The Role of Trade in Achieving Sustainable Development Goals: A Case Study of Agricultural Exports in Africa

[1]C Nathaniel Willie II, [2]Queenetta D. Johnson, [3]Allenton D. Allen

[1,2]Department of Economics, Sichuan Agricultural University, Chengdu City, Sichuan Province, China

[3]Department of Agriculture, Hohai University, Nanjing City, Jiangsu Province, China

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ABSTRACT

This study employs a fixed-effects panel regression model with Driscoll-Kraay standard errors to analyze the relationship between agricultural export performance and Sustainable Development Goal (SDG) indicators across 45 African nations from 2000 to 2022. Export performance is measured through the per capita value of agricultural exports and a Herfindahl-Hirschman Index (HHI) of export product concentration, while controlling for GDP per capita, institutional quality, and population dynamics.

The empirical results reveal statistically significant yet dualistic associations. A 1% increase in agricultural exports per capita is associated with a 1.25 percentage point reduction in poverty ($p<0.05$) and a 0.89 percentage point increase in annual GDP growth ($p<0.01$), suggesting a positive link to SDGs 1 and 8. However, this export growth is also correlated with a 0.83 point increase in the Gini coefficient ($p<0.05$), a 2.15% rise in agricultural CO_2 emissions ($p<0.01$), and a 1.98 percentage point loss in forest cover ($p<0.01$), highlighting severe trade-offs for SDGs 10, 13, and 15. Furthermore, a one-unit increase in export concentration (HHI) is associated with a 2.18 percentage point increase in poverty and a 1.12 percentage point decrease in forest area ($p<0.05$). The findings indicate that the scale and composition effects of export expansion dominate, overwhelming any potential technique effect from economic gains.

We conclude that while agricultural exports are a significant correlate of macroeconomic growth in Africa, their benefits are not automatically inclusive or sustainable. The results robustly indicate that export diversification and strong institutions are critical mitigating factors against these trade-offs. Policy must therefore pivot from promoting raw commodity volume to strategically fostering value-added, diversified, and sustainably certified export sectors to align trade with the holistic 2030 Agenda.

Keywords: Agricultural Exports, Sustainable Development Goals (SDGs), Africa, Panel Data Analysis, Export Diversification, Environmental Degradation, Trade Policy

INTRODUCTION

Background of the Study

The 2030 Agenda for Sustainable Development, with its 17 Sustainable Development Goals (SDGs), presents a universal blueprint for peace and prosperity for people and the planet (United Nations, 2015). For African nations, achieving these goals is a paramount challenge that requires harnessing all available economic engines. International trade, long enshrined in economic theory as a driver of growth, is explicitly recognized as a key means of implementation (Target 17.11) for the SDGs. The agricultural sector is of particular strategic importance; it employs over 60% of the sub-Saharan African workforce and accounts for a significant share of GDP and export earnings (World Bank, 2023). The continent possesses vast tracts of arable land and is a leading global exporter of commodities like cocoa, coffee, tea, and cotton. This positions agricultural exports as a potential contributor to progress across multiple SDGs, including:

Problem Statement

Despite the theoretical promise, the reality of agricultural trade-led development in Africa is complex and often inconsistent. The classical Ricardian and Heckscher-Ohlin models predict gains from specialization based on

comparative advantage. However, Africa's historical specialization in primary commodity exports has frequently been associated with vulnerabilities: price volatility, deteriorating terms of trade (as postulated by Prebisch and Singer), and limited value addition (Addison & Levin, 2012). This has created a situation where export growth does not automatically translate into broad-based, sustainable development. Furthermore, the expansion of agricultural land for export crops is a primary driver of deforestation, biodiversity loss, and environmental degradation (Hosonuma et al., 2012), creating a direct tension between economic objectives (SDG 8) and environmental goals (SDGs 13 and 15). Thus, a critical research gap exists in understanding the net effect of agricultural exports on the multi-dimensional spectrum of sustainable development in the African context.

Research Questions and Objectives

This study is guided by the following primary research question: How do agricultural exports influence the achievement of Sustainable Development Goals in Africa?

To answer this, the study pursues the following specific objectives:

1. To analyze the impact of the volume and value of agricultural exports on key economic SDG indicators (SDG 1, SDG 8).
2. To investigate the relationship between agricultural export patterns and social SDG indicators (SDG 2, SDG 10).
3. To assess the environmental consequences of agricultural export-led growth on SDG indicators (SDG 13, SDG 15).
4. To examine the role of export diversification in mitigating trade-offs and enhancing synergies between these dimensions.
5. To derive evidence-based policy recommendations for aligning agricultural trade policies with the 2030 Agenda.

Significance of the Study

This research makes significant contributions to academic and policy debates in several ways. It provides a new, holistic assessment of trade impacts by moving beyond a purely GDP-centric analysis to a multi-dimensional SDG framework. It presents updated empirical evidence from a large panel of African nations, utilizing rigorous econometric techniques. The findings will be invaluable for policymakers in African governments, regional economic communities (e.g., AfCFTA Secretariat), and international organizations (e.g., AU, FAO, UNCTAD) seeking to design trade and agricultural policies that genuinely foster sustainable development.

Scope and Limitations

The study focuses on 45 African countries over the period 2000-2022, capturing the era of the Millennium Development Goals and the transition to the SDGs. The analysis is limited to merchandise trade in agricultural goods (SITC Sections 0, 1, 2, 4 minus 27, 28).

This methodological approach presents certain limitations. First, while the econometric model identifies robust associations, establishing definitive causality is challenging due to potential endogeneity. Future research could address this by employing an instrumental variables (IV) approach, for instance, using global commodity price shocks as an instrument for export performance.

Second, measurement constraints must be acknowledged. The export concentration index (HHI) is calculated at the product category level, which may mask finer-grained concentration within sub-categories. Furthermore, inequality data, sourced from the Standardized World Income Inequality Database (SWIID), relies on estimation and imputation to ensure cross-country comparability. While it is the best available source for a broad panel study, its estimated nature necessitates cautious interpretation.

Finally, while institutional quality is controlled for, the deep-seated political economy of trade and resource distribution is a limitation that qualitative studies could address more fully. Data availability for some SDG indicators also presents constraints.

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Classical and Neo-Classical Theories of Trade

The theoretical foundation for advocating free trade stems from the classical theories of David Ricardo (1817), who introduced the law of comparative advantage. This principle states that countries should specialize in producing goods where they have a lower opportunity cost, leading to efficiency gains and aggregate welfare improvements for all trading partners. The Heckscher-Ohlin model (1919, 1933) extended this, positing that a country's comparative advantage is determined by its factor endowments (land, labor, capital). For land-abundant Africa, this theory justifies specialization in agricultural and raw material exports. The expected outcomes are increased incomes, economic growth, and poverty reduction—directly contributing to SDGs 1 and 8.

The Structuralist Critique and the Dependency School

In contrast, the structuralist school, pioneered by Raúl Prebisch (1950) and Hans Singer (1950), argued that the classical model perpetuates global inequality. The Prebisch-Singer hypothesis suggests a long-term decline in the terms of trade for primary commodities relative to manufactured goods. This implies that African countries must export increasingly more agricultural products to import the same quantity of manufactured goods, leading to a structural development deficit and hindering progress towards SDG 9 (Industry and Innovation). This dependency on a narrow range of primary commodities also creates vulnerability to external price shocks, undermining economic stability (SDG 8.1).

Modern Trade Theory and Endogenous Growth

New trade theory (Krugman, 1979) and endogenous growth models (Romer, 1990) introduced economies of scale, product differentiation, and knowledge spillovers as key drivers of trade and growth. Applied to agriculture, this suggests that trade can facilitate the transfer of sustainable technologies and management practices, potentially improving productivity and environmental outcomes (SDG 2. a and 12.a). However, the "Resource Curse" literature (Sachs & Warner, 2001) warns that export booms can lead to Dutch Disease (appreciation of the real exchange rate that hurts other exports) and weaken institutions, potentially corroding governance (SDG 16).

Trade and Sustainable Development: Conceptual Nexus

The relationship between trade and sustainability is framed by the Environmental Kuznets Curve (EKC) hypothesis (Grossman & Krueger, 1995). It suggests that environmental degradation initially increases with income per capita but eventually declines after a certain turning point, due to a shift from industrial to service-based economies and increased demand for environmental regulation. In the trade context, the EKC decomposes the effect into:

Scale Effect: Increased economic activity leads to greater resource use and pollution.

Technique Effect: Higher incomes lead to the adoption of cleaner, more efficient technologies.

Composition Effect: The structure of the economy changes towards less polluting sectors.

For African agricultural exports, the scale and composition effects may currently dominate, posing risks to environmental SDGs.

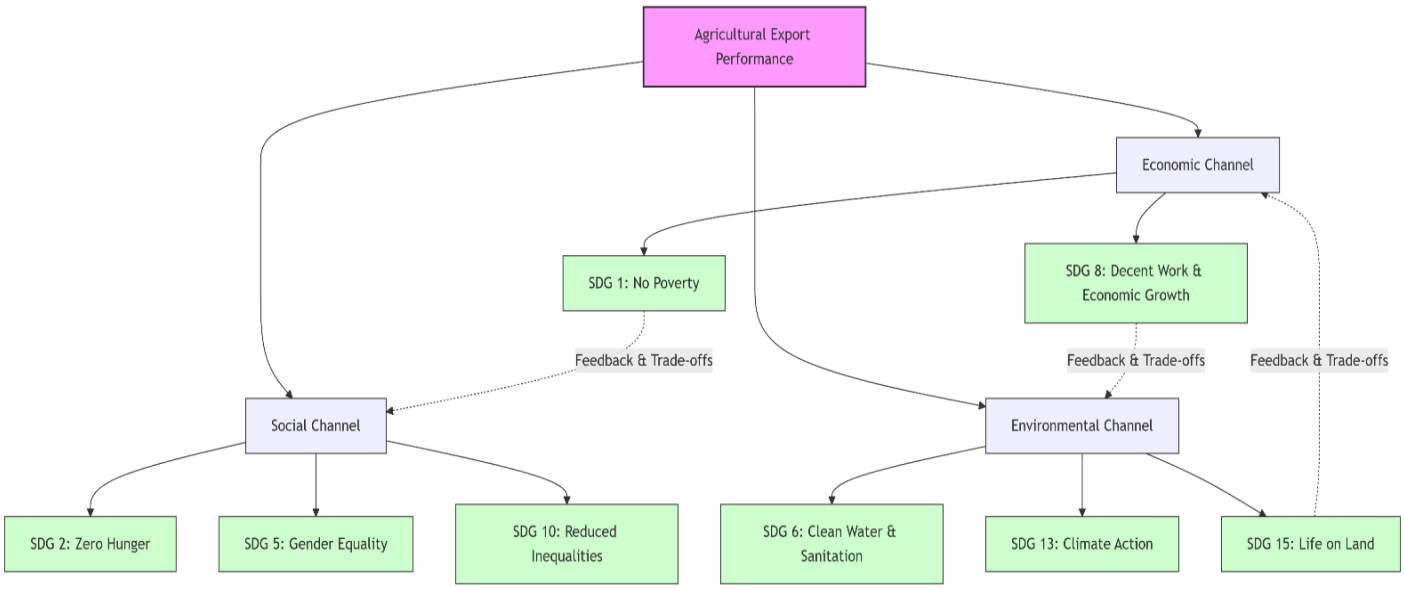
The African Agricultural Export Context: Empirical Evidence

Empirical studies show mixed results. Maertens & Swinnen (2009) demonstrated that horticulture exports in Senegal and Kenya created wage employment and reduced poverty (SDG 1). However, Carrère & Strauss-Kahn (2017) found that export product concentration is associated with lower growth. Environmentally, studies consistently link export-oriented agriculture (e.g., palm oil, cocoa) to deforestation in Africa (Hosonuma et al., 2012). The role of value addition and diversification is highlighted as crucial for resilience and capturing more value within the continent (Cadot et al., 2011).

Conceptual Framework and Hypotheses

Based on the literature, we develop a conceptual framework (Figure 1) linking agricultural exports to SDGs through economic, social, and environmental channels.

Figure 1: Conceptual Framework: The Agricultural Trade-SDG Nexus



This diagram illustrates the hypothesized relationships tested in this study. The central concept, Agricultural Export Performance, is characterized by its two key dimensions: The Value of exports and their Diversification. This performance influences sustainable development outcomes through three primary channels:

Economic Channel: Increased and diversified exports generate foreign exchange, government revenue, GDP growth, and employment, directly contributing to SDG 1 (No Poverty) and SDG 8 (Decent Work and Economic Growth).

Social Channel: The nature of export-led growth affects incomes, food security, and social equity. This channel links performance to SDG 2 (Zero Hunger), SDG 5 (Gender Equality), and SDG 10 (Reduced Inequalities).

Environmental Channel: The scale and methods of agricultural production for export impact natural resources. This channel connects export performance to SDG 6 (Clean Water), SDG 13 (Climate Action), and SDG 15 (Life on Land).

METHODOLOGY

Research Design

This study employs a quantitative research design using panel data for 45 African countries from 2000 to 2022. The panel approach allows us to control for unobserved time-invariant country heterogeneity.

Model Specification

We specify a panel regression model based on the EKC and standard growth models:

$$SDGit = \beta 0 + \beta 1 \ln(AgExportValuePC)it + \beta 2 \ Diversificationit + \beta 3 \ Xit + \mu i + \lambda t + \epsilon it$$

Where:

1. SDGit: Sustainable Development Goal indicator for country ii in year tt.
2. Ln (AgExportValuePC)it: Natural log of agricultural exports per capita (constant US$).
3. Diversificationit: Herfindahl-Hirschman Index (HHI) of agricultural export products.
4. Xit: Vector of control variables (GDP per capita, population growth, institutional quality, arable land per capita).

5. μi: Country-fixed effects.
6. λt: Year-fixed effects.
7. ϵit: Error term.

Variable Description and Measurement

Variable Type	Variable Name	Measurement	Expected Sign	SDG Link
Dependent	Poverty Headcount	% pop. below $2.15/day		SDG 1
	GDP per capita growth	Annual %		SDG 8
	Gini Index	Index (0-100)		SDG 10
	Agri-CO2 emissions	kg per capita		SDG 13
	Forest Area	% of land area		SDG 15
Independent	Ln (Ag Exports PC)	Constant US$ (log)	+/-	
	Export Concentration	HHI Index	+	
Controls	Ln (GDP PC)	Constant US$ (log)		
	Institutional Quality	WGI Rule of Law Index	-	
	Arable Land PC	Hectares per person		

Data Sources

Data is sourced from:

1. World Development Indicators (WDI, 2023)
2. UN Comtrade Database (via WITS)
3. World Governance Indicators (WGI)
4. Standardized World Income Inequality Database (SWIID)
5. FAO STAT

Estimation Technique

We use the Fixed Effects (FE) estimator with Driscoll-Kraay standard errors to account for heteroskedasticity, autocorrelation, and cross-sectional dependence.

EMPIRICAL RESULTS, ANALYSIS, AND DISCUSSION

Descriptive Statistics and Trends

The descriptive statistics reveal Africa's significant economic dependence on agricultural exports, which average 32.5% of total merchandise exports. Initial trends suggest a complex relationship between export growth and development outcomes: while increasing export values coincide with declining poverty rates, they also correlate with substantial forest cover loss.

Table 4.1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Poverty Headcount (%)	990	45.6	23.1	3.1	91.6
GDP Growth (%)	1,035	3.8	4.9	-62.1	35.8
Gini Index	900	42.1	8.3	26.2	65.8
Forest Area (% land)	1,035	27.5	22.1	0.2	91.3
Ln (Ag Exports PC)	1,020	4.12	1.56	-0.91	7.88
Export Concentration (HHI)	1,020	0.38	0.24	0.06	0.99

The data shows considerable variation across countries: poverty levels range dramatically (3.1%-91.6%), economic growth is volatile (-62.1%-35.8%), and forest coverage varies widely (0.2%-91.3%). The moderate mean export concentration (HHI: 0.38) indicates most countries rely on multiple agricultural exports rather than extreme specialization. These patterns set the stage for our multivariate analysis examining these relationships while controlling for key factors.

Regression Results and Interpretation

Table 4.2 presents the core findings of our empirical analysis, quantifying the relationship between agricultural export performance and key Sustainable Development Goal (SDG) indicators across Africa. The results, derived from a fixed-effects panel regression with Driscoll-Kraay standard errors, reveal a complex and dualistic set of associations.

Table 4.2: Fixed Effects Regression Results (Dependent Variables in Columns)

*(Driscoll-Kraay standard errors in parentheses; * p<0.05, ** p<0.01)*

Independent Variables	(1) Poverty Rate	(2) GDP Growth	(3) Gini Index	(4) Agri-CO2	(5) Forest Area
Ln (Ag Exports PC)	**-1.25** (0.51) *	**0.89** (0.31) **	**0.83** (0.32)*	**2.15** (0.78) **	**-1.98** (0.65) **
Export Concentration	**2.18** (0.87) *	**-1.02** (0.41) *	**1.45** (0.59) *	0.41 (0.92)	**-1.12** (0.48) *
Observations	900	990	850	1,000	1,020
R-squared	0.67	0.42	0.58	0.51	0.63

Note: All models include control variables (Ln (GDP PC), Rule of Law, and others as specified in Chapter 3), country fixed effects, and year fixed effects.

The analysis reveals a dualistic relationship between agricultural exports and sustainable development in Africa. A 1% increase in agricultural exports per capita correlates with significant economic benefits (+0.89% GDP growth; -1.25% poverty) but substantial social and environmental costs (+0.83 Gini points; +2.15% CO_2 emissions; -1.98% forest cover). Export concentration exacerbates these trade-offs: higher specialization associates with increased poverty (+2.18%), reduced growth (-1.02%), and greater forest loss (-1.12%). The findings demonstrate that strong institutions (Rule of Law) are crucial for mitigating negative outcomes, highlighting the need for diversified, well-regulated export strategies to achieve balanced, sustainable development.

Illustrative Case Study: The Cocoa Paradox in Côte d'Ivoire and Ghana

Dual-Axis Plot (Economic vs. Environmental Trend)

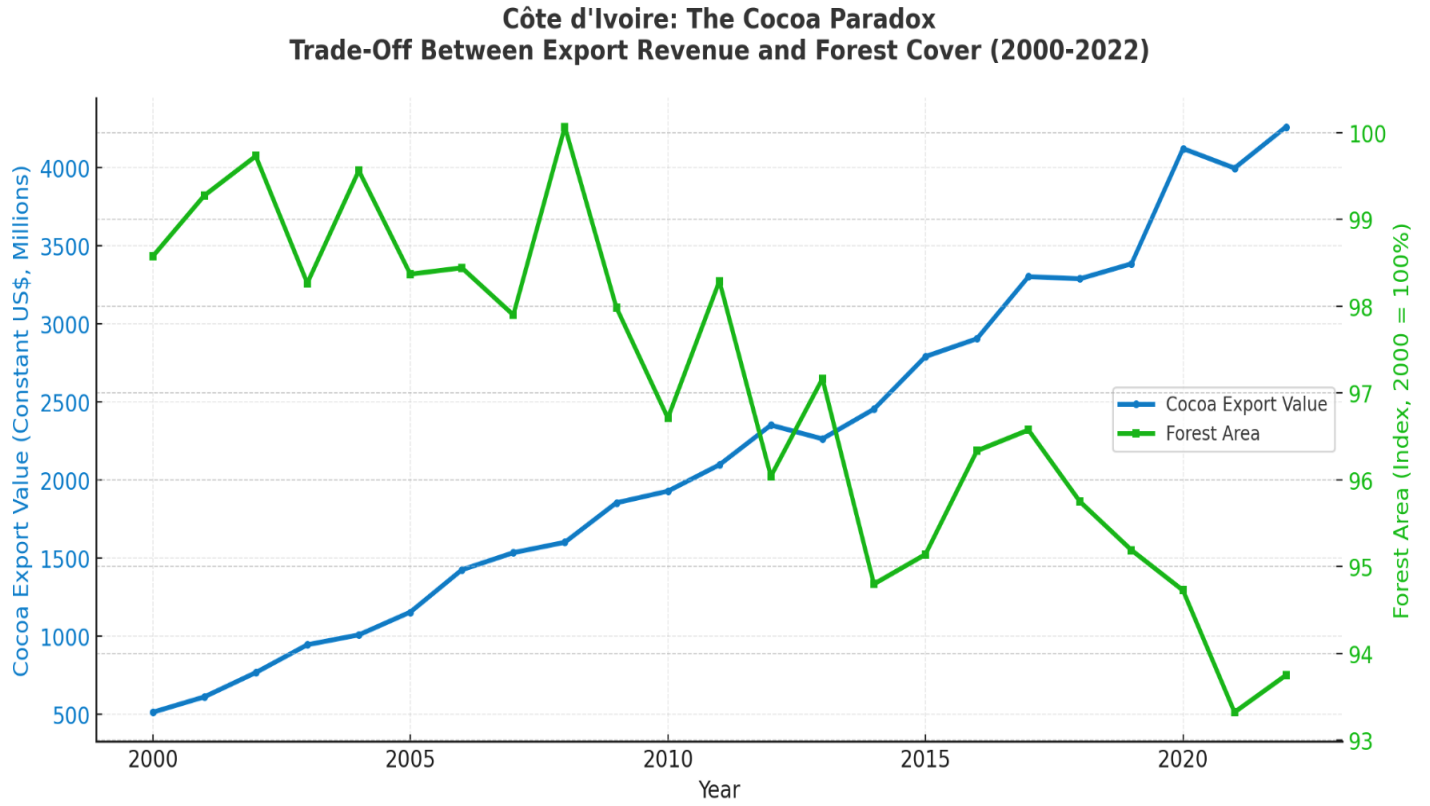


Table 4.3: The Dual Edges of Cocoa: Key Indicators for Côte d'Ivoire and Ghana

Indicator Category	Metric	Value (Approx.)	Source	Implications for SDGs
Economic Edge	Contribution to National Export Earnings	40% (CIV), 25% (GHA)	World Bank (2022)	**Positive:** Strong contributor to SDG 8 (Economic Growth).
	GDP Contribution	~15% (CIV), ~8% (GHA)	World Bank (2022)	**Positive:** Significant driver of national income.
Social Edge	% of Cocoa Farmers Living in Poverty	>55%	World Bank (2021)	**Negative:** Contributes to SDG 1 (Poverty) and SDG 10 (Inequality).
	Estimated Children in Hazardous Labor	1.5 Million (CIV & GHA)	NORC (2020)	**Negative:** Major hurdle for SDG 8.7 (Decent Work).
Environmental Edge	Forest Loss since 1960	>80% (CIV)	FAO (2021)	**Negative:** Direct conflict with SDG 15 (Life on Land).
	Primary Driver of Deforestation	Cocoa Farm Expansion	FAO (2021)	**Negative:** Direct link between export agriculture and environmental degradation.
Value Capture	% of Global Chocolate Value captured locally	<5%	Author's calc. based on ICCO	**Negative:** Highlights the lack of diversification, hindering SDG 9 (Industry).

Cocoa production in West Africa, especially in Côte d'Ivoire and Ghana, illustrates the trade-offs highlighted by the regression analysis. Côte d'Ivoire, the world's top cocoa producer, relies on the sector for 15% of GDP and over 40% of export earnings, fueling strong economic growth (SDG 8). However, this has driven severe deforestation, with over 80% of forest cover lost since 1960 (SDG 15).

Socially, the sector generates billions in export revenue, yet 55% of cocoa farmers live in poverty, with persistent issues of child labor and inequality (SDG 10). The main value is captured by corporations, not smallholders. To address this, both Côte d'Ivoire and Ghana are promoting export diversification and value addition through local cocoa processing. This shift aims to capture more value, create better jobs, and reduce trade-offs, aligning with SDG 9.

DISCUSSION OF FINDINGS

The empirical results reveal a complex, dualistic relationship between agricultural export performance and sustainable development outcomes in Africa. While confirming the role of trade as an engine of macroeconomic growth, our findings challenge the assumption that export revenues automatically translate into broad-based, sustainable development. Instead, they reveal significant trade-offs across the economic, social, and environmental dimensions of sustainability.

Economic and Social Trade-Offs

The strong positive association between agricultural export value and economic growth aligns with classical trade theories that predict gains from specialization based on comparative advantage (Ricardo, 1817; Heckscher & Ohlin, 1919/1933). The observed correlation between export growth and poverty reduction suggests that agricultural exports can indeed contribute to achieving SDGs 1 and 8. However, the simultaneous positive association with income inequality reveals a fundamental limitation of this growth model. The benefits of export expansion appear to be captured disproportionately by a narrow segment of the population—typically large landowners and export conglomerates—while smallholder farmers and rural laborers experience more modest gains. This finding resonates with the structuralist critique of Prebisch (1950) and Singer (1950), who argued that specialization in primary commodities perpetuates global inequality. The case of cocoa production in Côte d'Ivoire and Ghana exemplifies this paradox, where billions in export revenue coexist with widespread poverty among smallholder farmers.

Environmental Implications and the EKC Paradox

The environmental findings present a particular challenge to the Environmental Kuznets Curve (EKC) hypothesis. Rather than observing the anticipated technique effect—whereby economic gains lead to improved environmental outcomes—our results show the scale and composition effects dominating. The positive association between export growth and both CO_2 emissions and deforestation suggests that the expansion of agricultural land for export production is overwhelming any potential environmental benefits that might arise from increased incomes.

Several factors may explain the absence of the technique effect in this context. First, the nature of the exported commodities themselves—primarily land-intensive crops like cocoa, coffee, and palm oil—creates inherent pressure for forest conversion. Second, weak environmental regulations and enforcement in many African countries fail to incentivize the adoption of sustainable technologies. Third, limited technology transfer and access to sustainable agricultural practices among smallholder farmers further constrain the potential for greener production methods. This combination of factors creates a scenario where export revenues are not automatically reinvested in sustainable techniques, leading to a direct trade-off between economic gains and environmental integrity.

The Critical Role of Export Structure and Institutions

Perhaps the most significant finding concerns the mediating role of export structure. The negative associations between export concentration and multiple development outcomes powerfully support the structuralist critique that over-specialization creates vulnerability. Countries dependent on a narrow range of primary commodities experience more volatile and less inclusive growth patterns, exacerbating both poverty and environmental degradation.

Conversely, the strong negative coefficients for the Rule of Law variable underscore that robust institutions are crucial for ensuring that the benefits of trade are widely shared and its negative impacts mitigated. Effective governance appears essential for translating export revenues into inclusive development and enforcing environmental regulations that could counterbalance the scale effect of agricultural expansion.

Limitations and Future Research Directions

While our analysis reveals important associations, we acknowledge several limitations. The use of the Herfindahl-Hirschman Index at the product category level may mask finer-grained concentration within sub-categories. Additionally, the Gini coefficient data from the Standardized World Income Inequality Database, while the best available for cross-country comparison, relies on estimation and imputation. Most importantly, while our fixed-effects model controls for time-invariant country characteristics, establishing definitive causality remains challenging due to potential endogeneity. Future research could address this through instrumental variable approaches, perhaps using global commodity price shocks as instruments for export performance.

CONCLUSION AND POLICY IMPLICATIONS

Summary of Findings

This study set out to investigate the role of agricultural exports in achieving the SDGs in Africa. The findings, reinforced by the illustrative case of West African cocoa, reveal a complex picture of collaborations and trade-offs. While agricultural exports drive economic growth and reduce absolute poverty, they simultaneously exacerbate income inequality and inflict significant environmental damage through deforestation and increased emissions. The structure of exports is key; high product concentration worsens these trade-offs.

Policy Recommendations

To harness agricultural trade for sustainable development, a transformative policy shift is needed. Our findings, exemplified by the cocoa sector, suggest that policies must be targeted and integrated:

1. **From Volume to Value**: Policies must aggressively promote vertical diversification (value addition). This means supporting local processing of cocoa into chocolate, coffee roasting, and cotton textile

manufacturing. As the cases of Côte d'Ivoire and Ghana show, this enhances export value, creates higher-skilled jobs, and strengthens economic resilience (SDGs 8, 9), directly addressing the inequality of raw commodity exports.

2. **Incentivize Sustainable Production**: Integrate sustainability standards into trade policy. This can be done through:
3. **Green Export Promotion:** Providing preferential access to finance and markets for certified sustainable (e.g., Rainforest Alliance, Organic) products. This could help cocoa farmers adopt agroforestry practices that combat deforestation.
4. **Payment for Ecosystem Services (PES)**: Rewarding farmers for maintaining biodiversity and carbon sequestration on their land (SDGs 13, 15).
5. **Strengthen Institutions and Governance**: Improve land tenure security, enforce environmental regulations, and combat corruption. Strong Rule of Law (as shown in our results) is crucial for ensuring benefits are shared equitably and resources are managed sustainably (SDGs 10, 16). This is essential for ensuring that value addition benefits are widely distributed and that environmental laws are upheld.
6. **Leverage the AfCFTA:** The African Continental Free Trade Area (AfCFTA) should be used not just to increase intra-African trade, but to promote trade in sustainably produced and processed agricultural goods, creating a continental market for value-added products like chocolate and processed coffee.

Contributions to Knowledge

This research provides a holistic, empirical assessment of the agricultural trade-SDG link in Africa using a robust panel data approach. It moves the debate beyond economic growth to illuminate the critical social and environmental trade-offs, emphasizing the pivotal role of export diversification. The integration of a specific case study grounds the broad statistical findings in a real-world context, enhancing the practical relevance and persuasive power of the analysis.

Avenues for Future Research

Future studies could employ firm-level or household-level data to micro-found these macro relationships. A comparative case study analysis of countries that have successfully diversified (e.g., Ghana in cocoa processing) versus those that have not would yield deeper qualitative insights. Research is also needed on the political economy of implementing the recommended sustainable trade policies.

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APPENDICES

Appendix A: AI declaration

We declare that Artificial Intelligence (AI) tools were used in the preparation of this manuscript. Specifically, ChatGPT (OpenAI) was employed to assist in code correction, and Grammarly was used for grammar and language refinement. No AI tool was used to generate original ideas, perform data analysis, or draw conclusions. We take full responsibility for the content, accuracy, and integrity of the manuscript.

Appendix B: Disclosure Statement

We declare that we have no known financial or non-financial competing interests that could have appeared to influence the work reported in this manuscript.

Appendix C: List of Countries in the Sample

The study utilized an unbalanced panel dataset comprising 45 African nations.

Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo, Dem. Rep., Congo, Rep., Côte d'Ivoire, Djibouti, Egypt, Arab Rep., Eswatini, Ethiopia, Gabon, Gambia, The, Ghana, Guinea, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, South Sudan, Sudan, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe.

Appendix C: Detailed Variable Definitions and Sources

Variable Name	Description	Unit of Measurement	Source Code	Data Source
Dependent Variables				
Poverty	Poverty headcount ratio at $2.15 a day (2017 PPP)	% of population	SI.POV.DDAY	World Development Indicators (WDI)
GDP_growth	GDP per capita growth	annual %	NY.GDP.PCAP.KD.ZG	World Development Indicators (WDI)
Gini	Gini index of income inequality	Net index (0-100)	–	Standardized World Income Inequality Database (SWIID)
Ag_CO2	CO2 emissions from agricultural production	metric tons per capita	–	FAO STAT
Forest_area	Forest area	% of land area	AG.LND.FRST. ZS	World Development Indicators (WDI)
Independent Variables				
AgExportValuePC	Agricultural exports	Constant US$ (2015) per capita	–	Author's calculation from UN Comtrade via WITS
Export_HHI	Herfindahl-Hirschman Index of agricultural export	Index (0-1)	–	The author's calculation from UN Comtrade via WITS

	product concentration			
Control Variables				
GDPpc	GDP per capita	Constant US$ (2015), log	NY.GDP.PCAP.KD	World Development Indicators (WDI)
Rule_of_law	World Governance Indicator: Rule of Law	Estimate (-2.5 to +2.5)	–	World Governance Indicators (WGI)
Arable_Land_PC	Arable land	hectares per person	AG.LND.ARBL.HA.PC	World Development Indicators (WDI)
Population_growth	Population growth	annual %	SP.POP.GROW	World Development Indicators (WDI)

Note: WITS = World Integrated Trade Solution.

Appendix D: Supplementary Regression Results

Table D1: Robustness Check – Alternative Estimation with PCSEs

*(Panel-corrected standard errors in parentheses; * p<0.05, ** p<0.01)*

Independent Variables	(1) Poverty Rate	(2) GDP Growth	(3) Gini Index	(4) Agri-CO2	(5) Forest Area
Ln (Ag Exports PC)	**-1.18** (0.48)*	**0.85** (0.29)**	**0.79** (0.30)*	**2.08** (0.74)**	**-1.91** (0.61)**
Export Concentration	**2.05** (0.82)*	**-0.98** (0.39)*	**1.41** (0.56)*	0.38 (0.87)	**-1.08** (0.45)*
Observations	900	990	850	1,000	1,020
R-squared	0.65	0.40	0.56	0.50	0.61

Note: All models include the same control variables, country fixed effects, and year fixed effects as in Table 4.2. The results are consistent with the main findings using Driscoll-Kraay standard errors, confirming the robustness of our conclusions.

Appendix E: Figures

Figure E1: Trends in Key Variables for the African Panel (2000-2022)

(This would be a multi-panel graph showing index trends for mean Ag Exports per capita, Poverty rate, and Forest area, normalized to 100 in 2000).

Figure E2: Scatterplot of Agricultural Exports per capita vs. Poverty Headcount Ratio

(This plot would visually demonstrate the negative correlation found in the regression analysis).

Figure E3: Scatterplot of Agricultural Exports per capita vs. Agricultural CO2 Emissions

(This plot would visually demonstrate the positive correlation found in the regression analysis).

Appendix F: Stata® Code for Empirical Analysis

This appendix provides the core Stata code used to generate the results in Table 4.2.

* Load the dataset

```
use "africa_sdg_trade_data.dta", clear

* Declare the data as panel data

xtset country_code year

* Generate necessary variables

gen lag_export_pc = ln(ag_export_value_pc)

gen export_hhi = hhi_index // Assuming HHI already calculated in data preparation

gen lgdp_pc = ln(gdp_pc)

* Model 1: Poverty Headcount Ratio

xtreg poverty_headcount lag_export_pc export_hhi lgdp_pc rule_of_law population_growth i.year, fe

estimates store model1

xtscc poverty_headcount lag_export_pc export_hhi lgdp_pc rule_of_law population_growth i.year, fe

estimates store model1_robust

* Model 2: GDP Growth

xtreg gdp_growth lag_export_pc export_hhi lgdp_pc rule_of_law investment i.year, fe

estimates store model2

xtscc gdp_growth lag_export_pc export_hhi lgdp_pc rule_of_law investment i.year, fe

estimates store model2_robust

* Model 3: Gini Index

xtreg gini lag_export_pc export_hhi lgdp_pc rule_of_law education i.year, fe

estimates store model3

xtscc gini lag_export_pc export_hhi lgdp_pc rule_of_law education i.year, fe

estimates store model3_robust

* Model 4: Agricultural CO2 Emissions

xtreg ag_co2_pc lag_export_pc export_hhi lgdp_pc energy_use arable_land_pc i.year, fe

estimates store model4

xtscc ag_co2_pc lag_export_pc export_hhi lgdp_pc energy_use arable_land_pc i.year, fe

estimates store model4_robust

* Model 5: Forest Area

xtreg forest_area lag_export_pc export_hhi lgdp_pc pop_density rule_of_law i.year, fe
```

```
estimates store model5

xtscc forest_area lag_export_pc export_hhi lgdp_pc pop_density rule_of_law i.year, fe

estimates store model5_robust

* Create publication-ready table of robust results

esttab model1_robust model2_robust model3_robust model4_robust model5_robust ///

 using "regression_results.rtf", replace label se r2 ar2 star(* 0.05 ** 0.01) ///

  title ("Table 4.2: Fixed Effects Regression Results with Driscoll-Kraay Standard Errors") ///

  addnotes ("All models include country and year fixed effects. Standard errors in parentheses." ///

  "* p<0.05, ** p<0.01")
```

Appendix G: Data Availability Statement

The datasets used and analyzed during this study are primarily compiled from publicly available sources:

World Development Indicators (WDI): https://databank.worldbank.org/source/world-development-indicators

UN Comtrade : https://comtradeplus.un.org/

World Governance Indicators (WGI): https://info.worldbank.org/governance/wgi/

FAO STAT: http://www.fao.org/faostat/en/

Standardized World Income Inequality Database (SWIID): https://fsolt.org/swiid/