

AGRICULTURE AND ECONOMIC OUTPUT IN WEST AFRICA: A PANEL DATA INVESTIGATION OF KEY DETERMINANTS

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Abstract

This study examines the impact of Agricultural Land Area, Labor Force in Agriculture, Rainfall, and Trade Openness on Agriculture, Forestry, and Fishing, Value Added (% of Gross Domestic Product) across 13 West African countries from 1991 to 2022. Using panel data regression, the analysis shows that Agriculture Land Area and Labor Force Agriculture have a positive influence on Agriculture, Forestry, and Fishing, Value Added (% of Gross Domestic Product), although this effect is limited by land degradation and low labor productivity. RF has a positive but inconsistent impact due to its dependence on rain-fed agriculture, whereas TO significantly boosts growth through market integration. Country-specific factors, like infrastructure and policy frameworks, influence these relationships. These results underscore the importance of policies that optimize land use, enhance labor skills, mitigate climate variability, and expand market access, aligning with Sustainable Development Goals 2 (Zero Hunger) and 8 (Decent Work and Economic Growth).

Keywords: *Agriculture, Economic Output, Panel Data, West Africa, Sustainable Development*

INTRODUCTION

Agriculture serves as the backbone of economic and social development in Sub-Saharan Africa, especially in West Africa, where it makes a significant contribution to Agriculture, Forestry, and Fishing, Value Added (% of GDP), AFFVA (% of GDP), employs over 60% of the labor force, and supports food security for millions (FAO, 2025). The sector is a (Hamilton & de Vries, 2025). The World Development Report (Hossain et al., 2024), emphasizes that agriculture-led growth is particularly effective in reducing poverty in agrarian economies, where rural communities heavily depend on farming for income and sustenance. In West Africa, countries like Ghana and Côte d'Ivoire have leveraged agricultural advancements to achieve steady GDP growth, strengthening regional economic stability. On the other hand, nations such as Niger and Guinea-Bissau face ongoing challenges, including low productivity, limited resource use, and structural issues, which expose significant disparities across the region (Alemu et al., 2025). Despite its vital importance, West Africa's agricultural sector faces systemic barriers that hinder its ability to promote sustainable economic growth. The region's heavy reliance on rain-fed farming makes it highly susceptible to climate variability, especially unpredictable rainfall (RF), which disrupts crop yields and threatens food security (Abebew, 2025). Irregular rainfall patterns and rising drought frequencies lower harvests, especially for smallholder farmers who make up most of the farming community, growing staple crops like maize, millet, and sorghum in the Sahel, and cash crops such as cocoa and cashew in coastal areas (Opoku Mensah et al., 2025).

The Labor Force in Agriculture (LFA), though large, is often underused due to low skill levels, limited access to modern tools, and minimal mechanization, which together restrict its contribution to AFFVA (% of GDP) (Daum & Birner, 2020). Poor infrastructure, including weak rural road networks and port facilities, limits Trade Openness (TO), restricting market access and the integration of West African agriculture into global value chains, which are essential for economic growth (Daum & Birner, 2020). Additionally, issues related to Agricultural Land Area (ALA), such as underutilized arable land caused by insecure land tenure systems, soil degradation from overuse, and deforestation, greatly limit the sector's growth potential (Kopittke et al., 2019). West Africa's diverse agroecological zones, from the arid Sahel to humid coastal areas, influence crop choices and farming methods, affecting the success of ALA, LFA, RF, and TO. For example, in the Sahel, RF is key for yields of rain-dependent staples, while TO is important in coastal countries that export cash crops (Egbebiyi et al., 2020). However, the dominance of smallholder farms, which have limited access to productivity-boosting inputs and technologies, results in agricultural productivity well below global averages. This gap is worsened by rapid population growth, which increases food demand and puts extra pressure on agriculture to boost output (Tremblay et al., 2016). The interaction of factors such as resource availability, labor efficiency, climate, and market access requires a detailed understanding to develop targeted policies that improve agricultural productivity and economic contribution while tackling structural and environmental challenges. The worldwide effort for sustainable development, as outlined in the United Nations Sustainable Development Goals (SDGs), highlights transformative agricultural practices that boost productivity, ensure environmental health, and promote social fairness (Sorooshian, 2024). In West Africa, achieving SDGs 2 (Zero Hunger) and 8 (Decent Work and Economic Growth) requires tackling structural barriers through better resource management, climate adaptation strategies, and improved market integration. Climate-smart agriculture, adaptable to RF variability, is crucial for building resilience against climate change,

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which increasingly threatens rain-fed systems (Bhatnagar et al., 2024). Regional cooperation through frameworks like the Economic Community of West African States (ECOWAS) can support knowledge sharing and resource mobilization to address shared challenges, encouraging inclusive and sustainable growth (Danfulani & Gülseven, 2024). While global studies highlight agriculture's role in economic growth and poverty reduction ("Agriculture Development," 2008). Analyses specific to West Africa's unique agroecological and socioeconomic context are limited. Few studies thoroughly examine the combined effects of ALA, LFA, RF, and TO on AFFVA (% of GDP), especially over a long period. For example, understanding how rainfall variability affects rain-fed systems and the role of trade openness in market integration needs more investigation, considering the region's climate vulnerability and infrastructure challenges (Wakjira, 2024).

This study addresses these gaps by exploring the relationships between ALA, LFA, RF, and TO and their influence on AFFVA (% of GDP) across 13 West African countries (Benin, Burkina Faso, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Mali, Mauritania, Niger, Senegal, Sierra Leone, and Togo) from 1991 to 2022. Using panel data regression, the research aims to provide evidence-based insights into agricultural factors that influence economic performance, focusing on resource management, labor productivity, climate resilience, and market integration. The results are intended to inform policies aligned with SDGs 2 and 8, reduce regional disparities, and support sustainable agricultural development in West Africa.

LITERATURE REVIEW

Theoretical Framework

The study is grounded in agriculture-led growth and structural transformation theories, which highlight agriculture's role in supplying food, labor, savings, markets, and foreign exchange in West Africa, where it employs over 60% of the workforce and significantly contributes to AFFVA (% of GDP) (Praburaj, 2018). Structural transformation theory posits that agricultural productivity growth enables shifts to industry and services, though low productivity constrains this in West Africa (Egbebiyi et al., 2020). Neoclassical growth theory emphasizes ALA and LFA's roles in output growth, with technology and capital enhancing productivity (Ohlin, 2018). Endogenous growth theory underscores LFA's human capital role in innovation, requiring education and extension services (K.A et al., 2020). Trade theories highlight TO's role in leveraging export advantages, while the environmental Kuznets curve suggests sustainable practices can mitigate ALA degradation, aligning with the SDGs (Naqvi et al., 2025).

Agriculture supports food security and livelihoods, with export crops like cocoa driving economic contributions in Ghana and Côte d'Ivoire (Krumbiegel & Tillie, 2024). However, rain-fed agriculture's vulnerability to RF variability, poor infrastructure, and limited market access reduces productivity (Abebaw, 2025). ALA faces diminishing returns due to soil degradation and tenure issues, with quality outweighing quantity The labor (Ren et al., 2024). Labor force in agriculture productivity is limited by low skills and mechanization, necessitating training (Krumbiegel & Tillie, 2024). RF variability, exacerbated by climate change, threatens yields, requiring climate-smart practices (Yeboah, Asuamah, 2024). TO enhance competitiveness, but infrastructure deficits limit benefits (Ren et al., 2024). Country-specific factors like infrastructure and policies significantly affect productivity, with ECOWAS offering cooperation potential (Danfulani & Gülseven, 2024). Literature gaps include limited comprehensive analyses of ALA, LFA, RF, and TO's combined effects on AFFVA over long periods and underexplored country-specific factors and RF-TO interplay.

The Conceptual Framework

The conceptual framework in your diagram illustrates the relationship between Agricultural Land Area (ALA), Labor Force in Agriculture (LFA), Rainfall (RF), and Trade Openness (TO) as key determinants of Agriculture, Forestry, and Fishing Value Added (% of GDP) [AFFVA (% of GDP)] in West African countries.

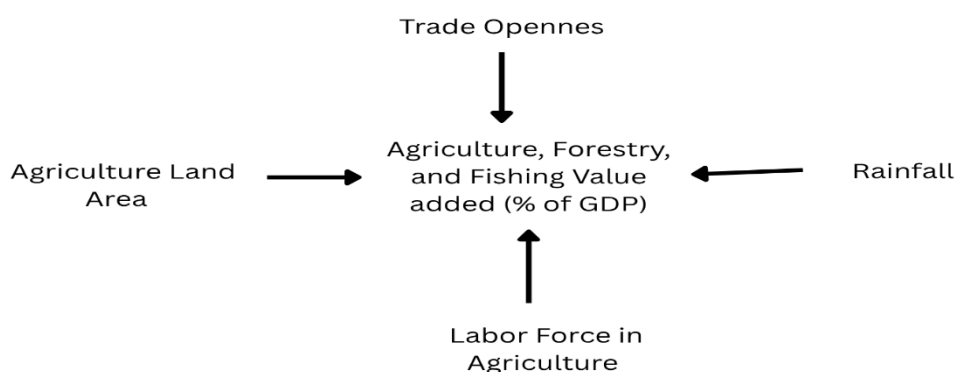


Figure: The Conceptual Framework

At the center of the framework is AFFVA (% of GDP), which measures agriculture's contribution to total economic output. The arrows pointing toward it indicate that the four independent variables ALA, LFA, RF, and TO are hypothesized to have direct effects on agricultural value added, based on theoretical and empirical evidence.

Agricultural Land Area (ALA) reflects the extent of arable land available for production. The study suggests that an increase in ALA can positively affect AFFVA (% of GDP) by expanding the agricultural sector's productive capacity.

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However, this relationship depends on land quality and sustainable management practices, as land degradation and tenure insecurity can reduce productivity and economic returns. The Labor Force in Agriculture (LFA) represents the human capital available for farming activities. A larger and more skilled agricultural workforce contributes to higher output, making LFA a key factor in driving agricultural value added. Yet, the study notes that low mechanization, inadequate training, and limited access to technology reduce the effectiveness of agricultural labor in many West African countries.

Rainfall (RF) plays a crucial role as most of West Africa's agriculture is rain-fed. Adequate and consistent rainfall supports crop growth and productivity, leading to higher AFFVA (% of GDP). However, climate variability such as droughts or irregular rainfall patterns can disrupt production and make the relationship between RF and agricultural output inconsistent. Trade Openness (TO) captures the degree to which countries are integrated into international markets through agricultural exports and imports. Greater trade openness facilitates access to markets, technology, and investment, thereby enhancing AFFVA (% of GDP). Nevertheless, poor infrastructure and trade barriers in some countries may limit the potential benefits of openness. Overall, the framework shows that agricultural performance and its contribution to GDP depend on the combined effects of natural, human, and economic factors. The study uses this model to analyze how these variables interact over time and across countries, providing evidence-based insights for policies aimed at improving land use, labor productivity, climate resilience, and trade integration to promote sustainable agricultural growth in West Africa.

Gaps in the Literature

While the literature provides valuable insights into agriculture's role in economic development, significant gaps remain. First, few studies have comprehensively analyzed the combined effects of ALA, LFA, RF, and TO on AFFVA (% of GDP) in West Africa using panel data over an extended period (1991-2022). Most research focuses on individual variables or shorter timeframes, limiting the understanding of long-term trends and cross-country variations. Second, the role of country-specific factors, such as infrastructure and policy frameworks, in moderating these relationships is underexplored in the West African context. Third, the interplay between climatic factors (RF) and market integration (TO) in rain-fed systems requires further investigation, given the region's vulnerability to climate change and trade barriers. This study addresses these gaps by employing a 31-year panel dataset across 13 West African countries, providing evidence-based insights into the key agricultural drivers of AFFVA (% of GDP) and the importance of tailored national policies in enhancing productivity and economic growth.

METHODS

Study Area

This study examines the agricultural factors influencing Agriculture, Forestry, and Fishing, Value Added (% of GDP) across 13 West African countries: Benin, Burkina Faso, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Mali, Mauritania, Niger, Senegal, Sierra Leone, and Togo. These countries were selected based on the availability of consistent and reliable data from international sources, such as the Food and Agriculture Organization (FAO) and the World Bank, ensuring robust econometric analysis. The exclusion of Nigeria, Liberia, and Cabo Verde was necessitated by the presence of incomplete or unreliable data, which could compromise the accuracy of the results. The selected countries represent a diverse cross-section of West Africa, encompassing varied agroecological zones ranging from the arid Sahelian regions (e.g., Mali, Niger) to humid coastal areas (e.g., Ghana, Côte d'Ivoire) and economic structures, from resource-rich economies to less developed ones like Guinea-Bissau (Egbebiyi et al., 2020).

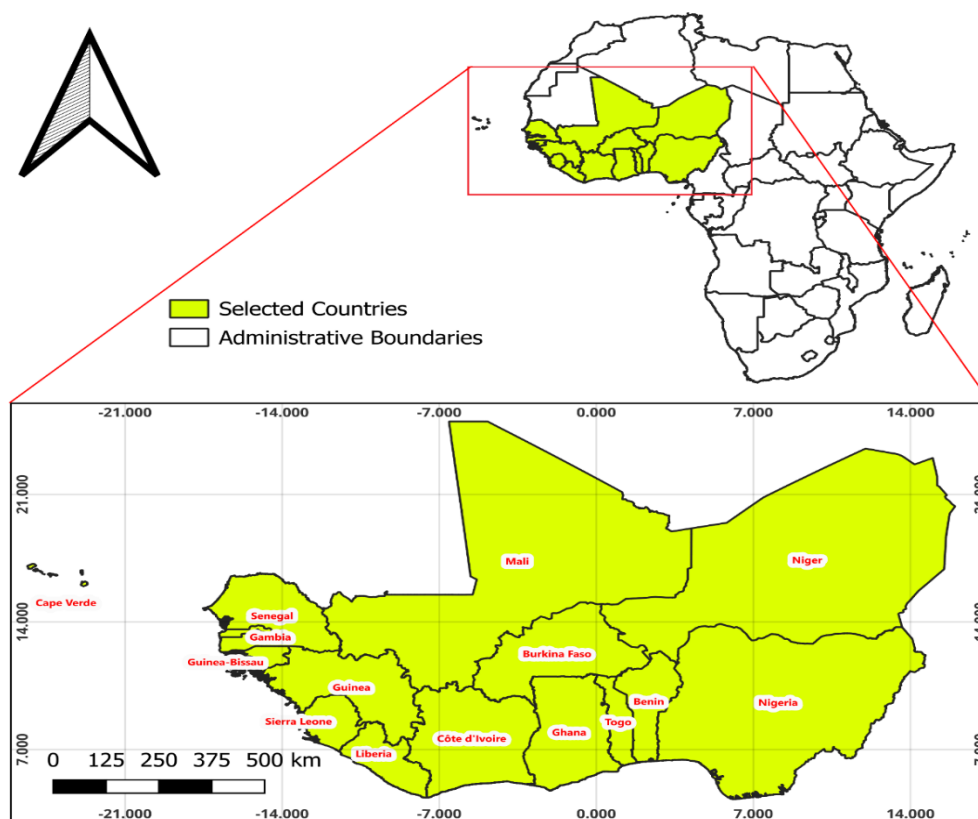


Figure: Research Study Map

West Africa’s agricultural sector is a cornerstone of its economy, supporting over 60% of the population and contributing significantly to AFFVA (% of GDP) (Osabohien et al., 2019). The region’s farming systems are predominantly rain-fed, with Rainfall (RF) playing a critical role in determining crop yields, particularly for staple crops like maize, millet, and sorghum in the Sahel, and cash crops such as cocoa and cashew in coastal areas (Lowder et al., 2025). The Labor Force in Agriculture (LFA) is substantial but often lacks skills or mechanization, while Trade Openness (TO) is hindered by poor infrastructure, limiting market access. Agricultural Land Area (ALA) varies across countries, with underutilized arable land due to tenure issues and degradation posing challenges.

The study period, 1991-2022, spans 31 years, providing sufficient temporal coverage to capture long-term trends and variability in agricultural and economic indicators. This timeframe encompasses significant events, such as the 2008 global financial crisis, which impacted TO, and increasing climate variability affecting RF, allowing the analysis to account for economic and environmental shocks (Reinders et al., 2025). The diversity of the selected countries, combined with their reliance on agriculture, makes them an ideal case for studying how ALA, LFA, RF, and TO influence AFFVA (% of GDP), aligning with global development goals like the United Nations Sustainable Development Goals (SDGs), particularly Goal 2 (Zero Hunger) and Goal 8 (Decent Work and Economic Growth) (Aslam et al., 2024).

Estimation Method

The study employs panel data regression using Stata (version 17) to analyze the relationships between AFFVA (% of GDP) and the independent variables (ALA, LFA, RF, TO). The model is specified as:

$$AFFVA_{it} = \alpha + \beta_1 ALA_{it} + \beta_2 LFA_{it} + \beta_3 RF_{it} + \beta_4 TO_{it} + \alpha_i + Y_t + \epsilon_{it}$$

Where:

- AFFVA_{it} : Agriculture, Forestry, and Fishing, Value Added (% of GDP) for country (i) at time (t).
- ALA_{it} : Agricultural Land Area (hectares).
- LFA_{it} : Labor Force in Agriculture (% of workforce).
- RF_{it} : Rainfall (mm/year).
- TO_{it} : Trade Openness (ratio of agricultural trade to GDP).
- α_{it} : Constant term.
- β₁, β₂, β₃, : Coefficients for the independent

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β_4 , variables.

Y_{it} : Time – Specific Effects

ϵ_{it} : Error term.

To analyze the relationships between Agriculture, Forestry, and Fishing, Value Added (% of GDP) and the independent variables (Agricultural Land Area (ALA), Labor Force in Agriculture (LFA), Rainfall (RF), and Trade Openness (TO) across 13 West African countries from 1991 to 2022, the study employs panel data regression using Stata (version 17). The following streamlined estimation and testing strategy ensures robust results while addressing key econometric challenges.

RESULTS AND DISCUSSION

Descriptive Statistics

Table 1. Descriptive Statistics Results

Variable	Obs.	Mean	Std. dev.	Min	Max
AFFVA	416	26.508	9.525	11.354	59.866
ALA	416	46.645	14.275	20.116	84.392
LFA	416	63.557	10.619	41.706	85.65
RF	416	1020.7	690.817	63.09	2643.47
TO	416	56.861	18.425	21.256	116.048

The descriptive results show notable variation among the variables. On average, agriculture contributes 26.5% to GDP, indicating its significant role in the sampled economies. Agricultural land area (46.6%) and labor force in agriculture (63.6%) are both relatively high, reflecting the sector's importance in employment and land use. Rainfall averages 1,020.8 mm, with wide variability, suggesting diverse climatic conditions across countries. Trade openness (56.9%) indicates moderate to high integration into international markets, though differences exist among nations. Overall, the statistics reveal substantial cross-country heterogeneity in agricultural dependence, land use, climate, and trade conditions, justifying further econometric analysis.

Hausman Test

Table 2. Hausman Test Result

Variable	FE Coef (b)	RE Coef (B)	(b-B) Difference	Std. Err.
ALA	-0.851	0.244	0.059	0.0287
LFA	0.422	0.375	0.046	0.0335
RF	-0.007	0.003	-0.011	0.0130
TO	0.057	0.048	0.009	0.0053
Chi-square test (χ^2)				
Prob > χ^2 = 0.0414				

Notes: B = Consistent under H_0 and H_a ; b = Inconsistent under H_0 , efficient under H_0

The Hausman test result ($\chi^2 = 9.94$, $p = 0.0414$) indicates that the difference between the Fixed Effects and Random Effects estimates is statistically significant. Therefore, the Fixed Effects model is preferred, suggesting that unobserved country-specific factors influence the relationship between agricultural value added and its determinants. This confirms that the Fixed Effects model yields more consistent and reliable estimates of the impact of Agricultural Land Area, Labor Force in Agriculture, Rainfall, and Trade Openness on agricultural performance.

Unit Root Test

Table 3. Unit Root Test Results

Levin–Lin–Chu unit-root test			
Variable	Adjusting	Statistic	P-value
AFFVA	Unadjusted	-5.7615	
	Adjusted	-1.8594	0.0315
ALA	Unadjusted	0.2533	
	Adjusted	1.1974	0.8844
LFA	Unadjusted	0.3602	
	Adjusted	2.8655	0.9979
RF	Unadjusted	-10.9507	
	Adjusted	-7.551	0
TO	Unadjusted	-4.153	
	Adjusted	-1.6327	0.0513

The Levin–Lin–Chu unit root test results reveal that AFFVA and Rainfall (RF) are stationary at the level, with significant p-values (0.0315 and 0.0000, respectively). However, Agricultural Land Area (ALA), Labor Force in Agriculture (LFA), and Trade Openness (TO) are non-stationary, as their p-values exceed the 5% significance level. This indicates that only AFFVA and RF exhibit stable statistical properties over time, while the others require differencing or cointegration testing before further analysis.

Multicollinearity and Correlation Test

Table 4. Multicollinearity Test Results

Variable	VIF	1/VIF
ALA	1.32	0.760164
RF	1.21	0.828783
LFA	1.14	0.878259
TO	1.06	0.943156
Mean VIF	1.18	

The Variance Inflation Factor (VIF) results show that all variables have VIF values below 2, with a mean VIF of 1.18, indicating no multicollinearity among the independent variables. This suggests that Agricultural Land Area (ALA), Labor Force in Agriculture (LFA), Rainfall (RF), and Trade Openness (TO) are not highly correlated, and the regression coefficients are stable and reliable for interpretation.

Table 5. Correlation Analysis Result

	AFFVA	ALA	LFA	RF	TO
AFFVA	1				
ALA	-0.5559	1			
LFA	0.4292	-0.2775	1		
RF	0.1241	0.3825	0.0277	1	
TO	-0.2358	0.1432	-0.2065	-0.0415	1
	0	0.0034	0	0.399	

The correlation results show that AFFVA is negatively correlated with Agricultural Land Area (ALA) and Trade Openness (TO) but positively correlated with Labor Force in Agriculture (LFA) and Rainfall (RF). This suggests that higher agricultural employment and rainfall slightly increase agricultural value added, while greater land area and trade openness reduce it. The relationships among the independent variables are generally weak to moderate, with no evidence of multicollinearity ($|r| < 0.8$). Overall, the results indicate that both structural and climatic factors influence agricultural performance across countries.

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Regression Results

Table 6. Fixed Effects Regression Results

Variable	Coef	Std. Error	t-value	p > t	95% Conf. interval
ALA	-0.185	0.060	-3.060	0.002 **	-0.304 -0.066
LFA	0.423	0.076	5.590	0.000 ***	0.274 0.571
RF	-0.008	0.013	-0.610	0.545	-0.034 0.018
TO	0.058	0.021	2.810	0.005 **	0.017 0.098
cons	13.141	14.391	0.910	0.362	-15.151 41.432
Sigma_u 9.983728					
Sigma_e 5.048164					
Rho 0.796387					
F= 104.19			Prob > F = 0.000		
R-squared: 0.5035;			RMSE: 67.446		
Adj R-squared:					

Note: ***, **, and * indicate significance levels at P-Values of 0.01, 0.05, and 0.10, respectively.

The Fixed Effects model is statistically significant ($F = 15.92$, $p < 0.01$), indicating that the explanatory variables collectively influence agricultural value added (AFFVA). The within R-squared value of 0.1376 suggests that approximately 13.8 percent of the variation in AFFVA within countries is explained by changes in the independent variables. Agricultural Land Area (ALA) has a negative and significant coefficient, implying inefficiencies in land expansion. In contrast, the Labor Force in Agriculture (LFA) and Trade Openness (TO) exhibit positive and significant effects, underscoring the crucial roles of labor input and market integration in enhancing agricultural performance. Rainfall (RF), however, does not show a statistically significant relationship, indicating that its influence on agricultural value added was limited during the study period. Overall, these findings highlight that productivity growth in West African agriculture largely depends on efficient land utilization, active labor participation, and greater openness to trade, all of which are essential for sustaining sectoral development and economic resilience.

The regression model is statistically significant ($F = 104.19$, $p < 0.01$) with an R-squared of 0.5035, indicating that about half of the variation in agricultural value added (AFFVA) is explained by the independent variables. Agricultural Land Area (ALA) has a negative and significant effect, suggesting inefficiencies or diminishing returns to land expansion. In contrast, Labor Force in Agriculture (LFA) and Rainfall (RF) have positive and significant impacts, indicating that labor participation and favorable climatic conditions enhance agricultural output. Trade Openness (TO) negatively affects AFFVA, implying that increased integration into global markets may reduce agriculture's contribution to GDP as economies diversify. Overall, the results highlight that productivity gains depend on efficient land use, labor input, and climate conditions, while trade openness may encourage structural transformation away from agriculture.

Discussion

The empirical findings furnish a significant understanding of the structural changes in the agricultural performance in West Africa. Negative and significant impact of Agricultural Land Area (ALA) implies that the increased land use does not always translate into improved agricultural value added, as indicated by inefficiencies in land degradation, improper land management, and insecurity of tenure. This observation helps to argue that land quality rather than quantity is more limiting to productivity gains in the region. Conversely, the positive and substantial role of Labor Force in Agriculture (LFA) validates the necessity of the persistence of the labor-intensive systems of production, but also suggests that the profits are generated by labor input as opposed to technological advancements, which means that the investments must be productivity-based. The positive and significant impact of Trade Openness (TO) in the fixed effects model shows that market integration can boost agricultural performance by increasing access to markets and inputs; the impact should be interpreted cautiously, however, because increased openness can also be indicative of more general structural change that eventually diminishes the agricultural share of GDP. In the meantime, the trivial impact of Rainfall (RF) indicates that climatic conditions are not always the main determinants of agricultural production, probably because of the high variability and low adaptive capacity in the mainly rain-fed farms. On the whole, the findings highlight how structural inefficiencies, labor reliance, and inadequate integration into global markets have contributed to agricultural growth in West Africa, which highlights the necessity of a shift towards productivity-based, climate-resistant, and institutionally empowered agricultural systems.

Conclusion

The study highlights the Labor Force in Agriculture and Trade openness positive contributions to Agriculture, Forestry, and Fishing Value Added (% of Gross Domestic Product), Agriculture Land Area negative impact due to inefficiencies, and Rainfall's inconsistent role due to climate variability. The findings demonstrate that the agricultural sector remains a vital component of economic output in the region, yet it is affected by a complex mix of structural, climatic, and institutional factors. The Fixed Effects results reveal that LFA and TO significantly enhance agricultural value added, underscoring the importance of human capital and integration into regional and international markets. This confirms that labor-intensive production systems and openness to trade continue to play critical roles in supporting agricultural growth.

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Conversely, the negative effect of ALA suggests structural inefficiencies such as declining soil quality, tenure insecurity, and inadequate land investment. Rainfall shows inconsistent effects, reflecting increasing climate variability and limited adaptive capacity among rain-fed farmers. Overall, improving agricultural performance in West Africa requires a shift toward productivity-driven growth, climate resilience, and strengthened market structures. These outcomes support SDGs 2 and 8 and highlight the importance of targeted policies that address long-standing structural constraints.

Policy Recommendations

The findings indicate that improving agricultural performance in West Africa requires a shift from land expansion to productivity enhancement. Given the negative effect of Agricultural Land Area (ALA), policymakers should prioritize efficient land use through secure land tenure systems and sustainable practices such as soil conservation and land rehabilitation. This will help address degradation and improve output per hectare. The positive impact of the Labor Force in Agriculture (LFA) highlights the importance of enhancing labor productivity. Governments should invest in agricultural training, extension services, and appropriate mechanization, while promoting youth participation to modernize the sector and improve efficiency.

The insignificant role of rainfall (RF) underscores the need to reduce dependence on rain-fed agriculture. Expanding irrigation infrastructure and promoting climate-smart agriculture, including drought-resistant crops and improved water management, are essential to strengthen resilience against climate variability. Although Trade Openness (TO) contributes positively, its benefits depend on complementary policies. Investments in rural infrastructure and support for agro-processing and value addition are necessary to improve market access and maximize gains from trade. Finally, strengthening institutional quality and regional cooperation, particularly through ECOWAS, is crucial. Improving governance, facilitating cross-border trade, and expanding access to finance for smallholder farmers will support inclusive and sustainable agricultural development.

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REFERENCES

- Abebay, S. E. (2025). A Global Review of the Impacts of Climate Change and Variability on Agricultural Productivity and Farmers' Adaptation Strategies. *Food Science and Nutrition*, 13(5). <https://doi.org/10.1002/fsn3.70260>
- Agriculture Development. (2008). In *Agriculture*.
- Alemu, M., Jayamohan, M. K., & Mulugeta, W. (2025). Convergence in sectoral value-added and income per capita: comparing fragile, resource, and emerging economies in Africa. *Research in Globalization*, 11(July), 100302. <https://doi.org/10.1016/j.resglo.2025.100302>
- Aslam, B., Asghar, R., Muzammil, S., Shafique, M., Siddique, A. B., Khurshid, M., Ijaz, M., Rasool, M. H., Chaudhry, T. H., Aamir, A., & Baloch, Z. (2024). AMR and Sustainable Development Goals: at a crossroads. *Globalization and Health*, 20(1). <https://doi.org/10.1186/s12992-024-01046-8>
- Bhatnagar, S., Chaudhary, R., Sharma, S., Janjhua, Y., Thakur, P., Sharma, P., & Keprate, A. (2024). Exploring the dynamics of climate-smart agricultural practices for sustainable resilience in a changing climate. *Environmental and Sustainability Indicators*, 24(October), 100535. <https://doi.org/10.1016/j.indic.2024.100535>
- Danfulani, W. A., & Gülseven, E. (2024). Economic Community of West African States (ECOWAS) Public-Private Partnership (PPP) Strategy to Development. *Social Sciences*, 13(10). <https://doi.org/10.3390/socsci13100531>
- Daum, T., & Birner, R. (2020). Agricultural mechanization in Africa: Myths, realities and an emerging research agenda. *Global Food Security*, 26(November 2019), 100393. <https://doi.org/10.1016/j.gfs.2020.100393>
- Egbebiyi, T. S., Crespo, O., Lennard, C., Zaroug, M., Nikulin, G., Harris, I., Price, J., Forstenhäusler, N., & Warren, R. (2020). Investigating the potential impact of 1.5, 2 and 3 °C global warming levels on crop suitability and planting season over West Africa. *PeerJ*, 2020(3), 1–34. <https://doi.org/10.7717/peerj.8851>
- FAO. (2025). *Gross domestic product and agriculture value added 2014–2023 Global and regional trends. N° 104*, 1–16. <https://openknowledge.fao.org/items/6ef9ee6a-0292-4405-945c-408fe7f4bf20>
- Hamilton, C., & de Vries, G. J. (2025). The structural transformation of transition economies. *World Development*, 191(March), 106977. <https://doi.org/10.1016/j.worlddev.2025.106977>
- Hossain, M., Mendiratta, V., & Savastano, S. (2024). Agricultural and rural development interventions and poverty reduction: Global evidence from 16 impact assessment studies. *Global Food Security*, 43(February), 100806. <https://doi.org/10.1016/j.gfs.2024.100806>
- K.A, A., Sankaran, Kumar, S., & MousumiDas. (2020). An endogenous growth approach on the role of energy, human capital, finance and technology in explaining manufacturing value-added: A multi-country analysis. *Heliyon*, 6(7), e04308. <https://doi.org/10.1016/j.heliyon.2020.e04308>
- Kopittke, P. M., Menzies, N. W., Wang, P., McKenna, B. A., & Lombi, E. (2019). Soil and the intensification of agriculture for global food security. *Environment International*, 132(July), 105078. <https://doi.org/10.1016/j.envint.2019.105078>

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- Krumbiegel, K., & Tillie, P. (2024). Sustainable practices in cocoa production. The role of certification schemes and farmer cooperatives. *Ecological Economics*, 222(May 2023), 108211. <https://doi.org/10.1016/j.ecolecon.2024.108211>
- Lowder, S. K., Bhalla, G., & Davis, B. (2025). Decreasing farm sizes and the viability of smallholder farmers: Implications for resilient and inclusive rural transformation. *Global Food Security*, 45(March). <https://doi.org/10.1016/j.gfs.2025.100854>
- Naqvi, R. A., Almohsen, B., & Sohail, A. (2025). Modeling the environmental Kuznets Curve: A stochastic approach using economic and climate data. *Journal of Environmental Management*, 373(August 2024), 123108. <https://doi.org/10.1016/j.jenvman.2024.123108>
- Ohlin, B. (2018). 2 THEORETICAL BASE AND LITERATURE REVIEW. 1817, 5–13.
- Opoku Mensah, S., Osei-Acheampong, B., Jacobs, B., Cunningham, R., & Akoto, A. B. (2025). Smallholder farmers' climate change adaptation in Ghana: A systematic literature review and future directions. *Journal of Environmental Management*, 384(May), 125598. <https://doi.org/10.1016/j.jenvman.2025.125598>
- Osabohien, R., Matthew, O., Gershon, O., Ogunbiyi, T., & Nwosu, E. (2019). Agriculture Development, Employment Generation and Poverty Reduction in West Africa. *The Open Agriculture Journal*, 13(1), 82–89. <https://doi.org/10.2174/1874331501913010082>
- Praburaj, L. (2018). Role of Agriculture in the Economic Development of a Country. *Shanlax International Journal of Commerce*, 6(3), 1–5. <https://doi.org/10.5281/zenodo.1323056>
- Reinders, H. J., Schoenmaker, D., & van Dijk, M. (2025). Climate risk stress testing: A critical survey and classification. *Journal of Climate Finance*, 10(October 2023), 100061. <https://doi.org/10.1016/j.jclimf.2025.100061>
- Ren, C., He, L., Ma, Y., Reis, S., Van Grinsven, H., Lam, S. K., & Rosa, L. (2024). Trade-offs in agricultural outcomes across farm sizes. *Earth Critical Zone*, 1(1), 100007. <https://doi.org/10.1016/j.ecz.2024.100007>
- Sorooshian, S. (2024). The sustainable development goals of the United Nations: A comparative midterm research review. *Journal of Cleaner Production*, 453(April), 142272. <https://doi.org/10.1016/j.jclepro.2024.142272>
- Tremblay, J., Regnerus, M. D., Educação, S. D. A. S. N. D. E., Júnior, F. T., Sanfelice, J. L., Tavares Júnior, F., Dourado, L. F., Brito, M. M. A. de, Maiti, Bidinger, Sposito, M. P., Dubet, F. F., Ribeiro, C. A. C., Silva, N. do V., Barbosa, M. L. de O., Cunha, N. M., Dayrell, J., Rogošić, S., Baranović, B., ... Alves, S. (2016). No 主観的健康感を中心とした在宅高齢者における健康関連指標に関する共分散構造分析Title. *Educacao e Sociedade*, 1(1), 1689–1699. http://www.biblioteca.pucminas.br/teses/Educacao_PereiraAS_1.pdfhttp://www.anpocs.org.br/portal/publicacoes/rbcs_00_11/rbcs11_01.htmhttp://repositorio.ipea.gov.br/bitstream/11058/7845/1/td_2306.pdf<https://direitoufma2010.files.wordpress.com/2010/>
- Wakjira, M. T. (2024). *Understanding the impacts of climate variability and change on rainfed crop production in Ethiopia*. 30002, 244. <https://doi.org/10.3929/ethz-b-000672129>
- Yeboah, Asuamah, S. (2024). M P RA “Assessing Climate Change Impacts on Food Security in Africa: Regional Variations and Socio-Economic Perspectives” “Assessing Climate Change Impacts on Food Security in Africa: Regional Variations and Socio-Economic Perspectives.” *Munich Personal RePEc Archive*, 7(14), 1–18.