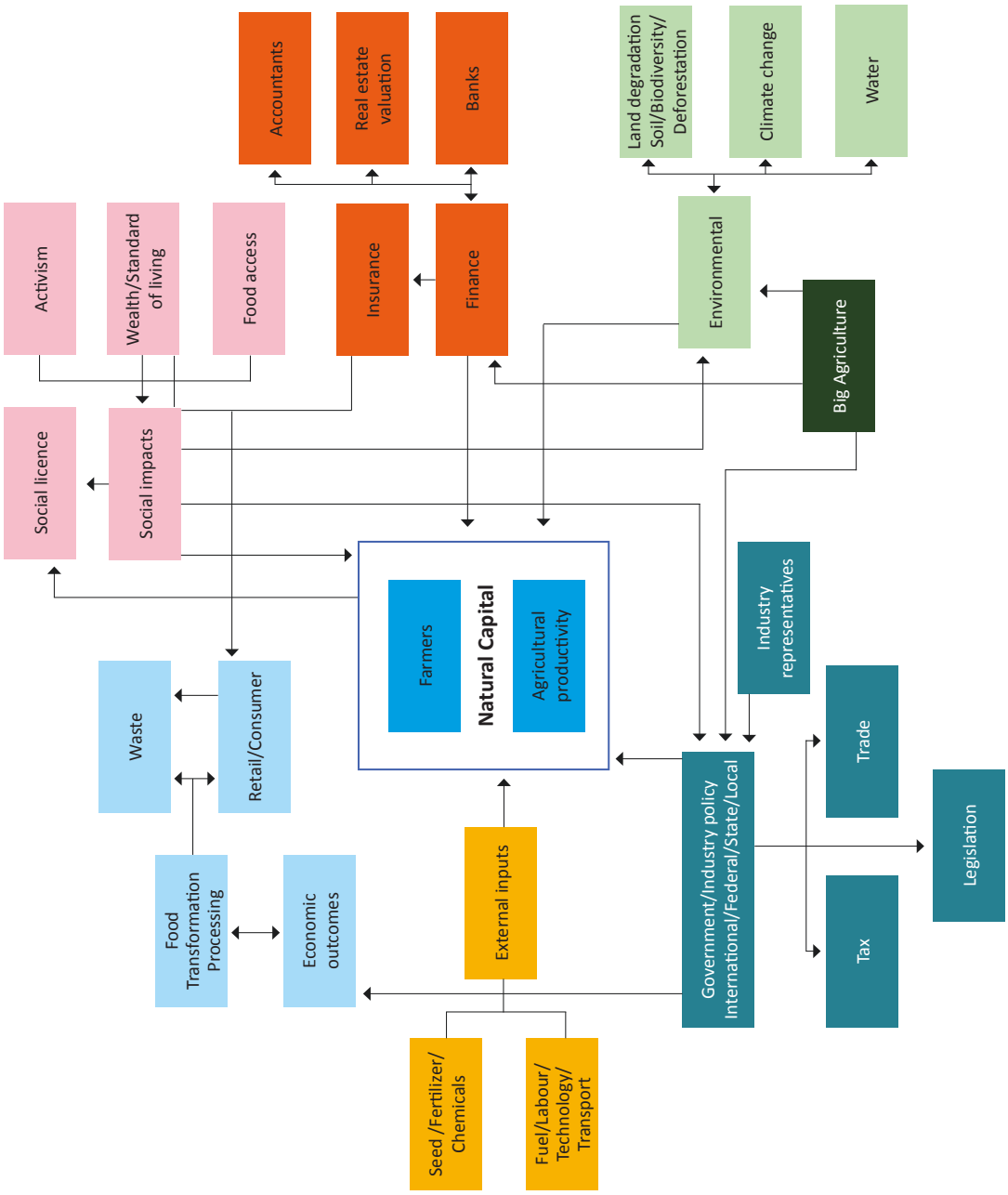


Figure 9: Conceptual diagram of an agricultural system and stakeholder relationships

Source: Author

3.3 Initial Steps in Research Design using a Conceptual Model

Transformational change that leads to a greater recognition of natural capital and its importance to agriculture requires an effective evidenced-based approach that can inform and address complexities. In the research design process, a conceptual model is used to clarify a complex problem, using a common framework to integrate knowledge across disciplines (Fortuin et al., 2011). The starting point for the concept map used in this study was the literature review described in Chapter 2, which established the knowledge behind the research problem, from which the research questions evolved. This approach established the context, which Alberto and Joseph (2010, p. 11) describe as "*the hierarchical structure of the concept map*". An example of a conceptual model that focuses on environmental problems and is highly relevant to this research is the *Millennium Ecosystems Assessment Framework* (Figure 10). In this example, the model emphasises the relationship between biodiversity and the quality of human life (Fortuin et al., 2011, p. 807).

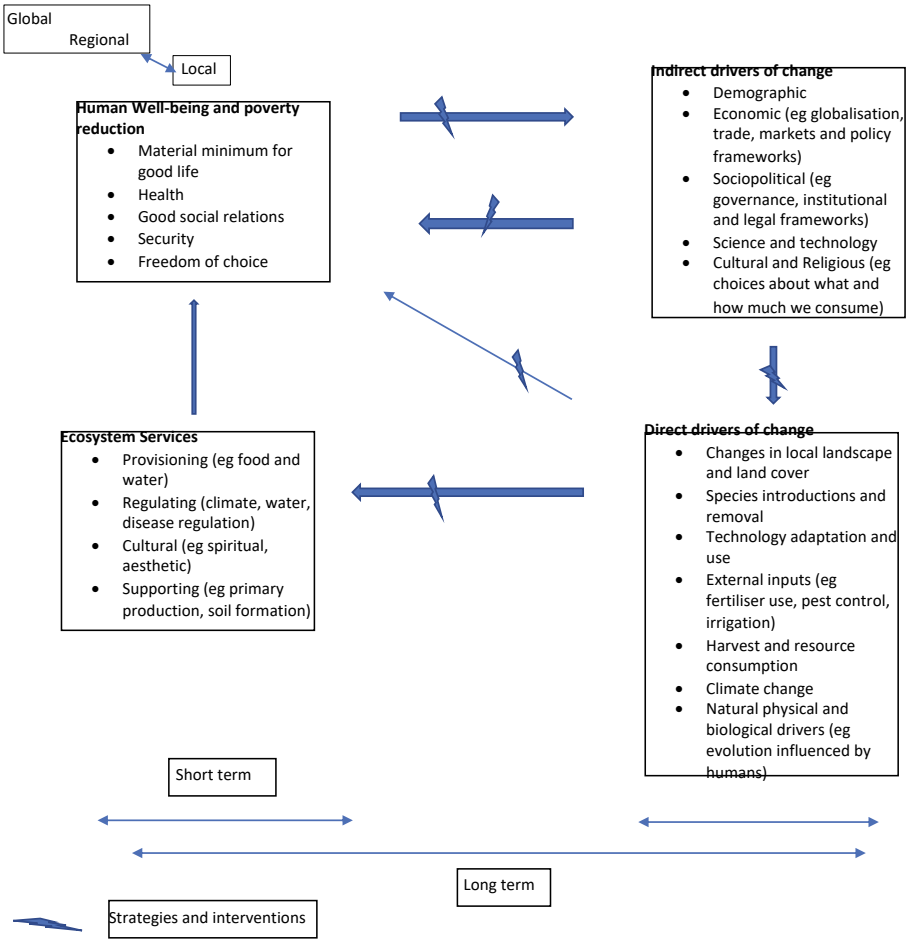


Figure 10: Millennium Ecosystem Assessment Framework, Adapted from (Millennium Ecosystem Assessment, 2003)

Alberto and Joseph (2010, p. 7) define a concept map as a "*template or scaffold to help organise knowledge and structure it*". Thus, "*scaffolding*" clarifies the starting point from which the methodology and methods required to address the problem(s) are developed (Fortuin et al., 2011). Based on the literature review and the research questions, I selected a domain model, as the conceptual model. Within this, I used a driving forces–pressure–state–impact–response (DPSIR) intervention model (Figure 11). The model is an abstract representation of reality that schematizes the interactions and consequences of environmental problems (Smeets & Weterings, 1999). In this study, the model was adapted to identify the issues around the degradation of natural capital and agriculture. The model has also been adjusted to include the changes required to influence the responses and solutions to the problem of natural capital degradation in agriculture. These include changes in societal behaviour to stimulate the responses. The model simplifies the complexity of the problem and identifies links between its components, insofar as a change in one affects the others. For instance, a response of society can be provoked by the implementation of policies or actions as solutions to address a specific problem (Smeets & Weterings, 1999).

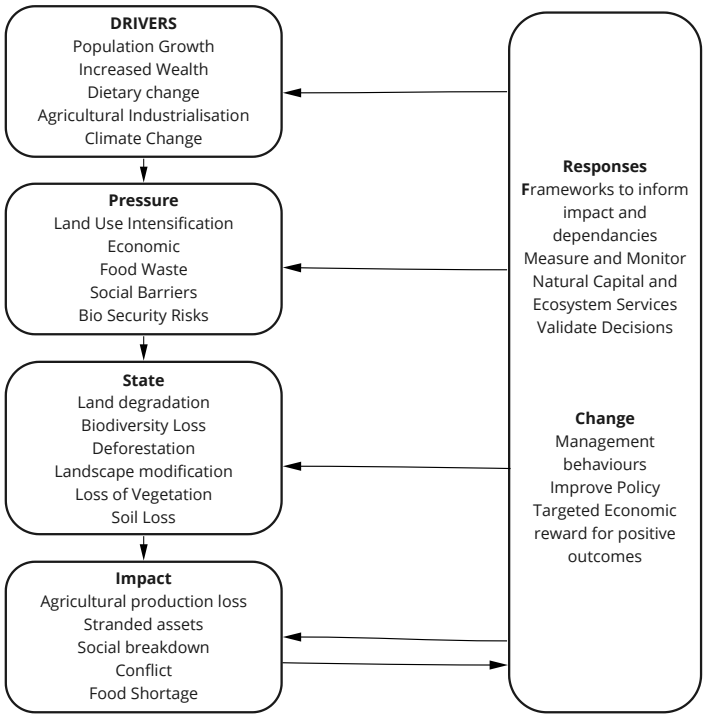


Figure 11: Driving forces–pressure–state–impact–response (DPSIR) intervention for implementing a natural capital accounting frameworks in agriculture. Adapted from (Smeets & Weterings, 1999)

The components of the model include:

a) Driving forces—or the basic causes of the decline in natural capital, such as population growth and the industrialization of agriculture;

b) Pressure—pressure on agricultural land use from intensification, increase in the extent of land used for production and economic pressure to produce more food from less land resulting from the need to meet the driving forces identified in (a);

c) State—is the environmental quality of the agricultural landscapes caused by the pressures brought to bear on it by the driving forces;

d) Impact—is the societal impact through conflict and food shortages and environmental impact through declining river systems on regional communities or through declining ecosystems on species diversity imposed by the decline in natural capital;

e) Responses—are the solutions used to address the decline in natural capital.

A sixth component has been added to the model, "change", to reflect the behavioural changes required to adopt the responses or actions to limit the impact from driving forces such as increasing ground cover on farms limiting chemical run off into river systems.

3.4 Interplay between Human and Natural Components

Janssen and Goldsworthy (1996) describe natural resource management as involving complex integrated systems so closely entangled that they cannot be viewed through a single lens. As can be seen from the DPSIR diagram (Figure 11) and the system (Figure 10), the drivers associated with the research problem of the degradation of natural capital range from environmental to social to economic. Farmers are often seen as central to these driving forces, through their management of the landscape. However, their decisions are not made in isolation, but with consideration of markets, costs, regulations, values, etc. The social element also plays a significant role in these decisions by influencing factors such as the social licence to operate, family, tradition, ethics, skills, financial position, etc. These affect an individual's or community's ability or capacity to implement the responses and thus change the decision-making around natural capital (Bennett et al., 2018). As Greiner (2015, p. 155) noted "*Economic theory considers the extrinsic drivers of decision making (product prices and*

input costs) while personal context relates to the "'individual and social conditions which the farmer operates"'.

The management of natural capital can be viewed in a similar framework as conservation biology, which determines the global loss of species and biodiversity, the disruption of ecosystem processes, and their causes (Van Dyke, 2008). Importantly, as highlighted by Balmford and Cowling (2006, p. 692), "*conservation is primarily not about biology but about people and the choices they make*". Consequently, addressing the decline in natural capital requires that a broad range information be brought together to influence decision-making and to drive behavioural change and the development of effective policies. In reflecting on these solutions, Hirsch Hadorn et al. (2006, p. 20) noted that changes to those practices require "*reliable knowledge that transgress disciplinary boundaries*".

3.5 World View

Combining the DPSIR intervention (Figure 11) and the system described in (Figure 10) allows the research questions to be considered in the context of the current literature and the research design. My aim was to establish a paradigm that sets out my beliefs and actions in undertaking the research (Guba, 1990, p. 17). Research design, as described by Creswell and Creswell (2018) (Figure 12), involves the intersection of philosophy, and methods.

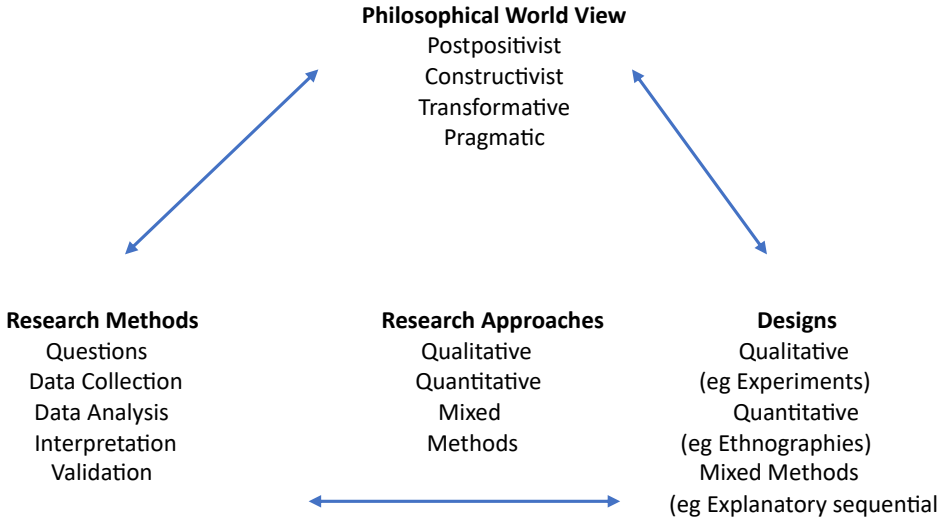


Figure 12: Research design. Adapted From (Creswell & Creswell, 2018)

Research design begins with the research questions and the researcher's personal experiences around the topic of study (Pabel et al., 2021). This leads to the formation of a

world view, or epistemologies and ontologies, as described by (Creswell & Creswell, 2018). These ultimately inform the theory and methodological approach to resolving the research problem (Crotty, 1998). The conceptual framework discussed in Section 3.3 is a scaffold, and a world view is similarly a framework that assists in shaping, as Killion & Fisher described, "*what should be studied, what is seen and how what is seen is studied and interpreted*" (2018, as cited in Pabel et al., 2021, p. 5). It also establishes the reliability and validity of the findings (Creswell & Miller, 2000; Crotty, 1998; Pabel et al., 2021). As illustrated in Figure 12 world views can range from post-positivist to pragmatist approaches.

A positivist world view focuses on evidence-based reality and causality, supported by repeatable data, which are used to test a hypothesis, generally using a quantitative approach. However, a post-positivist adapts the positivist world view to consider the background of the participants in the research and the context within which they operate. Therefore, a post-positivist uses both observations and measurements to test a hypothesis (Pabel et al., 2021).

Constructivist or interpretivists deal with complex issues and consider the "*environment as depending on socially acquired attitudes, habits of attention, and the language used to describe it*" (Tsoukas et al., 2011, p. 11). They typically approach research with qualitative methods and rely on the participants' views of the situation being studied (Creswell & Creswell, 2018).

In the transformative world view, an action agenda introduces political agendas to the research inquiry, to address the specific social agendas of marginalized or disenfranchised stakeholders (Creswell & Creswell, 2018).

Finally, pragmatists are described in Salkind (2010) as basing their understanding on human experience, seeking to understand the multiple factors contributing to people's actions in a given situation. The original classical pragmatist philosophers, Peirce, James, Mead, and Dewey, sought to identify practical solutions to practical problems based on lived human experience (Elkjaer & Simpson, 2011).

3.6 A Pragmatic Approach

In forming a world view to undertake this research, I considered the observation of Balmford and Cowling (2006) that conservation research is increasingly moving from a strong natural science focus to an integration of the social sciences. This perspective recognises that biodiversity decline is influenced by many factors, including social, political, economic, and institutional factors, as discussed at Section 3.3. As Chan (2021a) notes "*farmers are at the interface of the world's most wicked problems*". These problems go much deeper than the farm or the science behind biodiversity, but include social, political, and institutional influences, which can create tensions between stakeholders with differing goals or beliefs.

The term "wicked problem" used by Chan in her book was first introduced by Rittel and Webber (1973) in their article *Dilemmas in a general theory of planning*. Wicked problems can be described as societal problems that are ill-defined and can never be solved. The threats to natural capital, its decline and degradation, are sustainability challenges, and have the attributes of a wicked problem. These attributes are driven by the blurred lines that occur when a problem traverses several disciplines. A solution therefore requires a continuous learning approach that operates beyond such boundaries to develop new knowledge.

Moon and Blackman (2014) suggest, undertaking this type of research with a positivist world view would be challenging. To understand the social aspects involved in introducing natural capital accounting, or the values and attitudes that inform them, Evely et al. (2008) note that positivism cannot fully account for the subjective nature of human reasoning and choices. It is an approach driven by hard science.

Conversely, a constructivist world view must include the examination of subjective elements, by considering the social, cultural, and historical attitudes and experiences surrounding the problem with qualitative methods (Moon & Blackman, 2014). However, it may fail to consider the hard science behind the complexities of ecological systems or the ecological economic impacts or influences on agricultural systems. Given the complexities surrounding the issues of sustainability and the conservation of natural capital, a world view must be found that applies a methodological approach that allows the research to inform what is being studied.

Both positivism and constructivism offer useful perspectives but choosing one or the other may leave gaps in the data, omitting data that would otherwise be valuable in solving the research problem.

Therefore, a pragmatic world view was applied to this research, focusing on the delivery of practical outcomes through community-based enquiry and science-based knowledge. This provided an element of freedom in seeking the most suitable solution to the "wicked" problem of ecological damage. Salkind (2010) lists four goals to guide pragmatic research:

- to accept chaos in the inter-relationships among variables;
- to seek understanding based on human experience;
- to view a problem as a complex problematic situation;
- to promote activism, democracy, and policy formation.

These also allow the investigation of the value natural capital may have for those stakeholders most closely linked to farmers. As Glasgow (2013) states, the solution will be the one that best fits the needs of the problem and delivers change in the real world.

3.7 Method—From Pragmatism to a Transdisciplinary Approach

In her book *Why Give a F*** about Farming*, Chan (2021b, p. 5) states "*This is how food is grown and where it comes from are choices for every individual and country to make*". The phrase "*every individual and country*" signals that it is not simply farmers who are responsible for our natural capital; we are all responsible.

Natural capital and ecosystem services are integral to farming systems, are complex and non-linear, and are also closely intertwined with society. These elements are characteristic of problems most appropriately tackled with pragmatism. Pragmatism, as previously noted, seeks the best method to solve a problem that is both complex and contentious. For example, when considering the role of natural capital in agriculture, a banker who lends capital may have different views, goals, and needs to those of a farmer or fresh food retailer, or to those of an environmental scientist or property developer. Society also plays a role through its food choices, its willingness to pay for those choices, its ability to pay for its choices, and its beliefs and values around the environment, all of which influence the natural capital system. In

response to this complexity, pragmatism considers the participation of social actors, together with scientific credibility and legitimacy of information around the problems associated with natural capital and its degradation. This is done through a collaborative process resulting in the co-production of knowledge and mutual learning (Popa et al., 2015). The inclusion of societal actors together with empirical knowledge allows a multidimensional approach to the integration of knowledge around the problem. Transdisciplinarity is designed to address these complexities and to bridge disciplinary boundaries.

As noted by Jahn (2008, p. 1), Mittelstrass had defined "transdisciplinarity" as research that "*has freed itself from disciplinary boundaries, defining and solving problems independently of any discipline*". The strong link between pragmatism and transdisciplinarity brings together an approach to knowledge production that can solve complex real world problems Klein (2015) and that is not constrained by a specific-discipline-based approach. By considering the range of interests and understanding which ways the interests and needs of stakeholders are affected alongside the consequences of societal practices can assists in developing problem solving strategies (Hirsch Hadorn et al., 2006). This pluralistic approach to the co-production of knowledge is defined by Norström et al. (2020, p. 183) as an *"iterative and collaborative process involving diverse types of expertise, knowledge and actors to produce context specific knowledge and pathways towards a sustainable future*" Figure 13.

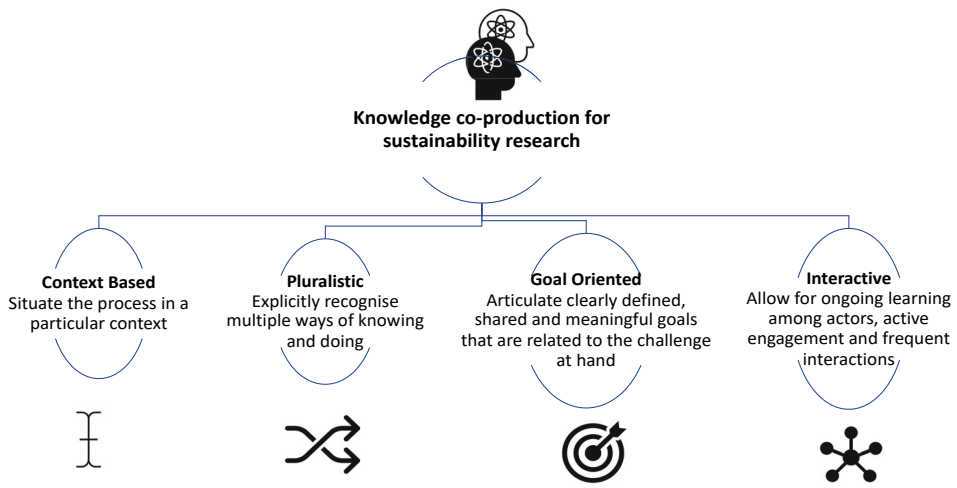


Figure 13: Knowledge co-production. Adapted from (Norström et al., 2020)

Much as a pragmatist seeks to unpack the complexity of a situation by considering human experience, the co-production of knowledge requires the recognition of the different values and beliefs that exist in a community. With collaboration, this can build knowledge through mutual learning. The importance of addressing complex problems by building knowledge across disciplines has gained support since its implementation in the development of ecologically sustainable practices. For example, the development of organic agriculture in Switzerland is cited by Aeberhard and Rist (2009) as a successful early example of the co-production of knowledge through the co-operation of a number of stakeholders, including farmers. This project embraced the fundamental principles of transdisciplinarity.

As previously mentioned, the problems around the sustainability of natural capital are wicked problems, and taking a transdisciplinary approach to improving the situation through ongoing learning is consistent with solving wicked problems. Hull et al. (2020) stated that the leadership practices required to solve wicked problems are collaboration, connection, and adaptation (Figure 14).

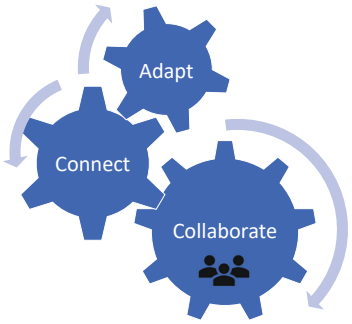


Figure 14 Leadership practices for solving wicked problems. Adapted From (Hull et al., 2020)

More recently, Baumber et al. (2018) assessed the interest of landholders in using online tools to collaborate on natural resource management using a case study of the Central Tablelands farmers. The research began with an interdisciplinary approach (merging concepts and knowledge across disciplines), also assessing the applicability of transdisciplinarity to the study (Baumber et al., 2018). They used five key factors from Polk (2015) to assess the applicability of transdisciplinarity: inclusion, collaboration, integration, usability, and reflexivity. These are consistent with the three characteristic practices required to solve

wicked problems, described by Hull et al. (2020). In their conclusion, the authors noted "*innovations need not be imported from outside but can arise from the integration of diverse knowledge types within a local system through a reflexive and collaborative process of mutual learning*" (Baumber et al., 2018, p. 24).

Christ and Burritt (2018) examined the potential utility of a transdisciplinarity approach to the investigation of water accounting. The use of transdisciplinarity to investigate water accounting not only brought together a cross-section of disciplines and the integration of knowledge, but also allowed the development of consistent terminologies and standards to provide clarity and unite stakeholders in a common goal (Carr & Wilkinson, 2005). This collaboration resulted in the greater links to water accounting and enhanced water management.

There are challenges to applying a transdisciplinary approach, in particular, the power imbalance between parties. Those with louder voices and possibly larger resource bases may drown out other stakeholders, dominating and diluting mutual learning and reducing the validity of the outcomes. The tensions and conflict between various stakeholders and/or power bases can at times sit uncomfortably with the principles of transdisciplinarity. When principles of mutual learning and mutual understanding are placed alongside established belief systems, traditions, and levels of literacy, understanding, stakeholder' interests can clash with new ideas and concepts. This makes mutual learning challenging, especially when trust has not been established.

Although there are recognised challenges in undertaking a transdisciplinary approach, there are examples in which disciplinary work has had limited success in developing broadly accepted solutions to the development of water accounting frameworks. Given the complexity of the systems of natural capital, the data collection methods, and the terminology, and the lack of standard metrics, the resolution of different perspectives requires trust and mutual respect (Christ & Burritt, 2018). Natural capital accounting is a complex problem that crosses disciplinary boundaries, so the application of a transdisciplinary approach can bridge the gaps between the information currently available and the information actually needed by different disciplines and stakeholders (Christ & Burritt, 2018).

Bringing together a diversity of disciplines through collaboration to solve complex societal problems has significant potential utility in the better management of natural capital.

Finding a solution to the complexity of sustainable land use and climate change dominates the world media, particularly during high-profile gatherings such as COP26 in Glasgow (2021), a meeting of world leaders, negotiators, business leaders, and citizens to discuss how to address climate change. The media reflected the diversity of interests, from those of farmers to those of politicians, retailers, and finance executives, who are all focused on risks to our natural environment. This provided a window into the interconnectedness of climate change and natural capital, and where the potential impacts of climate change lie.

Examples include:

- Farmers for Climate Action advocate action on climate change and aim to lobby politicians for faster action and stronger climate policies.
- Federal Trade Minister, Dan Tehan, warned Australian farmers and miners that they faced carbon border taxes, and that flagging businesses may find it difficult to obtain finance if Australia does not commit to net-zero emissions (Galloway, 2021).
- Macquarie Bank CEO, Ms Shemara Wikramanayake, noted in The Australian on 5 October, 2021, that "*the role of the land in our global net zero ambition is hard to overstate*", and that how we balance our needs against maintaining natural systems and biodiversity demands careful thought (Moullakis, 2021).
- Food wastage is responsible for around 6% of total global greenhouse gas emissions (Foodbank AU), and Harris Farm Markets announced an initiative to address food waste by upcycling their best unsold food (Harris, 2021).

These examples confirm that society has a stake in managing natural capital sustainably, and that growing our food and fibre is not solely the domain of farmers, as noted earlier by Chan (2021b) in her book *Why Give a F*** about Farming*. Adapting and building resilience in our natural capital systems, and ensuring that they are fit for purpose for future generations, is a complex task and involves many disciplines. Therefore, this research is based on data captured from a wide range of stakeholders.

3.8 Transdisciplinarity in a COVID World

It is important to recognise the challenges inherent in undertaking a transdisciplinary approach during a pandemic. During the COVID19 pandemic through 2020-2021, travel and lock-down restrictions required stakeholders to alter their priorities and business practices to ensure business continuity, and engagement with stakeholders in the co-production of knowledge became extremely challenging. My engagement with stakeholders in focus groups and with case-study participants required great patience and understanding to ensure the establishment of trust, as businesses prioritised staff engagement and well-being, together with business continuity. For many study participants, moving to a remote work environment also required more time on-line (ZOOM/Teams meetings), leaving limited time to participate in non-priority activities. This was clearly apparent in one engagement, in which one participant reflected on having to manage staff and ensure their daily well-being while managing projects. Taking a transdisciplinary approach also required that I remained adaptable when conducting interviews and focus groups. In a personal face-to-face environment, a more empathic approach to building trust and mutual respect was required. In both ZOOM meetings and interviews, I found patience and empathy were required to ensure the participants' supported the approach being used. I am grateful to all of those who committed time to this study, when time was at a premium and the value proposition was not always clear.

3.9 Conclusion

In this chapter, I have presented the philosophical world view that underpins this research. I have highlighted the key role that agriculture plays in global food security and social and economic structures. I have revisited the complexities faced by agricultural land managers in balancing the management of natural capital, upon which agriculture relies, with the conflicts and tensions that exist in a multi-stakeholder environment. I have examined the utility of a conceptual DPSIR model to simplify and understand the complex problem of natural capital and agriculture. This allowed the knowledge around the problem to be organised and clarified and the interactions between agricultural stakeholders to be identified. It simplifies

the problem and the responses to it, to improve the management of natural capital across agriculture.

I then used a DSPIR model as the scaffold upon which to develop the research design in the context of the world view best suited to finding a solution to the research problem. Because this research probes deeper than the farm or the science behind biodiversity, the complexity of the problem must be unpacked. Therefore, a pragmatic world view was selected as the most appropriate perspective from which to undertake the study. My focus is on the delivery of practical outcomes through a community enquiry coupled to science-based knowledge.

Finally, the chapter examined the resolution of problems around the sustainability of natural capital with a transdisciplinary approach, through the co-production of knowledge. A transdisciplinary approach that provides insight into the interests and needs of various stakeholders is a multi-dimensional strategy well suited to the integration of knowledge for the management of natural capital. The problem posed can be described as a **"**wicked problem", or one that traverses several disciplines.

In Chapter 4, I examine the methods used to conduct the research and to answer the research questions.

Chapter 4: Research Approach

In this chapter, I outline my approach in undertaking this research and the methods (tools) I used to collect the data Hesse-Biber et al. (2015, p. 6)

The research was designed to identify the barriers and value propositions around the application of natural capital accounting frameworks to agricultural practice. I utilised the shared knowledge of farmers and agricultural stakeholder groups to identify potential ways to encourage the wider adoption of natural capital accounting. I drew upon case studies of the application of natural capital accounting, collecting (qualitative) primary data from semi-structured interviews with the participants in the case studies, and secondary data from documents, web sites, podcast transcripts and newspaper articles.

4.1 Research Methods

The development and use of accounting frameworks for natural capital have been considered as tools to deliver better natural capital outcomes and create value for farmers, despite this there is limited evidence of their wider use. To understand why there has been limited adoption of natural capital this research explored and compared the views of the various stakeholders and assessed how these views can influence wider adoption of natural capital accounting in agriculture. I employed a mixed-method approach applying three primary data collection methods, case studies, focus groups and an on-line survey to collect data to answer the main research and secondary research questions.

Case Studies

Case Studies were selected for this research as they represent a detailed examination of the 'operational' viewpoint of those already engaged in natural capital accounting. My purpose was to understand why natural capital accounting was undertaken, given the limited evidence of its widespread adoption in agriculture. Primary data was collected by undertaking semi structured interviews with members of the case studies. The semi structured interviews were used to explore the experiences of the case study participants in implementation of natural

capital accounting; the value proposition in undertaking the process and the barriers they encountered. Secondary data was gathered from documents, podcast transcripts and newspaper articles to supplement the primary data from the semi structured interviews. The results from this analysis were used answering (RQ1). The results from the case studies were used to inform the development and approach to the focus groups.

Focus Groups

Two focus groups comprising stakeholders who influence or are influenced by agricultural practices, such as banks, investors, retailers, and policy makers, each with seven participants were undertaken. Each focus group comprised of one participant from each industry to create diversity in focus group membership and views. The targeted stakeholder group reflected the diverse range of industries and sectors that had close interaction with the farming industry as seen at Figure 9. The focus group were used to explore how these stakeholders might influence the adoption of natural capital accounting in agriculture (independent of the case studies). Due to the short time available to conduct the focus groups, quantitative data were initially collected with a pre-focus-group survey of the 14 participants, comprising 20 questions. The results were used to assist with the collection of qualitative data as a scaffold during the focus group sessions. The focus groups sessions were recorded on ZOOM due to COVID-19 restrictions. The data from the focus groups used to answer RQ(2)

Survey

As part of the research around the adoption of natural capital accounting an online survey was emailed to a broad range of farmers across Australia. The online survey was independent of both case studies and focus groups and asked farmers to about their understanding of natural capital and natural capital accounting; climate change and environmental concerns; the importance of natural capital and natural capital accounting and where they were on their sustainability journey. The survey was used to explore differences between the case studies who were undertaking natural capital accounting and landholders not undertaking natural capital accounting. Figure 15 is a visualisation of the data collection process

1) Beginning with the case studies and qualitative data collected from semi structured interviews and documentary analysis.
2) Secondly quantitative data was collected initially in a pre-focus group survey which was informed from the case study data. The Focus group sessions utilised the pre-focus group survey to build the discussion in each session and collect qualitative data.
3) Finally a survey of a diverse range of farmers was conducted, collecting both quantitative and qualitative data. The survey was also informed from the data collected from the case study analysis

The data from each method was then analysed, coded and themes developed.

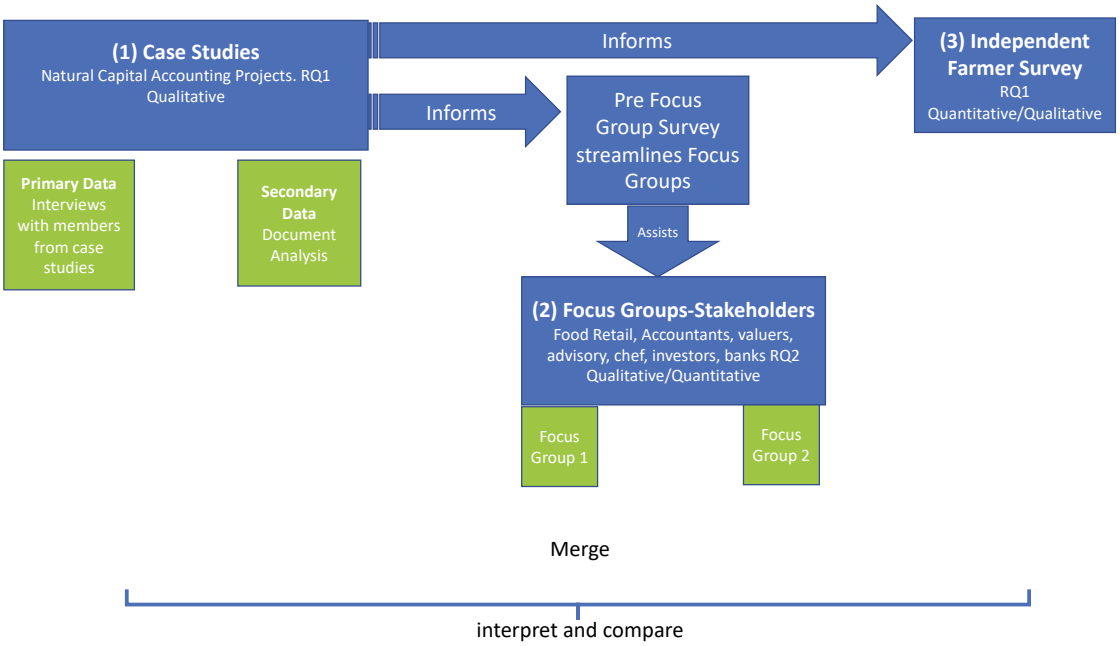


Figure 15 Mixed methods approach—data sources

The purpose of this approach was to answer the main research question: "***How can improved understanding of the views of various stakeholders be used to remove the barriers to the adoption and relevance of natural capital accounting in agriculture***?"

4.2 Data Collection and Analysis—Convergent Mixed Methods

Crossing the boundaries between economics, ecology, and the social sciences (Russell et al., 2008) and addressing "wicked" problems require a transdisciplinary approach, as discussed in Chapter 3. In this research, I examined the real experiences of individuals from multiple disciplines to gather data from a wider range of sources than was possible with a strict discipline-specific approach (Russell et al., 2008). In taking this approach collaboration has an important role in building knowledge through mutual learning as vague boundaries require continuous learning to develop new knowledge.

In Chapter 3, I discussed the theoretical perspective that formed the foundation of this research, pragmatism. Pragmatism focuses on practical outcomes achieved through enquiry and science-based knowledge, by understanding problems based on human experience and the recognition of them as complex situations.

The pragmatist philosophy adopted here defined the way methods and tools were used in this research (Hesse-Biber et al., 2015). The research strategies described in the introduction to this chapter, involving case studies, focus groups, and surveys, underpinning a narrative inquiry based on story-telling. They are observational strategies that seek to understand human experience in the complex system that combines both agriculture and natural capital.

These strategies fit within a qualitative approach to conducting research. As described by Lincoln & Denzin *"..qualitative research is multi method in focus, involving interpretive, naturalist approach to its subject matter"'* (Gupta & Awasthy, 2015, p. 15). Therefore, the qualitative data inform the research by collecting narratives and meanings from individuals or group that attribute the influences on farmers in the ways they manage natural capital, to answer RQ1 *How do farmers perceive natural capital value and the need to measure it?* The qualitative data also clarify how or if the power and motivation of external stakeholders influence farmers' decisions around natural capital (RQ2) *What inhibits or motivates the adoption of natural capital accounting frameworks and how do these vary between stakeholders such as retailers, financiers?*

As previously noted, a qualitative approach best fits the theoretical position of the research and its goal of understanding the process behind farmers' choices and how stakeholders influence their decisions around natural capital. It should establish the best solution to the main research question. In contrast, quantitative strategies are descriptive and hypothesis-driven, and are used to test hypotheses and to generalise and provide insights into human behaviour (Hesse-Biber et al., 2015). Therefore, the results derived from qualitative data can be supplemented with secondary quantitative data. Reconciling the results derived from qualitative data with quantitative survey data can provide a more comprehensive understanding of the phenomenon of interest, and test the validity of the qualitative findings, in a mixed-methods approach (Hesse-Biber et al., 2015).

A qualitative approach allows the researcher to better understand the lived experience and motivations of the agriculture sector and its stakeholders in terms of natural capital, to answer questions RQ1 and RQ2 (Merriam & Tisdell, 2016). This approach provides rich insights and understanding of complex problems. Yin has noted a mixed-methods approach also "*enables you to address broader more complicated research questions than case studies alone"* (Guetterman & Fetters, 2018).

4.2.1 The Influence of Agricultural Stakeholders on the Adoption of Natural Capital Accounting

The agricultural stakeholders who participated in this research were spread across industries and sectors, including some with a national footprint and others who were regionally or locally focused. Some were highly influential in their interactions with agricultural enterprises, wielding significant levels of power or influence. Stakeholders were defined in the Introduction as "*those groups and individuals who can effect or be affected by the actions connected to value creation and trade*" (Hörisch et al., 2014). Yin (2012, p. 12) also noted that interviews have greater value when key persons within an organisation are interviewed. These were important factors in selecting the focus-group participants from each category, because influencers provide insights and perspectives and identify strategies for future engagement that can increase the adoption of natural capital accounting and provide answers to (RQ2).

Table 4 Stakeholder analysis of those participating in the Focus Groups

Private sector stakeholders	Public sector stakeholders	Civil society stakeholders
Banks Investors Fresh Food Retailers	No participants were selected from this category	Accountants Advisory groups Hospitality Real Estate Valuers Family Farmers

According to Hovland (2005) on stakeholder analysis, the stakeholders were classified based on the influence and power they were deemed to bring to a natural capital accounting project. This interpretation requires further validation in future studies. With this approach, the industries represented in the focus groups were categorized in
Figure 16.

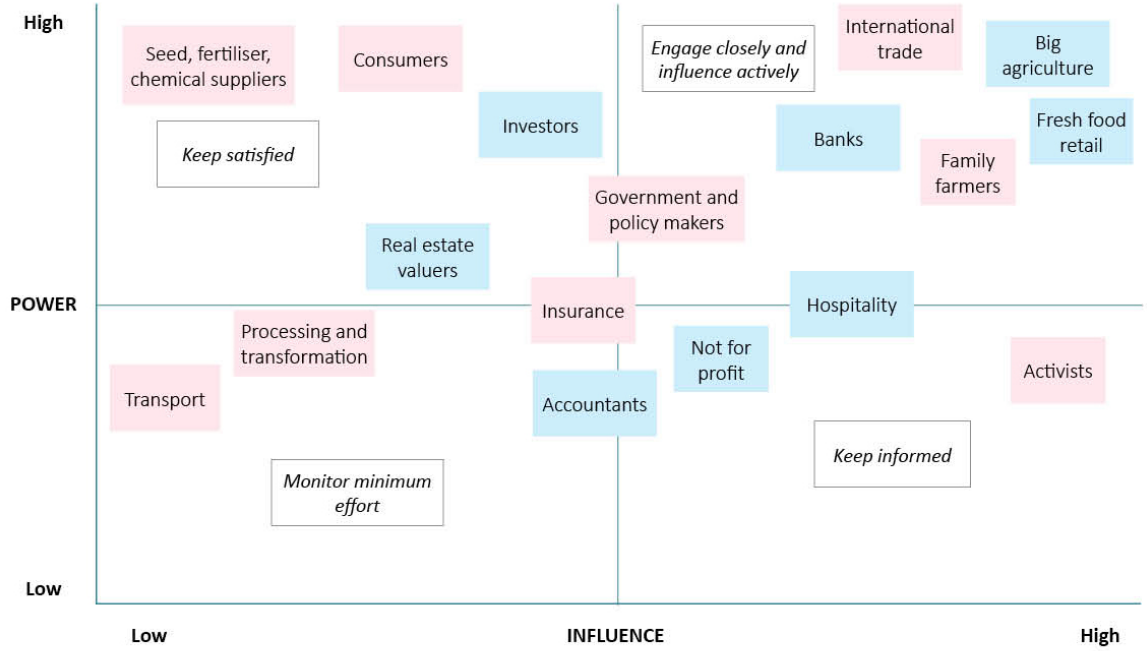


Figure 16 Interpretation of Stakeholder Power and influence around Agricultural

Source: Author: Adapted from (Hovland, 2005)

Legend

Stakeholders in Focus Groups	

Stakeholders from Figure 9 not in focus groups	

Power

1) Fresh food retailers, banks, valuers, and Investors. These key stakeholders showed a strong interest in agriculture and how it affects their industry or sector. They exert power through their direct or indirect influence over agriculture and its management of natural capital in the supply of fresh food. Through their financial strength and direct links to consumers, retailers influence consumer choices, but can also be influenced by consumer demands, conferring significant power on retailers in driving product demand. This group has the capacity to influence behaviour through their authority. The valuation industry represents several stakeholder groups, with various roles in formally valuing agricultural landscapes. Valuers identify the risks and opportunities associated with landscape conditions, which can directly, either positively or negatively, affect land values. Therefore, valuers have both power and influence as stakeholders. These stakeholders should be fully engaged in collaborative efforts because they exert substantial power on agriculture and its management of natural capital.

2) Consumers were not included in the focus group but can be considered to have high levels of power and medium-to-strong levels of interest in agriculture. They exert this influence directly through food choices, their purchasing power, and the effect of social licence on food production. Consumers achieve this through direct engagement with farmers, retailers, and hospitality. Future research and focus groups will benefit from the inclusion of consumers in the data-collection phase.

Influence

This group of influencers can affect the way people think or act in the context of natural capital. They do not use force but influence outcomes to through conformity to the demands of social and environmental pressures.

1. Accountants, hospitality workers (chefs), and advisory groups have an important role in ensuring that systems are fit for purpose. They therefore have high levels of interest in natural capital outcomes. Accountants play an advisory role on the financial implications of projects and the aggregation of natural capital accounting data,

affecting the financial decisions of farmers. As noted previously, hospitality (especially chefs) has become a high-profile influencer of the fresh food market. Members of the industry co-operate with retailers, through media channels such as TV, social media, and print, to promote food, its provenance, and its contribution to health and well-being. Importantly, the latter includes the health benefits of fresh food and food grown with limited chemicals or external input.

2. Government, as a decision maker, has a medium-level interest in but great influence on agriculture. It can provide stimulus strategies through policy development and funding channels, which encourage behavioural changes. It can also exert influence as a stakeholder, impeding natural capital projects with red tape, a lack of consistent policies, or mixed messaging. No government representatives participated in the focus groups due to difficulties in identifying participants and aligning focus group timings with participants, but once again, they will be a valuable inclusion in future research. The inclusion of the QLRF case study provided a proxy for government participation in the focus groups, and an example of government's role as a positive influencer.

4.3 Multiple Case Studies

The first set of data was drawn from multiple case studies. As Yin (2012) noted "*case research is not limited to a single source of data*" and "*good case studies benefit from having multiple sources of evidence*". Stake (2006) also noted that the benefits of multiple case studies will be limited if fewer than four cases are included, because 2–3 cases will not show enough interactivity between their situations, whereas more than 10 cases will provide too much data and will dilute the data. In this research, I selected five cases studies based on the key criterion that they were or were in the process of implementing natural capital accounting in an agricultural setting. This was consistent with Yin (1989), who argued that data from multiple case studies are more compelling and more robust, given their depth, when both primary and secondary data sources are used. How many cases are included also relates to the time and resources available to the researcher, and whether the number of cases chosen will dilute the overall analysis (Creswell & Poth, 2018). In the context of this research, the number of case

studies was also constrained by the limited number of agricultural enterprises undertaking natural capital accounting at the time the study commenced.

As noted above, the case studies were selected because they implemented natural capital accounting as part of their agricultural decision-making processes. The primary data were collected with semi-structured interviews with case study members and the secondary data were gathered from documents, podcasts, peer-reviewed literature, and newspapers associated with the case studies.

I used this approach because it suited my pragmatic world view on solving complex problems and on identifying the best solution to each problem. It allowed me to better understand why an agricultural enterprise chooses natural capital accounting as part of its decision-making process. In a case study approach, one or more real-life cases is investigated to capture the complexity and details of a problem. As Yin and Schramm note that "*case study research tries to illuminate a decision or set of decisions: why they were taken, how they were implemented with what result*", Guetterman and Fetters (2018); (Yin, 1989) which summarizes my approach to the research questions.

4.3.1 Case Study Parameters

The key parameters that link the case studies are:

1) These cases were unique, in that they actively adopted natural capital accounting in an agricultural context. Therefore, I used as the global unit of analysis "natural capital accounting in an agricultural context", in what Guetterman and Fetters (2018) describe as a holistic design approach. The research examined multiple perspectives and identified a range of factors around how and why natural capital accounting is implemented (Creswell & Creswell, 2018; Creswell & Poth, 2018).

2) The five agricultural organisations examined were at different stages of implementation and addressed the general characteristics of the research questions. They can be considered examples of paradigmatic cases, as defined Flyvbjerg (2016).

3) The cases also differed in that they approached natural capital from different perspectives and applied different frameworks, but with the same goal of improving the management of natural capital in an agricultural context. Stake (2006, p. 23) reported that this variability within a set of case studies allows us to examine "*how the program of phenomenon perform in different environments*" and Flyvbjerg (2016) called these "*maximum variation cases*". I also examined the significance of the circumstances of each case, such as its size, form of organization, location, how long they had been undertaking natural capital accounting, the framework used and how these influenced the process or outcomes of natural capital accounting (Flyvbjerg, 2016).

Creswell and Poth (2018) note that the defining feature of case studies is that they examine current, real-life situations that involve an individual, community, decision process, or event. Identifying the "case" begins with identifying the concepts or ideas that bind the cases together (Stake, 2006, p. 23). The selection of cases is oriented to maximize the value of the information captured (Flyvbjerg, 2016).

The identification of cases was initially undertaken with an Internet search of natural capital projects and promotional material around natural capital. Word of mouth and discussions with agricultural networks, including developers of natural capital frameworks, were also used to identify cases. This approach ensured that each case was supported by a variety of qualitative data, including documents, audios, and interviews.

4.3.2 Case Study Background

An overview of the case studies identified for analysis and a comparison of their key characteristics are listed in Table 5.

Table 5 Case Study Characteristics

Name	Location	Enterprise	Type	*Time Frame	Accounting Framework
Kilter Rural	Victoria	Farming/Horticulture	Investment/Funds Management	5 years	Accounting for Nature
Paraway Pastoral	Multiple States	Grazing	Investment/Funds Management	Implementation	To be determined
NAPCO	Queensland	Grazing	Investment/Funds Management	Implementation	To be determined
Queensland Land Restoration Fund	Queensland	Various, including grazing management, regeneration, savannah fire management, environmental plantings, reforestation, avoidance of clearing	Govt Policy Implementation	Round 1 Investment completed in 2020. Portfolio of 16 projects selected and implementation has begun. Round 2 investment and project selection underway.	Accounting for Nature
Land to Market	Various	Grazing	Co-operative/Family Farm	4 years	Ecological Outcome Verification

* 'Time frame' refers to the length of time each case has been undertaking natural capital accounting (using frameworks), and thus measuring and collecting data.

As noted previously, each case was characterised by its commitment to the application of a formal measurement and monitoring system to their natural capital. In each case, the

approach to natural capital measurement and monitoring was adapted to the specific location and stakeholders (i.e., investors, government, or individuals).

A short summary of each case is provided below, and further details are provided in the Results chapter.

4.3.2.1 Kilter Rural, Winlaton

An investment management group specialising in the management of rural assets on behalf of external investors. Kilter specialises in investment funds that have an environmental focus, including the Murray–Darling Basin Balanced Water Fund, the purpose of which is to secure water for agriculture, deliver financial returns to investors, and restore threatened wetlands. The Australian Farmlands Fund focuses on restoring degraded agricultural landscapes, including reafforestation and biodiversity protection (Kilter Rural, 2022). Kilter is one of the first groups in Australia to undertake a formal ecological assessment of an agricultural asset using the Accounting for Nature framework.

The accounting framework was applied to 8,900 hectares of agricultural land (irrigated cropping) at Winlaton in western Victoria, and the first set of accounts was released in 2018. The land is an aggregation of 35 properties, and is an investment managed on behalf of AWARE Super (formerly VICSuper), established in 2007–2012 (Heislers et al., 2019). This makes it an important case study in examining why natural capital accounting has been undertaken and identifying the benefits and problems of this approach.

4.3.2.2 Paraway Pastoral

Paraway operates over approximately 4.4 million hectares on 27 pastoral enterprises across Queensland, NSW, and Victoria. Paraway is an operating entity wholly owned by the Macquarie Pastoral Fund. The Fund is managed by Macquarie Agricultural Funds Management Limited, which forms part of the Infrastructure and Real Estate Asset Division of Macquarie Group Limited (*Paraway Pastoral - About us*, 2022). Paraway was initially established in 2007 as an investment with a fixed investment term and was converted to an

evergreen fund in 2018. The benefit of the evergreen structure is that it allows the manager to call upon capital as needed and in a measured way, to provide working capital or expand the investment portfolio. The structure suits the longer-term nature of the undertaking, and facilitates the delivery of sustainable natural capital outcomes. Paraway began to implement a natural capital accounting approach in 2019, a process that included reviewing potential frameworks.

4.3.2.3 North Australian Pastoral Company (NAPCO)

NAPCO is one of Australia's largest pastoral companies, including just over 6 million hectares, and is one of the oldest pastoral companies in Australia, established in 1877. NAPCO is 79% owned by the Queensland Government, through the Queensland Investment Corporation (QIC). In 2019, NAPCO's Five Founders Beef became the first beef product in Australia to be certified carbon neutral by the Australian Federal Government. NPACO has also partnered with the Australian Wildlife Conservancy to deliver measurable biodiversity outcomes across the NAPCO portfolio. NAPCO embarked on a programme to implement a natural capital accounting strategy in 2020 (*North Australian Pastoral Company. - Our Story*, 2022) At the time of compiling this PHD NAPCO had not chosen a framework although it was anticipated they would implement Accounting for Nature. .

4.3.2.4 The Queensland Land Restoration Fund (QLRF)

The QLRF s a $500 million initiative of the Queensland Government. The initiative seeks to expand carbon farming by supporting farmers to generate additional income streams from the co-benefits generated from carbon farming projects. These co-benefits include environmental, social, and economic benefits, healthy waterways, and maintaining the quality of the Great Barrier Reef, as well as carbon sequestration. The project is unique in that it also aims to generate other co-benefits, such as benefits to First Nation's people and the use of additional measurement tools to track how these benefits manifest.

By providing transparent, robust data from the initiative, the Queensland Government has established guidelines for measuring the outcomes of land restoration projects in Queensland

that generate co-benefits through carbon-farming projects. The environmental or natural capital co-benefits generated can be verified with the Accounting for Nature framework (Department of Environment and Science, 2020).

The QLRF initiative is a stimulatory package with which the Queensland Government facilitates project development by investing in them. Financial incentives are accessible to cover pre-application and set-up costs, making the programme readily accessible, particularly to family farmers. Projects will deliver Australian carbon credit units (ACCUs), together with environmental, social, and economic benefits.

In April 2020, the first round of projects under the initiative was granted funding. A second round of applications to participate in the fund closed in February 2022. This Government initiative should provide insight into the additional opportunities that can be generated with carbon-focused projects, and particularly into the role private markets can play in investment in projects.

4.3.2.5 Land to Market (L2M)

Land to Market Co-Operative—is a farmer-led initiative founded under the principle of holistic grazing and initiated by the Savory Group. The principles of holistic land management have been expanded to include a long-term system of monitoring and measurement called "Ecological Outcome Verification" (EOV™). Land to Market Australia is part of a global network "*committed to farming practices that measurably regenerate the land*" (Land to Market, 2022a). EOV is a science-based landscape assessment method that tracks the outcomes of several natural capital components. Originally developed by OVIS 21, a collective of sheep farmers in Patagonia, in conjunction with Michigan State University in the USA, the EOV programme has been running for 4 years in Australia, with the participation of approximately 50 farmers. (Savory Institute, 2019). Each farmer operates his/her own independent business and draws from the benefits the co-operative provides, such as marketing and education. Each participant commits to using both short-term (annual) and long-term (5 year) independent measurement and assessment strategies to monitor the ecological health of their landscape. A report is provided to each participant after the annual

assessment. The co-operative engages with business to promote the benefits of the approach and link these benefits to supply agreements. The participants interviewed were predominantly from family grazing operations with farms of 500–1,000 hectares.

4.3.3 Case Study Attributes

Each case study described above has distinct attributes that allow them to be segmented into categories (Table 6):

Table 6 Case Study Attributes

Case study	**Kilter Rural**	**Paraway**	**NAPCO**	**QLRF**	**L2M**
Attribute					
Family Farmers					✓
Investment Managers	✓	✓	✓		
Government/Policy Programme				✓	
Stage of Implementation[4]					
Commencing		✓	✓		
1 Year				✓	
>2 Years	✓				✓

Each category provides a different perspective on the importance of natural capital and the need to measure and monitor it in the agricultural context.

[4] Refers to how long a case study has been undertaking natural capital accounting

4.4 Focus Groups

Agriculture does not operate in isolation and is influenced by many stakeholder groups. As described in Chapter 3 (Figure 10), these include stakeholders that influence agriculture through demographic and social drivers, including governments, consumers, and institutions; and stakeholders that have direct economic influence through supply chains, finance, investment, and retailing. These stakeholders, together with natural drivers such as climate and weather, are among the very many factors that influence agriculture in its production of food, fibre, and shelter.

Focus groups were used in this research to examine the relationships between stakeholders and agricultural enterprises through a transdisciplinary lens. The purpose of this approach was to better understand the different motivations of the various stakeholders in agriculture and to generate new ideas, through interactions and knowledge exchange (Liamputtong, 2016). A qualitative approach utilizing a focus group is well suited to studying decision-making processes and exploring the views of stakeholders (Barbour, 2007). It is particularly relevant to understanding the competing priorities of stakeholders and how this can influence decisions around natural capital and the impact these decisions may have on farmers. It is used here to answer RQ2.

Two focus groups, comprising seven participants each, were established from representatives of industries and organisations with close links to agriculture, and who were therefore key stakeholders. Therefore, understanding how stakeholders can "*work together to create sustainable relationships in pursuit of value creation*" Freeman et al. (2007, p. 311) should allow RQ2 to be addressed.

Focus Group participants were identified initially through analysis, in section 4.2.1, of influential agricultural stakeholders in the supply chain. A cross section of industry groups were identified and key people within the industry were initially contacted through phone calls and emails. Recruiting one participant from each identified industry group enabled a broad range of views across stakeholders to be captured and avoided dominance of one industry group. The recruitment process was undertaken by emailing potential participants

an outline of my PHD and invited to participate in the focus groups. The email was followed up with a phone call to confirm their participation and undertake more detailed discussion. Once confirmed participants were emailed the information sheets and consent forms.

4.4.1 Pre-Focus-Group Survey

A short pre-focus-group survey (see Appendix 4B) was undertaken to stimulate discussion during the focus groups and optimize the use of the limited time available to conduct the focus groups. The pre-focus-group survey included 20 short-answer questions and was completed by all the focus group participants (14 in total). The responses were used as a scaffold upon which to build discussions during the focus groups themselves around value propositions, barriers to identifying solutions to integrating natural capital into agricultural decision-making, and positive moves towards this end. The survey was broken down into six sections (Table 7).

Table 7 Pre-Focus Group Survey – Survey Structure

Questions	Purpose
1–5	Designed to understand focus-group participant's knowledge of natural capital.
6–8	The participant was asked to consider whether natural capital was important to their industry
9-11	Designed to understand participants knowledge of natural capital accounting
12-15	Designed to understand how their industry had been influencing better natural capital outcomes.
16–18	Asked the participant's what they expect a natural capital benefit to be and when would they expect to see it
19-20	Asked the participant to consider the barriers and solutions to encourage greater focus or adoption of a natural capital accounting framework

4.4.2 Focus Group Background

Several stakeholders whose actions or interactions affect agriculture were selected as the focus group participants.

1. Banks—provide pools of finance to agriculture. This stakeholder group must understand the risks associated with providing capital to agriculture, consider the impact of environmental risks on the recipient's ability to meet loan repayments, and the social licence and its impact on farming operations and shareholder risk (Ascui & Cojoianu, 2019b).
2. Fresh Food Retailers—rely on a supply of fresh produce to meet consumers' demands. They influence farmers through supply contracts, which affect the type of supply, when it is delivered, the quality of the produce, etc.
3. Real Estate Valuers—provide land valuations to the industry and other stakeholders, including banks and insurers. Valuers are required to consider the productive value of the landscape based on its productive output and the risks to ongoing production, which could affect the underlying capital value of the land. The formation of the Carbon Farming Initiative (CFI) in recent years has seen the inclusion of the impact of carbon contracts on land values. Valuers may also be asked to assess the impact of biodiversity contracts, covenants, etc., on land values.
4. Accountants—provide taxation and financial advice to agricultural enterprises, and like valuers, may be asked for advice around carbon projects, biodiversity programmes, etc. They may also be required to advise on the future implications of natural capital accounting practices.
5. Advisory and not for profit policy groups groups—representing farmers or industries, advise and represent broad agricultural industries on the effects of changes in practices, social licence, well-being, etc. These groups provide advice and research that can influence farmers when making practice changes, through advice on policy developments across the industry, to deliver better the outcomes for farmers.
6. Investors—third party investors, such as superannuation funds and high-net-worth investors, provide investment capital to the industry through land purchases or through co-investment into agricultural enterprises. Like banks, they must understand the risks in deploying funds and the potential return opportunities. Many investors currently also have specific investment requirements around climate change, the environment, social impacts, and governance, which must be underpinned with robust evidence.

7. Hospitality—is a significant industry, providing services ranging from fast food to formal dining. In August, 2022, the Australian Bureau of Statistics noted that cafes, restaurants, and takeaway food services formed the largest sector of the accommodation and food services industry, employing 691,000 workers or 5% of Australia's total work force (Australian Bureau of Statistics (ABS), 2022; Australian Government). Several key trends have developed in this industry, including the promotion of fresh locally sourced, seasonal food (to reduce the carbon footprint), the improvement of the quality and health of the food society eats, and the reduction of food waste. Moreover, chefs have become more than just kitchen workers, but are now significant influencers across the food industry. Fuelled by TV (MasterChef, River Cottage, My Kitchen Rules, etc.), advertising, and the print media, they have a significant presence in the everyday life of society. This industry sector influences what we eat, how we eat, and how we source our food[5].

Focus groups have been used to identify the motivation, needs, and concerns that can potentially influence decision-making around the recognition and adoption of natural capital accounting (Hovland, 2005). As mentioned in Chapter 3, addressing these issues requires that a wide range of information be brought together to influence decision-making. This information can be used to drive behavioural changes, to influence outcomes through knowledge creation and collaboration, and to address RQ3. As Freytag and Young (2017) note, the research process is collaborative because it involves networks of participants, providing insights and information, in contrast to a "lone-wolf" approach.

4.5 Survey Data

The final data collected were quantitative, and were gathered with a survey across a broader, more-diverse range of farmers around Australia. This survey was distinct from the pre-focus group survey. Although they were drawn from a small sample of farming groups, the case

[5] In the second focus group, no hospitality participant was represented as no one was available to participate at the scheduled time. No replacement was found, so a second not for profit lobby group member acted as replacement.

study interviews provided rich, in-depth perspectives on the adoption of natural capital accounting (Creswell & Creswell, 2018). However, the purpose of the quantitative survey, consisting of 26 questions, was to gather data from a more generalised population of farmers about their understanding of natural capital and natural capital accounting, and their importance in their day-to-day operations. The survey did not aim to replicate the case studies or the pre-focus group survey, but to probe different perspectives from those of the interviews with the case-study participants.

In designing the survey, I aimed to use the responses from the semi-structured interviews to develop a survey to assist in validating or questioning the semi-structured interviews. By combining the quantitative data with the open-ended qualitative data, I aimed to generate new theoretical insights and produce a more-complete picture of the research questions, as described in (Lund, 2012). The outcome desired was to build an understanding of natural capital that could be used to identify pathways to better on-farm outcomes for both natural capital and farmers, and to address my main research question (RQ1). As noted by Creswell and Creswell (2018), a survey should be designed with consideration of the constructs and concepts derived from qualitative data.

There were no critical selection criteria for those participating in the survey, other than that he/she was a farmer. The survey focused on:

1) the participants' understanding of the importance of natural capital to agriculture;

2) where the survey participants were placed in relation to sustainable land management practices;

3) what the survey participants considered to be obstacles to and the value propositions of measuring and monitoring natural capital.

4.5.1 Survey—Composition

The survey was developed as an online tool using Qualtrics (see Appendix C1) to ensure rigour and validity. It was compiled based on the expertise of individuals involved in natural capital accounting, including my supervisors Adjunct Professor Scott Kelly, Professor Damien Guirco and Dr Cathy Waters. The survey contained 26 questions, predominantly requiring participants to check a single box or multiple boxes. The structure of the survey is shown in Table 8.

Table 8 Survey Structure

Questions	Purpose
Questions 1–6	Sought some introductory information about who was completing the survey, including age, location, area, type of agricultural enterprise, and who influenced them most in their decision-making.
Questions 7–9	Asked the participant how he/she ranked environmental and climate issues.
Question 10–15	Focused on the participant's understanding of definitions and terms relating to natural capital and natural capital accounting.
Questions 16–19	Examined the priority natural capital should be given, where the respondent was positioned on the sustainability journey, and the type of programme in which they were involved.
Questions 20–24	Focused on the value the participant saw in natural capital and in undertaking natural capital accounting; the barriers to undertaking natural capital accounting; and his/her understanding of the best approach to addressing issues of natural capital.
Questions 25–26	Investigated the commitment that farmers were prepared to make in undertaking environmental programmes.

Five questions also provided an option for participants to add a short more-detailed response. Qualtrics offers options that allow a survey to be completed at a desktop or via a hand-held device, to encourage participation and provide flexibility for the participants.

The purpose of the survey was to identify the characteristics, motivating factors, and beliefs of farmers and their knowledge of natural capital. The objective of comparing these data with the themes identified in the case study analyses was to identify convergent or divergent

themes in the data. As discussed by Creswell and Creswell (2018), a number of approaches can be used to analyse the results. The first, which was used in this research, is a side-by-side analysis, which considers the qualitative results through a discussion of the statistical results, compares these with the qualitative themes, and discusses the outcomes. The second is to merge the databases, transforming the qualitative codes into quantitative variables (transformation) to combine the two data bases. The final approach to interpreting the data is to merge the two data forms into a table or chart to display them in a single visual form. This is important because using a convergent approach risks the validity of the interpretation when unequal sample sizes and different concepts and variables are compared (Creswell & Creswell, 2018).

4.5.2 Survey Group Distribution

To identify farmers willing to participate in the survey, nine organisations with agricultural links (Food Agility CRC, Department of Primary industries NSW, Southern Cross University, Murdoch University, Marcus Oldham, Local Land Services NSW, Farm Link NSW, Boyce Chartered Accountants, and AgForce Qld) were asked to assist in distribution of the survey. These organisations agreed to distribute the link to the survey to their members. This recruitment process provided an opportunity to access a wide and diverse range of potential participants as possible, to mitigate bias arising from concentration of participants in location or industry type. Those assisting in distribution of the survey were dominated by an east coast presence and limited exposure to West coast and central Australian farmers. Participation was voluntary. It was difficult to fully ascertain how many people were sent the survey through these groups. The link was also sent to a network of farmers known to the author, which included 32 individual family farms. Only one organisation declined to assist, because their members had been surveyed recently. The participants were offered no incentive to complete the survey.

4.6 Ethical Considerations

As noted by Punch in Creswell and Creswell (2018, p. 88), research involves "*collecting data from people, about people*", which requires researchers to consider any ethical issues that may arise in the research.

This research was guided by the National Statement on Ethical Conduct on Human Research (*The National Statement on Ethical Conduct in Human Research 2007, Updated 2018*). Here, initial ethics approval was obtained from the Human Research Ethics Committee of the University of Technology, Sydney (UTS) in August 2020 under approval number ETH20-4900. After the initial approval, an additional case study was identified. The inclusion of the Land to Market case study required the amendment of the original ethics approval, which was granted in March 2021 under approval number ETH21-5878. A final amendment to undertake the survey and include NAPCO as a case study was approved in September 2021, under approval number ETH21-6562. The risk profile of the research was assessed as low overall (including the amendments).

All the participants interviewed as part of the case studies were provided, before the interview, with information sheets that outlined the rationale and objectives of the project. Informed consent forms were also provided to all participants. All the case study interviewees were informed that to protect their privacy, they would not be identified personally but only by reference to the specific case study. To protect the privacy of the case study interviewees in this research they were informed they would not be identified personally and only by reference to the specific case study. Finally at the commencement of the interview process all participants were asked to reconfirm they were happy to participate in the research and for the sessions to be recorded, with all agree they were.

Focus groups were provided with information sheets and consent forms along with a clear outline and time line and session details of how the focus groups were to run (see Appendix B: Focus Groups). This also specified designated breaks between sessions to ensure particpants did not feel fatigued. Focus groups were reminded prior to the commencement of the group of the ethics approvals and they could ask for the group be paused or stopped

at any time. If they felt uncomfortable they could stop their particpation. In addition particpants were reminded that the session was being recorded for data collection purposes and were asked if they were comfortable with this, which all agreed. Finally as the session was interactive all particpants were were reminded to be respectful of other particpants views and opinions.

The survey participants were informed in the introductory question that the survey was anonymous. They were also provided with an opportunity to opt out of completing the survey by answering NO to the initial question (see Appendix C1).

Mitigation strategies for data collection were put in place and were adapted where necessary to accommodate the impact of COVID-19. In particular, all interviews with case study members and all focus group sessions were undertaken on-line via ZOOM, in response to the COVID-19 pandemic. This required participants to agree to be recorded (video and audio), which allowed the accurate recording of case studies and focus. The recorded ZOOM sessions also minimized any disruption to participants' work and personal schedules (particularly given the additional demands experienced during lockdowns, such as home schooling and on-line meetings).

4.7 Conclusion

In this chapter, I have set out the reasoning behind the choice of methods used in this research. The chapter describes the approach taken to qualitative research and its relationship to the philosophical perspective identified in Chapter 3. The chapter provides the background to the choice and use of multiple case studies as the primary qualitative tool with which to understand the implementation of natural capital accounting in the agricultural context. I have also discussed the role that focus groups played in understanding the potential influence of stakeholders on farm outcomes and natural capital. Finally, I have discussed the data collection methods in the context of the credibility and reliability of the data collected, and within the context of the research questions. Chapter 5 addresses the approach taken in analysing the data, including the rigour of the analysis and the interpretation process.

Chapter 5: Tools and Methods Used in Data Collection and Coding Processes

5.1 Chapter Overview

This research was dominated by qualitative data, complemented with quantitative data. In this chapter, I describe the structured approach I used for data collection and the processes used to analyse them, to clarify the relationship between the data and the main research question. *How can understanding the views of the various stakeholders remove barriers to the adoption and relevance of natural capital accounting in agriculture?*

In particular, the chapter illustrates the inductive approach used to code the data collected from interviews and surveys, a process described by Saldaña (2021) as attributing meaning to individual data for the purpose of pattern detection. It details the storage, management, and sorting of the qualitative data with NVivo (a computer-assisted qualitative data analysis software [QDAS]-based system) and Excel spread sheets, and the manual coding of printed transcripts.

5.1.1 Challenges in Conducting the Research

As discussed in Chapter 4, the travel and lock-down restrictions imposed during the COVID-19 pandemic made in-person interviews impossible. ZOOM, video communications software, was considered a suitable alternative way to conduct interviews with case study members and to undertake focus groups, especially because the recording function of the technology allowed the data to be collected effectively and accurately.

The survey was distributed to a broad range of farmers with the assistance of several institutions (see 4.6.2). Despite this assistance ensuring that an adequate number of survey responses were received, to ensure validity of the data, was challenging because the farmers had already encountered several surveys in the period leading up to this study. It was necessary to ensure that the data was reliable.

5.2 Organizing and Managing the Data

Making sense of the data, as described in Creswell and Poth (2018) requires that the data be organized. As Jackson and Bazeley (2019) noted, data can only be analysed after they are rendered manageable and presented in a useful form. The process used to code the data and that used for the thematic analysis are described in section 5.2.1. In using this approach, I was mindful that in doing so, I had to ensure a meaningful link between the research questions and the research design (Jackson & Bazeley, 2019). It was also important to anonymise the 12 interviewees and focus group members. The case study members were therefore designated I1 to I12 and the focus group members were identified by the industry or sector they represented.

The qualitative data were primarily analysed using content analysis, which focused on the identification of thematic patterns in the responses of the interviewees and focus group members. This approach condenses the data and shortens the text while preserving the meaning (Erlingsson & Brysiewicz, 2017). The text was systematically condensed (shortened) to a code or label of one or two words, which described the meaning of the bulkier text. Codes were then allocated to themes, which expressed the underlying (latent) meaning. Where possible, each theme was linked to the main research questions. Figure 17 shows an example of the analytical process used in this research and the development of the codes and themes.

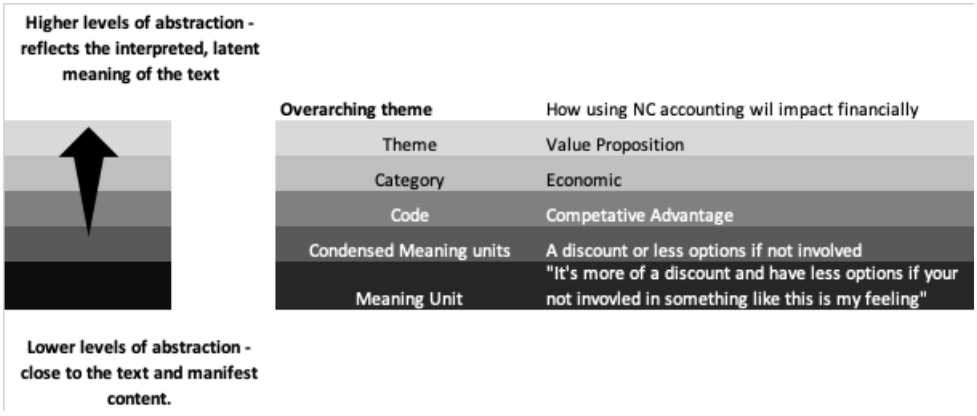


Figure 17 Illustration of the formation of concepts through the coding process. Adapted from (Erlingsson & Brysiewicz, 2017)

I also used a framework analysis (Gale et al., 2013; Goldsmith, 2021) to identify commonalities and differences within the qualitative data. As Gale et al. (2013) noted, this approach allowed

me to draw explanatory conclusion around the themes. A major challenge in this exercise was the underlying bias any researcher has (Erlingsson & Brysiewicz, 2017). With an investment management background, I therefore consciously tried to reduce any focus on the economic benefits of natural capital accounting, and to look more broadly at all its potential benefits.

5.2.1 Manual versus QDAS Tools

I initially used NVivo, a QDAS package (QSR International, 2021), to organize and manage the data from the interviews with case study members before they were coded. NVivo provides flexibility in the management, storage and analysis of large amounts of qualitative data, including the manipulation and querying of data from different sources (e.g., case studies, case study interviews, and focus groups). NVIVO was beneficial as the data was imported into the software and was searchable and re-useable making the data analysis process more efficient. The data analysis process of coding, sorting, or labelling to identify themes and hierarchies was a manual process which at times made it difficult to clearly identify important pieces of data requiring additional coding and refinement. Once this is complete NVIVO could be used to map the data or create visual representation of the data.

Moreover, although the survey data were predominantly quantitative, some of the questions required short qualitative answers, which could also be analysed with NVivo or manually, using coloured markers and Excel spread sheets. I coded the transcripts of the focus group sessions manually, using coloured markers and Excel, as described below.

To ensure confidence in the NVivo output, I sense-checked the case study data with an independent, manual review, using coloured markers. This was done by printing each interview transcript and using coloured pens to highlight the interview-based themes and key words. This revealed differences between the NVivo and manual coding results. In particular, the manual coding was more refined, with fewer codes and limited viral coding[6] (see below). In contrast, the NVivo coding tended to be lumpy and less refined, with more codes. As a

[6] Viral coding is creation of duplicate sets of nodes under multiple branches of the coding structure Jackson, K., & Bazeley, P. (2019). *Qualitative Data Analysis with NVivo* (3rd edition. ed.). Sage Publications, London.

researcher, I felt that manual coding provided an opportunity to get closer to the data, making it easier to understand the relationships between the interviews. Maher et al. (2018) suggested that because the physical act of writing, using coloured pens etc., slows the process, it encouraged a more meaningful process. To exemplify this, the following figures (Figure 18 and Figure 19) compare coding with NVivo and with a manual approach with coloured highlighters and pens.

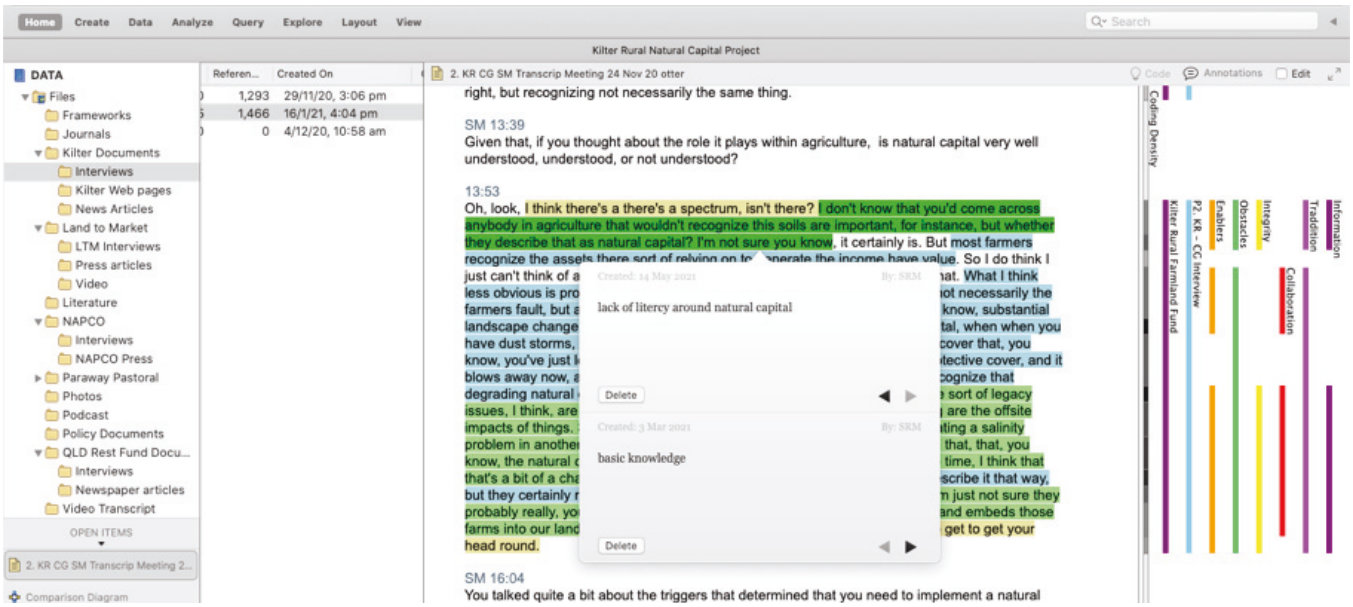


Figure 18 An Example of NVIVO Coding

The NVivo coding shown in Figure 18 evolved as follows.

First, in this example, large passages of text were coded against nodes[7], which at times made it difficult to separate the data into themes.

The themes identified in this passage were:

- “Tradition" was coded as an obstacle because the traditional farming practices and knowledge of farmers obstructed their understanding of land degradation and the

[7] A node is a collection of references about a specific theme, case or relationship QSR International (2022)

value of natural capital. In this case, the coding also showed that “tradition” and “information” or knowledge were intertwined.

“Information” or lack of information was identified as an obstacle and coded under “tradition”. The reasoning behind this was that it was a factor in the farmers’ poor literacy about natural capital. In contrast, the manual coding process was a more personal experience, which allowed a more-refined coding outcome, Figure 19 Example of manually coded interview using coloured markers

- exemplifies this coding process, which reduced viral coding or over coding. The use of coloured markers and being closer to the data allowed me to identify smaller passages of text and words for coding. The themes identified in this case were:
- “Obstacles”—identified a lack of understanding through lack of recognition and impact of the degradation of natural capital. Coded under “Lack of recognition”
- “Value propositions” – Identified importance of soils to production and income generation as a value proposition. Coded under “financial” category, given the importance of natural capital.

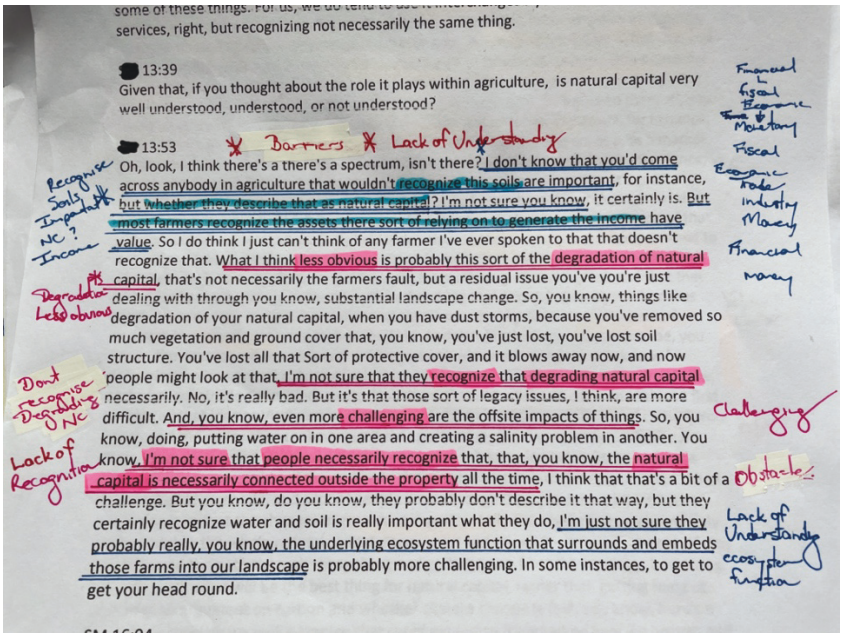


Figure 19 Example of manually coded interview using coloured markers

5.3 Coding Interviews with Case Study Members

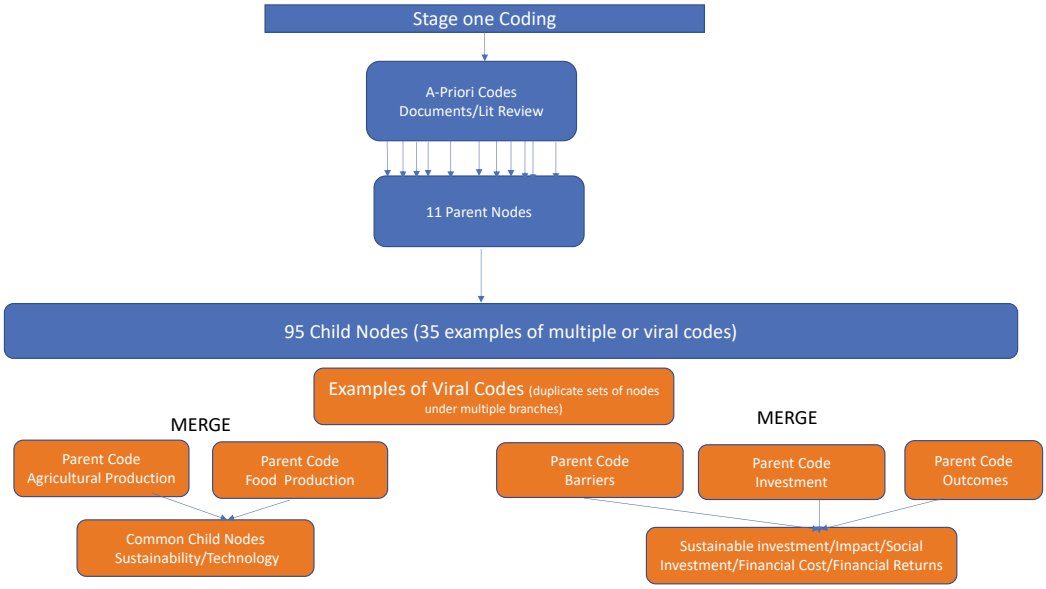
The primary qualitative interview data, comprising 12 one-hour interviews with case study members, were collected between August 2020 and November 2021. Engaging with and interviewing the key persons involved in the cases studied were central to the research and allowed the key themes within and across cases to be clarified. As noted in Chapter 4, this is consistent with the statement of Yin (2012) that the value of the insights gained is greater when the participants are key players in a project. To conduct the interviews, I utilised various technologies, including ZOOM and Otter.ai.

The semi-structured interview questions are given in Appendix A2. In summary, the structures of the interviews and the questions can be broken into three key parts:

1) the background of the interviewee and his/her understanding of natural capital;
2) the triggers and value propositions that determine why they had to or chose to implement natural capital accounting;
3) the barriers they encountered to the implementation of natural capital accounting.

5.3.1 Stage-One Coding: Interviews

Initially, a set of themes (initial parent nodes) was determined before the interviews with the case study members, the focus groups, or the surveys were undertaken. These were based on the theory-driven coding of publicly available documents, predominantly sourced from web sites and a review of the literature (see Tables 1 and 2 in Chapter 2). In total, 20 parent nodes were identified under the theme of “natural capital” and a further 14 related to the themes of “agriculture” and “natural capital”. These became the *a priori* codes. The initial coding of the interviews led to the creation of 95 child nodes, based on the themes identified in the coded interview transcripts (Figure 20). This initial early-stage coding generated in excessive codes, attributing multiple codes to words or passages, in a viral coding structure (Jackson and Bazeley (2019). Thirty-five examples of viral coding were identified at this stage. Viral coding occurs when nodes are repeated and therefore become difficult to navigate, making it hard to locate data and identify relationships.



** Orange boxes are examples of viral coding with common parent nodes and common child nodes. These Parent Nodes were merged into a new single parent nodes of agriculture and investment.

Figure 20 Outline of stage-one coding

5.3.2 Stage-Two Coding: Interviews

Critical analysis of this first-stage coding identified key codes to be carried forward as "core" categories, and with the merger and removal of viral codes, a hierarchy developed around the remaining codes.

To address the viral coding in stage one, as suggested in Jackson and Bazeley (2019), two temporary nodes were created:

1) old node—all original coding was placed under this node;
2) new node—under this node, data from the old node were merged and consolidated to create a code structure.

The result created two key themes or parent nodes:

1) barriers to adoption;
2) value propositions.

This process significantly reduced the number of nodes and removed the viral coding. Once complete, the files were backed up and the old nodes deleted (see Figure 21).

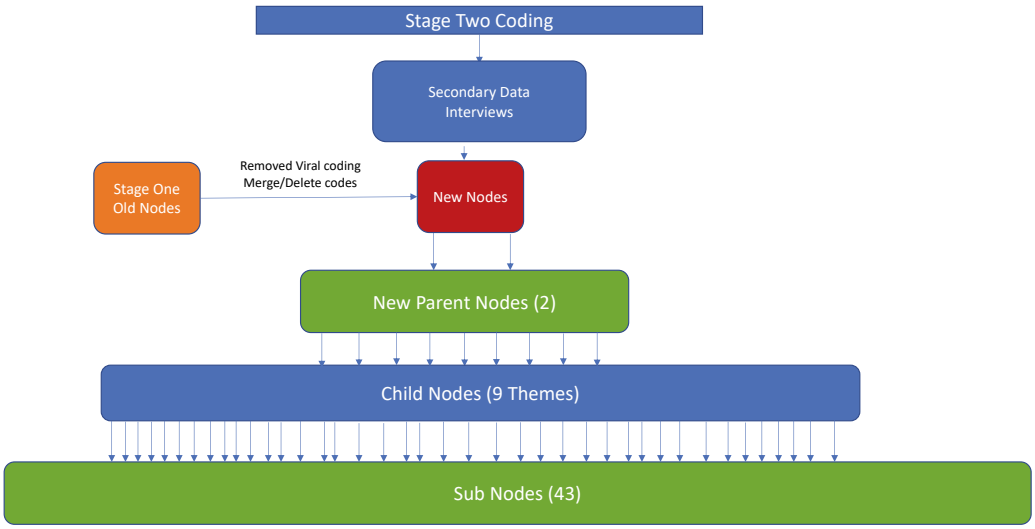


Figure 21 Outline of stage-two coding

At this stage, the interview transcripts were read, re-read, or listened to understand the statements of the participants and the coding undertaken with NVivo. This stage was critical to ensuring that the coding was relevant to my research questions and the relationships between the research questions and coding. Under the core parent nodes of "barriers" and "value "propositions", nine themes (or child nodes) were developed to expand the core themes:

Barriers	**Value Propositions**
Demand	Pre-requisites
Cost	Information (Collaboration)
Tradition	Integrity
Government	Opportunity
Complexity	Climate Change
	Risk Mitigation

The node hierarchies developed at this stage were similar to those identified by Jackson and Bazeley (2019, pp. 106-107). The value propositions, focusing on actions such as information, opportunities, events, or strategies, included the pre-requisites for and integrity of natural

capital accounting. Conversely, barrier cultures and beliefs played a role when traditional norms or behaviours around farming inhibited the integration of natural capital accounting into agriculture. This was also seen in politics, in which cultural values and ideological frameworks played a role in policy development and the consideration of natural capital. Other issues, such as the cost and complexity of implementation, also played a large role in the adoption of natural capital accounting frameworks. Another 43 sub-nodes were created that were associated with these child nodes.

5.3.3 Final-Stage Coding: Interviews

As discussed in section 5.2.1, using coloured markers in an analogue process, I reviewed the interviews and re-coded them. The codes generated with this approach were entered into an Excel spread sheet and compared with those created with NVivo at the end of stage-two coding. This further refined the themes and codes. Two key points of difference were detected between the stage two and stage three coding. The first was the description of categories under "value propositions" and "barriers", which were merged into new themes. The following table compares the codes developed for the value propositions in the manual process with those developed with NVivo and the resultant new themes and codes[8].

[8] Interviews were allocated a score of 1 if a sub-theme was mentioned during the interview. A maximum score for a sub-theme identified and associated with an interview with the attribute "type" see

Table 11 was; 5 = Investment Management, 2 = Policy, and 5 = family farmers. E.g.: The coded sub-theme "improved financial outcomes" was mentioned in 4 of the 5 interviews conducted with case studies identified as investment management, resulting in a relative importance score of 80%. Conversely, this was not mentioned in either of the two interviews undertaken with an interviewee from "policy", therefore scoring 0% relative importance. All five interviews in the case studies of family farms mentioned this code, scoring 100%. Total score for the code 75%. There were six sub-theme codes in the "economic opportunity" category and the aggregated score for these sub-themed codes was 64%.

Manual Coding	NVivo Coding	New Themes or Codes
Economics	Opportunity	Economics
Investment	Pre-requisites	Investment Pre-requisite
Social	Integrity	Public Good
Collaboration	Information	Collaboration
Environmental		Environmental
Productivity		Productivity
	Climate Change	Climate Change
	Risk Mitigation	

"Risk mitigation" was identified as a key category with NVivo. On review, this was merged into "productivity" because it can be viewed as a way to improve productivity outcomes. The core categories under "Barriers" in the stage-two coding were broadly consistent with those identified with manual coding. An additional theme centred around the implementation of systems and processes was added as the key category "Implementation". The interviewees cited the difficulties in implementing these systems, particularly when many systems were yet to be developed and traditional thinking or practices presented obstacles to change. At this stage, "tradition", a parent node in the NVIVO coding, was merged as a child node under "Implementation". The final coding structure is shown in Figure 22.

Manual Coding	NVivo Coding	New Codes
Complexity	Complexity	Complexity
Cost	Cost	Cost
Government	Government	Government
	Tradition	Implementation
Lack of Markets	Demand	Lack of Markets

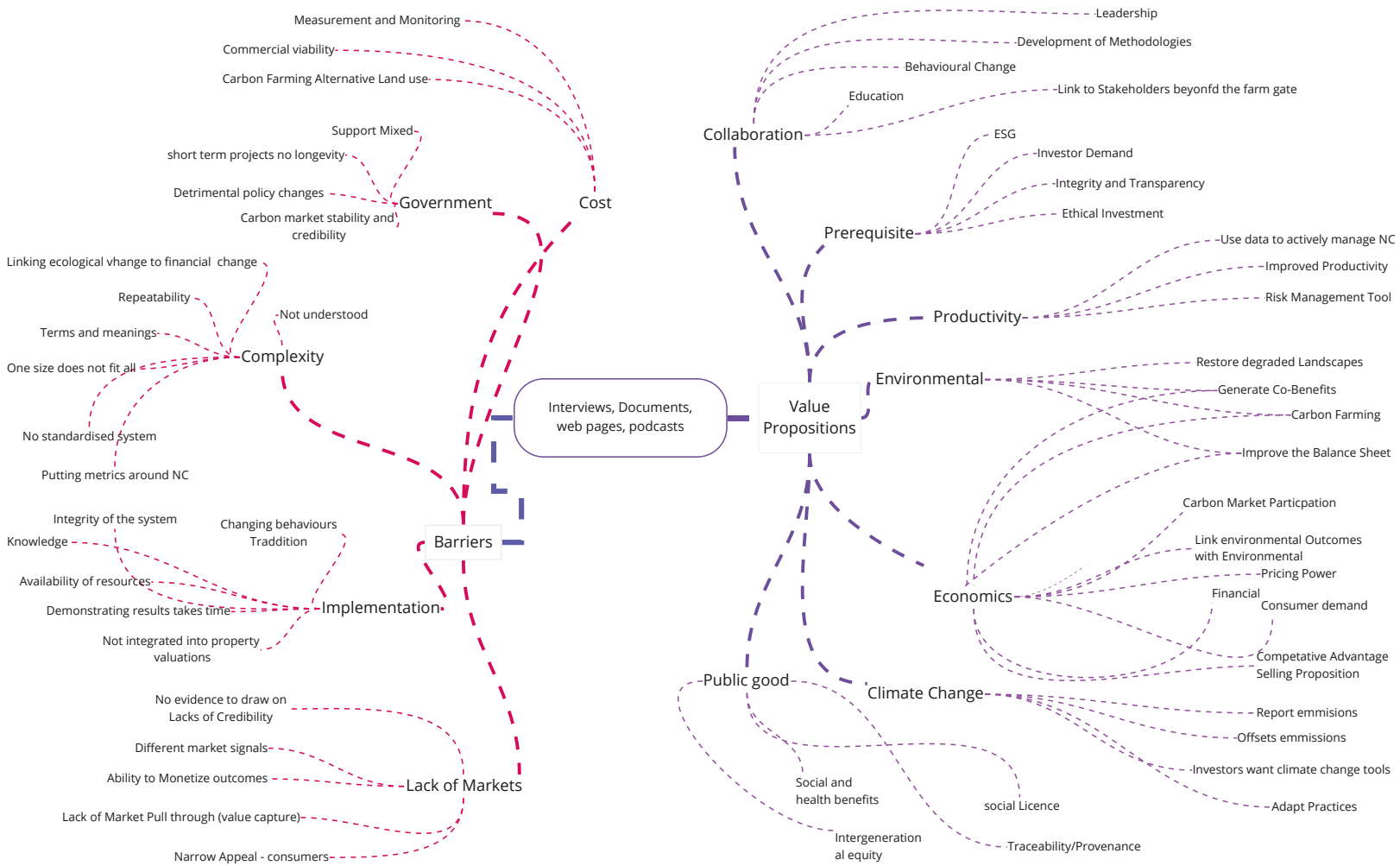


Figure 22 Final coding structure from interviews with case study members

5.5 Focus Groups

Qualitative data were the dominant form of data examined during this process, and were collected from two separate focus groups, each comprising seven participants. The sessions lasted 1.5 h and were broken into three 30 min sessions. The participants chose not to take a planned 10 min break between sessions, preferring to complete the whole session without a break. The ZOOM and Otter.ai technologies were used in this process. ZOOM was used to record and Otter.ai was used to transcribe the audio of the focus group sessions. Quantitative data were also gathered from the focus group members with a 20-question online Qualtrics survey (see Appendix B4). The purpose was to identify thematic patterns among the participants before the focus group sessions. The survey was distributed 2 weeks before the focus group sessions. The focus group participants were also provided with a snapshot of some of the responses from the case study interviews (see Appendix B3). These were used to stimulate the focus group discussions and to develop insights from the interview responses of the case study participants. The detailed structure of the focus groups is provided in Appendix B2. The aims of the focus group sessions were:

Stage 1—to develop an understanding of the group views around natural capital;
Stage 2—to discuss the value propositions and obstacles of a natural capital accounting approach and compare the views with those obtained from the case studies;
Stage 3—to collaborate on a strategy and recommend it to the board of a natural-capital-accounting-based project that would deliver the outcomes based on discussions in stage 1 and 2 above.

The first focus group was conducted in July 2021[9] and the second in November 2021

[9] Dr Simon Wright (UTS-ISF) assisted in moderating the first focus group to ensure continuity and that the participants were respectful to each other and no one participant dominated. No moderator was required for the second focus group as the process in the first group worked well and the linear approach of asking directly for a response ensured all voices were heard.

5.5.1 Focus Group Coding

In coding the focus group data, a manual process was used in preference to NVivo because understanding the relationships across the data was easier. The coding was broken into two stages: 1) the responses were broken down into "barriers", "value propositions", and "potential solutions"; and 2) the responses were coded against the "industry" category. This allowed the coding to be compared across the industry groups and the areas of common ground to be identified.

Table 9 provides an example of the results of the coding process applied to focus group data. A detailed table of the final coding, according to industry group, is given in Chapter 8.

Table 9 Examples of focus group coding

Bank	
Overarching theme	Shared knoweldge
Theme	Value Proposition
Category	Collaboaration
Code	Leadership
Condensed Meaning units	a strategic alliance
Meaning Unit	Our most successful NC example today has been a strategic alliance
Advisory	
Overarching theme	Lack of Markets for NC
Theme	Barrier
Category	Implementation
Code	Lack of communication
Condensed Meaning units	Not focused on NC
Meaning Unit	I think farmers aren't yet needing to focus on NC its still an option
Accountants	
Overarching theme	Lack of market pull through
Theme	Barrier
Category	Lack of Markets
Code	ability to monetize outcomes
Condensed Meaning units	Better bottom line
Meaning Unit	until my clients are seeing a better bottom line for going along these lines your probably not going to get a by in

The mind map resulting from the coding of focus groups data is given in

Figure 23.

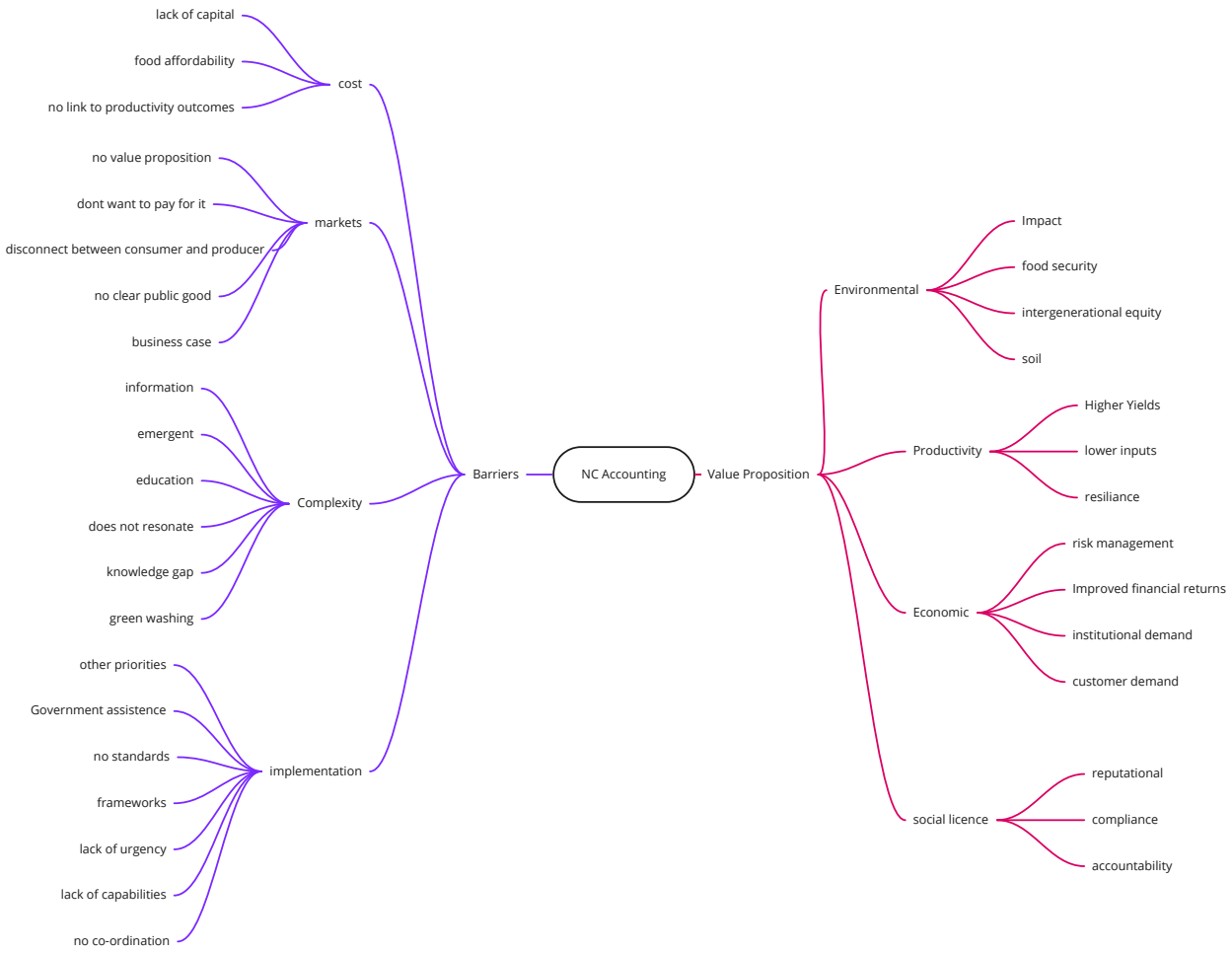


Figure 23: Mind map derived from focus group coding

5.5.2 Pre-Focus Group Survey

Qualtrics, an on online survey tool used to build and distribute surveys, was used as a separate parallel tool to gather quantitative data from the focus group participants, which were compared with the qualitative data gathered in the focus group sessions. Using the Qualtrics technology ensured that the survey was user-friendly and could be accessed on mobile

devices, such as phones and iPads. Figure 24 is a screen shot taken of the survey as it appeared on an iPhone.

Therefore, the data collected from the focus groups included both quantitative and qualitative data (short-answer responses).

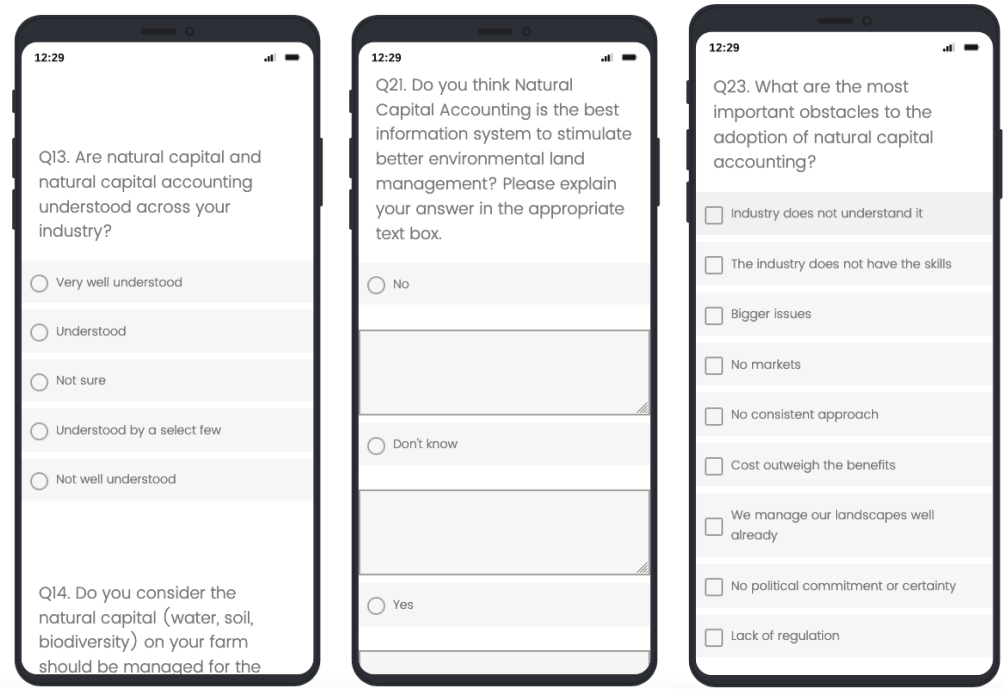


Figure 24 Screen shots of survey questions as seen on a smart phone

5.6 Wider Survey of a Diverse Range of Farmers

Data from the case study interviews and the focus groups were used to develop a stand-alone on-line Qualtrics survey for distribution to a diverse range of farmers, beyond those involved in the case studies. The survey was designed to be independent of the case studies and focus groups, and aimed to gather the perceptions of natural capital and natural capital accounting from a broader range of farmers. The use of Qualtrics ensured the survey was easy for the participants to use and so that the research data could be readily transformed into visual graphics for ease of interpretation. The data could also be manipulated within Qualtrics by applying filters to them. This allowed variables, such as age, to be excluded or included to identify if a specific factor influenced the results. As an example, when the age of the respondents was used as a determinant variable, the data could be filtered to establish how

age influenced the responses to questions such as “Are natural capital and natural capital accounting understood across your industry?”

5.7 Conclusion

In this chapter, I have described the tools used to gather and analyse the data collected in this research. The chapter details how these tools were applied to the data arising from my sequential mixed-methods approach and the challenges encountered. Detailed information is provided on the coding process and logic used to analyse the qualitative data. I have also discussed and compared the use of QDAS software and manual coding, and the benefits and disadvantages of each of these tools. The chapter includes the final coding structure used for the case studies and focus groups. Finally, the chapter provides background on the construction and use of an independent parallel survey to gather quantitative data, which were compared with the qualitative data from the case studies and focus groups.

The use of these tools allowed an iterative approach to the data, permitting a detailed interrogation of the interviews, focus groups, and documents to answer my research questions, and a comparison of the findings with those gathered with a broader survey.

In Chapter 6, I present the results of the semi-structured interviews with the case study participants.

Chapter 6: Results of Interviews with Case Study Participants

6.1 Background

In this chapter, I detail the findings of the semi-structured interviews undertaken with employees of the five case study enterprises. The 12 interviews included two interviews with Kilter Rural, Paraway Pastoral and the QLRF. Five interviews with L2M members and one with the North Australian Pastoral Company (NAPCO). Each interview was 1 h in length. The case studies had distinct characteristics, various values, attitudes, and beliefs that may have influenced their decisions around natural capital accounting and these were taken into consideration during the analysis (Saldaña, 2021). A summary of the categories (attributes) is given in Table 10. These categories (below) can influence both the enterprises themselves and how they view natural capital.

Table 10 Description of Case Study Attributes

Categories	
1.Type of Case Study	• Family Farm: Operated and owned by a family or individual as a single entity • Corporate: Owned or managed by and institution on behalf of external investors. • Government Policy Programme: an initiative run and or created by a government department or not for profit
2. How long a natural capital accounting project has been in place and data collects	• Initial stages in development of a natural capital project with no data collected. • Implementation of a natural capital accounting project • Establish project at least 1 year of data collected
3. Type of enterprise	• Grazing • Farming • Horticulture • Mixed
4. Location	• State

Table 11 Case study attributes

Case Studies					
	Kilter Rural N = 2	Paraway Pastoral N = 2	NAPCO N = 1	QLRF N = 2	L2M N = 5
Type of case Study	Investment Management			Policy Implementation	Family Farms
Stage of development	5 Years	Implementation	Implementation	Stage 1: Investment round complete; 16 projects have been implemented	4 Years
Type of enterprise	Mixed farming	Grazing	Grazing	Mixed	Grazing
Location	Victoria	NSW, Victoria, and Queensland	Queensland and Northern Territory	Queensland	NSW and South Australia

Legend	
N	Number of interviews undertaken with each case study
QLRF	Queensland Restoration Fund
NAPCO	North Australian Pastoral Company

The interviews focused on why each of the enterprises chose to adopt natural capital accounting as part of their operations when there was limited evidence of its broader acceptance. The objective of the interviews was to understand:

1) the factors that trigger their adoption of natural capital accounting;
2) the value propositions of each enterprise in undertaking natural capital accounting;
3) the barriers each enterprise encountered in the adoption of natural capital accounting.

The results in this chapter specifically address RQ1:

How do farmers perceive the value of natural capital and the need to measure it?

Each interview participant was provided with confirmation of ethics approval, a consent form, and a set of semi-structured interview questions before the interview (see Appendix A2). The introductory questions in the semi-structured interviews focused on the role and responsibilities of the interviewees and the type of organisation for which they worked. The questions aimed to set the participants at ease with the interview and to encourage them to generate the narrative. It also provided an opportunity to understand the participants, their experience, and their relationships with natural capital (Galletta & Cross, 2013).

6.2 Findings of the Interviews: An Overview

The triggers that prompted the decision to undertake natural capital accounting were shaped by the characteristics or attributes of each enterprise. These different attributes, including their motivations, capacities and networks, influenced how the enterprises approached decision-making around natural capital. These attributes influenced the triggers that led to the decisions to undertake natural capital accounting. For example, the enterprises with investment management attributes were triggered by investors' requirements and their requests for more information and for greater validity around the decisions taken that affected natural capital outcomes. In contrast, the decision of family farmers was triggered by family and educators, this provides a point of difference and reflects their altruistic approach to environmental stewardship. In contrast, the triggers that affected government-based enterprises included the need to serve the public good and to seize an opportunity to address historical landscape degradation with participants in the program influenced by costs being offset. Input from significant stakeholder groups also strongly influenced the government and its decision to develop a land restoration fund.

A common view across all enterprise was that economic opportunities and environmental benefits were key value propositions in undertaking natural capital accounting. Because the Queensland Land Restoration Fund (QLRF) is a government initiative, delivering public good was a specific and important value proposition. However, a key value proposition of the Land to Market Co-Operative (L2M) was collaboration, which was seen to increase the adoption of natural capital accounting and reinforce the need for behavioural change, through leadership and on-going education.

Four of the five L2M interviews indicated that sequestering carbon was an important factor in accruing long-term environmental and financial benefits. They see this being achieved through improving soil condition and over all landscape health to increase productivity while helping to reduce atmospheric carbon. Three interviewees also discussed the importance of enhancing soil quality (closely related to carbon sequestration) and two interviewees focused on the importance of water quality and filtration.

The enterprises were clearly distinguishable based on how long each had been using natural capital accounting. For those enterprises in the early phase of implementation, the value propositions in undertaking natural capital accounting were aspirational, because there is still a lack of tangible evidence of possible outcomes. For the two enterprises with a track record in natural capital accounting, the financial benefits were sparse, if not negligible. The key outcomes centred around environmental effects and their impact on production. All the case study members interviewed recognized a need for more consistency in the development of frameworks and the establishment of closer links between economic, productivity, and environmental benefits.

The lack of clear links between the environmental, productivity, and economic benefits contributed to a lack of the markets required to generate economic benefits that could offset the costs of instituting natural capital accounting (including the costs of methodology development, measurement, consultants, base lining[10], data collection, etc.). The Queensland Government identified these barriers, and as a function of the QLRF, stimulates voluntary participation by providing financial incentives, including payments to implement the programme and payments for verified outcomes.

The dearth of knowledge and understanding of the concepts around natural capital were seen as barriers, and the purpose of natural capital accounting and how its benefits accrue to farms through enhanced natural capital is also not well understood. This also will be reflected in that those taking a natural capital approach will have different expectations in using accounting tools.

This research was not designed to test the accuracy of the accounting frameworks. The complexity of the systems being measured makes these frameworks dependant on the methods used, type and quality of data collected to deliver specific outcomes. As previously mentioned, accounting frameworks are designed to deliver different things. They can deliver accounting measures through quantitative measures, footprint mapping,

[10] Base Line – is the starting point or benchmark against which changes in natural capital activities can be compared Natural Capital Coalition. (2016). *Natural Capital Protocol*. www.naturalcapitalcoalition.org/protocol.

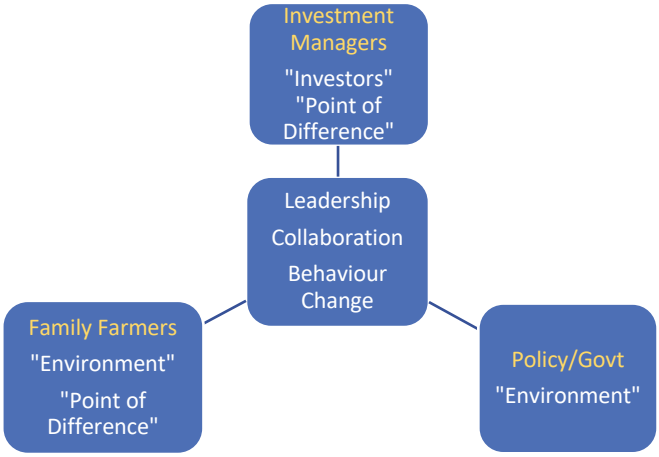
ecological performance measures. From the interviews one respondent noted "there is no clear well-defined system of natural capital accounting, a barrier to wider adoption.

6.3 Triggers—The Light Bulb Moment!

A "trigger" can be defined as "*an event or situation, etc. that causes something to start*" (Cambridge University Press, n.d-a).

Understanding what inspired the case study participants to innovate their practices and adopt natural capital accounting should allow the construction of a narrative around natural capital accounting and its current and future roles in agricultural decision-making. Consequently, the question asked the interviewees was designed to understand what prompted the enterprises studied to innovate and implement natural capital accounting as part of their business models, especially considering that the process is voluntary and not widely accepted. The questions asked interviewees to: "Describe the triggers that determined the need to implement natural capital accounting, measurement, and monitoring as part of your investment principles? Were other stakeholder groups influential in encouraging you to take this approach? If so, how have they influenced your decisions?" **Error! Reference source not found.** shows the three commonly acknowledged triggers, together with the specific triggers, which were influenced by the attributes of the individual enterprises.

Table *12*



provides examples of interview responses to the trigger questions.

Table 12 Triggers that influenced the enterprises in the case studies to implement natural capital accounting

	Case Studies **Factors that triggered the enterprises to adopt natural capital accounting**				
	Kilter Rural	Paraway	NAPCO	QLRF	L2M
Category: Time	5 years	Implementation	Implementation	Implementing	4 years
Category: Type		Investment		Policy	Family
Common Triggers	**LEADERSHIP** I1. "It's just part of our DNA" I7. "Election commitment" I12. "I'm very passionate about what I do"				
	COLLABORATION I1. "We tend to work with trusted individuals and institutions, research institutions" I7. "Several key stakeholders were involved in establishing the system" I8. "There is a small group of us who believe that doing things differently, how we manage our land"				
	BEHAVIOUR CHANGE I4. "We've observed that having a social licence is becoming more and more important in agriculture, particularly corporate Ag and so that's a sort of an internal driver" I6. "We're asking people to change their behaviour and that's central to the idea of additionality and carbon farming and additionality under any investment" I8. "If you can get some reward for what you're doing then that's a beneficial thing of getting people to change their way of thinking"				
Environment				I7. "A way to encourage voluntary actions to preserve the environment" I 11. "I see land stewardship as really big. It will be quite an important part of my business as time goes on".	
Point of Difference	I1. "We've always seen it as a point of difference"				I12. "Sets us apart in some way"
Investors	I5. "Getting a lot of inquiry for investments that have a natural capital component"				

Legend
NAPCO - North Australian Pastoral Company
QLRF - Queensland Land Restoration Fund
L2M - Land to Market

Three common triggers were identified by the interviewees (case study members):

- Leadership: The interviewees emphasised that natural capital was already embedded in the organisation or through characteristics of the organisation and the individuals within. This provided guidance for the objectives of the enterprise.
- Collaboration: This is a practice embedded in each enterprise. Schröter et al. (2015) noted that the co-production of agricultural goods and ecosystem services, including biodiversity maintenance, requires engagement with the public and/or civil society. This was reflected in the interviewees' responses regarding their engagement with

influencers/educators and collaborators, who acted as triggers to their adoption of a natural-capital-focused approach.

- Behavioural changes: These changes stem from leadership and collaboration. For example, investors create or encourage new investment products to meet the growing demand for investments with strong environmental, social, and governance (ESG) attributes (including social or green bonds). Alternatively, political or social influences motivate changes in behaviours, through the need for social licence, legislation, regulation, or education.

Other triggers mentioned in the interviews, which were unique to a specific TYPE of enterprise, included:

- Investment management enterprises identified investors as a trigger influencing their business decisions and providing a point of difference in attracting investment.

- The QLRF (policy) and L2M (family farms) identified a desire for positive environmental outcomes as a key trigger. Family farmers also identified the need for a point of difference to their business and the influence of educators and family members as triggers to their decision-making.

6.4 What are the Value Propositions in Undertaking Natural Capital Accounting?

A value proposition is defined by the online Cambridge English dictionary as "*a reason given by a seller for buying their particular product or service, based on the value it offers customers"(Cambridge University Press, n.d-b)*. In the *International <IR> Framework 2021* (The IFRS Foundation, 2021), a value proposition is described as "the ability of an organisation to create value for itself is linked to the value it creates for others." In this research, based on the literature discussed in Chapter 2, the value proposition can also be considered the improvement of natural capital in agricultural landscapes through management, and shaping the value it delivers through production benefits and in the context of managing risks across multiple stakeholders. It also includes the benefits conferred the wider society by delivering ecosystem services, and the positive impact on climate change and land degradation.

As suggested by Frow et al. (2014), value propositions can be co-created, reciprocal, and dynamic[11]. This is apparent in the responses to the question in section 6.3 regarding triggers. The interviewees identified collaboration as a value proposition, insofar as co-created shared knowledge triggered the decision to implement natural capital accounting. Furthermore, and as also identified by Frow et al. (2014), a value proposition can shape the market, determining the market interactions that influence who chooses to engage and shape the nature of market interactions. In this context, agriculture can be seen as a creator of natural capital value. How it captures the value it creates when it builds and improves natural capital is dependent upon how stakeholders perceive the value of the results and their willingness to reward the value created.

To understand how the enterprises examined viewed the value proposition in undertaking natural capital accounting, a question was framed in two parts: *"What outcomes did you expect from using natural capital accounting?"* and "*Why have you decided to take on natural capital accounting when there is little evidence of its wide use to date?*".

Seven "value proposition" categories were identified from the interviews and are listed in Figure 25, together with their relative importance. These categories and their relative importance have been interpreted by analysing and coding the interviewees responses to the questions put to the case study members around value proposition of undertaking natural capital accounting.

[11] Co-creation where stakeholders connect purposefully integrating their resources and co-creating value
Reciprocal – stakeholders working together for mutual advantage
Dynamic – interdependence between stakeholders and their adaptation evolution
Frow et al. (2014)

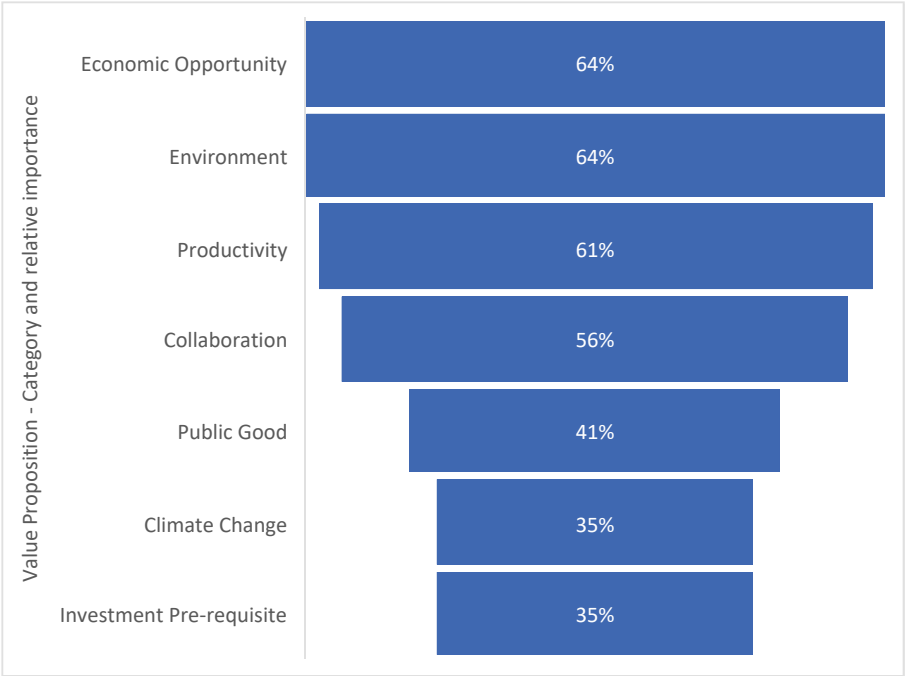


Figure 25 Relative importance of the value proposition categories

Table 13 expands on Figure 25 to include the themes, the relative importance of these themes, and their relationships to attributes associated with the TYPE of case study (investment, policy, or family farm). In some cases there were a higher proportion of sub themes identified under certain categories. This was offset by weighting the scores and also how interviewees attributes influenced results. As an example six sub categories were identified under Economic opportunity and this category had a high relative importance value given a high proportion of all interviews that mentioned these sub categories in interviews. In contrast under the collaboration category there were five sub themes with this category 4th of the seven categories, influenced by the lower mention of collaboration across the investment interviews. It thus provides greater insight into the interviewee responses by identifying the type of enterprise in which the interviewees were involved and how these unique attributes may have influenced the interviewees' responses. The percentage scores in Figure 25 and Table 13 represent the relative importance of each category[12].

[12] Total in table 13 refers to the weighted average of the three-case study categories

Table 13 Relative importance of identified themes from interviews

Theme - Value Proposition		Mentions - Relative importance			
Category	**Codes or sub-themes**	**Investment Interviews = 5**	**Policy Interviews = 2**	**Family Farms Interviews = 5**	**Total**
Economic opportunity	Improved Financial outcomes	80%		100%	75%
	Increased Pricing Power	80%		40%	50%
	Carbon Market participation	80%	100%	60%	75%
	Link environmental to economic outcome	80%	100%		50%
	Consumer Demand	40%		60%	41%
	Competitive Advantage/unique selling proposition	80%	100%	100%	91%
Productivity	Improved productivity	80%		80%	66%
	Apply data for active management	80%		80%	66%
	Risk management	40%	50%	60%	50%
Investment pre-requisite	Investor demand	80%	100%	0%	50%
	Investors require Integrity/transparency of	80%	100%	100%	91%
	ESG	20%			8%
	Ethical investors	20%			8%
Climate Change	Report emmisions	40%			16%
	Offsets	20%	100%		25%
	Investors want climate change tools and outcomes	80%			33%
	Adapt practices	40%	100%	80%	66%
Public good	Social and Health Benefits		100%	40%	33%
	intergenerational equity		50%	20%	16%
	Traceability/Provenance	40%	100%	40%	41%
	Social Licence	40%	100%	100%	75%
Collaboration	Leadership - encouraging more people to acc for	60%	100%	100%	83%
	Deliver behaviour change/adaptation	20%	100%	100%	83%
	Develop methodologies - relevant and easy to use	40%			16%
	With stakeholders beyond the farm gate	40%		60%	41%
	On going education	20%	50%	100%	58%
Environment	Restore Degraded Landscapes	40%		100%	58%
	Co-benefits	80%	100%	20%	58%
	Carbon farming	80%	100%	40%	66%
	Enhance management of NC/Improve balance	40%	100%	100%	75%

6.4.1 Economic Opportunities

The three enterprises that were investment managers identified the category “economic opportunities” as an important value proposition see Table 13. The nature of the investment management businesses and their fiduciary duties associated with generating investment returns for their subscribers explains why this would be a priority. At the time of interviews, a key difference between the investment enterprises was that one, Kilter Rural, was well advanced in the use of natural capital accounting (Gardner, 2018; Heislers et al., 2019), whereas the other two were still developing and implementing their approaches. Despite their different stages of implementation, the interviewees from these enterprises showed little, if any, discernible variation in their responses to these questions. However, it was clear that the value propositions identified could be viewed as “aspirational”, with limited evidence of their realisation at this stage.

A key outcome for the QLRF was the generation of financial benefits for the farmers participating in the programme. The financial outcomes were associated with carbon farming and the generation and monetization of natural capital co-benefits (Cook & Energetics Pty Ltd, 2017).

The more established case studies, L2M and Kilter Rural, had been able to realise some benefits from their use of natural capital accounting. L2M used the approach to gain market access for produce (see section 6.5.3), whereas Kilter Rural used the approach as a competitive advantage to attract new investment to their funds. It was unclear whether any direct financial benefits were attributed to natural capital accounting. Text Box 1 highlights some of the responses from the interviews that reflected the economic opportunity from natural capital accounting.

Table 14 Economic opportunities identified as value propositions

Attribute	**Investment**			**Policy**	**Family Farmers**
Enterprise	Kilter Rural	Paraway	NAPCO	QLRF	L2M
No. interviews	2	2	1	2	5
Economic opportunities	A competitive advantage			A competitive advantage	A competitive advantage
	Improved financial outcomes				Improved financial outcomes
	Linking environmental outcomes to economic outcomes			Linking environmental outcomes to economic outcomes	
	Carbon market participation			Carbon market participation[13]	

[13] This is central to participating in the QLRF

I1 “to access multiple revenue streams derived from a range of eco services”

I2 “Profitability means we want to get paid for agricultural produce and we want to be paid for environmental services”

I3 “I do see it leading to opportunities in terms of product, I don’t imagine it will be large. I think if the process is any good it will become standardised and as with most premiums, it will disappear and become a penalty if you’re either not adopting the system or you have poor metrics”

I7 “Providing a monetary incentive is how you get voluntary action”

I8 “I love the idea of a farmer getting paid a premium because they’re improving the health of their farmland”

Text Box 1, Examples of responses reflecting “economic opportunities” as a value proposition

The common theme across all the case studies in the category of economic opportunities was that all the interviewees considered the use of natural capital accounting as an opportunity to present a unique selling proposition that delivered a competitive advantage.

6.4.2 Productivity Benefits

As identified in the literature, agriculture has a unique position defined by its reliance on natural capital, the impact it has on natural capital, and its ability to deliver production outcomes. As has also been noted, incorporating natural capital into decision-making requires a greater understanding of the factors that drive productivity and the associated risks. These themes also surfaced in the interviews, when the second most-relevant value proposition for the adoption of natural capital accounting identified by interviewees was the opportunity for productivity benefits. This category and its associated themes were predominately linked to enterprises that had the attributes “investment” and “family farmers”. Three sub-codes emerged in this category:

1. improved productivity;
2. application of data to active management; and
3. Use as a risk management tool.

Unlike “economic opportunities”, this category and its sub-codes offer a realisable value proposition for the case studies. Several interviewees involved in the case studies that were applying natural capital accounting indicated they directly attributed productivity benefits to the use of natural capital accounting. Text Box 2 provides examples of how the interviewees’ responses reflected this.

Conversely for the case studies in the early stages of implementation, such as Paraway, NAPCO, and the QLRF, the value proposition under this category is the “expectation” that undertaking natural capital accounting will result in productivity and risk management benefits..

I3. “If we understand our natural resource base better, if we are measuring it better, at the same time measuring agricultural production and productivity, we’ll be able to see the impacts of one on another and vice versa and hope it leads to more profitable and sustainable agricultural production”

I4 “Going down this natural capital accounting path is going to allow us to provide data and to monitor and make better decisions because of that data”

I5 “Well-managed natural resources are actually more productive than poorly managed natural capital”

I6 “Next logical step would be for banks and lenders to start to take that stuff more seriously in their lending practice and their risk evaluation work. That kind of thinking around better land managers are low risk and therefore should be serviced with lower interest credit”

Text Box 2 Expectations of productivity benefits

6.4.3 Benefits from Collaboration

In section 6.3, collaboration was identified by the interviewees as a key trigger prompting enterprises to adopt natural capital accounting. Collaboration was also identified as a theme as value proposition for undertaking natural capital accounting. This reflects the interviewees’ desire to co-create value through interactions and a recognition that no single stakeholder has all the resources to achieve this (Frow et al., 2014). With all stakeholders’ desiring to increase the rate of adoption and acceptance of natural capital accounting as a legitimate management tool. It can be seen as expanding the relevance and visibility of natural capital

accounting to stakeholders and its potential economic, social, and productivity benefits (Frow et al., 2014; Rogers, 1995). Examples of the interview responses to this category are seen in Text Box 3.

I(1) "We are having our method trimmed down so it could be picked up by a family farmer and applied. I think the biggest thing is just having the simple hooks out there for someone new that wants to come into the space and account for natural capital but with confidence and without a lot of trouble they can grab something and apply it"

I(2) "The development of accounting methodologies—it becomes creative commons. Which is better as you just want as many people as possible using a methodology"

I(7) "The way we have been building trust, we have been engaging with peak bodies"

I(9) "As more people who understand the value of this get into the leadership positions within agriculture and in government, then some of that institutional scepticism will probably breakdown"

P(12) "Maybe it will give us some profile amongst other land holders. I believe that what we are doing is getting close to being what is good for the land in the long term and if we can be an example of what is possible, then that would be a really good outcome. If they believed in what we were doing, and they could come to see what we were doing and then be confident that it is possible and then start believing in themselves to make change, that would be fantastic"

Text Box 3 Importance of collaboration as a value proposition

6.4.4 Importance of Leadership

Leadership was considered an important value proposition, particularly for those enterprises advanced in natural capital accounting, such as Kilter Rural and L2M. These enterprises stress that validating the results of their endeavours with natural capital accounting will encourage others to undertake natural capital accounting and provide the scale required to generate economic benefits and greater legitimacy for the practice. The interviewees' responses also emphasized the importance of peer engagement, training, and the development of methodologies that generate behavioural changes and encourage new adoption of the practice. Unlike those enterprises already practising natural capital accounting, the QLRS is a government-led initiative that was seen by the interviewees as a leadership initiative, designed to deliver behavioural changes.

6.4.5 Improved Environmental Outcomes

Improved environmental outcomes featured prominently as a value proposition in the responses given by all the interviewees. Table 15 is a summary of response to this value proposition

Table 15 Environment as a Value Proposition

Attribute	Investment			Policy	Family Farmers
Case Study	Kilter Rural	Paraway	NAPCO	QLRF	L2M
Interviews	2	2	1	2	5
	I1 "It's really about working with what's been degraded and bringing value to it both in a natural capital sense and in a human productivity sense" "We see agriculture versus ecology as mutually reliant"				I8 "My decision-making really focuses around trying to restore the ecological function of this landscape"
	I2 "Natural capital plays a lot of different sorts of functions you don't necessarily build into your financial returns per se"				I8 "They don't see the damage being done to their soil, the erosion, loss of biodiversity and that's their balance sheet"
	I4 "I think that the natural capital accounting framework will enable us to tell our story better and to show we are contributing to environmental improvements"				I10 "We want to actually improve our land base because we've destroyed so much of it, and we've lost so much of that healthy soil base"
	I(6) "The fund is really there to further environmental outcomes, principally through carbon farming"				I11 "building ecology and not degrading the landscape, you're definitely creating resilience"

The themes of restoring degraded land and the enhanced management of natural capital, leading to improved ecological functions, were highly relevant to those interviewees associated with the L2M case study. The interview responses reflected an altruistic approach, which pointed to the ability of individuals to act as stewards of the land, and to their connection to the landscape (Bennett et al., 2018). The comments in Table 15 illustrate how the interviewees reflected this in their responses. Conversely, the enterprises with investment attributes and the QLRF offered more commercially focused responses, which centred on the creation of economic value through repairing the environment and generating co-benefits from improved environmental outcomes and carbon farming. The interview responses in text box 4 also highlight how improved ecological outcomes were assisting in manging risks and improving decision making. In the Kilter case study, the

interviews indicated the use of soil condition indicators had assisted in tracking how soil condition changed over time and how management of the soils may have influenced these changes. "We did photo points, dug soil pits after every crop rotation". "There has been a clear improvement in benchmark soil quality" this has assisted in improving production levels from the soils and can be directly linked to impact of changed management practices.

In addition, Kilter indicated increase in biodiversity areas has assisted in protecting crop assets. An example provided in the interviews identified flood plains that can flood and drain into environmental zones allowed cropping areas to recover quicker from major flooding events. The interview also highlighted that these were early stages in developing direct links between flood recovery and increased environmental performance. With the Kilter case study being the most advance in its natural capital accounting approach this highlights one of the key challenges in adopting these practices, that of the time required to identify change in landscape condition and attributing this to accounting practices.

I1 "Ag needs the ecological base or the natural asset base to support it enduring production"

I2 "Mixing biodiversity areas and agricultural areas together has provided us enormous flexibility in responding to events."

I9 "We're starting to get conversations with banks, and other institutions to quantify the risks involved in agriculture and they see natural capital as integral"

I10 "Having a framework for decision-making and looking at the environmental impact of everything we do, can make a difference. We make a decision because we were informed about it"

Text Box 4 How decision making is impacted by Natural Capital Accounting

6.4.6 Key Elements of Natural Capital

The interviews identified several elements of natural capital that were important to the case studies participants in the measurement process. Carbon and soil were seen as the two most important areas to be considered, and both carbon and soil were identified as important in seven of the 12 interviews. Soil was not directly mentioned in the interviews with the QLRF

participants, but is closely linked to the carbon and soil carbon projects under their stewardship. In the L2M interviews, the condition of the soil was seen as critical, with less emphasis placed on carbon. The L2M results also reflected the L2M approach to monitoring, in which 15 indicators are used to measure farm health, including ground cover diversity, abundance, context, and soil erosion (wind and water). The long-term indicators in the L2M approach are an extension of short-term indicators and available to members should they wish to undertake additional measurement. The long-term measurements include species biodiversity, soil health, and often soil carbon. Institutional investors also focused on soil and carbon, although it should be noted that two of these enterprises, which are in the initial stages of implementation, had not conclusively identified the important natural capital factors they intended to measure. Table 16 tabulates how the interviewees saw the importance of specific natural capital components in their measurement regimes[14].

Table 16 Key natural capital indicators identified by interviewees

	Soil (including salinity)	Carbon	Biodiversity	Water Filtration/Quality	Ground Cover	Soil Microbiology	Plant Diversity
Institutional investment (N = 5)	3	4	1	2	1		
Land to Market (N = 5)	4	1	3	2	2	2	1
QLRF (N = 2)		2	1				
Total	7	7	5	4	3	2	1

N= number of interviews that mentioned the natural capital indicator

6.4.7 A Pre-requisites for Investment

This category was highly relevant to the three enterprises with investment attributes (see *Table 17*). The interviewees associated with these three cases discussed the importance placed by investors on environmental credentials when they consider investment opportunities. Consequently, there is pressure on investment managers to build strong environmental attributes into investment fund outcomes to meet ESG goals.

[14] The responses do not show when the enterprises were involved in other environmental programmes, such as bush broking.

Commenting on the pre-requisites for investment, interviewees also noted that investors are beginning to focus on the validity and integrity of the environmental claims made by investment managers and are checking for greenwashing. This category was less relevant to the L2M enterprise because the family farmers interviewed were not seeking external investment for their agricultural enterprises.

Table 17 Pre-requisites for investment

Attribute	Investment		
Enterprise	Kilter Rural	Paraway	NAPCO
No. interviews	2	2	1
Attribute	5 years	Implementation	Implementation
Integrity of the investment	"It's repeatable and it's traceable"	"A natural capital accounting framework will enable us to tell a story and show we are contributing to environmental improvements"	
	"Investors will increasingly seek to know and be shown proof that the assets and natural capital you're managing is improving in value"	"There's also opportunity to attract investor funds"	"Getting a lot of enquiry for investments that have a natural capital component to the investments"
	"A new fund and we've made specific undertakings to investors"	"I think at some point in the future that investors will leave you if you're not undertaking this sort of approach"	
		" From conversations with bankers and others there is significant interest"	

Conversely, the QLRF is an established enterprise, funded initially by the Queensland Government. There are expectations that once it is fully established, external investment will be attracted to co-invest with the Government. The use of natural capital accounting with other co-benefit frameworks will provide validity and relevance to QLRF projects, supporting external investment. Once again, because the QLRF is in the early stages of implementing stage 1 projects, this remains a goal of the QLRF.

6.4.8 Climate Change

The interviewees' responses to the category of climate change provided a variety of perspectives that reflect the different attributes of the enterprises. All the enterprises

indicated they are actively managing the climate change risk. For the investment managers, the ability to utilise their accounts to report to investors on climate change and the impact of their management decisions on outcomes was considered highly relevant.

I4 "*During the drought, we were able to focus on protecting our soils even though we weren't sort of accounting for it, we weren't collecting any data, we just did it because you know we knew that it would help and reduce the duration of the drought in that it enabled the pastures to respond and to sort of shorten the duration of the drought. I definitely think that if we were able to get some data behind that and some metrics, then it makes those decisions even easier for us*."

For the QLRF, climate change and environmental considerations are embedded within its design and processes, and are seen as highly relevant (Queensland Government, 2020). Projects that are part of the QLRF are required to consider these factors at both the proposing and implementation stages of their project, and natural capital accounting plays an important role in measuring the outcomes of projects highlighted in section 2.3 of *Land Restoration Fund Co-Benefits Standard* (Queensland Government, 2020).

This theme was also reinforced in interviews with the case study members from the QLRF *"When you look at the national projections around how on earth we are going to manage to reduce our collective greenhouse gas emissions, there's a clear need for offsets. As part of that transition, when you look at the modelling as to where those offsets are likely to come from, Queensland certainly features front and centre".* "It also gives us exactly the types of environmental outcomes that we need to protect the fabric of Queensland life as well".

For the L2M interviewees, adapting practices was a key theme identified in their responses:

I9 "*A big factor of why I'm doing management the way I'm doing, I can say the climate is getting crazy";*

I8 "*The whole process is focused on developing and enhancing for climate change*".

I12 "*It gives us a much better understanding of the environment and better ability to work with the environment rather than against it*"

6.4.9 Contribution to Public Good

A final category was natural capital accounting and its relationship to public good. From the interviews, the themes identified included:

- Social and health benefits;
- Intergenerational equity;
- Traceability and provenance;
- Social licence.

This category was most relevant to the QLRF and L2M cases. A key factor was that the QLRF is a government initiative targeting investment in projects that deliver environmental benefits, particularly for the benefit of Queensland, and uses carbon farming as its central pillar. The QLRF uses natural capital accounting frameworks as a tool to link and validate the outcomes and co-benefits of the QLRF projects. This is seen in section 5 of the *Land Restoration Fund Co-Benefits Standard* (Queensland Government, 2020), which outlines the social and economic goals of the QLRF.

Interviewee I7 noted "*We are leveraging the carbon market to achieve the environmental outcomes but also social and economic outcomes*" and "*It's the public good which makes it the right place for the government to step in and create the market*"…. "*that there is increasing investor demand to know the provenance of their investment*".

I6 noted "*what we are trying to achieve in terms of healthy on-going environment and vibrant communities, all those things have been an ambition of government and community for a long time*".

It was also evident from the interviews that while economic outcomes were considered important several interviewees involved with L2M and the QLRF also focused on the social and intergenerational equity outcomes. These indirect benefits are not measured directly

with natural capital accounting, and the QRLF has established separate frameworks to measure these co-benefits, although this is proving more complex. These social and intergenerational equity outcomes are seen as indirect outcomes of the environmental improvements measured with natural capital accounting.

Of the L2M participants, interviewee I8 mentioned *"It's my dearest wish that we get more and more people playing and swimming in this pond because we just need to make the world a better place*". Another interviewee, I10, noted that "*we get healthier soil, healthier, food, healthier people, we don't have such epidemics in obesity or diabetes*". Interviewee I11 commented "*I'm getting the benefits now by just this sort of farming and look I'm really healthy, I've got a good community around me, I'm positive*".

6.4.10 Summary of the Value Proposition

The value propositions identified in the interviews with case study members indicated that the case studies that were well progressed in natural capital accounting identified the value propositions through tangible experience.

In comparison, the interviewees from enterprises in the early phases of implementation had aspirational expectations of the outcomes, assuming that over the longer term, it would be possible that benefits could be achieved as the market develops. This also reflected the limited evidence available of realised value propositions from actual natural capital accounting projects.

Mixed messages from the market were also identified as a challenge, and one interviewee stated that confused market signals led to unsatisfactory outcomes, such as a lack of product premiums. In contrast, the L2M had made some progress in achieving economic benefits by collaborating with retailers through preferred supplier agreements that focused on sourcing supply from L2M members. Although there was no evidence that this conferred financial benefits on the members at this stage, it did provide a competitive supply advantage to members. This was reflected in the responses "*I'm not getting any added benefit for the sale*

of my beef" and "*I think longer term this stuff will be more valuable, but I think in the first instance, it's not front and centre*".

The enterprises that involved investment management also considered that it was important to be able to demonstrate that changes in environmental conditions had targeted productivity benefits and good economic outcomes, because it would attract new investment. These interviewees strongly emphasized the core theme of delivering economic, financial, and productivity outcomes. Once again, only one case study, Kilter Rural, was able to demonstrate how environmental outcomes are linked to productivity benefits. Evidence of a clear link between natural capital accounting and financial outcomes was missing from all case studies.

The core categories of social and environmental outcomes featured highly in the interviews with QLRF members. They echoed the values and beliefs that underpin the QLRF, which set out in the QLRF co-benefit standards, which have been developed as part of the establishment of the fund. The interview participants also felt strongly that the integrity of the QLRF was a core outcome, ensuring its longevity, attracting external investment, and allowing the development of markets for the carbon and co-benefits that the fund seeks to deliver.

In contrast, individual farmers in the L2M showed a broad range of value propositions and beliefs in undertaking natural capital accounting. Although economic outcomes were important in this enterprise, more altruistic concerns were also prevalent around environmental, social, and collaborative outcomes. Prominent in the interviews was the value proposition of a competitive advantage or unique selling proposition which have, to some extent, been realised generated by the co-operative. The interview participants, as part of a co-operative, also recognised the importance of encouraging other farmers, through collaboration and education, to adopt the EOV process. The aim to achieve greater acceptance of the EOV method and increase the potential for of generating further value opportunities, including preferred supplier agreements, educational support, and healthy landscapes.

The role of government in natural capital accounting was seen by some as important in stimulating its adoption. Government's role was seen as stimulating market development to realise value propositions. The QLRF, a state government initiative, is designed to generate public good, using market-based incentives to deliver validated outcomes. Conversely, two case study interviewees also saw government as a barrier. This was based on past experiences of government programmes and the short-term nature of government funding relative to the long-term nature of natural capital accounting. This was addressed by one interviewee as "*they definitely have a long-term vision writing contracts for up to 15 years at a time*", recognition that the delivery of results requires long-term accounting projects. There was also scepticism around governments' knowledge and understanding of what is required from natural capital accounting in relation to climate change.

6.5 Barriers to Adopting Natural Capital Accounting

The interviewees also stressed that implementing natural capital accounting, does not come without its challenges. Understanding and exploring the barriers that each enterprise had experienced in the implementation of natural capital accounting can transform traditional practices to practices that focus on building natural capital. The cost of implementing programmes and a lack of markets were seen as the greatest obstacles to adopting these practices. The barrier posed by a lack of markets contrasts with the value proposition identified earlier in section 6.4, in which new markets and competitive advantages were seen as opportunities entailed by the adoption of natural capital accounting. A lack of knowledge and understanding of the complex issues involved has also proven a barrier.

6.5.1 What Have Been the Obstacles to Undertaking a Natural Capital Accounting Approach?

Once again, to identify the key differences between the case studies, I analysed the attributes of the enterprises, including the type of enterprise and the length of time it had been undertaking natural capital accounting. Figure 26 shows the core categories identified as obstacles to implementation. Table 18 detailing the coding themes associated with the barriers identified in the interviews.

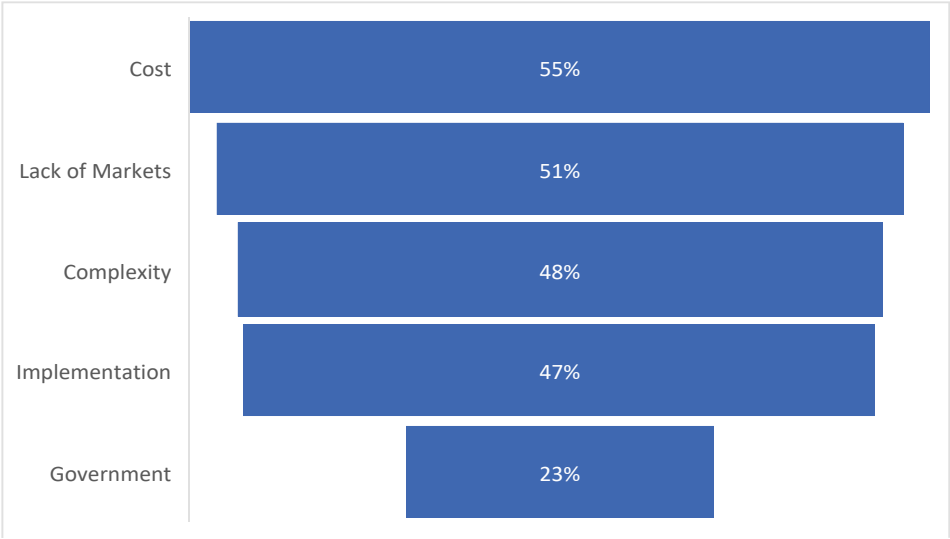


Figure 26 Relative Importance of the obstacles faced by enterprises in adopting natural capital accounting

Table 18 Highlights the key themes identified during coding for barriers to adoption

Theme - Obstacles to Implementation					
Category	**Codes or sub themes**	**Investment. N=5**	**Policy N=2**	**Family Farms N=5**	**Total N=12**
Cost	Measurement and monitoring	80%	50%	100%	83%
	Commercial viability	60%	50%	40%	50%
	Carbon farming and alternative land use	20%	50%	40%	33%
Lack of Markets	Different market signals	60%	100%	40%	58%
	Ability to monetize outcomes	60%	100%	80%	75%
	Lack market pull through (Value capture)	40%	50%	80%	58%
	No evidence to draw on and lacks credibility	40%		20%	25%
	Narrow appeal- Consumers	20%		80%	41%
Complexity	Knowledge of the terms and meanings	80%	50%	100%	83%
	Repeatability	20%	50%		16%
	One size does not fit all	20%	50%	20%	25%
	We are Still learning	40%	100%	40%	50%
	Link ecological change to financial change a challenge	60%	50%	20%	41%
	No standardised system	60%	50%	40%	50%
	Putting Metrics around NC	40%		20%	25%
	Not understood	100%	100%	100%	100%
Implementation	Not Integrated in Property Valuation	80%	100%	40%	66%
	Changing behaviours	40%	100%	80%	66%
	Demonstrating results takes time	60%	100%	40%	58%
	Integrity of system	20%	50%	20%	25%
	Availabilty of Resources	60%	50%		33%
	Lack of recognition of public good	20%	50%	60%	41%
	Ongoing education	40%	50%	40%	41%
Government	Short term projects no longevity in funding	20%	50%		16%
	Detrimental Policy Changes	20%	50%	20%	25%
	Carbon Market stability and credibility	40%	50%		25%
	Support mixed			60%	25%

6.5.2 Cost of Implementation and on-going management of Natural Capital Accounting

All interviewees emphasised the cost of measurement, monitoring, and establishing accounting programmes as obstacles to the wider adoption of natural capital accounting. The enterprises differed in this regard, and L2M, predominantly constituted of family-run farming operations, emphasized that the cost of implementing the new practice relative to the additional returns generated was an important concern. For the QLRF, financial investments and incentives were accessible to cover the pre-application and set-up costs, making the programme more accessible, particularly to family farmers, so cost was less relevant. The interviewees noted that because the QLRF is a public programme, cost control and the allocation of funds to projects should receive greater scrutiny: "*always a tug within government as how to prioritize the use of money*".

For the enterprises involving institutional investment management, the cost of establishing an accounting programme was especially an obstacle in the early phase of implementation, affecting the commercial viability of the programme and fund returns (Table 19). Offsetting this to some extent was the size of these operations, which allowed costs to be spread over several assets. Costs can also be related to knowledge and education, and some interviewees noted that the challenges in identifying and recruiting appropriately qualified staff had cost implications.

Table 19 Cost obstacles to the implementation of natural capital accounting

Attribute	**Investment**			**Policy**	**Family Farmers**
Case Study	**Kilter Rural**	**Paraway**	**NAPCO**	**QLRF**	**L2M**
No. interviews	**2**	**2**	**1**	**2**	**5**
Cost	"There was big expense associated with it at the time and nobody was paying us to do it. Investors weren't asking, so we couldn't pass the fee back to them"			"There's all sorts of barriers in terms of complexity and the cost effectiveness of doing measurements we are talking about"	"The main barrier, to be honest, is the financial cost"
	"If we spread ourselves too thin, then its going to become too expensive"			"We need to find the right balance between integrity and cost"	"Costing us more than we probably will ever realise in financial terms"
	"Commercial viability I think is one of the biggest challenges to any sort of natural capital project"			"We still have issues around cost from project partners as well as government"	"We're trying to do a robust measurement that has validity and also trying to do it in a cost-effective way"

6.5.3 Lack of Existing Markets—Realising Financial Opportunities is Challenging in Reality

In section 6.4.1, interviewees identified the *expectation* of realising economic outcomes and creating a unique selling proposition in undertaking this approach. The interviewee responses indicated that these opportunities were still "aspirational", given the relative immaturity of natural capital accounting in agriculture.

This was also evident in the interviews with members of those enterprises more advanced in their natural capital accounting programmes, Kilter Rural and L2M. These enterprises were yet to realise any direct financial benefits, despite at least 5 and 3 years of data collection, respectively. Once again as interviewee I10 noted "*I'm not getting any added benefit for the sale of my beef*", and I1 noted "*I think longer term this stuff will be more valuable, but I think in the first instance it's not front and centre*".

In contrast, two enterprises that were in the early phases of implementation of natural capital accounting indicated they were receiving mixed signals from the market in relation to the financial opportunities associated with environmental outcomes. One interviewee (I5) stated "*we get a strong signal from the market that consumers that are buying beef for their own use want a carbon neutral product, but we don't particularly get a premium for it*". Another response was "*there's not much appetite to pay us a premium for that, but in the future that could happen*".

The interviewees did report that some market opportunities were being accessed, although it was unclear whether any direct financial benefits were available to the participants. For example, partnership agreements had been established with the L2M members, which linked to the value proposition "competitive advantage". As the L2M web site states "Market partners commit to supporting the values of L2M and the efforts of our farmers and producers to improve the ecological health of their land" (Land to Market, 2021). Interviewee I8 noted *"they see this as giving them, for want of a better description, is a unique selling proposition" and "aims to link producers and consumers who are seeking ethical and regenerative products".* It is unclear whether the agreements are a direct response to the EOV approach or that participants in the L2M programme are considered regenerative graziers.

In the case of Kilter who sell "Organic" grain to a noodle maker, (Hakubaku Noodles[15]), there was no evidence that natural capital accounting was impacting pricing or demand at this time. Alternative the producer was beginning to request information on emissions and how they were being dealt with on farm but not necessarily natural capital. As one interview participant noted "*we are in the premium end of the commodities market and they tend to be niche with offtake agreements and the focus is on reliability of supply*". Where natural capital accounting plays a role is assisting in the reliability of supply through landscape management and resilience.

A lack of new markets or the ability to monetize outcomes or market pull-through were characteristic of the early stages of natural capital accounting, as one interviewee stated, "*No evidence to draw on and lacks credibility*". This view contrasts with the value propositions identified earlier in the interviews (sec 6.4.1). The interview responses were consistent across case studies.

I1. "*There hasn't been too many footholds to grab onto to do that you know in a fashion that is has been demonstrated and it's got credibility around it*"

I6 "*Until it really consolidates into something a bit more immediate, I think a lot of land-holders will probably just have a watching brief or a fairly disinterested kind of approach to it until it really congeals into something they can engage with on a more day-to-day and kind of financially meaningful level*"

I11 "*They are not really paying a premium. It's more they say they try and convince you that they are, but they are not. I'm prepared to take a bit of a drop in income because I really want to support them because I like the methodology*"

I(12) "*It doesn't turn into dollars at this stage, but we are all the time building foundation"*

[15] https://hakubaku.com.au

6.5.4 Lack of understanding of concepts and language

The literature stresses that 'natural capital' and 'natural capital accounting' are relatively new concepts, particularly in terms of agriculture, for which accounting frameworks have only been developed within the past 10 years. As noted in the literature review, 67% of the literature that referred to both "natural capital" and "agriculture" was published between 2014 and 2021. Given the contemporary nature of the subject, understanding how well the terminology and concepts are recognized or understood across agricultural industries should provide insight into the progress of embedding them in practice. To determine how this understanding was reflected across the industry interviewees, they were asked "Would you say natural capital accounting and the role it plays in agricultural decision-making is very well understood, understood, or not understood?" In four interviews, the question also included the term "natural capital". The interviewees from the various enterprises indicated that they felt these concepts are "not very well understood" by many in the agriculture industry. Some respondents felt that natural capital was broadly understood, indicating that the difference in the language used around natural capital may result in misunderstandings. Text box 5 is a summary of some of the responses to this question.

> *"I don't know that you'd come across anybody in agriculture that wouldn't recognize soils are important, for instance, but whether they describe that as natural capital, I'm not sure".* **– Investor**
>
> "*On the whole, I'd have to say not understood. I think there's some people in there who clearly understand that well, and are involved, you know, heavily in it. But I think that's a very small majority*" – **Investor**
>
> "*I think it's understood by select few*" – **Family Farmer**
>
> "*The concept is understood, but the language is still emerging and I suggest that any confusion is probably more around language than concept" -* ***Policy*** *and "I think that it's more understood where it directly impacts or more directly impacts your production and your ability to operate your business".*

Text Box 5 Farmers understanding of natural capital

This lack of knowledge and understanding of the concepts of natural capital and natural capital accounting was a seen by all enterprises as a significant obstacle to the wider adoption of natural capital accounting.

6.5.5 Inability to Link ecological outcomes to financial outcomes

Two themes in this category that were highly relevant to the enterprises with investment attributes but were also mentioned in interviews with the QLRF and L2M members, were the current inability to link ecological change to financial outcomes and the lack of standardised systems (see

Table 20). These obstacles also relate to the lack of markets, where markets require robust methods and valid data.

Table 20 Linking ecological conditions to financial

Attribute	**Investment**			**Policy**	**Family Farmers**
Case Study	**Kilter Rural**	**Paraway**	**NAPCO**	**QLRF**	**L2M**
No. interviews	**2**	**2**	**1**	**2**	**5**
Linking ecological conditions to financial outcomes	"next will be actually linking payments to environmental condition improvement"			"A lot of work to do on the co-benefits standard for social and economic benefits"	"That's the aim of the game"
	"The closer we can tie this natural capital accounting to the financial system the better more effective markets will be"				The value proposition has not been recognised by the market place"
No standardised system	"Not something you just pick off the shelf and just do"			"The valuation sector and the financial sector need to come to a consistent approach to dealing with these projects."	"If you have different monitoring systems that's going to be more confusing and it waters down the whole thing"
	"There is no one clear well-defined system of natural capital accounting. People speak different languages, until we have a clear accepted standard system or systems, then it's hard for anyone to agree on values"			"Superannuation funds etc. don't know how to engage yet because the systems aren't quite there"	

6.5.6 Land valuation and behavioural change as barriers

Several themes (Table 21) were identified as highly relevant in this category, including the lack of integration of real-estate valuation with natural capital accounting, which also relates

to the barriers of not being understood, availability of resources, linking ecological change to financial outcomes through valuation, and changing behaviours. Under this category theme, "no integration with property valuations" was the obstacle that was most relevant to the investment enterprises and QLRF. This is related to the fact that investment management is required to report their outcomes to investors, which links environmental outcomes to financial outcomes.

Table 21 Land Valuation a barrier to implementation

Attribute	Investment Management	Policy	Family Farmers
No. interviews	**5**	**2**	**5**
Lack of integration with real-estate valuation	"One of the biggest barriers will be the skill set of the property valuation community"		
	"Investors will increasingly want to be shown proof that assets and natural capital are improving in value"	"Medium-term goal would be to see greater correlation between overlaying condition value on the real estate"	
	"I don't think that valuers are taking natural capital very seriously"		
	"If we said to the valuer here's the line, we want you to fill this in for Natural Capital. they say no we can't do that"		

6.5.7 Behavioural change as a barrier

A second theme around the obstacle of changing behaviours was highly relevant to the QLRF and L2M. This theme is associated with farming traditions, defined as "beliefs, principles or ways of acting that people in a particular society or group have continued to follow for a long time"(Cambridge University Press, n.d-a). As noted in section 2.6.4, the Green Revolution significantly influenced farming practices and moved farming to an industrial-productivity-focused industry. Changing the behaviours and mind sets of farmers around these practices was seen by the interviewees as a barrier to implementing natural capital accounting. This could also be related to the complexity of natural capital accounting and the overall lack of understanding of its requirements and purpose. This was seen as most relevant by the interviewees from L2M and the QLRF, although it was also mentioned by those from the investment-based enterprises. Examples of responses are given in Table 21 and

Table 22.

Table 22 Changing behaviours a barrier to implementation

Attribute	Investment Management	Policy	Family farmers
Changing Behaviours	I've got to say that there's not a lot of understanding at the individual farmer, private family farmer level. They seem to think that it's something that corporates must do"	"The traditional ways of thinking that farmers don't want to be told how to do things differently or their actions are environmentally damaging. This encourages them to conform"	"The main sort of thought leaders and policy layers in agriculture are still very much in the industrial mind set"
	"It's a communication piece of what it's all about. Through our workforce, our customers, suppliers and contractors to get them in sync with what we are trying to do"	"If the consumers are pushing to say that we need this, then farmers must change the way they are doing it"	"It's hard to get people to change their way of approaching farming or grazing or whatever they are doing"
			"There is a problem of how we go about getting people to think differently about things"

Two other themes stood out, although with lower relevance. The first was the lack of recognition of natural capital as a public good, which was seen as relevant to the interviewees in the L2M case study. Their responses included "*another issue I feel is a disconnect between consumers and producers a big city country gap".*

The other theme was the availability of resources, which was particularly relevant to all investment management enterprises, and is closely linked to the obstacle "lack of knowledge and understanding". Some comments referring to this from those attributed to institutional investment case studies were;

"*It's been a slow process and that's because of resourcing*";

"*The biggest challenge at the moment is that we are not resourced for it"* and *"we don't have the people in our business to do it*";

"*It's probably going to demand some changes to human resources*"… "*Maybe it's some different people in the system that have different skill sets*."

6.5.8 Government as a barrier

The final category identified was government, which was less relevant than the other categories but should not been ignored. The role of government in natural capital management is identified as important in the literature. There were mixed responses to the perception of governments' role and its influence in stimulating projects to deliver positive natural capital outcomes. The Queensland Government has deployed the QLRF, as a politically driven initiative at the state level, with a 15-year time frame. Projects under this initiative undertake carbon projects and generate environmental co-benefits that can be attributed to these projects. Natural capital accounts can be prepared using a framework, such as Accounting for Nature, to verify the benefits generated and deliver co-benefit payments for verified outcomes. Providing a level of longer-term support, such as the QLRF, is seen is crucial to achieving its outcomes. In contrast, the lack of support from government was identified as a relevant theme in the L2M responses. Several enterprise members noted that past government schemes did not have the longevity to deliver results and that funding was too short-term.

6.6 Conclusion

This chapter details the results from the semi structured interviews with case study members. The aim of the case study analysis was to understand the value proposition and barriers in adopting a natural capital accounting approach from the perspective of those actively implementing the approach. While the attributes of the case studies contributed to some differences in the importance of the value proposition and barriers there were factors common to all case studies.

The triggers that influenced the decision to undertake natural capital accounting that were common to all case studies included leadership. The strong philosophies around natural capital that were embedded within the organisation or individual were important in role they had in leading a positive change in the way landscapes were being managed by implementing accounting tools to verify outcomes. This was built on collaboration with trusted individuals that was designed to encourage behavioural change across the agricultural industry.

The interviews also identified that the common themes around the value proposition were financial reward and productivity gains. The data suggesting these rewards were more aspirational at this stage as the links between improved natural capital and financial outcomes were unclear. In addition, for those case studies with an established accounting regime there was no evidence of premiums being achieved for output associated with natural capital accounts. The interviews highlighted the value proposition in collaboration, through supply chains that can deliver preferential supply agreements as achieved by the family farmers in this research. Key differences between the case studies were those with investment attributes also saw value proposition centred around attracting investor capital and meeting investor needs around ESG. In contrast the family farmers took a more altruistic view of the value proposition focused on the social and environmental health outcomes. The case study with the policy attributes had a more holistic value outlook. With better financial outcomes for farmers, through new income streams such as carbon and co-benefits,. environmental and social outcomes can be delivered at a broader societal level.

All case-study-associated interviewees identified the cost of implementation, measurement, monitoring, and resourcing as the greatest obstacle to the implementation and on-going monitoring of natural capital accounting. This was also associated with a lack of market opportunities to monetise outcomes that offset the implementation and on-going operating costs.

The complexity of the concepts involved in natural capital accounting was also identified as a significant barrier to its adoption, and the lack of industry knowledge and understanding was a key theme in this category for all enterprises examined, coupled to the lack of relevant skills in the area. Those interviewees with attributes of family farmers and policy identified traditional behaviours and traditional agricultural practices as obstacles to the adoption of natural capital accounting closely associated with the theme of lack of knowledge and education.

Investment management enterprises identified the lack of evidence of any link between economic outcomes and ecological change, including through property valuations, as an

obstacle to encouraging the greater acceptance of natural capital accounting in agriculture. Institutions also identified a barrier around the time from implementation of a natural accounting approach to delivering observable results. Chapter 7 details the results from the focus groups.

Chapter 7: Focus Groups

Two focus groups, consisting of seven industry representatives per group, were undertaken in July and November 2021. Each focus group included a single representative from a range of sectors, including banking, investment, advisory, retail, real estate valuation, hospitality, and accountancy, to encourage the exploration of ideas and thoughts. The focus group participants were a sample of those industries that are affected by or influence agricultural practice and were identified in section 4.2.1 (
Figure 16).

An initial, 20-question pre-focus-group survey (see Appendix B4) was completed to stimulate discussion during the focus groups and to optimise the use of the limited time available. The pre-focus-group survey was completed by all the focus group participants and was used as a scaffold upon which to build discussion during the running of the focus groups. Like the interviews undertaken with enterprise members (Chapter 6), the distinct themes considered by the focus groups were: i) the value propositions of natural capital accounting; ii) the barriers to its use and/or implementation. The final session differed from the interviews with the enterprise representatives in that it asked the focus group participants to identify strategies that would encourage the adoption of natural capital.

The focus groups were undertaken to answer ***RQ2: What inhibits or motivates the adoption of natural capital accounting frameworks and how do these factors vary between stakeholders such as retailers, financiers, accountant's and investors?*** with reference to the main research question: ***How can improved understanding the views of the various stakeholders be used to remove barriers to the adoption and relevance of natural capital accounting in agriculture?***

7.1 Introduction

The focus groups were undertaken in recorded ZOOM sessions in response to the current COVID-19 restrictions. As mentioned above, a pre-focus-group survey was undertaken prior

to the group sessions. The results were then used to stimulate discussion in the focus group sessions. The composition of the survey is broken down in Table 7.

7.2 Participants' Understanding of Natural Capital

There were potentially 14 responses to the pre-focus-group survey. All respondents indicated they had some knowledge of natural capital, ecosystem services, or natural capital accounting. One participant (accountancy) indicated they did not understand the terms. One third of respondents had only heard of natural capital in the preceding 3 years.

Drawing on the results of the interviews with the enterprise members, the pre-focus-group survey asked the focus group participants to describe (in 100 characters or fewer): *What does it mean when you hear the term 'natural capital'?* The 12 responses were assigned to one of four categories (see Table 23). (Note: one respondent returned N/A).

Table 23. What does it mean when you hear the term 'natural capital'?

Offered Meaning of Natural Capital				
Industry	Value	Measurement	Environment	Financial
Banking	A metaphor to help illustrate that nature provides beneficial services to the economy.			An opportunity to acknowledge and reward primary producers looking after land and water.
Retail	Natural capital means recognising the value of assets related to nature.		Valuing and developing intentional management practices to improve the quality of natural resources.	
Accountancy	How managers of a production system value the utilisation of natural resources.			
Valuation	The value attributed to natural resources and the environment separate to monetary profit.		It is the natural resources, soil, water, air, geology, and organisms. It is the ecosystems.	
Food				
Investment	The store of wealth in natural resources available to be utilised, e.g., by an organisation.		Soil, water, air, plants, animals.	
Advocacy	The store of natural (e.g., environmental) resources from which other sources of capital are derived. The world's stock of natural asset values (economic/spiritual/cultural) flora, fauna, soils, water, air.			
Unknown	Identification of the natural base of agricultural systems and providing it with an intrinsic value.			

There was a common understanding that the term 'natural capital' referred to a value attributed to nature and the benefit it delivers to society. Only one response associated 'natural capital' with the economic reward associated with good stewardship. Interestingly, no participant considered natural capital in the context of measuring it, which according to the literature, is the process from which the concept of 'natural capital' sprang.

In the focus group sessions, some concern was expressed that the proposed definitions were not easy to understand. A retail representative stated *"these definitions in front of me, I'm lost they don't resonate. I don't connect and the penny doesn't drop when I look at this because when I look at things, I think of then communicating it to a customer base"*. An accounting representative noted *"probably got to put a little more normal person to it".*

7.3 Value of Natural Capital and Natural Capital Accounting to the Participants

The next set of pre-focus-group survey questions was designed to clarify how relevant or important natural capital and natural capital accounting were to the stakeholders and their industries. In the survey 69% of participant's thought that natural capital was a priority for their industry. The remaining respondents, from the accountancy and real estate valuation sectors, only considered it somewhat a priority or were not sure.

Those who considered natural capital only somewhat a priority or who were not sure expanded upon their views in the focus group sessions. They noted that their responses reflected the emerging nature of the subject. They also expressed concern about the commercial viability of undertaking natural capital accounting and the need to allocate additional resources to the process, which contributed to its low priority. A representative of real estate valuers noted *"it's probably seen as emerging in terms of whether it's a compliance or a marketing tool"*, conceding that *"I don't think there is probably as much action around it as there should be".* From an accountant's perspective, *"it's that juggle around what different levers you're pulling that impact on profitability, so I guess there is limited time and resources for people to implement different things"*.

In the pre-focus-group survey, natural capital was seen as a high priority by those who represented the sectors of banking, retail, and investment. When they expanded their survey responses in the focus group sessions, these representatives noted that risk management and the ecological sustainability of business models were key reasons that their industries considered natural capital important. One banking participant stated *"we see that the food and agricultural industry is really at the forefront of an unprecedented requirement for change".* An investor noted *"I suppose how I think about it, is not natural capital accounting per se, but more like the importance of ecological sustainability to business models."*

In the pre-focus-group survey, 54% of respondents indicated that economic opportunity underpinned the importance of natural capital to their business, with banking participants considering this the benefit of natural capital (Figure 27). The investment sector was the only group in which both participants cited the financial opportunities associated with natural capital accounting. In contrast, both retail sector participants suggested that addressing climate change was important to their sector. Of the respondents, 23% expected there will be future requirements for suppliers to report around natural capital projects, and retailers and real estate valuers saw this increased reporting would be a benefit for their sectors.

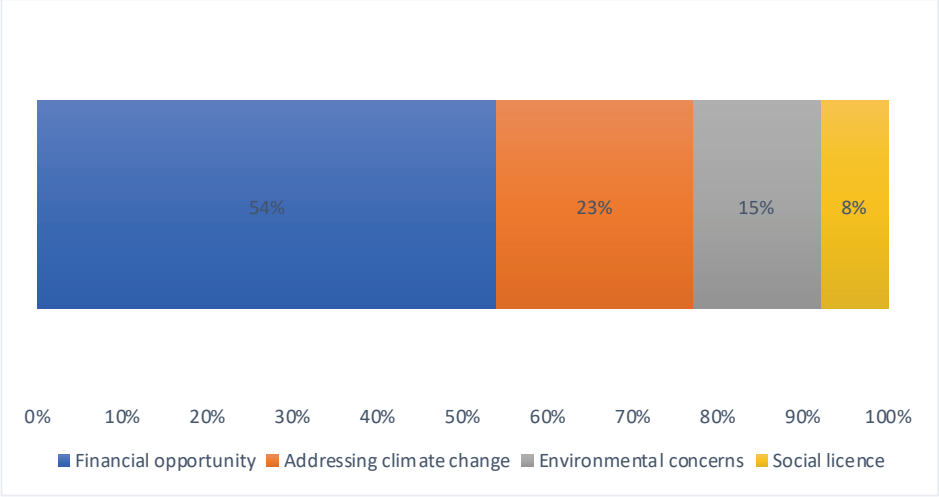


Figure 27. Why is natural capital important to your business?

These results contrast with the discussions in the two focus group sessions, in which understanding the risks and risk management was viewed by four of the industry groups as

an important value proposition of natural capital accounting. The response of one banking[16] participant referred to the financial aspect, but also considered the need to ensure the sustainability of a business, where "*it's a balance between commercial ambition, risk components and regulatory components*", whereas another commented "*customers need to communicate they understand their risks and their risks are being well managed*". An investor noted that the value proposition was centred around "*the importance of ecological sustainability to business models, as it represents risk*"; another noted that their business was trying to "*influence through analysing portfolios and portfolio companies and their exposure to natural capital*". An accountant responded within the context of climate change and intergenerational equity, that "for *the next generation, it's very much seen as a risk for them….how they manage their natural resources…we are seeing that conversation commence*".

Coding the session transcripts revealed that three of the participant sectors identified the potential financial benefits of engaging with natural capital accounting projects as a value proposition, which was consistent with the pre-focus-group survey results. A retail participant noted "*reward* [can be had] *through trading terms or a contract*", and one accountant noted that *"at the end of the day, it's got to be something that works for the business in terms of better productivity and better sustainability outcomes."* An investor noted that there were signs of financial rewards being generated when carbon projects were involved: *"if you have generated an ACCU [Australian Carbon Credit Unit] you can staple an AFN [Accounting for Nature] certificate to it to generate a higher price than an ACCU on its own".* While an AFN certificate is not an accounting it is a representation of the accounting results reflecting the condition of a landscape and can represent the additional value created by a carbon project.

These responses also indicate that the information or scope of natural capital accounts will need to be tailored to the needs of the user and what kind of decisions will be informed by the accounts. As an example, in retail, the accounts may need to identify how management

[16] One banking and one hospitality participant did not indicate financial or economic benefits as a value proposition. Both participants were in the first focus group, which experienced technical difficulties, so both of them did not participate in the full 1.5 hour session. This may have resulted in one or both not responding to the value proposition question.

activities can be attributed to change in the ecological health of natural capital. Translating through to financial benefits such as price premium or preferred supply agreements, with information presented as environmental condition accounts. Alternatively in the case of accountants or investors, natural capital accounts may identify how change is delivering better productivity on farm and measuring the economic benefits of the environmental assets, particularly in change in land value.

The differences between the results of the pre-focus-group survey and the qualitative focus group sessions highlight the potential limitations of the survey approach. The focus group sessions stimulated the development of ideas through discussion, which provided richer insights in the responses in the focus groups and the narratives behind them. A survey is one-dimensional and does not allow respondents to expand on their reasoning. A survey also does not allow respondents to consider the responses of other participants.

It was particularly revealing in the discussions within the focus group sessions that several participants felt there was no clear value proposition. One investor asked "*what are we trying to do, where is the pull for it? The utility doesn't seem clear at this point and how do you evolve it when you're not sure what you need it to do?"* Another investor noted that *"the business case is unclear from a perspective of it being able to articulate a percentage return on investment".* A member of a not-for-profit organization pointed out that *"we are really struggling to find a strong reward signal".*

No other theme was specified as either a value proposition or a barrier in either the pre-focus-group survey or the focus group sessions. As with the enterprise-associated interviewees in Chapter 6, the financial value propositions appeared more aspirational than tangible, and although one investor highlighted the potential to staple AFN certificates to ACCUs to generate higher values, this appeared emergent rather than mainstream.

When addressing climate change as a value proposition in the focus group sessions, an investor noted "*that sustainability of ecosystems is as important an issue as climate change*". Further discussion focused on climate change and its impact on food systems and therefore natural capital. One respondent from the not-for-profit sector noted "*climate change is an*

existential threat to Australian agriculture" and a banking sector representative asked "*as far as climate change is concerned, what is the food system of the future?*". In the pre-focus-group survey results (Figure 27), three respondents, representing the retail, real estate, and not-for-profit sectors, indicated that climate change was important. In the pre-focus-group survey, banking and real estate representatives stressed that environmental concerns were important.

The focus group participants were not specifically asked in either the pre-focus-group survey or the focus group sessions which natural capital elements they saw as important when accounting for natural capital. Despite not being directly asked there were indications identified in the transcripts of elements that are considered important. Of the 14 participants in the two focus groups, three participants identified soil as important, and three also identified carbon as important in measuring natural capital. These responses were consistent with the responses given in the interviews with enterprise representatives (see section 6.4.5). Biodiversity and water quality were also identified as important elements of natural capital by one participant each.

7.4 Integration of Natural Capital into Decision-Making

To understand how or if agricultural stakeholders consider natural capital when making decisions, the participants were asked in the pre-focus-group survey whether they knew others in their industry who were reporting the risks posed by the degradation of natural capital. Interestingly, the results (Figure 28) showed that 62% of those who responded answered "no", they were not aware of others reporting the risks of natural capital degradation. Because degradation is only one element of natural capital, a more specific question, such as "for which elements of natural capital, such as soil, water, or biodiversity, is your industry reporting the quality?" may have elicited a different response. Notwithstanding this, the response is rather surprising given the importance participants placed around natural capital. As indicated by the questions in the survey leading up to this point prompted very different responses:

- 69% of respondents indicated that natural capital was a priority;
- natural capital was a priority because it offered financial opportunities, and involved climate change and environmental concerns, as indicated in the pre-focus-group survey (and also in the discussions in the focus group sessions);
- 70% indicated that their industries had taken steps to improve the management of natural capital; and
- the participants also indicated that these responses reflected the attitudes of others in their industries.

It is difficult to pinpoint the reason for these seeming contradictions, although they could reflect of the immaturity of the concepts and the lack of focus on natural capital across the stakeholder industries and the small sample size. This was possibly best expressed in a focus group session by a real-estate representative, who noted that *"I don't think there's probably as much action around it as there possibly should be."*

The five focus group participants who stated that they knew of others in their industries reporting the risks of natural capital degradation were from real estate, retail, investment, policy, and banking. Interestingly, the real-estate-associated participants had previously provided a neutral response to the importance of natural capital for their industry in the pre-focus-group survey.

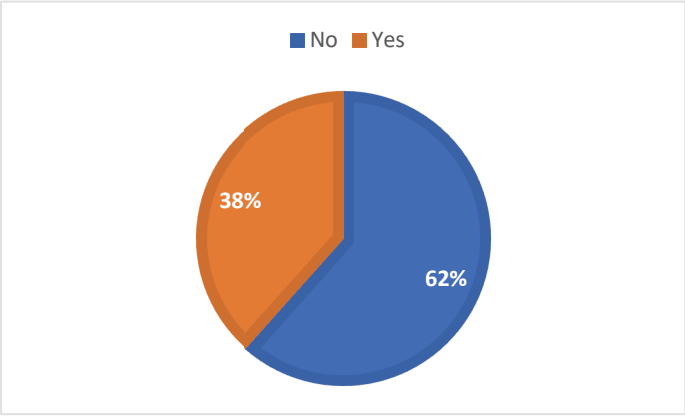


Figure 28. Do you know of others in your industry reporting on the risks posed by the degradation of natural capital?

7.5 Is Natural Capital Accounting Understood?

Natural capital accounting is a modern concept that is viewed in the literature as a tool to improve our understanding of natural capital, its condition, and its extent. As noted in section 6.5.4, an understanding of how well the terminology and concepts are recognized or understood in a population can clarify how the integration of natural capital and natural capital accounting into industry is progressing. The responses to the question in the pre-focus-group survey concerning how well natural capital accounting is understood can be seen in Figure 29. These results also support the findings of the cases studies, in that the participants in the focus groups indicated that the concept is understood by a very select few.

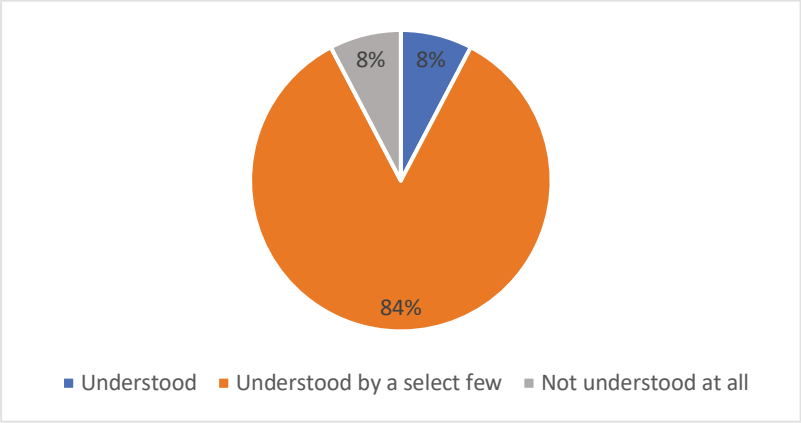


Figure 29 How well is natural capital accounting understood?

In terms of this question, the pre-focus-group survey results were reiterated in the focus group sessions. A retail participant noted that *"I don't think the penny has dropped"* and *"we need to train people to understand natural capital",* whereas an investor asked "*is the idea of natural capital itself important? I don't see it at this stage"*. Finally, a representative of the hospitality industry noted *"most people don't understand the concept of natural capital".*

7.6 Barriers to Implementing Natural Capital Accounting

The pre-focus-group survey asked the participants to describe the barriers to their sectors' adoption of a natural capital approach or focus. The survey question prompted some interesting responses, which were similar in some ways to those of the case study representatives. A consistent view of the respondents was the lack of evidence supporting the benefits of natural capital accounting. Table 24 summarises the responses to this survey question.

Table 24 Barriers that prevent industry adopting a natural capital approach or focus

Industry	Comment
Banking and Retail	Red tape; evidence around natural capital is weak; what are the benefits of doing this and what are the risks of not doing it? Lack of clarity
Banking and Retail	Lack of evidence; lack of capacity to measure and verify outcomes
Banking and Investors	Lack clear financial incentives
Banking	Status quo bias; family succession
Investors	Resourcing; competing priorities
Real Estate	Valuers already comment on condition; its complicated; and lacks transparency
Accountants	Focus is on financial return; compliance and tax; not natural capital
Policy/Government	Requires collaboration nationally and across industries; lack of market, trust, and control of destiny

The most surprising response to this question was provided by a banking representative who indicated succession where someone or some entity inherits or is considered for inheritance of a natural capital accounted project can be a barrier. This comment was not followed up or mentioned in the focus group sessions. Although it was not mentioned beyond the pre-focus-group survey, succession emerged as an important consideration in context of the interviews with the case study participants much later in reflective discussions with interviewees from the case studies. For example after the focus group, a banking representative also noted that *"the lack of succession outlook for farmers can impact the motivation and appetite to make long-term sustainability decisions for farm operations"*. This highlights the voluntary nature of natural capital accounting with no formal requirement for farmers to undertake the

approach. Considerations of succession planning or the transfer of ownership can influence the decision to undertake a natural capital accounting project. This also potentially impacts stakeholders, who rely on the data or the provenance of output. The lack of a succession outlook can lead to assessing opportunity cost of the near-term benefits compared to the cost of implementing and managing a natural capital program, and potential return expectations. This could lead to an alternative scenario of doing nothing if there is no long-term succession plan. The do-nothing scenario may be particularly relevant here, as rural land values have increased substantially in recent years providing landowners with the option to realise increased capital by divesting assets. The Australian Farmland Values survey 2021 indicated the median price per hectare of Australian farmland increased 12.9% in 2020 the seventh year of consecutive compound annual growth (Rural Bank, 2021). While continued growth in land values cannot be guaranteed the ability for a farmer to capture this additional value in land, when succession is not guaranteed, provides an alternative option to and a barrier to adopting a natural capital accounting approach. Conversely where natural capital accounting is undertaken and ownership of an asset is transferred there are no guarantees that new owners will continue to undertake natural capital accounting leading to uncertain long term natural capital outcomes.

In the pre-focus-group survey, another banking participant mentioned status quo bias, citing farmers' preference for existing practices as a barrier to the adoption of natural capital accounting. Expanding on these comments in one focus group session, an accountant pointed out that *"they feel they are doing a good stewardship job of their land and not seeing the bigger picture. Until my clients are seeing a better bottom line for going along these lines, you're probably not going to get buy in."* A real estate representative noted that "*we have this issue of adoption and acceptance of new systems"*.

These responses are consistent with the issues raised in the interviews with the case study participants, who also cited traditional values and practices as barriers to the adoption of new methods. These values are compounded by a lack of knowledge, education, and information, a point also raised by all the participants in focus groups.

The lack of evidence for the validity of natural capital accounting and its capacity to deliver a value proposition was deemed a significant barrier to the adoption of natural capital accounting in the pre-focus-group survey responses. These responses were also consistent with the discussions in the focus group sessions, with all sectors concurring that the evidence for validity of natural capital accounting is still in question. A representative of the not-for-profit sector suggested that *"we are struggling to find a strong reward signal"*, and another that "*there is no holistic whole farm systems reporting mechanism available to them for reporting"* and that *"most of this stuff is not driven by robust data"*. A banking sector representative pointed out that *"you want to be able to provide evidence that the information has been collected properly"*. One investor noted that *"I think the business case is unclear from a perspective of it being able to articulate a percentage return on investment"*, and another investor suggested that it *"needs to be relevant to doing management, needs to add some value there, otherwise you wouldn't bother".* These responses indicate that there is uncertainty around current frameworks and the robustness of the data behind them. Importantly they also they highlight a disconnect between the literature and the purpose of natural capital accounting. The literature has a strong focus on the risks posed to human well-being and agricultural business operations through the degradation of natural capital. If natural capital is degraded, then agricultural business will be constrained in what they can produce, if anything. From the responses above the focus of respondents on the additional financial benefits or value in undertaking natural capital accounting suggests a lack of understanding around the purpose of natural capital accounting and the risks in not measuring and monitoring.

As noted in section 7.5, the lack of knowledge and education around the subjects of natural capital and natural capital accounting were perceived as barriers to the adoption of natural capital accounting. This is closely related to the lack of skilled resources, which was also considered a barrier. "*I think it's a capability question"* (retail) and *"we need to train people to understand natural capital"* (retail).

Together with the lack of knowledge, accountants and bankers also identified time as a barrier to the adoption of natural capital accounting: "*what holds people back is not so much the actual capital itself but just the time to invest themselves in understanding"* (accountant). "*If*

you need to adopt certain practices, this going to cost an organisation more time and you need an educated workforce to actually do it" (banking).

Additional barriers identified during the discussions in the focus group sessions included competing priorities, which was raised by investors and retailers: "*so there is competing priorities, there's competing questions….there are so many different touch points "* (investor) and *"so considering the scale of operations, things like emissions, footprints, all those types of things start to feed into the melting pot of where we focus our attention"* (retail). The retail representatives also identified competing priorities, such as the problems of food waste and plastic, as examples of barriers with potentially higher priorities.

7.7 Is Natural Capital Accounting the Best Way Forward to Address and Reward Environmental Stewardship?

In the final stage of each focus group, the elements of the discussion were brought together to clarify the participants' thoughts and ideas about whether natural capital accounting is the most appropriate way to address the issues around natural capital.

The accountants in the focus group sessions felt there was a need to *"focus on the impact the process has on the productivity of the business and the sustainability of what was put in place"* and alternatively, *"if you want someone to invest, it's a federal government issue and they need to put some tax concessions around it".*

A banking industry representative stated in the pre-focus-group survey that natural capital accounting would "*not address public benefits provided by farmers*". The lack of focus on the public good or socio-economic factors was also highlighted in the pre-focus-group survey by a policy participant, who felt that the approach was "*too financially focused*". Retailers' responses to the pre-focus-group survey indicated that natural capital accounting was "*the best way forward to avoid alternative outcomes of regulation and restrictions on market access"*, while another felt that it was a great method although its benefits should still be transparent to customers.

In one focus group session, a retailer felt that the cost of establishing projects may be prohibitive and would require partnership arrangements to offset these costs. A similar response was given by a real estate representative: "*it is complex because without some form of kick start, it's a bit tricky having to fund that".*

In the focus group sessions, there was consensus among all the participants of the need for more strategic alliances and greater collaboration, which would be a catalyst for the wider adoption of natural capital accounting. These responses closely replicated the view of Dasgupta (2021, p. 492), who stated that knowledge must be pooled and disseminated across organisations and communities.

7.7.1 Potential Ways to Improve the Adoption of Natural Capital Accounting

From the responses in the pre-focus-group survey and focus group sessions, three common themes were identified as potential ways to stimulate the adoption of natural capital accounting. These were collaboration, communication, and a single, simple, flexible approach (see Table 25).

Table 25 Summary of strategies identified in focus groups to improve the uptake of natural capital accounting in agriculture

Industry/Sector	Collaboration	Single Simple Approach	Communication
Investment		*"The best, most efficient way to do that and in a repeatable way"*	*"Build the case that this delivers better outcomes with evidence"* *"Need to better articulate the positive outcomes to the broader public"*
Banking	*"I think strategic alliances are the way forward"* *"Defining shared values with supply chain"*	"*If we don't start from an agreed point, we have no means to measure*"	
Retail	*"Partnerships are being seen as critical, where you can have shared interest and create shared values"* *"Suppliers driving collective action"* *"Collaboration and shared values"* *"Partnerships with those needing offsets"* *"Corporate partnerships could kick this off""*	"*Need a consistent lens*"	"*It's about awareness"* *"The consumer has to be part of the story, getting them engaged is a bit of a barrier"*
Accounting	*"We are seeing good collaboration between Bega cheese and their suppliers, so there are areas where there is a bit of collaboration"*	"*Simplicity and consistency about a system is going to be what's important*"	
Real Estate Valuation		"*Avoid repeating what's been done*"	
Hospitality			"*Education, start with soil*"
Not-for-Profit Sector	"*it's about multi stakeholders having clear involvement*"	"*a national approach"* *"Leadership needed to make it work*"	

In contrast, as well as identifying the lack of a value proposition, concerns were voiced in the focus group sessions that a lack of focus and fragmentation around solutions would hinder the adoption of natural capital accounting. In the discussions, a representative of the not-for-profit sector noted *"it's at risk of sort of spinning off into nowhere unless its grabbed in and turned into some sort of agreed direction"* and an investor noted *"there needs to be some agreement to what it looks like at a national level"*; and from an accountant, *"we are going to end up with a whole heap of different parts of the industry going off and doing their own thing and not meaning a lot".*

In the pre-focus-group survey, one investor was hesitant that natural capital accounting was the right way forward, suggesting that "*for now it was the right way"*, whereas another responded in the survey that "*it needed to focus on real-world outcomes, such as productivity*". The focus group sessions reaffirmed this, with one investor asking *"shouldn't one of the benefits be better outcomes? Isn't it meant to get higher yields? Isn't it meant to reduce inputs? Won't natural capital help do that?".* Another responded *"that would be in terms of access to capital and access to lending, maybe getting better rates, etc. I think that requires evidence around it as well"*. The following

Table 26 and Table 27 identify the key coding themes from the Focus Groups.

Table 26 Focus Group Coding Section 1

Stakeholder Groups	Coding		
	Value Propositions	**Barriers**	**Solutions**
Investors	Impact Risk management Higher yields Lower inputs Investor demand Compliance	Climate change pre-eminent Emergent No value propositions Relevance Cost of doing it information Framework validity	Communication Collaboration Value proposition Link financial and government contributions
Banking	Food security Reputation Risk Sustainable business Institutional demands	Access to labour No clear public good Business case Lack of Capital Education Time	Supply chain Collaboration Share cost Information Measurement tools Data verification
Fresh Food Retail	Intergenerational equity Risk Management tool Financial/productivity Customer demand Accountability	Capability No urgency Value transfer Cost of doing it Does not resonate Understood by select few Reporting unclear	Frameworks Supply chain Collaboration Incentivise behaviours Capital Education Standards

Table 27 Focus Group Coding Section 2

Stakeholder Groups	Coding		
	Value Propositions	**Barriers**	**Solutions**
Real Estate Valuers	Improved returns	Food affordability Greenwashing Lack of value Knowledge	Identify issues Market will self-correct
Accountants	Intergenerational equity Better returns Condition of lending Shareholder driven	Perverse outcomes No interest No value proposition Productivity impact No capital Time No standard	Market will drive Banks Government incentives Commerciality Simple standards
Hospitality	Soil	Complexity Don't want to pay for it Cost Disconnect between consumers and producers Lack of farmer knowledge	Soil Standards
Industry/Not-for-Profit Sector	Intergenerational equity Social licence Risk management Market access Resilience	Lack or privacy of data No value proposition Market does not value it Cost No co-ordination Lack of knowledge Lack of framework No metrics	Shared values Government role Transparency National standards

7.8 Conclusion

In this chapter, I aimed to clarify the value propositions, barriers, and possible strategies to integrating natural capital accounting into stakeholder businesses. Over 50% of the respondents indicated that natural capital accounting is important to their business or industry, and 70% had taken steps to these address issues. A combination of financial opportunities, ecological sustainability, productivity benefits, and risk management were the main value propositions for stakeholders. Although these value propositions were

identified in both the focus groups and the interviews with enterprise representatives (Chapter 6), the overall value propositions for undertaking natural capital accounting were aspirational rather than empirical, which can be attributed, at least in part, to the emergent nature (identified as a barrier) of natural capital and natural capital accounting. A small number of participants in the focus group sessions considered soil and carbon to be important elements of natural capital that could be measured and where value could be captured.

The results also identified high levels of uncertainty around the value propositions of natural capital accounting, and the focus groups identified the lack of tangible value propositions as a barrier to its adoption. Some participants saw the financial opportunities emerging from natural capital engagement as debatable. The lack of knowledge, information, standardised data, and reporting frameworks, together with its complexity, compromised the acceptance of natural capital accounting by stakeholders. Broader issues around prioritising climate change, food waste, and eliminating plastics were also identified as barriers to its adoption as natural capital has not become a prominent issue.

The focus groups cited the need for strategic alliances and collaboration across industries and consumers to increase the knowledge of natural capital and natural capital accounting, together with education about them across stakeholder groups, to allow these stakeholders to develop effective tools to collect data, measure and monitor natural capital. The aim of collaboration is to ensure consistency in any approach developed and greater alignment of interests among stakeholders through shared values and shared interests. Investors, accountants, and industry advocates stated that government should play a role in developing strategies and/or providing incentives to encourage the wider adoption of natural capital accounting. Chapter 8 will review the results from the farmer survey.

Chapter 8: Survey Results

In this chapter, I present the results of an on-line survey sent to a diverse range of farmers. The survey does not replicate the case studies but aims to identify different perspectives on natural capital and natural capital accounting. The survey was independent of the pre-focus-group survey.

The survey also contributes to answering **RQ1: *How do farmers perceive natural capital value and the need to measure it?*** The survey was opened for responses from the beginning of December 2021 and closed at the end of February 2022. In total, 74 completed surveys were received. The survey was accessed or viewed 121 times. Only one person declined to participate in the survey, answering NO to the first question, which then prevented them from progressing further in the survey. Of the 74 completed surveys, one participant did not complete all the questions. Forty-six people appeared to choose not to participate after opening and browsing the survey questions, closing the survey without answering any questions. The survey was completed by a geographically diverse range of farmers and was dominated by responses from farmers in NSW (Figure 30), this was likely to be influenced by the location of groups assisting to distribute the survey being mainly located in NSW.

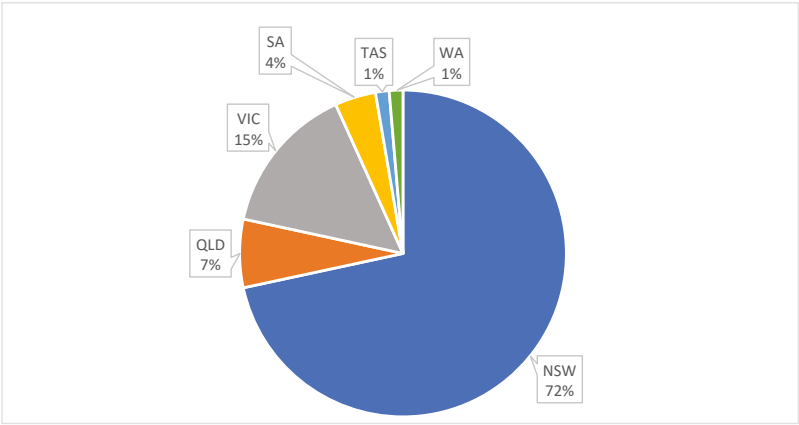


Figure 30 Locations of participants in the survey

Survey respondents were dominated by those in grazing enterprises *Figure* 31

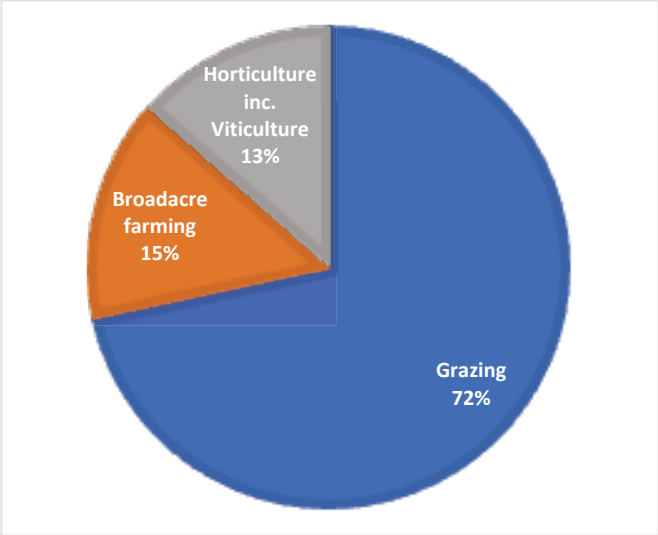


Figure 31 Respondent by farm type

The size of farming operations of respondents varied although 50% of respondents were associated with enterprises of between 500-250 hectares, With 13% associated with enterprises of greater than 5,000 hectares *Figure* 32.

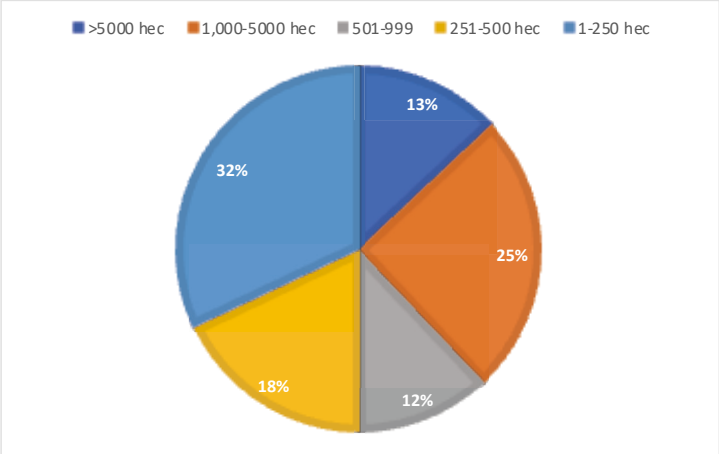


Figure 32 Respondent by farm area

The survey was not directly offered to the representatives of the case studies, although it was possible that they had access to the link through several external groups that assisted in the distribution of the survey. Evidence of their participation could be found in the responses to Q18 of the survey, which asked “Are you currently actively participating in environmental stewardship programmes?” The responses to this question indicated that natural capital accounting was not an environmental programme in which the survey respondents were or had been involved, indicating that no case study participants had completed the survey.

8.1 Survey

The survey provided an effective way to contact a wide range of farmers and to understand their perceptions of natural capital and natural capital accounting. As noted, the survey was completed by 74 participants across several states, with the majority in NSW. The survey was sent with the assistance of several sources[17] and it is difficult to ascertain with accuracy how many emails were distributed by these sources. Additionally, the survey was sent to 35 farmers known to myself. The results of the survey are predominantly quantitative, although questions 14, 16, 19, and 21 also provide short qualitative answers.

Of the farmers that participated, 49% of respondents were aged 46-65 years *Figure* 33;

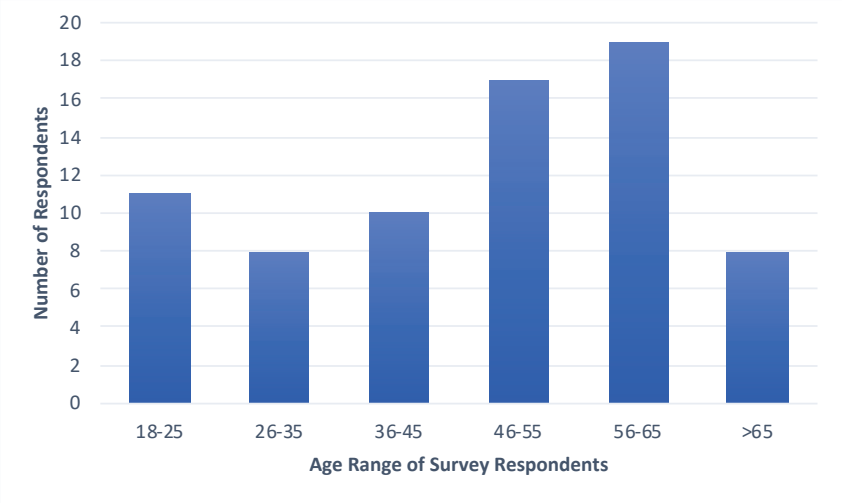


Figure 33 Age range of survey respondents

8.1.1 Who Influences Your Decisions in Relation to Your Agricultural Enterprise?

The participants were asked to tick their top two answers. The purpose of this question was to understand what stakeholders influence farmers' decisions and potentially motivate their behaviours around natural capital. It clarified how these relationships shape or influence the implementation and effectiveness of farming practices. Combining the choices, family or partners were the dominant influencers when farming decisions were made, followed by consultants and advisors (Figure 34). Those farmers who selected 'other' did not list anyone under that category, although they had the option to do so.

[17] External sources that assisted in distribution of survey included, DPI NSW, Southern Cross University, Marcus Oldham and FarmLink

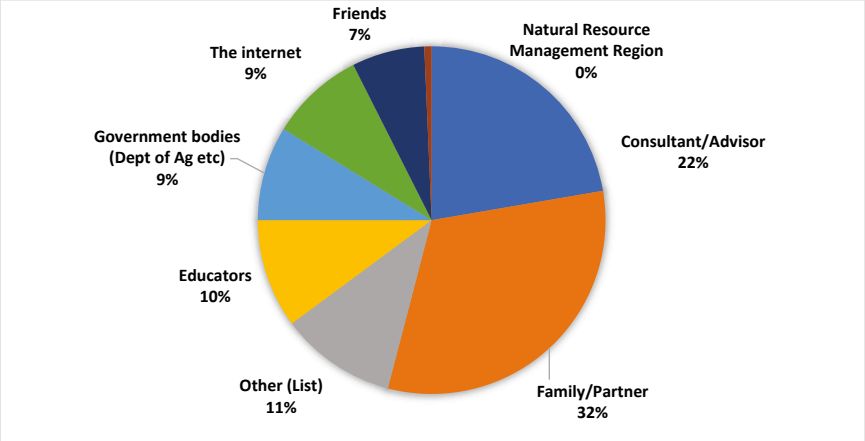


Figure 34 Who influences your decisions in relation to your agricultural enterprise?

8.1.2 How Do Long-term Environmental Issues Rank in the Context of Other Pressures/Issues Facing Day-to-Day Farming?

Environmental issues were considered important by 74% (n=55) of the survey participants, ranking environmental issues 'high' or 'very high' Figure 35. To determine whether the ages of the participants influenced their answers, the data were filtered according to age bracket. This indicated that of those completing the survey in the age group 18–34 years, only 28% ranked environmental concerns 'high' or 'very high'. By comparison, 47% of those aged ≥ 46 years ranked environmental concerns 'high' to 'very high'. Of the 19 participants who responded 'unsure' or 'low', eight were aged 18–35 years and six were 56–65 years. These data suggest that younger farmers are less concerned about environmental issues than about other issues affecting farming. Given the small sample it is difficult to draw any strong conclusion from these results.

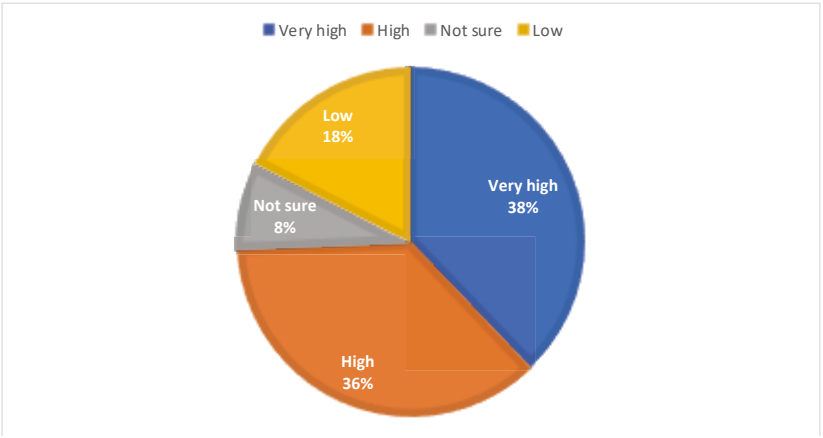


Figure 35 How do long-term environmental issues rank in the context of other pressures and issues facing you in day-to-day farming?

8.1.3 How Important is Climate Change?

Following on from environmental concerns, two questions were asked that focused on climate change.

Q8 How important is climate change to Australian agriculture?

Q9 Climate change will have an impact upon your business?

The responses to these questions indicated that climate change is considered very important in the context of Australian agriculture. The importance of climate change rated higher than the importance of environmental issues: 84% of respondents considering its importance 'high' to 'very high', whereas 74% considered the environment as important. *Figure* 36 indicates as a percentage of their age cohort, those in older age categories from 46 and older considered climate change as of very high importance to Australian Agriculture.

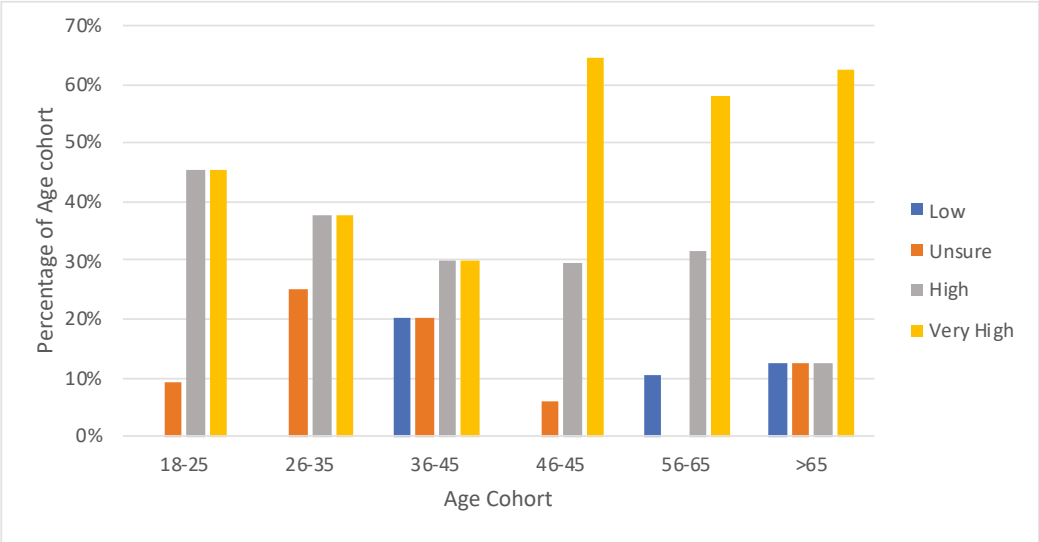


Figure 36 Importance of Climate Change to Agriculture by Age category

There was similar strong agreement with the statement that "climate change will impact agricultural businesses," with 83% (n=61) agreeing or agreeing strongly. There was also more uncertainty in the responses to this question, insofar as 12.2% (n=9) replied 'not sure'. When the data were filtered according to age, Figure 37 responses by age cohort to the statement "Climate change will impact your business"., older age groups (46->65) again agreed that climate change will impact their business. Interestingly a high percentage of the 18-25 age group that responded also agreed to this statement.

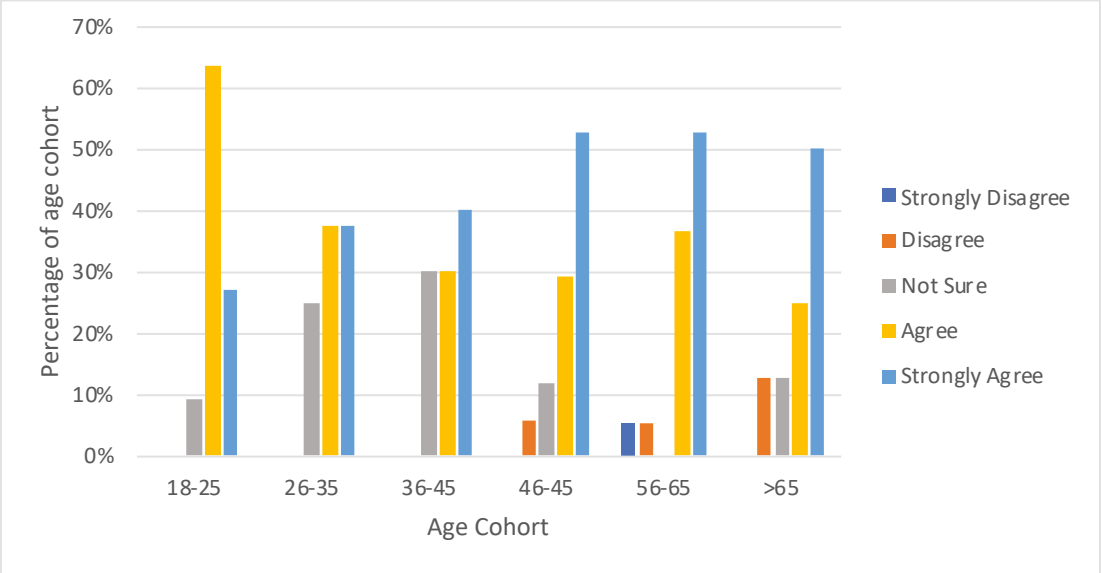


Figure 37 Survey Responses to statement "climate change will impact your business".

8.1.4 Terminology

The participants were asked to indicate the natural capital terminology that they had heard previously by ticking boxes next to the appropriate terms (participants could tick multiple boxes) (Figure 38). The answers were dominated by terms relating to carbon: most participants (99%) had heard of soil carbon and 93% had heard of carbon farming. Only 41% of participants had heard of natural capital accounting, and 60% had heard of natural capital. These responses are consistent with the findings of the case study interviews and focus groups, and indicate that knowledge and understanding of these concepts may be a barrier to the adoption of natural capital accounting.

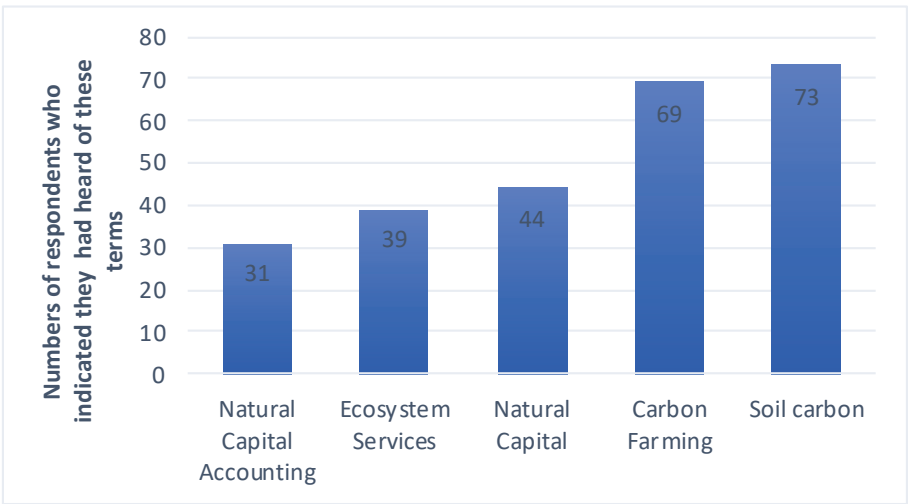


Figure 38 Which of these terms have you heard before?

8.1.5 Importance of Natural Capital and Natural Capital Accounting to Your Business

After the participants' understanding of the terminology had been established, they were provided with definitions of 'natural capital' and 'natural capital accounting' and asked how important these were to their businesses. Despite their poor understanding of the terminology revealed in the previous question, when provided with these definitions, the respondents were more positive about the importance of natural capital. However, their responses to the importance of natural capital accounting indicated that they considered it less important (Figure 39).

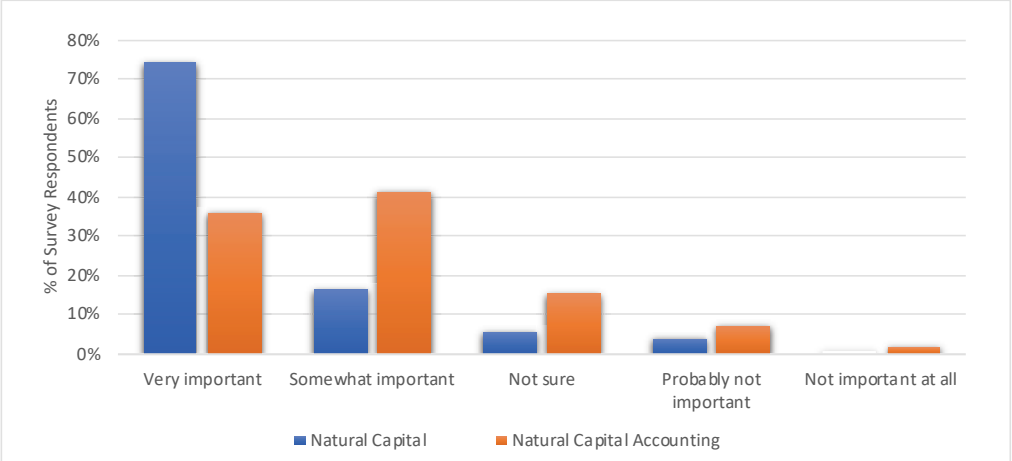


Figure 39 Importance of natural capital and natural accounting to your business

8.1.6 Are Natural Capital and Natural Capital Accounting Understood in your Industry?

As in the interviews with case study members and the focus groups, the survey asked how well the terms 'natural capital' and 'natural capital accounting' were understood across the farming industry (Figure 40). Given the responses to the previous questions, this question would have benefited from being separated into two questions, focusing on natural capital or natural capital accounting. The results strongly suggested that the terms are understood by only a select few across the farming industry, as in both the interviews with case study participants and focus groups.

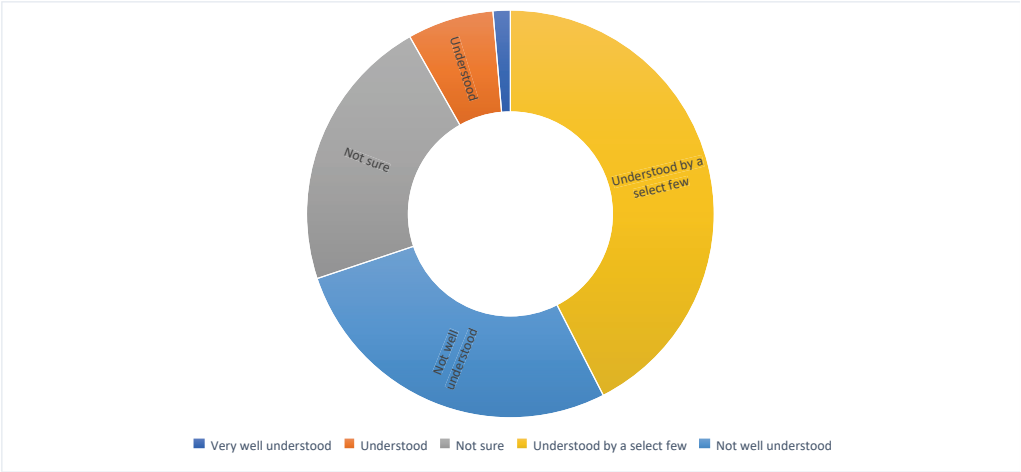


Figure 40 How well are 'natural capital' and 'natural capital accounting' understood?[18]

8.1.7 Do You Think Carbon Farming a Priority in Agriculture?

The purpose of this question was to identify how farmers perceive carbon farming, given that it is more advanced in its development than natural capital accounting, particularly through regulatory frameworks. The results were split evenly, with 47% of farmers unsure or disagreeing that carbon farming is a priority. The participants were also asked to explain their choice of answer. The respondents who were 'unsure' focused on the difficulty of access to the carbon credit scheme and the cost to access to the scheme, and showed a high level of scepticism, with one suggesting "*only people making money are the brokers—not the farmers*". The farmers who responded positively recognised the potential productivity benefits.

The negative responses to this question included:
"Current costs to base line are expensive, and those contractors doing it are locking the producer into long-term agreements. Some farmers are then getting less than 30% of the carbon credits"

"Significant concerns that carbon farming will be regarded by the public as a money grab or marketing tactic for corporate non-Ag businesses, which will overshadow the importance of what is trying to be achieved. Developing concept of natural capital for benefit of both private

[18] Very well understood represents 1.4%

Ag business and the on-going benefits that will have to the public and help to reduce atmospheric pollution is a better priority"

- *"I believe it should be a priority but there isn't enough information for farmers about it or it is all very complicated and expensive to be more readily used"*

The more-positive responses included:

- *"I don't understand it or how it works but believe we have an asset which should be tapped into"*
- "The higher the carbon soil level, the more productive the soil"
- "Being able to build carbon is a key indicator for a sustainable enterprise"

8.1.8 Environmental Stewardship Programmes

As stated above, this survey was sent to a wide range of farmers and the purpose of this question was to understand the work farmers are currently doing that involves sustainability or natural capital. The results of this question and the following four questions can be compared with the results of the five case studies reported in Chapter 6, whose understanding was well-developed and whose plans regarding natural capital clear.

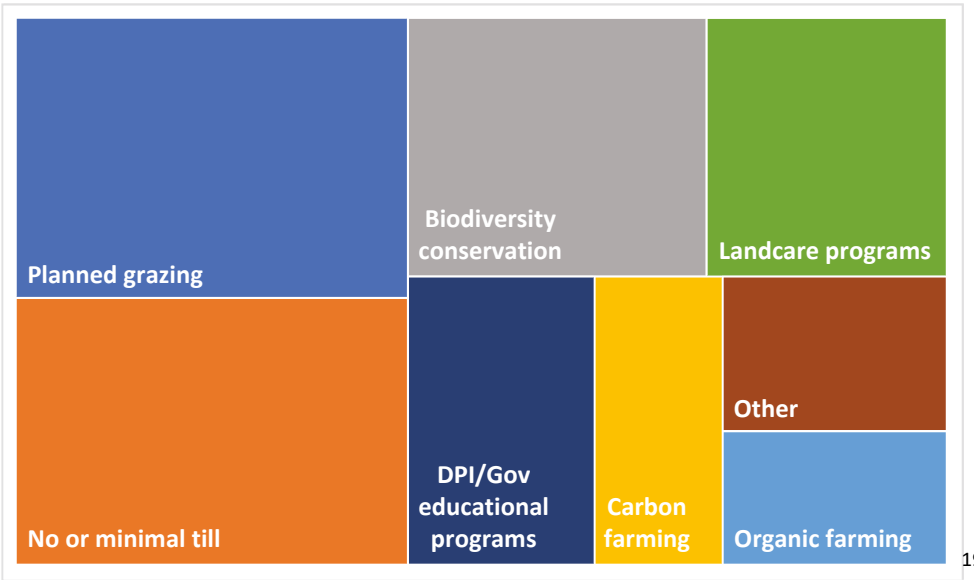
In this survey, 55% of participants reported that they were "actively" involved in some form of stewardship programme, whereas 45% were not actively involved. It should be noted that the use of the term "active" is important when considering the results of the question on stewardship programmes. Farmers may have previously participated in programmes but were transitioning to others or had completed programmes. One respondent noted *"one can do any or all of the above and not be involved in a programme"*, indicating that farmers can use their own knowledge and initiatives outside formal programmes.

This question can be compared with Question 17 that asked the respondents where they were on their sustainability journeys. In that case, the responses indicated that 47% were well advanced, with the rest just beginning it or considering their options. Figure 41 below illustrates the wide range of environmental programmes in which the survey participants

were involved. Many of these programmes do not provide any direct financial payment for stewardship and are undertaken to deliver long-term benefits to farming operations. Several programmes are designed to target specific environmental issues. The responses also indicate that farmers are willing to participate or try numerous programmes to determine what works best for their situation. This included farmers who said that they were not currently involved in environmental stewardship programmes.

Planned grazing, no-till or minimal-till farming, and biodiversity were the three main programmes in which the farmers were involved. The participants also listed:

- ecological farming, working with nature rather than against it;
- Yarra Ranges Ribbons of Green, Melbourne Water's Stream Frontage Management Program, Land for Wildlife, and Sustainable Winegrowing Australia;
- Hosting Natural Resource Management long-term ecological monitoring trial sites to evaluate the effect of regenerative agricultural practices on agroecology;
- "*We use strategic grazing that suits us.*
- Rivers of carbon; water management;
- Regenerative farming education;
- "*We practice many of the above-mentioned items, however, are not involved with any government schemes*";
- Education;
- Organic practice, not regeneration;
- Reclaiming unproductive land;
- Yellow box stewardship.



[19]

Figure 41 Environmental stewardship programmes that respondents indicated they are or have been involved with?[20]

One response to this question indicated that farmers could do any or all the above and not be involved in a formal programme, or that they may not be actively undertaking a programme but had previously done so.

8.1.9 Of Which Environmental Programmes Have You Heard?

Following on from the previous question, the participants were asked to nominate farming, programmes or frameworks of which they had heard (multiple responses were allowed which resulted in a total of 221 selections being made). The list provided in the survey included programmes that were associated with natural capital accounting or were frameworks. Over 50% of responses identified regenerative agriculture and permaculture as the dominant methods or programmes (Figure 42). There were 67 positive responses for regenerative agriculture and 54 for permaculture. The next highest response rate was 25 for Landcare Benchmarking projects, which included a targeted natural capital and carbon footprint awareness programme. The responses indicated fewer survey respondents were aware of natural capital and frameworks, such as Accounting for Nature, Ecological Outcome Verification (EOV), SEEA and the Natural Capital Protocol. Respondents were more aware of

[19] DPI = Department of Primary Industries NSW
[20] Size of the box represents number of responses – larger box higher number of responses

the methods or management practices associated with sustainable agriculture such as regenerative and permaculture.

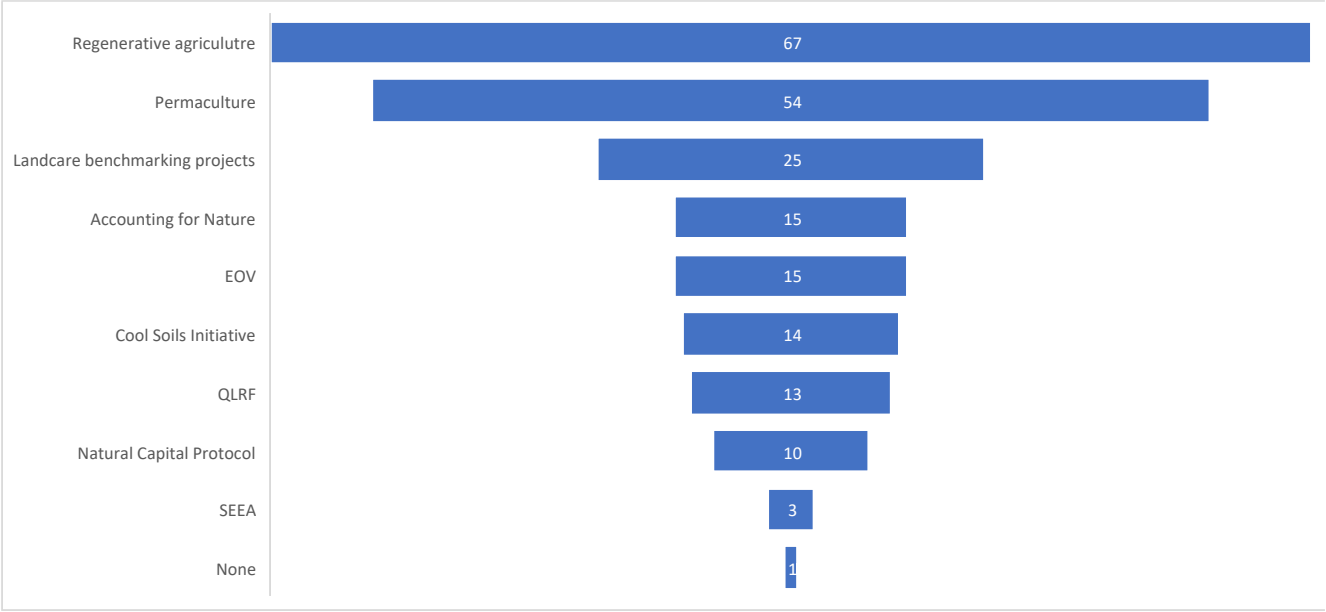


Figure 42 Of which of these environmental programmes have you heard?

8.1.10 Is Natural Capital Accounting the Best Method to Stimulate Better Environmental Management?

Sixty per cent of respondents did not know if natural capital accounting was the best way to stimulate better environmental management, and 11% responded that it was not. The respondents were offered the opportunity to provide a short comment on this question to explain their answer. The responses reflected their limited knowledge of natural capital accounting and their concerns around cost and compliance. Some responses indicated that a financial incentive was the best way to stimulate better land management outcomes.

- *"I'm pretty far along on my regenerative agriculture journey and this is the first time I have seen mention of these terms"*
- *"Never heard of it"*
- *"It will make sense to the money people, but its about money, which is why we have the problem in the first place"*
- *"Depends on the cost of compliance and accounting"*

- *"It needs to be linked with other motivators; especially intrinsic motivators customised for particular properties"*

8.1.11 Where are the Most Important Opportunities for Promoting the Management of Natural Capital and what are the Obstacles to Implementing Natural Capital Accounting?

This question allowed multiple responses. There was a clear consensus in the responses to this question (see Figure 43) around the opportunities available to promote the better management of natural capital. There was strong recognition that promoting productivity benefits would stimulate the management of natural capital, with 66 positive responses. Closely linked to productivity benefits was landscape health, supported by 55 responses. Financial benefits (56 responses) and future market opportunities (46 responses) were also considered to be potential stimuli.

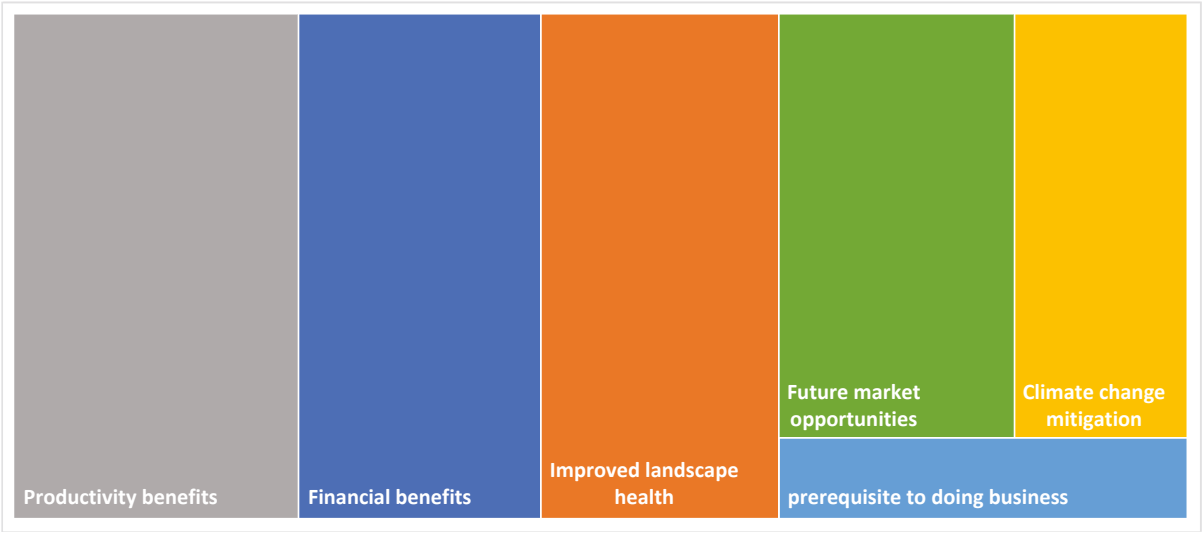


Figure 43 Most important opportunities for promoting the management of natural capital

The participants were also offered an opportunity to explain the best ways to improve environmental outcomes. There were 61 short answer responses to this question, 19 of which referred to the 'education' of farmers, including farmers helping farmers. 'Education' also referred to the education of consumers. Financial reward for undertaking this work was also considered important. Other responses included:

- *"Education is one very important aspect; however, government support is also required in terms of a framework consistent across all sectors"*

- *"Provide hard data to landholders on the financial long-term benefits of environmental projects (e.g., planting more trees?) in order to look past the short term losses"*
- *"Awareness and markets at the end of the day it is non-justifiable to spend money on a property without getting some sort of return"*
- *"Enforcement on farmers who constantly do the wrong thing is a quick way to get people educated on why giving back/looking after the land is important"*
- *"Consolidation of groups/resources and better co-ordination. As new farmers we are navigating so many different bodies (both govt and private) who offer access services and funding—it is exhausting !!!"*
- *"A national consistent policy towards carbon farming, more streamlined and cost-effective outcomes to establish baselines. Create a one stop shop for all government initiatives etc."*
- *"Long term customer education to purchase products from improving systems that are genuine with what they are doing"*

One respondent even replied "23 should have included a text box lack of time"

The obstacles to the implementation of natural capital accounting identified by the survey respondents are shown in Figure 44.

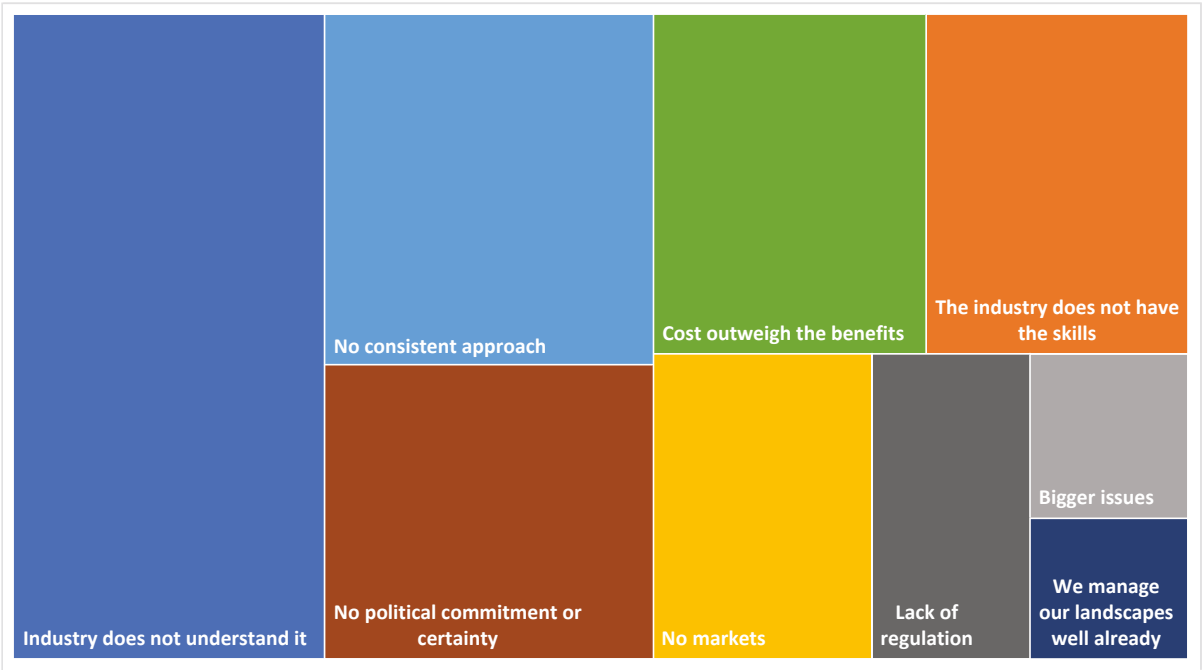


Figure 44 Obstacles to undertaking natural capital accounting

Once again multiple responses were possible for this question, and it is noteworthy that 54 survey respondents claimed that the greatest barrier to the adoption of natural capital accounting is that the industry does not understand it—73%[21] (54). When this is combined with the lack of industry skills 24 responses (32%), there are clearly large knowledge and skills gaps in this area. Other responses of note, and scoring highly, were the lack of a consistent approach n=31 (40%), the lack of political will n=26 (35%), and that the costs outweigh the benefits 25 (33%).

8.1.12 Farmers willingness to commit to environmental programmes

The survey participants were provided with two scenarios involving: 1) vegetation sequestration and the mutual benefits delivered to farms (Figure 45); and 2) the benefits of soil carbon projects (Figure 47). They were asked i) the percentage of their property that they would be prepared to set aside for a vegetation project to generate the identified benefits; and 2) when would they expect to receive a financial benefit from a carbon project.
These questions examined how committed the survey participants were to undertake these types of programmes and the awareness around the benefits they may deliver.

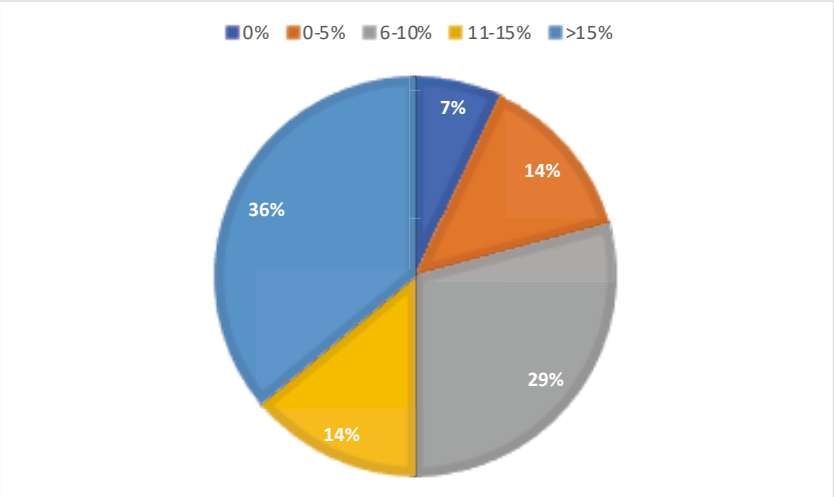


Figure 45 Percentage of your farm area that you would set aside to generate vegetation benefits

[21] Percentages in this case represent the number of response to the category relative to the number of participants in the survey, 74

Filtering these results based on the area farmed would have increased their relevance. Due to an error in the survey set up, this was not possible, but offers an opportunity for further research in the future. Alternatively, I filtered the results based on age and percentage of each age cohort and how much farm area they would be prepared to set aside to generate vegetation benefits *Figure* 46. Notably, these results indicate a willingness to undertake an environmental programme that potentially affects part of the farmers' productive farming area. It is also noteworthy that a high proportion of participants where in an older age bracket and 40% of each cohort was willing to give up 5-15% of their farm area for vegetation benefits. This parallels the responses in section 6.1.8, which indicated farmers' willingness to undertake programmes with an environmental focus.

In the younger cohort of 18-25 yrs over 40% would give up 0-5%. This reflects the older age brackets recognises the value around the benefits of higher percentages of vegetation over bare landscapes. These results could possibly be attributed to past learning and mistakes such removing vegetation by older farmers, with younger farmers focused on productivity values and less focused on potential environmental benefits. The responses of the younger cohort could also be aligned with the overall knowledge and education surround natural capital and its benefits. It was identified in the case studies, focus groups and in the earlier questions in this survey that lack of knowledge and education could be seen as a barrier to adoption of natural capital accounting. As an extension of these results, it raises the question of how younger farmers are educated and what focus is given to natural capital in education programs.

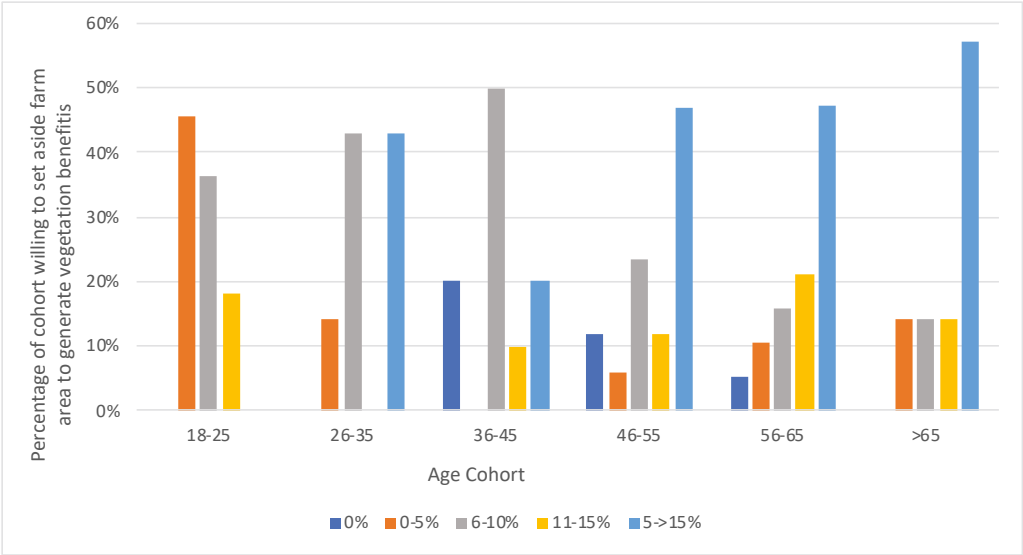


Figure 46 Willingness to set aside Farm area for vegetation benefits

In response to the second question regarding the timing of returns on investments in soil carbon projects, 73% of farmers believed they would occur after 5 years and 18% after > 10 years.

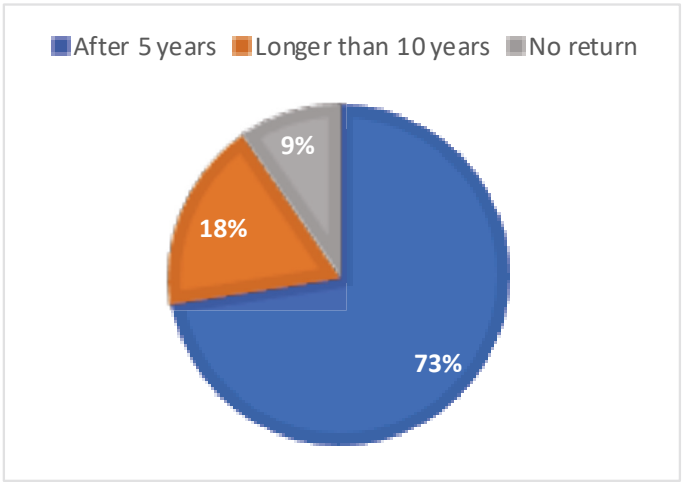


Figure 47 Minimum period estimated to deliver a return on investment in a carbon project

While the results above highlight there is a strong belief that soil benefits will flow from year 5, filtering the results for age indicates older age groups had a slightly more pessimistic view. With 46 to 65 age cohorts with circa 20% of these age brackets believing benefits would not flow until beyond yr 10 with a further 20% seeing no payback

Figure 48. This may be attributed to the profile around the benefits and opportunities of soil carbon built since the inception of the CFI in 2011. A higher level of awareness across

farmers contributing to the positive outlook for soil benefits. This profile also may have had a negative influence with some farmers sceptical of how benefits have crystalised since the beginning of the program.

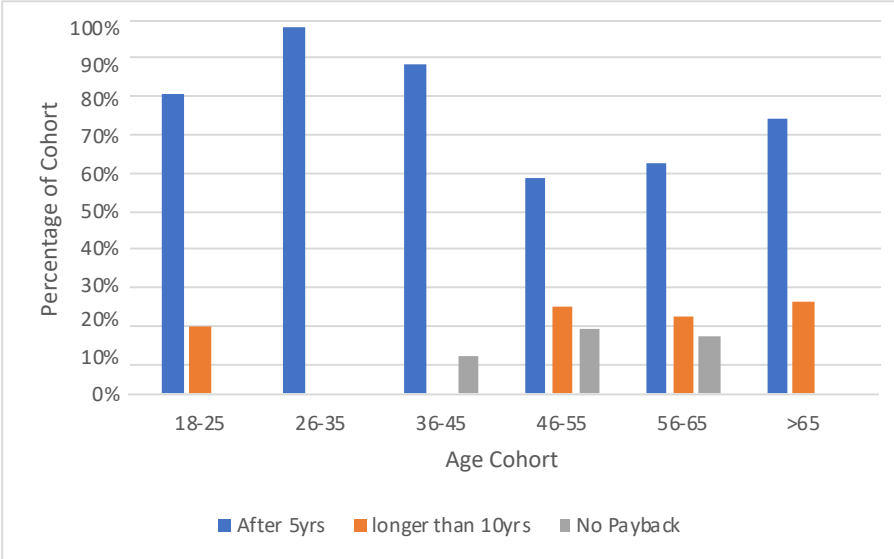


Figure 48 Perceptions of realisation of benefits from soil carbon projects by age cohort

8.2 Conclusion

This survey of a diverse range of farmers provides insight into how the general farming community views the concepts of natural capital and natural capital accounting. Although the survey sample was small (n = 74), it offered diversity in the participants' ages, enterprise sizes, and types, and to some extent, geographic location. The survey is important because it highlights how different farmers currently perceive or understand natural capital and natural capital accounting and complements the case studies in answering RQ1. The uniqueness of the survey in this research is the limited evidence in the literature of similar approaches being undertaken by those charged with implementing these new approaches.

The survey has similarities to recent work undertaken by van Putten et al. (2021) where 140 stakeholders were surveyed to gain an understanding of the value proposition in natural capital accounting across industries. The van Putten et al. (2021) survey approach had similarities to those applied in this survey although with a higher response rate and was focused on three primary industries. Cvitanovic et al. (2016) used interviews to identify how to improve design and implementation of research programmes to improve knowledge

exchange to improve conservation outcomes which could be equally applied to developing natural capital accounting programs. While this research was not focused on natural capital and the barriers and value propositions of its implementation the findings reinforce the importance of stakeholder mapping, co-development of research questions with stakeholders and a participatory approach to conservation research.

An introductory question to the survey which allowed two responses revealed that family and/or partners play a key role in farmers' decision-making with 47 participants (31% of total responses possible (n=148) selecting this choice, with consultants and advisors second with 33 (22%) selecting this option. Of the 47 indicating family and partners as having a key role in decision making, 17 as their second-choice selected consultants and advisors as having a key role. This demonstrates where most influence lies when decisions are made in relation to agricultural enterprises. It also establishes where guidance can be directed in addressing and influence behavioural changes in agriculture. Most respondents rated issues around the environment and climate change as high and were concerned they would affect their businesses.

In the next section, I examined how familiar the farmers were with key terminology Figure 38. This revealed that most farmers had heard of soil carbon (98%) and carbon farming (93%), whereas the proportion of farmers who had heard of natural capital (60%) or natural capital accounting (41%) was much lower. Despite this low recognition of 'natural capital' and 'natural capital accounting', the respondents stated that natural capital was important to their businesses (74%). However, only 35% indicated that natural capital accounting was important, and 40% considered it somewhat important. Overall, 70% of participants felt that natural capital and natural capital accounting were not well understood.

In the second section of the survey, I considered the experience of participants and their sustainability journeys. The purpose of these questions was to understand how farmers positioned themselves in relation to sustainability issues, to gain insight into their willingness to adopt sustainable practices such as natural capital accounting. The results indicated that the majority farmers were at the beginning their journeys and were engaged in a variety of programmes, both formal and informal. Sustainability practices such as regenerative

agriculture and permaculture were commonly recognized by the survey participants (54%). When the farmers were asked in which sustainability projects they had been involved, none cited natural capital accounting projects and only 7% of the participants cited carbon farming.

Finally, the third section of the survey examined what the participants expected to gain if they participated in a natural capital accounting project and the obstacles, they might encounter in taking this step. The results indicated that productivity and financial benefits were the two principal expectations, together accounting for 45% of responses, whereas 20% of respondents expected improved landscape health. The two principal barriers were the lack of understanding of natural capital accounting across the industry and the lack of a consistent approach to natural capital accounting, making up 41% of the responses. The third barrier cited was the lack of political certainty (13%), followed by the cost of implementation (12%).

The results of the survey clarified farmers' perceptions and understanding of natural capital and natural capital accounting. The survey findings support those in Chapters 6 and 7, consolidating much of the results of the case studies and focus groups, particularly around stakeholders' knowledge of natural capital concepts. The survey results support the premise that natural capital is generally understood by farmers, but within the narrow context of their day-to-day operations. Many believe that there are gaps in their knowledge of natural capital accounting, and that it is not generally understood. These significant knowledge gaps, also identified in the case studies and focus groups, are barriers to the adoption of natural capital accounting that must be overcome if it is to be adopted more widely. The respondents also emphasised the need to educate not only farmers, but also consumers. Most respondents (80%) were uncertain whether natural capital accounting was the best approach to improving natural capital.

The results also highlighted that farmers acknowledge the importance of natural capital but are less certain of the benefits or the need to apply natural capital accounting.

Chapter 9: Discussion

9.1 Introduction

In this chapter, I discuss the key research findings concerning natural capital accounting and its role in agricultural decision-making. I examine my findings regarding the literature reviewed in Chapter 2 and consider the factors that have shaped the evolving recognition of the value of natural capital and the emerging natural capital accounting frameworks and their application to agriculture. In this chapter, I also discuss the value propositions and barriers to the adoption of natural capital accounting identified in the case studies, the stakeholder consultations in the focus groups sessions, and a survey of a diverse range of farmers. Finally, I outline the multi-stakeholder consensus and how it can be used to stimulate greater adoption of natural capital accounting in agriculture.

Main Research Question

How can improved understanding of the views of various stakeholders be used to remove barriers to the adoption and relevance of natural capital accounting in agriculture?

Secondary Research Questions:

- ***RQ1 - How do farmers perceive the value of natural capital and the need to measure it?***
- ***RQ2 - What inhibits or motivates the adoption of natural capital accounting frameworks and how do these factors vary between stakeholders such as retailers, financiers, accountants and investors?***

9.1.1 Importance of the Research

Agriculture significantly influences natural capital, and as a sector, is exposed to substantial economic and social risks from declining natural capital. Critically, agriculture and on-farm management do not operate in isolation, but potentially materially affect agricultural supply chains. Recognition of the importance of natural capital to agriculture and its stakeholders is not explicitly acknowledged within long-term measurement and monitoring programmes. Despite the development of frameworks for more than 20-years (since 2000) to measure and monitor natural capital and environmental change,[22] there is still limited evidence of wide implementation of natural capital accounting across agriculture.

This research is important in that it aims to understand why there has been limited adoption of natural capital accounting, a tool designed to measure, monitor, and account for the condition of natural capital.

The literature review identified several gaps in the research around natural capital and natural capital accounting, including:

1) a lack of an understanding around the limited uptake of natural capital accounting in agriculture and of the factors that empower or motivate farmers to embrace and adopt natural capital accounting; and
2) a lack of understanding of agricultural stakeholders' beliefs and values about natural capital,
3) a lack of understanding around the mutual benefits of enhanced natural capital that would stimulate the wider adoption of natural capital accounting.

These deficiencies are significant, given the growing international focus on the importance of natural capital and the need to measure and monitor it, and must be redressed if natural capital accounting is to gain wider acceptance. The recent Dasgupta Report (2021) and the formation of the TFND in 2020 highlight the significance of natural capital to society and

[22] Frameworks that included The Economics of Ecosystems and Biodiversity (TEEB), the system of environmental economic accounting released by the United Nations in 2012 and 2014; the Natural Capital Protocol; and the Australian framework Accounting for Nature in 2008.

societal well-being. Significantly as this research was being completed, the United States Government announced its intention to quantify the loss of natural capital with accounting (The White House, 2022). Increasing the adoption of natural capital accounting is viewed in the literature as an important method of increasing the visibility of natural capital and its importance to society and agriculture. This is seen as a significant step, given the extent of natural capital under the stewardship of Australian farmers.

9.2 Summary of the Key Findings of the Research

My research has shown that the barriers and value propositions associated with natural capital accounting, which influence the decisions of agricultural stakeholders around its adoption, varied among those who participated in the research, similar to the findings of (van Putten et al., 2021). However, some perspectives were common to all parties. Figure 49 identifies the key barriers identified in each setting in which data was collected and the barriers that were common to all settings. It is noteworthy that in the farmer survey, a lack of permanency and the need for a long-term approach which incentivises adoption of natural capital accounting were only cited by participants in the context of government environmental programmes, and not in relation to the need for farmers to collect natural capital data over long periods.

9.2.1 Common Barriers Identified by Data Sources

The main barriers, identified in this research, to undertaking natural capital accounting were consistent across the farmer groups (including case studies) and stakeholder focus groups (Figure 49). The concern raised around the cost of establishing and running a natural capital project when there are limited (if any) markets to realise value from the approach was common to all data sources. All participants recognised the complexity and immaturity of the concepts of natural capital and natural capital accounting, which was reflected by participants reporting that few people in their worlds had a clear understanding or skills around the measurement and monitoring as part of natural capital accounting. Importantly Focus group sessions identified the “lack of a clear value proposition” as a barrier.

The participants also considered a lack of standard frameworks and poor-quality data to be barriers; and that poor-quality data risked the validity of the results; and the lack of an agreed standardised framework risked the comparability of the outcomes across frameworks. Addressing the condition of natural capital through management interventions also requires a long-term commitment. The delivery of tangible results and benefits and the realisation of the value propositions in undertaking natural capital accounting are challenging because they entail such strong commitments from farmers. This difficulty is compounded when family succession planning is considered by independent farmers or investment time horizons are set by investors to maximise returns and recycle capital. Breaking the cycle of a long-term project, such as a natural capital accounting project, before there are visible outcomes, risks data fragmentation and can affect how stakeholders engage with a project if the data loses rigour and validity. This was illustrated in the case studies where the requirements in a corporate farming environment require a long-term commitment to natural capital accounting to address increasing shareholder/investor awareness and information needs. These requirements are not part of family farming decision making.

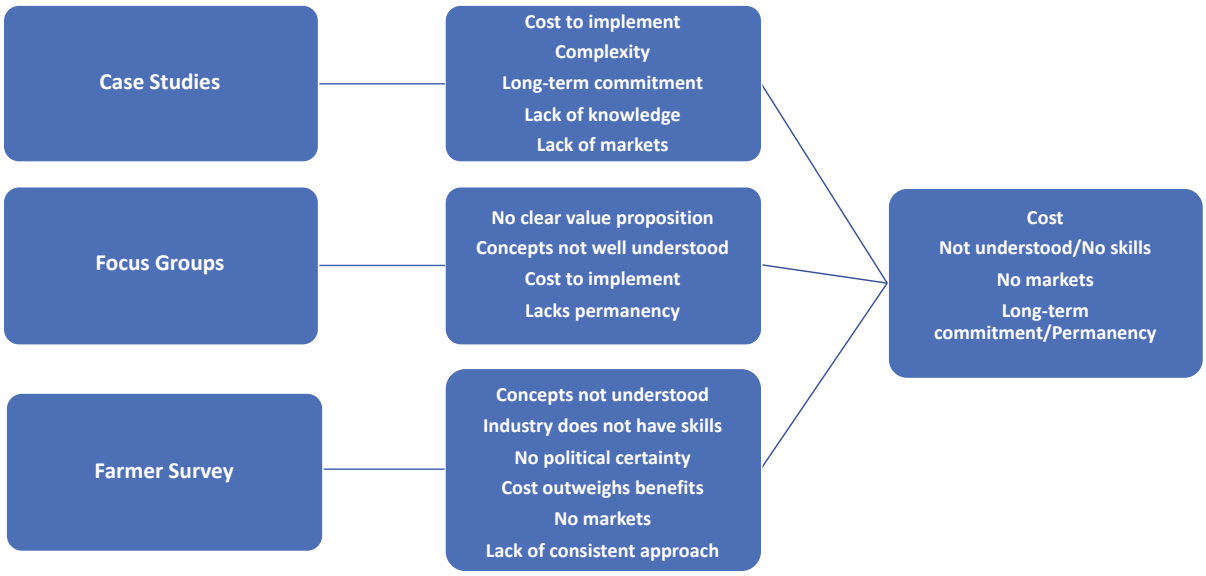


Figure 49 Barriers to the adoption of natural capital accounting identified in the research

9.2.2 Common Value Propositions Identified by Data Sources

In contrast to the barriers to natural capital accounting, there was more variation in the value propositions that were identified between farmers and stakeholders. This may be explained by the diverse range of industries and sectors represented in the data collection process. Only 'financial opportunities' was common to all data sources. Both the case studies and farmer surveys identified productivity benefits and landscape or environmental health as value propositions. The case studies and focus groups identified natural capital accounting as necessary for investors to invest in projects, for customers making purchasing decisions, and for farmers in gaining market access. The value propositions in undertaking natural capital accounting that were identified in the data collection processes are shown in Figure 50.

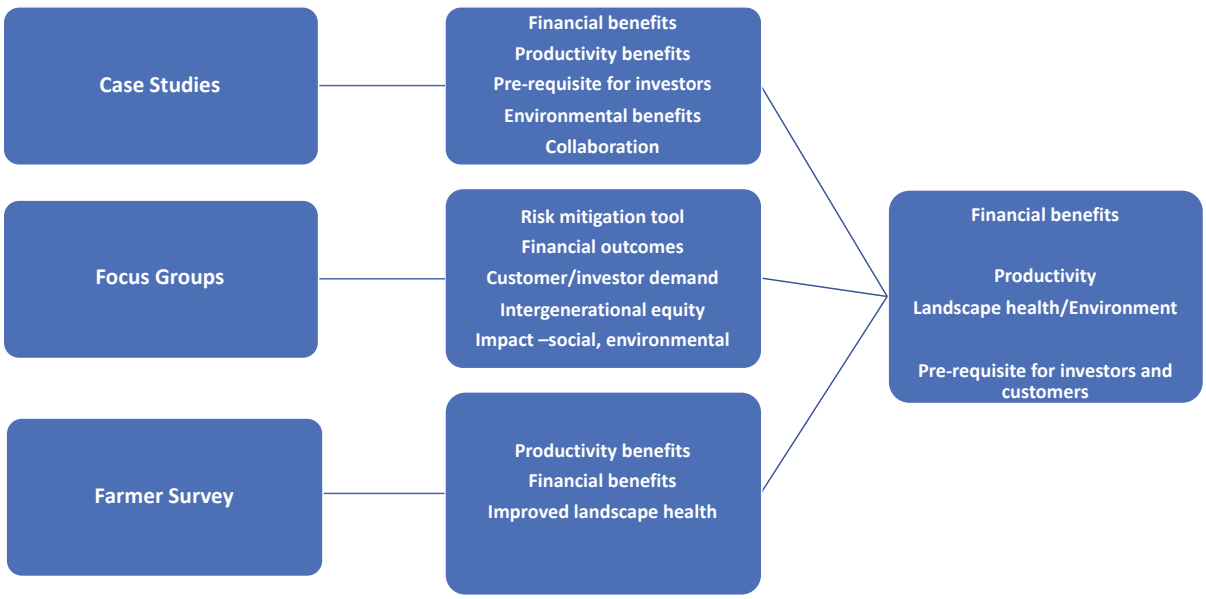


Figure 50 Summary of identified value propositions

9.3 What do the results mean

9.3.1 Natural Capital and Natural Capital Accounting are not well Understood

Natural capital accounting, in its simplest form, is a measurement system. It can be described as providing a structured set of information relating to natural capital and the flow of services provided by it (Office for National Statistics Department of Environment Food and Rural Affairs, 2017). However, these definitions fail to resonate, particularly with stakeholders, and at times cause confusion in agriculture. The data collected in this study indicate that the knowledge of natural capital and natural capital accounting is poor and that they are only understood by a select few stakeholders and which is consistent with Costanza (2020).

The limited progress in the adoption of natural capital accounting can, in part, be attributed to a lack of understanding of its purpose and method, which is not limited to farmers, but extends to wider stakeholder groups (identified in Chapter 3, Fig 10). This lack of understanding includes how the concepts relate to industries or sectors and the mutual benefits that natural capital accounting delivers. The participants in this research indicated a level of confusion around the language or jargon surrounding natural capital accounting. In an interview with a case study participant, they noted "*the concept is understood but the language is still emerging, and I suggest that confusion is probably more around language than concept*". In the focus group sessions with stakeholders, one participant noted "*these definitions in front of me, I'm lost they don't resonate."* This is consistent with Pannell (1999) in his work on farmers adoption of sustainable farming systems, that identified uncertainty around sustainable innovations that act as a barrier to adoption.

Consistent with these findings, Llewellyn (2011) suggested that the creation of a value proposition around natural capital will only occur when information and learning about natural capital has progressed sufficiently to influence change. Llewellyn (2011) highlighted several factors that suggest that increased learning or knowledge improves the adoption of new practices, including:

1) information has the greatest impact on learning when decision-makers are not well informed, and innovation has a high level of uncertainty;

2) information contributes to learning, through which decision-makers adjust their perceptions.

Several initiatives have recently been implemented to address the knowledge gaps of farmers about natural capital accounting (see section 2.7.1). My findings support the inclusion of a wider group of stakeholders in educational programmes. The challenge is to develop targeted educational programmes that will increase the awareness of natural capital, improve its visibility, and develop value propositions for it (Holden & Jones, 2021; Llewellyn, 2011; Pannell et al., 2011).

9.3.2 Including Consumers in the Discussion of Natural Capital

The findings of this research also show that greater effort is required to engage consumers in the importance of natural capital and increase their awareness and knowledge of the concepts involved. The results also indicate that there are mixed signals in what the market is prepared to reward or pay for in terms of produce with strong natural capital credentials. In their recent submission to the Review of Australian Carbon Credit Units, NAPCO noted that *"Consumers are becoming more discerning about brand credentials, environmental impacts and the ethical behaviour of the people and organisations producing our food. Despite this, the willingness of consumers to pay a premium for these attributes as awareness grows, the market is not yet at a point where this requirement could be sustained"* (NAPCO, 2022). This is consistent with the focus groups that identified the importance of educating consumers and improving the messaging around the importance of natural capital. This engagement is lacking from current approaches and is ignored in the literature.

Initiatives that include consumers in future research have practical implications, because they can identify consumer beliefs about and understanding of the concept of natural capital and their willingness to pay for products that have natural capital credentials. Here parallels can be drawn with similar research conducted around the organic food industry. As identified in Katt and Meixner (2020) willingness to pay can be influenced by a number of factors including

a products attributes such as perceived higher quality and food safety[23]. In the same study product signalling was also identified as influencing willingness to pay, with product certification having a positive impact on consumers alongside traceability and trust.

As van Kleef et al. (2005) noted it is important to understand how consumers perceive products, how their needs are shaped and influenced, and how they make product choices with Aschemann-Witzel and Zielke (2017, p. 213) noting "inaccurate *consumer knowledge and lack of information hinder purchases of organic food".* The authors suggesting that the provision of greater consumer information about price gaps, the cost of organic production, and the benefits of organic food, including through consumer experiences, can play an important role in altering behaviours.

The research of Padilla Bravo et al. (2013) showed that predictors of purchasing behaviours that included altruistic motives, such as the environment and animal welfare, were the most influential factors determining consumers' choice of organic foods. The inclusion of consumers in further research, focusing on consumers' healthy food choices and the role of nature in food production, should both increase their knowledge and prompt behavioural changes, and therefore consumer choices (Aschemann-Witzel & Zielke, 2017).

Understanding these beliefs may also allow the purchasing behaviours of consumers to be influenced by stressing the importance of natural capital in the context of a healthy environment, healthy food, and general well-being. This has implications for producers who use natural capital to distinguish their product, particularly because natural capital is not as well-established a market category as organic produce

9.3.3 Environmental Outcomes

Natural capital is a significant concept and a complex one, and given the extent of natural capital, two of the challenges for farmers is what to measure and how. In the semi-structured interviews, the participants were asked to name the components of natural capital that they

[23] Food Safety was more significant in developing countries where there was more concern around food safety standards.

considered important to measure and monitor in natural capital accounting. The participants interviewed from the case studies stressed that soil, carbon, and water were important elements that must be measured. Among the case studies that were well advanced in establishing a formal accounting approach, Kilter Rural had developed specific methodologies to account for native vegetation and soil condition, and were working on the development of others (Heislers et al., 2019). The *Ecological Outcome Verification™* (EOV) measurement tool (Hill, 2022) used by the Land to Market Co-operative (L2M) specifically includes biodiversity, and the interviews with the L2M case-study members restated the importance of biodiversity, together with that of soil:

- "*It's about diversity of plant matter, it's about water filtration*"
- "*Healthy soil, healthy food, and healthy people*"
- "*Once you have good soil health the plants are healthier*"

Interestingly, the survey of a broader range of farmers revealed that those participating in the survey were receptive to adopting or trialling a range of environmental stewardship programmes. The environmental stewardship programmes identified in the survey were dominated by soil and/or groundcover-based programmes, including planned grazing, although no or minimal-till and biodiversity programmes also figured in the responses.

These data suggest that the landholders involved in this research recognise the importance of changing their behaviours and attitudes towards environmental programmes. This challenges the notion that traditional farming practices and status quo bias (where farmers prefer to apply practices that have been used for some time) are barriers to changing the behaviours of farmers (Kacprzyk et al., 2019). These results support the further development of strategies that increase farmers' knowledge and encourage the adoption of natural capital accounting as discussed in section 9.3.1 and support existing endeavours in managing natural capital.

My results also highlight the importance that farmers place on soil in the context of natural capital management. As previously mentioned, given the parallels between carbon farming and natural capital accounting, this suggests that there is a strong case to link natural capital accounting projects to soil-carbon-based projects, in a structure similar to that developed by

the Queensland Land Restoration Fund (QLRF), and to measure the co-benefits associated with carbon farming. This could also offer potential additional income through "value stacking"[24] multiple ecosystem goods and services, validating carbon sequestration schemes, and in some recent cases, attaching co-benefit credits to Australian Carbon Credit Units (ACCU's) (Australian Government Clean Energy Regulator, 2022b; Sonter et al., 2020; von Hase & Cassin, 2018).

Accounting for the additional benefits from environmental projects requires rigour in delivering the stated outcomes while avoiding greenwashing (Leach et al., 2019). As one case study interviewee noted "*investors will increasingly seek to know and be shown proof that the assets and natural capital your managing is improving in value*". Traceable and auditable links to food production and natural capital outcomes should have similar characteristics to organic standards that confer validity of the production of organic food. This will be particularly important in crediting co-benefits to ensure the co-benefits are valid and deliver tangible natural capital outcomes, as not all co-benefits will deliver the same value.

The complexity of the systems being managed entail challenges to the adoption of natural capital accounting that must still be addressed. The focus groups and literature identified the availability and quality of on-farm economic and natural capital data as some of the standards that must be met, so that long term trends in the condition of natural capital can be evaluated Cojoianu and Ascui (2018).

9.3.4 Lack of Tangible Value Proposition in Natural Capital Accounting in Agriculture

In my research, economic opportunity and productivity benefits were the key value propositions identified for natural capital accounting by all data groups. These value propositions were generally associated with premiums for produce or preferred supply agreements to deliver better natural capital outcomes. The participants also indicated that economic benefits should include recognition of the embedded value of natural capital in land valuation.

[24] "Overlapping ecosystem services produced on a piece of land are measured and separately packaged into a range of different credit types or units of trade that together form a stack. Components of the stack can be sold individually to different buyers" von Hase & Cassin (2018)

Although these value propositions were identified across all the enterprises that were undertaking natural capital accounting and in responses to farmer the survey, they appear aspirational. There is limited (if any) evidence of the realisation of these value outcomes. This is attributable to the immaturity of the concept of natural capital accounting, its limited adoption, and the lack of existing markets for trading natural capital. In some enterprises that were undertaking natural capital accounting, the identified value propositions appeared more closely aligned to their management practices, rather than to the perceived importance of natural capital or measuring it.

This was evident from examples raised in the case studies. Kilter Rural produces certified organic wheat and barley from the Winlaton asset, the subject of farm-level environmental accounts assessed with the Accounting for Nature (AFN) framework (Heislers et al., 2019). Kilter Rural was optimistic that the increase in environmental markets could offset the cost of stewardship of the landscape (Gardner, 2018). The company's experience at the time of the interviews was that produce sold from the Winlaton asset was somewhat 'niche' and 'premium' given its 'organic' classification, without any consideration of a natural capital benefit. This suggests that undertaking natural capital accounting across these assets had yet to translate into an additional financial premium based on natural capital accounting itself, over and above that associated with the organic status of the produce. This may also be explained by the fact that 'organic' status is a more established and recognised standard, whereas natural capital is not yet recognised and has no recognised standards.

Several participants also expressed frustration that improved natural capital in agricultural landscapes was not considered by the real estate valuation industry. One case study interviewee noted "*I don't think that valuers, as a general rule, taking natural capital very seriously*". The commercial reality is that agriculture rewards greater production from the same area in the cheapest way possible and incorporating environmental considerations into farm decision-making comes at a cost. As one interviewee noted "*commercial viability I think is one of the biggest challenges to any sort of natural capital project*". Focus group sessions also highlighted that stakeholder similarly considered there to be the "*lack of value proposition*" and "*no market pull through* ". As one participant noted "*we are struggling to*

find a strong reward signal". This could be attributed, in part, to conflicting priorities (as one participant put it) of food waste, plastics and climate change, and because natural capital is not at the forefront of those priorities.

There is a need for more research, similar to research currently being undertaken by Farming for the Future[25], into how the direct links between natural capital and financial and productivity benefits can be demonstrated. Farmers see themselves as value creators, not as value capturers, and if the values of the multiple stakeholders are not mutually consistent, the translation of the benefits of natural capital and natural capital accounting along the supply chain will fail.

9.3.5 Emerging Value Propositions

Institutional fund managers, such as Kilter Rural, NAPCO, and Paraway, recognized that attracting investment capital requires the validation of outcomes: "*investors will increasingly seek to know and be shown proof that the assets and natural capital you're managing for them is improving in value*". During this research, Kilter raised new capital for an Australian Farmlands Fund (Kilter Investments Pty Ltd, 2020) with natural capital accounting, based on the AFN framework, cited in the information memorandum as part of the fund's core strategy in managing its assets. Natural capital accounting is used to report how the landscapes within the fund are being managed and how they change over time, with ultimate effects on production and the landscape values. This reflects Kilter's recognition of the importance of natural capital and of investors' appetites for investments that can validate and add to their environmental, social, and governance (ESG) credentials. It is also consistent with the interviews with other case study participants, which highlighted that natural capital accounting "*provides validity and relevance to projects that support external investment*".

In the L2M case study, the underlying management strategies and beliefs of the farmers involved in the programme were based on holistic management (grazing). The farmers focus on the management of the landscape condition, which is the foundation of their approach.

[25] Farming for the Future is a research programme dedicated to building this evidence base. Farming for the Future. (2020)

EOV is designed to verify and validate the delivery of improved landscapes. This validation has allowed the co-operative to reinforce the strength of their environmental credentials when collaborating with stakeholders and to link outcomes to agreements (section 9.3.6). For the L2M farmers, the value propositions also extended beyond financial concerns, and much of the value created through societal health benefits was delivered through the creation of healthy landscapes. Their responses in the interviews indicated a feeling of well-being and overall health, which they attributed to their healthy landscapes, "*we get healthier soil, healthier food and healthier people*" and "*I'm really healthy, I've got a good community around me and I'm really positive how do you put a value on that?*" These outcomes provide indirect benefits that extend beyond financial considerations and are seen as more altruistic value propositions.

For the QLRF, using public funds to improve land management practices requires evidence of the public value created. Given the probity required in spending public funds, it is crucial for the QLRF that the co-benefits generated are designed to validate, by measurement and reporting, with natural capital accounting to justify the payments made under the programme. For governments, improved natural capital and reduced land degradation reduce their exposure to the externalities caused by degradation. These externalities can result in future drought payments, the necessary remediation of water ways, and damage to the Great Barrier Reef from chemical leaching.

9.3.6 Collaboration is Key to Delivering Value Propositions

To achieve mutual benefits, there must be greater collaboration and strategic partnerships between farmers and stakeholders to advance the importance of natural capital and the need to monitor and measure it. Collaboration is necessary across industries to develop frameworks and standards that offer common values when undertaking natural capital accounting. Examples of this collaboration is seen in the approach of the L2M case study and the partnerships they are developing across the supply chain with the likes of Harris Farm and Provenir. Collaboration that can also be seen in the Cool Soils Initiative, where farmers are working with scientists and the likes of Mars Petcare and Manildra Group to address emissions reduction and improve yield and productivity (Charles Sturt University, 2022).

L2M, as a farmer co-operative, operates under the principles of holistic management and for the benefit of its members. This is important because the co-operative members benefit from a collaborative approach that provides governance, education, and training, and develops markets on behalf of its members. The L2M approach to collaboration recognises the social, cultural, and personal influences that affect decision-making, as noted by Pannell et al. (2011). Adopting a process of learning and using experience to inform is an important part of adoption and innovation progression. The L2M case study provided indirect evidence of the economic value attributed to its EOV approach, although it was difficult to establish a direct association with EOV and commercial partner arrangements, given the confidential nature of agreements. It also highlighted the link between economic outcomes and collaboration. This collaboration involved the development of preferred supplier agreements between L2M and several food processors and retailers, such as Harris Farm and Provinier (Land to Market, 2021) Figure 51.

Figure 51 Land to Market partners Reproduced with permission of Land to Market Australia.

This research provides limited evidence, at this stage, that these agreements are directly linked to the use of EOV, although the L2M website notes that "*L2M will encourage its farmers to supply to market partners who must prefer supply from L2M, which may allow for their use of Ecological Outcome Verification branding*" (Land to Market, 2021). Because this research is not privy to the commercial terms of these agreements, it is not possible to determine clearly whether an economic advantage has been achieved based on EOV outcomes or by undertaking EOV. In the semi-structured interviews in section 6.5.3, some interviewees indicated they were not receiving economic benefits at this stage. "*I'm not getting any added benefit for the sale of my beef*". Despite this, there is an expectation that over time, additional

value will be achieved. "*I think longer term this stuff will be more valuable, but I think in the first instance, it's not front and centre*".

The approach of L2M in forming strategic partnerships does not rely on EOV alone. The value proposition that L2M is building is a systems approach (Figure 52) that parallels the (The IFRS Foundation, 2021), in which the value L2M farmers create for themselves is the same value they create for others, by labelling and establishing a point of difference across the supply chain. This forms a link between natural capital outcomes and the economic benefits, productivity, and social benefits derived from those outcomes.

Figure 52. The value chain. Reproduced with permission from Land to Market Australia

Collaboration is also key in bridging the knowledge and education gaps, to support the important role natural capital plays in agriculture and society.

9.3.7 Cost currently outweigh the financial benefits

Across data sources, stakeholders to farmers, indicated that the cost of implementing natural capital accounting is a barrier to its adoption, which outweighs the current benefits, an issue also highlighted in Costanza (2020). Case studies with experience in adopting natural capital accounting provided a high weighting to cost as a barriers which can also be linked to the lack of ability to monetise outcomes which also had a high weighting across case studies Table 18. The costs associated with establishing programmes, the development of methodologies to suit their landscapes, and the on-going monitoring costs make the commercial viability of undertaking natural capital accounting problematical. Cost relative to lack of financial opportunities were also seen as a key barrier across focus group participants.

In contrast the farmer survey asked what were the most important obstacles to adopting natural capital accounting 25 of the 74 (34%) respondents indicated the cost of implementing programmes outweighed the benefits (multiple responses were allowed). This low response may be attributed to the survey respondents not having undertaken natural capital accounting at this point and understanding and not having direct experience or knowledge of the costs of implementation. This is reflected in the survey results indicated 54 or 73% of survey participants ticked the option that "Industry does not understand it".

Understanding the motivation and values of stakeholders in addressing the decline in natural capital does not clarify the capacity of those stakeholders to implement strategies to address this decline. Given the complexity of the concepts, frameworks, and measurements involved, farmers would require consultants or experts to assist with the establishment and management of such projects, and these costs to the farmer would further erode the financial benefits of natural capital accounting. This could prove another impediment to its wider adoption. This was highlighted in the interviews as "*we are not resourced for it*" and "*it's going to require different skill sets, some training of existing people and be equipped to take measurements and feed into the system*".

In the farmer survey, one respondent also reflected negatively around the role third parties play in the process of carbon farming at the expense of the farmer: "*only people making any*

money are the brokers", supported in the farmer survey by "*Consolidation of groups/resources and better co-ordination is needed. As new farmers, we are navigating so many different bodies (both gov and private) who offer access to services and funding—it is exhausting*".

9.3.8 Farmer Awareness and Willingness to Engage Despite the Cost

The literature recognises that encouraging farmers and land managers to undertake environmental programmes, particularly those seen to encroach upon private property rights, will require policies and an allocation of subsidies to incentivise them to do so (Benayas et al., 2009; Helm, 2014; Pretty, 2007). Interestingly, and in contrast to the literature, all case-study enterprises (except the QLRF) voluntarily undertook to develop or fund their natural capital measurement programmes, despite the cost of establishing them. Kilter Rural had spent time and invested resources to develop methodologies and report outcomes that allowed them to account for various natural capital components of the Winlaton landscapes.

The L2M farmers pay a fee to have their landscapes monitored as part of their involvement in EOV™ programme, which was developed in Argentina in conjunction with OVIS21, The Nature Conservancy and Michigan State University (Land to Market, 2022b). As one participant noted "*It's certainly costing us more than we probably will ever realise in financial terms*". Despite this, the L2M farmers are willing to invest capital (human and financial) and the time required to implement accounting programmes. The willingness of participants to undertake EOV with limited financial benefit is also apparent in section 9.2. The strength of the L2M co-operative approach is in the trust that it builds with its members, which allows the goals of both individual farmers and the organisation to be achieved through collaboration.

These examples indicate that other values, beyond purely financial motives, drive the enterprises reviewed in the case studies. These are also identified in the literature (Hein et al., 2006; Martin & Verbeek, 2006). In particular, Vanclay (2011, p. 71) highlighted *"adoption is a socio-cultural process, not an isolated decision*". The case studies exemplify how collaboration has stimulated behavioural changes and stress the need for continued efforts

to develop wider multi-stakeholder collaboration to generate systemic change. In the farmer survey, a question was framed differently, the better to understand who influences farmers' decisions about their agricultural enterprises. Here, the dominant response was 'family/partner' (31%), followed by consultant/adviser (23%).

These findings are important for the development of targeted programmes because family and consultants clearly play an important role in on-farm decision-making and therefore can influence the adoption of natural capital practices.

9.3.9 Permanency and Continuity of Data Collection through Succession

The literature has identified problems in historical government environmental programmes that have lacked longevity and effective monitoring and measurement (Cresswell & Murphy, 2017; Fifield, 2016; Salt, 2016). The responses of interviewees from the case studies also indicated that the short-termism of government programmes had affected their outcomes: "*government programmes and semi-market schemes around vegetation offsets, they've tended to be sporadic and haven't been consistent*". This short-termism makes it difficult to fully gauge the success or failure of programmes that were compromised by a lack of funding.

This research also demonstrates that where there is a limited perceived value proposition, there is also a risk to the permanency or continuity of a natural capital accounting programme. The result is a failure to achieve the goals of natural capital accounting, of long-term measurement and monitoring of natural capital. The need for long term measurement and monitoring were identified in the World Commission on Environment and Development (1987) in its concerns for the outlook for the worlds ecosystems.

The issue of long-term measurement became apparent in the case study interviews, in which two institutional investors indicated that they had changed or were changing the structure of their agricultural investment funds. They were moving from closed-ended limited-life funds (set investment terms, with a one-time injection of capital) to evergreen funds, in which funding is on-going and investments are on-going and long-term, with no specified end "*it needs to be a long-term investment, it needs to be an investment of 15 years plus*". A third

investment manager, Kilter Rural, established a new fund with a 15-year investment horizon, about which it issued an information memorandum in 2020. The QLRF also has a 15-year investment horizon.

Like the case studies, the pre-focus-group survey also drew attention to the issue of the longevity of programmes in the context of farm succession or continuity of ownership. Under this scenario, when the ownership of a property undertaking natural capital accounting changes, and the new owner chooses not to continue the accounting process, the data collection process is broken, together with its link to economic outcomes. The issue of a permanent requirement to undertake natural capital accounting has not been identified directly in the literature but is fundamental to the need for the *long-term* measurement and monitoring of natural capital. The literature does address how ownership change has been influencing environmental programmes.

In a study of the implications of rural property turnover on land use and management by Mendham et al. (2012) the authors note that land ownership change in the 10 years leading to their research resulted in the replacement of longer term owners with a new cohort of non-local landholders who were largely independent of agriculture. The authors concluded these new owners are generally less experience land managers and have less knowledge of NRM, spend less time on their properties and less engaged in traditional NRM programmes. Interestingly the research identified that new owners were more likely to value conservation over agricultural production and had lower levels of knowledge of land management.

This research suggests both opportunities and challenges from property turnover in applying a natural capital accounting approach. It provides opportunity to engage and influence new and motivated but less experienced landowners who lack in-depth knowledge and who value natural capital. Conversely there are challenges in engaging with absentee or weekend owners as identified by Kam et al. (2020). New owners may see a conflict between the environment and agriculture that results in productive agricultural land set aside for environmental purposes increasing risks from invasive plants, fire and feral animals if landscapes are not managed effectively. Placing this in perspective, over the past 26 years, there have been, on average, 10,000 farm land sales per annum, equivalent to 12 million

hectares per annum, in Australia (Rural Bank, 2021), representing a material change in land stewardship.[26]

These issues were further emphasised during a reflective conversation with an interviewee from Kilter Rural during the final write up of this thesis. In the discussion, in which I gained a perspective on what had changed since the original interviews, the interviewee noted that the original Winlaton portfolio had recently been sold on behalf of the original investor which was also the subject of a newspaper article in the Australian Financial Review (Schlesinger, 2022a). The sale raised the question of the status of the natural capital accounts and the data associated with the asset. The accounts and data had been developed over 6 years by Kilter Rural and its strategic partners. At the time of the discussion, there was no indication of the new purchaser's intention to continue to develop or utilise the existing accounts. Unfortunately, no financial details of the transaction were available, and it was not possible to know clearly whether additional value was attributed to the asset at the point of sale based on the enhanced natural capital, which could have been validated by the associated natural capital accounts.

The sale of this asset (the Winlaton portfolio of Kilter Rural) by a case study enterprise raises several issues, not clearly addressed in the current literature, surrounding the implementation of natural capital accounting. These include:

1) the voluntary nature of natural capital accounting, which can be affected by significant shifts in the priorities of asset owners;
2) without a value proposition, there is limited incentive to undertake a natural capital project;
3) natural capital accounting can be ineffective if the sequence of measurements is broken and data are fragmented by a lack of permanency in the programme;

[26] Over the past 26 years, there have been, on average, 10,000 farm land sales per annum, equivalent to 12 million hectares per annum, in Australia, Rural Bank. (2021) representing a material change in land stewardship. As noted in Kam et al. 2020 further analysis of absentee landowners will assist in future engagement around natural resource management and potentially natural capital accounting. Understanding where sales to absentee holders occur can assist in this process and requires further research.

4) rural property turnover can impact engagement in environmental programmes, which in the past have been seen as problematic (Kam et al., 2020; Mendham et al., 2012)

These issues have important implications for policy makers in developing incentives or covenants to entrench long-term environmental measurement and monitoring.

A possible strategy, also identified in section 9.3.7, is for the government to consider long-term purchase contracts for accounting data, that would require project initiators and their successors to account for natural capital for a specified period to preserve the integrity of a project. Using carbon projects as a focal point potentially brings a level of permanence to natural capital projects through covenants. This assumes that a natural capital project as part of a carbon project will also be required to register with the ERF, which would require a 25- or 99-year permanence period for the natural capital component.

9.4 The Role of Government in supporting the adoption of natural capital accounting

The results of my research indicate that the role of government in driving the increased adoption of natural capital accounting is contentious. The farmers surveyed and some participants in the focus group sessions expressed the view that government had a role to play in providing financial incentives for farmers to undertake natural capital accounting. As a focus group participant (an accountant) suggested tax incentives, as a short-term fix "*to get the ball rolling*", would be a positive contribution of government.

Alternatively, the role played by the Queensland Government in stimulating the measurement of natural capital as part of its QLRF is seen as a positive initiative. The Government's intervention overcomes a key barrier identified in the research: the costs associated with the establishment and monitoring of natural capital accounting by paying for positive outcomes. In return the government aims to achieves validated improvements in biodiversity attributable to the carbon projects and generates ACCU's.

Concerns were expressed that government could also act as a barrier to the adoption of natural capital accounting. Specific concerns involved the lack of outcomes in previous government environmental initiatives, and excessive red tape and regulations. This was

reinforced by Ansell et al. (2016, p. 8), who reported that regulatory approaches usually entail high transaction costs—especially, for example, in terms of compliance and enforcement. Pannell (2016, p. 227) noted "*Australian programs tend to rely too much on extension*", This has resulted in limited focus on positive incentives and the technological developments.

Historically, government environmental programmes have lacked the longevity required to deliver effective results. One interviewee cited the development of environmental indicators by the Victorian Government in the 1990s, which was shut down a week after its launch. As (Fifield, 2016, p. 28) noted, a major issue with some government agri-environment programmes is that they rarely run for longer than a few years and landowners are left without anyone to provide them with advice or feedback when problems arise. This was also highlighted in the literature, when the National Farmers' Federation cautioned that poorly executed policies and approaches "*could saddle farm businesses with additional costs*" (National Farmers Federation, 2019).

9.4.1 Challenges of Government Intervention

The challenges for government in acting as a catalyst for the creation of markets for natural capital were also highlighted recently when the Australian Government's Emissions Reduction Fund (ERF) was placed under the microscope. The ERF has been criticised for the lack of integrity of Australian Carbon Credit Units (ACCUs) and for activities incentivised by the ACCU scheme with the potential for greenwashing and perverse outcomes. These criticisms have prompted the establishment of an independent commission to review the activities of the scheme (Department of Climate Change Energy the Environment and Water, 2022).

The establishment of this independent review highlights the challenges posed when nature is transformed into a financial asset (Spash & Hache, 2021). The enquiry also accentuates that this transformation ignores the impact of environmental changes and how they affect human health and well-being and the productivity benefits to agriculture (*Our Common Future*, 1987; Whitmee et al., 2015).

The independent review has published 162 responses to the review on its website, from a cross-section of society, including heavy polluters, individuals, scientists, and agricultural enterprises. A snapshot of responses revealed a wide range of concerns with the ERF and the standards around ACCUs. These responses confirm the difficulties in developing markets for natural capital and highlight the potential power imbalances that potentially exist between the stakeholders participating in the review (as discussed in section 4.2.1), and the role of government in managing these imbalances.

Examples of responses

- NAPCO (a case study, Chapter 3) noted "*The requirement for ERF projects to meet "additionality" and newness are significant barriers for participation in the beef industry*" (NAPCO, 2022).
- Alinta Energy noted "*Credibility must be consistent and transparent across methods*" (Alinta Energy, 2022).
- Professor David Pannell stated "*The newness criterion is a weak measure of additionality and new efforts should be undertaken to develop a more accurate and reliable method for assessing additionality*" (Pannell, 2022).
- The Pew Charitable Trust stated "*The transparency of data and decision-making is crucial*" (The Pew Charitable Trust, 2022).

These are snapshots of documents submitted to the review and should be considered in the context of the full submissions. They also seem to be consistent with the findings of my research in terms of the need for transparency and the validity of outcomes around natural capital. They are also consistent with the concerns expressed by some of the participants that government programmes are not always effective and that poorly designed programmes result in perverse outcomes.

Part of the role of government, through the Clean Energy Regulator, is to ensure that any Emissions reduction methods meet integrity standards of the Carbon Credits (Carbon Farming Initiative) Act 2011 and give credibility to ACCU's. This includes new standards such as the role and use of integrated multiple carbon management methods. This method is designed to increase the carbon pool and activities which individual projects receive credits and reduce

costs of implementing and reporting on projects (Australian Government Clean Energy Regulator, 2022b).

This has significant relevance for natural capital accounting as some industries purchasing ACCUs have recently revealed a willingness to pay a premium for those ACCUs where environmental co-benefit credits are attached (Australian Government Clean Energy Regulator, 2022b). The Clean Energy Regulator does not currently provide checks or give assurances of the validity of these co-benefit credits.

Given the interest in co-benefit credits is consistent with the expected value propositions identified in my research as payment for natural capital outcomes there would be a strong argument for government to regulate and set minimum standards for co-benefit methods to measure environmental benefits as they do for carbon under the ERF. Without this co-benefit credit markets must also be interpreted with caution and further research is required into what the market requires from co-benefit credits, the transparency of these markets, and what characterises a co-benefit credit and how contracts are structured.

Although the role of government in delivering solutions to wicked problems can at times be contentious, as seen with the challenges to the role of the ERF above. Government can play a significant role as a facilitator in the development of solutions through reflexive and collaborative processes in solving wicked problems described by Hull et al. (2020). They also have a role as a regulator ensuring minimum standards and consistency of any natural capital or co-benefit programme.

Further natural capital accounting projects also provide a rich source of data that can be used to assess the effectiveness of management programmes. Importantly, government can also use these data to shape and develop future agricultural and environmental strategies. The data are a valuable resource for a wide range of stakeholders, including government. The value of these data in the validation of programmes or policies around natural capital supports the argument that governments should purchase data from farmers. This would offset the cost for farmers of implementing and managing projects. Government would become a project collaborator, incentivising farmers through its payment for data, which

would allow the validation of the condition of agricultural landscapes and how it translates into broader public benefits.

9.5 What these Results tell us and Final observations.

The use of natural capital accounting in agriculture remains nascent, and the value proposition aspirational, despite the developments that have occurred during the period of this research. The results of this research identify several significant issues around wider adoption of natural capital accounting. Several of which were identified during the development of my DPSIR model (Figure 11) around the responses and changes needed to limit the impact of the driving forces behind the interactions and consequences of environmental problems. Ordering the issues identified in the research based on a materiality assessment allows a pathway to be developed to address the identified issues. It also allows the issues to be prioritised to avoid creating a fragmented approach to addressing them. Given the importance of these issues it is critical that we take time to get the essential elements in place or risk heading down the wrong pathway and/or greenwashing. Table 28 highlights the materiality of the issues identified in this research and their prioritisation in the steps in stimulating wider acceptance of natural capital accounting in agricultural decision making.

Table 28 Key Elements required to move natural capital from niche to mainstream.

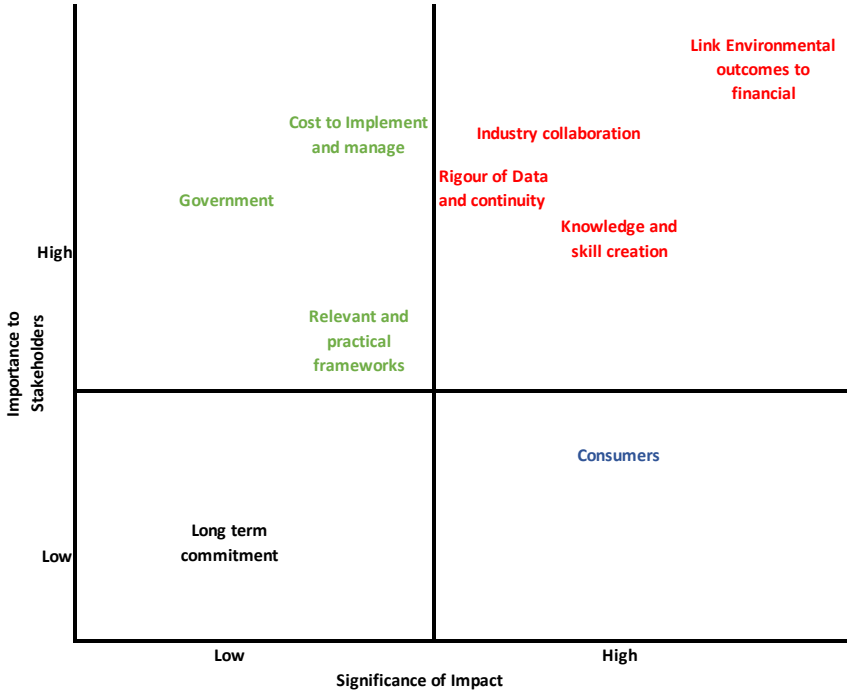
Key Elements	Impact	Driver	Time Frame for Action	Rational for Time frame	Potential Action
Industry Collaboration	**Significant.** Development of a common approach and creation of a value proposition will potentially lead new markets and through common goal setting.	TFND/Nature Repair Market Bill	Medium	Likely to take some time to get universal agreement on the approach to natural capital. Implementation of the TNFD and/or Nature Repair Market Bill gain may accelerate.	Agriculture supports the implementation of TNFD guidelines. Agriculture can be a rich source of data for the TNFD
Link Environmental Outcomes to financial Outcomes	**Significant.** Establishing a clear link between nature and economic outcomes will provide a catalyst to identify productivity and financial benefits to changing management practices.	Education/research and case studies	Medium to Long	Change in natural capital takes time, and economic, productivity links are not readily evident. Developing these links will be a significant catalyst for natural capital adoption. They will be key in validating outcomes and avoiding greenwashing.	Undertake detailed research to gather and interpret data to support and strengthen research thesis. This requires funding and support from Government, research institutions, supply chain stakeholders and philanthropy.
Data Rigour	**Significant.** This impacts the ability of participants to validate outcomes, avoid greenwashing, participate in new markets and apply frameworks effectively.	Development of frameworks, technology, and creation of environmental markets.	Short	Provides greater validity and transparency around environmental outcomes and supports integration with frameworks and markets.	Continued research work. This requires funding and support from Government, research institutions and philanthropy.
Knowledge and skill creation	**Significant.** Lack of knowledge and understanding is seen as a major impediment to wider adoption of natural capital accounting. This will require new skills in environmental accounting, ecological economics. Alongside skills in technology that delivers the data and skills in interpreting the data.	Influence of TNFD/Nature Repair Market Bill and evidence of positive outcomes for agricultural projects undertaking the approach. Likely to be farmer driven.	Short to Long	Traditional education programs in agriculture and economics need to be adapted to reflect new economic paradigms around Natural capital and ecosystem services.	Development of courses to educate farmers and stakeholders. Use of case studies to inform positive outcomes. Lobby political and educational advisors to alter traditional course to reflect changing theories and values.
Cost of Implementing and managing	**Important**. Costs are seen as an impediment to adoption with little if any value proposition to offset costs.	Adoption of natural capital accounting and development of technology to make data collection more cost effective.	Medium	Wider adoption should assist in greater economies of scale initially and development of markets are likely to offset costs.	Government subsidies for development of new methodologies and technologies to collect and analyse data.
Relevant and Practical Frameworks	**Important**. Testing existing frameworks for their rigour and practicality will support on going acceptance. It will also be required by investors when assessing investment credibility.	Development of environmental markets and implementation of the TFND. Improved technology and Data sources.	Medium	Some Frameworks already exist making this a less critical pathway. Existing frameworks could support development of new user-friendly approaches.	Some Frameworks already exist making this a less critical pathway. Existing frameworks could support development of new user-friendly approaches.
Government	**Important.** Government supports and incentivises new initiatives and tools to develop natural capital accounting. While supporting market development and the development of educational programs.	Lobbying and continued impetus from global initiatives will support Government action.	Short and Long Term	Government needs to embed natural capital into its legislative frameworks and provide long term funding solutions to assist in development of markets.	Policy changes to support long term commitments to improving natural capital. Government as acquirer of carbon or biodiversity certificates**.**
Consumers	**Important.**	Social licence and consumer awareness to drive demand for environmentally friendly food.	Short	The consumer voice continues to play an import role in how food is produced. Impact can be instant through use of media platforms	Increase in education programs, use of high-profile influencers such as chefs, social media to raise awareness etc.
Long Term Commitment	**Low**, Ensure management of natural capital is enduring.	Acceptance of the long-term benefits of Natural Capital	Long term	Evidence and markets to support long term natural capital management likely to take time.	Support industry collaboration to build a long-term commitment to knowledge creation and to aid market creation

Key: **Significant** – Material impact and likely to have an effect

Important – Likely to have high value already has some components in place

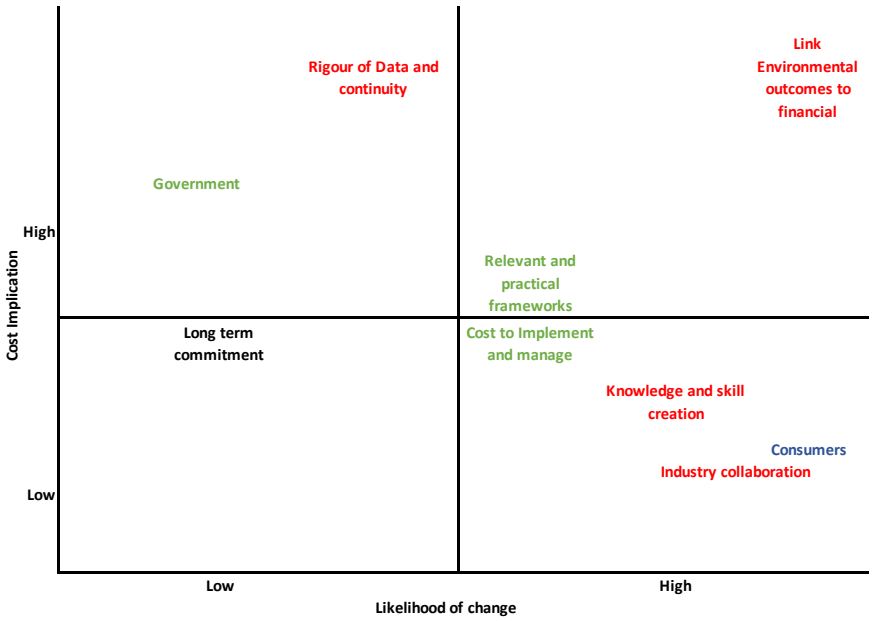
Low – Has value likely to endure long term and will require other key elements to realise

Based on the key elements identified in Table 28 I have assessed the relative materiality of each issue and developed several materiality matrices to identify the key impact drivers in the elements identified in the research. These matrices (Figure 53, Figure 54 and Figure 55) assist in identifying the elements that can potential have the greatest impact in influencing a wider implementation of natural capital accounting.



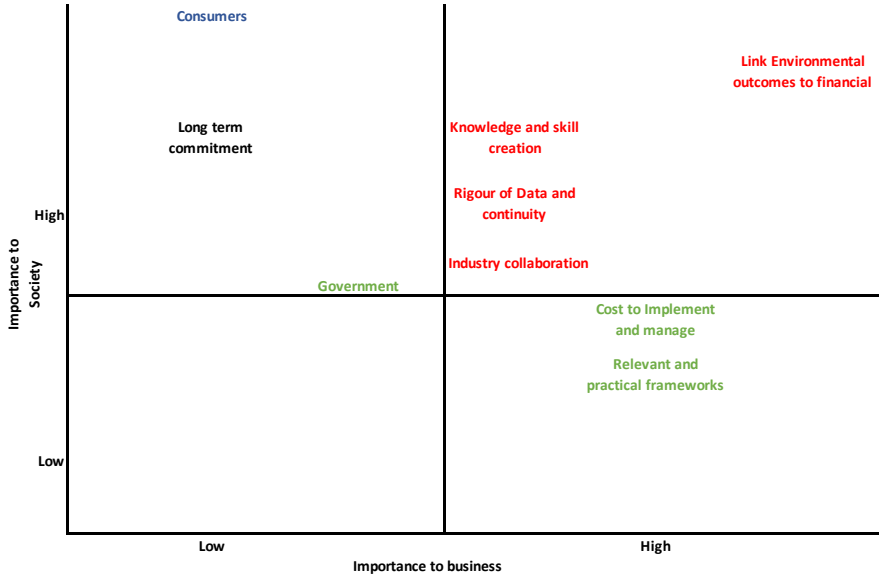
Source: Author (Adapted from Natural Capital Coalition (2016))

Figure 53 Importance to stakeholders v significance of impact



Source: Author (Adapted from Natural Capital Coalition (2016))

Figure 54 Cost of implication v likelihood of change



Source: Author (Adapted from Natural Capital Coalition (2016))

Figure 55 Importance to society v importance to business

Addressing these issues will be key to achieving wider adoption of natural capital accounting. From the materiality matrices the element identifies as having high importance and impact is

the need to link financial outcomes and environmental outcomes. It is common across farmers stakeholders and society in that there is a recognition that manging the environment comes at a cost and it is also the key element that is likely to influence behavioural change. I identify knowledge and skill development as having a high likelihood of influencing behavioural change and at a potentially lower implementation cost than other options.

Farmers have a responsibility to manage natural capital for both their own benefit and the publics. In doing so, they should not be placed in a position that is detrimental to the economic stability of their enterprises, which could cause farming to collapse and threaten food security. As the literature identified, in the past environmental programmes have failed to deliver clear results due the lack of long-term monitoring, measurement and long-term focus. Land degradation, biodiversity loss and increasing GHG emissions have increased unchecked. Natural capital accounting provides an opportunity to address the mistakes of the past to rebuild natural capital and to build greater resilience into agricultural systems. The use of materiality matrices can assist in identifying pathways that offer the potential to deliver strong outcomes and with lower risk.

9.7 Limitations

As noted above, the use of stakeholders and focus groups significantly benefited this research by building a more complete picture of natural capital and its importance. However, it did not come without its challenges. Recruiting the focus group teams proved difficult because it was done during the COVID-19 pandemic and the consequent lockdowns. Individual business priorities and COVID made scheduling mutually convenient times extremely challenging. Notwithstanding this, the willingness of the participants to engage in the research was extremely gratifying. Other limiting factors included the need to conduct the focus groups via ZOOM. This constrained the sessions to 1.5 h, which limited the time available to explore in depth all the key components identified, so strenuous time management was required. The first session was not without its technical problems, and two participants were unable to connect and one joined late. Finally, the focus groups were designed to allow the participants to share their thoughts and ideas, but ZOOM proved somewhat linear in its ability to allow the participants to engage effectively, which stifled interaction. The focus group participants

were only a small representation of these industries, which may have resulted in bias or incomplete data. The research would also have benefited from further focus groups to ensure the validity of the results. Further stakeholder-directed research would benefit from a traditional focus group approach, with all the participants in the same location and able to interact.

Conducting a survey of a diverse range of farmers entailed ensuring that sufficient participants completed the survey so that the data were relevant and representative. When recruiting potential participants for the survey, it became clear that farmers were becoming jaded with the number of surveys in which they had participated, and one group even declined to participate due to 'surveyitis'. The design of the survey could also have been refined to understand if they were involved in any environmental project, such as natural capital accounting. They were not asked this directly, and the research would have benefited from understanding how the participants extracted value from these projects.

The recruitment of the case studies participants was satisfactory, although at the time of commencing this research, there were limited examples of enterprises undertaking natural capital accounting. Of the enterprises recruited, only two had established natural capital accounts and data that could effectively identify how the benefits of such an approach manifest. The research would have benefited from engaging more-mature natural capital projects, because how their results translate to a value proposition becomes clearer as the approach becomes more mainstream.

COVID-19 played a part in restricting my ability to undertake face-to-face interviews and focus groups, and in limiting the personal interactions possible.

Since this research commenced developments in research, policy and voluntary co-benefit markets have advanced. What this research highlights is there is still much work to be done to educate, design and establish markets for natural capital if accounting for natural capital is to become mainstream practice in agriculture.

Natural capital does not change overnight, and these results cannot tell us emphatically that adopting natural capital accounting will definitively lead to significant improvements in

natural capital condition over the long term. The results also do not indicate if natural capital accounting is the most appropriate tool to address natural capital degradation.

Critically natural capital and accounting frameworks are nascent concepts and as this research highlights knowledge in understanding of them is poor. There is a clear need to increase awareness and normalise discussion around natural capital and demystifying the crucial role natural capital has in societal well-being. Bringing the discussion into mainstream education from an early phase, from ecological and economic perspectives can begin to normalise the discussion early and build strong platform to support its implementation.

This research also highlights that farmers create value but are rarely rewarded for that value creation. In the case of natural capital accounting the evidence that links financial reward to the value created through positive natural capital outcomes is still unclear. Without this evidence farmers are being asked to implement complex accounting frameworks at a cost that currently is not recoverable. The supply chain currently does not recognise the metrics around natural capital accounting tools and is unwilling to reward farmers for improved environmental management or pass costs to consumers. Those participating in this research view this a significant barrier to wider adoption of an accounting approach and future research should focus on developing these links between natural capital accounts and financial outcomes.

Understanding how our interactions on agricultural landscapes are impacting natural capital and our ability to feed the global population, while providing the ecosystem services society, requires transparent practical effective frameworks that resonate with broader society.

9.8 Recommendations and further research

What is clear from the research is there is no one strategy to increasing the adoption of natural capital accounting. Future strategies need to be collaborative and integrate the views of a wide range of societies stakeholders to achieve maximum impact and change behaviours and ensure farmers commit long term to accounting for natural capital.

Several case studies were still in early phase of implementation and tangible outcomes were difficult to identify. Observable results will take time and there is a need to develop a consensus around the most effective frameworks to accounting for natural capital, frameworks that can be applied in the real world across multiple farmers groups. Reliable and robust data is required to support the development of natural capital accounts and validate outcomes. Further research is needed to identify the role technology has in delivering this data.

The research acknowledges the complexity surrounding natural capital and accounting for it. Untangling this complexity should be a key priority to improve understanding across society. This should include analysis of the frameworks and their design and effectiveness in delivering outcomes. Importantly identifying the most effective educational pathways to increase knowledge and raise awareness of the importance of natural capital is crucial. This can be achieved by embedding concepts into early education programmes and prioritising the development of school curricula including targeted university courses.

Future strategies should not ignore consumers given the significant role consumers have in through product choice and influencing social licence. Identifying consumer beliefs and the understanding of the concept of natural capital, linking this to a willingness to pay for products that have natural capital credentials will be an important area for future research. Knowledge exchange and education is a two-way street, and this will not occur if programmes are run in isolation.

The opportunity to share and co-create knowledge between groups, ensures a more holistic approach to the problem. Knowledge sharing should include government as an intermediary

in developing programmes to increase both the awareness and knowledge of natural capital. This could include developing awareness and education programmes similar to the Heart Foundation Tick Program, recently retired (Heart Foundation, 2022). Future research that considers how the data from natural capital accounts can be used to verify the impact of production on natural capital and how it can be aligned to future TFND reporting.

Working with focus groups during a pandemic came with limitations. This experience suggests ensuring validity of these focus group findings consideration should be given to evolving the focus groups, particularly to a face-to-face environment and expanding the range of participants. This is likely to offer deeper understanding of how stakeholders views can influence wider adoption of natural capital accounting through more fluent idea exchange and provide more robust data.

Chapter 10: Conclusions—Addressing the Research Questions

In this chapter, I present the conclusions of this research and address the research questions. In the research, I undertook to fill the knowledge gaps around why natural capital accounting is not widely adopted in agricultural decision-making. I also summarise the limitations of the study, its significance, and opportunities for further research.

Natural capital is required to supply the ecosystem services essential for agriculture, society, the supply of food, fibre, and energy, and climate regulation. Agriculture is a voracious user of natural capital and is highly dependent upon its condition and quality. It is also a significant contributor to climate change through the production of greenhouse gas emissions. Conversely, agriculture also plays a significant role in maintaining the health of natural capital and ecosystems and as a sink for greenhouse gas emissions.

For agriculture to validate and quantify its economic and environmental contributions, the effective and workable measurement and monitoring of natural capital is required. The inclusion of natural capital accounting in agricultural decision-making may be a way to rigorously demonstrate the health of natural capital and validate the decisions and outcomes around its condition. However, continued failure to recognise the intrinsic links between the financial and natural worlds, and to prioritise economic growth over natural capital, poses not only the threat of a decline of agricultural landscapes but of significant economic losses through increased climate, business, and intergenerational equity risks.

The role played by farmers, both corporate and family, in managing their natural capital was the focus of this research because these groups manage over 50% of Australia's land. The inclusion of agricultural stakeholders who affect or are affected by agriculture focused a transdisciplinary lens on the importance of natural capital, where changes to practices requires "*reliable knowledge that transgress disciplinary boundaries*" (Hirsch Hadorn et al., 2006). This approach showed that the value proposition of natural capital is less evident to other stakeholders than to farmers. Given the immaturity of natural capital accounting, for those considering implementing it, the value proposition appeared aspirational rather than actual at this stage. Finally, the voluntary nature of natural capital accounting does not, at

present, provide the continuity required for the long-term measurement and monitoring of natural capital, as identified in the literature.

The conclusions of this research based on the final observations at section 9.5 are:

1) For farmers to adopt natural capital accounting, they require a clear value proposition that does not currently exist. Without a clear value proposition long term measurement and monitoring of natural capital this will remain a clear barrier to wider adoption. This will likely result in fragmented data and an inability for agriculture to demonstrate its natural capital credentials.
2) Further research is necessary to establish clearer links between natural capital and the financial and productivity benefits required to encourage market development and to compensate for the costs of the implementation and ongoing management of natural capital accounting projects.
3) Education programmes that increase the knowledge and awareness of natural capital and natural capital accounting are crucial to building greater understanding of the importance of natural capital and the purpose of natural capital accounting. Participants in this research emphasised the need to educate not only farmers, but a wide range of stakeholders, including consumers, and valuers particularly. Understanding where education can have the biggest impact is particularly relevant, and its inclusion in high school curricula and higher education degree programmes of the importance of natural capital to society must be considered. The value of short courses and extension programmes should also not be ignored.
4) Practical accounting tools, including effective measurement frameworks, and robust data are required to ensure the legitimacy of natural capital accounting and prevention of greenwashing. Collaboration is required to design and standardise frameworks that can be practically and effectively applied across agriculture.
5) Greater collaboration and strategic partnerships between farmers and their supply chains will support clearer messaging to consumers about the importance of natural capital for sustainable food production and landscape management. Collaboration should also aim to ensure mutually beneficial outcomes to deliver equitable value propositions through the supply chain. Examples of strategic partnerships likely to

have the desired effects include (i) partnerships with retailers, (ii) partnerships with valuers and (iii) partnerships with financiers and investors.

6) Future opportunities should be identified and made a priority to align natural capital accounting in agriculture with the TFND and global reporting requirements around nature-based risks.
7) Stakeholders' views on the role of governments in stimulating natural capital accounting were inconclusive. Although there is already government activity at both the state and national levels, federal financial assistance to farmers to support their implementation of natural capital accounting is required, as with the Emissions Reduction Fund (ERF) (Australian Government Clean Energy Regulator, 2022a). This could also include the purchase of data from on-farm natural capital accounting projects. Government also plays an important role in policy around education, in setting curricula and funding and developing extension and university programmes.

10.1 Conclusions—Sub-question RQ1

- ***RQ1—How do farmers perceive the value of natural capital and the need to measure it?***

The key lessons and conclusions drawn from this research about how farmers perceive natural capital and the need to measure it are:

- The foundational knowledge about the importance of natural capital has empowered a limited number of farmers and institutions to undertake natural capital accounting. The majority of those interviewed in the case studies had a strong educational grounding in landscape health, which positively influenced their decisions to measure and monitor natural capital (Chapter 6, Appendix).
- In the case studies, the common reasons given for undertaking natural capital accounting were the potential economic, productivity, and environmental benefits (Chapter 6).
- According to the case study participants, natural capital accounting is important in validating outcomes and management decisions and in creating a competitive advantage in accessing new markets or attracting new investors.
- Of the farmers who completed the broader survey, most respondents saw natural capital as very important to agriculture. Most also indicated they had or were participating in environmental or sustainability programmes on their farms but not natural capital accounting. The majority indicated that environmental issues ranked high among the pressures facing day-to-day farming[27]. (Chapter 8).
- Most farmers participating in the survey indicated a willingness to allocate between 6% and > 15% of their land to vegetation sequestration programmes for the mutual benefits this would generate (Chapter 8).
- In the farmer survey, the three most frequently cited benefits that would accrue to farmers promoting the management of natural capital[28] were: i) productivity

[27] Given the small sample and many of the respondents had undertaken environmental programs on farm this may not be representative of farmers more broadly.
[28] Where management of natural capital refers to the activities undertaken to preserve, improve natural capital to build resilience. Natural Capital Accounting is a process of quantifying the stocks and flows of natural capital either in physical or monetary terms and can be used to inform decision making.

benefits; ii) financial benefits; and 3) improved landscape health. These responses were consistent with those in the case studies (Chapters 6 and 8).

- In the survey, the farmers were generally unsure that natural capital accounting was an important activity.
- Reflecting how strongly the case study enterprises viewed natural capital, they chose to undertake the accounting process at their own cost and worked closely with trusted advisors to ensure that the programmes were effective and delivered the desired results. This was true of all the enterprises, even though there was no tangible financial benefit to offset the implementation costs. (Chapter 6)
- Despite the views and actions of those participating in this research, the wider adoption of natural capital accounting remains fragmented. The value propositions identified here appear aspirational, with little evidence of any financial benefits from the application of natural capital accounting. The cost of its implementation and on-going monitoring is seen as a significant barrier to its adoption, given there are no clear financial or productivity rewards. (Chapter 6 and 8)
- Although the case study participants displayed knowledge and understanding of natural capital and natural capital accounting, the interviewees from the case studies indicated that the lack of knowledge, education, and understanding around natural capital by the wider industry was another significant barrier to the implementation of natural capital accounting. Similarly, the farmer survey and focus groups also indicated that natural capital and natural capital accounting were not well understood or were understood by only a select few. (Chapter 6 and 8)

These points indicate that among the farmers who participated in this research, there is strong recognition of the importance of natural capital, particularly when considered in the context of the success or failure of their enterprises. The wider adoption of natural capital accounting is likely to be achieved with greater knowledge transfer and the development of clearer commercial benefits with links to measured environmental outcomes.

10.2 Conclusions—Sub-Question RQ2

- ***RQ2—What inhibits or motivates the use of natural capital accounting frameworks and how do these factors vary between stakeholders such as retailers, financiers accountants and investors?***

The key lessons and conclusions reported in this section show how agricultural stakeholders perceive natural capital and natural capital accounting; how these views vary between stakeholder sectors; and how they can influence the wider adoption of natural capital accounting. (Chapter 7)

- The participants in the focus groups were from a cross section of industries and sectors and had a diverse range of views on the importance of natural capital and natural capital accounting. This reveals the challenges to finding common or shared values around natural capital that motivates farmers and stakeholders in incorporating natural capital accounting as part their decision-making tools.
- The pre-focus-group survey showed that the participants viewed the value of natural capital and natural capital accounting slightly differently from the farmers and case study participants. The responses were broad, although 50% indicated that the potential financial opportunities and productivity gains were important. Other participants identified the use of natural capital accounting as a risk management tool, its role in maintaining intergenerational equity, and the fact that it was driven by regulators, investors, and business strategies.
- Significantly, the focus group sessions identified the lack of a value proposition for natural capital accounting as a barrier to its adoption. Financial benefit was only identified as a value proposition once in the sessions. There was a feeling that there was no evidence or business case that was relevant to their sector at this stage, so there was no urgency to adopt a position on natural capital. This can be linked to the concerns expressed in the focus group sessions around the poor quality of reporting and the lack of clarity on standards. This suggests that the participants had little incentive to engage with natural capital or natural capital accounting at this stage.

- As in the case studies, natural capital was viewed as important, but most participants were unsure where it rated relative other industry priorities.
- The formal definitions of natural capital and natural capital accounting did not resonate well with the focus group participants, with some indicating that they could not communicate this information to their customers. Participants felt that natural capital and natural capital accounting were not well understood or were only understood by a select few, views consistent with those of the case study participants and the farmers' survey responses.
- This was also linked to concerns around the lack of industry skills and capability in natural capital accounting. These concerns are consistent with the need for knowledge and education, identified as barriers in the case studies and the farmer survey.
- The focus groups were unclear on the actions that were currently being undertaken across their sectors in terms of natural capital. Some participants indicated that they knew of others in their sector reporting the risks to natural capital, but it was unclear who these were.
- The barriers to the implementation of natural capital accounting that involved social issues included farm succession planning and the need to make long-term decisions about sustainability in farm operations. Status quo bias, or the preference of farmers to keep doing what they are doing because they perceive that they are already a doing a good job and there is no clear message to change, was also raised.
- Barriers around the establishment of frameworks and the validity of data were also expressed in focus group sessions, including "*We are going to end up with a whole heap of different parts of the industry going off and doing their own thing and not meaning a lot*".

These points indicate there is still uncertainty within stakeholders of the relevance of stakeholders given they see limited value propositions. With significant other priorities and lack of skills and knowledge around natural capital significant work is required to create mutual values around natural capital and deliver equitable outcomes to all stakeholders.

10.3 Conclusions—Main Research Question

How can understanding the views of the various stakeholders remove the barriers to the adoption and relevance of natural capital accounting in agriculture?

Through their direct influence on farmers, stakeholders in the supply chain can play an important role in accelerating the adoption of methods to measure and monitor natural capital in agricultural landscapes. However, there is currently limited evidence that stakeholders are actively promoting behavioural changes to improve natural capital outcomes or see natural capital as a current priority to their industry. Importantly, from the survey, farmers rely on family and advisors in relation to on farm decisions. This offers insight into where opportunities to educate and share knowledge can be leveraged to encourage behavioural change. The removal of barriers to the adoption of natural capital accounting requires multiple solutions and collaboration across industries and sectors.

- Across all areas of data there was discussion around the uncertainty surrounding the standardisation of and robustness of measurement tools, data, and reporting. It is necessary to ensure that in the process of measuring and monitoring natural capital with natural capital accounting, the economic benefits that link productivity with the environmental benefits created are identified. This issue is not clearly expressed in the literature but was seen as an impediment to the wider adoption of natural capital accounting and should be a key area of future research.
- There was also uncertainty around natural capital and where it sits when placed against the background of climate change, food waste, emissions, and farm profitability. The TFND and the development of risk management and reporting frameworks is likely to significantly influence how these priorities evolve. As discussed in the first point there are risks and concerns around the possibility of perverse outcomes and greenwashing without robust data and standards. As the National Farmers' Federation pointed out, they may "*result in saddling farmers with additional costs*." This risks power imbalances that impose additional costs on farmers that could include validating their natural capital outcomes for suppliers, or when market access is limited when accounting information is not or cannot be provided. Reinforcing the

need for research into the development of standards, frameworks and associated data that are robust and validated.

- What is clear from the literature and the focus group sessions is that to achieve mutual benefits, greater collaboration and strategic partnerships must be created to advance the importance of natural capital and avoid power imbalances. As previously mentioned, Dasgupta (2021) stated that knowledge and perspectives must be shared and disseminated across organisations and communities. This was restated in the focus group sessions by representatives of the banking, not-for-profit, accounting, and retail sectors. Collaboration is also an important way to address another concern expressed by the focus groups and farmers: that a fragmented approach will result in poor execution and uncertain outcomes that lack practical applications. This should be targeted collaboration, to ensure that outcomes that can be applied in the real world.
- Bridging the knowledge gap through education, to communicate the important role of natural capital in agriculture to society, was also seen by farmers and stakeholders as a significant barrier to the adoption of natural capital accounting. This must be addressed at the national level through school curricula and university programmes, to entrench knowledge at an early stage of learning. Government policy plays a significant role in this area, at both the federal and state levels. Although education programmes for current farmers and stakeholders will fill a gap, ensuring intergenerational equity will also involve education, and the provision and development knowledge in will facilitate the transition to a natural-capital-focused society.

If natural capital accounting is the preferred tool with which to assess the condition of natural capital in agriculture, collaboration will be crucial across all stakeholder groups. It constitutes an important step in delivering a clear value proposition and in the development of a common language and frameworks that are practical and cost effective to implement. Without a value proposition, the continuity of natural capital accounting programmes and the long-term measurement of natural capital will probably lead to the ineffective management of natural capital on a large scale.

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APPENDICIES

Appendix A: Case Study Interviews

A-1 Introduction Letter and Consent Form
A-2 Semi-Structured Interview Questions Guide

A-1 Introduction letter and consent form

UTS UNIVERSITY OF TECHNOLOGY SYDNEY

Stuart Martin
PhD Candidate
Institute for Sustainable Futures
15 Broadway, Ultimo NSW 2007

T: +61 2 9514 0000
M: +61 (0)
Stuart.r.martin @student.uts.edu.au

PO Box 123
Broadway
NSW 2007 Australia
www.uts.edu.au

UTS CRICOS PROVIDER CODE 00099F

UTS Public

3 September 2020

,

RE: Proposed Case Study -

Integrating Natural Capital Accounting Frameworks into Agricultural Decision Making
UTS HREC REF NO. ETH20-4900

As discussed I am conducting research into the integration of natural capital accounting in agricultural decision making and would welcome your assistance. The research will involve examining 3 cases studies where natural capital accounting has been or is about to be undertaken. The Case study examination should take no more than 3-4 hours of your time through the participation in an informal interview and the provision of documentation relevant to the study. The interview will seek to explore your companies and your personal views around the integration of natural capital accounting in agricultural decision making. In light of current COVID 19 restrictions and health concerns the interview will be undertaken via recorded ZOOM session to ensure accurate data collection. You have been asked you to participate because of your organisations active interest or involvement in undertaking natural capital accounting in agriculture.

This research is being undertaken through the Institute for Sustainable Futures – UTS as part of my PhD along with the assistance of the Food Agility CRC and DPI NSW.

If you are interested in participating, I would be glad if you would contact me, *and/or my supervisors, Dr Scott Kelly, Professor Damien Giurco or Dr Cathy Waters.*

You are under no obligation to participate in this research.

Yours sincerely,

Stuart Martin B.Com (Land Ec) MSUS GAICD
Institute for Sustainable Futures
Level 10, Building 10
Broadway NSW 2007

Stuart.r.Martin@student.uts.edu.au

NOTE:

This study has been approved by the University of Technology, Sydney Human Research Ethics Committee. If you have any complaints or reservations about any aspect of your participation in this research which you cannot resolve with the researcher, you may contact the Ethics Committee through the Research Ethics Officer (ph: +61 2 9514 2478 Research.Ethics@uts.edu.au), and quote the UTS HREC reference number. Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

PARTICIPANT INFORMATION SHEET – CASE STUDY
Integrating Natural Capital Accounting Frameworks into Agricultural Decision Making
UTS HREC REF - ETH20-4900

WHO IS DOING THE RESEARCH?

My name is *Stuart Martin* and I am a student at UTS. My supervisor is Dr Scott Kelly *contact details* – +61 (0) [redacted] or scott.kelly@uts.edu.au

WHAT IS THIS RESEARCH ABOUT?

This research aims to identifying the barriers to the adoption of natural capital accounting frameworks in agricultural decision making and the pathways to increase its adoption.

FUNDING

Funding for this project – This research is supported by an Australian Government Research Training Program Scholarship and is also partially supported by funding from Food Agility CRC Ltd, funded under the Commonwealth Government CRC Program. The CRC Program supports industry-led collaborations between industry, researchers and the community.

WHY HAVE I BEEN ASKED?

You have been invited to participate in this study because *of your pre-existing involvement in agricultural and/or focus in the applications of Natural Capital Accounting in an agricultural systems context.*

IF I SAY YES, WHAT WILL IT INVOLVE?

If you decide to participate, I will invite you to:

Participate in no more than 3 X 1.5 hour semi structured audio recorded interviews as part of a case study and to speak on behalf of their organisation and themselves in respect to views and values around integrating natural capital accounting into agricultural decision making.

ARE THERE ANY RISKS/INCONVENIENCE?

Yes, there are some risks/inconvenience. They are times you may feel*, you may be asked sensitive questions, you may be asked questions that may result in providing potentially sensitive or commercial in confidence information.*

DO I HAVE TO SAY YES?

Participation in this study is voluntary. It is completely up to you whether or not you decide to take part.

WHAT WILL HAPPEN IF I SAY NO?

If you decide not to participate, it will not affect your relationship with the researchers or the University of Technology Sydney. If you wish to withdraw from the study once it has started, you can do so at any time without having to give a reason, by contacting Stuart Martin by calling [redacted] or emailing stuart.r.martin@student.uts.edu.au.

If you decide to leave the research project, we will not collect additional personal information from you, although personal information already collected will be retained to ensure that the results of the research project can be measured properly and to comply with law. You should be aware that data collected up to the time you withdraw will form part of the research project results. If you do not wish this, you must inform the researcher before joining the research project.

CONFIDENTIALITY

By signing the consent form you consent to the research team collecting and using personal information about you for the research project. All this information will be treated confidentially. The Data will be stored in a secure on-line location, onedrive, provided by UTS with access limited to the researcher and

supervisors – Dr Scott Kelly, Professor Damien Giurco and Dr Cathy Waters and to my funding partner Food Agility CRC. Your information will only be used for the purpose of this research project and it will only be disclosed with your permission, except as required by law.

We plan to *discuss/publish* the results as part of my PhD *with the results from the case studies summaries reported alongside outcomes/results from stakeholder focus groups. Publications are likely to include (but not limited to) academic journals, presentations, periodic publications such as "The Conversation" etc. The data collected from the case studies will be focused on the decisions around natural capital accounting, how, why or if it was implemented, issues surrounding the implementation and ongoing monitoring, value proposition of undertaking the program and where it could be improved.*

WHAT IF I HAVE CONCERNS OR A COMPLAINT?

If you have concerns about the research that you think I or my supervisor can help you with, please feel free to contact us – Stuart Martin [redacted] or Email stuart.r.martin@student.uts.edu.au or Dr Scott Kelly on [redacted] or email scott.kelly@uts.edu.au

You will be given a copy of this form to keep.

NOTE:
This study has been approved in line with the University of Technology Sydney Human Research Ethics Committee [UTS HREC] guidelines. If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat on ph.: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au, and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

CONSENT FORM
INTEGRATING NATURAL CAPITAL INTO AGRICULTURAL DECISION MAKING UTS HREC APPROVAL NUMBER

I _____ agree to participate in the research project *give name of research project and include the UTS HREC approval reference number when obtained]* being conducted by *Stuart Martin PhD Student – Institute for Sustainable Futures UTS Broadway NSW 2007* . I understand that funding for this research has been provided by *The Food Agility CRC and an Australian Government Research Training Program Scholarship* .

I have read the Participant Information Sheet or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research as described in the Participant Information Sheet.

I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time without affecting my relationship with the researchers or the University of Technology Sydney.

I understand that I will be given a signed copy of this document to keep.

I agree to be:
☐ Audio recorded

I agree that the research data gathered from this project may be published in a form that:
☐ Identifies my organisation Only

I am aware that I can contact *Stuart Martin* if I have any concerns about the research.

_____ ____/____/____
Name and Signature [participant] Date

_____ ____/____/____
Name and Signature [researcher or delegate] Date

_____ ____/____/____
Name and Signature [witness*] Date

A2- Semi-Structured Interview Questions Guide

The questionnaire was designed with the assistance and guidance of my supervisors and Dr Rebecca Cross from the School of Geosciences at Sydney University. Each interviewee was provided with a copy of these questions one week prior to the interviews. These were provided in addition to the ethics approval and participant information sheet. The Purpose of the providing the questions was to allow interviewees to be prepared for the interview and to be able to answer the questions in as much detail as possible.

Semi Structured Interview Question Guide for Case Studies

1) Interview No More than 1 hour

The purpose of the semi structured interview is to explore the characteristics of the farming organisations that undertake Natural Capital Accounting as part of their day-to-day operations. The aim is to understand why they are using natural capital accounting when there is limited evidence of its wide adoption. Also to understand the value proposition they see from using natural capital accounting in day to day decision making.

Welcome and Rapport building (10 mins)
Welcome and thank the participant for taking time to participate in the research. Confirm that the participant is comfortable to have the interview recorded using the ZOOM record function. Provide background to the research and myself. Also reconfirming the research and checking that the participant had received and understood the information and consent sheets. Then begin the interview and confirm recording has commenced.

1) **How do different farming groups perceive natural capital value and the need to measure it?**

Rapport Building

- What is your Role within XXX and your background? Is your background reflective of others within XXX?
- When was XX established and what principles was it founded on. What does it aim to achieve and over what time frame has it set itself to reach these goals.

Participants understanding of the subject

- What does it mean to you when you hear the words natural capital accounting?
- Taking into consideration your response would you say natural capital and the role it plays in agricultural decision making is very well understood, understood or not understood. Can

you give more detail around this view.

Why is your organisation undertaking Natural Capital Accounting – triggers, what or who influence the organisation and what is the value proposition

- Describe the triggers that determined the need to implement natural capital accounting In particular were other stakeholder groups, identified as key to the project's success, influential in encouraging you to take this approach. If so how did they influenced your decisions.
- What outcomes do you expect from using a Natural Capital Accounting approach.
- Why have you decided to take on natural capital accounting approach where this is little evidence of wide adoption of the approach to date?
- How has the accounting process worked so far and what adaptions do you think you need or have made to ensure you achieve desired outcomes?
- What do XX see as the key benefits from using the Natural Capital Accounting and how confident are you investors/industry will support it long term?
- How many others have shown an interest in the project? What have been their reflections on what has been established e.g. did they identify what was missing or potential issues?

2) **What are the major barriers to the adoption of natural capital accounting frameworks?**

- When you began to explore the use of the accounting for nature framework what issues did you encounter? How did you overcome them?
- How did you determine what natural capital elements to measure?
- Were you aware of other Natural Capital accounting frameworks? What other frameworks or systems did you consider? Why did you choose not to use them?
- How do you directly link your financial outcomes to natural capital outcomes?
- If Natural capital accounting make sense can you give reasons for why there is a lack of examples such as Kilter undertaking this approach.
- What interactions have there been with other state based or federal institutions to ensure there is a standardised approach to recognising natural capital accounting and its co-benefits

3) Can understanding alternative stakeholder views lead to the removal of the barriers to the adoption and relevance of natural capital measurement in agriculture?

- How do stakeholders benefit from undertaking natural capital accounting? What engagement have you had with other farmers/stakeholders to build trust in the process.
- By undertaking natural capital accounting over an extended period have you been able to clearly identify a market premium or pricing differential in either your production or land values? If so how and if not what is the greatest barrier to unlocking this value differential.
- Who else have you engaged with around your accounting approach? What questions or concerns did they have about the approach. What questions do stakeholders ask when they talk to you about natural cap accounting?

- Did these stakeholders see any benefits to them by you taking this approach? Have you shared your experiences with other farmers? What has been their response?

Final Broad Questions

Climate and weather plays a significant role in agriculture and its success year to year how has keeping Natural Capital Accounts assisted in managing climate and weather? Has it made the enterprise more resilient and if so how?

What do you need to do next, what are new things you are exploring i.e. integrating new carbon accounting methodologies?

Wrap up

Inform the participant that the interview is ended and that the recording will stop now. Summaries the interview and thank them for the time. Explain to the participant that the interview recording will be transcribed, and a transcription will be sent to them via email once complete. Request they review the transcript and inform myself if anything has been omitted or transcribed incorrectly.

Thank the participant for their time and reaffirm the confidentiality of the information and that they will not be identified personally.

End

Appendix B: Focus Groups

B-1 Introduction Letter and Consent Form
B-2 Focus Group Agenda Provided to Participant's
B-3 Sample of Case Study Interview Statements Provided to Participants pre-Focus Group
B-4 Pre-Focus Group Survey

B-1 Introductory Letter and Consent Form

UTS UNIVERSITY OF TECHNOLOGY SYDNEY

INVITATION LETTER
Integrating Natural Capital Accounting Frameworks into Agricultural Decision Making
UTS HREC REF NO. ETH20-4900 and ETH21-5878

Dear [redacted]

My name is Stuart Martin and I am a student at the University of Technology, Sydney.

I am conducting research into the integration of natural capital accounting in agricultural decision making and would welcome your assistance. The research has involved examining 4 cases studies where natural capital accounting has been or is about to be undertaken. In addition I am conducting focus groups with agricultural stakeholders as part of a transdisciplinary approach to my research. The aim is to used shared knowledge to build and link a value proposition around better adoption of natural capital accounting in agricultural decision making. I am inviting you to participate in a focus group with 6-7 other stakeholders.

The Focus Group should take no more than 1.5 hours of your time through the participation in a facilitated recorded ZOOM session. The focus group is designed to generate knowledge across stakeholders providing insights into the understandings around natural capital and its importance to agriculture and it's stakeholders which may include contradictive views.

In light of current COVID 19 restrictions and health concerns the focus group will be undertaken via recorded ZOOM session. You have been asked you to participate because of your organisations active interest or links to natural capital accounting and agriculture.

This research is being undertaken through the Institute for Sustainable Futures – UTS as part of my PhD along with the assistance of the Food Agility CRC and DPI NSW.

If you are interested in participating, I would be glad if you would contact me, *and/or my supervisors, Dr Scott Kelly, Professor Damien Giuirco or Dr Cathy Waters.*

You are under no obligation to participate in this research.

Yours sincerely,

Production Note:
Signature removed
prior to publication.

Stuart Martin
Institute for Sustainable Futures
Level 10, Building 10
Broadway NSW 2007
[redacted]
Stuart.r.Martin@student.uts.edu.au

NOTE:
This study has been approved by the University of Technology, Sydney Human Research Ethics Committee. If you have any complaints or reservations about any aspect of your participation in this research which you cannot resolve with the researcher, you may contact the Ethics Committee through the Research Ethics Officer (ph: +61 2 9514 2478 Research.Ethics@uts.edu.au), and quote the UTS HREC reference number. Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

PARTICIPANT INFORMATION SHEET – CASE STUDY
Integrating Natural Capital Accounting Frameworks into Agricultural Decision Making
UTS HREC REF - ETH20-4900 and ETH21-5878

WHO IS DOING THE RESEARCH?

My name is *Stuart Martin* and I am a student at UTS. My supervisor is Adjunct Associate Professor Scott Kelly *contact details* – +64 (0) [redacted] or scott.kelly@uts.edu.au

WHAT IS THIS RESEARCH ABOUT?

This research aims to identifying the barriers to the adoption of natural capital accounting frameworks in agricultural decision making and the pathways to increase its adoption.

FUNDING

Funding for this project – This research is supported by an Australian Government Research Training Program Scholarship and is also partially supported by funding from Food Agility CRC Ltd, funded under the Commonwealth Government CRC Program. The CRC Program supports industry-led collaborations between industry, researchers and the community.

WHY HAVE I BEEN ASKED?

You have been invited to participate in this study because *of your pre-existing involvement in agricultural and/or focus in the applications of Natural Capital Accounting in an agricultural systems context.*

IF I SAY YES, WHAT WILL IT INVOLVE?

If you decide to participate, I will invite you to:

Participate in a ZOOM recorded Focus Group as part of my research and to speak on behalf of their organisation/industry or themselves in respect to views and values around integrating natural capital accounting into agricultural decision making.

ARE THERE ANY RISKS/INCONVENIENCE?

Yes, there are some risks/inconvenience. They are times you may feel*, you may be asked sensitive questions, you may be asked questions that may result in providing potentially sensitive or commercial in confidence information.*

DO I HAVE TO SAY YES?

Participation in this study is voluntary. It is completely up to you whether or not you decide to take part.

WHAT WILL HAPPEN IF I SAY NO?

If you decide not to participate, it will not affect your relationship with the researchers or the University of Technology Sydney. If you wish to withdraw from the study once it has started, you can do so at any time without having to give a reason, by contacting Stuart Martin by calling [redacted] or emailing stuart.r.martin@student.uts.edu.au.

If you decide to leave the research project, we will not collect additional personal information from you, although personal information already collected will be retained to ensure that the results of the research project can be measured properly and to comply with law. You should be aware that data collected up to the time you withdraw will form part of the research project results. If you do not wish this, you must inform the researcher before joining the research project.

CONFIDENTIALITY

By signing the consent form you consent to the research team collecting and using personal information about you for the research project. All this information will be treated confidentially. The Data will be stored in a secure on-line location, onedrive, provided by UTS with access limited to the researcher and

supervisors – Adjunct Associate Professor Scott Kelly, Professor Damien Giurco and Dr Cathy Waters and to my funding partner Food Agility CRC. Your information will only be used for the purpose of this research project and it will only be disclosed with your permission, except as required by law.

We plan to *discuss/publish* the results as part of my PhD *with the results from case studies summaries alongside outcomes/results from stakeholder focus groups. Publications are likely to include (but not limited to) academic journals, presentations, periodic publications such as "The Conversation" etc. The data collected from the case studies will be focused on the decisions around natural capital accounting, how, why or if it was implemented, issues surrounding the implementation and ongoing monitoring, value proposition of undertaking the program and where it could be improved. You will not be identified individually or by company. Reference will only made to the industry which you are associated with.*

WHAT IF I HAVE CONCERNS OR A COMPLAINT?

If you have concerns about the research that you think I or my supervisor can help you with, please feel free to contact us – Stuart Martin [redacted] or Email stuart.r.martin@student.uts.edu.au or Adjunct Associate Professor Scott Kelly on +64 (0) [redacted] or email scott.kelly@uts.edu.au

You will be given a copy of this form to keep.

NOTE:

This study has been approved in line with the University of Technology Sydney Human Research Ethics Committee [UTS HREC] guidelines. If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat on ph.: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au, and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

UTS UNIVERSITY OF TECHNOLOGY SYDNEY

CONSENT FORM
INTEGRATING NATURAL CAPITAL INTO AGRICULTURAL DECISION MAKING UTS HREC APPROVAL NUMBER *UTS HREC REF - ETH20-4900 and ETH21-5878*

I _____ agree to participate in the research project Integrating natural capital accounting into agricultural decision-making being conducted by Stuart Martin PhD Student – Institute for Sustainable Futures UTS Broadway NSW 2007. I understand that funding for this research has been provided by *The Food Agility CRC and an Australian Government Research Training Program Scholarship.*

I have read the Participant Information Sheet or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research as described in the Participant Information Sheet.

I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time without affecting my relationship with the researchers or the University of Technology Sydney.

I understand that I will be given a signed copy of this document to keep.

I agree to be:
☐ Audio and video recorded

I agree that the research data gathered from this project may be published in a form that:
☐ Identifies my industry only

I am aware that I can contact *Stuart Martin* if I have any concerns about the research.

_____ ____/____/____
Name and Signature [participant] Date

Production Note:
Signature removed prior to publication.
_____ 22/06/2021
Name and Signature [researcher or delegate] Date

_____ ____/____/____
Name and Signature [witness*] Date

B-2 Focus Group Agenda Provided to Participant's

FOCUS GROUP AGENDA

10.30am	Intro ***Focus Group – Session Breakdown*** Intro and overview of survey and re-affirming ethics and safety
10.40am	**Session 1: Stakeholder understanding** (20 Minutes) What is the importance of Natural Capital and Ecosystem Services to industry groups or businesses (prompts from survey will be used to assist discussion) Outcomes from this session 1) Stakeholder understanding of terminology being used 2) Where do the concepts fit into their business? 3) How does it or does it manifest itself across or in the industry currently. If not, why not? 4) Is there a value to the industry or are there any barriers – Develop the themes
11.00am	Break (5min)
11.05am	**Session 2: Case Study Review** (20 minutes) 1) Compare themes arising from the case studies with themes developed in session 1 – identify common ground and areas of divergence 2) Link – identify what stakeholders see as the value proposition themes from the case studies and the obstacles that link or are common to stakeholders
11.25am	**Break (5min)**
11.30am	**Session 3: Bringing it together** (20 minutes) Outcomes Consider where Natural Capital Ecosystem services fit in the near term and long term with your industry. Identify when you would first anticipate engaging in a Natural Capital Project and how? Or if at all ie. as sponsor, offset project, influencer, participant? *Activity: As a group if you were to put a Natural Capital engagement proposition to a board what would it look like (how you would sell it to the board) ie how you will benefit and where the benefits come from.*
11.50am	**Session Ends (& thankyou)**

B-3 Sample of Case Study Interview Statements Provided to Participants pre-Focus Group

These short responses taken from the semi structured interviews with case study members were provided to the Focus Group participants prior to the Focus Group sessions. The purpose was to allow the focus group participants to prepare for the second part of the focus group by having considered responses from case study members. Participants were asked to compare and link the responses by case study members to their own thoughts and industry positions around the value proposition of NC Accounting and the barriers to implementation.

The following slides provides a snapshot of some of the key themes/responses raised in the Case Study interviews.

As a snapshot this comments are designed to provide an insight to what have been identified as the obstacles and the value proposition as seen by those agricultural enterprises undertaking or about to undertake natural capital accounting.

- HIGHLIGHT 3 from each section that align with your thoughts or stand out as key issues
- We will use them in Session 2 to compare with your own and industry views from other participants.
- It will provide context for session 3 when examining possible solutions. Is it possible to design a system to meet all stakeholder values?

Identified Obstacles to NC Accounting from Case Study Interviews

- "People speak different languages" – "No clear well-defined system" – "need one common language"
- "we need to train people to understand NC and equip them to measure, monitor and report"
- "Its costing us more than we will ever realise in financial terms"– "not commercially viable"
- "There is a disconnect between consumers and producers" – "I don't think it's very well understood" - "consumers want carbon neutral won't pay for it"
- "Leaders and policy makers still have industrial mindset". - "Our regulators are our disincentive rather than an incentive"
- "Traditional thinking farmers don't want to be told how to do things differently or can be resistant to change"
- "One of the biggest barriers will be the skill set of the Property Valuation community"
- "Not a lot of good robust examples around" – "No longevity once funding runs out, they fall over"
- "Investors not plugged in to the mechanics of natural capital" - "Investors send mixed signals"

Identified Value Proposition of undertaking NC Accounting from Case Study Interviews

- "We will be rewarded for performance" - "No way we can sell anything if we can't measure it"
- "Capital Preservation" – "If the market says you have to show us you're improving then we will pay you"
- "I love the idea of a farmer getting paid a premium because they're very improving the health of their, their farmland"
- "Leads to more profitable and sustainable agricultural production, and that's quite separate from any income streams we might get from measuring natural capital. So that, to me, is the exciting bit as a as a farmer"
- "The value proposition really is that we have an opportunity here to drive a new industry that will be to our economic advantage, but also to our environmental and social advantage"
- "Somebody is going to ask how we were improving country; how can you prove it?" – "a lot of inquiry for investments that have a natural capital component to the investments"

- “Attracting investors that have a clear ethic themselves and have and environmental dividend alongside their annual report”
- “there's a clear interest in provenance from customers” - “as with most premiums, it'll disappear and become a penalty if you if you're either not adopting the systems or you have poor metrics”

Other Statements

- “next phase will be actually linking payment, to environmental conditioning improvement” - “I think there'll be an ongoing education process”
- “if they could broaden that appeal and market, so that, you know, not just corporates, but average every day, operators can access these things in a market that makes sense and you have a framework for monitoring and reporting that’s repeatable and cost effective for people, you’d see a transformation of the landscape and the way it's managed”
- “there is both an intrinsically structural issue in relation to carbon on title but there's also another issue around understanding and education of those people in those sectors that influence this”
- “I think the type of farmers involved in this sort of stuff, and the type of consumers interested in this sort of stuff is still in the minority”
- “If we can't link them in some way (profitability and ecological outcomes), either directly or, at least have some good narrative about the, the linkages, then it won't be useful”
- if you're going to take a market approach, then markets require transparent and robust information. Natural capital accounting provides a way to make that information consistent and translate it to language that's readily understood

B-4 Pre-Focus Group Survey

The purpose of the pre focus group survey was to overcome time constraints in undertaking the two focus group sessions. The aim was to build an understanding of participants knowledge and expertise prior to the focus groups session and use this as a scaffold and expand on the responses during the sessions.

Pre-Focus Group Survey - Integrating Natural Capital into Agricultural Decision Making

Q1 Which industry do you work in?

- ○ Real Estate/Property Valuation
- ○ Banking
- ○ Investment
- ○ Agricultural Management/Advisory
- ○ Insurance
- ○ Accountancy
- ○ Retail (Food/Fibre etc)
- ○ Government/Policy
- ○ Not for Profit
- ○ Carbon Farming or Aggregation
- ○ Industry Representative
- ○ Other

Q2 Do you understand the term Natural Capital?

- ○ Yes
- ○ No

Q3 Do you understand the term Ecosystem Services

- ○ Yes
- ○ No

Q4 If you answered YES to the previous questions when did you begin to hear about these?

- ○ Within the last 12 months
- ○ 1 year ago
- ○ In last three years
- ○ 5 years ago
- ○ More than 5 years ago

Q5 If you answered YES to questions 2 and 3 in 100 characters or less what does it mean when you hear the term Natural Capital?

Q6 Natural Capital is a Priority to your industry.

- ○ Strongly agree
- ○ Somewhat agree
- ○ Neither agree nor disagree
- ○ Somewhat disagree
- ○ Strongly disagree

Q7 Why is Natural Capital important to your Industry?

- ○ Financial Opportunity
- ○ Risk Management (Task Force for Nature related Financial Disclosures)
- ○ Environmental Concerns
- ○ Addressing Climate change
- ○ Social License
- ○ Risk of Stranding Assets

Q8 Based on your answer to the previous question do you think this is reflective of others in your industry?

- ○ Yes
- ○ No

Q9 Have you heard of Natural Capital Accounting?

- ○ Yes
- ○ No

Q10 Which of these you have heard of? Tick all those you have.

- ○ SEEA - System of Experimental Environment Accounts
- ○ Accounting for Nature
- ○ Natural Capital Protocol
- ○ EOV - Ecological Outcome Verification
- ○ TEEB - The Economics of the Environment and Biodiversity
- ○ TFND - Task Force on Nature related financial Disclosure
- ○ None of these

Q11 Do you think Natural Capital Accounting is

- ○ Understood
- ○ Well Understood
- ○ Not Understood at all
- ○ Understood by a select few

Q12 Has your industry taken steps to influence better management of natural capital?

- ○ Yes
- ○ No

Q13 Do you know of anyone in your industry that is currently reporting on risks associated with degradation of Natural Capital?

- ○ Yes
- ○ No

Q14 Why is it important to account for natural capital using a standardised measuring and monitoring framework?

- ○ Validating outcomes of management practices
- ○ Avoidance of Green Washing
- ○ Accurate reporting of nature-based risks
- ○ Feel good
- ○ Comparable

Q15 When did you first engage with or when would you expect to engage with natural capital projects?

- ○ Now
- ○ Within 1 year
- ○ Within 2-3 years
- ○ Within 5 years
- ○ Not sure

Q16 Thinking of your response to Q15 how do you expect outcomes, through your involvement in Natural Capital projects, to be reflected?

- ○ Financial incentives for validated and improved natural capital management
- ○ Financial penalties for poor natural capital outcomes
- ○ Require increased reporting from suppliers/projects around natural capital
- ○ Increased Promotion of products with Natural Capital credentials
- ○ Non-financial incentives for projects with validated improved natural capital

Q17 What would a natural capital benefit look like?

- ○ Financial
- ○ Competitive advantage
- ○ Reduced risk
- ○ Not sure
- ○ Improved social license
- ○ None - will result in increased cost

Q18 Should natural capital become mainstream when would you see that you would benefit from a natural capital project?

- ○ 1-2 yrs
- ○ 3-5 yrs
- ○ 10 yrs
- ○ Not sure

Q19 What are the barriers that stop your industry adopting a natural capital approach/focus? 100 characters or less

Q20 Is Natural Capital and Natural Capital Accounting the best way to address and reward environmental stewardship? If no what is the alternative?

_____

Appendix C

C-1 Farmer Survey

C-1 Farmer Survey and Consent

To gain a broader perspective around farmers understanding of natural capital and natural capital accounting an online Qualtrics survey was developed and distributed to family and friends who are farmers. Several industry and educational organisations also assisted in its distribution (see Chapters 4 and 8). This resulted in 74 responses.

Introductory Question

An Introductory question to the Qualtrics Survey was provided to gain participants consent and ensure they were comfortable in participating. To complete the survey participants had to agree to the introductory question by responding YES to this question. Those responding NO were automatically prevented from proceeding. It was noted that several participants responded YES to access the questions then did not complete the survey.

Q1 - This anonymous survey is part of my PhD research project - "Integrating Natural Capital Accounting into Agricultural Decision Making" and subject to ethics approvals. The survey looks at the participants understanding of natural capital, carbon farming and their applicability in the management of environmental assets in agriculture. My PHD is being undertaken through Institute for Sustainable Futures - University of Technology Sydney and in conjunction with Food Agility CRC. It is planned the data collected will be aggregated and used to discuss/publish the results as part of my PhD thesis and related publications. The anonymous results may be discussed with my supervisors and members of the Food Agility CRC. They may also be used in presentations at seminars, conferences etc. The survey is predominantly single answer questions with options to provide additional information and should take around 15-20 minutes to complete. If you have any questions regarding this survey or ethics approvals, please contact my supervisor scott.kelly@uts.edu.au or research.ethics@uts.edu.au and quote ethics REF NO. ETH20-6562. You can only progress with this survey by answering YES to agree to participate

The Survey

Q2
Which state is your farming operation?

- ○ NSW
- ○ QLD
- ○ VIC
- ○ SA
- ○ TAS
- ○ WA
- ○ NT
- ○ ACT

Q3
What is your farming enterprise?

- ○ Grazing
- ○ Broadacre farming
- ○ Horticulture inc. Viticulture

Q4
Who influences your decisions in relation to your agricultural enterprises? - Tick Top 2

- ○ Consultant/Advisor
- ○ Government bodies (Dept of Ag etc)
- ○ Educators
- ○ Family/Partner
- ○ Friends
- ○ The internet
- ○ NRM
- ○ Other (List) _____

Q5
What area of land do you manage? (Hectares)

Q6

Which age bracket do you fall into?

- ○ 18-25
- ○ 26-35
- ○ 36-45
- ○ 46-55
- ○ 56-65
- ○ >65

Q7

How do long term environmental issues rank in the context of other pressures/issues facing day to day farming for you?

- ○ Very high
- ○ High
- ○ Not sure
- ○ Low
- ○ Very Low

Q8

How important is climate change to Australian agriculture?

- ○ Very high
- ○ High
- ○ Not sure
- ○ Low
- ○ Very Low

Q9
Climate change will have an impact upon your business.

- ○ Strongly agree
- ○ Agree
- ○ Not sure
- ○ Disagree
- ○ Strongly disagree

Q10
Tick the following terms you have heard of.

- ○ Natural capital
- ○ Natural capital accounting
- ○ Carbon farming
- ○ Ecosystem services
- ○ Soil carbon

Q11
Natural capital can be defined as "the stock of renewable and non renewable natural resources that combine to yield a flow of benefits to people" (Natural Capital Coalition, 2016). Natural capital includes soil, water, biodiversity.

Given this definition - is natural capital important to your business?

- ○ Very important
- ○ Somewhat important
- ○ Not sure
- ○ Probably not important
- ○ Not important at all

Q12
Natural capital accounting can be defined as "as series of interconnected accounts that provide a structured set of information relating to natural capital and flows of services provided by them (Principles of Natural Capital Accounting, 2017).

They can be
a) Physical - measurement and monitoring that classifies and records quality and quantity of your farms natural capital and its ecosystems services, which may assist in assessing production or financial risk of your operations or*;*

b) Monetary - measurement and monitoring that assigns a monetary valuation to selected services on an annual basis that may result in a payment for conservation, biodiversity, carbon etc.

Given this definition do you see natural capital accounting as important to your business?

- ○ Very important
- ○ Somewhat important
- ○ Not sure
- ○ Probably not important
- ○ Not important at all

Q13
Are natural capital and natural capital accounting understood across your industry?

- ○ Very well understood
- ○ Understood
- ○ Not sure
- ○ Understood by a select few
- ○ Not well understood

Q14

Do you consider the natural capital (water, soil, biodiversity) on your farm should be managed for the general public benefit or as a private benefit (for the management of your farm)? Please explain your response in the appropriate text box.

- ○ Public _____
- ○ Private_____
- ○ Both Public and Private _____
- ○ Not sure _____

Q15

Of the options below tick the ones you have heard of

- ○ Clean Energy Regulator (CER)
- ○ Australian Carbon Credit Unit (ACCU)
- ○ Emissions Reduction Fund (ERF)
- ○ Co-Benefits
- ○ Human induced regeneration
- ○ Environmental plantings
- ○ Base line
- ○ Reference State
- ○ None of these

Q16

Do you think carbon farming is a priority to agriculture? Please explain your response in the appropriate text box.

- ○ Agree _____
- ○ Not sure _____
- ○ Disagree _____

Q17
Where are you on your sustainability journey?

- ○ We have done everything possible
- ○ We are well advanced on our journey but still adapting
- ○ We are just beginning
- ○ We are considering what we should do
- ○ Not really started

Q18
Are you currently actively participating in environmental stewardship programs?

- ○ Yes
- ○ No

Q19
Which, if any, environmental stewardship programs do you undertake (tick all appropriate options)

- ○ Planned grazing
- ○ No or minimal till
- ○ Biodiversity conservation
- ○ Carbon farming
- ○ Organic farming
- ○ Landcare programs
- ○ DPI/Government educational programs
- ○ Other (provide details max 100 characters)

_____

Q20
Which of these have you heard of?

- ○ Accounting for Nature
- ○ Regenerative agriculture
- ○ Permaculture
- ○ Landcare benchmarking projects
- ○ Ecological Outcome Verification
- ○ Queensland Land Restoration Fund
- ○ Cool soils Initiative
- ○ Natural Capital Protocol
- ○ System of Experimental Environmental Accounts
- ○ None of these

Q21
Do you think Natural Capital Accounting is the best information system to stimulate better environmental land management? Please explain your answer in the appropriate text box.

- ○ No _____
- ○ Don't know _____
- ○ Yes _____

Q22
What are the most important opportunities for promoting the management of natural capital?

- ○ Financial benefits
- ○ Improved landscape health
- ○ Productivity benefits
- ○ Climate change mitigation
- ○ It's becoming a prerequisite to doing business
- ○ Future market opportunities

Q23
What are the most important obstacles to the adoption of natural capital accounting?

- ○ Industry does not understand it
- ○ The industry does not have the skills
- ○ Bigger issues
- ○ No markets
- ○ No consistent approach
- ○ Cost outweigh the benefits
- ○ We manage our landscapes well already
- ○ No political commitment or certainty
- ○ Lack of regulation

Q24
What do you think is the best way to improve environmental outcomes?

_____

Q25

A vegetation sequestration program delivers mutual benefits through increased shelter provision, biodiversity enhancement, ground cover protection in addition to potential income through participation in carbon sequestration programs. What proportion of your farm area would you set aside to generate these benefits?

- ○ 0%
- ○ 0-5%
- ○ 6-10%
- ○ 11-15%
- ○ >15%

Q26

Building soil carbon improves soil quality (including reducing soil erosion, moisture capture, nutrient exchange, microbiology), on farm biodiversity and assists in improving resilience against climate change. Ultimately building soil carbon will build sustainability, profitability and enhance productivity. What is the minimum period you would expect to receive a payback on investment in a soil carbon project?

- ○ After 5 years
- ○ Longer than 10 years
- ○ No payback

Appendix D

D-1 Case Study Secondary Data

D-1 Case Study Secondary Data

Case	Secondary Data	
Kilter Rural	• AWARE Super keeps $100M of water, sells the farm to Costa Family. (Schlesinger, 2022a) • Accounting for Nature Framework in Progress (Kilter Rural, 2020) • What do Kilter Rural and David Attenborough have in common? Landscape regeneration. (Ingram, 2020) • Inside the Rope Interview with Cullen Gunn (Koda Capital, 2020) • Kilter Rural farm fund rejects water-intensive almond and avo crops (Schlesinger, 2019) • 2018 FUTURE FARMING LANDSCAPES WINLATON Environmental Condition Account – (Heislers et al., 2019). • Building soil carbon in semi-arid drylands for landscape resilience Kilter Rural, (Heislers, 2016) • INFORMATION MEMORANDUM, Australian Farmlands Funds JUNE 2020 (Kilter Investments Pty Ltd, 2020) • 2018 FFL WINLATON CASE STUDY: THE KILTER RURAL STORY- Soils For Life Case Study (Gardner, 2018)	
Paraway Pastoral	• Future farms: Sowing the seeds for sustainability (Macquarie Asset Management, 2020) • Paraway Pastoral (*Paraway Pastoral - About us*, 2022) • CEFC commits $75 million to Macquarie's cattle station fund. (Schlesinger, 2022b)	
NAPCO	• We are on the cusp of an Australian agri boom for the ages. (King, 2021)	
Queensland Land Restoration Fund	• 2017 Policy Document - Saving Habitat, Protecting Wildlife and Restoring Land: Ending broadscale tree clearing in Queensland again (Queensland Labour Party). (*Saving Habitat, Protecting Wildlife and Restoring Land: Ending Broadscale tree clearing in Queensland (again)*, 2017) • DES. 2020. Land Restoration Fund: Priority Investment Plan. (Department of Environment and Science, 2020) • Transcript – Introductory Video (*An Introduction to the Land Restoration Fund*, 2020) • Land Restoration Fund Co-benefits Standard Version 1.3 (Queensland Government, 2020)	

	• Unlocking value for the Queensland economy with land and agriculture offsets (Cook & Energetics Pty Ltd, 2017)	
Land to Market	• ECOLOGICAL OUTCOME VERIFICATION (EOV) Version 2.0 June 2019 (Savory Institute, 2019) • Accreditation program established for beef produced on farms which are improving ecological value (Calver) • The power of groups: The secret to the 8 families success. (*The Power of Groups: The secret to the 8 famlies success*, 2021) • Our Market Partners Buy into a healthier Australia (Land to Market, 2021) • Our Regen Partner: Land to Market (Harris Farm Market, 2021) • Ashes to showers, dust to crops • Five ways farmers across NSW have regenerated parched properties to make them not just drought-resilient but richly fertile (Warwick, 2019) • Presentation at NSW DPI/LLS Carbon forum (Hill, 2022)	