UNS Fintech Center | Bulletin of Fintech and Digital Economy

Agricultural Determinants of Gross Regional Domestic Product in Selected West African Countries (2007-2021)

Aja Kofi Mabengba David*, Fadli Septianto, Rizq Nahdah Syahwa Praba

Dapartment of Development Economic, Faculty of Economics and Business, Universitas Sebelas Maret, Surakarta, Indonesia

Abstract:
This study investigates the relationship between key agricultural determinants and Gross Regional Domestic Product (GRDP) across 13 West African countries over the period 2007–2021. Using panel data regression analysis, the study examines the impact of agricultural land area, permanent cropland, cereal yield, land under cereal production, and fertilizer consumption on GRDP. The results show that cereal yield and fertilizer consumption are significant positive predictors of regional economic output, whereas agricultural land, permanent cropland, and land under cereal production do not exhibit statistically significant effects. The findings underscore the importance of productivity-enhancing inputs over land expansion strategies in agricultural development. Model diagnostics further reveal that approximately 57% of GRDP variability is explained by unobserved country-specific factors, highlighting the need for tailored policy interventions to address structural challenges and enhance economic performance through sustainable agricultural practices.

JEL: Q10; Q12; Q13; C33

Keywords:
agriculture; GRDP; cereal yield; fertilizer consumption; west Africa; panel data; economic development; agricultural productivity

Corresponding Author*:
Aja Kofi Mabengba David

Email:
davidmabengba@gmail.com

DOI:
https://doi.org/10.20961/bfde.v5i2.107336

1. Introduction

Macroeconomics In Sub-Saharan Africa, agriculture is a critical factor in the development and expansion of the economy, contributing a substantial amount of GDP and employment. A substantial portion of GDP and employment in Sub-Saharan Africa are attributed to agriculture, which is a fundamental driver of economic growth and development. The sector is the foundation for economic transformation and food security in West Africa, providing sustenance to over 60% of the population.

Nevertheless, the region's agricultural productivity is still below the global average due to a lack of access to modern farming techniques, insufficient infrastructure, and climatic variability. The relationship between agriculture and economic growth has been extensively investigated, with researchers emphasizing its significance in structural transformation.

Similarly, the World Development Report (2008) contends that poverty reduction is contingent upon investment in agriculture, particularly in regions such as West Africa where most of the population relies on cultivation. The agricultural sector in West Africa is confronted with systemic challenges, despite its significance. Land-use patterns, such as reliance on rain-fed agriculture and underutilization of arable land, restrict productivity growth (Pingali, 2007).

In addition, poor fertilizer consumption and ineffective land management methods contribute to yield disparities. For example, West African farmers utilize only 16 kilograms of fertilizer per acre, compared to 135 kilos in South Asia (Evenson & Gollin, 2003).

Climate and policy frameworks also have an impact on agricultural productivity and economic output. Increasing grain yields and implementing climate-smart techniques have been found to boost agricultural GDP in underdeveloped countries (Food, 1948). However, the impacts of specific agricultural inputs, such as fertilizer use and cereal production land, on larger economic metrics such as Gross Regional Domestic Product (GRDP), are largely unknown.

The study investigates the relationship between agricultural variables and GRDP in 13 West African countries. By analyzing panel data from 2007 to 2021, it seeks to provide evidence-based insights into which factors most significantly influence regional economic performance. This research is particularly relevant given ongoing efforts to achieve the United Nations Sustainable Development Goals (SDGs), including Goal 2 (Zero Hunger) and Goal 8 (Decent Work and Economic Growth). The document provides a comprehensive dataset that captures critical indicators for countries in the region over 15 years (2007-2021), including metrics such as GDP (G), agricultural land percentage (AL), Permanent Cropland (% of land area) (PC), crop yields (CY), forest cover (FC), and other socioeconomic indicators.

These indicators provide insights into the development trajectories of West African nations, highlighting trends in resource management, economic growth, environmental sustainability, and social welfare. By analyzing this data, policymakers, researchers, and development practitioners can better understand regional disparities and identify opportunities for targeted interventions to foster sustainable growth and development (UNEC, 2017).

These indicators shed information on the development paths of West African states, highlighting patterns in resource management, economic growth, environmental sustainability, and social welfare. This data can help policymakers, researchers, and development practitioners better understand regional inequities and find opportunities for focused interventions to promote long-term growth and development (2024).

2. Literature Review

The relationship between agricultural productivity and economic growth in West Africa has been a critical area of study due to the region's heavy reliance on agriculture as a primary economic driver. The reviewed research examines the roles of various agricultural and environmental factors, providing insights into the mechanisms through which these variables influence Gross Regional Domestic Product (GRDP).

2.1. Agricultural Land and Economic Output

One significant focus in the literature is the role of agricultural land (AL) as a percentage of total land area in influencing GRDP. However, the findings suggest that agricultural land's contribution is statistically insignificant. This lack of significance, as indicated by a coefficient of -3.2018 and a high p-value of 0.826, highlights the diminishing returns of simply expanding agricultural land without improving productivity or inputs. This observation aligns with findings in other studies suggesting that land expansion alone cannot sustain agricultural productivity in regions where soil fertility and infrastructure remain challenging (Collier & Dercon, 2014).

2.2. Permanent Cropland and Agricultural Sustainability

The literature also evaluates the effect of permanent cropland (PC) as a percentage of total land area. With a coefficient of 84.6997 and a p-value of 0.232, the findings indicate an insignificant relationship between permanent cropland and GRDP. These results reflect that land under permanent crops might not yield substantial economic benefits unless accompanied by improved farming practices, such as crop rotation and intercropping (Byerlee, 2008) Moreover, the stability of permanent cropland's impact may depend on the cultivation of high value perennial crops, such as cocoa or cashew, which require long-term investments.

2.3. Cereal Yield as a Key Driver

Cereal yield (CY), measured in kilograms per hectare, emerges as a significant positive factor influencing GRDP. With a coefficient of 0.3977 and a p-value of 0.000, the results affirm that increases in cereal productivity directly enhance regional economic output. This finding underscores the importance of agricultural efficiency and the adoption of high-yield crop varieties. Similar studies in Sub-Saharan Africa have highlighted the critical role of productivity improvements in addressing food security and economic stability. Investments in irrigation systems, pest control, and drought-resistant crops are pivotal for sustaining cereal yield growth in the region (Alimagham et al., 2024).

2.4. Land Under Cereal Production

The study finds that the total land area under Cereal Production (CL) does not significantly affect GRDP, as reflected in a near-zero coefficient and a p-value of 0.373. This outcome suggests that the expansion of cereal land alone is insufficient to drive economic growth without concurrent improvements in farming practices or input use. The findings echo previous research advocating for a shift in focus from land expansion to intensive farming systems that maximize output on existing land (Yu et al., 2019).

2.5. Fertilizer Consumption and Agricultural Inputs

Fertilizer Consumption (FC) shows a statistically significant positive effect on GRDP, with a coefficient of 13.8198 and a p-value of 0.000. This relationship highlights the importance of adopting modern agricultural inputs to enhance soil fertility and crop productivity. The positive impact of fertilizer use has been well-documented in agricultural economics, particularly in the context of the Green Revolution's successes in Asia. However, the limited access to affordable fertilizers in West Africa remains a barrier to achieving similar outcomes (Evenson & Gollin, 2003).

2.6. Model Diagnostics and Implications

The model diagnostics reveal that country-specific factors account for a significant portion of GRDP variability, as indicated by a rho value of 0.5749. This finding suggests that national policies, infrastructure development, and institutional frameworks play critical roles in shaping agricultural productivity and economic growth. Addressing these structural issues, such as improving rural road networks and access to markets, is essential for leveraging agriculture's full potential.

3. Data and Methodology

3.1. Scope of Research

This study investigates the relationship between agricultural factors and Gross Regional Domestic Product (GRDP) across 13 West African countries. Using panel data regression analysis, we examine the impacts of agricultural land use, permanent cropland, cereal yield, land under cereal production, and fertilizer consumption on GRDP. Results indicate that cereal yield and fertilizer consumption positively influence GRDP, while other variables show no significant effects.

The review uses a quantitative econometric approach to analyze the relationship between agricultural variables and economic output (GRDP) in 13 West African countries. Liberia, Côte d'Ivoire, Sierra Leone, and Cabo Verde were excluded due to challenges in obtaining reliable data. The countries included in the study are Ghana, Nigeria, Burkina Faso, Mali, Niger, Guinea, Togo, Benin, Mauritania, and others with accessible and consistent data.

The econometric model used is specified as follows:

$G = \alpha + \beta 1AL + \beta 2PC + \beta 3CY + \beta 4CL + \beta 5FC + \epsilon$

Where:

- G: Gross Regional Domestic Product (dependent variable).
- AL: Agricultural Land as a percentage of total land area.
- PC: Permanent Cropland as a percentage of total land area.
- CY: Cereal yield (kg per hectare).
- CL: Land under Cereal Production (hectares).
- FC: Fertilizer Consumption (kg per hectare of arable land).
- α: Constant term (intercept).
- $\beta 1, \beta 2, \beta 3, \beta 4, \beta 5$: Coefficients estimated for each independent variable.
- ϵ: Error term, accounting for unobserved factors affecting GRD

3.2. Estimation Method

Panel regression was employed to analyze the dataset, allowing for the assessment of both cross-country variations and temporal changes. Fixed effects and random effects models were tested, with the Hausman test used to determine the most appropriate model. The model diagnostics include the significance of coefficients, standard errors, z-values, p-values, and confidence intervals to assess the robustness of the results.

3.3. Data Sources

The data was sourced from international databases, including the Food and Agriculture Organization (FAO), World Bank, and national statistical agencies. The study spans the years 2007 to 2021, ensuring sufficient temporal coverage to capture trends and variability.

3.4. Model Diagnostics

- Sigma u (Standard Deviation of the Random Effect): 65, which represents the variation due to unobserved factors at the country level (within the panel).
- Sigma e (Standard Deviation of the Error Term): 56, which represents the variation within each observation that is not explained by the model.
- p: The value of 0.5749 indicates that 57.49% of the total variance in the dependent variable (GRDP) is due to differences across countries (the panel level). This suggests that unobserved country-specific factors play a significant role in explaining the variability in GRDP.

4. Findings

4.1. Agricultural Land and Economic Output

Agricultural land (AL) as a percentage of total land area shows an insignificant relationship with GRDP (coefficient = -3.2018, p-value = 0.826). The findings suggest that expanding agricultural land alone does not significantly drive economic growth. This aligns with previous studies emphasizing that agricultural productivity, rather than land expansion, is critical for economic development in regions with limited arable land (Collier & Dercon, 2014).

4.2. Permanent Cropland and Agricultural Sustainability

Permanent Cropland (PC) also exhibits an insignificant effect on GRDP (coefficient = 84.6997, p-value = 0.232). This outcome suggests that the economic benefits of permanent cropland depend on complementary investments in high-value perennial crops and sustainable practices.

4.3. Cereal Yield as a Key Driver

Cereal Yield (CY) is a significant positive determinant of GRDP (coefficient = 0.3977, p-value = 0.000). The findings highlight those improvements in cereal productivity, driven by technological advancements and better input use, directly enhance regional economic output. This result supports global evidence that agricultural productivity is crucial for food security and economic stability (FAO, 2021).

4.4. Land Under Cereal Production

The analysis shows no significant relationship between land under Cereal Production (CL) and GRDP (coefficient near zero, p-value = 0.373). This indicates that expanding cereal-growing areas without improving productivity has a limited economic impact.

4.5. Fertilizer Consumption and Agricultural Inputs

Fertilizer Consumption (FC) significantly influences GRDP (coefficient = 13.8198, p value = 0.000), highlighting the importance of modern agricultural inputs. Increased fertilizer use improves soil fertility and crop yields, contributing to economic growth. However, the limited access to affordable fertilizers remains a barrier in many West African countries.

4.6. Model Diagnostics

The model diagnostics reveal that unobserved country-specific factors account for 57.49% of GRDP variability (ρ=0.5749). This emphasizes the need for tailored national policies to address structural challenges, such as infrastructure deficits and market inefficiencies.

5. Result

5.1. Descriptive Analysis

The purpose of the formulation of the first is to the agricultural determinants of gross regional domestic product in selected West African countries (2007-2021) index which is described through descriptive statistics and is then analyzed. The following are the results of descriptive statistics obtained through data processing.

Table 1. Summary Data

G	Coefficient	Std. err.	z	P>z	[95% conf.	interval]
AL	-3,2018	14,5282	0,22	0,826	-32	25
PC	84,6997	70,8351	1,2	0,232	-54	224
CY	0,3977	0,0789	5,04	0	0,243071	0,5523116
CL	0,0000	0,0001	0,89	0,373	-0,000159	0,0000598
FC	13,8198	2,9022	4,76	0	8	20
_cons	1.071,7370	671,4596	1,6	0,11	-244	2.388
sigma_u	65					
sigma_e	56					
Rho	0,5748891	(fraction variance due u_i)				

Interpretation of Coefficients:

- **AL** (Agricultural Land %): The coefficient for AL is -3.2018, with a standard error of 14.5282. The z-value of 0.22 and a p-value of 0.826 suggest that the relationship between agricultural land and Gross Regional Domestic Product (GRDP) is not statistically significant. The 95% confidence interval for this variable is (-32, 25), which includes zero, further confirming the lack of significance. This implies that changes in agricultural land as a percentage of total land area do not have a meaningful impact on GRDP, at least in this model.
- **PC** (Permanent Cropland %): The coefficient for PC is 84.6997, with a standard error of 70.8351. The z-value of 1.2 and p-value of 0.232 indicate that this variable also does not significantly affect GRDP. The confidence interval ranges from -54 to 224, which includes zero, reinforcing the lack of statistical significance.
- **CY (**Cereal Yield, kg per hectare): The coefficient for CY is 0.3977, with a standard error of 0.0789, and a z-value of 5.04, with a p-value of 0.000. This indicates that cereal yield has a statistically significant positive effect on GRDP. The confidence interval (0.243 to 0.552) does not contain zero, further supporting the significance of this result. The positive coefficient suggests that increases in cereal yield, measured in kilograms per hectare, increase GRDP.
- **CL** (Land under Cereal Production, hectares): The coefficient for CL is 0.0000, with a standard error of 0.0001, and a z-value of 0.89. The p-value of 0.373 suggests that land under cereal production does not significantly influence GRDP. The confidence interval is (-0.0001594, 0.0000598), which includes zero, confirming that this variable is not statistically significant.
- **FC** (Fertilizer Consumption, kg per hectare): The coefficient for FC is 13.8198, with a standard error of 2.9022, and a z-value of 4.76, with a p-value of 0.000. This indicates that fertilizer consumption has a statistically significant positive effect on GRDP. The confidence interval (8 to 20) confirms that this result is highly significant. The positive coefficient suggests that increased fertilizer consumption leads to higher GRDP, implying that better input use (via fertilizer) positively impacts agricultural productivity and economic output.
- **_cons** (Intercept): The intercept value is 1,071.7370, with a standard error of 671.4596. The z-value of 1.6 and a p-value of 0.11 suggest that the intercept is not statistically significant, as it is not significantly different from zero.

The following are the results of data processing using the GRDP method with data in 2007- 2021.

Table 2. *xtsum* Analysis

Variable		Mean	Std. dev.	Min	Max	Observations
G	Overall	2.140.095	3.113.871	3.847.183	16653.71	N = 195
	Between		3176.89	5.130.047	12434.71	n = 13
	Within		5.761.079	- 1.107.447	6.359.101	T = 15
AL	Overall	4.457.735	183.953	1.005.088	7.536.919	N = 195
	Between		1.902.924	1.044.093	7.421.471	n = 13
	Within		1.551.494	3.191.595	4.792.469	T = 15
PC	overall	3.561.546	3.377.348	.059209	1.190.421	N = 195
	between		3.482.964	.0813663	1.073.176	n = 13
	within		.3884223	.9601512	4.733.992	T = 15
CY	overall	1.653.874	1.421.262	360.6	9453.7	N = 195
	between		1304.56	475.88	5.815.007	n = 13
	within		6.640.209	- 1.465.232	5.292.568	T = 15
CL	overall	2907970	4392421	14	1.94e+07	N = 195
	between		4522200	183.6	1.72e+07	n = 13
	within		564676	- 378899.2	5141101	T = 15
FC	overall	286.891	5.992.117	1.00e-06	3.132.905	N = 195
	between		6.026.728	.5596122	2.276.893	n = 13
	within		1.484.976	- 4.853.236	1.142.903	T = 15

The *xtsum* analysis results show that the variable G has an overall mean of 2,140,095 with a standard deviation of 3,113,871, indicating a large variation in the data. In terms of between- unit variation, the mean ranges from 5,130,047 to 12,434.71 with a standard deviation of 3,176.89, reflecting significant differences between units (e.g., regions or individuals) in the data. Meanwhile, within-unit variation has a standard deviation of 5,761,079, with a range from -1,107,447 to 6,359,101, indicating fluctuations occurring within each unit over time. A similar analysis is

conducted for other variables such as AL, PC, CY, CL, and FC, revealing different patterns of variation between and within units depending on the characteristics of each variable.

5.2. Pearson Correlation

The Pearson correlation matrix provides insights into the relationships between the variables in your dataset:

Table 3. Pearson Analysis

	G	AL	PC	CY	CL	FC
G	1					
AL	-0,003	1				
PC	0,0464	0,2082	1			
CY	0,8526	0,0258	0,0442	1		
CL	-0,1165	0,4204	0,206	-0,1025	1	
FC	0,9155	-0,0425	-0,0837	0,7941	-0,1732	1

- **G and AL**: The correlation between G (Gross Regional Domestic Product) and AL (Agricultural Land) is -0.003, which is very close to zero. This indicates a very weak or negligible negative relationship between these two variables, suggesting that changes in agricultural land area do not significantly influence regional GDP.
- **G and PC**: The correlation between G and PC (Permanent Cropland) is 0.0464, which is also a very weak positive correlation. It implies that there is little to no direct relationship between gross regional product and the percentage of land used for permanent cropland.
- **G and CY**: The correlation between G and CY (Cereal Yield) is 0.8526, which is a strong positive correlation. This indicates that higher cereal yields are strongly associated with higher regional GDP, suggesting that agricultural productivity, particularly cereal production, has a significant impact on the economic output of the region.
- **G and CL**: The correlation between G and CL (Land under Cereal Production) is - 0.1165, indicating a weak negative relationship. This suggests that changes in the area of land used for cereal production have a small, negative effect on the regional GDP.
- **G and FC**: The correlation between G and FC (Fertilizer Consumption) is 0.9155, which is a very strong positive correlation. This indicates that increased fertilizer consumption is closely associated with higher regional GDP, possibly reflecting the importance of agricultural productivity enhancements in economic growth.
- **AL and PC**: The correlation between AL and PC is 0.2082, a weak positive relationship, meaning that the amount of agricultural land is somewhat positively related to the area used for permanent cropland.
- **AL and CY**: The correlation between AL and CY is 0.0258, indicating a very weak positive relationship between agricultural land and cereal yield.
- **AL and CL**: The correlation between AL and CL is 0.4204, a moderate positive correlation. This suggests that larger agricultural areas are associated with more land being used for cereal production.
- **AL and FC**: The correlation between AL and FC is -0.0425, which is a very weak negative correlation, implying that changes in agricultural land area have a negligible negative effect on fertilizer consumption.

- **PC and CY**: The correlation between PC and CY is 0.0442, which is very weak, indicating almost no relationship between the percentage of land used for permanent cropland and cereal yield.
- **PC and CL**: The correlation between PC and CL is 0.206, a weak positive relationship. This suggests a mild positive association between the proportion of permanent cropland and the land area used for cereal production.
- **PC and FC**: The correlation between PC and FC is -0.0837, a very weak negative correlation, indicating that the amount of permanent cropland is almost uncorrelated with fertilizer consumption.
- **CY and CL**: The correlation between CY and CL is -0.1025, suggesting a very weak negative relationship between cereal yield and the area of land used for cereal production.
- **CY and FC**: The correlation between CY and FC is 0.7941, a strong positive correlation. This suggests that as fertilizer consumption increases, cereal yields tend to increase as well, highlighting the role of fertilizers in boosting agricultural productivity.
- **CL and FC**: The correlation between CL and FC is -0.1732, a weak negative relationship, indicating that the amount of land used for cereal production has a small negative correlation with fertilizer consumption.

6. Conclusion

Economic and developmental dynamics in West Africa are complex, as evidenced by the data presented. Although certain nations, including Ghana and Nigeria, demonstrate consistent GDP growth and enhanced economic indicators, others, such as Guinea-Bissau and Niger, encounter substantial obstacles, including reduced agricultural productivity and restricted resource utilization. Environmental factors, including deforestation and declining forest cover in specific countries further complicate sustainable development endeavors.

This analysis reveals that while progress has been made in economic development across the region, disparities in wealth distribution, resource management, and environmental sustainability remain significant. To mitigate these disparities, governments and stakeholders must prioritize regional cooperation, sustainable resource management, and inclusive growth strategies. Additional research and targeted interventions are imperative to guarantee sustainable and equitable development in all West African nations.

From this regression output, we can conclude that:

- Cereal yield (CY) and fertilizer consumption (FC) significantly affect GRDP, both showing positive coefficients. This suggests that improving agricultural productivity and input usage is crucial for economic growth.
- Agricultural land (AL), permanent cropland (PC), and land under cereal production (CL) do not significantly affect GRDP, suggesting that these factors might not have an immediate or strong impact on the economic output in the countries studied, at least in this model specification.

These findings could guide future research, perhaps focusing more on factors that directly enhance agricultural output or incorporating additional variables that could better explain GRDP variations.

West Africa 13 refers to a group of countries in West Africa, consisting of 13 nations. However, it excludes Liberia, Côte d'Ivoire (Ivory Coast), Sierra Leone, and Cabo Verde. These countries were left out of the study due to difficulties in gathering reliable data or limited access to the necessary data for research purposes. The countries included in the study are Ghana, Nigeria, Burkina Faso, Mali, Niger, Guinea, Togo, Benin, Mauritania, and others that were considered feasible for analysis based on the availability and

consistency of data. This focus ensures that the research is based on countries with more accessible and consistent information.

Country	Code	Year	G	AL	PC	CY	CL	FC
Ghana	1	2007	1047,199	54,81345	9,396532	1317	1270218	18,70589
Ghana	1	2008	1178,956	52,7589	9,589064	1598,1	1437191	15,84987
Ghana	1	2009	1044,005	54,10242	9,781596	1659,8	1570744	20,89121
Ghana	1	2010	1258,964	54,49784	9,974128	1814,3	1602099	20,43723
Ghana	1	2011	1501,059	54,09091	10,16666	1594,2	1642866	14,6057
Ghana	1	2012	1536,62	54,27766	10,35919	1768,1	1634973	37,78139
Ghana	1	2013	2282,408	54,77312	10,55172	1688,8	1625970	27,15352
Ghana	1	2014	1942,922	54,38452	10,74426	1703,4	1632045	16,69547
Ghana	1	2015	1711,271	54,5641	10,93679	1830,3	1504191	24,97417
Ghana	1	2016	1900,398	54,31108	11,12932	1842,4	1518801	22,29418
Ghana	1	2017	1998,723	53,10699	11,32185	1930,7	1619488	38,24644
Ghana	1	2018	2180,03	53,69404	11,51438	2172,6	1644881	27,55026
Ghana	1	2019	2167,925	54,84739	11,70691	2346,2	1880045	40,13606
Ghana	1	2020	2176,576	55,39302	11,89981	2410,8	1923044	50,11192
Ghana	1	2021	2422,086	55,39302	11,90421	2360,5	2058044	37,37177
Nigeria	2	2007	1876,413	73,06565	7,027021	1399,8	19410000	4,34055
Nigeria	2	2008	2227,79	73,23034	7,136818	1598,4	18899000	5,896981
Nigeria	2	2009	1883,888	73,39175	7,136818	1531,1	13890000	4,565877
Nigeria	2	2010	2280,111	73,55754	7,136818	1528	16132376	11,21455
Nigeria	2	2011	2504,879	73,72114	7,136818	1334,4	15512438	6,201774
Nigeria	2	2012	2728,023	73,88583	7,136818	1399	15316190	8,427198
Nigeria	2	2013	2976,757	74,04943	7,136818	1234,7	15888765	8,509127
Nigeria	2	2014	3200,953	74,21522	7,136818	1552,4	16948908	8,957569
Nigeria	2	2015	2679,554	74,37333	7,136818	1552,7	16541075	7,965851
Nigeria	2	2016	2144,78	74,54242	7,136818	1733,4	17443380	10,73497
Nigeria	2	2017	1941,879	74,70492	7,246616	1614,7	18676572	20,29591
Nigeria	2	2018	2125,834	74,87291	7,246616	1684,2	18195673	18,8413
Nigeria	2	2019	2334,024	75,03761	7,246616	1628,2	18299733	18,61033
Nigeria	2	2020	2074,614	75,2034	7,246616	1620,5	18025044	18,61033
Nigeria	2	2021	2065,774	75,36919	7,246616	1619,2	18473891	18,61033
Niger	3	2007	384,7183	11,93107	0,059209	424,8	901020	0,2456
Niger	3	2008	472,1784	11,52079	0,063156	496,5	1093977	0,3204
Niger	3	2009	458,4219	11,24726	0,078945	386	1059450	6,544
Niger	3	2010	471,6127	10,86433	0,078945	494,8	1110660	9,134
Niger	3	2011	507,6025	10,41028	0,078945	362,8	1017434	4,44
Niger	3	2012	525,0473	10,06751	0,078945	520,3	1147742	10,29042
Niger	3	2013	548,1578	10,05088	0,078945	407,7	1211080	5,002278

Niger	3	2014	560,7545	10,05088	0,078945	446,8	1173784	8,086548
Niger	3	2015	481,1113	10,06729	0,089208	551,3	1229296	0,133233
Niger	3	2016	497,0361	10,06729	0,089208	536,5	1246199	9,949325
Niger	3	2017	514,5434	10,06729	0,089208	541,9	1350154	0,016396
Niger	3	2018	568,5997	10,06729	0,089208	554,8	1624577	36,64275
Niger	3	2019	549,8161	10,06729	0,089208	501,5	1758745	55,46367
Niger	3	2020	564,8417	10,06729	0,089208	551,9	1537675	40,21206
Niger	3	2021	590,6295	10,06729	0,089208	360,6	1639128	40,70602
Benin	4	2007	944,6432	29,70912	2,660518	1286	901020	0,354908
Benin	4	2008	1098,947	31,4828	4,434197	1158,7	1093977	0,153418
Benin	4	2009	1061,718	32,36963	5,321036	1423,5	1059450	0,35349
Benin	4	2010	1009,489	32,36963	5,321036	1200,6	1110660	0,496026
Benin	4	2011	1099,414	32,36963	5,321036	1517,8	1017434	0,485641
Benin	4	2012	1112,57	33,25647	5,321036	1373,2	1147742	0,923295
Benin	4	2013	1214,296	35,03015	6,207875	1479,6	1211080	0,637151
Benin	4	2014	1251,505	35,03015	6,207875	1460,3	1173784	0,999243
Benin	4	2015	1041,653	35,03015	6,207875	1336,7	1229296	0,406191
Benin	4	2016	1049,82	35,03015	5,321036	1455,9	1246199	0,386007
Benin	4	2017	1095,274	35,03015	5,321036	1405,4	1350154	0,381645
Benin	4	2018	1194,438	35,03015	5,321036	1428,5	1624577	0,694769
Benin	4	2019	1170,886	35,03015	5,321036	1238,3	1758745	0,949462
Benin	4	2020	1240,733	35,03015	5,321036	1432,8	1537675	0,586468
Benin	4	2021	1360,911	35,03015	5,321036	1408,6	1639128	0,586468
Mali	5	2007	579,2571	33,27105	0,122932	1101,2	3528534	13,52644
Mali	5	2008	676,127	33,45463	0,122932	1397,7	3445025	17,39217
Mali	5	2009	680,65	33,63853	0,122932	1800,4	3364533	17,64636
Mali	5	2010	688,3279	33,64312	0,122932	1452,8	3674945	18,50789
Mali	5	2011	810,1826	33,79802	0,122932	1046,8	5519796	9,604814
Mali	5	2012	753,3921	33,95291	0,122932	1506,8	4350436	8,914618
Mali	5	2013	778,7971	34,1078	0,122932	1512,4	4624379	13,69808
Mali	5	2014	818,4303	34,2627	0,122932	1550,7	4501731	19,22494

Mali	5	2015	723,5042	34,41759	0,122932	1575,5	5112560	24,46189
Mali	5	2016	750,0518	34,5733	0,122932	1607,5	5505277	29,42717
Mali	5	2017	795,6828	34,7282	0,122932	1601,9	5803284	20,92116
Mali	5	2018	856,3566	34,88309	0,122932	1728,9	5876534	20,41253
Mali	5	2019	840,1757	35,03799	0,122932	1767,7	5912553	29,9793
Mali	5	2020	822,9061	35,19288	0,122932	1686	6140158	29,28424
Mali	5	2021	881,5101	35,34777	0,122932	1441,2	6119493	28,62069
Burkina Faso	6	2007	516,7503	39,80629	0,475146	936,1	3320950	10,39593
Burkina Faso	6	2008	621,8903	40,20285	0,520833	1039,9	4191339	11,77826
Burkina Faso	6	2009	603,8775	40,61404	0,584795	1002	3619256	10,87964
Burkina Faso	6	2010	627,2704	41,08918	0,709064	1062,7	4291496	11,20662
Burkina Faso	6	2011	727,6125	41,71418	0,986842	995,1	3684446	11,86156
Burkina Faso	6	2012	733,9729	42,17471	1,096491	1203	4071781	15,53767
Burkina Faso	6	2013	762,3038	42,85453	1,425439	1156,5	4210656	17,96756
Burkina Faso	6	2014	767,3713	43,3114	1,535088	1225,8	3646006	17,5478
Burkina Faso	6	2015	632,1267	43,80848	1,681287	1168,9	3584230	17,68447
Burkina Faso	6	2016	665,7863	44,23246	1,754386	1136,8	4017586	23,23748
Burkina Faso	6	2017	711,1845	44,65278	1,827485	1009	4026919	19,07377
Burkina Faso	6	2018	779,2028	45,36915	2,192982	1152,3	4495792	18,13725
Burkina Faso	6	2019	765,2296	45,75658	2,229532	1156,1	4272786	9,688458
Burkina Faso	6	2020	823,5524	46,1038	2,229532	1261,7	4104826	17,1697
Burkina Faso	6	2021	888,8036	46,56433	2,339181	1095,7	4254016	11,91106
Togo	7	2007	621,7349	66,09671	3,401361	1121,6	782496	0,000001
Togo	7	2008	735,8558	66,83214	3,769075	1144,4	817193	0,000222
Togo	7	2009	737,9541	67,19985	3,769075	1242,9	853985	2,908931
Togo	7	2010	722,2298	67,38371	3,769075	1187,4	880827	9,837927
Togo	7	2011	803,4828	67,38371	3,769075	1226,3	862697	10,20384
Togo	7	2012	781,5548	70,78507	3,677147	1112,4	1140181	5,022868
Togo	7	2013	847,388	70,2335	3,125575	1090,1	1198660	11,72499
Togo	7	2014	877,193	70,2335	3,125575	1153,1	1136766	1,846204

Togo	7	2015	770,1438	70,2335	3,125575	1236,2	1010956	3,327215
Togo	7	2016	792,441	70,2335	3,125575	1130,8	1117554	13,67819
Togo	7	2017	813,3948	70,2335	3,125575	1137,2	1144144	5,779389
Togo	7	2018	873,5654	70,2335	3,125575	1145,2	1169323	15,35685
Togo	7	2019	848,3101	70,2335	3,125575	1143	1200694	2,676038
Togo	7	2020	876,543	70,2335	3,125575	1150,3	1178372	2,676038
Togo	7	2021	964,9981	70,2335	3,125575	1149,5	1221064	2,064834
Gambia, The	8	2007	725,0923	49,01186	0,592885	805,3	186202	8,976898
Gambia, The	8	2008	857,8582	55,92885	0,6917	983,5	238381	4,260753
Gambia, The	8	2009	772,1249	61,46245	0,6917	1058,1	293340	6,343458
Gambia, The	8	2010	796,6318	63,63636	0,6917	1136,4	319350	7,3
Gambia, The	8	2011	705,4775	63,63636	0,6917	879,6	207523	10,27556
Gambia, The	8	2012	686,5576	63,63636	0,6917	920,5	242866	2,582311
Gambia, The	8	2013	647,3855	63,63636	0,6917	969,6	234062	0,403956
Gambia, The	8	2014	561,6496	63,63636	0,6917	753,4	231053	0,455156
Gambia, The	8	2015	611,6712	63,63636	0,6917	800,2	256195	0,528911
Gambia, The	8	2016	640,6763	63,63636	0,6917	743,9	233900	0,665978
Gambia, The	8	2017	632,001	62,64822	0,6917	634,2	212854	0,391386
Gambia, The	8	2018	683,3246	62,64822	0,6917	536,8	160213	8,051841
Gambia, The	8	2019	722,8754	62,64822	0,6917	461,4	210000	4,219614
Gambia, The	8	2020	704,0305	62,64822	0,6917	656,3	162046	0,780136
Gambia, The	8	2021	762,9632	62,64822	0,6917	1056,8	106514	2,236386
Senegal	9	2007	1210,167	44,16455	0,275282	722,5	1068876	2,145965
Senegal	9	2008	1419,531	48,17431	0,28567	1174,2	1481557	2,303039
Senegal	9	2009	1323,971	48,18989	0,301252	1134,6	1614337	6,741436
Senegal	9	2010	1286,605	48,18989	0,301252	1196,5	1477513	8,610221
Senegal	9	2011	1383,539	46,56417	0,33761	966,9	1136905	6,827576
Senegal	9	2012	1334,726	46,56417	0,33761	1221,3	1227966	10,52424
Senegal	9	2013	1391,532	46,57975	0,353192	1124,1	1130646	12,00606
Senegal	9	2014	1417,095	46,60053	0,373968	1111,5	1125682	11,38485
Senegal	9	2015	1238,126	48,44959	0,379162	1376,1	1563993	14,21888

Senegal	9	2016	1290,75	48,24183	0,405132	1350,6	1663755	19,10355
Senegal	9	2017	1385,199	48,42362	0,405132	1476,2	1704719	30,3546
Senegal	9	2018	1484,227	48,60541	0,405132	1644,3	1757142	14,66196
Senegal	9	2019	1462,678	48,79759	0,41552	1601,3	1729124	18,56559
Senegal	9	2020	1492,476	48,97938	0,41552	1821,6	1998542	21,56525
Senegal	9	2021	1630,695	49,40009	0,420714	1854,7	1906374	8,839141
Guinea	10	2007	657,9935	57,70796	2,767378	1514	1718070	1,213571
Guinea	10	2008	712,0994	57,95214	2,808074	1464,7	1870890	1,297544
Guinea	10	2009	670,2613	57,99284	2,848771	1484,3	1772804	0,634035
Guinea	10	2010	667,2816	58,19632	2,848771	1184,7	2415040	0,932759
Guinea	10	2011	644,5025	58,19632	2,848771	1226	2450394	3,583103
Guinea	10	2012	707,9677	58,60329	2,848771	1152,2	2812308	2,931833
Guinea	10	2013	757,6923	59,01026	2,848771	1189,6	2884400	2,868068
Guinea	10	2014	774,569	59,14455	2,98307	1123	3028634	1,023087
Guinea	10	2015	756,4256	59,19339	3,031906	1122,4	3147605	0,912826
Guinea	10	2016	720,4733	59,27478	3,1133	1155,5	3157882	0,757742
Guinea	10	2017	843,4643	59,39687	3,23539	1165,4	3238934	8,512223
Guinea	10	2018	944,4173	59,50676	3,345271	1186,7	3295749	6,857345
Guinea	10	2019	1043,9	59,53931	3,377828	1257,9	3093277	6,857345
Guinea	10	2020	1073,659	59,55966	3,398177	1323,7	3028055	6,857345
Guinea	10	2021	1189,176	59,57187	3,410386	1344,9	3002599	6,857345
Guinea- Bissau	11	2007	2344,403	25,68403	8,890469	1346,1	136586	9,01
Guinea- Bissau	11	2008	2420,749	25,98435	8,890469	1490,3	145611	10,10786
Guinea-Bissau	11	2009	2598,404	26,28467	8,890469	1632,2	139290	10,71357
Guinea-Bissau	11	2010	2760,011	26,58499	8,890469	1723,8	148586	16,555
Guinea-Bissau	11	2011	2885,441	26,88528	8,890469	1588,7	137316	10,54167
Guinea-Bissau	11	2012	3023,585	27,18556	8,890469	1512,1	164149	14,795
Guinea-Bissau	11	2013	2920,701	27,48585	8,890469	1397,7	188953	15,43667
Guinea-Bissau	11	2014	2928,449	27,78613	8,890469	1394,8	119173	15,60167

Guinea-Bissau	11	2015	2891,322	28,08642	8,890469	1402,1	148340	15,93167
Guinea-Bissau	11	2016	2956,561	28,38656	8,890469	1414,4	159119	21,02833
Guinea-Bissau	11	2017	3250,928	28,6867	8,890469	1385,9	152250	27,29833
Guinea-Bissau	11	2018	3533,792	28,98684	8,890469	1397,3	160194	26,18
Guinea-Bissau	11	2019	3537,471	28,98684	8,890469	1287,3	186310	28,47167
Guinea-Bissau	11	2020	3318,288	28,98684	8,890469	1343,2	191878	31,71667
Guinea-Bissau	11	2021	3447,331	28,98684	8,890469	1352,7	207384	31,71667
Mauritania	12	2007	9187,166	45,3202	1,970443	9453,7	108	282,2222
Mauritania	12	2008	10019,5	44,82759	1,970443	7541	61	228,775
Mauritania	12	2009	12191,6	44,82759	1,970443	8000	14	227,9625
Mauritania	12	2010	10446,86	44,82759	1,970443	6833,3	48	163,2
Mauritania	12	2011	10495,3	44,56685	2,003005	3901,8	163	243,2308
Mauritania	12	2012	11920,06	43,56535	2,003005	3389,6	367	274,8454
Mauritania	12	2013	12038,87	43,0646	2,003005	3219,1	397	248,1483
Mauritania	12	2014	12314	43,0646	2,003005	3765,1	481	313,2905
Mauritania	12	2015	13101,54	43,0646	2,003005	2695,9	411	183,8361
Mauritania	12	2016	13300,82	43,0646	2,003005	3455	222	273,258
Mauritania	12	2017	12372,88	43,0646	2,003005	5234,8	115	257,6135
Mauritania	12	2018	13195,94	43,0646	2,003005	5272,7	77	187,1136
Mauritania	12	2019	13672,58	43,0646	2,003005	6880	75	194,8719
Mauritania	12	2020	15609,78	43,0646	2,003005	8942,5	87	150,4679
Mauritania	12	2021	16653,71	43,0646	2,003005	8640,6	128	186,5043
Cameroon	13	2007	1311,003	19,48975	2,644327	1676,3	1412908	8,622841
Cameroon	13	2008	1476,009	19,59552	2,7501	1678,5	1474005	6,557438
Cameroon	13	2009	1445,86	19,7013	2,855874	1722,9	1636978	7,002851
Cameroon	13	2010	1383,814	20,51998	3,173193	1648,7	1826815	9,239032
Cameroon	13	2011	1497,927	20,62575	3,278966	1710	1747441	11,03597
Cameroon	13	2012	1433,724	20,62575	3,278966	1591,5	2029134	10,33573
Cameroon	13	2013	1559,139	20,62575	3,278966	1676,4	1907139	10,05834
Cameroon	13	2014	1631,714	20,62575	3,278966	1630,4	2059576	9,621035

Cameroon	13	2015	1399,675	20,62575	3,278966	1615,3	2256907	13,59096
Cameroon	13	2016	1426,065	20,62575	3,278966	1578,1	2354801	10,90362
Cameroon	13	2017	1479,862	20,62575	3,278966	1711,2	2158098	13,02838
Cameroon	13	2018	1593,331	20,62575	3,278966	1809,6	2225159	13,38533
Cameroon	13	2019	1538,563	20,62575	3,278966	3470,8	1102789	13,38533
Cameroon	13	2020	1539,131	20,62575	3,278966	1736,5	2118556	13,38533
Cameroon	13	2021	1654,257	20,62575	3,278966	1726,7	2152054	13,38533

7. References

Alimagham, S., van Loon, M. P., Ramirez-Villegas, J., Adjei-Nsiah, S., Baijukya, F., Bala, A., Chikowo, R., Silva, J. V., Soulé, A. M., Taulya, G., Tenorio, F. A., Tesfaye, K., & van Ittersum, M. K. (2024). Climate change impact and adaptation of rainfed cereal crops in sub-Saharan Africa. *European Journal of Agronomy*, *155*(February). https://doi.org/10.1016/j.eja.2024.127137.

Byerlee, D. (2008). *The World Bank ' s 2008 World Development Report*. *January 2007*, 4–6.

Collier, P., & Dercon, S. (2014). African Agriculture in 50 Years: Smallholders in a Rapidly Changing World? *World Development*, *63*(June 2009), 92–101. https://doi.org/10.1016/j.worlddev.2013.10.001.

Evenson, R. E., & Gollin, D. (2003). Assessing the impact of the Green Revolution, 1960 to 2000. *Science*, *300*(5620), 758–762. https://doi.org/10.1126/science.1078710.

FAO. (2021). Faostat Analytical Brief 60 Agricultural production statistics Agricultural production statistics 2000-2021 Faostat Analytical Brief 60 Faostat Crops and Livestock Production Introduction. *Fao*, 1–17.

Food, W. (1948). Food and agriculture organisation. In *Nature* (Vol. 162, Issue 4123). https://doi.org/10.1038/162728a0.

Johnston, B. B. F., & Mellor, J. W. (2016). *American Economic Association The Role of Agriculture in Economic Development Author (s): Bruce F . Johnston and John W . Mellor Source : The American Economic Review , Vol . 51 , No . 4 (Sep ., 1961), pp . 566-593 Published by : American Economic Ass*. *51*(4), 566–593.

Pingali, P. (2007). Chapter 54 Agricultural Mechanization: Adoption Patterns and Economic Impact. *Handbook of Agricultural Economics*, *3*(January 2007), 2779–2805. https://doi.org/10.1016/S1574-0072(06)03054-4.

UNEC. (2017). Africa Sustainable Development Report 2017. *Africa Sustainable Development Report 2017*, 111.

Yu, Q., Xiang, M., Wu, W., & Tang, H. (2019). Changes in global cropland area and cereal production: An inter-country comparison. *Agriculture, Ecosystems and Environment*, *269*(September 2018), 140–147. https://doi.org/10.1016/j.agee.2018.09.031.

(2024). Sustainable Investment Policy Perspectives in the Economic Community of West African States (ECOWAS). In *Sustainable Investment Policy Perspectives in the Economic Community of West African States (ECOWAS)*. https://doi.org/10.1787/654e2de5-en