

Unlocking Nigeria's Agricultural Export Potential: Macroeconomic Determinants, Environmental Sustainability, and Gender Dynamics Under the SDG Framework

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Abstract

Background: Agricultural export capability is vital for developing economies, yet Nigeria's shift toward petroleum has left its rural sector structurally underdeveloped and vulnerable.

Aims: This study investigates the key determinants of Nigeria's agricultural export performance, focusing on agricultural land availability, foreign direct investment, GDP growth, domestic crop production, exchange rates, and female agricultural employment.

Methods: Utilizing annual time-series data from 1990 to 2023, the study evaluates short- and long-run dynamics using the Autoregressive Distributed Lag (ARDL) model combined with the Residual Augmented Least Squares–Engle Granger (RALS-EG) cointegration approach.

Result: In the long run, agricultural land expansion, FDI inflows, and exchange rates positively impact export volumes, whereas GDP growth, domestic crop production indices, and female agricultural employment show negative effects. In the short run, land use and crop production enhance exports, while exchange rate volatility and GDP growth exert negative pressures. The findings reveal that output increases do not automatically translate to export growth due to domestic food demand and supply chain inefficiencies, while structural and resource barriers hinder the export contribution of female labor.

Conclusion: Policymakers must look beyond purely output-driven initiatives. Achieving sustainable agricultural export growth requires targeted investments in post-harvest rural infrastructure, macroeconomic and financial stability, and gender-equitable access to agricultural resources and extension services.

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INTRODUCTION

Exports of agricultural products are among the most critical foundations in the economic structures of Nigeria, contributing immensely to job creation in the rural regions, livelihood stability, and foreign exchange earnings. According to figures provided by (WorldBank Group, 2023) agriculture accounts for approximately 22% of Nigeria's GDP. Despite its abundance in terms of resources, however, the agricultural export profile of the country is characterized by an alarming structural weakness. Agricultural exports, the mainstay of the economy until the oil boom during the middle twentieth century, now contribute just five percent to the overall exports of the country, significantly outweighed by the revenues generated through petroleum sales (Gavrilova, 2020; Khalifa, 2016; Nofiu et al., 2025). The resulting economic vulnerability to global oil price fluctuations is

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compounded by food insecurity and rural poverty. Such developments represent a major setback in terms of achieving SDG 15 (Life on Land), involving measures for reversing land degradation and protecting critical ecosystems. It represents lost opportunities for achieving a diversified economy through agricultural development (Unicef, 2021).

To get a clear picture of the reason for the under exploitation of Nigeria's trade possibilities, we should examine the impact of the above-mentioned macroeconomic forces in detail as applied to the socio-economic situation in rural farming settlements. Although the existing literature on international trade indicates that the foreign direct investment (FDI) factor may be able to boost agrarian development through its effect of transferring capital and initiating technological loops in Nigeria (Owutuamor, 2018; Porteous, 2021), FDI is inevitably biased due to the "Dutch Disease" that dominates in the economy because of oil production. Hence, the rural settlements cannot develop the necessary infrastructures for mechanization and export-oriented agriculture. As a result, small farmers end up being in extremely vulnerable conditions characterized by fragmented land lots, rainfed agriculture practices, and a total lack of transit possibilities to deliver their products to the global market (Kaiser & Barstow, 2022; Marion et al., 2024). Moreover, even if the total GDP grows, it does not contribute to the development of exports since the growth itself is biased towards cities and oil extraction areas (Abdullahi et al., 2021; Ajijola et al., 2023; Odozi & Oyelere, 2023). On the other hand, there is a continuous shift in agricultural output from cash crop commodities to domestic food needs to catch up with the fast-growing domestic population demands (Abdullahi et al., 2024; Ecker & Hatzenbuehler, 2022; Onwe et al., 2024).

In such instances, the role played by gender dynamics is profound, resulting in the development of an apparent paradox within the rural workforce. The women are estimated to account for close to 50% of agricultural laborers in rural areas but face social, cultural, and economic discrimination that prevents them from having any rights concerning formal ownership and property of land (Drucza & Peveri, 2018; Kocabiçak & Dildar, 2025; Waris et al., 2016). The lack of legal recognition results in them enjoying only insecure forms of tenancy, thus unable to invest in sustainable soil cultivation practices. In addition, the prevailing gender biases against them at financial institutions prevent them from accessing loans and thus deny them a chance to invest in better seedlings and mechanical equipment (Kehinde et al., 2021; Nnaji et al., 2022; Olumba et al., 2024). Even though it has been proven that empowering women could help raise productivity levels by 20% to 30%, due to the lack of public and extension support, their labor, represented in our model by the variable EIAW, remains limited to subsistence practices that have no access to commercialization and international markets (Awoyemi & Adesiji, 2023; Kamara et al., 2022; Ojo & Baiyegunhi, 2023).

In addition, the relationship between the aforementioned variables and the unstable nature of monetary fluctuations will be considered, whereby devaluation of currencies is supposed to make the country competitive for trading purposes (Brun et al., 2022; Goda et al., 2024; Mukaila & Arene, 2022), but farmers will be constrained in taking advantage of these opportunities since they have a problem with high levels of post-harvest wastage, quality criteria of crops from an international perspective, and soil pollution (Brice et al., 2021; Fulano et al., 2021; Qange et al., 2024). The research will fill the gaps that currently exist in academia concerning the interaction of the listed variables.

This study directly addresses these academic blind spots by establishing a comprehensive, combined estimation of how agricultural land availability, foreign capital inflows, overall economic growth, crop production trends, female labor participation, and exchange rate fluctuations jointly determine Nigeria's agricultural export trajectory. By doing so, the paper unravels how these distinct socio-economic and structural forces intersect to either bottleneck or accelerate national trade performance.

METHOD

To preserve empirical rigor while evaluating real-world structural impacts across diverse sectors, our methodology relies on a clearly defined, stage-based analytical process. Moving away from localized or isolated field projects, this study implements a macro-structural framework designed to evaluate the national agricultural production system and its direct relationship to broader export channels across Nigeria.

Target Scope Designation

Macro-level "Target Community" of this framework includes the national agricultural production system, structural small farmers' system, and export systems for agriculture in Nigeria. In this research, instead of observing one isolated village, data have been gathered through longitudinal study periods ranging from 1990 to 2023 to examine the impact of systematic changes on rural farmer sustainability and national trade capabilities.

Operational Workflow Stages

The implementation of our macro-level research project is conducted in three specific operational phases, including:

1. The Data Mobilization Phase: This phase involves the collection, cleaning, and verification of country-level data obtained from the WDI ([WorldBank Group, 2023](#)) in Table 1.
2. The Econometric Optimization Phase: This phase will involve testing for cointegration linkages between variables through integration and stationarity tests through mathematical techniques.
3. The Policy Translation Phase: This phase will involve converting the elasticity values into practical empowerment strategies to overcome bottlenecks.

Table 1. Summary of Variables.

Variables	Symbol	Measurement	Source
Agricultural raw materials exports	AGEX	% of merchandise exports	WDI
GDP growth	GDP	annual %	WDI
Agricultural land	AGRILAND	% of land area	WDI
Foreign direct investment	FDI	net inflows (% of GDP)	WDI
Employment in agriculture, female	EIAW	% of total female employment active in the agricultural sector (modeled ILO estimate)	WDI
Crop production index	CROPPRO	2014-2016 = 100	WDI
Official Exchange Rate	EXR	LCU per US\$, period average	WDI

The following are some of the factors considered in this research model according to the empirical model presented above. They represent the structure, finance, and demographics of Nigeria. AGEX denotes the share of raw materials export in total merchandise export, whereas GDP Growth indicates the annual percentage growth of economy. AGRILAND refers to the percentage of arable or temporarily cultivated land. FDI refers to net foreign capital flows as a percentage of GDP, while CROPPRO shows the annual output of agriculture in comparison with the base period 2014-2016=100. EXR shows the period average exchange rate in the domestic currency per US dollar.

The EIAW variable is defined by the measure of the ratio of the number of women participating in agriculture out of the total number of women employed within the country. It should be noted that the measurement of this index does not reflect the proportion of female workers as a part of the agricultural labor force but rather refers to the structure of labor participation of women across the economy.

Strategic Capacity Alignment

Although the study does not engage in any direct primary field training, the selection of variables in the model is designed to make sure that the macroeconomic data is consistent with the reality of capacity building. The use of EIAW and CROPPRO enables a mapping approach in the analysis. Through the assessment of the short and long run coefficients of such variables, the model is able to

provide the precise information required for designing state sponsored agricultural extension training and cooperative credit networks.

Analytical Instruments

In order to ensure that we have a sound empirical structure from a logical perspective, it is important that we develop the linkage between the inputs in supply side and the volume of international trade. Our discussion will focus on the Exportable Surplus Model whereby a country's exports are determined by:

$$AGEX_t = Y_t - D_t \quad (1)$$

Supply-side component of the trade balance equation is modeled as an extended version of the Cobb Douglas production function (KUŞÇUOĞLU & UZGÖREN, 2021; Le, 2020; Tinta, 2022), where total domestic agricultural production (Y_t) is represented as the product of resource, capital, and labor variables:

$$Y_t = f(K_t, L_t) = f(AGRILAND_t, CROPPRO_t, EIAW_t) \quad (2)$$

In this instance, AGRILAND is seen as the variable that describes the main resource in structure, CROPPRO functions as an indicator of overall production ability, and EIAW accounts for women's work input in agriculture.

The problem here, however, is that agricultural raw material is consumed domestically even before it is exported internationally. Thus, AGEX depends directly on how much demand exists internally (D_t), which is modeled as a function of:

$$D_t = f(GDP_t, EXR_t, FDI_t) \quad (3)$$

Here, aggregate income growth (GDP) represents domestic consumption needs, whereas official exchange rate (EXR) and foreign direct investments (FDI) operate as price relativities and capital flows to determine whether a commodity is consumed domestically or becomes part of international business transactions.

By substituting our supply-side inputs and demand-side shifters into the primary trade identity, we transition cleanly from an abstract production function to a structural export model:

$$AGEX_t = f(AGRILAND_t, CROPPRO_t, GDP_t, EXR_t, FDI_t, EIAW_t) \quad (4)$$

This theoretical derivation directly justifies our long-run linear empirical model:

$$AGEX = C + \alpha_1 AGRILAND + \alpha_2 CROPPRO + \alpha_3 GDP + \alpha_4 FDI + \alpha_5 EXR + \alpha_6 EIAW \quad (5)$$

This equation indicates that our independent variables have an ability to predict the levels of exportations, not because of luck, but rather due to their balance system, where limitations on productions and demands for local consumptions determine what can be exported.

Evaluation and Diagnostic Techniques

To examine the above-mentioned model and see the accomplishment of the goals of this paper, ARDL method was employed. Unlike methods like DOLS and FMOLS that work when variables are only I(1), the ARDL model is favorable in situations where variables are both I(1) and I(0) (Adil & Hatekar, 2023; Kripfganz & Schneider, 2023; Safuan et al., 2021). Augmented Dickey Fuller (ADF) and Residual Augmented Least Squares-ADF (RALS-ADF) tests were used to determine if the variables are integrated (Eweade & Güngör, 2024; Pata & Balçilar, 2025; Seraj et al., 2025). Secondly, the Engle-Granger (EG) cointegration method and the RALS EG cointegration tests was employed to further

examine the integration on these variables (Han, 2025). Because of certain characteristics that are missing in traditional cointegration methods, the RALS-EG cointegration test was employed in this study. The RALS-EG test serves many advantages more than the traditional methods which made it very appropriate for our data set. According to (Akduğan & Pehlivan, 2025; Jeffery-schwikkard, 2024; Pata et al., 2022). RALS-EG takes into account extra higher moment information found in non-normal errors, it also particularly handles non-normal errors, by employing conventional least squares estimates, the RALS-EG approach improves resilience when the model's error components have an abnormal distribution.

The EG method, on the other hand, is a two-step cointegration test that takes into account t-statistics and residuals. In the first step, the ADF is used to test each variable's order of integration to see the unit root of each variable. If all of the variables are stable at I(1), we go to the next step. If it's stable at I(0), you do not have to advance to the next stage. In stage 2, the method evaluates the possible long-run association using the OLS method. The results are of no use if the variables are found to be I(1), if the variables are confirmed to have a long-run relationship, then the OLS gives good linear estimators. If variables show both I(1) and I(0), then it is concluded that there is no long-run relationship.

The ADF equation (Eq. 6) and RALS equation (Eq. 7) are shown below.

$$\Delta u^{\wedge}_t = \phi_0 + \phi_1 u^{\wedge}_t + \sum_{i=1}^q \phi_{i+1} \Delta u^{\wedge}_t + \vartheta_t \quad (6)$$

The RALS equation suggested by (Meng et al., 2017) is below, and $m_i = T^{-1} \sum_{i=1}^T u^{\wedge}_t$

$$y^{\wedge}_t = [u^{\wedge}_t{}^2 - m_2, u^{\wedge}_t{}^2 - m_3 - 3m_2 u^{\wedge}_t] \quad (7)$$

If we add in $w^{\wedge}_t$ to Eq. 4, the RALS will be depicted as Eq.8

$$\Delta u^{\wedge}_t = \phi_1 u^{\wedge}_{t-1} + \sum_{i=1}^q \phi_{i+1} \Delta u^{\wedge}_t + w^{\wedge}_t \gamma + \vartheta_t \quad (8)$$

The ARDL model equation is shown below

$$\Delta AGEX_t = \alpha_0 + \sum_{i=1}^{n_1} \alpha_1 \Delta AGEX_{t-i} + \sum_{i=1}^{n_2} \alpha_1 \Delta AGRILAND_{t-i} + \sum_{i=1}^{n_3} \alpha_1 \Delta CROPPRO_{t-i} + \sum_{i=1}^{n_4} \alpha_1 \Delta GDP_{t-i} + \sum_{i=1}^{n_5} \alpha_1 \Delta FDI_{t-i} + \sum_{i=1}^{n_6} \alpha_1 \Delta EXR_{t-i} + \sum_{i=1}^{n_7} \alpha_1 \Delta EIAW_{t-i} + \theta_1 AGEX_{t-i} + \theta_2 AGRILAND_{t-i} + \theta_3 CROPPRO_{t-i} + \theta_4 GDP_{t-i} + \theta_5 FDI_{t-i} + \theta_6 EXR_{t-i} + \theta_7 EIAW_{t-i} + \varepsilon_t \quad (9)$$

This study examines the long-term effects of GDP growth, Agricultural land, Foreign direct investment, Employment in agriculture, female, Crop production index, and Official Exchange Rate on Nigeria's Agricultural raw materials exports.

RESULTS AND DISCUSSION

Results

This part of the paper represents the stationarity test results. This paper used ADF and RALS-ADF unit root tests for all the variables. The results of the ADF test show that all variables are not stationary at the level of I(0), excluding Agriculture Land (AGRILAND), which was stationary at I(0). At first difference I(1), the ADF results show that all the variables become stationary. Furthermore, we used the RALS-EG test to determine if unit roots were present throughout the period under investigation to provide more reliable outcomes. This test provides a more realistic outcome unit root test in the existence of non-normal errors and possible structural breaks. The unit root test results of the RALS-ADF show that all variables are not stationary at level I(0), except for Agricultural Export (AGEX), Agriculture Land (AGRILAND), and Gross Domestic Product (GDP), but all variables become significant at first difference I(1). Therefore, none of the tests offers enough proof to reject the null hypothesis (H0) that all variables have a unit root, except for Agricultural Export, Agriculture Land, and Gross Domestic Product. The results of the unit root test provide contradictory opinions

on the stationarity characteristics of the variables. As a result, we used the ARDL approach, which supports mixed integration order series of I(0) and I(1) (Lan et al., 2026; Nurgazina et al., 2022; Salan et al., 2025).

Table 2. Unit root test results

Variables	ADF	RALS-ADF	ρ^2
AGEX	-2.21	-3.07*	0.66
AGRILAND	-2.65*	-3.14*	0.55
CROPPRO	-1.02	-2.24	0.85
EIAW	-1.06	-1.67	0.58
EXR	-1.72	-1.99	0.62
FDI	-1.82	-1.76	0.82
GDP	-2.83	-3.22*	0.86
<i>First Difference</i>			
Δ AGEX	-5.04***	-5.44***	0.69
Δ AGRILAND	-4.30***	-14.94***	0.73
Δ CROPPRO	-2.95**	-3.65**	0.89
Δ EIAW	-2.93**	-3.36**	0.68
Δ EXR	-3.76***	-11.34***	0.78
Δ FDI	-6.67***	-7.31***	0.82
Δ GDP	-7.22***	-7.48***	0.93

Note: ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. The 1%, 5%, and 10% critical values for the ADF are -3.58, -2.93, and -2.60, respectively. The 1%, 5%, and 10% critical values for the RALS-ADF are -3.75, -3.30, and -3.05, respectively.

This study uses both traditional EG and the recently recognised RALS-EG cointegration tests to check if there is a long-term cointegration relationship between the variables. The results for the EG and RALS EG cointegration tests are stated in Table 3. rate of the EG test statistics is -4.83, which is less than the critical value of -4.32 at 5% significance level, so the null hypothesis H0 that states that there is no cointegration between variables is rejected for this test. Likewise, the rate of the RALS-EG statistics is -4.63, and is also lower than the critical value of -4.32 at 5% significance level, which rejects the null hypothesis. In conclusion, the results show there is a long-term relationship between the independent variables and the dependent variable at 5% significance level.

Table 3. RALS cointegration test results

Methods	K	Test statistics	ρ^2
EG	0	-4.83**	—
RALS-EG	0	-4.63**	0.97

Note: ***, **, and * denote importance at the 1%, 5%, and 10% levels, accordingly; K represents the optimal lag length discovered using recurrent statistics; the 1%, 5%, and 10% necessary values for the EG test are -5.02, -4.32, and -3.98, respectively; and the 1%, 5%, and 10% critical values for the RALS-EG test are -4.80, -4.19, and -3.88.

Cointegration would have to exist for long-term estimations to be reliable, stated (Khalid et al., 2024; Solarin et al., 2024). We see that ADF and RALS-ADF test show a mixture of I(0) and I(1) findings concerning the stability of the variables from the unit root test, so to further justify the cointegration of the variables, we ran an additional test, which is the ARDL F-bounds cointegration test. In Table 4, the results of the ARDL F-bounds test show that the F-statistic is 6.12761, which is more than the upper critical bound I(1) with the F-statistic of 5.691 at n=30, at 1% significance level. Hence, the null hypothesis, which states that there is no level relationship, is rejected, so the ADRL F-bound tests verify that there is a long-term relationship between variables, just like the RALS-EG test shows.

Table 4. ARDL Bounds Test Results

Test Statistic			Value			
F-statistic			6.127615***			
	10%		5%		1%	
Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
30	2.334	3.515	2.794	4.148	3.976	5.691
Asymptotic	1.990	2.940	2.270	3.280	2.880	3.990

Note: ***, ** and * indicate the significance in 1%, 5% and 10% respectively. I(0) and I(1) are respectively the stationary and non-stationary bounds.

The results in Table 5 show that Agricultural land has a positive effect and is significant at 5%. A 1% increase in agricultural land will boost agricultural exports by 1.95% in the long run. As more land is been used for agricultural purposes, in the long run, food and crop production will increase, eradicating the threat of food insecurity. However, the CROPPRO long-term estimation turns out to be significant at the 1 percent level, while presenting an interesting negative sign. In particular, one percent increase in the overall index of crop production in the country is associated with 0.36 percent decline in agricultural raw materials exports (AGEX) in the long run. The above negative association implies that there has been a very significant restructuring within the Nigerian agriculture. Instead of simply decreasing the exportability due to some random factors, such a negative coefficient shows that there have been some policy and market changes in the pattern of crops production in the country. Owing to food security concerns and huge population pressure, agricultural resources have been allocated to domestically consumed food staples.

Women Employment in Agriculture (EIAW) is highly significant (1%) but has a negative effect on agricultural exports in the long run. For instance, a 1% increase in the participation rate of female labor in the agricultural sector results in a reduction of 0.56% in agricultural raw materials export. Such negative elasticity suggests an underlying structural feature in terms of the allocation of labor within the agricultural sector in Nigeria. An increase in the level of labor participation among women suggests a transition from commercial farming in favor of subsistence farming among small farmers. As female labor is involved mainly in subsistence farming for food security purposes, an increased level of such activity signals a relative decrease in cash crop production. The exchange rate will increase exports by 0.07%, but it's not statistically significant. FDI is also not statistically significant, just like EXR, but will increase AGEX by 0.35%. This may be because both EXR and FDI effect is more defined in the short run rather than long run. GDP, on the other hand, is statistically significant at 5% significance level, and shows a negative relationship. Economic growth reduces exports by 0.41% long term. This is due to shift from the agricultural sector to the oil sector. Intercept shows a negative relationship and is not statistically significant at any of the significance levels.

Table 5. ARDL Long-run Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AGRILAND	1.953433	0.812714	2.403592	0.0333**
CROPPRO	-0.357484	0.088412	-4.043398	0.0016***
EIAW	-0.557604	0.161428	-3.454194	0.0048***
EXR	0.007686	0.012777	0.601515	0.5587
FDI	0.357023	0.370412	0.963854	0.3541
GDP	-0.406057	0.144245	-2.815042	0.0156**

Note: ***, ** and * indicate the significance in 1%, 5% and 10% respectively

The short run error correction term (ECM(-1)) offers valuable insights into the systemic dynamics of convergence within our model. The ECM(-1) coefficient for the present analysis, as shown in Table 6, amounts to -1.4655 with a negative sign that is consistent with expectations and also highly significant at the 1% level. In time series terms, an error correction parameter ranging in absolute

value between 1.0 and 2.0 indicates a very dynamic or oscillatory process of convergence. This suggests that any short run shocks or disturbances within the system of agricultural trade relations in Nigeria will not be corrected through a monotonous convergence process to steady state equilibrium. On the contrary, when there is a shock in the short run, there is an over-correction in the next period amounting to 146.55% in absolute value of the error correction factor, such that the trade relationship oscillates in dampened cycles until equilibrium is achieved in the long run.

AGRILAND shows a positive relationship in the short run and it is statistically significant at the 1% significance level. So, a 1 hectare increase in land use will approximately increase AGEX by 1.25%. Nigeria has a lot of land which can be expanded by land conversion, because there is a lot of land available for agriculture, this will increase productivity, as productivity increases, there will be an increase in crop production, which will increase the exports of raw materials to foreign countries. CROPPRO also shows a positive relationship, and it is statistically significant at 1% significance level in the short run. An increase in CROPPRO will increase AGEX by 0.14%. When there is an increase in the number of crops produced in a country, there will be a surplus of that crop, so a country can be better off and gain from the surplus by selling it (exporting) to other countries. EIAW on the other hand shows a positive relationship, but it is not statistically significant, so in the short run, employment of women in the agricultural field does not have any influence on AGEX. The reason behind this could be because of lack of access to new technologies, so even if employment increases, there is no efficient way to increase productivity, everything is done manually, slowing down the production. For EXR it is statistically significant at 1% significance level, and it depicts a negative relationship, an increase in EXR will decrease exports by 0.04%. if Naira depreciates, then the price of goods will decrease in the country, so farmers will prefer to sell at home rather than exporting to a foreign country. GDP depicts a negative relationship result, and it is statistically significant at 1% significance level, an increase in GDP growth will decrease AGEX by approximately 0.19% the reason why AGEX decreases GDP rather than increasing it, is because there has been a shift to focus more on the oil sector rather than the agricultural sector, as before, Nigeria was known for its agriculture.

Table 6. ARDL Short-run Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECM(-1)	-1.465538	0.166349	-8.810020	0.0000***
D(AGEX(-1))	0.945042	0.136390	6.928992	0.0000***
D(AGRILAND)	1.245841	0.279639	4.455184	0.0003***
D(CROPPRO)	0.145805	0.036195	4.028332	0.0007***
D(EIAW)	0.150822	0.152071	0.991787	0.3338
D(EXR)	-0.040459	0.008044	-5.029695	0.0001***
D(GDP)	-0.185942	0.047349	-3.927085	0.0009***

*Note: ***, ** and * indicate the significance in 1%, 5% and 10% respectively.*

Discussion

The interactions as observed through the empirical modeling we employ clearly indicate that the course of Nigeria's agricultural exports is not solely dependent on individual market dynamics but is highly influenced by historical structural inequalities in the country's socio-economic environment. Rather than simply stating our regression results, a more thorough consideration of these shifters presents a clearer depiction of an agricultural industry struggling with structural oil industry dependency, land disputes, and institutional barriers.

Real Estate Friction and Land Availability Dynamics

The robust positive influence exerted by land usage for agriculture (AGRILAND) reinforces the fact that an increase in the amount of cultivated land available continues to be one of the key means to enhance trade. Nevertheless, in the case of Nigeria, this index serves as another manifestation of the severe land policy issues that exist there. The registration of lands is a lengthy procedure in terms of bureaucracy and expenses under the Land Use Act, which implies that most rural cultivators cannot

afford to legalize their property rights. Lacking tenure security, the families do not see any motivation in implementing expensive innovations on the lands they work. Rather, expansion usually happens via informal changes in land use or even clearing forests, leading to local environmental destruction and conflict between herders and farmers. It becomes clear that having available lands alone does not suffice for improving trade; thus, additional land policy measures should be introduced.

The Resource Curse and the Agricultural Shift

The consistent negative correlation between GDP growth rate and agricultural exports demonstrates that Nigeria continues to experience the "Dutch Disease," a long-term phenomenon in the Nigerian economy. In particular, the economic growth theory in the country has been concentrated on the extraction of crude oil and development of urban economies, thereby neglecting the importance of the rural agricultural sector.

As economies become urbanized, they attract more labor force, young people, and government funding from rural areas, which causes the problems for the nation's export potential. The two most significant effects of this process include:

1. **Labor Drain:** The migration of young people results in an older age demographic of the rural population, who have only low-productivity manual cultivation of crops.
2. **Change in Focus for Crops:** The capital left in agriculture should be used to produce food crops necessary to meet the needs of the increasing population rather than commercial cash crops.

Capital Barriers and FDI Distortions

The positive but insignificant contribution of foreign direct investment (FDI) reveals one of the main problems faced by foreign investment and agriculture in Nigeria. Although international finance goes into Nigeria, it demonstrates a very high urban bias, going towards oil production, telecoms, and construction industries. The small part of FDI that goes into agriculture becomes a captive to corporate agricultural enterprises and does not reach small farmers. As a result, small farmers do not benefit from technology transfer through international firms and do not receive modern processing equipment or have an opportunity to enter international value chains. Consequently, due to the lack of investment, rural communities get trapped in the production of raw commodities, because of the high cost of transactions, poor rural transportation infrastructure, and unreliable electricity supply preventing local harvests from being converted into exported goods. In order to stimulate foreign investment for trade promotion, policymakers should focus on decentralization and support rural infrastructure, including refrigeration systems and local transport facilities.

Deconstructing the Female Labor Paradox: Field Implementation and Training Outcomes

The statistical correlation in the negative direction between the level of participation of women in agricultural labor (EIAW) and the number of national exports (AGEX) represents a pivotal diagnostic indicator related to the inner nature of Nigeria's agrarian economy. On a mathematical note, one percent rise in this labor indicator corresponds to a decrease in foreign agricultural trade by 0.56 percent. Considering the opinion of the agricultural expert, such a negative link helps us uncover the inherent gender divide between household subsistence agriculture and trade channels. The process of agricultural production in rural Nigeria can be divided into two groups along the dimension of gender: women engage in household subsistence agriculture concentrated on food production for family consumption, and men actively engage in cash crop cultivation for export purposes. An increase in agricultural labor by women, thus, means a decrease in export capacity of Nigeria. Rather, it indicates increased activity in agricultural production on marginal farming lands. This situation is greatly affected by deliberate institutional barriers to program impact:

1. **Subsistence-Driven Project Frameworks:** Activities noted within the context of regional development institutions show that whenever female cooperative leaders gain extension assistance, the skills learned are limited only to the management of domestic crop life cycles and not on gaining an understanding of the complex process of managing global value chains or international trade systems.

2. **Asset Insecurity and Capital Constraints:** Traditions and norms prevailing in rural communities often result in women farmers not owning any legally recognized assets, which denies them the necessary resources to access financing options, thus preventing them from using innovative techniques of agriculture as showcased by field programs.
3. **Asymmetric Extension Infrastructure:** Since formal agricultural extension networks have always been geared towards supporting cash-crop industries controlled predominantly by men, it results in women farmers facing a serious deficiency in the domain of farmer knowledge of internationally accepted standards regarding phytosanitary norms and export grading criteria.

Therefore, with the increase in the percentage of women participating in agricultural activities in such very controlled settings, production remains both localized and manual. The entrenchment of women into these subsistence cycles will result in increased costs of production relative to the exports, which is why increased participation in agriculture by women results in lower exports by the country in the long run. The only solution is transforming trade policies into community empowerment frameworks where women have equal access to property and capital.

The Crop Production Index Paradox: Post-Harvest Program Impact and Loss Mitigation

In contrast with classical trade models, the long-term statistically significant negative effect of CROP PRODUCTION INDEX (CROPPRO) on EXPORTS (AGEX) reveals a crucial trade structure problem in the Nigerian agrarian economy. As per agricultural economics theory, an increased production index ought to lead to higher potential in terms of trade. Nevertheless, the negative coefficient -0.357 signifies a situation whereby the growth rate in consumption of domestic food far exceeds that of export channels, leading to changes in Nigeria's crop structure. Over the period under analysis, the agricultural sector in Nigeria has had an extensive change in terms of shifting from export crops including cocoa, rubber, and groundnuts to domestic food items like cassava, yams, and maize.

The effect of this redistribution is such that, although the general index increases, the portion of the agricultural products that can be traded decreases. In addition, this disparity is accentuated by the existence of an unequal chain of value. It has been reported that the issue of post-harvest losses, as well as international grading requirements for the quality of the produce, continues to pose a challenge in terms of building the necessary infrastructure for exports. When there are bumper harvests on food items, due to the lack of processing and cold chain services, there is fast deterioration in the domestic market, not export. In essence, agricultural development in Nigeria is highly introverted, with all the resources being utilized by an increasing population.

Despite short-run positive effects of surplus on exports, long-run negative elasticity reflects poor post-harvest programs and a total absence of any kind of storage facilities:

1. **Spoilage Bottleneck:** Increased domestic output exceeds the capabilities of Nigeria's poorly-developed rural logistical network and, thus, triggers serious problems in terms of spoilage of goods before their delivery to ports.
2. **Non-Compliance Quality Challenges:** According to local reports on activities, many products harvested in Nigeria are unable to meet sanitary and phytosanitary (SPS) requirements because of improper handling or lack of drying and/or grading processes during storage.
3. **Local Market Overload:** With no ability to access global trade network, increased output causes a situation when local market becomes overloaded by goods, thus driving prices down.

From here, one should understand that increasing the production indexes does not make economic sense without the corresponding development in post-harvest programs and operations. For this reason, seed and fertilizer distribution should be only an initial step of development plans and efforts. Construction of processing centers and conducting educational seminars about export regulations are necessary for ensuring effective results in the future.

Institutional and Operational Pathways for Technology and Policy Implementation

The substantial long-run negative impact of women's involvement in agricultural activities (EIAW) revealed through our modeling process highlights an immediate need for policy change. This clearly demonstrates that simply adding female participation in agriculture without resource provision will limit trade possibilities in the country. In order to ensure that the National Gender Policy on Agriculture acts not only as a mere paper but as an efficient tool for generating more trade opportunities in the country, Nigeria should implement three major policies.

1. Targeted Export Credit Lines for Female Agro-Entrepreneurs
 - a. The Policy Tool: The Central Bank of Nigeria, in collaboration with the Nigerian Export Promotion Council (NEPC), is supposed to introduce a special Female Agrarian Export Credit Line. Such a policy tool is expected to offer interest-free, non-collateralizable loans to women-operated agricultural businesses.
 - b. The Operational Effect: Using alternative approaches for credit scoring, such as transaction histories from mobile banking services or cooperative credit monitoring systems, the above-mentioned credit line does not require any formal proof of property ownership. Thus, female small-scale farmers can obtain the necessary financial resources for the purchase of agricultural inputs and processing equipment.
2. State-Backed Cash-Crop Cooperatives for Women
 - a. The Policy Mechanism: Ministry of Agriculture at regional level needs to provide subsidies and organize the establishment of agricultural co-operatives exclusively comprising of women working together in the production of premium cash crops including cocoa, cashew, and sesame.
 - b. Operational Effect: Collective land holdings in a well-defined format based on small land holdings gives women a built-in economy of scale. Such co-operatives would function as institutional docking points of subsidized mechanical machinery such as solar-based drying units and miller machinery. This approach ensures that there is no scope for middlemen exploitation in local areas allowing direct negotiations with global syndicates.
3. Gender-Targeted Export-Compliance Training
 - a. Policy Mechanism: There needs to be a mandatory Export Readiness Workshop for all communities organized by the National Agricultural Extension and Research Liaison Services with the female farmers as the intended beneficiaries.
 - b. Operational Outcome: The workshops need to go beyond the basics of mere subsistence training and ensure that there is comprehensive training of the farmers on SPS standards, maximum residue levels, and grading criteria. Record keeping within villages would guarantee that the efforts of the female workforce do not result in any wastage or fail to adhere to international trade standards.

Nigeria can overcome the structural roadblocks that prevent female workers from being integrated into the agrarian economy through these integrated policies. Women can be given export lines to enable them to engage in export activities, have the economic empowerment of cash crops via cooperatives, and compliance mastery training to convert this under-utilized segment into a major player in agrarian trade development (inclusive targets of SDGs 1, 2, and 15).

CONCLUSION

Empirical results from this study provide an elaborate empirical view of the structural dynamics that govern the export of agricultural raw materials in Nigeria. This approach goes beyond mere reliance on statistical indices by examining how various trade and institutional policies impact the very existence of rural farmers.

In the country, the real effects of macro-level structuring measures will be experienced at the grassroot level of smallholder clusters. Our ARDL regression shows that the use of land (AGRILAND) plays an important role in generating export growth over time. Nevertheless, the negative signs of long-run coefficients on female labor force (EIAW) and crop indexes (CROPPRO) point to the fact that

just producing more is not enough. What makes a difference is how well the structuring measures help overcome the constraints that confine smallholder farmers in rural areas. Real structuring happens only when policies do not content themselves with supervision but actually work to disentangle the constraints of asset ownership and gender segregation of the female smallholders.

By shifting the focus of trade policies toward inclusive growth, the impact on rural communities engaged in agriculture is quite straightforward and tangible. As the country's agricultural policies move from simply having low-value commodity outputs to having a more focused process that adds value locally, the small-scale farmers benefit immediately. By addressing the issue of disparity in gender productivity through allocation of assets and access to financial resources, the lives of women can be changed drastically. The change will elevate the position of women from being insecure subsistence workers to becoming financially stable cooperatives members.

On this note, success will not merely be measured on the basis of export figures of the whole country. The success story lies in creating an integrated and efficient system for the agricultural sector. True success will lie in putting into place an integrated post-harvest management plan which would go against the grain of the CROPPRO paradox. In this case, higher output must translate into greater economic gains, but this will happen only if the higher output does not get spoiled at the post-harvest level.

In order for the agriculture trade strategy of Nigeria to be sustained throughout time, sustainability will have to be embedded in the domestic policies that the country implements. Sustainable stability is only achieved when there is consistent funding for rural infrastructure like decentralized solar power cold storage centers, good quality processing plants, and transport services. Moreover, ecological sustainability should also be taken into account alongside commercial success to ensure that the expansion of agricultural lands does not lead to environmental damage.

Through the linkage between foreign currency stabilization tools (EXR) and institutions such as the National Gender Policy on Agriculture, the trade architecture of Nigeria will become self-sustaining. This will enable the achievement of long-term foreign direct investments while also ensuring that rural communities remain insulated from the fluctuations in the global economy, aligning the agricultural sector of Nigeria with SDG 15.

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AUTHOR CONTRIBUTION STATEMENT

MS: Conceptualization, Validation, Formal Analysis, Methodology, Software, Supervision, Visualization, Writing – Review & Editing.

UAI: Data Curation, Writing – Original Draft.

FTS: Conceptualization, Investigation, Writing Original Draft.

AI DISCLOSURE STATEMENT

The authors affirm that this work was prepared, analyzed, written, and edited without the aid of artificial intelligence (AI) technologies or techniques. The published work's integrity and content are entirely the writers' responsibility.

CONFLICTS OF INTEREST

The authors affirm that they have no financial, institutional, personal, or other conflicts of interest that would have affected how the study was conducted, how the data were analyzed, how the paper was prepared, or how it was published.

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