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Research Article

The Green Dilemma: When Environmental Good Depletes Financial Good in Emerging Economies

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Abstract

Purpose- This paper aims to examine the relationship between environmental sustainability practices and firm profitability within Zambia's agro-food sector, assessing both short-term financial effects and strategic implications.

Design/Methodology- The study adopted explanatory sequential mixed-methods. Using fixed and random effects regression models, panel data from listed agro-food firms (2014-2024) were analysed. It was followed by thematic analysis of sustainability reports and a semi-structured interview with firm-level sustainability officers.

Findings- The quantitative results showed a significant negative relationship between environmental performance and short-term profitability. The Random Effects model revealed a coefficient of –15.739 ($p = 0.0006$) for the Environmental Score, indicating that higher sustainability scores are associated with lower immediate ROA. Governance was a strong positive predictor of profitability ($\beta = 23.08$, $p < 0.01$). Qualitative findings highlighted long-term benefits. Revenue was statistically insignificant.

Practical Implications- Firms need to pursue environmental strategies that are scalable and context sensitive. Regulatory supports, enhancement of technical capacity, and alignment of stakeholders are also critical to make firms' investment in sustainability compatible with their profitability targets.

Originality- As one of the first African emerging-market studies to focus only on environmental sustainability–profitability trade-offs, the paper makes an original contribution, methodologically by the application of an ISO-aligned environmental scoring framework in a context-specific and theoretically by extending Stakeholder and Signaling Theory to illustrate how environmental practices may act as a credible signal for long-term value.

Introduction

Environmental sustainability has become a central subject of corporate strategy as it helps to reduce environmental degradation while creating profitability and resilience (DesJardine *et al.,* 2019; Nogueira *et al.,* 2023). Firms around the world are increasingly adopting sustainability-oriented business models due to regulatory pressures, market pressures, and the growing prominence of environmental concerns and risk awareness, but much of what we know about the relationships between sustainability and profitability comes from the developed world while little is known regarding this relationship in emerging markets, in industries vital for national growth and development (Goel *et al.,* 2022; Fertő & Harangozó, 2025). This study focuses on Zambia's agro-food sector. The agro-food sector greatly contributes to a nation's economy in employment creation, food sufficiency and significant GDP growth. However, Zambia's agro-food sector is fraught with enormous resource inefficiencies, waste mismanagement and environmental degradation. Phiri *et al.* (2020) assert that if these environmental externalities remain unaddressed alongside conventional practices (e.g., the linear waste model - a traditional approach to production and consumption that follows a "take-make-use-dispose" trajectory), sustainability and profitability of Zambia's agro-food sector will be threatened in the long term. Moreover, the prevailing challenges are aggravated by weak regulatory enforcement and limited resources of many emerging economies (Ruan & Liu, 2021).

Emerging evidence suggests the possibility of green initiatives such as energy saving measures, waste reduction, and efficient use of resources potentially contribute to the financial performance. For instance, Nkwoji (2021) opines that spending strategically on environmental improves the stakeholder trust and the organization's reputation that contributes to profitability even if the costs are astronomical on the initial investment. Conversely, Esfahbodi *et al. (*2023) posit that green supply chain practices(GSCP) enable the firm to complement the financial performance and environmental performance even in resource constrained SMEs if the advanced information systems are adopted. Many of the green initiatives implored in Zambia have remained unexplored, and how these initiatives impact firm financial performance has not been established adequately especially in the agro-food sector.

By addressing these gaps, this study examines the relationship between environmental practices and financial performance in Zambia's agro-food sector. The study aims to generate results that provide useful insights for agro-food sector firms seeking to improve their financial performance while minimizing their environmental footprint. This study makes a practical contribution to the debate on sustainability in emerging markets by offering a contextual understanding of how food companies can integrate environmental issues into core business strategies to generate economic growth while preserving natural resources. The research also answers the calls to research concerning sustainable development in emerging economies and to develop a practical framework that seeks to link environmental and financial performance (De Mendonca and Zhou, 2019; Anderson *et al.,* 2020). This study also highlights the critical role sustainability plays not only as an ethical obligation but also as a strategic driver for long-term corporate success in sectors that serve as the backbone of national economies.

Literature Review

Environmental Practices and Profitability

More and more companies are realizing that sustainability isn't just the right thing to do, however, it can also be an opportunity to make profits. In practice, this usually involves spending less on energy and materials, avoiding regulatory trouble and winning the public's trust (Lah & Kotnik, 2021; Oncioiu *et al*., 2020; Zimon *et al.,* 2022; Mishra *et al.,* 2023). Studies have demonstrated that most firms with strong environmental strategies are able to achieve operational efficiencies and build trust for stakeholders especially in developed market

(Friede *et al.,* 2015; Whelan & Fink, 2016; Fatemi *et al.,* 2018; Shmelev & Gilardi, 2025). However, results from emerging market such as Zambia remains limited and context-specific. Similarly, environmental strategies have greater impact in resource intensive sectors as sustainability practices enhances the level of long-term profitability and resilience of the resources (Kurniansyah *et al.,* 2021; Nkwoji, 2021).

Challenges in Emerging Markets

Emerging economies have unique challenges such as limited resources; weak regulatory enforcement; conflicting development priorities (Dechezleprêtre & Sato, 2017; Durrani *et al.,* 2024; Shah *et al.,* 2025). Despite these barriers, proactive environmental strategies can yield considerable advantages. Research by Ruan & Liu (2021) emphasizes the potential for firms in resource-dependent industries to improve profitability by integrating sustainability measures into their operations (Esfahbodi *et al.,* 2023). Furthermore, the Zambian agro-food sector, characterized by its dependence on natural resources and exposure to climate risks, presents a fertile ground for assessing the intersection of environmental stewardship and financial outcomes (Kurniansyah *et al.,* 2021; Akhmadi & Januarsi, 2021).

Theoretical Foundations and Conceptual Rationale

This study is based on two related theories: signaling theory and stakeholder theory. According to signaling theory, corporate entities could reduce information asymmetry by issuing credible information to one or more external audiences (Flammer *et al.* 2021). One way to issue such signals is by voluntarily engaging in environmental- and sustainability-related assertion activities that showcase a firm's openness in operations and activities, long-term orientation, and commitment to responsible governance. We are therefore able to survey information regarding the environmental disclosures and report these to investors. Such signals can enhance investor confidence and subsequently increase a firm's market valuation, particularly if companies adopt and communicate sustainability practices beyond the regulatory demands. Prior studies confirm this being the case such that environmental disclosures are often a mediating variable in the association of corporate governance and firm performance (Li *et al.,* 2018; Yang *et al.,* 2020; Kurniansyah *et al.,* 2021).

However, the significance of signaling theory in emerging market contexts like Zambia is arguably limited by the weakness of the institutional environment and the relatively low sophistication of capital markets when interpreting ESG matters. In such contexts, the effectiveness of environmental disclosures in signaling the market may be somewhat diluted, as indicated by the mixed results in the literature (Rahardian *et al.,* 2022; Esfahbodi *et al.,* 2023; Gabr & ElBannan, 2024). To overcome this limitation, this study utilises stakeholder theory as a supplementary perspective. Stakeholder theory suggests that firms are responsible not only to shareholders, but to a wide range of stakeholders, such as regulators, communities, employees and investors, that can affect or are affected by corporate conduct (Freeman 1984; Donaldson & Preston, 1995; Clarkson, 1995). In this case, environmental sustainability reflects organisations' strategic response to institutional and social claims. Stakeholder salience model (Mitchell *et al.*, 1997) becomes relevant here, in explaining that firms are likely to prioritise their environmental practices according to their perceptions of power, urgency, and legitimacy of stakeholders´ claims.

In emerging economies, stakeholder theory has been applied to understand ESG adoption under institutional voids (Reed, 2008). Firms may implement environmental practices not just to gain financial returns but to maintain legitimacy, comply with international expectations, or build reputational capital especially where formal incentives are lacking. This theoretical integration forms a basis for the study's conceptual framework, which argues that the regulatory environment and firm capacity intervene as moderators that influence the relationship between the impact of environmental practices and profitability in Zambia's agro-food sector. Collectively, these theories argue that environmental practices may affect profitability via two different but intersecting mechanisms: (1) by signaling responsible behaviour to help gain investor confidence and market recognition; and (2) by responding to stakeholder pressure to help ensure legitimacy, access markets or build reputational capital (see **Figure 1**).

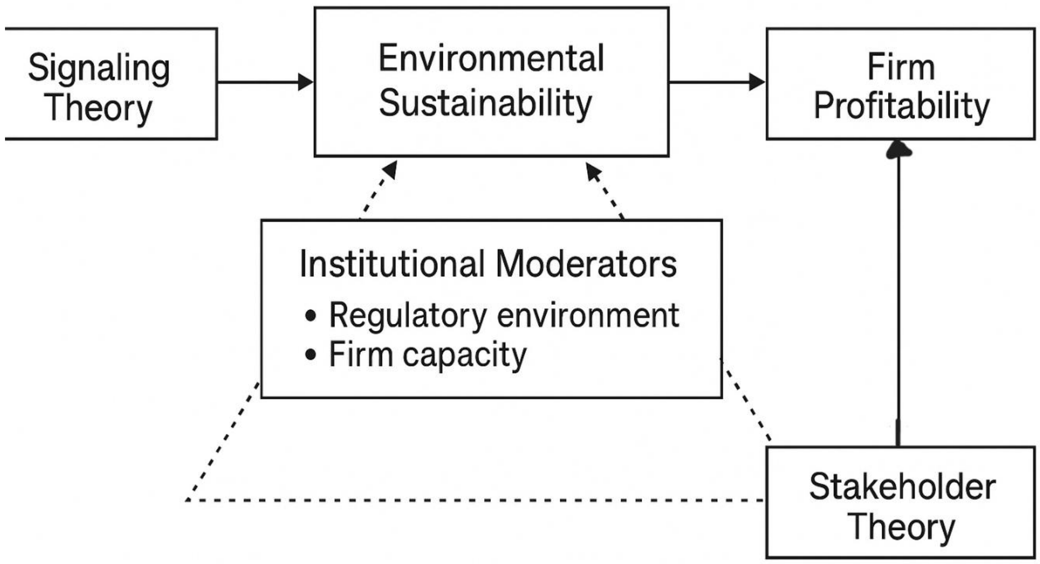

Figure 1. Conceptual Framework Linking Environmental Sustainability to Firm Profitability through Institutional Moderators and Theoretical Mechanisms

Environmental Sustainability as Strategic Leverage for Long-Term Profitability

Both theories reach a similar proposition: environmental sustainability contributes positively to firms' profitability and financial competitiveness when strategically implemented. However, the sustainability-profitability relationship does not appear to be linear or automatic. In fact, in many cases firms withstand extra costs (e.g. capital investment in energy efficiency, waste treatment etc.) with no or little financial returns in the short run (Esfahbodi et al., 2023; Aydoğmuş et al., 2022). What distinguished financially resilient firms is the extent to which environmental practices are institutionally embedded within firms' governance and aligned to long term strategic objectives (Boulhaga *et al.,* 2023; Singh *et al.,* 2024).

This study therefore examines environmental sustainability not merely as a compliance activity, but as a strategic orientation, shaped by institutional conditions, stakeholder dynamics, and signaling mechanisms. This study accordingly examines environmental sustainability not simply as a merely compliance activity, but rather as a strategy orientation, shaped by institutional conditions, stakeholder dynamics and signalling mechanisms. The theoretical framing guides the choice of variables as well as the interpretation of the results and deriving implications for theory and practice.

Customer and Market Dynamics as Catalysts for Environmental Action

Although customer satisfaction has a positive influence on profitability of environmentally friendly companies (Moisescu & Gică, 2020), literature suggests that most firms fail to meet expected sustainability metrics, explained by customer dissatisfaction. De Mendonca & Zhou (2019), for example, observed that corporate social responsibility (CSR) did not impact profitability whereas end customer satisfaction positively affected profitability. Taken together, these observations imply that market acceptance is a precondition for profitability and that firms must innovate to meet market demands. Thus, the implementation of environmental sustainability-oriented practices in the agro-food sector is not only an endogenous practice that follows management's strategic orientation, but to a fair extent, is increasingly shaped by customer demand and the influence of other supply chain players more generally. Local end market demand for eco-labelled or sustainability-oriented products is still incipient in Zambia (Phiri *et al.,* 2020; Maulu *et al.,* 2024). However, external end market players have begun to shape the way agri-food firms operate, especially regional and international customers. Firms engaged in export of products abroad, for instance, face demand from customers in South Africa and the EU to pursue environmental certifications and demonstrate transparency in the way they use resources and limit emissions for example (Goel *et al.,* 2022; Yushchenko & Patel, 2017). Thus, the customer and market dynamics in Zambia's agro-food sector illustrate indirect but powerful ESG drivers, underscoring the need to consider supply chain responsiveness when formulating sustainability strategies. In underlying, these supply-side dynamics thus show a convergence around stakeholder theory's fundamental assumption i.e. that external agents exert pressure on the firm to ensure its legitimacy and long-term profitability (Freeman, 1984; Khan & Liu, 2023).

Insights from Zambia's Agro-Food Sector

Some firms in Zambia are embedding and pursuing sustainability in order to follow not just the global trend of Environmental, Social and Governance (ESG) reporting but also to improve profitability in a resource-constrained context characterized by limited regulation. Notwithstanding these constraints, there is scope for firms to improve their competitiveness and profitability by reducing resource use and environmental impact and their transparent reporting on sustainability initiatives (Rahardian *et al.,* 2022; Esfahbodi *et al.,* 2023). Integrating environmental sustainability in strategy has high potential to improve firm profitability. This is particularly true for firms in resource-intensive industries such as the agro-food sector in Zambia. However, this potential will be unlocked only through broad attention to the contextual challenges, incorporation of theoretical insights and alignment of corporate practices with stakeholders' expectations. The mixed empirical evidence suggests that appropriate firm-specific customized approaches need to be considered and applied to address challenges and while creating innovative ways to minimize the cost of becoming environmentally sustainable so that a win-win association between environmental sustainability and financial performance may be necessary for a firm's long-term benefit.

Methodology

Research Design

This study adopted an explanatory sequential mixed-methods design to examine the relationship between environmental sustainability practices and firm profitability in Zambia's agro-food sector. The research progressed in two phases: a quantitative phase that established statistical relationships, followed by a qualitative phase intended to contextualize and explain those findings.

Quantitative Phase

The quantitative phase used panel data analysis on five publicly listed food firms on the Lusaka Securities Exchange (LuSE) ranging from 2014 to 2024. Environmental sustainability practices were operationalised using a composite Environmental (E) Score at a firm level, based on their reported disclosures on the firm's energy efficiency; waste management; and resource utilisation. The composite E Score was normalised and standardized to generate an E Score that facilitates comparability across firms. Financial performance was measured in terms of Return on Assets (ROA). Revenue was used as the control variable to control for the size of the firm and its level of operations. The fixed effects and random effects regression models were used to estimate the relationship between the E Score and ROA. Based on the Hausman test, the random effects model was appropriate. The reliability of each regressions model was checked using diagnostics tests. Multicollinearity was checked using the Variance Inflation Factor (VIF), the Breusch Pagan test was used to test for heteroskedasticity and the Ljung Box's Q-test was used to test for serial correlation. In each diagnostic it was shown that the model meets the basic assumptions of econometrics.

Qualitative Phase

The second phase of the study was a qualitative inquiry aimed at explaining and augmenting the statistical findings with additional granularity. Data was sourced from document analysis and semi-structured interviews. The sourcing documents analyzed were sustainability reports, ESG disclosures and statutory financial reports from those companies selected in the quantitative dimension. Evaluation and scoring of firm environmental performance was attained from these documents via a structured rubric informed by guidelines in the ISO IWA 48:2024 standard (International Organization for Standardization, 2024). The environmental dimension was chosen based on its closest connectedness with operational efficiency and environmental risk management inherent in Zambia's food industry. Firm disclosure scores were derived by way of a 5-point ordinal scale (0= no disclosure; 1=intention to disclose; 2=partial disclosure; 3= full disclosure; 4=Full, verifiable disclosure with timeline targets and performance metrics), averaged across four core environmental sub-components.

The first indicator, energy reduction policies, was examined by looking at whether firms disclosed efforts to reduce energy use, purchase renewable energy, or adopt energy-saving technologies in production and logistics. The second indicator of waste and water policies captured whether firms were engaging in waste minimisation (e.g. efforts to reduce waste in supply chain and logistics), had a water management policy, or disclosed use recycling or wastewater treatment systems. Third, emissions disclosure examined the extent to which firms were disclosing emissions relating to greenhouse gases, specifically Scope 1 and Scope 2 emissions, as well as evidence that firms were aligning emissions reduction targets with national o global environmental targets. The fourth indicator of resource use policies examined firm commitments to sustainable procurement processes, raw material efficiency, sustainable and circularity practices relating to resource use such as reusing inputs, or reducing waste from packaging.

Each company was given a score for each of the indicators, and these were then normalized and averaged to obtain the overall Environmental Score (E Score). The scoring was conducted according to systematic three-stage protocol that ensures inter-rater reliability through in-depth analysis of documents, double coding by independent raters and consensus validation. In the construction of the E Scores, we used only publicly available information (stand-alone annual reports, sustainability reports, integrated corporate reports) for the period of 2014–2024. In order to retain the maximum sample size possible without any distortion of the results, we employed pairwise deletion in case of any missing data. Additionally, a semi-structured interview with sustainability and operations managers of the selected firms also explored their implementation experiences, perceived barriers, strategic drivers, and perceived financial impact of environmental practices. Interview transcripts were thematically analysed in Excel thematically using an inductive coding followed by an identification of emergent themes of environmental strategy and profitability.

Research Hypotheses

Drawing on the Stakeholder Theory, which highlights the need to balance the interests of heterogeneous actors, and the Signaling Theory, which considers disclosure to be a means of signaling hidden strengths and future prospects, we propose four testable hypotheses in this study.

H1: Environmental sustainability practices are negatively associated with short-term profitability because of compliance cost, capital expenditure and operational inefficiencies.

H2: Environmental sustainability practices are positively associated with long-term profitability through efficiency gains, reputational capital, and stakeholder trust.

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H3: Governance quality moderates the environmental–profitability relationship: increasing the credibility of the signals and mitigating the short-run cost penalty.

H4 (non-linear effect): The relationship between environmental sustainability practices and profitability is a non-linear relationship with diminishing negative returns at lower levels of adoption, but possibly positive returns once a signaling threshold has been reached.

Justification of Research Design and Parameters

The study used the explanatory sequential mixed-methods design because the research question called for both statistical evidence and contextual explanation. The quantitative phase was required to determine whether environmental practices have a statistically significant effect on profitability, and the qualitative phase was required to explain why and how such patterns occur in Zambia's agro-food sector. Together, the design captures not only the numerical effects of the association but also the institutional and managerial circumstances shaping the association.

The selection of the quantitative measures was deliberate. The measure for profitability is Return on Assets (ROA). ROA is the most suitable indicator of profitability as it best expresses the efficiency with which returns are generated within the firm on the resources controlled by the firm. The environmental practices measure is the ISO IWA 48:2024-the world's first internationally-agreed business sustainability framework-boxed Environmental Score (energy efficiency, waste and water management, emissions disclosure, resources use). This framework is selected due to the credibility it brings as an internationally recognized measure to compare between firms, as well as the flexibility it allows for applicability to the Zambian context.

With respect to econometric modelling, alternative Fixed Effects (FE) and Random Effects (RE) models were estimated to control for unobservable firm-specific factors, and the Hausman test supported the use of RE, which were more efficient. To ensure robustness, the empirical models were subject to the following robustness and diagnostics tests: (1) the variance inflation factor (VIF), (2) Breusch–Pagan tests for heteroskedasticity, and (3) the Ljung-Box Q test of autocorrelation. Clustered standard errors at the firm level were further implemented to avoid potentially inflating significance. Finally, the models were subject to additional sensitivity checks to reinforce confidence in the findings, including lagged the Environmental Score and restricted to non-linear effects.

Bearing in mind the limited population of firms ($n = 5$), depth and contextual embedding were prioritized over statistical generalizability. This limitation was explicitly managed by triangulating the regression results with qualitative evidence. The qualitative phase entailed systematic document analysis of annual and sustainability reports and one semi-structured interview. This twofold evidence base enabled to take stock of not only the numeric trade-offs but also the lived struggles of putting environmental practices into effect in a resource-thin corner. Hence, every methodological choice, from the mixed-methods research design to the selection of econometric parameters, resulted from the study's aims and the context of the Zambian agro-food sector rather than random selection.

Integration and Interpretation

Findings generated from the quantitative and qualitative phases of the research were integrated during the interpretation phase in order to provide a more holistic understanding of the relationship between environmental practices and firm profitability. Integration allowed the research to triangulate the results, provide a deeper understanding of underlying contextual factors, and bring explanatory power to statistical relationships.

Ethical Considerations

The research was conducted in adherence to a high standard of ethical probity. The quantitative phase of the study only utilized publicly available information from annual reports, sustainability reports and other statutory filings of the sampled firms. As these data are already in the public domain, there is low-level risk to the organisations or individuals. For the qualitative part of this study, one semi-structured interview was conducted with a sustainability manager. An information sheet was provided to the participant, outlining the purpose of the study, the voluntary nature of participation and the right to withdraw at any point without repercussions. Informed consent was obtained in written form prior to the interview. The interview transcript was anonymized and relevant identifying detail withheld from this report. Any quotes provided have been either paraphrased or presented in such a way as to protect confidentially. All electronic data including the interview notes, coding matrices and document analysis files were stored on a password protected computer in a restricted area. Hard copy notes were stored in a locked cabinet accessible only to the researcher. Data will be kept for a period commensurate with University of Lusaka research ethics guidelines after which it will be securely deleted. By combining reliance on public data with strict consent and confidentiality protocols for the interview, the study conformed to the principles of respect, beneficence, and justice, and did not subject participants or firms to undue risk.

Results

Data Preparation and Model Specification

The first step of the analysis was to arrange the dataset in a suitable panel structure, where firm observations are collected over multiple periods (2014-2024) for the five Zambian agro-food sector firms. In the panel data, every firm-year observation was indexed by firm indices and the time periods so that the longitudinal data set-up is reflected. The key aim of the study was to establish a link between Environmental sustainability practices, exhibited by the Environmental (E) Score, and firm profitability, proxied by the Return on Assets (ROA). Revenue was the control variable as it is possible that it may have an impact on profitability that is unrelated to sustainability efforts.

Panel Regression Analysis

Two common approaches to panel regression analysis were considered: a Fixed Effects (FE) model and a Random Effects (RE) model. First, a Fixed Effects model was estimated (see **Table 1**). The findings showed that environmental scores negatively affected firms' profitability (**coefficient = -16.588, p-value = 0.0005**) while revenue was not statistically significant (**coefficient = 2.555e-10, p-value = 0.3544**) (see **Table 2**). The estimation of a Random Effects model resulted in similar results (see **Table 3**): environmental scores still had a significant negative relationship with ROA (**coefficient = -15.739, p-value = 0.0006**), while revenue was still statistically insignificant.

Table 1 summarizes the Fixed Effects regression model used to assess the relationship between environmental practices and profitability. The R-squared (within = **0.23**) suggests that almost a quarter of the variation in profitability is explained by the model, indicating that the environmental and revenue variables are meaningful, but there are also other factors in the firm that contribute to the explanation of firm profitability that are not included in this model.

Table 1. Fixed Effects Model Summary

Statistic	Value
R-squared	0.2277
R-squared (Within)	0.2277
F-statistic	7.0772
Prob (F-statistic)	0.0020
Number of Observations	55

Table 2 displays the results corresponding to the coefficient estimates of the Fixed Effects model, with both environmental and governance factors considered. The coefficient for environmental practices is negative (**–26.07)** and marginally significant (**p = 0.061**), which somewhat supports the negative effect of environmental initiatives in the short run as compliance and implementation cost affect and weigh on the profitability (H1). Governance, on the other hand, exhibits a strong positive sign and is statistically significant (**β = 22.44, p = 0.032**), which confirms governance is indeed a critical driver of profitability. The Environmental × Governance interaction term bears a positive sign (**β = 4.69**), yet the estimate is not statistically significant (**p = 0.513**), which is suggestive of a possible but inconclusive moderating effect of governance. Revenue is found to be statistically insignificant (**p = 0.458**), which demonstrates that variations in profitability relate more to ESG practices than firm size.

Table 2. Fixed Effects Parameter Estimates

Parameter	Coefficient	Std. Error	P-value
Constant	–43.98	3.69	0.0000
E Score (centered)	–26.07	13.93	0.061
G Score (centered)	+22.44	10.49	0.032
E × G (interaction)	+4.69	7.16	0.513
Revenue	8.47e-11	1.14e-10	0.458

To check the robustness, we additionally estimated the Random Effects model. As can be seen from **Table 3**, the results are consistent with the Fixed Effects estimates, providing additional context on H3; the E×G term is positive but not significant. **Table 3** presents the coefficient estimates of the Random Effects. The coefficient of environmental practices remains negative and significant (**–15.739, p < 0.001**), indicating the robustness of H1 with respect to model type. The consistent results further reinforce the findings, which allow us to ascertain the relatively cost-burdening impact of environmental practices in the short run. When Governance was included in the Random Effects model, it was a strong, positive predictor of profitability (**β = 23.08, p < 0.01**). The interaction (E × G), that is, moderation effect of Governance on Environmental practices was a positive (**β = 4.63**) but not statistically significant (**p = 0.605**). This suggests that the negative effect of environmental initiatives on firm profitability may be reduced by governance bolstering H3, but evidence for moderation was weak. Revenue continued to not have any significant effect.

Table 3. Random Effects Parameter Estimates

Parameter	Coefficient	Std. Error	P-value
Constant	115.67	34.573	0.0015
E Score	-15.739	4.2837	0.0006
G Score (centered)	+23.08	7.41	0.002
E × G (interaction)	+4.63	9.01	0.605
Revenue	2.013e-10	1.64e-10	0.2253

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Model Selection: Hausman Test

The Hausman test was run to select the best model between the fixed and random effects. The Hausman test statistic examines whether the firm-specific intercepts (individual effects) are uncorrelated with the other regressors in the model and thus suggests which estimator is more appropriate for a given model. The result of the Hausman test provided a Chi-square value of **0.9660** with a p-value of **0.8095**. The test results ($p > 0.05$) failed to reject the null hypothesis that states Random Effects is a consistent and efficient estimator (**Table 4**). Hence, the Random Effects model was the more appropriate estimation model.

Table 4. Hausman Test for Model Selection

Statistic	Value	Conclusion
Chi-square Statistic	0.9660	Random Effects Model preferred
p-value	0.8095	

Diagnostic Tests

To further validate the chosen Random Effects model, several critical diagnostic tests were performed:

Multicollinearity Check: A Variance Inflation Factor (VIF) test was conducted to examine multicollinearity among the independent variables. E Score showed VIF values of approximately **2.28**, G Score showed VIF values of approximately **2.03**, E × G showed VIF values of approximately **1.22** and Revenue showed VIF values of approximately **1.08**, significantly below the threshold of 10, indicating no substantial multicollinearity issues. The results are displayed in **Table 5**

Table 5. Multicollinearity Test (Variance Inflation Factor)

Variable	VIF	Conclusion
E Score (centered)	2.28	No Multicollinearity
G Score (centered)	2.03	No Multicollinearity
E × G (interaction)	1.22	No Multicollinearity
Revenue	1.08	No Multicollinearity

Note: Variables were mean-centered prior to creating the interaction term to reduce potential collinearity. All VIFs are well below the threshold of 10, indicating no multicollinearity concerns.

Autocorrelation Test: The Ljung-Box test was applied to examine potential autocorrelation in residuals. Results showed a p-value of **0.0741**, above the 0.05 significance level, suggesting no significant serial correlation concerns in the model residuals (**Table 6**).

Table 6. Autocorrelation Test (Ljung-Box)

Statistic	Value	Conclusion
Ljung-Box Statistic	3.1904	No significant autocorrelation
p-value	0.0741	

Heteroskedasticity Test: A Breusch-Pagan test for heteroskedasticity was conducted, yielding a p-value of **0.2961**, which indicated constant variance in residuals and no significant presence of heteroskedasticity (**Table 7**).

Table 7. Heteroskedasticity Test (Breusch-Pagan)

Statistic	Value	Conclusion
Chi-square Statistic	2.4339	No significant heteroskedasticity
p-value	0.2961	

These diagnostic results collectively affirmed the appropriateness and reliability of the Random Effects model, reinforcing confidence in the robustness of the findings.

Final Model Interpretation

The final Random Effects model (**Table 8**) indicates a strong and significant negative relationship between firms' environmental sustainability initiatives and their short-term profitability in Zambia's agro-food sector. These findings support H2 by indicating that longer-term benefits might materialize beyond the shorter-term cost penalty although long-run effects are not directly estimated here, and substantiate H4 by suggesting that the profitability returns only arise after firms reach a certain threshold of environmental investment. Although revenue was not statistically significant, its inclusion controlled for firm size and market position, isolating the specific impact of environmental sustainability efforts. While the analysis indicates that profit suffers in the short term, the decrease in profit may merely reflect short-term, pressing financial demands, and the actual impact of sustainability initiatives may have positive financial payoff in the longer term. In addition, it is also important to appreciate that Zambian agro-food sector does operate in an emerging economy where the premium for environmental initiatives may not be immediate financial benefits, but could include other benefits such as improved good will for the firm from stakeholders and better efficiencies.

Table 8. Random Effects Model Summary

Statistic	Value
R-squared (Overall)	0.0904
R-squared (Within)	0.2268
F-statistic	6.8770
Prob (F-statistic)	0.0022
Number of Observations	55

Discussion

The results of this study support the suggestion that environmental sustainability in the agro-food sector in Zambia requires short-run trade-offs but that it is a possible source of long-run competitive advantage if the governance environment is supportive. This dynamic is consistent with stakeholder theory that characterizes how firms respond to stakeholder demands even at high contemporary total costs, and signaling theory that characterizes environmental disclosures as a credible signal of long-run value to external audiences. Quantitatively, the regression models confirmed that environmental practice was related to lower short-term profitability (H1), a result consistent with compliance costs, capital expenditure and, operational inefficiencies. Qualitatively, this result was consistent with the evidence across several firms, with reporting recurrently emphasizing the presence of impediments, such as "margins eroded due to high increases in the cost of imported packaging materials" and "load-shedding imposed an enormous cost burden." These examples encapsulate the empirical sentiments of how environmental responsibility impairs margin in the short term. Over time though, both models and the qualitative data indicated efficiency savings and reputational returns (H2). Firms reported lower packaging costs through returnable bottles, millions in taxes to the state and fast-growing sales, and record domestic sales with ESG targets met. Such evidence supports the expectation that environmental practices can increase legitimacy, stakeholder trust, and ultimately financial resilience, if credibly implemented and communicated.

The moderating effect of governance (H3) was not statistically significant, though the positive sign suggests governance may reduce the short-run cost penalty of environmental practices. Thus, H3 receives only partial support. The interaction terms revealed that governance reduced the negative environment effects and the qualitative analysis added detail on some of the governance mechanisms that moderated these direct effects (such as board involvement, whistleblowing and ISO certifications). Strengthening credible signaling mitigates the suspicion of greenwashing and aligns with Signaling Theory's emphasis on strengthening credible disclosure. Strengthening accountability to stakeholders aligns with Stakeholder Theory's emphasis on balancing stakeholder relationships (e.g., investors, regulators, suppliers, communities). Exploratory checks suggest potential nonlinear dynamics (H4), though we do not claim statistical confirmation here. Regression models indicated that relatively minor environmental practices often entail net costs, but once firms reach a threshold—such as heavy investments in renewable energy or certified water stewardship — then the profitability relationship flips to positive. This finding reinforces the notion that environmental practices are both a cost burden and a credible signal of strategic commitment — once they have reached a sufficient scale.

Taken together, these findings show that the meaning of environmental sustainability in Zambia's agro-food sector is best understood as a matter of managing trade-offs. Stakeholders exert pressure on firms to pursue behaviors that result in loss of profits in the short term; however, affordance of credible signals supported by governance enables these behaviors to become sources of efficiency, legitimacy and competitive advantage in the long-term. Thus, environmental sustainability is simultaneously an outcome of stakeholder pressure and a source of market signaling, and in this way, the meaning of environmental sustainability reflects and reconciles the theoretical oppositions that have structured this study.

Strategic Implications

The results of this study support the suggestion that environmental sustainability in the agro-food sector in Zambia entails short-run trade-offs but that it is a possible source of long-run competitive advantage if the governance environment is supportive. This dynamism is consistent with stakeholder theory that characterizes how firms respond to stakeholder demands even at high contemporary total costs, and signaling theory that characterizes environmental disclosures as a credible signal of long-run value to external audiences. While these measures take up significant resources at the initial stages of implementation, they are necessary to ensure profitability and sustainability in the long run. The results also add to the existent knowledge that supports a strong albeit complex link between environmental practices and firm performance, aligning well with previous worldwide examples. While it takes time to show positive results, investment in green technologies and sustainability infrastructure leads to visible cost savings in operations, increased regulatory setup and improved trust of stakeholders (Zhao *et al.* 2018; Saeed *et al.,* 2018; Velte, 2021; Khan & Liu, 2023).

In Zambia, firms face unique distinct financial challenges that make incremental and scalable investment necessary. For example, some existing energy efficient technologies and mechanisms for minimizing waste, are prohibitively expensive in the short term (i.e. capital intensive), despite having the capacity to significantly minimize costs and operational inefficiencies in the long term (Singh *et al.,* 2024). Firms that are pre-emptive in aligning their business to long term environmentally sustainable standards (i.e. those more aligned to global ESG ethos in their business operations), can be operationally advantageous relative to competitors who do not.

The results of this study support the suggestion that environmental sustainability in the agro-food sector in Zambia requires short-run trade-offs but that it is a possible source of long-run competitive advantage if the governance conditions are supportive. This dynamism is consistent with stakeholder theory that characterizes how firms respond to stakeholder demands even at high contemporary total costs, and signaling theory that characterizes environmental disclosures as a credible signal of long-run value to external audiences. As sustainability becomes an increasing focal point for investors (and clients), being in a position of attracting ESG-conscious investors, provides an additional source of financial capacity for firms to alleviate immediate financial burdens related to maintaining long term environmental sustainability (Pham *et al*, 2021; Nogueira *et al.,* 2023).

Barriers to Adoption

The adoption of environmental practices in Zambia's agro-food sector is constrained by several systemic barriers. Firstly, the high cost of investments in green technologies remain a critical challenge to adoption (Aydoğmuş *et al.,* 2022). Compliance with environmental standards, waste management programs, and energy efficiency retrofits require significant capital investments, which impose a significant financial burden on firms particularly those operating in resource-constrained settings such as Zambia (Makondo *et al.*, 2015; Asubiojo *et al.,* 2023). Firms also struggle with a lack of technical capacity and inadequate regulatory incentives, such as the availability of tax breaks or subsidies, to environmental sustainability at scale. Ubeda-García *et al.* (2021) note the critical role of government and industry collaboration in alleviating the aforementioned constraints to environmental sustainability.

Quantitatively, the regression models confirmed that environmental practices were related to lower short-term profitability (H1), a result consistent with compliance costs, capital expenditure and, operational inefficiencies. Qualitatively, this result was consistent with the evidence across several firms with emphasizing the presence of impediments, such as "margins eroded due to high increases in the cost of imported packaging materials" and "load-shedding which imposed an enormous cost burden." These examples encapsulate the empirical sentiments of how environmental responsibility impairs margin in the short term. Giannopoulos *et al.* (2022) find that differences in financial and technical resources are key determinants of environmental performance among firms. Firms with access to adequate financial resources and technical capacity are more likely to achieve successful implementation of their environmental practices and realize the long-term benefits of these practices. Boulhaga *et al.* (2022) also point to the role of internal controls and corporate governance, arguing that the ability of firms to realize positive outcomes from environmental practices is contingent on the strength of their corporate governance. Firms with strong corporate governance are more likely to benefit from their sustainability initiatives.

Barriers like energy unreliability, packaging/input inflation, illicit competition, and compliance costs are not tangential to our study; rather, they are mechanisms underlying the estimated short-run cost effects of environmental and social practices (H1–H2). The qualitative record details firms' offsetting of such headwinds through governance improvements and operational strategies (e.g., returnable packaging, supplier development) in a manner consistent with our moderation results (H4–H5) and essential to interpret them. Recording qualitative barriers is thus essential for explaining why environmental and social investments depress profitability initially—and how governance transforms them into durable gains.

Managerial Recommendations for Sustainability Integration

Overcoming these challenges will require Zambian agro-food firms to develop targeted measures that respond to contextual needs adequately, such that the short-term resource implications can be balanced in tandem with broader long-term shores of environmental sustainability outcomes. Incremental and tier-based approaches such as staggered adoption of energy efficiency improvements, could allow firm to internalize the upfront implementation costs, while allowing for tangible returns (Yushchenko & Patel, 2017). Building partnerships and creating collaborations present important opportunity to help resource-constrained firms build technical capacity (Ubeda-García et al., 2021). For example, agro-food firms in Zambia can build partnerships with financial institutions to access green finance, or develop collaborations with each other to pool together technical expertise and share in the cost of implementation. Integrating environmental sustainability in their operational and long-term business strategies can help build resilience and profitability in a market that is increasingly restricting and incentivizing actions towards sustainability. The medium- to longer-term payoffs—improved competitiveness, minimization of regulatory threats, and enhanced credibility with stakeholders (Maulu *et al.,* 2024)—are proof that these investments unlock sustained growth and a sustainable future for the sector.

Integrating Environmental Sustainability and Firm Profitability in Zambia's Agro-Food Sector

This study presents a conceptual framework that identifies how environmental sustainability practices affect firm profitability in Zambia's agro-food sector, and how institutional and organizational factors moderate this relationship. Environmental sustainability practices; energy efficiency, waste management and sustainable resource usage form the basis for the precise internal push that desires to improve firm profitability (measured using Return on Assets, ROA). Specifically, it is hypothesized that environmental sustainability practices, which often entail short-term costs, can yield long-term profitability benefits through enhanced operational efficiency, regulatory compliance, and stakeholder trust. The relationship between environmental sustainability practice and firms' profitability are not in a vacuum, but reinforced or inhibited by contextual factors, such as regulatory context and firm-level capacity. Such factors, therefore, moderate the degree to which sustainability practice links to enhanced profitability by strengthening or weakening the sustainability–profitability relationship. For example, firms situated in favorable institutional environments with availability of green finance, government support or in-house expertise are more likely to reap positive financial returns from their environmental investment.

The framework (see **Figure 2**) illustrates the hypothesized relationship between environmental sustainability practices and firm profitability. Zambian agro-food firms' environmental practices include energy efficiency, waste management, and sustainable resource use, and are hypothesized to influence financial performance. This relationship is moderated by two institutional factors: the regulatory environment and firm-level capacity (technical and financial resources), which either strengthen or constrain the profitability impact of sustainability efforts.

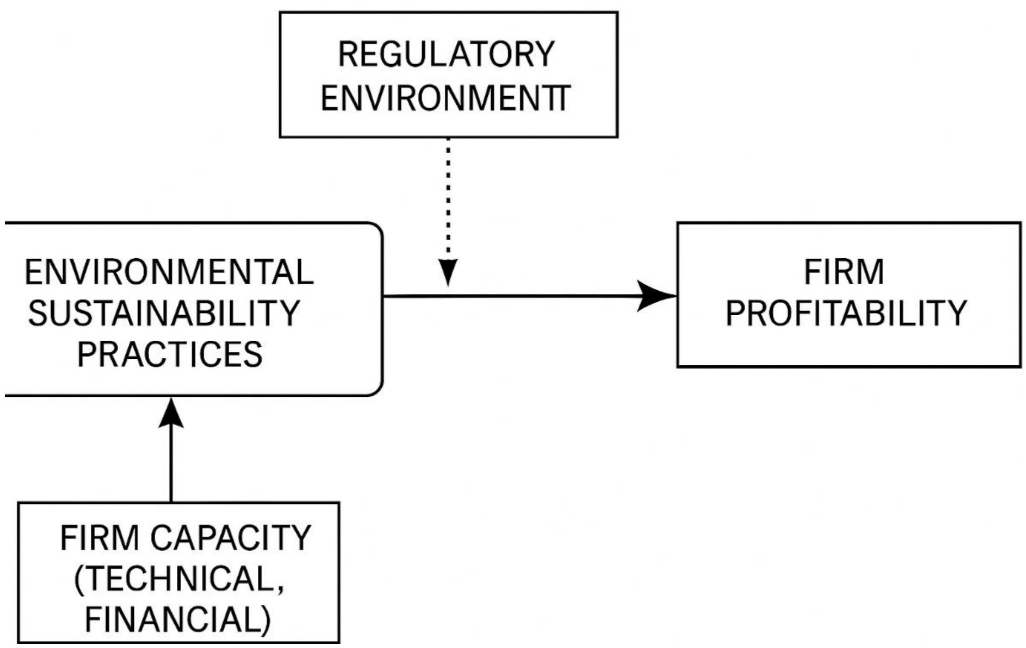

Figure 2. Conceptual Framework: Environmental Sustainability and Firm Profitability

Zambia's Institutional Context

Zambia's institutional context presents both prospects and constraints towards ESG adoption. Guided by institutional theorization, a weakly enforced regulatory setting, lack of investor activism, and fluctuating disclosure requirements, cumulatively represent predominant ESG adoption circumstances (Makondo *et al.,* 2015; Maulu *et al.,* 2024). ESG reporting has mostly been a matter of experimentation and lived inconsistencies, credited to the lack of a single understanding of a sustainability reporting framework, perpetuation of donor funding, and dominance by voluntary initiatives. In context, a careful delicate tension between external pressure and internal will dictate the extent to which Zambian firms pursue their path towards sustainability integration. The resource-constrained nature of the agro-food sector coupled with widespread sectoral challenges arising from high energy costs, climate induced volatility, and fragmented supply chains has deepened the sectoral institutional voids present in most developing economies (Khanna & Palepu, 2010). It is common for firms in such environments to embrace ESG as mere window-dressing and for signaling legitimation imperatives. Such a shift points to hybridity in the institutional environment, in which formal rules become increasingly weak while informal norms and expectations grow.

Contribution

This study offers several key contributions to management theory and practice, particularly in the context of environmental sustainability in emerging markets.

Theoretical Contribution

This paper enriches Stakeholder Theory and Signaling Theory by showing how environmental practices and voluntary ESG disclosures function as both legitimacy-enhancing tools and strategic signals in weak institutional environments. It responds to calls in the sustainability literature to contextualize ESG-performance relationships beyond developed economies (Flammer *et al.,* 2021; Gabr & ElBannan, 2024). By applying these theories in the Zambian agro-food sector, the study demonstrates that stakeholder alignment and signaling are conditioned by institutional gaps and sector-specific pressures, offering a localized extension of global theory.

Empirical Contribution

The study introduces a novel, ISO IWA 48:2024-aligned scoring framework to assess environmental sustainability across 10 years of firm-level data. In doing so, it bridges a gap in the African ESG literature, which often lacks standardized evaluation metrics. The explanatory sequential mixed-methods design enhances methodological rigor and integrates financial metrics (ROA) with qualitative insights from sustainability reports providing a multidimensional view of ESG adoption.

Practical and Policy Implications

The findings of this study reveal that although environmental sustainability causes short-run costs to firms, it can become a credible signal of their long-run value with governance support and stakeholder congruence. The findings can be interpreted through the prisms of Stakeholder Theory and Signaling Theory. Regulators should enhance the institutional environment to develop the credibility of firm-level signals to the environment. For instance, standardized disclosure guidelines could be issued such that firms are required to report their environmental performance in a transparent, comparable manner, decreasing the noise surrounding voluntary disclosures. This allows signals sent to investors and communities to be more credible. In line with Stakeholder Theory, regulators could coordinate enforcement actions against illicit and uncompliant operators, the latter of whom introduces distortional incentives for legitimate firms. Simultaneously, green incentives – such as tax allowances for upgrading a firm's energy efficiency, or concessional finance for investing in water-saving technologies – could be provided by government to decrease the costly period of environmental adoption. By doing so, policy insulates stakeholders (e.g., consumers, communities), while boosting the credibility of firm-level signals.

Firms can see environmental sustainability as not just a compliance matter, but also a strategic signaling activity. ISO- aligned disclosures, assured sustainability reports, and the communicative transparency of their environmental investments comprise credible signals to regulators, investors, and local communities that help them secure capital and legitimacy. At the same time, managers can sequence their environmental investments, pursuing efficiency "quick wins" (e.g., returnable packaging, water conservation) even as they build up to longer-term environmental projects (e.g., construction of renewable energy plants) that credibly signal their commitment to environmental goals. Finally, strong governance processes—such as ESG oversight committees, whistleblowing, and reporting at the board level—can increase the credibility of their signals and reduce greenwashing risk. Taken together using Stakeholder Theory and Signaling Theory as our dual lenses, these implications suggest that environmental sustainability need not be a necessary evil. Provided appropriate forms of regulatory incentives and reliable disclosure, environmental practices can both protect stakeholder interests and serve as a credible signal of competitive strength. The net result is that environmental trade-offs can be transformed into financial and societal value in the long run.

Conclusion

The study explored profitability dynamics of environmental sustainability practices in Zambia's agro-food sector (2014–2024). With an explanatory sequential mixed-methods design, panel regressions integrated with qualitative indications from firms' reports and one interview conducted and transcribed both numeric associations and their underpinning mechanisms. The results show that environmental practices entail short-term cost burdens (H1), aligned with compliance, investment and operational costs. Yet, when sustained and backed by strong governance, they produce long-term efficiency, reputational and market gain (H2).Governance mechanisms –including board oversight, whistleblowing programs, ISO-aligned dis- closure– were found to strongly support profitability directly, and while their moderating role was positive, it was not statistically significant. Exploratory checks suggest possible nonlinear effects (H4), indicating that profitability payoffs may only arise once a threshold of environmental investment has been reached, though statistical confirmation was not established.

In theory, this study extends Stakeholder Theory by unveiling how firms operating in the weak institutional contexts strike a balance between competing pressures exerted by the regulators, communities, and investors, and balancing these with financial survival. It also advances Signaling Theory by showing that, when credibly disclosed, environmental practices act as effective signals of legitimacy and long-term value, attenuating the information asymmetries in emerging markets. Empirically, three contributions arise. First, the study provides one of the few African emerging-market specific evidence exclusive to environmental sustainability and profitability. Second, the study deploys an ISO IWA 48:2024-aligned scoring framework, thus taking forward methodological rigor in sustainability measurement. Third, the study provides supporting (qualitative) evidence on how the barriers (e.g., illicit competition, energy cost), strategies (packaging innovation, renewable energy, out grower scheme), and governance mechanisms provide the structure for quantitative patterns observed.

To policymakers, these findings call for coordinated initiatives to promulgate more explicit disclosure guidelines, strengthen enforcement against unverified operators, reduce the pool of non-compliant or low-quality operators, and incentivize verified investments. To managers, these findings suggest sequencing investments, setting up governance oversight, and approaching environmental investments as signals that can augment stakeholder trust and environmental competitiveness. In totality, the study suggest that environmental sustainability in the Zambian agro-food sector is both a trade-off and a strategic path; it is not a win-win. In the short run, cost consideration matter, while in the long run, governance and credible signals enable firms to transform environmental liabilities and cost into long-lasting financial and social benefits.

Limitations

Despite its contributions, this study is not without limitations. The scope was limited to listed firms in Zambia's agro-food sector, which may affect the generalizability of the findings to other sectors or countries. The reliance on document-based data and limited interviews may constrain the depth of qualitative insight, particularly regarding firm-level motivations and barriers. The cross-sectional nature of the financial analysis limits causal inference; longitudinal designs would be better suited to assess the sustainability - profitability relationship over time. Finally, consumer perspectives; an important determinant of sustainability impact were not captured and merit inclusion in future studies. The small sample size (five LuSE-listed agro-food companies) limits the generalizability of the findings outside of the population of listed agro-food companies, and we refrain from over-generalising the results. Our Environmental variables are based on secondary, self-reported data, which we triangulate across documents and years but cannot fully eliminate the risk of positive reporting bias. The short-run empirical specifications may mask the lagged effects of environmental investments and disclosures, on performance. Although we include one-year lags and non-linear models, they do not fully capture the potential payoff time horizons of over one decade. Finally, despite including firm specific time-invariant effects, the results may still be subject to omitted variable bias of criticisms from sources such as corporate culture and rent-seeking private benefits of managers. Future research could increase the generalizability of the results by studying other industries and extend the time horizon to fully capture the long-term effects more deeply. Another fruitful possible future research direction would be to further test alternative possible signaling mechanisms such as third-party assurance and test investor reactions to sustainability disclosures.

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