



Australian Government

Australian Accounting Standards Board

Working Paper No. 23-01

Improving the Visibility of Soil Health in Corporate Reporting

Nicholas Pawsey

Charles Sturt University | Soil CRC

npawsey@csu.edu.au

Francisco Ascui

Federation University | Soil CRC

ff.ascui@federation.edu.au

Mark Frost

Charles Sturt University | Soil CRC

mfrost@csu.edu.au

Benjamin Wills

Charles Sturt University

bwills@csu.edu.au

April 2023

All rights reserved. Short sections of text, not to exceed two paragraphs, may be quoted without explicit permission, provided that full credit including © notice is given to the source. This paper can be downloaded without charge from the AASB and Social Science Research Network Electronic Paper Collections:

<https://www.aasb.gov.au/research-resources/publications/aasb-working-papers-series/>
www.ssrn.com/index.cfm/en/Australian-Accounting-Standards-Brd-RES/

Improving the Visibility of Soil Health in Corporate Reporting

ABSTRACT

Soil health significantly influences agricultural production, drought resilience and the delivery of other essential ecosystem services including climate regulation. Compared to other natural resources, however, soil has been largely overlooked from a sustainability reporting perspective. The invisibility of soil in financial reporting has contributed to the broader lack of financial incentives for agribusinesses to implement soil stewardship strategies. At present, the ISSB and other sustainability reporting bodies including the TCFD, GRI, IIRC, SASB and CDSB have offered only limited coverage on soil-related matters.

Our study aimed to contribute to the development of ED/2022/S1 and advance soil-related reporting by engaging ASX-listed agribusiness financial statement preparers and investors to understand their perspectives on the relevance of soil-related risks and opportunities to investment decisions and their general soil reporting preferences. A mixed-method approach was adopted across two research phases: 1. archival analysis of current soil disclosure practices based on a review of the 2019-21 annual reports, corporate governance statements and CSR-reports of the 25 largest ASX-listed agribusinesses; and 2. in-depth, semi-structured interviews (n = 14) with stakeholders from a broad range of Australian agribusiness financial statement preparers and users. These interviewees included senior representatives from large corporate agribusinesses, investment entities and corporate advisors.

Our archival review found that while reporting on sustainability-related matters is increasing around factors such as greenhouse gas emissions, water management, and climate change more generally, there is minimal discussion around the management of soil, soil health and soil-related risks. Interviewees confirmed the significance of soil health in sustaining agricultural productivity. Whilst many investors still lack a detailed appreciation of the nature and ramifications of soil health, the recognition of the importance of soil is clearly growing. In this regard, many respondents anticipated that soil will be the focus of increased agribusiness investment and lending decisions. There

was strong support for enhanced soil reporting by agribusiness and it was felt that the ED/2022/S1 framing of disclosures (i.e. governance; strategy; risk management; and metrics and targets) would provide a good foundation for this. This being said, given the diverse and complex nature of soils, respondents acknowledged the difficulty associated with reaching consensus on the definition of soil health and universal soil health metrics and targets. Should soil reporting be enhanced, there was a preference for soil-related information which is simple, concise and communicated in terms which are familiar to investors. Furthermore, any information communicated to investors should not be above and beyond the kinds of information which is already used by agribusinesses for their own management purposes.

These results will help to identify the most appropriate approaches to enhance corporate soil reporting and priority areas for regulatory attention. Doing so will help determine the decision needs of investors and creditors in the listed agribusiness sector. This will facilitate the process of overcoming information asymmetries between corporate farmers and their investors and creditors, which currently act as a barrier to increased investment in soil stewardship. The project's focus on soil reporting practices will directly contribute to the AASB's focus on new areas of financial reporting, the international advancement of ISSB's sustainability reporting agenda and other related international developments focused on climate-change and nature-related risk reporting.

This paper is work-in-progress and the preliminary findings were presented at the 2022 AASB Research Forum.

Keywords: Soil Health, Sustainability Reporting, Agriculture, ISSB

JEL classification: M40; M41; M48, Q14, Q18

Acknowledgements: This work has been supported by the Cooperative Research Centre for High Performance Soils whose activities are funded by the Australian Government's Cooperative Research Centre Program. Our work has also been supported by the Australian Accounting Standards Board (AASB). We thank Dr Eric Lee, Dr Ao Li, Professor Lee Moerman and Associate Professor Brad Potter for their ongoing advice and guidance throughout our participation in the AASB's 2022 Research Forum. We also acknowledge the contributions of our accounting Research Forum panel members Professor Jayne Godfrey, Doug Niven and Dr Sue Ogilvy and the participants of the forum for their valuable insights on our research findings and recommendations.

*Corresponding author at: Nicholas Pawsey, npawsey@csu.edu.au

I. INTRODUCTION

The International Sustainability Standards Board's (ISSB) Exposure Draft ED/2022/S1 *General Requirements for Disclosure of Sustainability-related Financial Information* recognises the relevance of sustainability-related information given the relationship between natural resources and enterprise value. ED/2022/S1 therefore proposes to enhance the disclosure of information concerning an entity's natural resource impacts and dependencies, and the associated sustainability risks and opportunities.

Compared to other natural resources, soil has been largely overlooked from a sustainability reporting perspective. Soil health significantly influences agricultural production, drought resilience and the delivery of other essential ecosystem services including flood control, water purification and climate regulation (Greiner et al. 2017). Soil is rapidly degrading at a global scale (Yang et al. 2020) and most of Australia's soil suffers from constraints that significantly impact productivity (see Orgill et al. 2018). Sodicity, acidity and salinity problems across the Australian Wheatbelt, for instance, are estimated to cost around \$2 billion/year in lost production (Orton et al. 2018). Problems associated with ongoing soil degradation are of particular concern given the confluence of climate change and global food demand projections (Bennett et al. 2010).

The invisibility of soil in financial reporting has contributed to the broader lack of financial incentives for agribusinesses to implement soil stewardship strategies (Pawsey et al. 2021). Over the short-term, soil nutrient levels can be exploited to boost productivity. This can ultimately lead to longer-term problems which may require costly corrective measures to restore soil health. These and other soil-related risks are generally not considered within current equity and credit risk assessments (Voysey 2022; CISL & Robeco 2022).

At present, the ISSB and other sustainability reporting bodies including the TCFD, GRI, IIRC, SASB and CDSB have offered only limited coverage on soil-related matters.

Noting the gaps, our study aims to contribute to the development of ED/2022/S1 and advance soil-related reporting by engaging ASX-listed agribusiness financial statement preparers and investors to understand their perspectives on:

- the relevance of soil-related risks and opportunities to investment decisions, and
- opportunities to enhance soil reporting and the most appropriate means by which

useful soil-related information could be disclosed and connected to the information in an entity's general purpose financial statements.

Australian agribusinesses are significant both from an environmental and economic standpoint. These entities account for more than 50% of Australia's land use (Jackson et al. 2020) and the market capitalisation of the Top 50 ASX-listed agricultural entities is approximately \$40 billion (Bull Market, 2020). There is growing investor interest in agribusinesses with an S&P/ASX Agribusiness Index having recently been launched to support the monitoring of this sector.

Whilst our working paper is focused on agribusinesses with immediate soil-related risks and opportunities, the results are likely to be relevant to food manufacturers and retailers and other organisations who are dependent on agricultural produce. The project findings will provide important insights by which reporting entities might consider the materiality of sustainability-related risks and opportunities and disclose relevant information on these matters more broadly.

Our project commenced with an analysis of current soil disclosure practices based on a review of the 2019-21 annual reports, corporate governance statements and CSR-reports of the 25 largest ASX-listed agribusinesses. This review found that while reporting on sustainability-related matters is increasing around factors such as greenhouse gas emissions, water management, and climate change more generally, there is minimal discussion around the management of soil, soil health and soil-related risks.

The archival analysis was followed-up through in-depth, semi-structured interviews (n = 14) with stakeholders from a broad range of Australian agribusiness financial statement preparers and users. These interviewees included senior representatives from large corporate agribusinesses, investment entities and corporate advisors.

Interviewees confirmed the significance of soil health in sustaining agricultural productivity. Whilst many investors still lack a detailed appreciation of the nature and ramifications of soil health, the recognition of the importance of soil is clearly growing. In this regard, many respondents anticipated that soil will be the focus of increased agribusiness investment and lending decisions. There was strong support for enhanced soil reporting by agribusiness and it was felt that the ED/2022/S1 framing of disclosures (i.e. governance; strategy; risk management; and metrics and targets) would provide a

good foundation for this. This being said, given the diverse and complex nature of soils, respondents acknowledged the difficulty associated with reaching consensus on the definition of soil health and universal soil health metrics and targets. Should soil reporting be enhanced, there was a preference for soil-related information which is simple, concise and communicated in terms which are familiar to investors. Furthermore, any information communicated to investors should not be above and beyond the kinds of information which is already used by agribusinesses for their own management purposes.

The results of our archival and interview analysis will help to identify the most appropriate approaches to enhance corporate soil reporting and priority areas for regulatory attention. Doing so will help determine the decision needs of investors and creditors in the listed agribusiness sector. This will facilitate the process of overcoming information asymmetries between corporate farmers and their investors and creditors, which currently act as a barrier to increased investment in soil stewardship. The project's focus on soil reporting practices will directly contribute to the AASB's focus on new areas of financial reporting, the international advancement of ISSB's sustainability reporting agenda and other related international developments focused on climate-change and nature-related risk reporting.

Whilst our project is focused on agribusinesses with immediate soil-related risks and opportunities, the results are also likely to be relevant to other organisations who are dependent on agricultural produce such as food manufacturers and retailers.. The project findings provide important insights by which reporting entities might consider the materiality of sustainability-related risks and opportunities and disclose relevant information on these matters more broadly.

2. Literature review

Disclosure of Sustainability-related Financial Information

There has been growing appreciation of the financial statement ramifications from sustainability-related matters (see Anderson, 2019) and interest in broadening the traditional role of financial reporting to include the valuation of adaption costs and benefits, and the disclosure of risks associated with climate change and environmental degradation (Linnenlueke et al., 2015). These trends culminated in recent times with the ISSB's release of ED/2022/S1, which broadly proposes to require entities to:

“disclose information about its significant sustainability-related risks and opportunities that is useful to the primary users of general purpose financial reporting when they assess enterprise value and decide whether to provide resources to the entity” (par. 1).

ED/2022/S1 was motivated by calls from users of general purpose financial statement users for two key improvements. Firstly, enhanced information concerning sustainability-related risks and opportunities arising from an entity’s dependencies and impacts on natural resources. And secondly, improved consistency, completeness, comparability and verifiability of sustainability-related financial information to help financial statement users to assess an entity’s enterprise value.

ED/2022/S1 recognises the relevance of sustainability-related information given the relationship between natural resources and enterprise value. ED/2022/S1 therefore proposes to enhance the disclosure of information concerning an entity’s natural resource impacts and dependencies, as well as the associated sustainability risks and opportunities.

ED/2022/S1 requires firms to disclose information on four core content areas: governance; strategy; risk management; and metrics and targets. Importantly, this information concerning sustainability-related risks and opportunities should be connected to the information in an entity’s general purpose financial statements.

- (a) governance—the governance processes, controls and procedures the entity uses to monitor and manage sustainability-related risks and opportunities;*
- (b) strategy—the approach for addressing sustainability-related risks and opportunities that could affect the entity’s business model and strategy over the short, medium and long term;*
- (c) risk management—the processes the entity used to identify, assess and manage sustainability-related risks; and*
- (d) metrics and targets—information used to assess, manage and monitor the entity’s performance in relation to sustainability-related risks and opportunities over time (par. 11).*

ED/2022/S1 builds on the work of existing globally recognised frameworks including the recommendations of the Task Force on Climate-related Disclosures (TCFD). In an Australian context, the recommendations of the TCFD are increasingly utilised by firms

to meet their narrative and non-financial reporting obligations under applicable annual directors' report operating and financial review (see ASIC 2019, RG 247) and corporate governance disclosure (see ASX Corporate Governance Council, 2019) requirements. Given sustainability reporting developments, a growing body of academic research (see, for example, Buckby et al., 2015; Czernkowski et al., 2019; Dumay & Hossain, 2019; Bayne & Wee, 2019; Bayne et al., 2022) has explored corporate non-financial reporting by ASX-listed entities. Collectively, these studies have identified that firms are increasingly likely to disclose sustainability-related information as part of their non-financial reporting disclosures. There are, however, opportunities to enhance these non-financial disclosures given the tendency for firms to cover a relatively narrow range of topics, instances of non-disclosure of apparent environmental impacts and a lack of disclosure of comparative information and/or targets. In light of this, Bayne et al. (2021) advocated for the development of industry-specific guidance to allow for divergent issues across industries to be recognised.

The Australian agricultural sector

There are close to 90,000 agribusinesses within Australia (ABS 2020). These businesses are vitally important to the Australian economy given their contribution to exports (~10% of goods and services exports) and employment (~2.5% of employment) (Jackson et al., 2020).

The provision of sustainability-related information by agribusinesses is of fundamental relevance given the sector's inherent exposure to climate-related risks, which have been associated with higher temperatures, lower winter rainfall and increased risk in terms of cash and profit variability (Hughes, 2021). The sector also impacts the environment in a number of considerable ways. For instance, the sector generates between 19 and 29% of total global greenhouse gas emissions (World Bank Group, 2021). Furthermore, agribusinesses account for more than 50% of land use and water extractions within Australia (Jackson et al., 2020).

The National Farmers' Federation (NFF, 2019) released an ambitious plan to grow farm gate output of the Australian agricultural sector to \$100 billion by 2030, up from a \$60 billion in 2016-17. As part of this plan, the NFF (2019) estimated that approximately \$160 billion in new capital would be required and identified five roadmap pillars, namely, customers and the value chain, growing sustainably, unlocking innovation, people and

communities, and capital and risk management. Across these pillars, accountability and environmental accounting practices are to have a large role given, for instance, the focus on:

- improving the value of ecosystem services and the extent to which “farmers are recognised by the community as trusted and proactive stewards of Australia’s landmass” (p. 22);
- promoting communication between farmers and the community and the degree to which customers are informed about farming practices; and
- ensuring farm businesses are ‘investment-ready’ given a focus on improved transparency, financial literacy and reliable and timely investment performance data.

Given the perception that “farms are risky financial investments in comparison to other economic sectors such as manufacturing or services”, investors have been historically reluctant to direct funds towards farming activities in the absence of government support and assurances (Martin & Clapp, 2015, p. 551). In more recent times, particularly following the global financial crisis, the quantum of investment funds directed towards agricultural investments has grown significantly as investors seek to capitalise on rising commodity prices and population growth (Buxton & Campanale, 2012). These global trends have been facilitated by the relaxation of government protections and the emergence of new financial tools (Martin & Clapp, 2015).

There are increasing opportunities for investment in publicly listed agribusinesses with the market capitalisation of the Top 50 ASX-listed agribusinesses being approximately \$40 billion (Bull Market, 2020). In terms of land holdings, some of the largest ASX-listed agricultural firms include, for instance, the Australian Agricultural Company whose properties exceed six million hectares and “equates to roughly 1% of Australia’s land mass (AAC, 2020), Macquarie Infrastructure and Real Assets who controls 4.8 million hectares of farmland across Australia and Brazil (Macquarie Group Limited 2020), and Rural Funds Group whose properties exceed 800,000 hectares (Rural Funds Group, 2020).

In another sign of the growing opportunities for investments within Australian agribusiness sector, the S&P/ASX Agribusiness Index was launch in May 2022. As outlined by the ASX (2022), this development reflects the heightened recognition of the

need for sustainable agriculture and is designed to raise the profile of agribusinesses and enhance investor understanding of the sector. The index has 25 constituents with a total market capitalisation of around \$30 billion.

3. Soil – The ‘forgotten resource’

Soil Stewardship

Amongst other sustainability-related concerns, as recognised by the GRI (2022), soil health is a major consideration for agribusinesses. Soil is a “non-renewable resource at a human temporal scale” (Yang et al., 2020, p. 2) and can degrade or depreciate through various physical (i.e. erosion, compaction), chemical (i.e. salinization, acidification), and biological degradation processes (Dominati et al., 2010).

Within Australia, the large majority of Australian soils are constrained in some shape or form (see Orgill et al., 2018) and the actual yields for many Australian wheat growing regions are often no more than 60% of the total possible water-limited yields (Yield-Gap Australia, N.d.). Problems associated with ongoing soil degradation is particularly critical given future global food demand projections (Bennett et al., 2019). Agricultural practices are a key driver of soil degradation and accordingly have a direct impact on soil health (Yang et al., 2020; Dominati et al., 2010; Adhikari & Hartemink, 2016).

Given the significance of soil degradation, it is critical that soil stewardship practices are promoted which “carefully tend[.] the soil, but also guard[.] it and protect[.] it from harm” (Gregorich et al. 2006, p. 407). In this regard, there is a growing body of research concerning the benefits of soil stewardship practices relating, for instance, to:

- Conservation agricultural practices including minimal tillage, use of cover crops and the retention of crop residues, and/or crop rotations;
- Soil amelioration including the application of biochar, lime, gypsum, organic materials and/or deep ripping;
- Tactics designed to mitigate soil compaction including controlled traffic farming (CTF) systems, machinery modifications (i.e. use of low-mass harvesters), and/or other operational changes designed to limit traffic when soils are most exposed to compaction risks;

- Precision agriculture techniques including the use of soil sensors and data, and strategic fertilisation; and
- Use of buffer strips to promote biodiversity and reduce nutrient run-off (Hobbs et al., 2008; Chamem et al., 2015; Hedley, 2015; McPhee et al., 2020; Tepes et al., 2021).

Beyond the impact on agricultural productivity, soil stewardship practices which enhance soil health can support various provisioning, regulating, cultural and supporting ecosystem services (Adhikari & Hartemink, 2016). These services relate, for instance, to the regulation of water and nutrient cycles; carbon sequestration; biodiversity promotion and the provision of habitat for plants, animals and microorganisms (Greiner et al., 2017).

With soils holding around three times more carbon than the atmosphere (Keenor et al., 2021), there has been a rapid growth in interest in investments in soil carbon sequestration. The Federal Government's Emissions Reduction Fund (ERF) now includes a measurement method for generating carbon credits through a range of approved soil carbon sequestration activities, for instance, sowing permanent pasture, the application of lime and gypsum and altering herd stocking rates or the duration or intensity of grazing (Badgery et al., 2020).

Outside of the ERF, there are also growing opportunities for private investment in soil carbon sequestration through voluntary carbon offset schemes (Dinesh et al. 2022). There are, however, a number of challenges associated with such schemes given the costs associated with long-term monitoring, difficulty of guaranteeing additionality (i.e. that farmers are compensated for soil organic carbon increases which are in addition to what would have happened without any interventions) and lack of accountability if stored carbon is re-emitted (Paul et al., 2023).

In response to the role of soil stewardship and importance of promoting soil health, a National Soil Strategy (2021-2021) was released by the Department of Agricultural, Water and Environment in April 2021 (DAWE, 2021). As presented in Table 1, The National Soil Strategy includes three key goals relating to prioritising soil health, empowering soil innovation and stewards, and strengthening soil knowledge and capability.

Table 1. National Soil Strategy priorities

Goal 1: Goal 1: Prioritise soil health	Goal 2: Empower soil innovation and stewards	Goal 3: Strengthen soil knowledge and capability
Objective 1a: Recognise the value of soil Objective 1b: Strengthen leadership and partnerships to address national soil priorities Objective 1c: Advocate the importance of soil Objective 1d: Improve Australia’s international leadership in soil knowledge, awareness and management	Objective 2a: Promote soil stewardship Objective 2b: Optimise soil productivity, sustainability and resilience Objective 2c: Help protect and enhance Australia’s environment through effective soil management Objective 2d: Increase and maintain soil organic carbon	Objective 3a: Increase soil knowledge for better decisions Objective 3b: Measure benefits of improved soil management Objective 3c: Make Australian soil information and data available Objective 3d: Build and retain diverse soil expertise

(DAWE, 2021)

The National Soil Strategy’s focus on prioritising soil health, soil knowledge and capability was motivated by the recognition that many Australians including the private sector see soil “as ‘just dirt’” (DAWE, 2021, p. 37). Presently, there is limited information concerning the contribution of soil health towards the provision of environmental services and how “accounting for soil in all relevant decision-making significantly enhances outcomes in terms of agricultural production and ecosystem services” (DAWE, 2021, p. 33).

Accountability for Soil

Despite the recognised importance of soil stewardship, there has been a general failure to “join the dots... between good soil management and broader social, environmental and social outcomes” (Campbell 2008, p. 15). Compared to other environmental goods such as water, soil governance lacks defined property rights, and the method to account for both private and public goods associated with soil ecosystem services requires attention (Juerges and Hansjürgens 2018). It is unsurprising, therefore, to observe that soil health is generally absent from equity and credit analysis and investment products (Voysey, 2019). As a result, the risks to agribusinesses from soil degradation are often overlooked (Robeco & University of Cambridge Institute for Sustainability Leadership, 2022)

The failure to recognise the underlying value of soils has been reflected across major sustainability reporting frameworks. Table 2 summarises the results of a review of Global Reporting Initiative (GRI), Climate Disclosure Standards Board (CDSB), Integrated Reporting Initiative (IRI), Sustainability Accounting Standards Board (SASB), and Task Force on Climate-related Disclosures (TCFD) standards and guidance. This review considered the extent to which these bodies provided guidance on soil-related matters. The standards that were assessed were selected because they dealt with environmental reporting generally, or with relevant sub-issues such as bio-diversity or wastes and effluent.

None of the standards setting bodies reviewed have developed a specific soil stewardship related standard. This contrasts, for instance, to the explicit coverage of water by the GRI and CDSB. Outside of GRI 13, none of the other standards reviewed contained any detailed guidance on how to report on issues relevant to soil. While soil and soil stewardship were not discussed directly, most of the standards contained guidance that could be inferred as being relevant to soil reporting. These included mentions of the relevance of reporting factors that impact: ecological processes, salinity, soil absorption of runoff and natural capital.

Table 2. Review of soil reporting guidance

Standards Body	Standard Reviewed	Specific Soil Stewardship Standard	Soil Stewardship as explicit sub-component of standard	Soil Stewardship as inferred sub-component of standard	Key nomenclature
Global Reporting Initiative (GRI)	GRI304: Biodiversity Standard	No	No	Yes	Ecological processes, salinity
Global Reporting Initiative (GRI)	GRI 303: Waste and Effluents	No	No	Yes	Soil absorption of runoff
Global Reporting Initiative (GRI)	GRI 307: Environmental Compliance	No	No	No	
Global Reporting Initiative (GRI)	GRI 308: Supplier Environmental Assessment	No	No	No	
Global Reporting Initiative (GRI)	GRI 13: Agriculture, Aquaculture & Fishing Sectors	No	Yes	Yes	Soil health
Climate Disclosure Standards Board (CDSB)	CDSB Framework for reporting environmental and climate change information 2019	No	No	Yes	Land, biodiversity, ecosystem services
Integrated Reporting Initiative (IRI)	IRI Framework 2020 Consultation Draft	No	No	Yes	Natural capital, land
Sustainability Accounting Standards Board (SASB)	Agricultural Products	No	No	Yes	Environmental risk
Task Force on Climate-related Disclosures (TCFD)	Annex	No	No	Yes	Land use metrics (i.e. land use by cover type, carbon stocks, tillage, conservation practices)

The recently released GRI 13 identifies soil health as one of 26 likely material topics for agribusinesses. GRI 13 requires agricultural firms to explain how it manages soil health in accordance with GRI 3 together with details of their soil management plan.

As identified in the basis for conclusions for GRI 13, some respondents to the associated GRI 13 ED suggested that reference should be made to the Food and Agricultural

Organisation's soils portal to provide guidance key soil qualities. The GRI, however, justified the exclusion of a requirement to report on quantitative soil health indicators on the grounds that it would be difficult to do so at an organisational level and achieve comparability given:

- How organisations may operate farms in different locations,
- How different soils have different needs,
- The impact of external factors (i.e. drought) on production.

This scant guidance on soil reporting has been attributed as a key factor holding back corporate soil reporting (Davies 2017). In response, a small number of academic papers have attempted to advance the understanding of how relevant soil disclosures could be made. As summarised in Table 3, these efforts have included the works of Ogilvy (2015) and Maroun and Atkins (2021).

Ogilvy (2015) drew on double entry and accrual accounting principles and proposed a model for improved firm level environmental accounting for agricultural enterprises through the development of an Ecological Balance Sheet (EBS) which records the stocks of a farm's "ecological assets and the changes to these stocks that result from actions and transactions" (p. 127). As part of EBS approach promoted by Ogilvy (2015), soils (as with other natural resources including vegetation, livestock and water) are recorded as a farm's ecological capital.

In light of the role of the ecosystem in providing the foundation of modern society, Maroun and Atkins (2021) developed a normative model for reporting on soil health. It was argued that this model would serve to "educate managers and stakeholders, as well as promote action to protect and improve ecosystems" (p. 38). The authors drew on the IIRC and GRI guidelines and established biodiversity reporting and extinction accounting theory and principles and identified how soil health reporting could span five key disclosure themes.

Table 3. Existing soil reporting proposals

Author/s	Aims	Recommendations
Ogilvy (2015)	Illustrate how accrual accounting and double-entry bookkeeping might be applied, in relation to the management of agricultural grasslands, to describe natural assets, the flows between them and how these assets may impact the flow of economic benefits.	Agricultural enterprises could prepare Ecological Balance Sheets (EBS) which record the stocks of their “ecological assets and the changes to these stocks that result from actions and transactions” (p. 127). As part of this, soil would be recognised as a non-current asset and a subclass of land (distinct from grassland and the trees and shrubs), and a standard depreciation schedule could be developed based on the pattern in which soil structure and fertility are expected to be consumed by the entity. Furthermore, an internal liability could be recognised where the soil surface has been damaged due to livestock management practices and livestock must be subsequently excluded for a period of time to allow for grasslands to regenerate and soil health to improve.
Maroun & Atkins (2021)	Develop a normative model for reporting on soil health based on IIRC and GRI guidelines and established biodiversity reporting and extinction accounting theory and principles.	Soil reporting could include five key disclosure themes: 1. Scene setting and species reporting; 2. Risk statement; 3. Stakeholder engagement; 4. Internal management; and 5. Reporting codes. Soil reports should include both quantitative and financial measures in conjunction with other forms of reporting for biodiversity. Referencing the IIRC, a multi-capital assessment of risks was also promoted with firms encouraged to map policies and performance indicators against the associated capitals.

The soil reporting processes outlined by Ogilvy (2015) and Maroun and Atkins (2021) share similarities in that they propose that land managers should identify key soils health metrics and measure them over time. Ogilvy (2015) focused on valuation of the contribution soil ecosystem assets to farm productivity and profitability, the reporting of soils as a sub-class of land as part of the preparation of an EBS, and the monitoring of how soil stocks change through farm activities. Maroun and Atkins (2021), by comparison, focused on the adaption of existing IIRC and GRI frameworks and the disclosure concerning the significance of soil health and risks to an organisation’s business model with an organisation’s soil health policies and performance mapped across the capitals.

Ogilvy (2015) and Maroun and Atkins (2021) focus on voluntary disclosures outside of general purpose financial reporting. There are, however, valuable potential benefits from a consideration of the inclusion of soil-related information within mainstream financial reports. As the TCFD argues, disclosure of sustainability-related information within these mainstreams reports ought to foster a broader engagement and use of these disclosures by investors and others. Consistent with this premise, ED/2022/S1 proposes to require firms to disclose sustainability-related information within their general purpose financial reports given how this information can supplement and complement financial statement information. The accompanying ED/2022/S1 basis for conclusions holds that, by its underlying nature, general purpose financial reporting encompasses sustainability-related

financial information.

4. Current investigation

Research aims

Our project sought to address the general omission of soil-related matters by mainstream sustainability reporting bodies and lack of consultation with agribusinesses, agri-investors and other stakeholders to consider their soil reporting perspectives and preferences. We aimed to contribute to the development of ED/2022/S1 and advance soil-related reporting by engaging corporate agribusinesses and investors to:

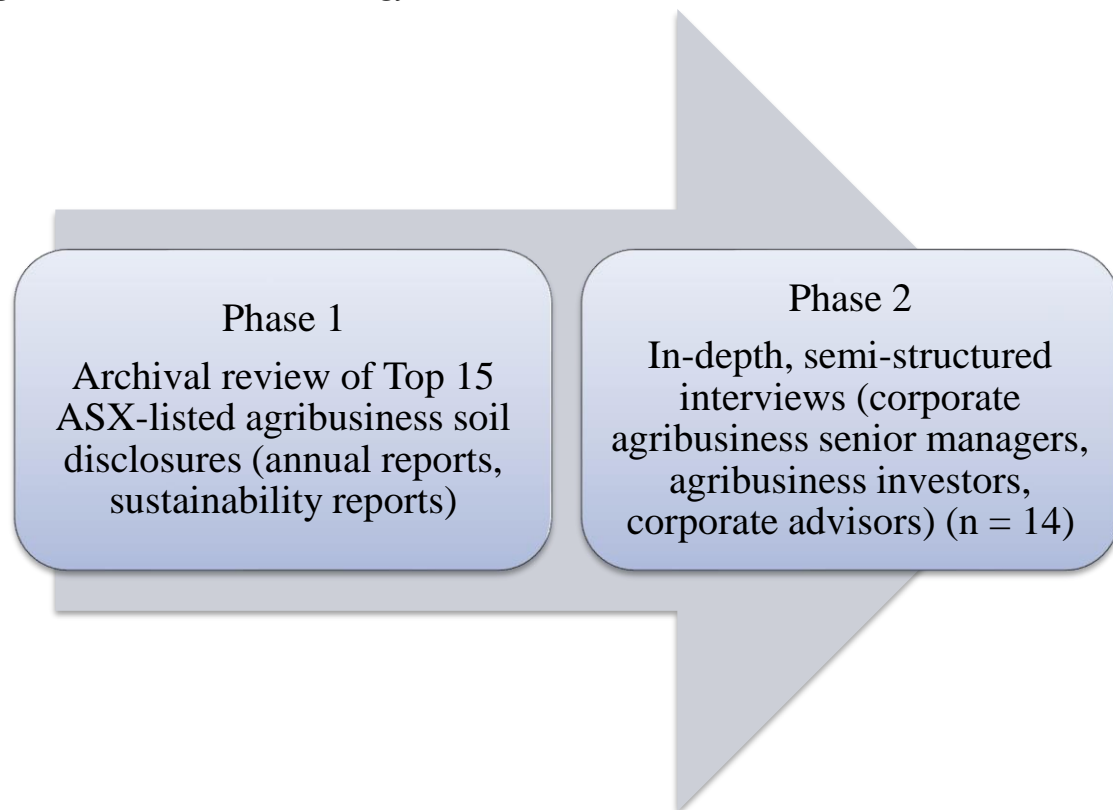
1. Determine the significance of soil-related risks and opportunities to agribusinesses and investment decisions.
2. Understand the usefulness of soil-related information to the understanding of an entity's business model, strategy, access to finance and current and anticipated future financial performance, position and cash flows.
3. Identify the most appropriate means by which useful soil-related information could be disclosed and connected to the information in an entity's general purpose financial statements.
4. Understand how can financial statement preparers can be best supported to provide relevant information on soil-related risks and opportunities.
5. Establish a soil reporting exemplar.

Fundamentally, we respond to the calls for new forms of accounting that account for the impact of corporate farming on nature, clearly communicate any damage to soil health caused by corporate farming activities and overcome the past tendency to view these impacts as externalities (see Lanka et al., 2017; Weir, 2019). Our focus on soil accountability contributes to the broader natural capital literature which have sought to “make nature values visible and legible economically, both as stocks of ‘natural capital’ and as associated flows of ‘ecosystem and/or environmental services’” (Sullivan & Hannis 2017, p.). These efforts designed to extend the underlying scope of financial reporting have been long advocated for (see, for example, Matthews, 1997).

Research methodology

As depicted Figure 1, our study adopted a mixed-methodology across two phases. This included an initial archival review and analysis of the current soil reporting practices of ASX-listed agribusinesses following by a series of in-depth, semi-structured interviews with corporate agribusiness senior managers, agribusiness investors, corporate advisors.

Figure 1. Research methodology



Our archival analysis examined the FYE 2020 and FYE 2021 audited annual accounts, Annual Sustainability Reports (where available), Annual Climate Reports (where available) as well as individual company websites. Data was sourced for 15 public agribusiness related companies, including the 10 companies listed on the ASX Agribusiness Index (ASX:XAG) as well as the next 5 largest agribusinesses based on market capitalisation as at FYE 2021.

The ASX Agribusiness Index was utilised as it is considered a benchmark for monitoring the overall sectoral performance of agribusiness through agribusiness companies listed on the Australian Stock Exchange, and who are arguably the more visible public agribusiness related companies. All ten companies in the Index are listed in the top 1000

ASX companies, have a minimum daily trade of \$80,000 and each contribute a constant 10% to the index.

A sample list of prospective interviewees was initially developed through an analysis of ASX-listed entities and web (i.e. corporate websites, LinkedIn) sources to identify senior management representatives of large corporate agribusinesses, major agri-investment entities and international corporate advisors with significant agribusiness involvement. Interviewees were invited to participate in the project through email and LinkedIn message exchanges.

The interviews were in-depth and semi-structured to allow for the emergence of unexpected themes. An interview guide was developed based on the research aims. This guide promoted comparability across interviews and included a number of questions and prompts to support our ability to establish an in-depth understanding on the significance of soils and opportunities to advance soil reporting.

A total of 14 interviewees agreed to participate in the study. These individuals all had significant knowledge of the Australian agribusiness sector and sustainability reporting. Each interview lasted between 45 and 60 minutes and was conducted via the online video conference software Zoom. The interviewees collectively represented a broad range of farming types from across Australia.

The interviews were recorded, transcribed and coded. Following Williams and Moser (2019), the coding process supported our ability to assemble and categorise the interview data to facilitate the development of meaning and an understanding of the key opportunities to advance soil reporting.

5. Research findings and recommendations

Archival Analysis

The analysis showed that of the 15 agribusinesses analysed, 5 were directly involved with farmland, either through freehold or leasehold ownership. Of these five companies, 3 were also vertically integrated in the supply chain as either processors or aggregators. Furthermore, of the 15 agribusinesses, five are involved in the cropping sector (grains and rice), three in the beef cattle sector, three in the dairy sector, two in the horticulture sector and one each in wine and rural land holding sectors respectively. Key highlights from the

analysis are detailed below in Table 5.

Table 4. Key highlights from company archival analysis

Top 15 Agribusinesses		Direct Farmland Users	Not Farmland users
No. of Agribusinesses		5	10
Report against TCFD, UN SGD, GRI	Commentary	5	10
	Metrics	2	6
Separate Sustainability Report		3	9
GHG Emissions		5	8
Soil Health	Direct	2	4
	Indirect		2

As discussed previously, reporting by the public companies against TCFD’s, UN SDGs and or GRIs is well advanced. Agribusinesses are no different, with all 15 companies including commentary against at least one of these sustainability frameworks.

Notwithstanding this, while all 15 included sustainability related commentary as part of their reporting, only two of five farmland-based agribusinesses included metrics, while six of ten non-farmland agribusinesses also included accompanying metrics.

It is noted that there has been an improvement in the quality and quantity of reporting across all companies between 2019 and 2021. For example, as at FYE 2021 all companies now provide either sustainability reporting in their annual accounts, a separate sustainability report or both. Furthermore, reporting is more comprehensive for agribusinesses involved further up the supply chain, where higher intensive processing industries are more likely to have comprehensive reporting around GHG emissions, water, energy, environmental regulations, waste etc.

A common factor is that reporting of soil (let alone soil health) is still lagging when compared to other “environmental” factors as mentioned above. From the 15 companies, soil health is only mentioned twice from a farming landowner where pasture management and stocking rates are directly linked to the underlying health of soil. Soil health is also mentioned from six non-farmland agribusinesses, (2 directly and 4 indirectly) through commentary on pasture health, agronomic advice, weed management, biodiversity, pollination etc.

Given the lack of soil health related reporting, our analysis was widened to determine if there are any companies which report on soil health, and the suitability of their reporting. From this secondary analysis two companies were identified – Duxton Broadacre Farms Limited and Australian Farmlands Trust. Both companies have direct farmland reporting and consider soil stewardship and health important management priorities. Duxton Broadacre Farms Limited, for instance (see Figure 2), reported on soil cover, soil erosion and soil health more generally within its Directors’ Report for the year ended 30 June 2021.

Figure 2. Example soil disclosures

Climate change risk

Duxton Broadacre Farms is a publicly listed company supported by a very long dated investment thesis and a theoretically infinite investment horizon. Our ability to reliably generate value for our stakeholders over the long term is a function of the productivity and risk management of the portfolio.

We perceive our stewardship over the land constituting our portfolio as not just conferring the right to use it to grow crops and manage livestock for years or decades, but as a responsibility to maintain it into perpetuity. We believe it is our responsibility to ensure that we are directly maintaining or improving factors such as soil health, ecological diversity, water security and water quality, and that in doing so we aim to improve productivity and also transition to a lower carbon operation.

(Duxton Broadacre Farmers, 2021, p. 14)

Similarly, Australian Farmlands Trust report on their soil conditions as part of their reporting against UN SDG 15 – Life on Land. The company reports on its soil cover and pasture management regimes that protect soil health, including soil testing and measurement. Such management practices are common across most agricultural farmland such that reporting on this should not add additional expectations of direct farmland users.

In summary, our analysis should improve reporting in sustainability, particularly around energy, water efficiency, waste and GHG emissions. These could be considered more “outcome” based resulting from agricultural production rather than the underlying farmland asset being utilised.

In-depth Interviews

Across all interviewees, whilst some observed that soil is still sometimes overlooked by

investors, there was recognition that the importance of soils was growing. As one interviewee perceived, there is definitely a:

“... growing appetite and a growing awareness as to the importance of soil in the productivity of the Australian agriculture”.

In the view of some respondents, the importance of soil and the promotion of soil stewardship cannot be overstated given its role in underpinning an agribusiness and sustaining life:

“... the whole world exists because of the top foot or two feet of what on the earth's crust. Once that's buggered we're all buggered”.

This recognition was particularly poignant in the context of agri-investments by superannuation funds:

“We're moving all this capital around to save for people's retirements, but if we're trashing the world at the same time, it just doesn't make any sense”.

A number of respondents acknowledged how the emerging interests in soils has been driven by interest in the ability to create carbon assets through soil carbon sequestration. The ability to deliver biodiversity credits through soil stewardship was also raised by some respondents.

For some corporate farmers and investors, investments in soil or “building soil” is at the core of their investment strategies. If an agribusiness is already fully developed, there can be limited gains from an investment point of view. There can, however, be substantial gains from lifting soil health and productivity on more degraded sites through investments in best management soil stewardship.

There was a general sense that investors, creditors and other participants in the agricultural value chain including supermarkets are moving towards a more sophisticated use of soil information. In the case of one agribusiness in particular that was known for its soil stewardship focus, there was a feeling that their efforts were already making their investment “capital a bit stickier”.

In the words of one interviewee, it is only a matter of time before agribusiness financiers and produce buyers are going to be approaching agribusinesses and ask “what’s your data related to your soil”. Ultimately, as other respondents suggested, if an agribusiness is not

meeting certain soil standards or “trash soil health”, a risk premium could be applied to it. This could ultimately “impeded their ability to get loans, get investment, and have that access to capital”.

In sum, respondents generally pointed to a major shift in thinking over the past decade. In the case of prospective agri-investments, sustainability has moved from “a little tick box at the end of the due diligence process” to being “one of the first items that’s raised”.

Across the large majority of interviewees, there was strong support for enhanced soil reporting by agribusinesses. Soil disclosures are likely to enhance the “focus on improving the productivity and performance of Australian soils”. This information will promote investor understanding of the condition of agribusiness assets they are investing in.

To the extent to which this soil-related information is benchmarked against a relevant basis of comparison, it will enable financial statement users to evaluate the competence of management in managing the soils under their control. This sentiment was typified by the following interviewee observations:

“Because if they were having to report on the condition, they'd have to measure it and understand it and think about what interventions they could make that would improve it. They mightn't be so keen to just get the offset disk and smash it up every year..”

“it could also be quite powerful if it was used by providers of capital as a tool for either pricing the cost of the capital or making the capital available in the first place”

Against this backdrop, however, some interviewees questioned whether a lack of soil information “is the barrier”. This position was justified on the grounds that, fundamentally, some investors still fail to appreciate the importance of soils and how it works. In these cases, additional soil disclosures may have limited impact.

Whilst there was support for enhance soil reporting, the opinions on whether soil reporting should become mandatory was mixed. On the one hand, those in support of making soil reporting mandatory, argued that we don’t have time for a more gradual process of moving from voluntary reporting to a mandatory system:

“I think you just say... We need the disclosure. If the companies aren't disclosing, then investors can't do anything with it”.

On the flip side, those against a mandated soil reporting system questioned whether it was needed given that “once you started on that, you'd need to think about what other disclosures [water, carbon, etc.] are equally as important”. At the end of the day, this may not be “the most efficient way of getting better data”.

The large majority of interviewees identified how defining ‘soil health’ will be a key challenge to overcome if soil reporting is to advance. One respondent simply put it that they are simply not aware of anything that says “this is good soil health... this is bad soil health”. Soil health, by its nature, will vary by site and as a result of climatic variation. Even within a single farm, you might have “10 different soil types”. This impacts the ability to easily compare soil health across agribusinesses and through time. It can also be problematic when it comes to efforts to lift poor soil health through soil stewardship. In these instances, “what's your reference condition and how do you assess good and bad is actually a little bit problematic”.

Amongst other areas of concern when it comes to defining and measuring soil health, soil carbon was singled out as a particular area of difficulty. These concerns relate to the recognition that, when it comes to living systems, “carbon is not fixed, and it doesn't actually stay in one place”. A number of interviewees noted their frustration when it came to the use of carbon models with every model throwing “out a different result effectively”. Others were concerned about the cost of measuring soil carbon levels and noted the need to develop more cost-effective measurement tools.

Despite the challenges, interviewees strongly emphasised the importance of soil metrics and targets. As one respondent argued, if measuring relevant soil metrics and targets was an insurmountable hurdle, “you wouldn't do anything in agriculture”. This position of interviewees goes against the direction of the GRI 13 which has omitted the requirement for agribusinesses to report on soil metrics and targets.

Interviewees with relatively strong soil science backgrounds were able to suggest a range of physical, chemical and biological soil metrics that might be relevant to investors. These included, for instance, soil cover, calcium ratios, biome, pH, organic carbon levels, and soil texture.

To facilitate the process of identifying and reporting on soil metrics and targets, a number of practical options were suggested to help to overcome the challenges. Chiefly amongst the suggestions was the acknowledgement that we will need to ensure that investors are provided with sufficient information to understand the context and the “location of the soil”.

The most viable approach for soil metric reporting, in the eyes of interviewees, was to establish “different expectations in different locations”. To support investor appreciation of the positive or negative ramifications of the soil information, it will be important to convey a range or spectrum of expectations based on relative baseline or benchmark. This overall approach is certainly something that investors will recognise given that they are “very familiar with the world of relatives and benchmarks”.

As one experienced agribusiness manager noted given their experiences in communicating complicated soil information with investors, the use of weighted averages can also be effective:

“I use a lot of weighted averages... if you just pick an area, for example, you might have 100 hectares and you might have 10% of those soils might be two, 5% might be one, but the weighted average...”

Critically, some interviewees stressed the importance of moving beyond the mere disclosure of soil metrics, targets and trends. In their view, it is also important to clearly articulate the ultimate impact and what this all actually means in terms of soil health, ecosystem services and an agribusiness’s future performance and resilience. Metrics on their own don’t “really mean anything to anybody”.

To extend investor appreciation of the underlying meaning of soil-related disclosures and the ultimate impact of an agribusiness’s investments in soil stewardship, there was strong support for narrative disclosures as a complement to any soil-related metrics or targets.

The use of both narratives and metrics will help agribusinesses to educate investors on the benefits of their production systems and how/why it is a sustainable approach. It will be “a learning experience for a lot of investors” with agribusinesses, for instance, hoping to clearly communicate the corrective actions they’ve undertaken around pH and retain stubble with the goal of boosting organic matter in the soil, biodiversity and ultimately

productivity. In the eyes of an agribusiness, the underlying objective here is to communicate the “value that we’ve invested in our soil”.

Given the appreciation of both narratives and metrics to communicate soil-related information, most interviewees agreed with the underlying of approach ED/2022/S1 to frame sustainability-related disclosures around governance, strategy, risk management, and metrics and targets. This approach to soil reporting will help investors to appreciate:

“... what's the plan? What skillsets are there? Who's involved in the governance? What is the culture of the place? What's the intention?”

The accounting for nature model was suggested as a good starting point for the advancement of soil reporting. This model has strong recognition amongst industry, is reasonably comprehensive and can always be further refined if needed.

Regardless of the underlying content for soil reporting, all interviewees recognised the value of communicating soil information in a simple and concise manner. As one interviewee portrayed it, in their view it can be “a case of trying to keep investors out of the weeds”. The important thing is to “focus on the general message overall as opposed to getting into the specific detail”.

A “consolidated level as opposed to aggregation-specific or location-specific” to soil reporting was advocated for. To illustrate how this might look in practice, one respondent suggested that useful approach could be to start with a one-page summary with the detailed metrics and other information to follow. This enables investors to start with the summary of everything with the option “forward from there and if you want to go further”.

Other practical suggestions for soil reporting were focused around a “traffic light” or “star rating” styled approach which communicates soil-related information in very simple terms. Doing so would clearly flag the soil-related risks and opportunities and plainly convey the improvements over time.

In further support of the general foundations of ED/2022/S1 there was strong support for the proposition that soil health disclosures should be linked both to other sustainability reporting topics and also financial statement disclosures. Linking soil-related disclosures to other sustainability topics will help to provide context to the information and promote

the understanding of the role of soil stewardship in water use efficiency, food security and climate change.

As exemplified by the following, the monetization of soil-related risks and opportunities was viewed a powerful driver of practice change:

“Unless you monetize this stuff, farmers are reluctant to change”.

Whilst potentially powerful in incentivising the adoption of soil stewardship practices, measuring the financial consequences of soil-related risks and opportunities was depicted as complex task. This is currently constrained by a lack of research which “explains the link” in quantitative terms. Current valuation approaches and standards are also perceived as holding back progress. This was illustrated by a number of interviewees who raised the issue of land valuers failing to recognise the outcomes of soil stewardship investments given their focus on revaluing land based on market values:

“People just aren't getting rewarded for applying good practices... It's crazy.”

Somewhat expectedly, given the broader experiences with sustainability reporting, a number of respondents noted that soil reporting advocates will need to be mindful of greenwashing. As one interviewee warned:

“I reckon that a lot of this is going to be stymied by token sustainability managers that these companies are putting in place”.

Some agribusiness interviewees, however, felt that soil report preparers are “going to be very cautious about the information that's being prepared and presented to the public”. Another interviewee equivalently contented that their business has “been very mindful as a business to ensure we're not making certain claims about our farming practices”.

Against this backdrop of concern about greenwashing, some interviewees recognised that the risks of soil reporting greenwashing are likely to be further mitigated by the moves by regulators internationally to more closely scrutinize the sustainability claims of corporate reporters. Others accepted the benefits from auditing in enhancing investor trust in soil-related disclosures. With observations such as we already “pay enough for audits as it is” and concerns about explaining soil stewardship and carbon to auditors, though, it will be

important to more broadly consider the overall costs and benefits from auditing before any requirements are put in place.

A further key risk with the advancement of soil that was raised by interviewees was the risk for disclosure overload for agribusiness report preparers. This was put well by one respondent who alerted that soil reporting advocates will need to avoid the perception that it just “adding another topic to the list” of ever growing sustainability reporting topics. In the words of other interviewees, “what nobody wants right now is another framework”. A more effective approach will be incorporate soil disclosures within an existing framework such as the ISSB, TCFD or TNFD.

When it came to views on the most appropriate channels to disclose soil-related information, the views were mixed and interviewees appreciated the benefits of the various options. Disclosing soil information within annual reports or risk statements could, for instance, help to promote standardisation of the disclosures. In other instances, however, some agribusinesses are likely to prefer to have the option of including the information in a separate sustainability report. An integrated approach has its own benefits too. This being said, it will be important to appreciate how an annual reporting period might not align effectively with soil health reporting given the long-term gains from soil stewardship and the relatively slow moving nature of some soil health metrics.

Looking to the future advancement of soil reporting, interviewees highlighted the importance of ongoing industry consultation. This should include participants from “across the value chain” with industry being provided with the opportunity to “define it themselves”. Given the polarity in the farmer capacity and existing use of soil-related and other performance metrics, there will need to be a focus on building farmer capability. Some interviewees cautioned that this could be a big challenge in some instances given the need to educate farmers in:

“... understanding the importance and significance of addressing their soil health, their soil carbon, just soil in general, and how there needs to be a buy-in in order to respond and adapt now so they can be prepared for what is going to come”

Naturally, the cost of soil-reporting was also pointed out by some respondents. Such costs can, however, be offset given the benefits from the use of the information to facilitated practice change and technology advancements. One interviewee, for example, identified how their agribusiness now uses satellite technology to monitor ground cover to enable them to balance out stocking levels with feed availability.

The overall costs and complexity of soil-reporting can be further managed to the extent that soil-reporting leverages off soil information that is already captured by agribusinesses. As one respondent asserted, the information included in a soil-report for investors “shouldn't be something that you would have to go and commission separately”, This supports the importance of adopting a management approach to soil-reporting.

Proposed Soil Reporting Model

Soil reporting could take many different forms, depending on what information is intended to be conveyed. A key distinction that is emerging in the natural capital disclosure space generally is between natural capital *accounting* information and natural capital *assessment* information. Natural capital accounting has been defined as “the process of compiling consistent, comparable and regularly produced data using an accounting approach on natural capital and the flow of services generated in physical and monetary terms”, compared with natural capital assessment as “the process of identifying, measuring and valuing relevant (“material”) natural capital impacts and/or dependencies, using appropriate methods” (Lammerant, 2019, p. 6). The United Nations System of Environmental-Economic Accounting (SEEA) has been adopted as an international standard for natural capital accounting at the national level (United Nations *et al.*, 2014; United Nations, 2021), and a variety of approaches have been proposed for natural capital accounting at the corporate level (Efttec, RSPB, and PwC, 2015; Wentworth Group of Concerned Scientists, 2016; Accounting for Nature, 2021; BSI, 2021). Soil information may be reported under these frameworks as either an environmental asset inextricably linked with land (United Nations *et al.*, 2014), or as an aspect of the condition of terrestrial ecosystem assets (e.g. cropping or pasture lands).

In this project, however, we focus on the potential for soil reporting through the lens of natural capital assessment. Several voluntary assessment and reporting frameworks have been developed in this area, notably the generic assessment framework known as the

Natural Capital Protocol (Natural Capital Coalition, 2016) and more specific guidance on nature-related risk assessment and disclosure (Ascuí and Cojoianu, 2019; TNFD, 2022). A key difference between these assessment approaches and an asset-based accounting approach is that the focus is on the reporting entity's *impacts* and *dependencies* on natural capital, regardless of the ownership or control of the natural capital in question. An impact is defined as a “negative or positive effect of business activity on natural capital”, while a dependency is a “business reliance on or use of natural capital” (Natural Capital Coalition, 2016, pp. 16–17). Furthermore, impacts and dependencies can include those directly caused by the reporting entity's business activities, as well as those indirectly caused via its supply chain. The set of natural assets that an entity may impact or depend on is therefore typically much greater than the set of natural assets that the entity owns or controls, making it unrealistic to provide natural capital accounting information on all such assets. Furthermore, even if such information could be provided, this would not necessarily serve to clarify the entity's causal relationships with the assets. Natural capital assessment aims to clarify these causal relationships, between an entity's activities and the natural capital assets that those activities impact or depend on.

Similar concepts of sustainability-related impacts and dependencies are contained in Exposure Draft standard IFRS S1 *General Requirements for Disclosure of Sustainability-related Financial Information* (ISSB, 2022), only with an enlarged scope to cover ‘resources’ in general, which could include human, social and other ‘capitals’ (Adams *et al.*, 2013) in addition to natural capital. Exposure Draft IFRS S1 clarifies that an entity's sustainability-related impacts and dependencies can give rise to sustainability-related risks and opportunities, for example when a resource on which an entity's business model depends is threatened by changes in its availability or pricing, or when impacts are subject to stricter regulation or lead to negative reputational consequences.

We suggest that information about the degree or magnitude of an entity's impact-causing activities (known as impact drivers) and the availability of its significant dependencies can be thought of as the core information to be disclosed in natural capital assessment disclosures, and therefore also in soil reporting as viewed through this lens. Although ultimately it is the risks and opportunities that these impacts and dependencies give rise to that is of interest to investors and lenders, such users will undoubtedly also make use of other information sources (such as scientific, regulatory or stakeholder reviews) to form

their own judgements about the threats to the entity's dependencies, and the consequences of their impacts. By contrast, what we term core information about impacts and dependencies can, in most cases, only realistically be obtained from the reporting entity. Core information about natural capital impacts and dependencies can therefore be seen as analogous to a company's revenue or cost figures, whereas information about risks and opportunities arising from natural capital impacts and dependencies is more like a company's revenue projections, which a primary user would evaluate alongside other sources of information, such as technological or market studies.

What, then, might core information about an entity's natural capital impacts and dependencies actually look like, in terms of soils? In our interviews, stakeholders recommended that reporting should be concise, simple (e.g. using a traffic-light or star rating system) and focused on providing a summary of the overall picture, rather than getting lost in the details. Importantly, as one interviewee stated, investors need "*some kind of assessment about whether it's good or bad. But that can be on a spectrum.... Investors are... very familiar with the world of relativities and benchmarks.*"

Indeed, one of the challenges with reporting soil information, as opposed to something like emissions of globally mixed greenhouse gases, is that the meaning of soil-related information fundamentally depends on the site-specific context. Different farming systems depend on different soil characteristics, and impacts on soils can be very different for different soil types. Blueberry farming, for example, requires acidic soils with a pH of 4.0-5.3 for optimum production, but these are levels which would be seen as dangerously low for wheat production (Cojoianu and Ascui, 2018).¹ Therefore while soil pH is a highly relevant variable for soil reporting, due to its influence on productivity and as an indicator of longer-term acidification problems, it is only meaningful when related to a target level that is appropriate for the relevant production system. The significance of other soil variables might also depend on further context such as the climatic region, soil type, position within the soil profile, etc. The same is true for soil-related impacts. For example, soil-related impacts on water quality (e.g. increased sediment, nitrates and other chemicals in run-off) depend, *inter alia*, on the proximity of affected soils to waterways and the extent of riparian buffers. The implication of this context-dependence is that it is

¹ <https://blueberries.extension.org/soil-ph-for-blueberry-plantings/> (accessed 22 February 2023).

probably unrealistic to expect there to be a consistent set of soil indicators that all soil managers would be able to use.

Nevertheless, soil reporting (and nature-related financial disclosure generally) could still benefit from a consistent approach, even if implemented using a variety of different indicators. One problem with the plethora of existing indicators under different sustainability-related reporting frameworks is that it can be hard to interpret whether a given figure is better or worse than a higher or lower one, and also whether a given absolute level is significant or negligible. To address this and improve the interpretability of nature-related financial disclosures, we propose that all impacts and dependencies should be reported against an ‘acceptable risk’ threshold or target level, such that, for impacts, figures **over** the threshold indicate a risk to enterprise value due to significant consequences of impacts; and for dependencies, figures **under** the threshold indicate a risk to enterprise value due to threats to the availability of significant dependencies (Figure 1).

Figure 1: Generic approach to reporting on impacts and dependencies



For example, if the target for emissions of a particular pollutant is set at zero (e.g. because any emissions will lead to fines or loss of market access), then any positive number can be easily interpreted as representing a risk to enterprise value. Likewise, if the target for availability of a certain dependency is set at, say, 90% (for example if a blueberry farmer requires at least 90% of their soil to be below pH 5.3 in order to maintain target

productivity), then any lower number (e.g. 80%) likewise represents a risk to enterprise value.

Additional information that could be provided alongside quantitative nature-related information could include an assessment of the materiality of the nature-related risks associated with the reported impact or dependency (Ascui and Cojoianu, 2019; TNFD, 2022), a summary of mitigation actions taken, and a summary of associated opportunities. It is expected that, as with financial statements, summary statements would be accompanied by more detailed textual explanations and/or supplementary quantitative information.

Building on these principles, we provide a worked set of example summary accounts below, for a fictitious West Australian wheat producer, WheatCo.

Figure 2: Example soil dependency statement

TOPIC	DEPENDENCY	AVAILABILITY METRIC	TARGET THRESHOLD	2021	2022	MATERIALITY	MITIGATION	OPPORTUNITIES
Acidification	Absence of acid soil conditions	% arable area with $\text{pH}_{(\text{CaCl})} > 5.5$	90%	80%	85%	Very high	Apply lime Shift to precision fertiliser application	Increase yield in affected areas by 0.04t/ha
Sodicity	Absence of sodic soil conditions	% arable area with exchangeable sodium percentage (ESP) < 15%	100%	90%	95%	Very high	Apply gypsum	Increase yield in affected areas by 0.13t/ha
Salinity	Absence of saline soil conditions	% arable area with EC < 0.3 dS/m in topsoil and 0.7 dS/m in subsoil	100%	100%	100%	Very low	Retain remaining and plant additional native vegetation	Biodiversity benefits Additional revenue from carbon sequestration
Erosion	Absence of soil erosion	% arable area with minimum ground cover >50%	100%	95%	100%	Moderate	Maintain >50% ground cover	Reduce water quality impacts from run-off
Compaction	Absence of soil compaction	% arable area under controlled farming traffic system	100%	0%	50%	Very high	Adopt controlled traffic farming system Deep ripping	Increase yield by 15-30%
Soil organic carbon (SOC)	Presence of sufficient soil organic carbon	% arable area with SOC >2%	100%	95%	95%	Moderate	Continue conservation tillage and stubble retention	Improve resilience to drought

Figure 3: Example soil impact statement

TOPIC	IMPACT	DEGREE OF IMPACT METRIC	TARGET THRESHOLD	2021	2022	MATERIALITY	MITIGATION	OPPORTUNITIES
Water quality	Soil run-off affects the quality of surface or sub-surface water	Length of riparian zone without buffer (km)	0.5	3	3	High	Continue conservation tillage and stubble retention Maintain > 50% ground cover Plant riparian buffers	Biodiversity benefits from planting riparian buffers
Weeds, pests and diseases	Soil movement affects the incidence of weeds, pests or diseases	Not currently measured	N/A	N/A	N/A	Very low	Implement biosecurity practices	Grower community benefits
GHG emissions	Soil nutrient management affects greenhouse gas emissions	Net GHG emissions intensity (kgCO ₂ -e/t produced)	380 (industry mid-point)	535	535	High	Support industry transition to low-emission fertilisers	Reputational benefits Less volatile fertiliser prices in future
Other air emissions	Soil affects other air emissions (e.g. dust, nitrogen)	Not currently measured	N/A	N/A	N/A	Very low	Maintain > 50% ground cover	Reputational benefits

In summary, while many aspects of the definition and measurement of soil impacts and dependencies remain challenging, this should not prevent the development of concise, simple and comprehensible soil reporting, starting with a small set of key indicators appropriate to the relevant production system and context. We have proposed that a consistent approach could be taken to the representation of all impact and dependency indicators to improve their interpretability, even if a variety of different indicators are used. For preparers of such accounts, the benefits of reporting could include sharper focus on key risks and opportunities, leading to improved management of soils; learning from early voluntary adoption of emerging disclosure frameworks such as the TNFD recommendations and Exposure Draft IFRS S1; demonstrating sustainability credentials to consumers, supply chains, government or regulators; and demonstrating improved risk management to investors and lenders, potentially leading to better returns and/or lower cost of capital. The primary users of such accounts would likewise benefit from improved understanding of risk and return at individual asset, industry and portfolio levels; leading to insights on systemic risks as well as increased allocation and/or lower cost of capital for much-needed sustainable agriculture investments to feed a growing global population (Tilman *et al.*, 2011; Alexandratos and Bruinsma, 2012). And last but not least, soils themselves would benefit from the improved visibility that soil reporting would bring to soil stewardship practices, leading to reduced impacts and maintenance or improvement of this essential natural capital asset, enabling it to continue providing critical support to the economy and society into the future.

6. Conclusions

This study has broadly sought to establish the significance of soil-related risks and opportunities to agribusinesses and investment decisions and identify the most appropriate methods by which agribusinesses can disclose value-relevant soil information. Our research findings were initially informed through archival analysis of current soil reporting practices of ASX listed agribusinesses. This analysis was subsequently extended through in-depth interviews with a senior representatives from both corporate agribusinesses and agri-investment entities. This permitted us to capture the soil reporting perspectives and attitudes of both agribusiness report preparers and their financial report users.

Overall, there is increased investment interest in Agriculture due to long term in demand for agricultural outputs linked to population growth and long terms constraints on the supply of agricultural outputs linked to both land availability and climate change. At the same time, there is an increased awareness of the fundamental role soil health plays in both agricultural productivity and the provision of environmental services more broadly.

With an increasing number of sophisticated investors attracted to the agricultural sector, there is a growing desire for information on soil related risks at the enterprise level. While there is a demand for increased information about soil health at the enterprise level there is limited agreement about how that information can or should be provided, largely due to the inherent heterogeneity and context specific nature of soil health relevant information.

Despite the difficulties of presenting soil health relevant data to agricultural investors and regulators, our research affirms that it is non-the-less worth the effort. Our interviewees supported an approach to soil reporting which:

1. Is concise and simple to understand (i.e. traffic-light style reporting).
2. Focuses on helping investors to understand the contextual nature of soil-health and enables investors to understand the trends through time and relative performance against comparable agribusinesses.
3. Links soil-related risks and opportunities to other environmental topics and with financial statement information (i.e. land revaluations).
4. Is integrated within an existing environmental reporting framework.
5. Minimises the reporting burden on agribusinesses given a focus on the disclosure of soil-related information which is already captured and used by agribusinesses for management purposes.

Based upon a combination of desk top review of existing studies and primary research with Australian agribusiness experts, we propose a structure for soil health reporting which combines parsimony, contextual relevance and opportunities for narrative reporting within the founds of a consistent framework.

References

- Accounting for Nature (2021) Accounting for Nature Standard. Version 2.3. Sydney: Accounting for Nature.
- Adams, C.A. et al. (2013) Capitals Background paper for <IR>. London: International Integrated Reporting Council.
- Adhikari, K., & Hartemink, A. E. (2016). Linking soils to ecosystem services—A global review. *Geoderma*, 262, 101-111.
- Alexandratos, N. and Bruinsma, J. (2012) World agriculture towards 2030/2050: The 2012 revision. Rome: Food and Agriculture Organization of the United Nations.
- Anderson, N. (2019). IFRS Standards and climate-related disclosures. In brief. Retrieved from: <https://www.ifrs.org/content/dam/ifrs/news/2019/november/in-brief-climate-change-nick-anderson.pdf>.
- Ascuí, F. and Cojoianu, T.F. (2019) Natural Capital Credit Risk Assessment in Agricultural Lending: An Approach Based on the Natural Capital Protocol. Oxford: Natural Capital Finance Alliance.
- ASX (2022). S&P/ASX Agribusiness Index Launched. Media Reliance (31 May 2022). Retrieved from: <https://www2.asx.com.au/content/dam/asx/about/media-releases/2022/20-31-may-2022-s-and-p-asx-agribusiness-index-launched.pdf>
- Badgery, W., Murphy, B., Cowie, A., Orgill, S., Rawson, A., Simmons, A., & Crean, J. (2020). Soil carbon market-based instrument pilot—the sequestration of soil organic carbon for the purpose of obtaining carbon credits. *Soil Research*. 59(1), 12-23.
- Bayne, L., Ng, J., & Wee, M. (2022). Supply chain disclosure: stakeholder preferences versus current practice in Australia. *Accounting & Finance*, 62(3), 3875-3911.
- Bayne, L., & Wee, M. (2019). Non-financial KPIs in annual report narratives: Australian practice. *Accounting Research Journal*. 32(1), 7-19.
- Bennett, J. M., McBratney, A., Field, D., Kidd, D., Stockmann, U., Liddicoat, C., and Grover, S. (2019). Soil Security for Australia. *Sustainability*, 11(12), 3416.
- BSI (2021) BS 8632:2021 Natural Capital Accounting for Organizations - Specification. London: British Standards Institution.

- Buckby, S., Gallery, G., & Ma, J. (2015). An analysis of risk management disclosures: Australian evidence. *Managerial Auditing Journal*. 30(8/9), 812-869.
- BULL MARKET. (2020, Mar 11). The Weekly Times. Retrieved from <https://searchproquest-com.ezproxy.csu.edu.au/docview/2375510965?accountid=10344>
- Buxton, A. and Campanale, M. (2012). Farms and funds: Investment funds in the global land rush. IIED. Retrieved from: <http://pubs.iied.org/pdfs/17121IIED.pdf>
- Campbell, A. (2008) Managing Australia's Soils: A Policy Discussion Paper. Prepared for the National Resource Management Ministerial Council.
- Chamen, W. T., Moxey, A. P., Towers, W., Balana, B., & Hallett, P. D. (2015). Mitigating arable soil compaction: A review and analysis of available cost and benefit data. *Soil and Tillage Research*, 146, 10-25.
- Cojoianu, T.F. and Ascuri, F. (2018) 'Developing an evidence base for assessing natural capital risks and dependencies in lending to Australian wheat farms', *Journal of Sustainable Finance & Investment*, 8(2), pp. 95–113.
- Czernkowski, R., Kean, S., & Lim, S. (2019). Impact of ASX corporate governance guidelines on sustainability reporting. *Accounting Research Journal*, 32(4), 692-724.
- DAWE (2021). National Soil Strategy. Retrieved from: <https://www.agriculture.gov.au/agriculture-land/farm-food-drought/natural-resources/soils#:~:text=The%20National%20Soil%20Strategy%2C%20released,strengthens%20soil%20knowledge%20and%20capability>.
- Dinesh, G. K., Sinduja, M., Priyanka, B., Sathya, V., Karthika, S., Meena, R. S., & Prasad, S. (2022). Enhancing Soil Organic Carbon Sequestration in Agriculture: Plans and Policies. In *Plans and Policies for Soil Organic Carbon Management in Agriculture* (pp. 95-121). Singapore: Springer Nature Singapore.
- Dominati, E., Patterson, M., & Mackay, A. (2010). A framework for classifying and quantifying the natural capital and ecosystem services of soils. *Ecological economics*, 69(9), 1858-1868.

- Dumay, J., & Hossain, M. A. (2019). Sustainability risk disclosure practices of listed companies in Australia. *Australian Accounting Review*, 29(2), 343-359.
- Eftec, RSPB, and PwC (2015) Developing corporate natural capital accounts: Guidelines. London, UK: Natural Capital Committee. Available at: <https://www.naturalcapitalcommittee.org/corporate-natural-capital-accounting.html>.
- Gregorich, E.G., Sparling, G.P. and Gregorich, L.J. (2006). Stewardship and soil health. In: Warkentin, B.P. (Ed.). *Footprints in the Soil: People and Ideas in Soil History*. Elsevier, Amsterdam.
- Greiner, L., Keller, A., Grêt-Regamey, A., & Papritz, A. (2017). Soil function assessment: review of methods for quantifying the contributions of soils to ecosystem services. *Land use policy*, 69, 224-237.
- GRI (2022). Sector Standard for Agriculture, Aquaculture, and Fishing. Retrieved from: <https://www.globalreporting.org/standards/standards-development/sector-standard-for-agriculture-aquaculture-and-fishing/>
- Hedley, C. (2015). The role of precision agriculture for improved nutrient management on farms. *Journal of the Science of Food and Agriculture*, 95(1), 12-19.
- Hobbs, P. R., Sayre, K., & Gupta, R. (2008). The role of conservation agriculture in sustainable agriculture. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 363(1491), 543-555.
- Hughes, N 2021, Analysis of climate change impacts and adaptation on Australian farms, ABARES Insights, Canberra. DOI: <https://doi.org/10.25814/589v-7662>. CC BY 4.0.
- ISSB (2022) Exposure Draft IFRS S1 General Requirements for Disclosure of Sustainability-related Financial Information. London: International Accounting Standards Board. Available at: <https://www.ifrs.org/content/dam/ifrs/project/general-sustainability-related-disclosures/exposure-draft-ifrs-s1-general-requirements-for-disclosure-of-sustainability-related-financial-information.pdf>.
- Jackson, T., Hatfield-Dodds, S. & Zammit, K. (2020). Snapshot of Australian Agriculture 2020. <https://www.agriculture.gov.au/abares/publications/insights/snapshot-of->

[australian-agriculture-2020#australian-farmers-manage-significant-risk-and-variability](#)

- Jones, M. J., & Solomon, J. F. (2013). Problematizing accounting for biodiversity. *Accounting, Auditing & Accountability Journal*, 26(5), 668-687.
- Juerges, N., and Hansjürgens, B. (2018). Soil governance in the transition towards a sustainable bioeconomy—A review. *Journal of Cleaner Production*, 170, 1628-1639.
- Keenor, S. G., Rodrigues, A. F., Mao, L., Latawiec, A. E., Harwood, A. R., & Reid, B. J. (2021). Capturing a soil carbon economy. *Royal Society open science*, 8(4), 202305.
- Lammerant, J. (2019) NCA VES – State of Play of Business Accounting and Reporting on Ecosystems. United Nations and European Union.
- Langberg, N., & Sivaramakrishnan, K. (2010). Voluntary disclosures and analyst feedback. *Journal of Accounting Research*, 48(3), 603-646.
- Lanka, S. V., Khadaroo, I., & Böhm, S. (2017). Agroecology accounting: biodiversity and sustainable livelihoods from the margins. *Accounting, Auditing & Accountability Journal*. 30 (7), 1592-1613.
- Linnenluecke, M. K., Birt, J., & Griffiths, A. (2015). The role of accounting in supporting adaptation to climate change. *Accounting & finance*, 55(3), 607-625.
- Magnan, A. (2015). The financialization of agri-food in Canada and Australia: Corporate farmland and farm ownership in the grains and oilseed sector. *Journal of Rural Studies*, 41, 1-12.
- Maroun, W., & Atkins, J. (2021). A Practical Application of Accounting for Biodiversity: The Case of Soil Health. *Social and Environmental Accountability Journal*, 41(1-2), 37-65.
- Martin, S. J., & Clapp, J. (2015). Finance for agriculture or agriculture for finance? *Journal of Agrarian Change*, 15(4), 549-559.
- Mathews, M. R. (1997). Towards a mega-theory of accounting. *Asia-Pacific Journal of Accounting*, 4(2), 273-289.
- McPhee, J. E., Antille, D. L., Tullberg, J. N., Doyle, R. B., & Boersma, M. (2020).

- Managing soil compaction—A choice of low-mass autonomous vehicles or controlled traffic?. *Biosystems Engineering*, 195, 227-241.
- Natural Capital Coalition (2016) Natural Capital Protocol. London: Natural Capital Coalition. Available at: <https://naturalcapitalcoalition.org/natural-capital-protocol/>.
- NFF (2019). 2030 Roadmap – Australian Agriculture’s Plan for a \$100 Billion Industry. Retrieved from: <https://nff.org.au/policies/roadmap/>
- Ogilvy, S. (2015). Developing the ecological balance sheet for agricultural sustainability. *Sustainability Accounting, Management and Policy Journal*, 6(2), pp. 110-137.
- Orgill, S. et al. (2018). Mapping projects on ameliorating soil constraints, and review of soil constraints, products and technologies [Project 3.3.01]. Newcastle, NSW: Cooperative Research Centre for High Performance Soils.
- Paul, C., Bartkowski, B., Dönmez, C., Don, A., Mayer, S., Steffens, M., Weigl, S., Wiesmeier, M., & Helming, K. (2023). Carbon farming: Are soil carbon certificates a suitable tool for climate change mitigation?. *Journal of Environmental Management*, 330, 117142.
- Pawsey, N., Wills, B., Ascui, F., Allan, C., Colliver, R., Cockfield, G., Cook, S., Frost, M., Lynch, J., and Wong, A. (2020). Collaborative approaches to innovation. Newcastle, NSW: Cooperative Research Centre for High Performance Soils.
- Robeco & University of Cambridge Institute for Sustainability Leadership (2022). How soil degradation amplified financial vulnerability – Nature-related financial risk use case. Retrieved from: <https://www.cisl.cam.ac.uk/resources/publications/how-soil-degradation-amplified-financial-vulnerability-nature-related>
- Sullivan, S., & Hannis, M. (2017). Mathematics maybe, but not money. *Accounting, Auditing & Accountability Journal*. 30(7), 1459-1480.
- Tepes, A., Galarraga, I., Markandya, A., & Sánchez, M. J. S. (2021). Costs and benefits of soil protection and sustainable land management practices in selected European countries: Towards multidisciplinary insights. *Science of the Total Environment*, 756, 143925.
- Tilman, D. et al. (2011) ‘Global food demand and the sustainable intensification of

agriculture', Proceedings of the National Academy of Sciences of the United States of America, 108(50), pp. 20260–20264.

TNFD (2022) The TNFD Nature-related Risk and Opportunity Management and Disclosure Framework. Beta v0.3. Taskforce on Nature-related Financial Disclosures.

United Nations et al. (2014) System of Environmental-Economic Accounting 2012 — Central Framework. New York, NY: United Nations.

United Nations (2021) System of Environmental-Economic Accounting—Ecosystem Accounting: White cover (pre-edited) version. New York, NY: United Nations. Retrieved from:

https://seea.un.org/sites/seea.un.org/files/documents/EA/seea_ea_white_cover_final.pdf.

Voysey, A. (2019). Soil: the missed opportunity under investors' feet. Retrieved from: <https://www.environmental-finance.com/content/analysis/soil-the-missed-opportunity-under-investors-feet.html?pf=print>

Weir, K. (2019). The logics of biodiversity accounting in the UK public sector. 43(3), 348-347.

Wentworth Group of Concerned Scientists (2016) Accounting for nature: A scientific method for constructing environmental asset condition accounts. Sydney: Wentworth Group of Concerned Scientists. Available at: <https://doi.org/10.1525/bio.2009.59.3.13>.

Williams, M., & Moser, T. (2019). The art of coding and thematic exploration in qualitative research. *International Management Review*, 15(1), 45-55.

World Bank Group (2021). Climate-Smart Agriculture. Retrieved from: <https://www.worldbank.org/en/topic/climate-smart-agriculture>

Yang, T., Siddique, K. H., & Liu, K. (2020). Cropping systems in agriculture and their impact on soil health-A review. *Global Ecology and Conservation*, 23, e01118.

Yield Gap Australia (N.D.). Map. Retrieved from: <https://yieldgapaustralia.com.au/maps/>