SUB-THEME 1: CORPORATE SUSTAINABILITY AND GREEN INNOVATION

Green Supply Chain Management in Zimbabwe's Agricultural Export Sector: Climate Adaptation and Market Competitiveness

Madzikanda G.M.[1]; Nkala D.[2]; Machingura T.[3]

[1] Africa Research University; [2]Midlands State University; [3]University of Zambia ECampus

madzigm@gmail.com; nkalad@staff.msu.ac.zw; tsuu2013@gmail.com

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Abstract

Zimbabwe's tobacco, horticulture, and floriculture export sectors occupy a structurally precarious position at the intersection of two intensifying pressures: accelerating climate change impacts that threaten productive capacity, and increasingly stringent international sustainability standards that condition market access. This study examines how Zimbabwean agribusinesses are integrating Green Supply Chain Management (GSCM) practices to maintain global market competitiveness while simultaneously building climate resilience across the value chain. Drawing on qualitative case studies of five purposively selected export oriented agribusiness operations and participatory supply chain mapping across all three subsectors (n = 67 interviews; 6 workshops), the research analyses four critical GSCM transformation domains: the shift from conventional to organic and regenerative farming; carbon footprint reduction in cold chain logistics; deployment of water efficient irrigation systems; and fair trade certification and smallholder inclusion in sustainable value chains. Findings reveal that successful GSCM adoption generates measurable competitive advantages including price premiums of 8-12%, enhanced buyer loyalty, and access to concessional green finance but that these benefits are distributed highly unevenly, with smallholder farmers bearing disproportionate transition costs while capturing a structurally limited share of value chain returns. The study introduces the Zimbabwe Agricultural Green Supply Chain Framework (ZimAGSCF), a context specific, multiactor model delineating roles, incentive structures, and enabling conditions for GSCM transformation across producer, processor, exporter, certifying body, and government agency levels. The framework connects directly to Zimbabwe's National Development Strategy, the UN SDGs, the Paris Agreement, and Africa's green growth agenda, and advances an inclusive GSCM approach in which smallholder capability development is positioned as a strategic supply chain asset rather than a social responsibility appendage. The paper contributes a replicable Southern African framework for agricultural green supply chain transformation that is simultaneously environmentally credible, commercially viable, and socially equitable.

Key Words: Green supply chain management; Agricultural exports; Climate adaptation; Smallholder farmers; Carbon footprint; Zimbabwe; Sustainable value chains; ZimAGSCF

1. Introduction

Agriculture remains the backbone of Zimbabwe's rural economy and a critical driver of foreign exchange earnings, employing approximately 70 percent of the rural labour force and contributing 12 to 14 percent of GDP directly, with upstream and downstream linkages accounting for an estimated 40 percent of national economic activity (Food and Agriculture Organisation (FAO), 2022; Zimbabwe Ministry of Lands, Agriculture, Fisheries, Water and Rural Development (MLAFWRD), 2023). The export sub-sectors of tobacco, horticulture, and floriculture are of particular strategic importance: tobacco alone generates over USD 800 million annually in foreign exchange, while horticulture and floriculture exports to European Union markets have grown substantially over the past decade, driven by Zimbabwe's comparative advantages in climate, skilled labour, and proximity to South African logistics infrastructure (Zimbabwe Revenue Authority (ZIMRA), 2023).

Yet these sectors face a dual existential threat. Climate change is reshaping Zimbabwe's agricultural landscape with documented intensity: mean annual temperatures have increased by approximately 0.4°C per decade since 1990, the frequency and severity of mid-season dry spells has increased markedly, and the 2015-2016 and 2018-2019 El Niño events produced droughts that reduced national agricultural output by over 20 percent (Climate Change Adaptation in Africa (CCAA), 2020; Chikodzi et al., 2013). Simultaneously, Zimbabwe's principal export market the European Union, the United Kingdom, and increasingly East Asian premium buyers are imposing progressively stringent sustainability standards on imported agricultural products, encompassing carbon footprint disclosure, pesticide residue limits, water stewardship certification, fair labour practices, and biodiversity protection (European Commission, 2022; Rainforest Alliance, 2023). These market-driven sustainability requirements represent both a market access risk for non-compliant exporters and a competitive differentiation opportunity for those who achieve credible green certification.

Green Supply Chain Management (GSCM)defined as the integration of environmental considerations into supply chain management, encompassing product design, material sourcing, manufacturing processes, delivery, and end-of-life management (Srivastava, 2007; Green et al., 2012) has emerged as the strategic framework through which agribusinesses in comparable contexts have navigated this dual pressure. However, GSCM research and practice have been overwhelmingly concentrated in East Asian manufacturing and Northern European food retail contexts, with African agricultural export supply chains receiving comparatively little scholarly attention (Ncube et al., 2020; Mafini & Loury-Okoumba, 2018). The specific conditions that characterise Zimbabwe's export agriculture dualistic farming structures with a small commercial sector and a large smallholder base, constrained cold chain infrastructure, currency instability, and an evolving regulatory environment require context-specific GSCM frameworks rather than the transplantation of models designed for fundamentally different settings.

This study addresses this gap by examining GSCM adoption across Zimbabwe's tobacco, horticulture, and floriculture export sectors, proposing the Zimbabwe Agricultural Green Supply Chain Framework (ZimAGSCF) as a context-specific model for sustainable value chain transformation, and generating findings with direct relevance to agribusiness managers, policymakers, certifying bodies, and development finance institutions. The paper proceeds as follows: Section 2 reviews the theoretical and empirical literature; Section 3 outlines the research methodology; Section 4 presents and discusses findings; Section 5 addresses economic, managerial, and business implications; and Section 6 concludes with contributions, limitations, and future research directions.

2. Literature Review

2.1 Green Supply Chain Management: Theoretical Foundations

The theoretical foundations of GSCM draw from three principal scholarly traditions. Supply chain management theory, originating in logistics and operations management, provides the foundational architecture of value chain analysis the systematic mapping of flows of materials, information, and financial resources from primary production through processing, logistics, retail, and end use (Mentzer et al., 2001; Christopher, 2016). Environmental management theory, grounded in industrial ecology and environmental economics, provides the conceptual tools for analysing the ecological impacts embedded within supply chain processes including carbon accounting, life cycle assessment (LCA), and water footprint analysis (Srivastava, 2007; Carter & Rogers, 2008). Strategic management theory, particularly the Natural Resource-Based View (Hart, 1995) and Dynamic Capabilities theory (Teece et al., 1997), provides the framework for understanding how GSCM capabilities generate and sustain competitive advantage in environmentally demanding markets.

The theoretical synthesis of these traditions yields the proposition that GSCM is simultaneously an environmental management system, a competitive strategy, and a governance architecture (Zhu et al., 2008). As an environmental management system, it reduces the ecological footprint of supply chain operations through process redesign, material substitution, and waste elimination. As a competitive strategy, it enables differentiation through premium market access, buyer loyalty, and regulatory compliance in sustainability-demanding markets. As a governance architecture, it establishes the rules, roles, and relationships through which multiple actors from smallholder farmers to international certifying bodies coordinate their activities in pursuit of shared sustainability outcomes. For Zimbabwe's export agriculture, all three dimensions are simultaneously relevant, and a framework that privileges any one at the expense of the others will fail to capture the full complexity of the transformation challenge.

2.2 GSCM in African Agricultural Export Contexts

GSCM scholarship in African agricultural contexts has grown substantially since the early 2010s, though it remains geographically concentrated in East African horticulture (Kenya, Ethiopia) and West African cocoa and coffee supply chains (Ghana, Ivory Coast). Opara and Mubvuma (2013) demonstrated that Zimbabwean horticultural exporters faced a dual compliance burden meeting both the phytosanitary requirements of importing country regulators and the private sustainability standards of supermarket buyers with inadequate institutional support for navigating either. Mafini and Loury-Okoumba (2018) documented GSCM adoption in South African agri-food supply chains, finding that environmental purchasing and green logistics were the most adopted practices, while reverse logistics and life cycle assessment were the least developed a pattern consistent with the cost-minimisation logic that dominates procurement decisions in financially constrained operating environments.

For smallholder-dominated supply chains which characterise significant portions of Zimbabwe's tobacco and horticulture sectors the literature identifies a structural tension between the collective action requirements of GSCM certification and the individual decision-making constraints of smallholder agriculture. Certification schemes such as Global GAP, Rainforest Alliance, and Fairtrade require standardised practices across groups of producers, systematic record-keeping, third-party audit compliance, and investment in post-harvest handling infrastructure that individual smallholders cannot typically finance unilaterally (Henson & Humphrey, 2010; Ruben & Fort, 2012). Group certification models in which smallholders access certification collectively through an Internal Control System (ICS)

managed by an out grower company, cooperative, or farmer association have emerged as the principal mechanism for extending GSCM certification into smallholder supply chains, but their effectiveness is highly sensitive to the governance quality of the managing entity and the balance of power between smallholders and commercial intermediaries (Graffham & Cooper, 2008; Tallontire et al., 2011).

2.3 Climate Adaptation and Agricultural Supply Chains

The intersection of climate change adaptation and GSCM represents a theoretically productive and practically urgent domain that the literature has begun to address. Vermeulen et al. (2012) estimated that agricultural supply chains contribute 19 to 29 percent of global greenhouse gas emissions when deforestation, synthetic fertiliser production, cold chain energy use, and transportation are included, making agriculture simultaneously a major climate change contributor and one of its most exposed victims. For Zimbabwe, climate-related supply chain disruption is not a future risk but a present operational reality: the 2018–2019 drought reduced tobacco output by 21 percent and caused export revenue losses estimated at USD 170 million (Tobacco Industry and Marketing Board (TIMB), 2020). Building climate resilience into supply chain design through diversification, water management investment, drought-tolerant variety adoption, and carbon sequestration practices therefore both an adaptation imperative and a contribution to mitigation.

Water efficiency merits particular attention as a GSCM dimension in the Zimbabwean context. Agriculture accounts for approximately 80 percent of Zimbabwe's freshwater withdrawals (Global Water Partnership Southern Africa (GWPSA), 2021), and the overlap between Zimbabwe's primary agricultural zones and its most water-stressed catchments creates acute competition between irrigation demand and ecosystem service provision. Water stewardship certification frameworks including the AWS Standard and the Alliance for Water Stewardship have emerged as mechanisms for managing this competition at catchment scale, requiring participating agribusinesses to measure, reduce, and responsibly share water resources as conditions of certification. These frameworks are gaining traction among Zimbabwe's larger horticultural exporters serving European supermarket chains but remain largely inaccessible to smallholder farmers who lack the technical capacity to implement and document water management practices at the required standard.

2.4 Fair Trade, Certification, and Smallholder Inclusion

The relationship between sustainability certification and smallholder welfare is theoretically complex and empirically contested. Proponents argue that certification generates welfare benefits through price premiums, market access, capacity building, and collective governance development (Fairtrade International, 2021; Nelson & Pound, 2009). Critics counter that the costs of certification compliance are frequently underestimated, that price premiums are often absorbed by intermediaries rather than transmitted to producers, and that certification requirements can create barriers to market entry that disadvantage the most resource-constrained smallholders (Valkila & Nygren, 2010; Ruben & Fort, 2012). For Zimbabwe, the empirical evidence is limited, with most available studies focusing on the Eastern Highlands tea sector rather than the tobacco and horticulture sectors that dominate export agriculture (Chirau et al., 2018).

The concept of 'inclusive value chains ‘supply chain configurations that deliberately design for smallholder participation rather than treating smallholder inclusion as an incidental outcome of market forces has gained significant traction in development policy circles (World Bank, 2020; UNCTAD, 2021). However, the operationalisation of inclusive value chain

principles in specific sector and country contexts remains underdeveloped, particularly with respect to the governance and financing mechanisms required to bridge the gap between small holder production systems and the GSCM requirements of international buyers. This gap constitutes a secondary theoretical motivation for the current study's framework development.

3. Research Methodology

3.1 Research Design

This study employs a qualitative multiple case study design combined with systematic supply chain mapping, consistent with the interpretivist tradition's emphasis on contextually embedded understanding of complex organisational phenomena (Yin, 2018; Miles et al., 2020). Case study methodology is particularly well suited to GSCM research in the Zimbabwean context because it enables the researcher to trace the causal processes through which GSCM practices are adopted, implemented, and translated into competitive and environmental outcomes within specific organisational and institutional settings processes that surveys or statistical analyses cannot adequately capture. Supply chain mapping provides a complementary visual and analytical tool for documenting material flows, actor relationships, information exchange, and value distribution across the full supply chain architecture.

3.2 Case Selection and Sampling

Five export-oriented agricultural operations were selected through purposive sampling to represent the range of firm sizes, ownership structures, sub-sectors, and GSCM maturity levels present in Zimbabwe's agricultural export sector. Case A is a large-scale, vertically integrated tobacco grower-processor with direct export contracts to European leaf dealers and a documented ESG reporting history. Case B is a medium-scale commercial horticultural operation (vegetables and herbs) supplying UK supermarkets under Global GAP and Rainforest Alliance certification. Case C is a floriculture cooperative of 23 smallholder growers supplying cut flowers to a Dutch auction house under the MPS-SQ sustainability certification scheme. Case D is a tobacco contract farming scheme involving approximately 340 smallholders out growers coordinated by a large domestic leaf dealer. Case E is a mixed horticulture operation that had attempted and abandoned Global GAP certification, providing a critical negative case that illuminates the barriers to successful GSCM adoption. Supply chain mapping extended beyond these focal cases to document the full value chain architecture across all three sub-sectors, encompassing input suppliers, logistics providers, cold chain operators, freight forwarders, and certifying bodies.

3.3 Data Collection

Data collection employed three methods. Semi-structured interviews (n = 67) were conducted with farm owners and managers, sustainability and compliance officers, smallholder farmers (through interpreter-assisted sessions in Shona and Ndebele), input suppliers, logistics managers, cold chain operators, export agents, certifying body auditors, and officials of the Tobacco Industry and Marketing Board (TIMB), the Horticultural Development Council (HDC), and the Zimbabwe Investment and Development Agency (ZIDA). Supply chain mapping workshops (n = 6, total participants = 84) used participatory value chain analysis methods to document actor relationships, cost structures, value distribution, and GSCM practice adoption status. Documentary analysis encompassed farm sustainability reports, certification audit reports, export contracts, GSCM policy documents, and government agricultural development strategy documents.

3.4 Analysis and Validation

Data were analysed through a hybrid thematic and supply chain analysis approach. Interview and workshop data were coded thematically using NVivo 14, with themes organised around the study's four GSCM transformation domains and cross-cutting issues of power, equity, and institutional enabling conditions. Supply chain maps were constructed using value chain analysis conventions (Kaplinsky & Morris, 2001), with GSCM practice adoption annotated at each node. Case study findings were validated through triangulation across data sources, respondent validation of preliminary findings with key informants at each case site, and external peer review by two supply chain management scholars not affiliated with the research team.

4. Findings and Discussion

4.1 Transition to Organic and Regenerative Practices: Promise, Friction, and Prerequisite Conditions

The transition from conventional to organic and regenerative farming practices emerged as the GSCM domain with the greatest complexity and the most significant variability in adoption experience across the five cases. Case B the Global GAP and Rainforest Alliance-certified horticultural operation had pursued a phased transition to Integrated Pest Management (IPM), reduced synthetic fertiliser use, and soil health monitoring over a six-year period, supported by buyer-financed technical assistance from a dedicated sustainability agronomist and a guaranteed price premium structure. By Year 4 of the transition, the operation had reduced synthetic pesticide expenditure by 34 percent, improved soil organic matter measurements across all production zones, and achieved buyer approval for a 12 percent price premium reflecting its sustainability certification. The managing director attributed the successful transition directly to the buyer financing model: 'Without the buyer's commitment to fund the transition costs and guarantee the premium, we would not have been able to finance six years of investment without guaranteed return. The market had to be created before the transition was economically viable for us.'

Case D the tobacco out grower scheme presented a sharply contrasting experience. The leaf dealer coordinating the scheme had introduced a modified conservation agriculture protocol to out growers in response to regulatory pressure and international buyer requests for soil carbon management documentation. However, the protocol was introduced without transition financing support, without technical extension accompaniment, and with a compliance verification mechanism that penalised non-compliant out growers through price deductions rather than supporting them with remedial assistance. Predictably, adoption rates were low (38 percent of contracted out growers in Year 1), reversion to conventional practices was common in seasons of financial stress, and the documentation records required for carbon accounting were inconsistently maintained. The GSCM initiative had the appearance of institutional compliance without the substance of supply chain transformation pattern that several scholars have described as 'sustainability theatre' in the context of certification-driven value chain governance (Boström & Klintman, 2008; Dauvergne & Lister, 2013).

These contrasting cases illuminate the prerequisite conditions for successful organic and regenerative transition at different scales of operation. At commercial scale, the critical conditions are: a committed buyer with a long-term sourcing relationship and willingness to finance transition costs; a price premium structure that is both credible and commercially significant; access to specialist agronomic expertise; and sufficient operational scale to amortise certification costs. At smallholder scale, additional conditions are required: group

certification mechanisms that distribute compliance costs collectively; technical extension services delivered in local languages and calibrated to smallholder resource constraints; input credit facilities that reduce the upfront cash burden of input substitution; and governance structures that protect smallholders from having transition costs imposed unilaterally by powerful value chain intermediaries.

4.2 Carbon Footprint Reduction in Cold Chain Logistics: Operational Necessity and Strategic Opportunity

Cold chain logistics represents the most carbon-intensive node in Zimbabwe's horticultural and floriculture export supply chains, accounting for an estimated 35 to 45 percent of total supply chain emissions for fresh produce and up to 60 percent for cut flowers, where temperature-controlled air freight is the predominant export mode (International Institute of Refrigeration (IIR), 2021; Case B supply chain mapping data). The cold chain's carbon intensity creates both a sustainability compliance challenge as EU carbon border adjustment mechanisms begin to extend to agricultural products and a cost reduction opportunity, given that energy constitutes 40 to 60 percent of cold store operating costs in Zimbabwe's current energy cost environment.

Survey and interview data revealed three principal cold chain emissions reduction strategies being deployed by sampled cases. Solar-powered cold storage replacing diesel generator backup with photovoltaic generation had been adopted by Cases A and B, generating estimated diesel cost savings of USD 28,000 and USD 19,000 per annum respectively, with payback periods of 4.2 and 5.8 years at prevailing energy prices. Route optimisation for refrigerated transport, using digital load management platforms to maximise vehicle utilisation and minimise empty return journeys, had been adopted by Case A's logistics partner, reducing fuel consumption per tonne of product transported by 22 percent over a two-year implementation period. Sea freight substitution transitioning floriculture exports from air to refrigerated sea freight where buyer lead time requirements permit was being piloted by Case C's cooperative, with preliminary data suggesting a 78 percent reduction in transport-related carbon emissions per stem delivered, albeit with a two-week extension of transit time that required buyer market education and modified post-harvest quality management protocols.

A significant finding was the carbon accounting gap that characterised most of the sampled supply chains. While Cases A and B had implemented ISO 14064-compliant greenhouse gas inventories covering their own operational (Scope 1 and 2) emissions, none of the sampled cases had implemented comprehensive Scope 3 emissions accounting that would capture supplier, logistics, and customer use emissions the categories most material to the full supply chain carbon footprint. This gap is consequential: the EU Corporate Sustainability Reporting Directive (CSRD), which came into force in 2024, requires large companies and their suppliers to disclose Scope 3 emissions, meaning that Zimbabwean exporters supplying EU-domiciled buyers face an imminent requirement to develop supply chain carbon accounting capabilities that are currently absent. Developing these capabilities particularly for smallholder-dominated supply chains in which individual farm-level emissions data are difficult and expensive to collect represents one of the most technically demanding challenges in the GSCM transformation agenda.

4.3 Water-Efficient Irrigation: Survival Adaptation and Competitive Prerequisite

Water management emerged from supply chain mapping and interview data as the GSCM domain most directly shaped by climate change impacts and most urgently requiring investment across all three sub-sectors. Zimbabwe's primary agricultural zones the highveld

and midlevel regions that host most commercial and smallholder horticulture have experienced documented deterioration in seasonal rainfall reliability, with meteorological data indicating a 15 to 20 percent increase in the coefficient of variation of seasonal rainfall over the past three decades (Mazvimavi, 2010; CCAA, 2020). For export horticulture and floriculture, which require predictable, high-quality water supply to maintain the product quality standards demanded by international buyers, irrigation system reliability has shifted from a productivity enhancement to a production survival prerequisite.

Case B's horticultural operation had invested USD 340,000 in drip irrigation infrastructure between 2018 and 2022, replacing overhead sprinkler systems across 85 percent of its production area. Measured water use efficiency improvements were substantial: water application per unit of output fell by 41 percent relative to pre-conversion baselines, irrigation-related energy costs declined by 28 percent, and leaf disease incidence reduced by elimination of foliar wetting fell by 35 percent, directly reducing pesticide expenditure. The investment had been partially financed through a green investment facility administered by a development finance institution with an agricultural water stewardship mandate, at a concessional interest rate 4.5 percentage points below commercial lending rates. This financing structure was identified by the farm's financial director as the decisive factor enabling the investment: 'At commercial rates, the payback period would have been unacceptable to our board. The concessional facility made the internal rate of return work.'

For smallholder farmers in Case D's tobacco out grower scheme, the water management picture was dramatically different. Most out growers relied on gravity-fed furrow irrigation from seasonal streams, a system that provided adequate water in normal rainfall years but failed progressively during mid-season dry spells of increasing frequency. Drip irrigation conversion the technically superior alternative was practically inaccessible: the capital cost of approximately USD 1,200 per hectare was equivalent to approximately 18 months of average farm family income, no concessional facility existed for smallholder irrigation at this scale, and the leaf dealer coordinating the scheme had no incentive to finance irrigation infrastructure on land it did not own. This combination of capital inaccessibility and governance misalignment constitutes what the study designates a 'climate adaptation financing gap at the smallholder frontier ‘a structural failure that will progressively erode smallholder competitiveness and climate resilience in the absence of targeted public investment or innovative financing mechanisms.

4.4 Fair Trade Certification and Smallholder Inclusion: Value Distribution and Governance Quality

The study's supply chain mapping exercise produced detailed value distribution analyses across all three sub-sectors that illuminate the structural inequity embedded in current export value chain architectures. In the horticultural supply chain (Case B), the farm-gate price as a percentage of UK retail price ranged from 18 to 24 percent across the main product lines a distribution pattern consistent with the broader horticulture literature's documentation of value concentration in retail, logistics, and certification service nodes (Barrientos et al., 2016). In the floriculture cooperative (Case C), the MPS-SQ certification and the direct auction house relationship generated a price premium of approximately 8 percent above uncertified competitors, of which an estimated 60 percent was transmitted to grower members after deduction of certification fees, cooperative management costs, and cold chain levies. In the tobacco out grower scheme (Case D), the sustainability compliance premium paid by the leaf dealer equivalent to 3 percent above the floor price was structured as a conditional payment subject to documentation compliance, meaning that the least resource-endowed out growers,

who faced the greatest difficulty maintaining documentation, were systematically excluded from the sustainability premium they were nominally entitled to receive.

Case C's floriculture cooperative offered the most encouraging model for smallholder inclusion in sustainable value chains. The cooperative's governance structure with grower members holding board majority, financial management transparency enforced through quarterly audited accounts shared with all members, and a collective investment fund that accumulated sustainability certification upgrade costs over a three-year savings period before audit had achieved both certification maintenance and equitable benefit distribution over a sustained period. Critical success factors included: the cooperative's pre-existing social capital from a shared history of communal land management; the Netherlands Development Finance Company (FMO) technical assistance grant that financed initial certification and governance capacity building; and the auction house buyer's commitment to a two-year price guarantee that provided the financial stability required for cooperative investment planning.

4.5 The Zimbabwe Agricultural Green Supply Chain Framework (ZimAGSCF)

Synthesising the theoretical frameworks and empirical findings across all four GSCM transformation domains, this study proposes the Zimbabwe Agricultural Green Supply Chain Framework (ZimAGSCF) as a structured, multi-actor model for advancing sustainable value chain transformation in Zimbabwe's agricultural export sector. Table 1 presents the framework, organised around the five actor categories whose coordinated action is essential for GSCM success, with the enabling conditions and intervention priorities specified for each.

Table 1: The Zimbabwe Agricultural Green Supply Chain Framework (ZimAGSCF)Actor Roles, GSCM Responsibilities, and Enabling Conditions

Actor Category	Core GSCM Role	Key Responsibilities	Critical Enabling Conditions	Priority Interventions
1. Producers (Commercial & Smallholder)	Primary locus of environmental practice adoption soil management, water use, agrochemical management, energy use	Adopt regenerative/organic practices; implement water efficiency measures; maintain GSCM documentation; participate in group certification ICS	Transition financing at concessional rates; technical extension in local languages; group certification governance structures; climate-adaptive input systems	Smallholder irrigation investment funds; ICS governance capacity building; regenerative farming demonstration plots; weather-indexed crop insurance
2. Processors & Exporters	Cold chain management;	Invest in solar cold storage; implement	Access to green	Cold chain solar energy

Actor Category	Core GSCM Role	Key Responsibilities	Critical Enabling Conditions	Priority Interventions
	GSCM documentation aggregation; buyer relationship management; supply chain carbon accounting	route optimisation; develop Scope 3 carbon accounts; transmit price premiums to producers transparently	investment finance; digital supply chain management systems; long-term buyer contracts with sustainability premiums	facility; digital traceability platform investment; Supply chain carbon accounting capacity building; fair premium transmission audits
3. Certifying Bodies	Standards development; audit and verification; group certification scheme administration; smallholder-accessible compliance pathways	Develop smallholder-appropriate certification tracks; reduce documentation burden for resource-constrained producers; provide capacity building support alongside audit	Adequate auditor capacity in Zimbabwe; digital audit systems; smallholder ICS technical support resources; alignment across competing certification standards	Zimbabwean auditor certification programme; digital ICS management platform; simplified smallholder certification track; multi-standard recognition agreements
4. Government Agencies	Policy framework; public investment; regulatory standards; trade facilitation; institutional coordination	Enact GSCM-supportive regulations; operate public green finance facilities; enforce water stewardship standards; provide phytosanitary certification efficiency; coordinate across agencies	Adequate institutional capacity; inter-ministerial coordination mechanisms; fiscal space for green agriculture investment; alignment with NDS and NDC commitments	Green Agricultural Investment Fund; water stewardship regulatory framework; GSCM compliance support unit within TIMB and HDC; inter-ministerial GSCM

Actor Category	Core GSCM Role	Key Responsibilities	Critical Enabling Conditions	Priority Interventions
				coordination committee
5. International Buyers & Development Finance	Market demand signals; price premium commitment; transition financing; technical assistance; long-term sourcing relationships	Commit to long-term supply relationships conditional on GSCM improvement; co-finance transition costs; provide technical assistance; accept phased compliance timelines for smallholders	Credible buyer ESG procurement policies; development finance institution green agricultural windows; blended finance mechanisms for smallholder transition	Buyer-led transition financing consortia; development finance agricultural GSCM facility; impact bond structures for smallholder certification; supply chain traceability platforms

The ZimAGSCF central insight is that GSCM transformation in Zimbabwe's agricultural export sector cannot be driven by any single actor category acting in isolation. The repeated pattern of partial adoption practices adopted by commercially capable producers without transmission to smallholder suppliers, carbon accounting at Scope 1 and 2 without Scope 3 integration, certification achieved without equitable premium transmission reflects the fragmented, actor-siloed approach that has characterised GSCM in Zimbabwe to date. The framework prescribes a systems-level transformation that aligns actor incentives, coordinates financing flows, and establishes governance mechanisms capable of ensuring both environmental credibility and social equity across the full supply chain.

The framework explicitly addresses the tension identified in the empirical findings between commercial-scale and smallholder-scale GSCM adoption. Rather than treating smallholder inclusion as an aspirational supplement to a commercially driven transformation, the ZimAGSCF positions smallholder GSCM capability as a structural prerequisite for the sector's long-term sustainability credentials since the majority of Zimbabwe's tobacco and a significant portion of its horticulture production originates with smallholder farmers whose exclusion from the green transition would undermine the sectoral sustainability claims that drive market access and price premium generation.

5. Economic, Managerial, and Business Implications

5.1 The GSCM Business Case in Zimbabwe's Export Context

The study's empirical findings establish a robust, if differentiated, business case for GSCM adoption in Zimbabwe's agricultural export sector. For commercially oriented

operations with direct buyer relationships Cases A, B, and CGSCM investments generated measurable returns through five channels: price premium revenue from sustainability certification; market access preservation as buyer sustainability requirements tightened; operational cost reduction from energy efficiency (solar cold storage) and resource efficiency (drip irrigation, IPM); risk reduction from climate adaptation investments that reduced weather-related production losses; and reputational capital with buyers, financiers, and regulators that opened access to concessional finance facilities. Across the three commercial cases, net annual financial benefit from GSCM investments calculated after amortised capital costs and operating expenditure ranged from USD 34,000 (Case C, floriculture cooperative) to USD 187,000 (Case A, large tobacco operation), representing returns on GSCM investment of between 9 and 23 percent annually.

For smallholder farmers in Case D's out grower scheme, the business case was structurally weaker and more contingent. Where sustainability compliance requirements were imposed without transition financing support, smallholders experienced GSCM primarily as a cost burden documentation labour, input substitution costs, certification levy deductions rather than as a pathway to premium income. This cost-burden experience of GSCM is not intrinsic to the model but reflects a specific, correctable governance failure: the allocation of compliance costs to the weakest supply chain actor rather than their equitable distribution across value chain participants with differential capacity to absorb them. Redesigning the cost allocation architecture of out grower GSCM schemes through buyer co-financing, government subsidy, and leaf dealer cost-sharing is a prerequisite for converting the smallholder GSCM experience from cost burden to competitive opportunity.

5.2 Strategic Implications for Agribusiness Managers

For agribusiness managers in Zimbabwe's export sector, the ZimAGSCF implies a fundamental repositioning of GSCM from a compliance function to a strategic one. This repositioning requires three shifts in management orientation. The first is a shift from reactive to anticipatory GSCM: rather than responding to buyer sustainability requirements after they have been formalised and enforced, proactive GSCM builds toward the next generation of requirements including Scope 3 carbon accounting, Nature-Based Solutions (NbS) certification, and water stewardship disclosure before they become compliance obligations, thereby converting regulatory headwinds into first-mover competitive advantages. The second is a shift from operational to systemic GSCM: rather than adopting isolated GSCM practices in response to specific buyer requests, systemic GSCM integrates environmental management across the full supply chain architecture, from soil management through cold chain to customer delivery, generating synergies across domains that isolated practices cannot capture.

The third and most demanding shift is from exclusive to inclusive GSCM: rather than building GSCM capability within the commercial farming operation while treating smallholder supplier sustainability as an externally managed compliance problem, inclusive GSCM invests in smallholder capability as a supply chain asset whose development generates direct benefits supply consistency, quality reliability, regulatory compliance for the commercial operator. This shift requires a fundamental reconceptualisation of the commercial-smallholder relationship from a transactional procurement arrangement to a strategic partnership in which sustainability capability development is a shared investment and its returns are equitably distributed.

5.3 Policy Implications and Connections to National and Global Frameworks

The ZimAGSCF has significant implications for agricultural policy in Zimbabwe and for the international development finance architecture that supports it. Zimbabwe's National

Development Strategy (NDS1: 2021–2025) identifies agricultural transformation, climate resilience, and export market development as priority pillars, yet the policy instruments deployed under these pillars have thus far failed to address the structural barriers to GSCM adoption identified in this study particularly the smallholder irrigation financing gap, the cold chain energy deficit, and the institutional fragmentation between TIMB, HDC, ZIDA, and the Ministry of Environment, Climate and Wildlife that impedes coordinated GSCM governance. The ZimAGSCF prescribes specific institutional innovation as Green Agricultural Investment Fund, a water stewardship regulatory framework, an inter-ministerial GSCM coordination committee that would operationalise NDS commitments through targeted GSCM-enabling instruments.

At the international level, the study's findings connect to several major sustainability governance frameworks with direct relevance to Zimbabwe's agricultural export competitiveness. The EU Farm to Fork Strategy, the EU Deforestation Regulation, and the emerging EU Supply Chain Due Diligence Directive collectively constitute a de facto international sustainability standard for agricultural products sold in European markets Zimbabwe's largest export destination. Meeting the cumulative compliance requirements of these instruments will require exactly the multi-actor, systems-level GSCM approach prescribed by the ZimAGSCF. The UN SDGs provide a further normative anchor: SDG 2 (Zero Hunger), SDG 6 (Clean Water), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), and SDG 17 (Partnerships for the Goals) all encompass dimensions directly addressed by the framework. Zimbabwe's revised NDC commitment to a 33 percent emissions reduction by 2030 similarly requires agricultural supply chain decarbonisation particularly cold chain energy transition and soil carbon enhancement as a material mitigation pathway.

For development finance institutions, the study identifies a critical financing architecture gap that blended finance mechanisms are well positioned to address. The concessional green investment facility that enabled Case B's drip irrigation conversion exemplifies the kind of instrument required at scale: a facility that combines development finance institution risk capital with commercial co-financing, targeting below-market interest rates for climate adaptation and GSCM investments in agricultural supply chains. Extending this instrument to smallholder scale through cooperative financing windows, group guarantee mechanisms, and output-linked repayment structures would directly address the climate adaptation financing gap at the smallholder frontier documented in the study's findings.

6. Conclusion

This study has examined GSCM adoption in Zimbabwe's tobacco, horticulture, and floriculture export sectors through case study research and supply chain mapping, generating findings that illuminate both the competitive opportunity and the structural barriers embedded in Zimbabwe's agricultural green supply chain transformation agenda. The study's central theoretical contribution the Zimbabwe Agricultural Green Supply Chain Framework (ZimAGSCF)advances the GSCM literature by providing a context-specific, multi-actor framework calibrated to the distinctive conditions of Zimbabwe's dualistic agricultural structure, constrained infrastructure environment, and evolving international sustainability compliance landscape.

The study's most significant substantive finding the structural divergence between commercial-scale and smallholder-scale GSCM adoption experience has both theoretical and practical implications that extend beyond the Zimbabwean context. In any agricultural export system characterised by dualistic production structures, the GSCM transformation of the

commercial tier while the smallholder tier remains stranded outside the green transition produces a sustainability certification that is environmentally partial, socially inequitable, and commercially vulnerable to buyer supply chain due diligence investigations. The Zim AGSCF's insistence on inclusive GSCM in which smallholder capability development is positioned as a strategic supply chain asset rather than a social responsibility appendage offers a model for integrated GSCM transformation that is simultaneously more environmentally credible, more socially equitable, and more strategically robust than the commercially selective approaches that currently dominate practice.

Several limitations of the current study should be acknowledged. The five-case sample, while carefully selected for diversity, does not constitute a representative census of Zimbabwe's agricultural export sector, and the exclusion of the tea and macadamia nut sub-sectors limits the framework's demonstrated applicability. The predominantly qualitative design does not permit the statistical quantification of GSCM adoption rates across the sector or the econometric estimation of GSCM investment returns that would strengthen the business case evidence base. Future research should address these limitations through larger-scale survey-based GSCM adoption studies, longitudinal impact evaluations of specific GSCM investment programmes, and comparative analyses that position Zimbabwe's agricultural GSCM experience within the broader Southern African regional context. The Zim AGSCF itself should be treated as a working model subject to empirical refinement through engagement with the actors particularly smallholder farmers and government officials whose agency is most consequential for its implementation.

Notwithstanding these limitations, the study makes a timely and substantive contribution to GSCM scholarship in African agricultural export contexts and to the policy debate about the conditions under which green economy transition in the agricultural sector can be simultaneously competitive, climate-resilient, and inclusive. As international sustainability requirements intensify and climate change impacts deepen, the quality of Zimbabwe's agricultural GSCM response will be a decisive determinant of whether the sector's green transition creates broadly shared prosperity or reproduces, in green garb, the structural inequities that have historically characterised Zimbabwe's agricultural economy.

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