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Integration of ESG standards in Australian sugarcane farming: A co-design approach to accelerate ESG adoption and innovation

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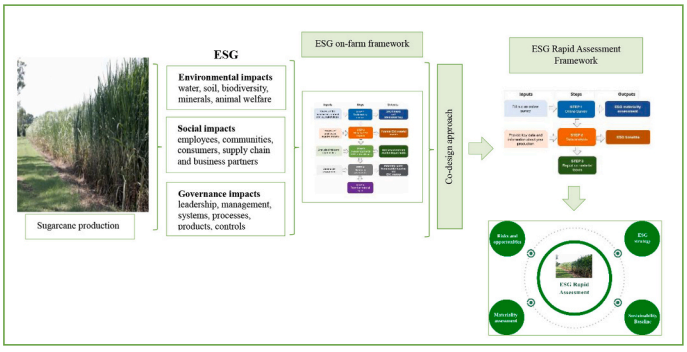
HIGHLIGHTS

- We developed an ESG Rapid Assessment to help QLD sugarcane farmers boost credentials and access green markets.
- The tool was co-designed with farmers, industry, and stakeholders to drive practical ESG adoption on farms.
- Results show ESG tools must be simple, actionable, and supported to ensure broad adoption in agriculture.
- Findings stress better data, clearer guidance, and aligned incentives to enhance sustainability and resilience.

GRAPHICAL ABSTRACT



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ABSTRACT

Context: Environmental, Social, and Governance (ESG) practices have become critical for the agricultural sector, particularly for high-impact and sensitive consumer demand industries like sugarcane. In Australia, the sugarcane industry faces mounting environmental and regulatory pressures, including concerns over nutrient and pesticide runoff affecting the Great Barrier Reef, climate change-driven, water resource challenges, and the need to reduce carbon emissions.
Objective: Aiming to enhance environmental performance and facilitate access to environmental markets and new income streams, this research focuses on developing and testing an ESG Rapid Assessment framework tailored to sugarcane farmers in North Queensland, Australia.
Methods: In this research we adopted a co-design approach, integrating stakeholder insights and industry needs to develop the ESG tool, to facilitate the adoption of ESG standards on farm.

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Results and conclusions: Findings highlight the importance of simplified ESG tools, clear implementation roadmaps, and ongoing support to drive adoption. Addressing knowledge gaps, improving data collection, and aligning policy incentives will be crucial for fostering transparency, sustainability, and long-term economic resilience while minimising regulatory burdens. Results from two case studies involving sugarcane producers and stakeholders showed that over 75 % of participants found the ESG assessment easy to use, and 62.5 % considered it valuable in supporting their ESG management. However, only 25 % indicated a willingness to change practices, likely due to prior engagement in sustainability best practices. These findings validate the tool's usability and highlight key barriers and opportunities for ESG adoption in agriculture.
Significance: This research offers a practical and innovative tool for North Queensland sugarcane farmers to strengthen their sustainability credentials. The ESG Rapid Assessment tool serves as a gateway to capital and environmental markets, supporting the transition to new decarbonisation pathways. By empowering farmers with actionable insights, the tool can enhance resilience, drive sustainable practices, and contribute to achieve net-zero goals.

1. Introduction

Environmental, Social, and Governance (ESG) frameworks have become mainstream across both private and public sectors, evolving from a niche concept to a widely adopted standard (Edmans, 2023). Reflecting the basic principles of sustainable development (Brundtland, 1987), ESG standards reflect a vision of agricultural systems that are economically viable, environmentally responsible, and socially equitable (Mnisi and Dlamini, 2012). In the agriculture sector, the integration of ESG concepts has arguably become essential, as agribusinesses are considered high-impact enterprises with sensitive consumer demand requirements (Gerber et al., 2024; Dutta and Shome, 2024). Globally, agricultural systems are experiencing rapid transformations, with a growing emphasis on integrating ESG principles into agribusiness practices. Key drivers of this shift include the potential for environmental degradation, social impacts, rising consumer awareness influencing demand for food and non-food products, and global trade dynamics causing fluctuations in farm product prices (Meynard at al., 2012). However, primary producers also face the challenge of balancing societal expectations and environmental demands with competitive pressures that push for low-cost production (Burton, 2004; Busse et al., 2021; Deuffic and Candau, 2006). Financial support and increased social recognition of their efforts may assist farmers, who typically possess a deep understanding of the environmental characteristics and production potential, to integrate more sustainability practices (Hanley et al., 2012).

Despite the growing relevance of ESG in agriculture, existing frameworks are often complex, poorly tailored to farm-level realities, and lacking local context. This study addresses this gap by developing and testing an ESG Rapid Assessment tool through a co-design process with sugarcane producers and stakeholders. Unlike conventional top-down ESG frameworks, our approach is farmer-centred, pragmatic, and grounded in both global standards and regional conditions. The innovation of our approach lies in the adaptation of ESG concepts to small and medium-scale farming through a simplified, fit-for-purpose tool that balances rigor with accessibility, an area where little empirical work currently exists.

Adopting ESG standards could offer significant benefits for farmers, fostering long-term sustainability and enhancing resilience. For instance, government investments in environmental protection have been shown to boost national ESG performance by improving environmental quality, social well-being, and governance practices (Niu, 2024). In addition, an increase in funding that promotes the adoption of ESG criteria standards can also foster green innovation (Takalo and Tooranloo, 2021) and positively influence export intensity, opening new opportunities for Australia's sugar export market (Wu et al., 2022). Integrating ESG standards into policy and governance, as seen in some European countries, could improve institutional arrangements, policy effectiveness, and collaboration between government and businesses in tackling climate change and managing climate-related financial risks (Wang et al., 2023).

Moreover, adopting ESG criteria and metrics could not only streamline on-farm emission estimation and reporting but also enhance sustainable management practices among farmers. Current management strategies often overlook the fundamental differences between economic, social, and ethical values, resulting in flawed attempts to assign economic value and objectively measure the social and ecological impacts of economic activities (Ikerd, 2024). ESG practices, if appropriately applied and managed, can contribute to accelerate sustainability-readiness, particularly increasing food quality, minimising the negative impacts that farmers' operations have on the environment and local community, while practising good governance (Yap and Al-Mutairi, 2024).

In this sense, farmers play a crucial role in the agricultural sustainability transition, but many still lack the knowledge and incentives needed to develop an ESG assessment. There is significant potential for using ESG assessments to help farmers integrate sustainable practices into their operations, facilitating a shift toward more sustainable production systems, reducing greenhouse gas emissions, preserving biodiversity, and maintaining profitability. However, ESG frameworks were not specifically designed with farmers' needs in mind, making it challenging for them to adopt these practices. Engaging farmers in the design and implementation of ESG tools and practices could ensure that the final product better meets the needs of end-users, increasing the likelihood of adoption and sustained interest (Hölting et al., 2022).

In Australia, agriculture is a key economic driver, and sugarcane has been a staple crop for more than 150 years, particularly in Queensland, which accounts for around 95 % of the country's sugar production (DAFF - Department of Agriculture, Fisheries and Forestry, 2024). As Australia's second-largest agricultural export, the industry contributes approximately AUS$2.4 billion to the national economy, with around 362,000 ha of sugarcane harvested annually. The industry also supports roughly 23,000 direct and indirect jobs annually (Australian Sugar Milling Council, 2025). The sustainability of sugarcane production in Australia is largely attributed to its social and economic benefits, the implementation of advanced farming techniques and renewable energy, adherence to best management practices, compliance with stringent environmental regulations, and a strong emphasis on research and innovation.

However, like many other sectors, the sugar and sugar-related bioproduct industries are facing important sustainability issues and opportunities (Eggleston and Lima, 2015). Given its proximity to the World Heritage-listed Great Barrier Reef (Star et al., 2024) and the Wet Tropics of Queensland World Heritage Area, the Australian sugarcane industry is under increasing scrutiny for its environmental impact, particularly regarding the use and runoff of fertilisers and pesticides (Power et al., 2021; Pringle, 2021; Reef Water Quality Protection Plan Secretariat, 2017). Additionally, given much of Australia is prone to drought, and with the risk of drought expected to rise due to ongoing human-induced climate change, the country needs to implement careful water resource

management and adaptation strategies (Falster et al., 2024). Moreover, Australia's agricultural sector, responsible for 17.7 % of carbon emissions (CSIRO, 2023), is central to the government's plan for achieving net-zero emissions by 2050 (DCCEEW - Department of Climate Change, Energy, the Environment and Water, 2021). The net-zero plan includes a specific strategy for the agriculture and land sector to enhance emission estimation and report both nationally and on-farm (DAFF2- Department of Agriculture, Fisheries and Forestry, 2024). In this context, besides offering significant environmental benefits, sustainable farming practices can enhance carbon sequestration and offer economic profitability for primary producers (Kumara et al., 2023).

In this research, we focused on the sugarcane sector in North Queensland, Australia, aiming to develop and test an ESG Rapid Assessment tool to facilitate understanding and accelerate adoption of ESG standards by sugarcane farmers (Leite de Almeida et al., 2024). Focused on two case studies conducted to integrate both stakeholders and sugarcane farmers' perspectives in the co-creation process, this research outlines a co-creation approach to i) present the ESG on-farm framework (de Almeida et al., 2024) for farmers and other industry stakeholders; ii) discuss the potential benefits of this framework in the context of farmland; iii) assess the application of ESG on-farm framework; and iv) jointly assess, develop and analyse a practical and locally adapted fit-for-purpose tool to streamline and accelerate ESG adoption on sugarcane farms.

2. Methods

2.1. Study sites

We selected two regions (Mackay and Burdekin) located in Queensland, Australia, to apply the framework. Those two sites are the most significant sugarcane-producing areas in Queensland, accounting for a substantial portion of Australia's sugar output. Both regions also fall within the Great Barrier Reef catchment, placing them under high regulatory scrutiny for environmental performance. Their differing biophysical conditions and farming practices allowed us to test the ESG framework across diverse production settings, enhancing the tool's robustness and relevance. Table 1 outlines the key characteristics of the production systems adopted in both regions.

Table 1
Sugarcane production systems and bio-physical conditions (Schroeder et al., 2008; Qureshi et al., 2001).

	Burdekin	Mackay
Production systems	Intensive irrigation-based system using predominantly furrow irrigation.	Predominantly rain-fed with supplementary irrigation to manage rainfall variability.
Bio-physical conditions	Tropical climate with distinct wet and dry seasons. Low annual rainfall (~973.2 mm), supplemented by high irrigation use (8–15 ML/ha). Temperatures average 18.1 °C (min) 29 °C (max). (Climate data online, Bureau of Meteorology, Ayr DPI stn, 1950 to 2024, accessed on 8/1/25) Alluvial soils dominate, requiring efficient water management to avoid nutrient leaching. High evaporation rates (up to 10 mm/day in summer).	Tropical climate with distinct wet and dry seasons. Higher rainfall than Burdekin (approx. 1539.6 mm/year). Temperatures average 18 °C (min) to 27.4 °C (max). (Climate data online, Bureau of Meteorology, Mackay Aero station, 1950 to 2024, accessed on 8/1/25) Soils vary from alluvial to clay loams, and good drainage is essential.
Bioregion	Brigalow Belt North	Central Mackay Coast
Economic	One of Australia's most productive sugarcane-growing areas, with the sugar industry being a major economic driver	A more diverse economy compared to the Burdekin, with strong sectors in manufacturing, transport, and education
Social	The sugar industry supports thousands of jobs in farming, processing, and transport	An economic centre for Central Queensland, providing services to neighbouring communities and industries

2.2. Participants

Sugarcane farmers were selected and invited to participate in the research based on the following criteria: a) they already engage in data collection and measurement, b) they implement sustainable practices on their farms, and c) they are interested in enhancing their sustainability performance. In total, 14 sugarcane producers from a farm organisation in the Burdekin region participated in Case Study 1, while 19 individuals including farmers, agronomists, and productivity service providers took part in a co-design workshop in Mackay as part of Case Study 2. These groups were selected with the support of industry partners and reflect a targeted cohort of producers already engaged in sustainable practices. All participants provided informed consent, and ethical approval for the study was obtained (H9299).

2.3. Research co-design approach

The research approach draws on social marketing theory (Rundle-Thiele et al., 2019) and applies a six-step co-design framework for public service design (Fig. 1) aimed to create public value through an ESG assessment tool. Social marketing (a sub-discipline of marketing) focuses on using marketing principles and techniques to influence behaviours that benefit individuals and society (Kassirer et al., 2019). Its value lies in its ability to address complex social, health, and environmental issues by creating frameworks and strategies that promote sustainable and beneficial changes within communities (Rundle-Thiele et al., 2019). Public value creation depends on politically mediated, collectively determined preferences, reflecting what citizens and stakeholders deem valuable (Moore, 1997; O'Flynn, 2007). This highlights the importance of multi-actor value co-creation, a key aspect of the service ecosystems lens in service-dominant logic (Vargo and Lusch, 2008). The six-step model was used to transform the needs of the user into a new service idea and included the framing of and between the problem and solution (Trischler et al., 2019).

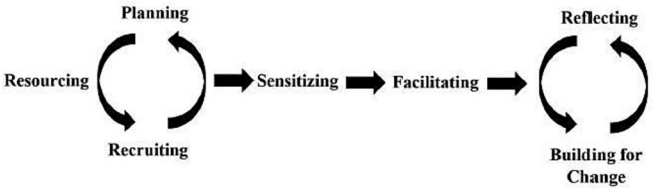

Fig. 1. Six-step Co-Design Model (Trischler et al., 2019).

The innovativeness of the ESG on-farm tool lies in its design principles: (1) it uses a co-created, farmer-centric methodology, (2) it integrates elements from leading ESG standards (GRI, SASB, SDGs, TCFD), and (3) it simplifies ESG adoption into a Rapid Assessment model tailored for small-to-medium farms. To our knowledge, this is the first application of a double materiality-informed ESG framework co-designed specifically for Australian primary producers, balancing local context and global disclosure expectations. The double materiality approach considers both the external sustainability issues that may impact the business ("outside-in" risks) and the business's own impacts on society and the environment ("inside-out" risks), as defined by the European Union (2014).

2.3.1. The co-design process

The co-design preparation process involved three key steps: resourcing, planning, and recruiting.

Step 1 - Resourcing.

During the resourcing step we conducted a literature review to get a better understanding of the problem, guiding the planning phase. A systematic literature review, *"Environmental, social and governance (ESG) in agriculture: trends and gaps on research"* (Leite de Almeida et al., 2024) aimed to identify gaps and opportunities for farmers to use ESG principles to improve sustainability performance and facilitate market access. Nearly 400 articles were identified, screened and refined to critically analyse 62 articles. The articles were selected through a systematic literature review conducted across several major databases, including Web of Science, SCOPUS, ProQuest, SAGE Journals, AgEcon, and Google Scholar. Inclusion criteria required that articles: (i) were published in English; (ii) appeared in peer-reviewed academic journals; (iii) were published in 2004 or later; and (iv) had full-text availability online. Articles that did not meet these criteria were excluded from the review (Leite de Almeida et al., 2024).

Findings identified that ESG research in the agricultural sector is in its infancy but progressing quickly and that future research should focus on ESG policy and management and innovative technologies that address limitations and advance the adoption of ESG principles and practices in agriculture. It also identified a need to create sustainability credentials to improve the adoption of ESG in the agricultural sector to benefit sustainable producers and the potential of technologies for verifying improved ESG outcomes.

Step 2 - Planning.

This step was iterative and developed with the collaboration of industry. The insights gained from literature review were also used to inform the planning step. We collaborated with industry to co-design a preliminary ESG framework aiming to allow producers to self-assess their readiness for ESG.

. The ESG on-farm framework is a blended model, adapted from the GRI 3: Material Topics 2021 standard and grounded in the principle of double materiality. It also integrates elements from the GRI 13: Agriculture, Aquaculture and Fishing Sectors 2022 standard, Australian Agricultural Sustainability Framework (AASF), Agricultural Products Sustainability Accounting Standards Board (SASB), and other international ESG frameworks and standards, such as the Task Force on Climate-Related Financial Disclosures (TCFD) and the Sustainable Development Goals (SDGs) (GRI – Global Reporting Initiative, 2022; SASB - Sustainability Accounting Standards Board, 2018; TCFD - Task Force on Climate-Related Financial Disclosures, 2021). The framework was collaboratively refined during our research to create a user-friendly, locally tailored ESG assessment tool that better aligns with the needs and realities of farmers. Importantly, the ESG on-farm framework goes beyond co-designing with farmers by integrating training, educational materials, and extension components to enhance farmer engagement and understanding (Fig. 2).

Step 3 - Recruitment.

The recruitment step involved identification, screening, and selection of participants relevant to the problem being addressed (Trischler et al., 2019). Our ESG research began after discussions with a grower organisation interested in enhancing environmental performance to access environmental markets and new income streams. The industry organisation represents approximately 130 sugarcane growers in the Burdekin region, collectively supplying around 1.6 million tonnes of cane annually to major sugar mills.

To test the preliminary ESG on-farm framework, we partnered with one of Australia's largest sugarcane producer groups, comprising 14 cane growers in the Burdekin region (see Case Study 1 below). After implementing the framework, we conducted a survey to assess its effectiveness and identify areas for improvement. The results of this initial trial were later published in a conference paper "*ESG analysis on-farm: a practical framework to support Australian producers*" (de Almeida et al., 2024). To further refine the framework, we conducted a broader survey involving 48 key stakeholder organisations across the sugarcane

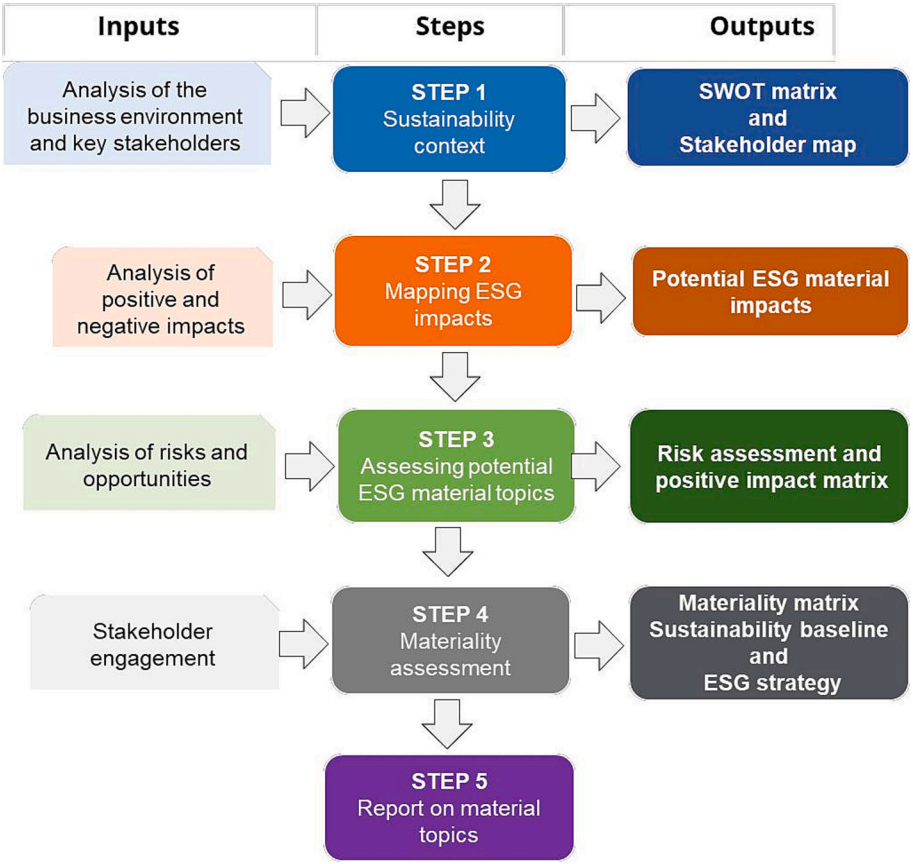

Fig. 2. ESG on-farm framework (de Almeida et al., 2024).

sector (see stakeholder consultation below). This group included representatives from industry, state and federal governments, financial institutions, employees, productivity services, growers, and local community organisations. The feedback gathered from this consultation helped us better understand the practical challenges and opportunities of ESG adoption in the sector.

Building on insights from the first trial, we extended our research to individual farmers to explore how ESG could support on-farm sustainability improvements and market access. With support from industry organisations and natural resource management groups, we identified participating farmers and organised a hands-on workshop (see Case Study 2 below). The workshop included 19 participants, including farmers, industry representatives, agronomists, and productivity service providers. To ensure consistency, we applied the same survey used in the first trial.

Step 4 - Sensitisation.

Introducing the ESG on-farm framework to farmers

Sensitisation is considered a key step aiming to prepare the participants and stimulate reflection before co-design facilitation through activities or thought-provoking questions (Trischler et al., 2019). In our research we introduced the framework to farmers at two different points using distinct approaches through case studies. In the first case study, conducted in August 2023, the presentation was delivered individually to representatives of the farm organisation in the Burdekin region who had been identified for participating in the research. We presented specific information regarding the importance and the process to develop the analysis as well as the type of data necessary to carry out the study. We also informed that all data would be provided by farmers since the analysis did not involve data collection in the field.

In contrast, during the second case study in May 2024, a workshop was organised in Mackay to present and discuss the ESG on-farm framework with a group of selected farmers, allowing for broader engagement and collaborative discussion.

Step 5 - Facilitation.

Implementing the framework - Case Study 1.

Using a case study approach, we implemented the ESG on-farm framework for the first time, partnering with a farm organisation that involved 14 farmers. Our 5-step methodology was tailored into two custom Microsoft Excel spreadsheets specifically designed for ESG data collection. These spreadsheets were shared with the participating farm organisation to gather their input. The first spreadsheet focused on collecting information for a materiality assessment, related to steps 1 to 4 of the ESG on-farm framework (Fig. 2), while the second gathered both quantitative and qualitative data to establish an ESG sustainability baseline, focused on step 5 (Fig. 2).

Primary data were gathered using the two customised spreadsheets and a survey, while secondary data (e.g. journal articles and technical reports) were incorporated into the spreadsheets to streamline the process to identify material topics. A material topic is an **ESG** issue that has a significant impact on a business's performance, strategy, or stakeholders. These topics are considered material because they are essential for the business's long-term success and can influence decisions made by investors, customers, and other stakeholders.

The combined dataset of primary and secondary information was then analysed within the on-farm operational context. Additionally, a workbook with step-by-step guidelines on conducting an ESG assessment and using the two spreadsheets was co-developed and provided to the organisation.

Following the completion of the ESG materiality and baseline assessments, we conducted a survey based on the KASA (Knowledge, Attitude, Skills, and Aspirations) framework. The purpose was to refine the co-design of the ESG on-farm framework, ensuring its adaptability to local conditions. The KASA model helps measure knowledge gain, shifts in attitude, skills development, and participants' aspirations, providing insights into how individuals respond to program initiatives (Rockwell and Bennett, 2004). The evaluation measured: 1) Changes in KASA; 2) Confidence in ESG decision-making; and 3) Intentions and actual changes in practices related to ESG standards. The survey results were analysed and used to further design an ESG Rapid Assessment tool.

Engaging with stakeholders for feedback and insights

We developed an online survey to engage key stakeholders to collect their insights on ESG issues with the aim of enhancing the sustainability of sugarcane production. This group included 48 representatives from the sugarcane industry, state and federal governments, financial institutions, employees, productivity services, growers, and local community organisations. We reached out to representatives from these organisations via email, to invite them to participate in the online survey, outlining the details of participation and the purpose of the consultation. We asked these group of stakeholders to identify material and emerging topics. An **emerging topic** refers to a new or growing issue related to **ESG** factors that businesses should pay attention to. These topics are not yet mainstream but are becoming increasingly important. After the survey was concluded, we analysed the results and reviewed material, and emerging topics identified by key stakeholders to be included into an ESG Rapid Assessment Tool.

Applying the framework in Case Study 2.

We organised a practical workshop in Mackay, QLD, bringing together 19 participants including farmers, industry representatives, agronomists, and productivity services. The workshop aimed to provide valuable insights into ESG, covering "what ESG is" and "how ESG can benefit farmers," and introduced participants to the ESG on-farm framework. During the workshop, the participants worked in groups, with the support of a facilitator, and had the opportunity to use the framework to develop ESG materiality and baseline assessments and provide feedback on the process. After the activities, a representative of each group shared their findings and experiences. The workshop evaluation utilised the same KASA model applied in Case Study 1.

Step 6 - Evaluation.

ESG-on farm Rapid Assessment Tool.

Reflecting on the aforementioned workshop evaluations, the co-design model led to the development of an ESG Rapid Assessment methodology. This streamlined methodology was designed to provide a practical, scalable approach for sugarcane farmers to support farmers to develop their sustainability credentials, enhance sustainability performance and facilitate access to environmental markets.

The simplified ESG Rapid Assessment framework can help farmers to conduct ESG materiality assessments and establish baselines. This new framework, named **ESG On-Farm Rapid Assessment**, is a streamlined, three-step methodology designed to help small-to-medium sized farms (in the Australian context) to quickly adopt ESG standards and enhance the sustainability of their farming practices. Like the previous 5-steps approach, it builds on the Global Reporting Initiative (GRI) framework and incorporates elements from SASB, GRI-13, SDGs and TCFD standards. The three steps of the methodology involve an online survey (materiality assessment), followed by data collection and analysis and

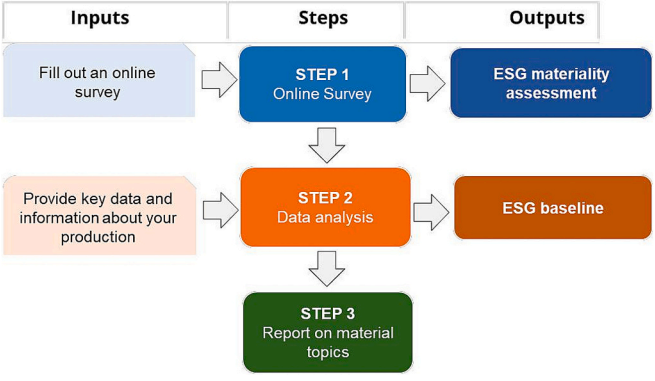

Fig. 3. ESG on-farm Rapid Assessment.

report (Fig. 3).

ESG on-farm metrics.

Considering the material topics identified by farmers and key stakeholders, we selected associated indicators from the SASB, GRI 13, TCFD and SDGs.

The Global Reporting Initiative (GRI 13) standards can be used by any organisation in the agriculture, aquaculture, and fishing sectors (GRI 13, 2022, p. 6) and include 26 likely material topics. According to GRI 13 guides, the organisation is required to review each topic in this section and determine whether it is a material topic for the organisation, and then to determine what information to report for its material topics (GRI 13, 2022, p. 14).

The Sustainability Accounting Standards Board (SASB) standards are designed to identify the core sustainability issues most likely to affect the operational performance or financial health of a typical company within a given industry, regardless of its location. These standards aim to facilitate cost-effective, decision-useful communication about corporate performance on industry-specific sustainability matters using existing disclosure and reporting frameworks (SASB, 2018, p. 4). Adopting SASB is expected to enhance engagement with stakeholders focused more on financial outcomes than sustainability performance (Pizzi et al., 2023).

The Task Force on Climate-related Financial Disclosures (TCFD) guidance was designed to be applied by a wide range of organisations of all sizes and located in various countries around the world (TCFD - Task Force on Climate-Related Financial Disclosures, 2021, p. 7). The TCFD recommendations are voluntary disclosure guidelines designed to provide consistent climate-related information to investors and other key stakeholders (Auzepy et al., 2023).

The Sustainable Development Goals (SDGs) were adopted by the United Nations General Assembly in 2015 as part of the 2030 Agenda for Sustainable Development, comprising 17 goals and 169 targets, designed to take a holistic approach to addressing the social, economic, and environmental aspects of sustainable development (Abraham and Pingali, 2020).

As shown in Table 2, the current rapid assessment covers 13 material topics and 30 indicators that can easily be collected by farmers to ensure an initial evaluation of ESG performance and sustainability on-farm. Our research suggests that the use of those indicators can help farmers to inform relevant, credible, and concise information about ESG on-farm.

3. Results

3.1. Case study 1

The ESG on-farm framework was easily introduced to sugarcane farmers and successfully implemented, resulting in the creation of an ESG materiality assessment and a comprehensive ESG baseline report. Additionally, the findings from the KASA survey, summarized in Table 3, demonstrate the framework's potential to help farmers develop their ESG assessments and enhance their reporting capabilities.

3.2. Stakeholder engagement

Through the online survey developed to engage key stakeholders and collect their insights, we gathered 567 contributions addressing 19 material topics and 10 emerging issues. A diverse group of representatives, including 48 stakeholders from the sugarcane industry, state and federal governments, financial institutions, employees, productivity services, growers, and local community organisations, participated in the online survey. Material topics are those that significantly impact producers and long-term value creation, while emerging topics represent areas of growing importance. Figs. 4a, b and c provide a visual summary of these findings, showcasing the most significant ESG topics identified through stakeholder input. Among the 19 material topics identified, 11 were within an environmental dimension, with soil health, water management, and chemical application recognised as the top priorities.

In the social dimension, workplace health and safety were considered as the most crucial issue (Fig. 4b).

On the governance side, key concerns included the lack of a robust

Table 2
Proposed ESG on-farm metrics to evaluate impact of sugarcane production.

Material Topics	Indicators
Environmental indicators	
1. Emissions	1.1. Gross direct (Scope 1) GHG emissions 1.2. Energy indirect (Scope 2) GHG emissions 1.3. Other indirect (Scope 3) GHG emissions 1.4. GHG emissions intensity (including sequestration)
2. Biodiversity	2.1. Protected areas and areas of high biodiversity value outside protected areas (total area) 2.2. Protected areas and areas of high biodiversity value outside protected areas (description about the type of area preserved)
3. Energy management	3.1. Annual electricity consumption 3.2. Annual diesel consumption 3.3. Annual petrol consumption 3.4. Percentage renewable energy
4. Water management	4.1. Total surface water withdrawal 4.2. Total groundwater withdrawal 4.3. Third party (supply company) 4.4. Water discharge (*runoff*) 4.5. Water consumption
5. Waste management	5.1. Total weight of waste generated 5.2. Total weight of waste directed to disposal 5.3. Total weight of waste diverted from disposal 5.4. Total weight of hazardous waste directed to disposal 5.5. Total weight of waste diverted from disposal
6. Pesticide use	6.1. Quantity of herbicide/ pesticide used 6.2. Quantity of paraquat, diquat and glyphosate used
Social indicators	
7. Local communities	7.1. Description of the approach to engage with local community and traditional owners
8. Occupational health and safety/ Workforce Health & Safety*	8.1. Demonstration of WHS as a priority in the business 8.2. Description of practices to prevent and manage risks
9. Non-discrimination and equal opportunity*	9.1. Describe the approach used to prevent/ eliminate discriminatory treatment of workers
Governance indicators	
10. Data collection	10.1. Description and frequency of data collection processes
11. Monitoring system	11.1. Overview of the developed system and its functionality
12. Business plan	12.1. Existence and implementation of a business plan
13. Succession plan	13.1. Existence of a succession plan

* Relevant only for farmers who have employees.

Table 3
Results of KASA survey - Case study 1.

Topics	Survey questions	Results
Overall satisfaction and engagement with the methodology	How satisfied are you with the ESG assessment methodology?	Highly satisfied
Ease of implementation	How easy was it to use the ESG assessment framework?	Easy
Impacts on business and ESG management	How valuable will be the ESG assessment in assisting to management ESG commitments?	Very valuable
Behavioural intentions and future changes	Do you plan to make changes to your business as a result of the ESG assessment?	Yes

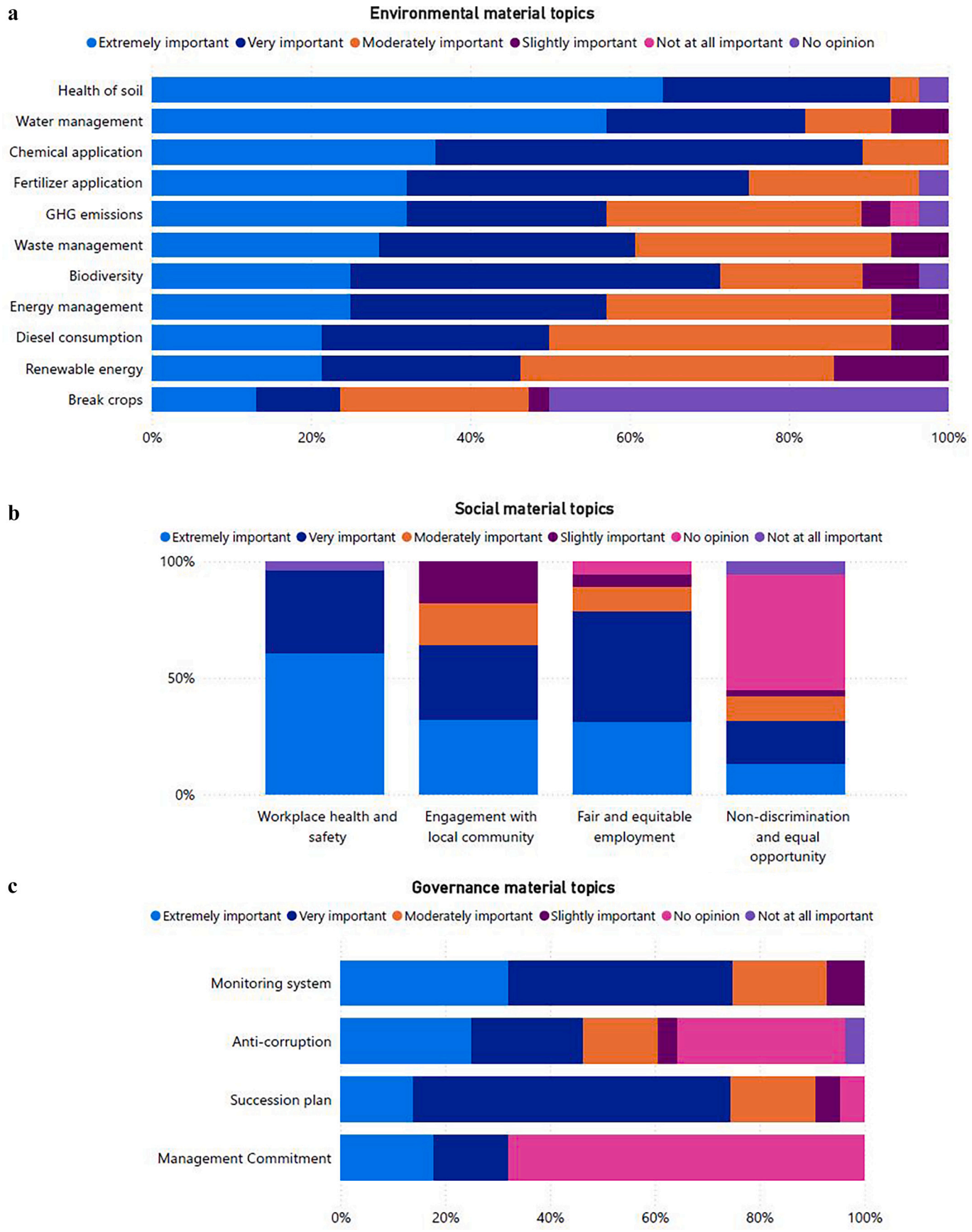

Fig. 4. a. Environmental Material Topics as gathered through key stakeholder engagement. b. Social Material Topics as gathered through key stakeholder engagement. c. Governance Material Topics as gathered through key stakeholder engagement.

monitoring system and the need for a clear succession plan.

Ten emerging topics were highlighted by key stakeholders as being of utmost importance, with a classification of "extremely" and "very important" (Table 4). These topics were identified as areas where significant evidence gaps still exist, which sugarcane producers should address to enhance their sustainability performance.

3.3. Case study 2

Case Study 2 was analysed using primary data collected through a post-workshop survey. Most respondents (66 %) identified as sugarcane farmers. As shown in Fig. 5, over 80 % of respondents expressed satisfaction with the workshop and the ESG assessment methodology. Additionally, 75 % of respondents reported that the methodology was easy or very easy to use. Furthermore, 62.5 % of respondents found the ESG assessment valuable in supporting the management of their ESG commitments. However, only 25 % indicated that they plan to make changes to their business because of the ESG assessment.

While the majority of participants found the ESG assessment tool easy to use and valuable, the relatively low percentage (25 %) intending to make immediate changes in their business practices suggests several underlying dynamics. Many participants were already implementing sustainability practices, and therefore may have seen the tool more as a validation of existing efforts than a prompt for change. Feedback gathered during the workshop indicated that although the tool improved awareness of ESG issues, participants felt that more tangible changes would require stronger market signals, clearer policy incentives, and accessible financial support. This highlights the tool's utility as a diagnostic and awareness-raising mechanism, while underscoring the need for complementary support structures such as funding programs or compliance pathways to drive on-farm action. These findings also point to the importance of adapting ESG engagement strategies to different levels of sustainability readiness across farming populations.

Key barriers to acceleration of the ESG transition were identified by farmers both: a) prior to farmer's decision to develop an ESG on-farm assessment; and b) once the decision to integrate ESG has been made by farmers (Table 5).

4. Discussion

4.1. Co-design an ESG assessment tool

In this research, we addressed the practical implementation of co-designing an ESG assessment through close collaboration with farmers and other key stakeholders (e.g. other practitioners, agricultural advisors, industry). The co-design aspect of this research was key to understanding farmers' needs and enabled us to integrate farmers' perspectives throughout the process to improve the ESG on-farm framework and develop the ESG on-farm Rapid Assessment tool. The Rapid Assessment can offer valuable insights into on-farm risks and opportunities, enabling farmers to enhance their sustainability performance and differentiate themselves in the agricultural market.

Our results emphasise the significance of engaging stakeholders to ensure the effective design and implementation of ESG tools. By adopting a co-design approach, we gathered valuable insights that helped shape the ESG Rapid Assessment. Numerous studies support the benefits of co-design processes, showing how the inclusion of end-users in the development of innovative, user-centred tools can lead to more successful outcomes, creating solutions that meet real-world needs (Calvera-Isabal et al., 2024; Singer et al., 2022; Ross et al., 2022).

Table 4
ESG emerging topics highlighted by key stakeholders for primary producers.

Extremely important	Very important
Prioritising ESG and on-farm practices that harmonise profitability with sustainability for long-term growth and resilience	Implementing integrated strategies for sustainable and efficient farm management
Demonstrating holistic ESG compliance for market success and financial resilience	Driving environmental stewardship by all primary producers
Addressing irrigation challenges, impacts of electricity pricing and solar limitations	Ensuring supply chain traceability transparency and accountability
	Advancing emissions reduction and biodiversity strategies for sustainable agriculture
	Meeting growing ESG and sustainability demands in a changing business environment
	Proactively managing ESG for growth and regulatory readiness in the sugar industry
	Ageing workforce challenge in sugarcane and broader agriculture

4.2. Challenges for ESG adoption on-farm and ESG-related incentives

Our research highlighted the complexity of integrating ESG factors into sugarcane production, particularly when considering the diverse perspectives of various stakeholders. Key stakeholder contributions identified several material and emerging topics that are already being addressed by many producers through the adoption of best practices, such as the Smartcane BMP,[1] Game Changer,[2] Six Easy Steps program,[3] among others. Within this context, sugarcane farmers perceive that they are already making meaningful progress toward sustainability and expect that any additional improvements should be supported by tangible economic incentives and financial returns. This perception that current practices are already aligned with many ESG expectations may help explain why only 25 % of participants indicated an intention to make changes to their business following the ESG assessment. However, while this finding may limit the generalisability of the results across the broader farming population, it also demonstrates that the tool was effectively tested with early adopters who are well-positioned to lead transitions within the industry. Testing the ESG Rapid Assessment tool with a more diverse cohort, including those less engaged in sustainability initiatives, could yield different outcomes and help further assess the tool's adaptability and scalability. Extending this research to other agricultural sectors could also provide valuable insights into sector-specific ESG challenges and opportunities. Although such expansion would require additional resources, it offers a promising avenue for future work and broader application.

Indeed, national governments can push for ESG and support this shift by offering targeted incentive programs and public investments to incentivise ESG adoption. For example, the European Union promotes ESG through economic incentives linked to the European Investment Bank (Mendenhall and Sutter, 2024). Similarly, the United States, United Kingdom, Germany, and Canada have long used tax credits and subsidies to encourage environmental sustainability. On the flip side, economic disincentives, such as tax penalties for the petroleum and crude oil industries (IRS - Internal Revenue Service, Petroleum Tax - Crude Oil Exports, 2023), also play a role. The challenge is understanding how these types of economic incentives can be effectively accessed by primary producers and contribute to improving ESG

[1] The Smartcane BMP is a voluntary program for the sugarcane industry

[2] Funded through the Australian Government's Reef Programme, the Game Changer initiative supports sustainable farming practices that are good for farmers and good for the reef, by reducing the amount of nitrogen and residual herbicides leaving sugarcane farms in run off.

[3] The Six Easy Steps nutrient management program is a comprehensive, integrated and science-based nutrient management program that is recognised by industry and government as nutrient best practice.

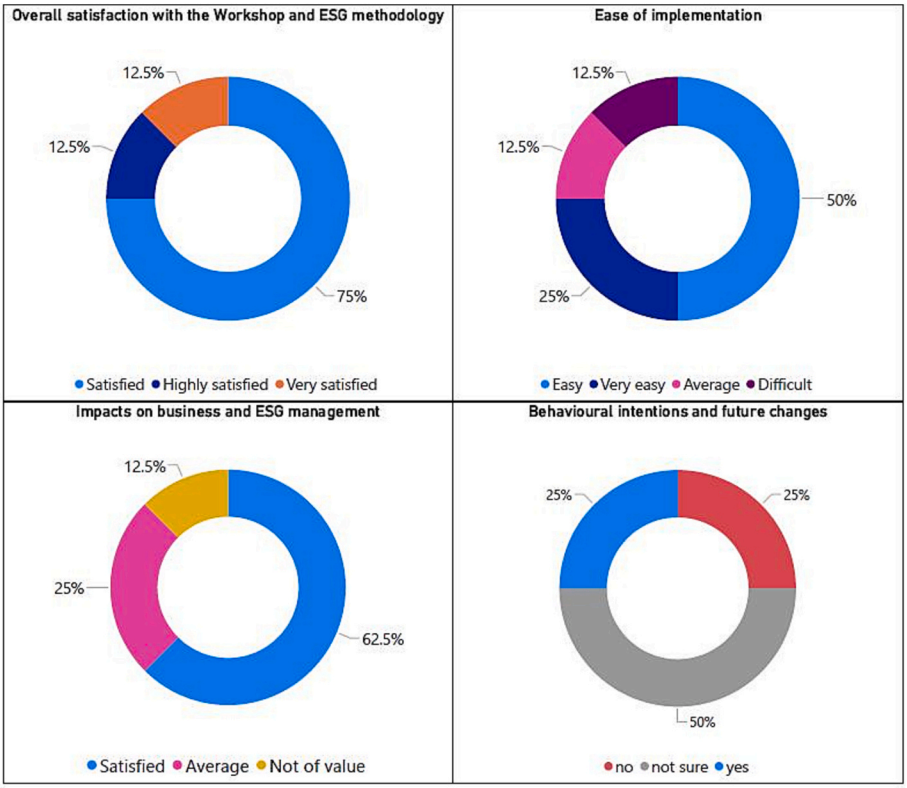

Fig. 5. Workshop survey results.

practices on-farm.

Additionally, while some sugarcane farmers perceive ESG as a burden, there is insufficient evidence to substantiate this claim regarding its adoption by primary producers. In fact, the topic remains contentious, while some studies suggest ESG may be a burden (Lin et al., 2024), others highlight its potential benefits in improving ESG performance, contributing to sustainable development (Meng et al., 2023; Zhang and Liu, 2023, Kusumaningrum and Utama, 2023).

Moreover, improving ESG practices for sugarcane farming is hampered by a lack of clarity regarding the pathway to delivering long-term value through ESG. As highlighted by sugarcane farmers and some key stakeholders participating in this research, several ESG-related factors remain without clear, actionable strategies and practices for integration into their operations. Farmers are discouraged from fully embracing ESG where they remain unsure of the concrete steps needed to drive value and improve sustainability on their farms.

The ESG Rapid Assessment tool makes an important contribution to the practical implementation of sustainability in agriculture by translating global ESG principles into a locally relevant, farmer-friendly framework. Its co-design methodology with iterative feedback from producers, industry advisors, and stakeholders ensures that the tool is not only scientifically grounded, but also operationally realistic. This approach contrasts with many existing ESG models that are top-down, compliance-driven, and poorly adapted to the specific needs of primary producers. The tool's emphasis on double materiality, streamlined indicators, and contextual adaptability represents an innovative step forward in embedding ESG practices at the farm level. Moreover, by piloting the tool in a sector as environmentally and politically sensitive as sugarcane farming near the Great Barrier Reef, the study demonstrates how ESG practices can be practically embedded in regions facing complex sustainability challenges. These design principles could be transferred to other agricultural sectors, highlighting the tool's potential scalability.

Governments are crucial in shaping environmental standards, enforcing regulations, and driving innovation through distinct policy instruments. By aligning regulatory frameworks with sustainability goals, governments enhance environmental stewardship, foster fair competition, stimulate investment in clean technologies, and propel the transition to a low-carbon economy (Simpa et al., 2024; Petrie, 2021). In comparison to regions like the European Union, where regulations on ESG factors are well-established and tightly enforced, Australia's lack of specific and comprehensive ESG regulations poses significant challenges for farmers. Without clear directives, Australian farmers may struggle to adapt to sustainability practices that are increasingly expected by international markets, particularly those in the EU, where regulations such as the EU Green Deal and the Farm to Fork strategy set stringent sustainability standards.

This regulatory gap can create uncertainty for Australian farmers, particularly in areas like reporting, carbon emissions reduction, and nature-related practices. The absence of mandatory compliance requirements means that farmers may face difficulties in accessing financial support, securing trade partnerships, and competing in global markets where ESG credentials are becoming a key differentiator. Without clear policies guiding ESG practices, farmers may struggle with inconsistent standards and face challenges in aligning with global sustainability trends. Moreover, a materiality assessment is essential for analysis and reporting, as it prevents producers from using frameworks symbolically and only reporting on topics with positive outcomes (Adams et al., 2022).

The EU's regulatory approach offers a strong example, with its emphasis on traceability, carbon neutrality goals, and sustainable agriculture. Such regulations give farmers clear guidelines and support to transition toward more sustainable practices, enabling them to meet market expectations and governmental policies. By contrast, Australia's lack of similar regulations may leave farmers at a disadvantage in both international trade and the evolving agricultural landscape.

In addition to regulation, financial institutions in Australia should take a more proactive role in engaging with primary producers. A

Table 5
Barriers to accelerating ESG transition on farm according to sugarcane producers.

1. Prior to farmers' decision to develop an ESG on-farm assessment	
Burden	Perception that ESG analysis adds unnecessary complexity or administrative burden
Sustainability	Belief that farmers are already implementing sustainable practices without formal ESG frameworks
Profitability	Expectation that adopting ESG standards should deliver measurable financial benefits
Information	Limited access to information on methodologies and baseline data for effective ESG reporting
Alignment	Uncertainty about how ESG aligns with existing best practices in agriculture
Gaps	Need to identify gaps and deficiencies in industry data for more comprehensive analysis
Goal	Minimise bureaucracy and avoid adding unnecessary administrative complexity
Carbon capture	Need clarity on how to link carbon capture practices already in place to ESG standards
Requirements	Clear guidelines on what is expected
Solutions	Readily accepted, straightforward, and easy-to-implement approaches
2. Once the decision to integrate ESG has been made by farmers	
Support	Assistance in developing ESG assessments
Cost	Initiatives to lower the cost of existing sustainability solutions
Innovation	Support for developing and scaling new technologies to enhance sustainability
Data	Guidance on data collection and formulation across the industry
Credibility	Addressing whether sustainability credibility requires ESG frameworks
Integration	How ESG aligns with biodiversity credits
Opportunity	Rewards and Return on Investments (ROI) for farmers adopting ESG practices
Carbon	Exploration of new carbon-related opportunities
Impact	Clarifying whether ESG helps or hinders progress
Filling Gaps	Whether ESG addresses current deficiencies in sustainability
Adaptability	How ESG fits amid shifting regulatory and market "goalposts"
Social Licence	Demonstrating responsibility beyond economic impact to environment and society
Perception	Managing community perceptions beyond job creation
Voluntary Model	ESG as a pseudo-audit pathway with voluntary participation
Financial Incentives	Linking adoption to potential financial benefits
Enforcement	Ensuring financial returns as a motivator for adoption
Accreditation	Leveraging accreditation as an industry influencer
Clarity	Clearly defining the end goals and benefits for farmers
Communication	Continuous, transparent communication rather than immediate action demands
Common Data	Leveraging shared, consistent data for industry-wide reporting

comprehensive approach to ESG is crucial for the sustainable advancement of both businesses and society. As key players in the economy's financial systems, financial institutions should lead transformative change, not just react to external pressures. By embracing their potential as catalysts for positive change, they can set a strong example, encouraging a more responsible and responsive global business community (Boudt et al., 2024).

Finally, in the way of accelerating ESG adoption, an easy and accessible tool is needed, as well as more research programs adapted to the specificity of the regional context and involving academy, industry, farmers, and decision-makers. Long-term use of ESG tools will also be needed to have a more comprehensive understanding of ESG benefits.

4.3. Challenges for ESG on-farm historical data and metrics

Overall, the set of indicators selected from GRI 13, SASB, TCFD and SDGs and adopted in this study are easily collected by farmers. Our research suggests that a simple and consistent set of indicators should include, in addition to common domains, some variables that are measured identically for each actor and are not part of those four international frameworks.

However, our research revealed that some relevant indicators, such as business and succession plans, are not part of those four international frameworks, previously mentioned, demonstrating that some current ESG standards and material topics are not focused on primary producers demanding some adjustments.

A study developed by Gerber et al. (2024) highlighted notable differences across countries, revealing that agribusinesses in Australia incorporated significantly fewer GRI 13 material topics compared to those in South Africa and Chile. The authors also identified a clear lack of harmonisation in agri-food sector disclosures, which undermines transparency and reduces opportunities for strategic advantage. The authors also emphasised the importance of focusing on the concept of materiality, as it aligns with stakeholder theory by ensuring that only the most relevant information is disclosed.

Our research found that farmers seek more support and guidance on data collection and formulation across the industry. Ensuring that the data collected are relevant, trustworthy, and fit for purpose is a key challenge in designing ESG systems, as well as in establishing effective monitoring and auditing processes. One of the reasons for this is that ESG data often originates from second and third parties within supply chains, which necessitates careful attention to trust across both data and software supply chains (Rabhi et al., 2024, p. 42). As mentioned by Wang (2024) the issues of data acquisition and quality, regulatory uncertainty, and a lack of understanding of ESG values among market participants present significant barriers that the financial sector must overcome in integrating ESG. Leveraging shared and consistent data for industry-wide reporting is likely to be one of the key challenges to address in the coming years.

Another key finding from our research is the growing importance of environmental stewardship, which has become a critical priority in light of global challenges, especially climate change and responsible farming practices (Simpa et al., 2024). Linnenluecke et al. (2020) findings showed that increases in atmospheric carbon concentration have had a significant negative impact on QLD sugarcane output after 1995. We found that while sugarcane farmers are already adopting environmental stewardship practices, there is still a need for greater transparency and accountability, which are essential for effective environmental stewardship (Mason, 2020). The quality of data collection, verification, and analysis, as well as the scope of material topics, are critical (Appelbaum et al., 2024). Our research revealed that data collection and analysis are major challenges for farmers. Additionally, some material topics such as soil health, biodiversity condition, ecosystem functionality, climate resilience, labour availability, and emerging risks like disease outbreaks are essential to sustainability but remain difficult to capture using standard ESG metrics. For example, while our current indicator for biodiversity - the area of protected land - provides a useful starting point, it does not reflect critical aspects such as ecosystem health, species diversity, connectivity, or the presence of wildlife corridors. Similarly, social and governance dimensions like adaptive capacity, cultural heritage, or succession planning often require more nuanced and context-specific approaches to measurement. These gaps highlight a broader challenge in ESG reporting which is the need for frameworks to remain flexible, dynamic, and responsive to evolving environmental, social, and economic realities. ESG should therefore be understood as an iterative and adaptive process that evolves through continued stakeholder engagement, integration of new scientific insights, and application of innovative technologies. Moreover, while we see promising potential in indicators proposed by the Taskforce on Nature-related Financial Disclosures (TNFD – Task force on Nature-related Financial Disclosures, 2024, p. 61) to support more robust and comparable disclosures, future iterations of the ESG on-farm framework should aim to broaden the scope of indicators to better capture these complex dimensions, without compromising accessibility and usability for producers.Finally, assuming that there is a positive association between the adoption the International Financial Reporting Standard (IFRS) and ESG (Dayanandan et al., 2024), it is important to note that Australia was

early adopter of IFRS principles to reduce information asymmetry and attract investors. While Australia was an early adopter of IFRS to reduce information asymmetry and attract investors, challenges persist, including issues with endorsement, translation, interpretation, and implementation (Uzma, 2016). Assuming a positive link between IFRS adoption and ESG (Dayanandan et al., 2024), Australian financial institutions should take a more proactive role in addressing ESG challenges, particularly climate change and social inequalities. They should support primary producers in adopting ESG-driven practices, such as carbon accounting, low-carbon transitions, and climate-resilient infrastructure projects.

5. Conclusion

The novelty in this research is concerned with adopting a co-design approach to develop a an ESG Rapid Assessment tool, that aims to facilitate and accelerate the adoption of ESG standards on farm. This research highlights five key messages. First, we believe that industry-wide adoption of ESG standards can help sugarcane farmers establish their sustainability credentials. However, to accelerate ESG adoption, it is essential to provide support as well simple, adaptable tools that facilitate reliable data collection, analysis, and reporting. Additionally, it is crucial to conduct studies that measure the financial benefits resulting from the adoption of ESG standards.

Second, while some agricultural sectors have started integrating ESG standards, Australian agricultural industries, stakeholders, and farmers must prioritise these efforts to fully realise their benefits. In addition to a clear, direct roadmap outlining end goals and benefits for farmers, it is essential to provide access to information on methodologies, offer capacity-building opportunities, and ensure continuous training and support to help farmers adopt ESG standards. A key innovation of this research lies in bridging the gap between global ESG disclosure frameworks and the practical realities of on-farm decision-making. By using a participatory, co-design methodology, we developed an ESG Rapid Assessment tool that is both technically aligned with international standards and functionally tailored to the agricultural context. This dual focus offers a model that could be adapted across other agricultural sectors and geographies. Importantly, the tool enables farmers to engage with ESG not just as a regulatory burden, but as a strategic opportunity to build resilience, access emerging markets, and contribute to long-term sustainability transitions.

Third, a significant knowledge gap must be addressed to make ESG practices more accessible and understandable for farmers. One key barrier is grasping the concept of double materiality and integrating it into analysis. Conducting a materiality assessment is vital for meaningful reporting, as it prevents producers from using frameworks superficially and focusing only on positive outcomes. Closing this knowledge gap would promote wider acceptance of ESG standards, making them more practical, straightforward, and easier to implement.

Fourth, enhancing data collection and developing appropriate metrics are critical for improving transparency, reporting, and environmental stewardship. Transparent reporting and disclosure of sustainability metrics enable primary producers to demonstrate their commitment to a sustainable agricultural industry while building their sustainability credentials. Identifying gaps and deficiencies in industry data is key to comprehensive analysis. Moreover, it is essential to incorporate material topics like natural ecosystem conservation and soil health, aligning with TNFD indicators, and tailoring social and governance metrics to reflect the realities faced by farmers. For key material topics such as biodiversity and water management, additional relevant indicators related to water quality and biodiversity conservation must also be included.

Fifth, government policy support, funding and institutional investments should align with initiatives to enhance ESG performance on farms while delivering returns for farmers adopting ESG practices. It is crucial to avoid excessive regulatory demands or added administrative complexity. Instead, efforts should focus on leveraging innovation and emerging opportunities, positioning ESG compliance as a strategic advantage rather than a burden. Overregulation should be minimised, and innovative sustainability approaches, like the circular economy, should be actively promoted and incentivised. Investment in developing and scaling new technologies to drive sustainability should also be prioritised.

A key limitation of this research is the narrow scope of quantitative and qualitative consultations, which should be expanded to include broader stakeholder representation from academia, local communities, and investors. We also encountered challenges in engaging with local producers and community organisations. However, despite the need for a more extensive participant base, the highly regulated nature of the sugarcane production sector suggests that the material topics and barriers to accelerate ESG on-farm identified by producers and key stakeholders in this research are likely to remain relevant. Addressing these issues will be crucial in preparing farmers for ESG compliance in the coming years.

Finally, we aim for this research to reach scientists, practitioners, and local decision-makers, fostering the development of innovative ESG tools tailored to local contexts.

CRediT authorship contribution statement

Ana Carla Leite de Almeida: Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Carlos Bueno:** Writing – review & editing, Writing – original draft. **Allan Dale:** Writing – review & editing. **Rachel Hay:** Writing – review & editing, Writing – original draft, Methodology. **Ben Jarihani:** Writing – review & editing. **Yvette Everingham:** Writing – review & editing. **Stewart Lockie:** Writing – review & editing.

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Declaration of competing interest

None.

Data availability

Data will be made available on request.

References

Abraham, M., Pingali, P., 2020. Transforming smallholder agriculture to achieve the SDGs. In: The role of smallholder farms in food and nutrition security, 173-209. https://doi.org/10.1007/978-3-030-42148-9_9.

Adams, C., Alhamood, A., He, X., Tian, J., Wang, L., Wang, Y., 2022. The development and implementation of GRI standards: Practice and policy issues. In: Handbook of Accounting and Sustainability. Edward Elgar Publishing Ltd. https://drcaroladams.net/th
edevelopment-and-implementation-of-gristandards-practiceand-policyissues/#.

de Almeida, A.C.L., Hay, R., Dale, A., Lockie, S., Everingham, Y., 2024. ESG analysis on-farm: a practical framework to support Australian producers. In: *Proceedings of the 45th Annual Conference of the Australian Society of Sugar Cane Technologists* (Vol. 45, pp. 147–153). Available at https://www.tnqdroughthub.com.au/wp-content/uploads/2024/07/ESG-analysis-on-farm-a-practical-framework-to-support-Australian-producer-ASSCT-Conference-Paper.pdf.

Appelbaum, D., Duan, H.K., Hu, H., Sun, T., 2024. The double materiality audit: attestation of ESG disclosures in financial statements. Account. Horiz. 1-16. https://doi.org/10.2308/HORIZONS-2023-036.

Australian Sugar Milling Council, 2025. https://asmc.com.au/federal-budget-sugar-manufacturers-call-for-a-new-approach-to-industry-policy-in-the-wake-of-emerging-international-trade-uncertainty-3-february-2025/. Online, accessed in 14/03/2025.

Auzepy, A., Tönjes, E., Lenz, D., Funk, C., 2023. Evaluating TCFD reporting - a new application of zero-shot analysis to climate-related financial disclosures. PLoS One 18 (11), e0288052. https://doi.org/10.1371/journal.pone.0288052.

Boudt, K., Delmarcelle, O., Petitjean, M., 2024. The Risk of Ignorance: How Financial Institutions Can Make a Difference in Large-Scale Media ESG News Monitoring.

Available at SSRN: https://ssrn.com/abstract=4701247 or https://doi.org/10.2139/ssrn.4701247.
Brundtland, G.H., 1987. Our Common Future: Report of the World Commission on Environment and Development. Geneva, UN-Document A/42/427. Available at http://www.un-documents.net/ocf-ov.htm.
Burton, R.J.F., 2004. Seeing through the "good farmer's" eyes: towards developing an understanding of the social symbolic value of "productivist" behaviour. Sociol. Rural. 44 (2), 195–215. https://doi.org/10.1111/j.1467-9523.2004.00270.
Busse, M., Zoll, F., Siebert, R., Bartels, A., Bokelmann, A., Scharschmidt, P., 2021. How farmers think about insects: perceptions of biodiversity, biodiversity loss and attitudes towards insect-friendly farming practices. Biodivers. Conserv. 30 (11), 3045–3066. https://doi.org/10.1007/s10531-021-02235-2.
Calvera-Isabal, M., Santos, P., Hernández-Leo, D., 2024. Towards citizen science-inspired learning activities: the co-design of an exploration tool for teachers following a human-centred design approach. Int. J. Human–Computer Interaction 40 (14), 3805–3826.
CSIRO, 2023. What are the sources of carbon dioxide in the atmosphere? https://www.csiro.au/en/research/environmental-impacts/climate-change/Climate-change-QA/Sources-of-CO2. Online, accessed in 12/09/2024.
DAFF - Department of Agriculture, Fisheries and Forestry, 2024. Sugar. https://www.agriculture.gov.au/agriculture-land/farm-food-drought/crops/sugar. Online, accessed in 09/09/2024.
DAFF2- Department of Agriculture, Fisheries and Forestry, 2024. Driving emissions reduction in the agriculture and land sectors. https://www.agriculture.gov.au/agriculture-land/farm-food-drought/climatechange/ag-and-land-sectoral-plan. Online, accessed in 12/09/2024.
Dayanandan, A., Donker, H., Kuntluru, S., 2024. IFRS and ESG disclosure in Indian corporate sector. J. Emerg. Market Fin. 23 (2), 143–169. https://doi.org/10.1177/09726527231197328.
DCCEEW - Department of Climate Change, Energy, the Environment and Water, 2021. Australia's Long-Term Emissions Reduction Plan: Modelling and Analysis. https://www.dcceew.gov.au/sites/default/files/documents/australias-long-term-emissions-reduction-plan-modelling.pdf. Online, accessed in 12/03/2025.
Deuffic, P., Candau, J., 2006. Farming and landscape management: how French farmers are coping with the ecologization of their activities. J. Agric. Environ. Ethics 19 (6), 563–585. https://doi.org/10.1007/s10806-006-9010-0.
Dutta, M., Shome, N., 2024. Consumer Awareness and Conscious Consumerism Study into the relationship between ESG and Consumer Awareness and Conscious Consumerism. *Available at SSRN 4887836*. https://doi.org/10.2139/ssrn.4887836.
Edmans, A., 2023. The end of ESG. Financ. Manag. 52 (1), 3–17. https://doi.org/10.1111/fima.12413.
Eggleston, G., Lima, I., 2015. Sustainability issues and opportunities in the sugar and sugar-bioproduct industries. Sustainability 7 (9), 12209–12235. https://doi.org/10.3390/su70912209.
European Union, 2014. Directive 2014/95/EU of the European Parliament and of the Council of 22 October 2014 amending Directive 2013/34/EU as regards disclosure of non-financial and diversity information by certain large undertakings and groups Text with EEA relevance. Accessed 03/06/2025.
Falster, G.M., Wright, N.M., Abram, N.J., Ukkola, A.M., Henley, B.J., 2024. Potential for historically unprecedented Australian droughts from natural variability and climate change. Hydrol. Earth Syst. Sci. 28 (6), 1383–1401. https://doi.org/10.5194/hess-28-1383-2024.
Gerber, R., Smit, A., Botha, M., 2024. An evaluation of environmental, social, and governance reporting in the agricultural sector. Business Strategy Develop. 7 (1), e316.
GRI – Global Reporting Initiative, 2022. GRI 13: Agriculture, Aquaculture and Fishing Sectors 2022. https://www.globalreporting.org/standards/standards-development/sector-standard-for-agriculture-aquaculture-and-fishing/. Online, accessed, 11/11/2024.
Hanley, N., Banerjee, S., Lennox, G.D., Armsworth, P.R., 2012. How should we incentivize private landowners to "produce" more biodiversity? Oxf. Rev. Econ. Policy 28 (1), 93–113. https://doi.org/10.1093/oxrep/grs002.
Hölting, L., Busse, M., Bülow, S., Engler, J.O., Hagemann, N., Joormann, I., Cord, A.F., 2022. Co-design: working with farmers in Europe to halt the loss of biological diversity. Ecol. Solut. Evidence 3 (3). https://doi.org/10.1002/2688-8319.12169.
Ikerd, J., 2024. Business management for sustainability. Sustainability 16 (9), 3714. https://doi.org/10.3390/su16093714.
IRS - Internal Revenue Service, Petroleum Tax - Crude Oil Exports, 2023. Reinstatement of Hazardous Substance Superfund Financing Rate. available at: https://www.irs.gov/businesses/smallbusinesses-self-employed/petroleum-tax-crude-oil-exports-reinstatement-of-hazardous-substancesuperfund-financing-rate (last visited May 10, 2024). Doi: 10.1177/1524500419866206.
Kassirer, J., Lefebvre, C., Morgan, W., Russell-Bennett, R., Gordon, R., French, J., Biroscak, B.J., 2019. Social marketing comes of age: a brief history of the community of practice, profession, and related associations, with recommendations for future growth. Soc. Mark. Q. 25 (3), 209–225.
Kumara, K., Pal, S., Chand, P., Kandpal, A., 2023. Carbon sequestration potential of sustainable agricultural practices to mitigate climate change in Indian agriculture: a meta-analysis. Sustain. Prod. Consumpt. 35, 697–708. https://doi.org/10.1016/j.spc.2022.12.015.
Kusumaningrum, I., Utama, C.A., 2023. The impact of Additioning ESG factors in the financial model in Power plant development can be categorized as a burden or benefit in PT XYZ. Asian J. Eng. Soc. Health 2 (9), 1102–1119.
Leite de Almeida, A.C., Dale, A., Hay, R., Everingham, Y., Lockie, S., 2024. Environmental, social and governance (ESG) in agriculture: trends and gaps on research. Aust. J. Environ. Manag. 1-30. https://doi.org/10.1080/14486563.2024.2430313.
Lin, Y., Lu, Z., Fan, D., Zheng, Z., 2024. The bright and dark sides of ESG during the COVID-19 pandemic: evidence from China hospitality industry. Int. J. Contemp. Hosp. Manag. 36 (4), 1393–1417.
Linnenluecke, M.K., Zhou, C., Smith, T., Thompson, N., Nucifora, N., 2020. The impact of climate change on the Australian sugarcane industry. Journal of Cleaner Production 246, 118974. https://doi.org/10.1016/j.jclepro.2019.118974.
Mason, M., 2020. Transparency, accountability and empowerment in sustainability governance: a conceptual review. J. Environ. Policy Plan. 22 (1), 98–111. https://doi.org/10.1080/1523908X.2019.1661231.
Mendenhall, Allen, Sutter, Daniel, 2024. ESG Investing: Government Push or Market Pull? Santa Clara J. Int. Law 22 (2), 75. AGLC 4th ed.
Meng, T., Yahya, M.H.D.H., Ashhari, Z.M., Yu, D., 2023. ESG performance, investor attention, and company reputation: threshold model analysis based on panel data from listed companies in China. Heliyon 9 (10).
Meynard, J.M., Dedieu, B., Bos, A.P., 2012. Re-design and co-design of farming systems. An overview of methods and practices. In: Darnhofer, I., Gibbon, D., Dedieu, B. (Eds.), Farming Systems Research into the 21st Century: The New Dynamic. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-4503-2_18.
Mnisi, M.S., Dlamini, C.S., 2012. The concept of sustainable sugarcane production: global, African and south African perceptions. Afr. J. Agric. Res. 7 (31), 4337–4343. https://doi.org/10.5897/AJAR12.446.
Moore, M.H., 1997. Creating Public Value: Strategic Management in Government. Harvard university press.
Niu, B., 2024. Government environmental protection expenditure and national ESG performance: global evidence. Innov. Green Develop. 3 (2), 100117. https://doi.org/10.1016/j.igd.2023.100117.
O'Flynn, J., 2007. From new public management to public value: paradigmatic change and managerial implications. Aust. J. Public Adm. 66 (3), 353–366. https://doi.org/10.1111/j.1467-8500.2007.00545.x.
Petrie, M., 2021. Mainstreaming environmental stewardship in government strategy and policy. In: Environmental Governance and Greening Fiscal Policy: Government Accountability for Environmental Stewardship, 43-60. https://doi.org/10.1007/978-3-030-83796-9_3.
Pizzi, S., Principale, S., De Nuccio, E., 2023. Material sustainability information and reporting standards. Exploring the differences between GRI and SASB. Meditari Account. Res. 31 (6), 1654–1674. https://doi.org/10.1108/MEDAR-11-2021-1486.
Power, B., Shaw, M., Vilas, M.P., Farr, M., Thompson, M., Poggio, M.J., 2021. Modelling to determine key drivers of water quality off sugarcane paddocks in the great barrier reef catchment. In: *MODSIM2021, 24th International Congress on Modelling and Simulation* (pp. 666-672).
Pringle, M.J., 2021. Detecting the annual areal extent of sugarcane crops in Queensland, Australia. Remote Sens. Appl. Soc. Environ. 22, 100496. https://doi.org/10.1016/j.rsase.2021.100496.
Qureshi, M.E., Wegener, M.K., Bristow, K.L., Harrison, S.R., 2001. Economic evaluation of alternative irrigation systems for sugarcane in the Burdekin delta in North Queensland, Australia. WIT Trans. Ecol. Environ. 48, 47–57.
Rabhi, F., Yu, M., Ng, A., Lim, E., Tan, F., Hsiao, A., 2024. Building an ESG decision-making system: challenges and research directions. Adv. Complex Decision Making 38-51. https://doi.org/10.1201/9781003340621-3.
Reef Water Quality Protection Plan Secretariat, 2017. Reef 2050 Water Quality Improvement Plan 2017–2022, Brisbane, QLD. https://www.reefplan.qld.gov.au/_data/assets/pdf_file/0017/46115/reef-2050-water-quality-improvement-plan-2017-22.pdf accessed in 12/03/2025.
Rockwell, K., Bennett, C., 2004. Targeting outcomes of programs: a hierarchy for targeting outcomes and evaluating their achievement. In: Faculty Publications: Agricultural Leadership, Education & Communication Department, 48. https://digitalcommons.unl.edu/aglecfacpub/48.
Ross, H., Hall, M., Herber, D.R., Jonkman, J., Sundarrajan, A.K., Tran, T.T., Johnson, N., 2022, October. Development of a control co-design modeling tool for marine hydrokinetic turbines. In: ASME International Mechanical Engineering Congress and Exposition (Vol. 86687, p. V006T08A067). American Society of Mechanical Engineers. https://doi.org/10.1115/IMECE2022-94483.
Rundle-Thiele, S., David, P., Willmott, T., Pang, B., Eagle, L., Hay, R., 2019. Social marketing theory development goals: an agenda to drive change. J. Mark. Manag. 35 (1–2), 160–181. https://doi.org/10.1080/0267257X.2018.1559871.
SASB - Sustainability Accounting Standards Board, 2018. Agricultural Products. Online. https://navigator.sasb.ifrs.org/login.
Schroeder, B., Calcino, D., Hurney, A., Smith, R., Panitz, J., Cairns, R., Allsopp, P.G., 2008. SmartCane Principles of Best Management Practice. BSES Limited (Available at: SmartCane-Principles-of-Best-Management-Practice.pdf).
Simpa, P., Solomon, N.O., Adenekan, O.A., Obasi, S.C., 2024. Environmental stewardship in the oil and gas sector: current practices and future directions. Int. J. Appl. Res. Social Sci. 6 (5), 903–926. https://doi.org/10.51594/ijarss.v6i5.1132.
Singer, I., Klatte, I.S., de Vries, R., van der Lugt, R., Gerrits, E., 2022. Using co-design to develop a tool for shared goal-setting with parents in speech and language therapy. Int. J. Lang. Commun. Disord. 57 (6), 1281–1303. https://doi.org/10.1111/1460-6984.12753.
Star, M., Hasan, S., Smart, J.C., Wegscheidl, C., 2024. What are the measured costs, and cost drivers associated with the use of natural/near natural wetlands, restored, treatment (constructed) wetlands and other treatment systems in Great Barrier Reef catchments in improving water quality? Available at: https://www.reefwqconsensus.com.au/wp-content/uploads/2024/06/2022-SCS-Q4.8_Evidence-Summary_Final.pdf.

Takalo, S.K., Tooranloo, H.S., 2021. Green innovation: a systematic literature review. J. Clean. Prod. 279, 122474. https://doi.org/10.1016/j.jclepro.2020.122474.

TCFD - Task Force on Climate-Related Financial Disclosures, 2021. Guidance on Metrics, Targets, and Transition Plans. https://assets.bbhub.io/company/sites/60/2021/07/2021-Metrics_Targets_Guidance-1.pdf. Online, accessed 05/10/2024.

TNFD – Task force on Nature-related Financial Disclosures, 2024. Recommendations on the Taskforce on Nature-related Financial Disclosures (TNFD). https://tnfd.global/publication/recommendations-of-the-taskforce-on-nature-related-financial-disclosures/#publication-content. Online, accesses 18/11/2024.

Trischler, J., Dietrich, T., Rundle-Thiele, S., 2019. Co-design: from expert-to user-driven ideas in public service design. Public Manag. Rev. 21 (11), 1595–1619. https://doi.org/10.1080/14719037.2019.1619810.

Uzma, S.H., 2016. Cost-benefit analysis of IFRS adoption: developed and emerging countries. J. Fin. Report. Account. 14 (2), 198–229. https://doi.org/10.1108/JFRA-01-2015-0019.

Vargo, S.L., Lusch, R.F., 2008. Service-dominant logic: continuing the evolution. J. Acad. Mark. Sci. 36, 1–10. https://doi.org/10.1007/s11747-007-0069-6.

Wang, D., Dong, L., Mei, J., 2023. An advanced review of climate change mitigation policies in Germany, France, and the Netherlands. Environ. Res. Lett. 18 (10), 103001. https://doi.org/10.1088/1748-9326/acf58f.

Wang, L., 2024. Challenges and Opportunities of ESG Integration in Financial Operations. In: *International Conference on Finance and Economics* (Vol. 6, No. 1). https://doi.org/10.22158/mmse.v6n1p162.

Wu, Q., Chen, G., Han, J., Wu, L., 2022. Does corporate ESG performance improve export intensity? Evidence from Chinese listed firms. Sustainability 14 (20), 12981. https://doi.org/10.3390/su142012981.

Yap, C.K., Al-Mutairi, K.A., 2024. A conceptual model relationship between industry 4.0—food-agriculture Nexus and agroecosystem: a literature review and knowledge gaps. Foods 13 (1), 150. https://doi.org/10.3390/foods13010150.

Zhang, J., Liu, Z., 2023. Study on the impact of corporate ESG performance on green innovation performance—evidence from listed companies in China A-shares. Sustainability 15 (20), 14750. https://doi.org/10.3390/su141811324.