

## **Wheat Production and Food Self-Sufficiency in Algeria: An ARDL-Based Analysis (1990–2024)**

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### **Abstract**

Food security remains a major strategic challenge for Algeria due to its high dependence on wheat imports and vulnerability to climatic variability. This study examines the impact of domestic wheat production on food self-sufficiency over the period 1990-2024 using an Autoregressive Distributed Lag (ARDL) approach. The results show that a 1% increase in local wheat production is associated with a 0.59% rise in the self-sufficiency rate. Short- and long-term analyses indicate a stable and robust relationship, with short-term deviations corrected rapidly, reflecting a resilient adjustment mechanism in the wheat sector.

Despite progress in domestic production, Algeria remains heavily reliant on imports, particularly soft wheat, highlighting structural vulnerabilities such as climate risks, limited irrigation, and slow agricultural modernization. This study contributes by providing updated empirical evidence on the dynamics between wheat production, consumption, and self-

sufficiency in Algeria using the most recent data up to 2024, offering insights for policy design to enhance national food security

**Keywords:** Food security; Wheat production; Self-sufficiency; ARDL model; Algeria; Agricultural policy

## **1. INTRODUCTION**

In light of rapid population growth, climate change, and increasing volatility in global agricultural markets, food security has become a critical strategic challenge for emerging nations such as Algeria. Ensuring a stable and adequate domestic food supply is essential not only for economic stability but also for social cohesion and national sovereignty.

Wheat, as the staple cereal, plays a central role in Algeria's food system. However, domestic production remains structurally insufficient to meet national demand, resulting in heavy reliance on imports, particularly soft wheat. This dependence exposes the country to external shocks, including international price fluctuations, geopolitical tensions, and climatic risks. Structural constraints such as low agricultural productivity, limited irrigation infrastructure, and slow modernization of the farming sector further exacerbate this vulnerability.

### **The question of the study:**

This study aims to analyze how domestic wheat production affects Algeria's food self-sufficiency over the period 1990-2024 using an ARDL framework. It addresses the following research question: What is the contribution of domestic wheat production to achieving food self-sufficiency in Algeria?

### **Hypothesis:**

Accordingly, the study tests the following hypothesis: Increasing domestic wheat production significantly enhances food self-sufficiency in Algeria, reduces dependence on imports, and contributes to stabilizing national supply. Conversely, domestic wheat production

may have an insignificant effect on the country's food self-sufficiency.

By examining both short- and long-term relationships between wheat production, consumption, and the self-sufficiency rate, this study provides updated empirical evidence to inform policy measures aimed at strengthening food security

### **The importance of the study:**

This study is important as it addresses a strategic issue related to food security and food sovereignty in Algeria. It provides empirical evidence to help policymakers reduce dependence on wheat imports, improve national production, and strengthen resilience against external shocks. It also contributes to the academic literature by applying an econometric model (ARDL) to analyze the dynamics of the cereal sector

### **Methodology:**

In terms of methodology, the study uses an econometric and descriptive approach based on the Autoregressive Distributed Lag (ARDL) model, which is calculated using EViews software. Using basic unit root and cointegration tests, this methodology enables the investigation of both short- and long-term correlations between wheat production, consumption, and the self-sufficiency rate. The results are intended to strengthen Algeria's food sovereignty, assist in modernizing the cereal industry, and guide changes to agricultural policy

## **2-Theoretical Concept and Literature Review**

Several empirical studies highlight the strategic role of wheat production in achieving food security in Algeria and

comparable developing nations. Ben Aziz and Bouabdelli (2022), using an ARDL model (1990–2019), found that increases in wheat output significantly enhance the self-sufficiency rate, indicating a stable long-run equilibrium. Broader agricultural sector indicators, such as cultivated land and agricultural employment, also contribute positively to food security, as shown by quantile regression studies. Rahal and Belouerghi (2025) emphasize that Algeria's reliance on cereal imports has intensified due to stagnating domestic production relative to rising demand, reflecting structural challenges such as limited irrigation, low productivity, and traditional farming practices. Other studies, including Bekkis et al. (2022) and Abis (2015), confirm that domestic wheat production remains central to reducing import dependency and achieving long-term self-sufficiency. Long-term ARDL and Asymmetric Error Correction Model analyses further illustrate that production increases can mitigate food gaps, while consumption pressures continue to challenge self-sufficiency. Collectively, these findings provide robust empirical support for the centrality of wheat production in Algeria's food security, offering guidance for policies to enhance production, stabilize supply, and reduce import dependence.

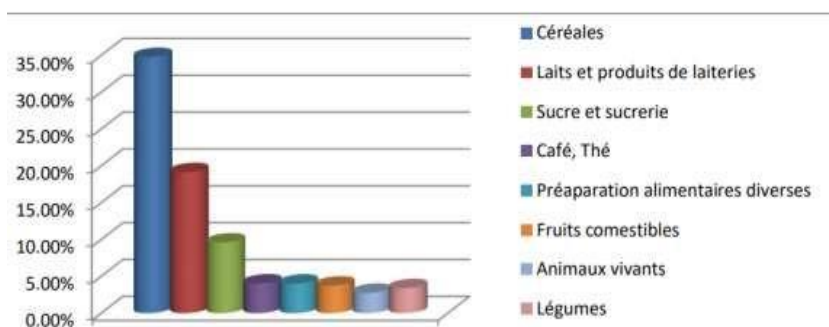
### **3. Stakes of Food Security in Algeria**

Algeria's heavy reliance on cereal imports, especially soft wheat, makes it more vulnerable to global price volatility and geopolitical upheavals, making food security a significant strategic challenge. The comparatively low level of national self-sufficiency emphasizes the need to increase productive capacity and draws attention to the structural constraints of domestic agriculture output.

Climate shocks, particularly frequent droughts and unpredictable rains, worsen this vulnerability by threatening the stability of the food supply. At the same time, persistent population increase is driving up demand, further taxing already limited domestic resources.

The majority of Algeria's food imports are cereals, which reflects the importance of wheat in the country's consumption habits. Wheat plays a major role in household meals as a staple item, therefore changes in its price and availability are especially sensitive from an economic and social standpoint. Algeria is therefore more susceptible to external shocks due to its reliance on foreign markets, which emphasizes the strategic significance of increasing domestic production to improve food security.

**Figure1:** Distribution of Algerian imports by usage groups



**Source:** Cherrou (2023) highlights the challenges and issues related to food security in Algeria.

The vulnerability of the country's cereal production is demonstrated by empirical data. Due mostly to unfavorable weather and low agricultural yields, output

fell by about 38% in the 2021–2022 season and by more than 12% in 2023. Due to this gap, significant import requirements have resulted; for the 2023–2024 season, almost 8.7 million tonnes of wheat and roughly 14 million tons of all cereals combined are anticipated. Algeria has responded by broadening its sources of imports, particularly by combining old European partners with suppliers like Russia. Although this approach reduces supply concerns, it does not significantly lessen reliance on outside sources.

All things considered, these dynamics show that boosting domestic cereal production is a strategic necessity for enhancing food self-sufficiency as well as for preserving social stability, protecting purchasing power, and bolstering national sovereignty in the face of external shocks.

#### **4-Wheat production situation in Algeria**

With over 69% of all cereal production and 62% of cereal-cultivated land, the wheat industry is strategically important to Algeria's agricultural system. It also contributes roughly 4.44% of the country's total agricultural output. Despite this substantial burden, domestic wheat production is still insufficient to meet the country's demand, which leads to ongoing reliance on imports and poses a serious threat to food security.

Geographical and meteorological conditions have a significant impact on wheat production. Although rainfall is mostly concentrated in the north, there is still little effective use of it.

Only around 8.5 million hectares of Algeria's projected 42.5 million hectares of agricultural land are now being used, indicating significant unrealized productive potential that might be mobilized to boost domestic supply and increase food self-sufficiency.

**Figure 2:** Evolution of wheat production in Algeria



**Source :** FAO

Algeria's wheat production fluctuated significantly between 1990 and 2024. As a result of increased irrigation and agricultural technology, output increased in the 2000s, reaching roughly 3.7–3.8 million tonnes between 2000 and 2010. In 2018 and 2019, production reached a record high of 3.9 million tonnes. But following 2020, wheat production has grown more erratic, falling precipitously to roughly 2.5 million tonnes in 2021–2022 as a result of extreme drought conditions, then rising to 3.6 million tonnes in 2023 before reducing slightly to about 3.0 million tonnes in 2024.

Algeria's reliance on wheat imports is strengthened by this severe instability, which highlights the vulnerability of the country's food security. In order to stabilize production

and improve long-term food self-sufficiency, it emphasizes the critical need to bolster agricultural technology, extend effective irrigation infrastructure, and encourage climate-resilient farming techniques.

**Figure3:** Trends in wheat cultivation area in Algeria.



**Source :** FAO

Algeria has set aside large tracts of land for the production of wheat, especially in the High Plateaus, which have comparatively good soil and climate. Following the National Agricultural Development Plan's implementation, wheat-sown areas increased significantly in the early 2000s, rising from 826.6 thousand hectares in 2000 to 1,836.4 thousand hectares in 2001 before falling to 1,396.5 thousand hectares in 2002 as a result of unfavorable weather. Cultivated areas increased once more after the National Agricultural and Rural Development Plan was introduced in 2004, reaching roughly 2,010.7 thousand hectares. A relative stabilization of 1,713.3 thousand hectares occurred between 2010 and 2015, although subsequent years were marked by oscillations related to climate variability, the 2008 economic crisis, and changes in

agricultural support programs. Following slight fluctuations, a renewed expansion was observed during the 2018–2019.

By the end of 2023, total cereal-sown areas reached nearly 3.3 million hectares, with durum and soft wheat accounting for the largest share. However, these areas remain highly sensitive to climatic shocks and policy incentives, and recent agricultural campaigns (2023/2024) have aimed to maintain wheat cultivation between 1.8 and 2.0 million hectares. This pronounced interannual variability in cultivated areas highlights the structural vulnerability of the cereal sector and underscores the importance of strengthening agricultural resilience to enhance national food security.

## **5. Analysis of Wheat Self-Sufficiency in Algeria**

Food self-sufficiency refers to a country's ability to meet its domestic food needs through local production without relying on imports. In the cereal sector, it is commonly measured by the self-sufficiency rate, defined as the ratio of national production to total domestic consumption, expressed as a percentage. A self-sufficiency rate indicates full coverage of domestic needs, whereas lower values reflect varying degrees of dependence on external markets.

Algeria has historically exhibited a low level of wheat self-sufficiency, reflecting persistent climatic constraints, limited cultivated areas, and a continuous increase in domestic demand. During the early 1990s (1990–1994), the self-sufficiency rate frequently remained below 30%, despite improved market availability, indicating a strong reliance on imports to offset declining domestic production and satisfy the needs of a growing population.

A modest improvement was observed over the 1995–2001 period, with the average self-sufficiency rate rising to

approximately 35%, largely driven by a gradual increase in domestic output. However, this progress remained insufficient to achieve food independence. Between 2002 and 2010, wheat production continued to expand, yet the self-sufficiency rate remained broadly stable, except in 2008, when it fell sharply to around 16.5% as a result of the global food crisis combined with weaker domestic production.

For Algeria's most popular type of wheat, common wheat, the situation is essentially same in the most recent period (2022–2024), with domestic production meeting only roughly 25% of the country's needs and requiring yearly imports of nearly 9 million tons. On the other hand, durum wheat has made great strides; in 2024, its self-sufficiency rate was close to 80%. Building on this momentum, Algerian officials hope to attain complete durum wheat self-sufficiency by the 2025–2026 season through the extension of farmed areas, improved agronomic practices, improved seed types, and targeted incentive schemes.

## **6- Empirical study**

The primary variables in this model—wheat output, domestic consumption, and the self-sufficiency rate—were chosen because they accurately reflect the link between production and self-sufficiency and represent the major factors influencing food security in Algeria. Even while additional variables like rainfall, wheat prices, and agricultural subsidies can also affect food self-sufficiency, their inclusion in the model was not possible due to the absence of regular and trustworthy annual data for the years 1990–2024. In order to guarantee the robustness and dependability of the econometric analysis, the study concentrated on the variables that were available.

The data used in our study are annual in nature and cover the period from 1990 to 2024. They were extracted from United

Nations (FAO) databases. Three main variables were taken into account for the analysis.

**ATS (Self-Sufficiency Rate, %):** measures the country's ability to satisfy its wheat consumption through local production.

**DCM (Availability of consumption, thousand tons):** represents the quantity of wheat available for domestic consumption.

**PRD (Wheat Production, Thousand Tonnes):** corresponds to national wheat production, a key indicator of food security.

### **-Analyse descriptiv**

**Table 1: Descriptive Statistics of the Model**

| <b>Statistic</b> | <b>Wheat Production</b> | <b>Availability for Consumption</b> | <b>Self-Sufficiency Rate</b> |
|------------------|-------------------------|-------------------------------------|------------------------------|
| Mean             | 1.4592                  | 3.7876                              | 3.2430                       |
| Median           | 1.4900                  | 3.8195                              | 3.2718                       |
| Maximum          | 1.7782                  | 4.0714                              | 3.6000                       |
| Minimum          | 1.1424                  | 3.4184                              | 2.6920                       |
| Std. Dev.        | 0.1298                  | 0.1878                              | 0.2329                       |
| Skewness         | -0.3236                 | -0.2698                             | -0.4838                      |
| Kurtosis         | 3.1907                  | 1.8621                              | 2.3559                       |
| Jarque-Bera      | 0.7777                  | 2.7094                              | 2.3078                       |
| Probability      | 0.6778                  | 0.2580                              | 0.3154                       |
| Sum Sq. Dev.     | 0.6734                  | 1.4107                              | 2.1696                       |
| Observations     | 35                      | 35                                  | 35                           |

**Source:** Constructed by the authors based on EViews 12 results

Descriptive statistics indicate that wheat production and food availability exhibit greater volatility than the self-sufficiency rate, as reflected by their relatively higher standard deviations. In addition, most variables display distributions that do not significantly deviate from normality, as confirmed by the Jarque–Bera test, with probability values exceeding the 5% significance level.

### - Stationarity Analysis of Time Series

Testing for stationarity is a fundamental prerequisite in time-series econometric modeling. A series is considered stationary when it fluctuates around a constant mean and its variance remains stable over time. To assess this property, the Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests are commonly employed to detect the presence of unit roots, which indicate non-stationarity. The results of these tests, including test statistics and associated p-values, are reported in the table below and serve as the basis for selecting an appropriate econometric framework.

**Table 2:** Results of Stationarity Tests (ADF, PP)

| Les variables | Model | Test ADF              |                       | Test PP               |                       |
|---------------|-------|-----------------------|-----------------------|-----------------------|-----------------------|
|               |       | I(0)                  | I(1)                  | I(0)                  | I(1)                  |
|               |       | t-statistic<br>prob   | t-statistic<br>prob   | t-statistic<br>prob   | t-statistic<br>prob   |
| ATS           | 3     | -5,110434<br>(0,0001) | -5,105598<br>(0,0001) | -5,110434<br>(0,0001) | -14,44760<br>(0,0000) |
|               | 2     | -5,094935<br>(0,0009) | -5,152518<br>(0,0010) | -5,094935<br>(0,0009) | -15,23114<br>(0,0000) |
|               | 1     | -0,213007<br>(0,6023) | -5,299143<br>(0,0000) | -0,505868<br>(0,4910) | -14,74928<br>(0,0000) |
| DCM           | 3     | -1,190842<br>(0,6688) | -9,897512<br>(0,0000) | -0,856930<br>(0,7915) | -15,10626<br>(0,0000) |
|               | 2     | -5,749333<br>(0,0001) | -9,777774<br>(0,0000) | -5,763531<br>(0,0001) | -14,68766<br>(0,0000) |
|               | 1     | 1,458995<br>(0,9618)  | -9,620776<br>(0,0000) | 3,142368<br>(0,9993)  | -9,620776<br>(0,0000) |
| PRD           | 3     | -2,754950<br>(0,0740) | -5,966745<br>(0,0000) | -2,533999<br>(0,1153) | -17,55974<br>(0,0001) |
|               | 2     | -5,150583<br>(0,0009) | -5,879400<br>(0,0001) | -6,763573<br>(0,0000) | -18,25214<br>(0,0000) |
|               | 1     | 1,679102<br>(0,9751)  | -5,532622<br>(0,0000) | 0,636015<br>(0,8496)  | -11,72243<br>(0,0000) |

**Source:** Constructed by the authors based on EViews 12 results

Analysis of the results shows that the three variables studied have at least one unit root in one of the three models, even at the 10% significance level, according to the ADF and PP tests. However,

after applying a first-order differentiation, all variables become stationary at the 1% threshold, with no unit roots detected in all three models. Thus, the original series are considered integrated of order 1 .

### **-ARDL Model Estimation :**

**Figure 4: ARDL Model Estimation**

Dependent Variable: ATS

Method: ARDL

Date: 25/10/25 Time: 07:08

Sample (adjusted): 1990 2024

Included observations: 35 after adjustments

Maximum dependent lags: 4 (Automatic selection)

Model selection method: Akaike info criterion (AIC)

Dynamic regressors (4 lags, automatic): DCM PRD

Fixed regressors: C

Number of models evaluated: 100

Selected Model: ARDL(1, 1, 0)

Note: final equation sample is larger than selection sample

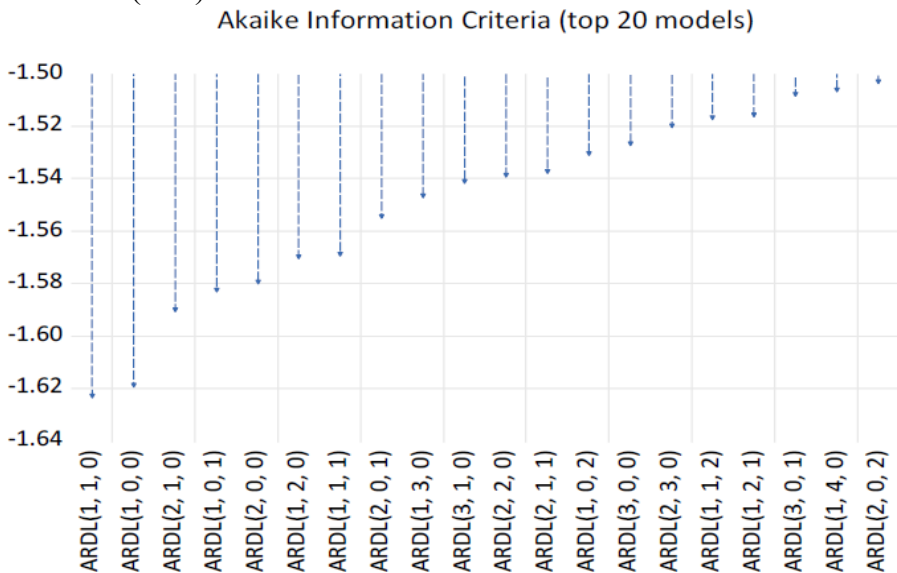
| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.* |
|--------------------|-------------|-----------------------|-------------|--------|
| ATS(-1)            | 0.013960    | 0.133052              | 0.104920    | 0.9170 |
| DCM                | -0.181041   | 0.217905              | -0.830828   | 0.4117 |
| DCM(-1)            | -0.356326   | 0.204230              | -1.744728   | 0.0898 |
| PRD                | 0.585255    | 0.117544              | 4.979039    | 0.0000 |
| C                  | 1.570755    | 0.388349              | 4.044695    | 0.0003 |
| R-squared          | 0.446175    | Mean dependent var    | 1.457273    |        |
| Adjusted R-squared | 0.382881    | S.D. dependent var    | 0.131165    |        |
| S.E. of regression | 0.103039    | Akaike info criterion | -1.590954   |        |
| Sum squared resid  | 0.371595    | Schwarz criterion     | -1.379844   |        |
| Log likelihood     | 36.81908    | Hannan-Quinn criter.  | -1.514623   |        |
| F-statistic        | 7.049225    | Durbin-Watson stat    | 1.958707    |        |
| Prob(F-statistic)  | 0.000284    |                       |             |        |

\*Note: p-values and any subsequent tests do not account for model selection.

**Source:** EViews 12 results

The model was estimated to examine the short- and long-term relationships between wheat self-sufficiency (ATS) and its determinants. The results indicate that past values of ATS have no significant effect on current levels (ATS(-1),  $p = 0.917$ ), while domestic consumption (DCM) exerts a negative influence, with the first lag being marginally significant (DCM(-1),  $p = 0.0898$ ). In contrast, domestic wheat production (PRD) has a highly significant positive effect on self-sufficiency ( $p < 0.001$ ), highlighting the central role of increasing production in achieving food security. The model explains approximately 38% of the variation in ATS (adjusted  $R^2 = 0.383$ ) and passes diagnostic checks, with a Durbin–Watson statistic close to 2, indicating no autocorrelation. Overall, these results underscore the importance of production expansion over short-term consumption changes in improving Algeria’s wheat self-sufficiency.

**Figure 5:** Top 20 ARDL Models Based on the Akaike Information Criterion (AIC)



Source: EViews 12 results

From the graph presented above, the ARDL model (1,1,0) was identified as the most appropriate model. This selection is based on the Akaike Information Criterion (AIC), which reaches its minimum value for this model, indicating that it offers the best compromise between fit quality and parameter parsimony.

The model specification is as follows:

$$ATS = C(1)*ATS (-1) + C(2)*DCM + C(3)*DCM (-1) + C(4)*PRD + C(5)$$

Based on the Fisher test, the ARDL (1,1,0) model is statistically significant overall, as indicated by the p-value associated with the F-statistic, which is less than 0.05. This implies that all the explanatory variables included in the model contribute significantly to explaining the variation in the dependent variable.

### **- Co-integration Test (Bound test):**

The results of the Boundary Co-integration test confirm the existence of a Co-integration relationship between the variables (The F-Statistic value (16.43) is greater than the value of the upper bound) at all 1%, 5% and 10% significance thresholds, which gives the possibility of estimating the long-term effects between the variables.

**Table 3** Results of the Cointegration Test (Bounds Test)

| F-Bounds Test       |          | Null Hypothesis: No levels relationship |       |       |
|---------------------|----------|-----------------------------------------|-------|-------|
| Test Statistic      | Value    | Signif.                                 | I(0)  | I(1)  |
| Asymptotic: n=1000  |          |                                         |       |       |
| F-statistic         | 16.43094 | 10%                                     | 2.63  | 3.35  |
| k                   | 2        | 5%                                      | 3.1   | 3.87  |
|                     |          | 2.5%                                    | 3.55  | 4.38  |
|                     |          | 1%                                      | 4.13  | 5     |
| Finite Sample: n=40 |          |                                         |       |       |
| Actual Sample Size  | 40       | 10%                                     | 2.835 | 3.585 |
|                     |          | 5%                                      | 3.435 | 4.26  |
|                     |          | 1%                                      | 4.77  | 5.855 |

**Source:** EViews 12 results

The bounds test for cointegration confirms the existence of a long-term relationship between the variables, as the F-statistic (16.43) exceeds the upper critical bound at all significance levels (1%, 5%, and 10%). This result validates the presence of cointegration and allows for the estimation of long-term effects among the variables.

#### **-Short-term relationship:**

**Table 4:** Short-Term Relationship Estimation Results

| ECM Regression                           |             |                       |             |        |
|------------------------------------------|-------------|-----------------------|-------------|--------|
| Case 2: Restricted Constant and No Trend |             |                       |             |        |
| Variable                                 | Coefficient | Std. Error            | t-Statistic | Prob.  |
| D(DCM)                                   | -0.181041   | 0.194885              | -0.928964   | 0.3593 |
| CointEq(-1)*                             | -0.986040   | 0.116728              | -8.447321   | 0.0000 |
| R-squared                                | 0.661083    | Mean dependent var    | -0.004506   |        |
| Adjusted R-squared                       | 0.652164    | S.D. dependent var    | 0.167670    |        |
| S.E. of regression                       | 0.098888    | Akaike info criterion | -1.740954   |        |
| Sum squared resid                        | 0.371595    | Schwarz criterion     | -1.656510   |        |
| Log likelihood                           | 36.81908    | Hannan-Quinn criter.  | -1.710422   |        |
| Durbin-Watson stat                       | 1.958707    |                       |             |        |

\* p-value incompatible with t-Bounds distribution.

**Source:** EViews 12 results

The estimation of the error correction coefficient ( $\pi = -0.98$ ) is statistically significant at the level of 1%, which confirms the validity of the error correction model (ECM). This value indicates that nearly 98% of short-term deviations from equilibrium can be corrected in the first year, allowing the system to quickly return to its long-term equilibrium level after a shock.

This strong adjustment capacity reflects a rapid restoration of equilibrium in the Algerian economy in the event of disruptions affecting the wheat market and the level of self-sufficiency. In other words, the variables considered — namely the self-sufficiency rate, wheat production and availability for consumption — are integrated jointly, and their interaction reflects a stable long-term equilibrium relationship.

These results highlight that short-term fluctuations in wheat production or consumption are quickly absorbed, and that agricultural policies or external shocks only lead to temporary imbalances. Thus, the error correction model provides a better understanding of the dynamics of convergence towards equilibrium and resilience of the Algerian economy in the cereals sector.

### **-Long-term dynamics:**

After confirming the existence of a Co-integration relationship between the model variables, summarizes the results of the ARDL model estimation for error correction, highlighting the long-term dynamics.

**Table 5: Long-Term Relationship Estimation Results**

| Levels Equation                                |             |            |             |        |
|------------------------------------------------|-------------|------------|-------------|--------|
| Case 2: Restricted Constant and No Trend       |             |            |             |        |
| Variable                                       | Coefficient | Std. Error | t-Statistic | Prob.  |
| DCM                                            | -0.544975   | 0.157979   | -3.449672   | 0.0015 |
| PRD                                            | 0.593541    | 0.125942   | 4.712802    | 0.0000 |
| C                                              | 1.592993    | 0.357148   | 4.460316    | 0.0001 |
| EC = ATS - (-0.5450*DCM + 0.5935*PRD + 1.5930) |             |            |             |        |

**Source:** EViews 12 results

The long-term parameters estimated in the model are statistically significant at the 1% level, which confirms their reliability in interpreting the impact of explanatory variables on the wheat self-sufficiency rate in Algeria. According to the results, the self-sufficiency rate is negatively impacted by the size of consumption (coefficient  $\approx -0.54$ ) and positively by the size of production (coefficient  $\approx 0.59$ ).

These coefficients show that wheat production plays a decisive role in improving the country's food self-sufficiency. In concrete terms, an increase of one unit in national wheat production leads to an

improvement of about 0.6 units in the rate of self-sufficiency, all other things being equal. Conversely, an increase in consumption exerts a negative pressure on self-sufficiency, which underlines the importance of a balance between local production and domestic demand.

### -Model validation:

Residue autocorrelation test:

In order to check the autocorrelation of the series:

**H0:** non-correlation of series.

**H1:** series correlation

**Table 6:** Residuals Autocorrelation Test Results

Sample (adjusted): 1982 2021  
Q-statistic probabilities adjusted for 1 dynamic regressor

| Autocorrelation                                                                     | Partial Correlation                                                                 | AC | PAC    | Q-Stat | Prob*  |       |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|----|--------|--------|--------|-------|
|    |    | 1  | 0.006  | 0.006  | 0.0016 | 0.968 |
|    |    | 2  | 0.167  | 0.167  | 1.2345 | 0.539 |
|    |    | 3  | -0.200 | -0.207 | 3.0434 | 0.385 |
|    |    | 4  | 0.113  | 0.101  | 3.6405 | 0.457 |
|    |    | 5  | -0.118 | -0.065 | 4.3110 | 0.506 |
|   |   | 6  | 0.284  | 0.239  | 8.3057 | 0.217 |
|  |  | 7  | -0.144 | -0.128 | 9.3673 | 0.227 |
|  |  | 8  | -0.059 | -0.175 | 9.5479 | 0.298 |
|  |  | 9  | -0.019 | 0.172  | 9.5678 | 0.387 |
|  |  | 10 | 0.209  | 0.161  | 12.022 | 0.284 |
|  |  | 11 | -0.203 | -0.289 | 14.412 | 0.211 |
|  |  | 12 | -0.015 | -0.117 | 14.426 | 0.274 |
|  |  | 13 | -0.089 | 0.163  | 14.919 | 0.312 |
|  |  | 14 | -0.191 | -0.275 | 17.274 | 0.242 |
|  |  | 15 | 0.070  | 0.077  | 17.601 | 0.284 |
|  |  | 16 | -0.064 | -0.164 | 17.886 | 0.331 |
|  |  | 17 | -0.108 | -0.029 | 18.737 | 0.344 |
|  |  | 18 | -0.114 | 0.050  | 19.737 | 0.348 |
|  |  | 19 | 0.137  | -0.035 | 21.231 | 0.324 |
|  |  | 20 | -0.067 | 0.014  | 21.611 | 0.362 |

\*Probabilities may not be valid for this equation specification.

**Source:** EViews 12 results

The results of the Q-statistic test show that the p-value is greater than the significance level of 1%. Therefore, we accept the null hypothesis (H0), which states the absence of autocorrelation in the model residues.

– **Breusch-Godfrey LM test:**

We will use the Breusch-Godfrey LM serial correlation test, which is particularly suitable for ARDL estimation.

**Table 7:** Breusch–Godfrey LM Test Results

|                                                                                                      |          |                     |        |
|------------------------------------------------------------------------------------------------------|----------|---------------------|--------|
| Breusch-Godfrey Serial Correlation LM Test:<br>Null hypothesis: No serial correlation at up to 1 lag |          |                     |        |
| F-statistic                                                                                          | 0.003166 | Prob. F(1,34)       | 0.9555 |
| Obs*R-squared                                                                                        | 0.003724 | Prob. Chi-Square(1) | 0.9513 |

**Source:** EViews 12 results

According to the test results, our probability is very high and higher than 5%. Via therefore, we accept the null hypothesis that there is no serial correlation Our Model

**8-Residue heteroscedasticity test:**

We will use the Breusch-Pagan-Godfrey test to test the heteroscedasticity of our residues. The detection of heteroscedasticity is done with the hypothesis

**H0:** there is homoscedasticity

**H1:** there is heteroscedasticity

**Table 8:** Heteroscedasticity Test Results

|                                                                                     |          |                     |        |
|-------------------------------------------------------------------------------------|----------|---------------------|--------|
| Heteroskedasticity Test: Breusch-Pagan-Godfrey<br>Null hypothesis: Homoskedasticity |          |                     |        |
| F-statistic                                                                         | 1.348921 | Prob. F(4,35)       | 0.2715 |
| Obs*R-squared                                                                       | 5.342832 | Prob. Chi-Square(4) | 0.2539 |
| Scaled explained SS                                                                 | 7.572061 | Prob. Chi-Square(4) | 0.1086 |

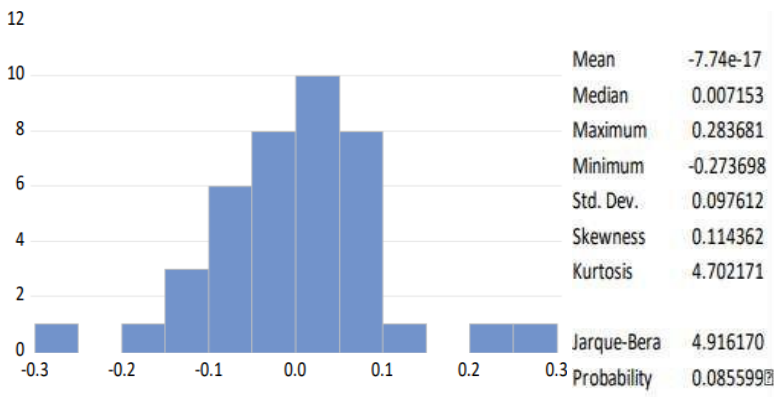
**Source:** EViews 12 results

we accept the null hypothesis that there is no heteroscedasticity among the residues.

- **Residue normality test**

To verify the assumption of normality of the residuals and that the residuals of the estimate of long-term model are white noise we use the Jarque Berae normality test

**Figure 6:** Residuals Normality Test Results



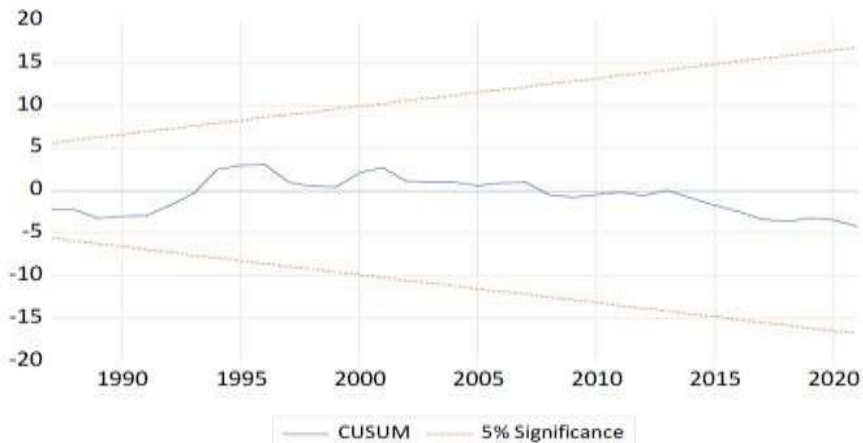
**Source:** EViews 12 results

The probability associated with the Jarque-Bera 0.08 statistic is therefore greater than 0.05 the assumption of normality of the residues is therefore verified. We can therefore conclude that the residuals of the estimation of the long-term model are white noise. The normality of their distributions is confirmed.

- **Stability test (Cusum):**

To assess the constancy of the parameters in our ARDL model, we performed a structural stability test. The test is based on the cumulative sum of recursive residuals (CUSUM) method to verify the stability of the long-term and short-term parameters. The residuals are accumulated from the first observations, then the CUSUM statistic is plotted according to the breakpoints. If the curve of the CUSUM statistic remains within the significance level of 5%, this indicates that the estimated coefficients are stable

**Figure 7:** Stability Test Results (CUSUM)



**Source:** EViews 12 results

This observation indicates that the model is stable over time, i.e. that the estimated parameters do not undergo significant structural variations over the period studied. As a result, the results obtained can be considered reliable and robust, which reinforces the credibility of analyses on the relationship between the self-sufficiency rate, wheat production and consumption in Algeria.

## **7. CONCLUSION**

This study examined the role of domestic wheat production in achieving food self-sufficiency in Algeria over the period 1990–2024 using an Autoregressive Distributed Lag (ARDL) approach. The empirical findings confirm a stable and significant long-run relationship between wheat production, domestic consumption, and the self-sufficiency rate. Consistent with the study hypothesis, increases in national wheat production positively and significantly enhance food self-sufficiency, while growing consumption continues to exert downward pressure, reflecting a persistent structural gap between supply and demand.

The results also indicate a rapid speed of adjustment toward long-term equilibrium, suggesting that the wheat sector is capable of absorbing short-term shocks. However, despite this adjustment capacity, Algeria remains highly dependent on wheat imports—particularly soft wheat—due to climatic risks, limited irrigation efficiency, low productivity, and delayed agricultural modernization. These structural constraints continue to undermine sustainable food security.

From a policy perspective, the findings emphasize the need for a comprehensive strategy combining production expansion with structural reforms. Priority should be given to climate-resilient and high-yield seed adoption, irrigation modernization, and improved post-harvest storage and distribution systems. Strengthening farmer support and aligning production policies with consumption dynamics are also essential. Future research could incorporate climatic and price variables to provide deeper insights into food security determinants and support evidence-based policymaking aimed at reinforcing Algeria's food sovereignty.

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