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Measuring the contribution of the agricultural sector to the GDP in Algeria: a study using the ARDL model for the period 1999-2022

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Abstract:

This study examines the role of Algeria's agricultural sector in boosting GDP from 1999 to 2022. Through the ARDL model, it was observed that the time series exhibit variations in stability and time lags. The boundary test confirmed a long-term equilibrium among variables, suggesting a shift from short-term impacts to long-term outcomes. The optimal model identified for the long run is ARDL(3,3).

Key Words : *Agriculture sector, GDP, ARDL model, Degree of delay, Estimat-ECM*

JEL Classification: *P44، Q13، Q19، C21، C01*

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1. Introduction

The agricultural sector is essential for both developed and developing countries, contributing to GDP growth, reducing unemployment in less industrialized areas, and enhancing food security. It also lowers import dependency, supplies raw materials for industries, and generates revenue through exports. (Zlatou & Hadachi, 2019).The agricultural sector plays a key role in both developed and developing countries by boosting GDP, reducing unemployment in regions with limited industry, and improving food security. It also decreases import needs, provides raw materials for industries, and generates export revenue. (Ahmed, 2015).

Agriculture is a vital sector in Algeria's economy, driving economic growth and supporting sustainable development. It provides employment and meets society's basic food needs. This research examines the sector's role in boosting Algeria's economic growth from 1999 to 2022, using the Autoregressive Distributed Lag (ARDL) model.

The main question: Does the agricultural sector, unlike other sectors, contribute to economic growth in Algeria?

Premise:

The agricultural sector significantly boosts Algeria's economic growth by increasing GDP through higher agricultural production, satisfying local food needs, and generating exportable surpluses.

2.Agricultural sector:

2.1 Development of the Agricultural Sector in Algeria: Since independence, Algeria's agricultural sector has gone through several phases:

2.1.1 The Self-Management Stage: This phase began post-independence when Algeria acquired agricultural land. Nationalized assets were seen as key to agricultural independence, and abandoned farms were reorganized into collective units under self-management for workers. (Talbi & Salma, 2015)

2.1.2 agricultural revolution: This approach led to large landholders neglecting or renting out land, with small farmers owning less than 10%. In response, President Boumediene introduced the 1971 Agricultural Revolution Law, promoting fair land distribution with the slogan "Land for those who work it." However, the law failed due to lack of state support and inadequate policy monitoring.

2.1.3 Land Reclamation Act*:* The Land Reclamation Law granted ownership to those who actively cultivated the land, establishing rules to encourage peasants in land reclamation efforts. (Abdelrazak, 2010)

2.1.4 The law on agricultural investments : Law No. 87-19, enacted on December 8, 1987, provided permanent, transferable rights to agricultural land to promote diversified production and economic development. (Abdelrazak, 2010)

2.1.5 Agricultural development nineties: The policy emerged as Algeria transitioned to a market economy, requiring a restructuring of the agricultural sector.

The state reclaimed approximately 445,000 hectares of peasant land and, in response to the adverse effects of reduced subsidies, shifted toward direct support measures. These included increased loans, specialized funding, and tax exemptions for peasants. (Geneie, 2011)

2.1.6 National Rural Development Plan: This plan seeks to advance the agricultural sector by improving technical, financial, and regulatory frameworks. It focuses on resource conservation, land reclamation, and the effective management of water and land resources to promote sustainable development. (Ahmed, 2015)

2.2 The role of the agricultural sector in the national economy: Algeria's agricultural sector is essential to the economy, contributing to GDP growth, job creation, foreign currency earnings, and supporting industrial development.

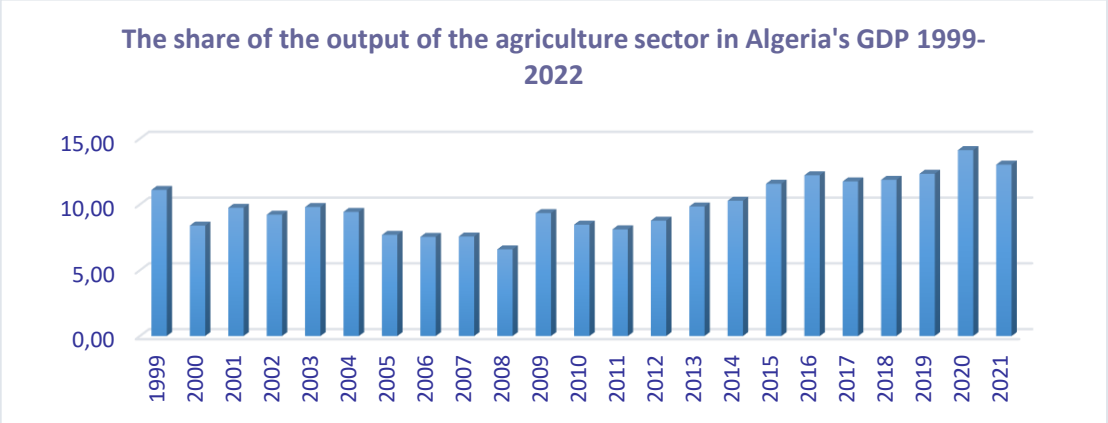
2.2.1 The Contribution of the Agricultural Sector to the Gross Domestic Product

Table n° 01: The Agricultural Sector's Output Contribution as a Percentage of Algeria's GDP from 1999 to 2021

1999	2000	2001	2002	2003	2004
%11,11	%8,40	%9,75	%9,22	%9,81	%9,44
2005	**2006**	**2007**	**2008**	**2009**	**2010**
%7,69	%7,54	%7,57	%6,59	%9,34	%8,47
2011	**2012**	**2013**	**2014**	**2015**	**2016**
%8,11	%8,77	%9,85	%10,29	%11,58	%12,22
2017	**2018**	**2019**	**2020**	**2021**	2022
%11,76	%11,87	%12,34	%14,13	%13,03	11.59%

Source: World Bank

Fig.1. illustrates the percentage of the agricultural sector's output relative to GDP in Algeria from 1999 to 2022.



Source: compiled by the researcher using Excel software.

From 1999 to 2021, Algeria's agricultural output grew from 359 billion dinars (11.11% of national output) to 2,869 billion dinars (12.03%). The average

output was 1,303 billion dinars with an 8.04% standard deviation, and an absolute standard deviation of 841 billion dinars (7.61%), resulting in a 64.03% coefficient of variation.

2.2.2 Employment in the Agricultural Sector: Agricultural labor is vital to Algeria's productivity and heavily influenced by national policies. It is most prominent in coastal and steppe areas (32.34%), followed by highlands (29.15%). Labor is lower in mountainous (21.38%) and southern regions (17.21%), reflecting regional differences in agricultural activity and resource availability. (Harir, 2019)

2.2.3 Agricultural sector and trade balance: Algeria's agricultural sector supports trade, with a $4 billion export goal. In early 2021, it exported 50,000 tons, with over 100,000 tons exported the previous year despite COVID-19 challenges.

3. Economic growth:

Economic growth represents the long-term increase in a country's wealth production. To grasp it fully, we need to understand economic growth itself, along with related concepts of production and value added.

3.1 the concept of economic growth: Economic growth, as defined by Simon Kuznets, is the long-term increase in a country's capacity to provide a broader range of goods through sustained technical progress and institutional changes. It is measured as the continuous rise in real net gross product. (Kuznets, 1973) Mohammed Houcine Wajdi defines economic growth as an increase in real per capita income from improvements in productivity and expanded production, while aligning with natural population growth. (Hussein & Wajdi, 1973) . Economic growth denotes a sustained, long-term increase in a country's yearly production of goods and services, indicating ongoing and irreversible progress and development.

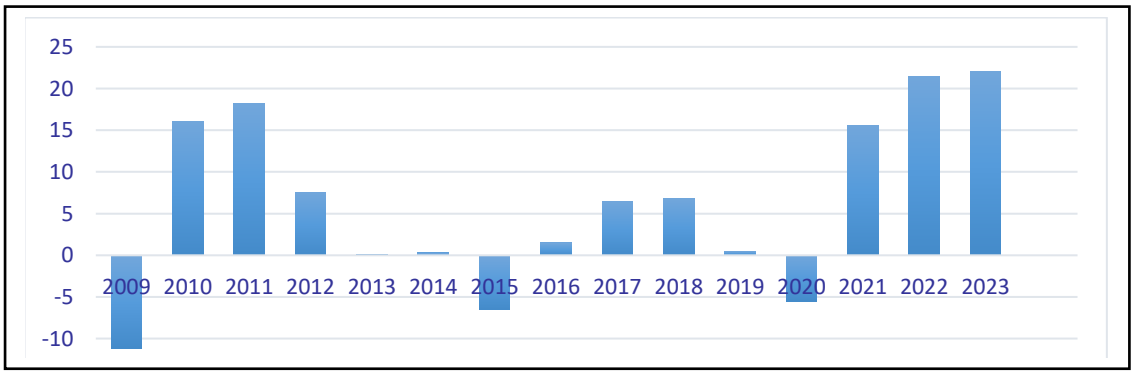
3.2 forms of economic growth: Economic growth can be expansive, utilizing more resources like physical, human, or natural capital, or intensive, increasing efficiency and productivity with the same resources. Thus, there are two forms of economic growth: expansive and intensive. (Mustafa Rushdi, 2013)

3.2.1 expansionary economic growth: Expansionary economic growth depends on increasing traditional production factors, boosting production capacity and output proportionally by expanding resource use rather than improving productivity.

3.2.2 intensive economic growth: Intensive economic growth enhances production capacity through technological advancements, driven by technical progress from research and development. It enhances productivity and innovation by boosting the efficiency of production organization and coordination.

3.3 Economic growth in Algeria: Algeria is improving its economic performance, but growth rates are below target. The next
sections will detail the evolution of its growth rate. (Hafadi, Jalil)

Fig.2. Economic growth rate trends in Algeria from 2009 to 2023



Source: World Bank

Algeria's growth rate fluctuated from 11.20% in 2009 to 22.10% in 2023, rebounding after a financial crisis but remains unsustainable due to a lack of sectoral diversification.

Algeria's economic growth is heavily dependent on the hydrocarbon sector and is influenced by global oil market conditions, as it lacks control over sales and pricing.

Algeria's economic growth is marked by fluctuations and weakness, largely due to an ineffective industrial sector.

4. Assessing the impact of Algeria's agricultural sector on economic growth using the ARDL model (1999-2022).

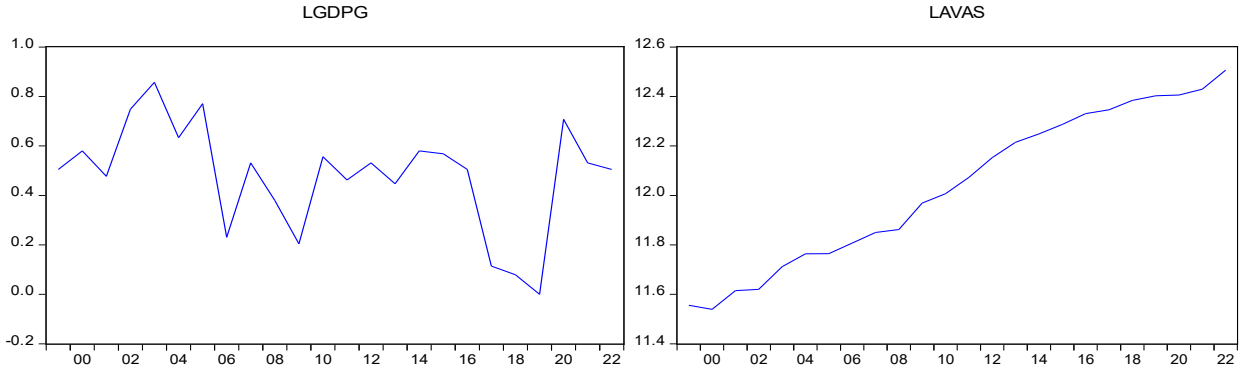
We assess the agricultural sector's impact on Algeria's economic growth (1999 – 2022) using the ARDL model, focusing on its contribution to GDP.

4.1 Descriptive Analysis:

Table n° 02:Displays the evolution of agricultural value added and economic growth rates in Algeria (1999 – 2022). **Unit: 106 / Da ،%**

Year	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
GDPG	3,2	3,8	3	5,6	7,2	4,3
The added value of the agriculture sector	359666	346171	412119	417225	515282	580506
Year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
GDPG	5,9	1,7	3,4	2,4	1,6	3,6
The added value of the agriculture sector	581616	641285	708072	727413	931349	1015259
Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
GDPG	2,9	3,4	2,8	3,8	3,7	3,2
The added value of the agriculture sector	1183216	1421693	1640006	1772202	1935113	2140305
Year	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
GDPG	1,3	1,2	1	-5,1	3,4	3,2
The added value of the agriculture sector	2219100	2421600	2529100	2546900	2688300	3207800

Source: World Bank



Source: Preparation by the researchers.

4.2 Definition of the studied variables:

As a first step, we define the study variables: agricultural value added (in fixed local currency) representing the agricultural sector, and GDP growth representing economic growth. To standardize different units, we apply the decimal logarithm. The required variables are:

LGDPG: The logarithm indicates the growth of GDP.

LAVAS: The logarithm reflects the added value of the agricultural sector.

4.2.1 Self-regressive distributed lag model:

This model can be represented as ARDL(ρ , q1, q2, \ldots), where (p) is the lag period of the dependent variable, and (q1, q2, \ldots) are the lag periods of the independent variables. The ARDL model is formulated as follows:

$$GDPG_t = \alpha + \sum_{t=1}^{\rho} \gamma_t GDPG_{t-1} + \sum_{j=1}^{k} \sum_{i=0}^{q} \beta_{ij} AVAS_{J,t-i} + \varepsilon_t$$

Distributed lag self-regression model.

$$LGDPG_t = \alpha + \sum_{t=1}^{\rho} \gamma_t LGDPG_{t-1} + \sum_{j=1}^{k} \sum_{i=0}^{q} \beta_{ij} LAVAS_{J,t-i} + \varepsilon_t$$

4.3 Determining the time lag degrees:

Prior to conducting the unit root test, it is crucial to identify the optimal lag periods using minimum criteria values.

following parameters :-Akaike Criterion (AIC) $: AIC(P) = Ln\left|\sum_e\right| + \frac{2k^2 p}{n}$

−Shwartz Criterion (SC):

$$SC(P) = Ln\left|\sum_e\right| + \frac{k^2 p.Ln(n)}{n}$$

The results obtained are summarized in the table below:

Table n° 03: Time dilation determination

Number of slowdowns	**0**	**1**	**2**	Optima deceleration period	
LGDPG	**Akaik**	-0.181216	-0.146376	-0.048822	**0**
	Schwar	-0.131508	-0.046961	0.100300	
LAVAS	**Akaik**	0.130063	4.204964-	-4.100584	**1**
	Schwar	0.179771	-4.105549	-3.951462	
Number of slowdowns	3	4	5		
LGDPG	**Akaik**	-0.040632	0.035778	0.086911	
	Schwar	0.158197	0.284314	0.385155	
LAVAS	**Akaike**	-4.001816	-4.006683	-3.936605	
	Schwarz	-3.802987	-3.758146	-3.638361	

Source: Preparation by the researchers

Here's a rephrased version of the sentence:

Optimal lag degrees are zero for GDP growth and renewable energy, and first-degree for agricultural value-added.

4.4 Assessing time series stability for the investigated variables.

This study utilizes the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test from among several available methods.

Premise: $H_0 : \phi_1 = 1$, $H_1 : \phi_1 \langle 1$

- If it is $t_{tab} < t_{\phi_i}$: We fail to reject the null hypothesis.

- If it is $t_{tab} > t_{\phi_i}$: We reject the null hypothesis in favor of the alternative hypothesis.

Table n° 04:stability test of ADF and PP significance level 5%

Variants		ADF		
		The constant	**Constant and**	**Without constant**
LGDPG	**Calcu**	-3.258330	-3.788997	-1.960656
	Criti	-2.998064	-3.658446	-1.956406
LAVAS	**Calcu**	-0.327354	-2.013597	6.210202
	Criti	-2.998064	-3.658446	-1.956406
Variants		**phill- Perr / PP**		
		The constant	**Constant and time**	**(Without constant and time)**
	Calcu	-3.240506	-3.788997	1.660656-
LGDPG	***Criti***	-2.998064	-3.658446	-1.956406
LAVAS	**Calcu**	-0.327354	-2.008242	6.953733
	Criti	-2.998064	-3.658446	-1.956406

Source: Preparation by the researchers

Table (4) shows a stability test comparison between LGDPG and LAVAS. The LGDPG series is stationary at level I(0), as its ADF test value exceeds the critical value. However, the LAVAS series shows lower calculated values in both ADF and PP tests, indicating a trend and non-stationarity at the origin.

4.5 remove the instability of the original LAVAS chain: Stationary differencing $D(LAVAS) = LLAVAS_t - LAVAS_{t-1}$, It is possible to obtain the first-order Difference series:

Table n° 05:stability test for ADF and PP significance leve5%

Variant		ADF		
		The constant	**Constant and time**	**(Without constant and time)**
LAVAS	**Calcul**	-6.762493	-6.605440	-6.929302
	Criti	-3.004861	-3.632896	-1.957204
	phill- Perr / PP			
		The constant	**Constant and time**	**(Without constant and time)**
	Calcu	-6.898677	-6.746821	-7.074163
	Criti	-3.004861	-3.632896	-1.957204

Source: Preparation by the researchers.

4.6 Evaluating the stability of the residual series, Resid

Table n° 06: steadiness test of the residuals series Resid / first difference

Variants		ADF		
		The constant	**Constant and time**	**(Without constant and time)**
LGDPG	***Calcu***	-3.258330	-3.588997	-1.160656
	Criti	-2.998064	-3.622033	-1.956406
LAVAS	***Calcu***	-0.327354	-2.013597	6.210202
	Criti	−2.998064	−3.658446	−1.956406
Variants		**phill- Perr / PP**		
		The constant	**Constant and time**	**(*Without constant and time*)**
LGDPG	***Calcu***	−3.240506	−3.788997	−1.660656
	Criti	−2.998064	−3.658446	−1.956406
LAVAS	***Calcu***	−0.327354	−2.008242	6.953733
	Criti	−2.998064	−3.658446	−1.956406

Source: Preparation by the researchers.

The table shows that the residue series for LGDPG is stable at I(0), with calculated ADF and PP values (-3.258330 and -3.240506) greater than the critical value (-2.998064).

For the LAVAS series, the Resid series is stable at I(0), as the calculated ADF and PP values (6.210202 and 6.953733) exceed the critical value (-1.956406).

The results indicate that LGDPG and LAVAS have a short-term equilibrium relationship and exhibit similar behavior in the short term.

4.7 Boundary testing for joint integration: If the computed F value surpasses the upper critical value using the boundary approach, we reject the null hypothesis and accept the alternative hypothesis, indicating a long-term equilibrium relationship among the variables under study.3-7-1 modified common integration boundary test:

$$\Delta \mathbf{GDPG}_t = \alpha + \sum_{i=1}^{\rho-1} \gamma_i \Delta \mathbf{LGDPG}_{t-i} + \sum_{j=1}^{k} \sum_{i=0}^{q-1} \beta_{ij} \Delta LAVAS_{J,t-i} + \rho \mathbf{LGDPG}_{t-1} + \sum_{j=1}^{k} \delta_j LAVAS_{j,t-1} + \varepsilon_t$$

Test hypothesis : $\begin{cases} H_0 : \rho = \delta_j = 0 \\ H_1 : \rho \neq \delta_j \neq 0 \end{cases}$

Table n° 07: boundary test results

Moral level			Critical values	Calcu F value
10%	**5%**	1%		
3.02	3.62	4.94	The minimum I(0)	4.439697
3.51	4.16	5.58	The upper limit I(1)	

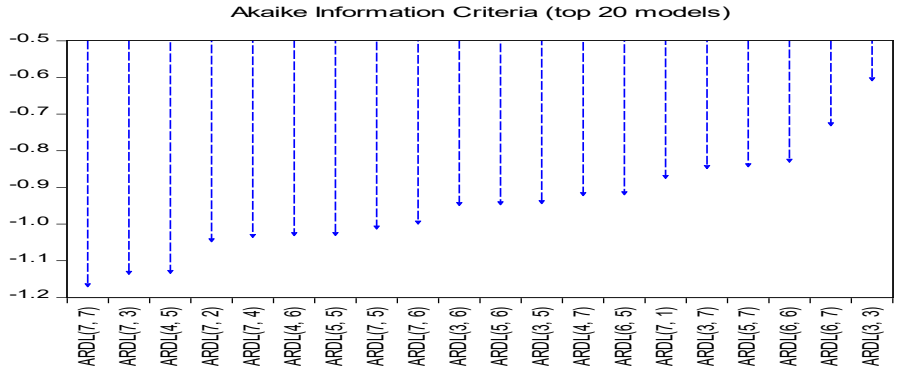
Source: Preparation by the researchers.

Table No. 08 indicates that the Fisher value exceeds the maximum limit, confirming

long-term integration between GDP growth and agricultural value-added at the 5% and 10% levels.

4.7.2 long-term relationship estimation: cointegration regression model:

Fig.3. Long-term equilibrium framework.



Source: Preparation by the researchers.

The ARDL model(3,3) was selected for long-term equilibrium estimation based on the lowest AIC value.

4.8 model estimation:

$$\mathbf{LGDPG} = 0.210781829687 * \mathbf{LGDPG}(-1) - 0.223450165525 * \mathbf{LAVAS} + 3.07142521112$$ GDP growth (LGDPG) is influenced by its own previous year's lag and the lagged agricultural value added (LAVAS).

4.9 economic interpretation:

GDP growth (LGDPG) is influenced by its previous year's lag and lagged agricultural value (LAVAS).

A 1% increase in lagged LGDPG leads to a 0.21% increase in GDP growth for the current year, assuming other variables are constant.

There is an inverse relationship between the current year's agricultural value-added logarithm and GDP growth logarithm.

There is a direct relationship between the lagged GDP growth logarithm and the current year's GDP growth logarithm.

4.10 ECM estimation:

We need to estimate the error correction model to analyze the adjustment speed coefficient, which confirms the common integration relationship between the variables if it meets specific criteria

$$\cdot \Delta \mathbf{GDPG}_t = \alpha + \sum_{i=1}^{p-1} \gamma_i \Delta \mathbf{LGDPG}_{t-i} + \sum_{j=1}^{k} \sum_{i=0}^{q-1} \beta_{ij} \Delta LAVAS_{J,t-i} - \varphi ECT_{t-1} + \varepsilon_t$$

Refers ECT_{t-1} To the variable the random errors (residuals) generated when estimating the relationship in the long run are time-lagged by one period of slowdown، and Refers φ The modulation speed coefficient, along with the results of this model, is displayed in the following table:

Table n° 08: error correction results

ARDL Erro Correct Regressi
Dependent Variabl: D(LGDPG)
Selected Model: ARDL(3, 3)

Sampl: 1999 2022				
Included obs: 21				
ECM Regression				
Varia	**Coeffic**	**Std. Err**	**t-Stat**	**Pro.**
D(LGDPG(-1))	0.737703	0.275980	2.673032	0.0192
D(LGDPG(-2))	0.908427	0.254622	3.567755	0.0034
D(LAVAS)	-4.116598	1.408394	-2.922901	0.0119
D(LAVAS(-1))	1.443495	1.021078	1.413697	0.1809
D(LAVAS(-2))	2.652633	1.308015	2.027983	0.0636
CointEq(-1)*	-1.571915	0.328351	-4.787299	0.0004

Source: Preparation by the researchers.

The estimation of the error correction model reveals that all variables are significant at the 5% level. The error correction coefficient (CointEq(-1)) is negative and significant ($\text{Prob} = 0.0004$), suggesting a long-term equilibrium relationship. With a coefficient value of -1.57, it demonstrates a rapid adjustment speed, correcting 157% of short-term deviations from equilibrium in each period.

5.Analysis of results:

-The optimal lag degrees, minimizing AIC and SC criteria, are zero for the GDP growth and renewable energy logarithm series, and one for the agricultural sector value-added logarithm series.

-The lgdpg series is unstable at I(0) due to unit roots, while the lavas series is stable at I(0).

-Both residue series (LGDPG, LAVAS) are stable at the origin I(0).

Long-term integration exists between the logarithm of GDP growth and the logarithm of agricultural sector value added at 5% and 10% significance levels.

The negative and significant error correction coefficient $\text{CointEq}(-1)$ $(\text{Prob} = 0.0004)$ indicates a long-term equilibrium relationship, with a -1.57 value signifying a 157% adjustment speed to equilibrium per period.

6.Hypothesis testing:

The study confirms that the agricultural sector significantly contributes to Algeria's economic growth by boosting GDP through increased production and food supply for domestic and export markets, showing that both sectors are complementary in the short and long term.

7.Recommendations:

Based on the ARDL model study (1999-2022), recommendations include :

Improvementof agricultural infrastructure:

- Enhance irrigation and drainage networks to boost productivity and reduce reliance on rainfall.
- Upgrade transportation networks and modernize storage facilities for efficient market access.

Financial support for farmers:

- Offer low-interest or interest-free loans to farmers for production and expansion.
- Agricultural insurance: establishment of an agricultural insurance system to protect farmers from environmental and economic risks.

Encouraging innovation and technology:

The ARDL model (3,3) evaluates the long-term equilibrium relationship.

- Organize training for farmers on modern technologies and sustainable agriculture methods.
- Support agricultural research centers to develop new technologies, enhance productivity, and improve crop quality.

Strengtheningpublic-private partnership:

- Encourage private investment in agriculture through tax incentives and streamlined procedures.
- Promote joint ventures between government and private companies to enhance infrastructure and boost agricultural production.

Improvement of agricultural policies:

- Develop long-term strategic plans to advance the agricultural sector and achieve food self-sufficiency.
- Update agricultural laws and regulations to facilitate operations and protect farmers' rights.

Development of agricultural product markets:

- Boost farmers' marketing skills and explore new international markets for Algerian agricultural products.
- Implement strict quality standards to enhance the competitiveness of Algerian products in global markets.

Environmental Protection and sustainability:

- Implement sustainable agricultural practices to conserve resources and reduce environmental impact.
- Implement programs to combat desertification and land degradation through afforestation and soil protection.

8. Conclusion:

This study highlights the agricultural sector's significant contribution to Algeria's economic growth from 1999 to 2022, as evidenced by the ARDL model. The results show a positive long- and short-term impact on GDP, emphasizing the importance of investing in this sector for sustainable development.

The agricultural sector is vital for food security, employment, and the national economy's stability and growth. Government policies should enhance agricultural infrastructure, offer financial incentives to farmers, and promote modern technologies to advance this sector.

The agricultural sector in Algeria encounters challenges such as limited funding and inadequate infrastructure. Addressing these issues necessitates comprehensive solutions, with the government playing a crucial role in supporting research, innovation, and investment in the sector.

Algeria's agricultural sector has great potential for economic growth, requiring sustainable development strategies to enhance the economy, ensure food security, and promote social stability.

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