



Does Internet Usage Enhance Food Production in Algeria? A Structural Break ARDL Approach

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Received: 01/02/2025

Accepted: 14/03/2025

Published: 27/04/2025

Abstract:

This study explores how Algeria's rapid internet penetration has influenced food production through the adoption of agricultural technologies. Utilizing a structural break autoregressive distributed lag (ARDL) approach with data from 1990 to 2020, it examines the relationships among food production index (FPI), internet usage (NET), agricultural raw material imports (AMRI), and population growth (POPgr). The findings reveal that (1) internet adoption has a marginally significant short-term positive effect on food production, but its long-term impact is statistically insignificant, highlighting the rural-urban digital divide; (2) agricultural imports temporarily boost production while undermining long-term sustainability; and (3) population growth increases food demand, requiring productivity gains. The study concludes that Algeria's digital transformation holds potential, but targeted policies—such as improving rural ICT infrastructure, creating localized e-agriculture platforms, and pursuing import substitution—are essential for sustainable food security in the agricultural sector.

Key Words: Internet adoption, food security, structural break ARDL, import dependency, Algeria.

JEL Classification: Q16, O33, C22

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Introduction

The global food security situation is worsening due to growing food prices and general inflation, especially in low-income countries suffering from food deficits. At the same time, the high cost of agricultural raw material imports along with high increase of population might result in higher cost of production which will in turn drive up general food prices and eventually poses a significant threat to food security. According to the Quarterly Global FAO report (Crop Prospects and Food Situation, 2022), 46 nations worldwide, including 1 in Europe, 2 in Latin America and the Caribbean, and 10 in Asia, where Africa has had the lion's share with 33 countries that are in real need for food aid from outside.

Africa, in particular, has experienced a severe increase in food insecurity by more than 60% in 2020 resulting in over 100 million undernourished people (African Center for Strategic studies, 2021), and it is on the verge of becoming worse as



COVID-19's consequences compound other factors like violence and weak political governance.

As a part of Africa, Algeria is also among the countries heavily dependent on food imports. By opting for heavy industrialization oriented towards the development of hydrocarbons, The country has largely neglected agriculture, which has resulted in almost absolute dependence on the outside (imports of raw materials and other intermediate goods such as ingredients and packaging, specific equipment and technologies), weak integration into the agricultural upstream, low diversification, timid exports, in value and volumes, and finally, significant lag in terms of food production firms and technological cooperation at the internal and international level . According to the Algerian customs department (2024), Algeria is one of the most important customers of producing countries and among the biggest importers of agricultural goods worldwide, where Algeria's cereal import dependency ratio has reached 66.2% in 2022. This absolute reliance on importing food from abroad has become one of the prominent features of the Algerian economy, which increases the size of its food dependency abroad, and this constitutes a great danger to the Algerian economy. This situation requires to find solutions and policies to confront the problem of food dependency and achieve a dependent food security.

Despite the bleak condition in Algeria's food and agricultural industries, the ICT industry is one of the most important economic sectors that has achieved substantial development over the last two decades in the country. According the World Bank database, in 22 years the percentage of people using the internet in Algeria has increased from 0.5% in 2000 to as high as 71.2432% in 2022.

It is widely acknowledged that internet usage has significantly reduced global distances than it was before where with a click of a button you can connect with whoever you want in any field you want. In the food industry the internet usage can be used as a great tool to adopt agricultural technologies which can help access information, improve traceability, optimize the food production process, and increase efficiency.

Numerous scholars have noted that the use of internet as a means of agricultural technology adoption is a vital way to increase the capacity of food producer (ZHENG et al., 2022). On the one hand, through the use of internet, traditional food production practices may be altered by embracing new agricultural technology, which can enormously enhance the allocation of key Agricultural raw materials, reduce production costs, and increase production efficiency (Mwangi & Kariuki, 2015). On the other hand, modern production methods help to realize the objective of green agricultural growth through reducing water usage and allocating the appropriate cultivation for each type of soil (Hashemi et al., 2024). Additionally, using the internet as a means of technological adoption by food producers may expand market possibilities, boost revenue, and break the cycle of poverty while fostering food production progress (Amankwah & Gwatidzo, 2024)

To the best of the authors' knowledge, despite empirical research that have examined the relationship between technology adoption, the use of internet and food



production, very few empirical studies that have addressed the impact of the use of internet on food production in Algeria.

In light of this, this study seeks to answer the following research question:

- *Does internet usage significantly impact food production in Algeria?*

The hypotheses tested are:

- H1: Internet penetration positively affects food production in Algeria in the short run.
- H2: Internet usage has an insignificant long-term effect on food production.
- H3: Agricultural raw material imports boost short-term food production but undermine long-term sustainability.
- H4: Population growth drives increased food demand, necessitating higher agricultural productivity.

The remainder of this paper is structured as follows: Section 1 reviews the literature, Section 2 describes the data and methodology, Section 3 presents and analyzes the results, and Section 4 discusses policy implications and concludes the study.

I. Literature Review

Agricultural innovation is the process through which individuals or organizations utilize new or existing products, processes, or organizational methods for the first time in a specific context. The aim is to enhance effectiveness, competitiveness, resilience to shocks, and environmental sustainability, thereby supporting food security, economic development, and sustainable natural resource management (FAO, 2023)

According to research by Abiri et al. (2023) Introducing innovation and technology into the agricultural sector can significantly increase productivity and help address food insecurity. The importance of innovation in improving food farming cannot be underestimated. Moreover, the adoption of new technologies can effectively reduce manufacturing costs (Hassoun et al., 2023)

For more food to be grown in order to aid with food security, a labor-intensive agricultural sector is required. According (Konfo et al., 2023) innovation is a worldwide phenomenon, influencing all economic sectors, including food and agriculture, which are one of the oldest and most significant industries in the world. The research reveals how technology may boost food output and handle other relevant difficulties impacting the agriculture industry.

Recent years have seen extensive research into how Internet access and use affect agricultural productivity among farmers (Li et al., 2024a) . Numerous studies indicate that the rapid expansion of the Internet in rural areas significantly enhances agricultural production efficiency. Lio and Liu (2006) estimated the agricultural production function using data from 81 countries between 1995 and 2000, finding that the Internet had a significant positive impact on agricultural productivity. Similarly, Zhang et al., (2024) noted that the widespread use of the Internet contributed to the growth of agricultural total factor productivity at the provincial level.



Moreover, numerous studies at the farm level in developing countries have shown similar benefits. For instance, Chen et al., (2022) utilizes survey data from 1,122 rice farmers in the Yangtze River Basin, China, to evaluate how Internet information influences technical efficiency in rice production. The finding indicate that Internet access enhances technical efficiency by 6.657 percentage points. Notably, the positive impact is more pronounced among farmers with larger farms, less experience, and those located in Guizhou and Hubei provinces. In the same vein, Internet access enhanced the production efficiency of maize and rice farmers in Bangladesh (Das et al., 2016), improved productivity among rice farmers in Vietnam (Kaila & Tarp, 2019a), and increased the efficiency of banana growers in China (Zheng et al., 2021)

According to Ahmad et al., (2024) mobile phones and internet access, though underutilized in agriculture, significantly enhance productivity in Boro rice farming by providing vital farming information, extension services, and training. Factors like education, credit access, and household income drive their adoption, leading to a 1.6–4.5% increase in production, highlighting their potential for sustainable agricultural development.

The integration of internet usage among farmers enhances agricultural productivity through three primary mechanisms. First, digital connectivity broadens access to critical information while lowering the costs of information acquisition (Yang et al., 2023). Farmers leverage online platforms to obtain real-time market data on agricultural inputs, enabling cost-effective procurement through e-commerce channels (Wu et al., 2020). Empirical evidence suggests that internet adoption improves market accessibility for smallholder farmers, elevating profitability through optimized sales strategies (Reddy & Mehjabeen, 2019).

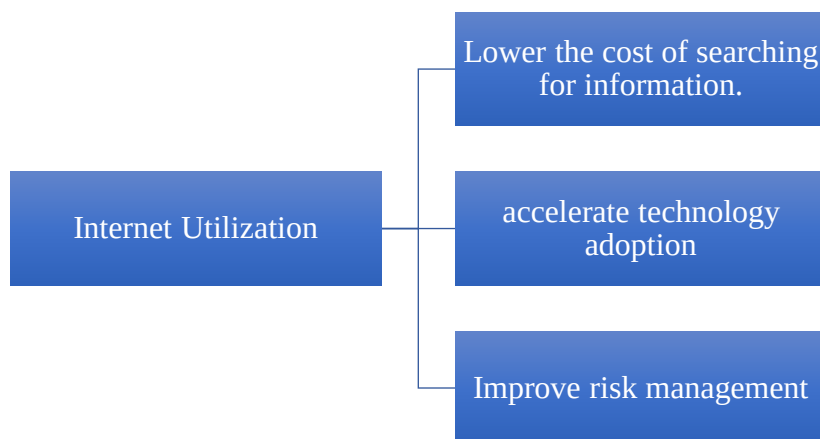
Second, the internet serves as a catalyst for agricultural extension services, accelerating the adoption of innovative technologies. Digital platforms disseminate knowledge on sustainable practices, such as precision agriculture and water-efficient irrigation systems, which enhance input utilization (Ma et al., 2022) For instance, internet-enabled advisory services have been shown to promote the uptake of green technologies, reducing fertilizer waste and improving yield sustainability.

Third, internet access empowers farmers with real-time meteorological and disaster-risk data, including precipitation forecasts, pest outbreaks, and extreme weather alerts (Yu et al., 2025). Such information enables proactive risk mitigation, strengthening resilience against climatic and ecological disruptions.

As illustrated in fig.1, Li et al., (2024) introduced a framework that comprises three pathways through which internet usage contributes to improved food production efficiency.



Figure 1: The role of the internet in food production efficiency



Source: Authors' Elaboration based on the work of Li et al., (2024)

Access to the Internet may serve as a useful indicator of whether a farmer is online, but it doesn't clearly reflect if they are utilizing the Internet for agricultural purposes. It's often noted that farmers frequently watch humorous videos or play games on their smartphones. Engaging with the Internet for leisure and seeking out agricultural information influences farming productivity in distinct ways. When the Internet is employed to enhance farming practices, it can lead to greater technical efficiency for food producers. In the subsequent section, we will examine the potential significant impact of internet usage on food production in Algeria.

II. Data and Methodology

Based on the research's main purpose and the related literature review, the empirical study's variables were carefully selected as follows:

- **Dependent Variable:** FPI: Food Security - Measured by the Food Production Index, which includes consumable food crops with nutritional value but excludes coffee and tea due to their minimal nutritional benefit. Data is from the Food and Agriculture Organization (FAO).
- **Independent Variable:** NET: Internet Usage - Measured by the percentage of the population that used the Internet in the past three months, sourced from the International Telecommunication Union (ITU).
- **Control Variables:** AMRI: Agricultural Raw Materials Imports - The percentage of merchandise imports, excluding crude fertilizers and certain minerals, based on World Bank data.
- POPgr: Annual Population Growth Rate - This includes all inhabitants, regardless of legal status, using data from the World Bank.



1. Descriptive Statistics & data exploring :

Table 1 : Descriptive Statistics

Variable	N	Mean	St. Dev.	Min	Max
Year	31	2005.000	9.092	1990	2020
NET	31	14.483	19.288	0.000	60.653
FPI	31	65.438	27.458	31.080	112.500
AMRI	31	0.033	0.028	0.002	0.110
POPgr	31	1.859	0.342	1.330	2.479

Source: Authors' calculations using STATA 17. Data from World Bank's World Development Indicators.

The descriptive statistics for the period 1990–2020 reveal key trends in Algeria's agricultural and digital landscape. Internet penetration (NET) shows significant growth, rising from 0% to 60.65%, with a mean of 14.48%, reflecting Algeria's digital transformation. However, the low mean and high standard deviation (19.29) indicate uneven adoption, particularly in rural areas. Food production (FPI) exhibits substantial variability (Std. Dev. = 27.46), ranging from 31.08 to 112.50, likely due to external shocks such as climate variability or policy changes. Agricultural raw material imports (AMRI) remain low (mean = 0.033), but their variability underscores Algeria's reliance on foreign inputs. Population growth (POPgr) averages 1.86%, with a narrow range (1.33–2.48%), indicating steady demographic pressure on food demand. Together, these trends underscore the urgency of leveraging ICT adoption to enhance agricultural productivity, reduce import dependency, and mitigate the risks posed by population growth and external shocks.

Figure 2 : Internet and food production trends in Algeria



Source: Authors' calculations using R 4.3.1. Data from World Bank's World Development Indicators.



The graph in figure 2 illustrates the trends in Algeria's Food Production Index (FPI) and Internet Penetration Rate (NET) from 1990 to 2020. The FPI increased steadily from 34.66 to 112.5, reflecting improved agricultural practices, despite high variability (Std. Dev. = 26.04) likely due to external factors such as climate or market shocks. Simultaneously, internet penetration rose dramatically from 0% to 60.65%, driven by rapid digital growth in recent decades, though its historically low mean (15.522) indicates limited early adoption.

The convergence of rising FPI and NET after 2010 suggests a potential link between ICT advancements and agricultural productivity, meriting further analysis to explore causal relationships.

2. Correlation and multicollinearity testing:

In order to strengthen the results' viability, Food security (FPI), the use of internet (NET), Population growth (POPgr), and Agricultural raw material import (ARMI), were all correlated in pairs. The table below displays the significance level, and Pearson coefficient value for each variable in the data set.

Table 2 : Pairwise correlations & the variance inflation factor test

Variables	(FPI)	(NET)	(AMRI)	(POPgr)	VIF
FPI	1.000				-----
NET	0.934* (0.000)	1.000			4.44
AMRI	-0.871* (0.000)	-0.752*(0.000)	1.000		3.51
POPgr	0.418* (0.027)	0.440* (0.017)	0.000 (0.999)	1.000	1.93
*** p<0.01, ** p<0.05, * p<0.1					Mean VIF: 3.29

Source: Authors' calculations using STATA 17. Data from World Bank's World Development Indicators.

The output reflects that there is a negative correlation between AMRI and the food production index which is significant at a 5% significance level. In contrast, a positive correlation exists between NET, POPgr, and FPI.

The variance inflation factor (VIF) determines the existence and magnitude of correlations between independent variables. When the VIF is larger than 5, it indicates a critical degree of multicollinearity where the p-values and coefficients are doubtful (Daoud, 2017). As indicated in table.2 VIF shows that there is no sever correlations between independent variables of our model as long as values are not higher than 5.

3. Structural break examination:

The figure below is divided into two parts, the first part represents a time series line plot for our data. Based on this part we have suspected a structural change in both food production index and internet usage data. The second part represents a CUSUM test to determine whether there is a structural change in the food index equation.

Cusum tests evaluate the coefficient stability in a multiple linear regression model of the type $Y = X\beta + \varepsilon$, the inference is based on a series of sums or sums of squares



of recursive residuals (standardized one-step-ahead forecast errors) derived iteratively from nested data subsamples. According to the null hypothesis of coefficient stability, values in the sequence outside an anticipated range show structural change in the model over time (Brown et al., 1975; Durbin, 1969)

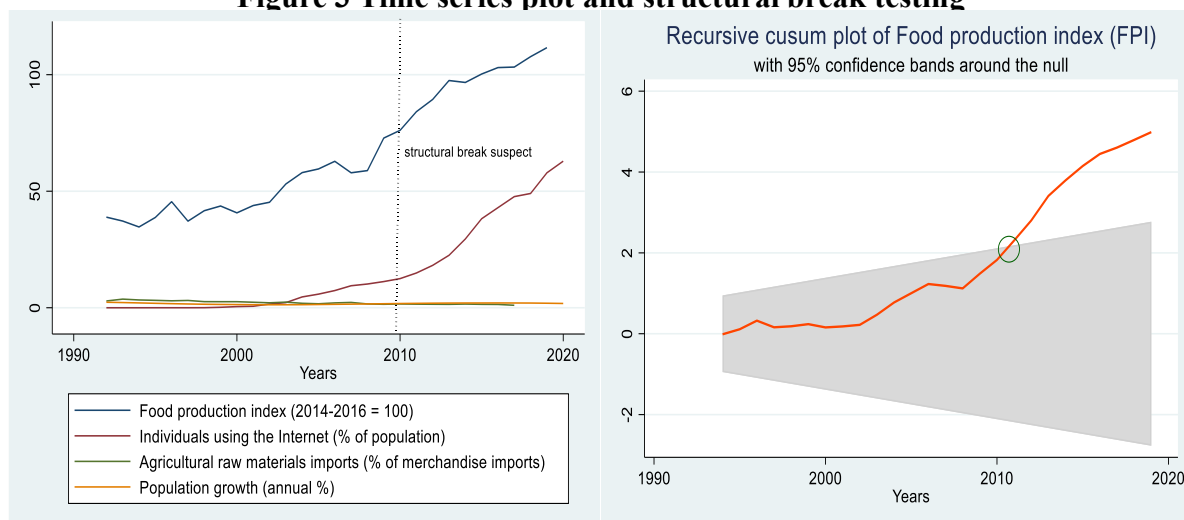
Because the test statistics surpass the crucial lines, the tests reject the null hypothesis of stable volatility at the 5% level. The recursive cusum plot of food production index change direction and cross the critical line around the Year 2010, which corresponds to the predicted break in data volatility.

Due to the presence of a breakpoint, the bounds integration test will yield inconsistent results, hence we use the G-H cointegration test for a break point at unknown date. In order to solve this problem, (Gregory & Hansen, 1996) devised the GH-test, a residual-based cointegration test that accounts for regime shifts in either the intercept or the whole vector of coefficients. The GH test is a residual-based test that evaluates the cointegration alternative in the context of a potential regime change against the null of no cointegration. Gregory and Hansen suggest that we include a dummy variable to represent the break date (which may be used to describe different structural breaks).

Table 3 : Gregory-Hansen Test for Cointegration with Regime Shifts

	Test statistic break in the constant	Breakpoint	Date	Asymptotic Critical Values		
				1%	5%	10%
ADF	-5.44	19	2010***	-5.77	-5.28	-5.02
Zt	-5.55	19	2010***	-5.77	-5.28	-5.02
Za	-28.68	19	2010	-63.64	-53.58	-48.65
	Test Statistic break in the constant and trend	Break point	Date	Asymptotic Critical Values		
				1%	5%	10%
ADF	-5.12	14	2005	-6.05	-5.57	-5.33
Zt	-5.23	14	2005	-6.05	-5.57	-5.33
Za	-27.36	14	2005	-70.27	-59.76	-54.94
	Test Statistic break in the constant and slope	Breakpoint	Date	Asymptotic Critical Values		
				1%	5%	10%
ADF	-7.42	15	2010**	-6.51	-6	-5.75
Zt	-7.29	15	2010**	-6.51	-6	-5.75
Za	-34.82	15	2010	-80.15	-68.94	-63.42
*** denotes significance at 5% level						
STATA routine <i>ghansen</i> is used with optimal lag structure chosen by the Bayesian Information Criterion (BIC)						

Source: Authors' calculations using STATA 17. Data from World Bank's World Development

**Figure 3 Time series plot and structural break testing**

Source: Authors' calculations using STATA 17. Data from World Bank's World Development Indicators.

The Gregory-Hansen cointegration test: H_0 : no co-integration at the break point. We compare the lowest absolute value between z_t and adf and see if it is higher than the 5% critical value. Then we reject the null hypothesis and state that there is a breakpoint date.

The null hypothesis that there is no cointegration with structural change is rejected by the Z_t statistic test at the 5% level of significance. The test demonstrates a cointegration connection with structural change in 2010 (break in the constant and slope). The structural shift in 2010 can be explained by the initial strategy launched by the Ministry of Agriculture and Rural Development in the year 2008 after 10-Year civil war (1990-2000) where there was a huge rural exodus to the cities. These initial reforms aim to gradually revive rural areas by strengthening institutions that aspire to introduce more crops, in addition to investing in the storage system for produced foods. Based on Gregory-Hansen evidence, 2010 is the chosen date for the breaking point, therefore it is necessary to generate dummy variables and an interacting dummy variable for the independent variable.



4. Stationarity examination

Table 4 : Unit root tests

ADF: Augmented Dickey-Fuller test for unit root PP: Phillips-Perron test for unit root				
<i>Variables</i>	<i>Level data</i>		<i>First difference data</i>	
	ADF	PP	ADF	PP
FPI	-2.188	-2.411	-4.295 ***	-5.764***
NET	0.036	0.793	0.0286**	-4.282 ***
AMRI	-2.267	-3.447 *	-5.084 ***	-----
POPgr	-7.017***	-3.642**	-----	-----
z	-2.026	-2.026	-5.146***	-5.146 ***
z_NEt	-0.029	0.113	-3.275*	-4.971***
*** p<0.01, ** p<0.05, * p<0.1				

Source: Authors' calculations using STATA 17. Data from W. Bank's World Development Indicators.

Table 4 presents the findings of the Augmented Dickey-Fuller and, Phillips-Perron unit root tests. The outputs demonstrate that three variables (FPI, NET, and AMRI) are not stationary at level, yet, at the first difference. In contrast, the POPgr seems to be stationary at its level form. Therefore, we continue to apply the ARDL method rather than standard static or the Vector Correction Model (VECM) tests due to the presence of mixed degrees of integration between sequences (Asteriou & Monastiriotis, 2004; Rafindadi & Yosuf, 2013)

5. Model specification

In this study, we are mostly interested in re-parameterized ARDL (p, q, q....., q) error correction mode, specified as:

$$\Delta y_{it} = \theta_i [y_{i,t-1} - \lambda'_i X_{it}] + \sum_{j=1}^{p-1} \xi_{y^2} \Delta y_{i,t-j} + \sum_{j=1}^{q-1} \xi_{ij} \beta'_{ij} \Delta X_{i,t-j} + \varphi_i + e_{it} \quad (1)$$

Notes:

$\theta_i = -(1 - \delta_i)$, group-specific speed of adjustment coefficient (expected that $\theta_i > 0$).

λ'_i = vector of log-run relationship.

ECT = $[y_{i,t-1} - \lambda'_i X_{it}]$, the error correlation term

$\xi_{ij} \beta'_{ij}$, the short-run dynamic coefficients

The model specification:

$$\Delta FPI_{it} = \theta_i [FPI_{i,t-1} - \lambda'_i X_{it}] + \sum_{j=1}^{p-1} \xi_{y^2} \Delta FPI_{i,t-j} + \sum_{j=1}^{q-1} \xi_{ij} \beta'_{ij} \Delta X_{i,t-j} + \varphi_i + e_{it} \quad (2)$$

The Panel ARDL approach is characterized by massive benefits that it emphasizes and provides the possibility of calculating multiple variables with varying stationary which is the case of our unit root test outputs. Importantly, the ARDL estimators enable one to estimate both short-term and long-term linkages and the coefficient of error correction.



III. Econometric Results, and diagnostic

1. Cointegration test

The Pesaran/Shin/Smith (2001) ARDL Bounds Test was employed to examine the presence of a long-run relationship between the variables. The computed F-statistic (9.75) and t-statistic (-5.989) were compared against the critical values at various significance levels. At the 1% significance level, the critical values for the F-statistic are 3.41 (I(0)) and 4.68 (I(1)). Since the computed F-statistic (9.75) exceeds the upper bound (4.68), we reject the null hypothesis of no cointegration. This indicates a significant long-run relationship between the variables. Similarly, the t-statistic (-5.989) falls below the lower bound (-3.43) at the 1% level, further confirming the presence of cointegration. These results suggest that the variables—Food Production Index (FPI), Internet Penetration Rate (NET), Agricultural Raw Material Imports (AMRI), and Population Growth Rate (POPgr)—are cointegrated, implying a stable long-run equilibrium relationship. This finding justifies the use of the ARDL model to estimate both short-run dynamics and long-run effects.

Table 5 : Pesaran/Shin/Smith (2001) ARDL Bounds Test

	[I_0] L_1	[I_1] L_1	[I_0] L_05	[I_1] L_05	[I_0] L_025	[I_1] L_025	[I_0] L_01	[I_1] L_01
k_5 F-statistic	2.260	3.350	2.620	3.790	2.960	4.180	3.410	4.680
k_5 t-statistic	-2.570	-3.860	-2.860	-4.190	-3.130	-4.460	-3.430	-4.790
H0: no levels relationship Accept if F < critical value for I(0) regressors Reject if F > critical value for I(1) regressors								
Pesaran/Shin/Smith (2001) ARDL Bounds Test F = 9.75, t = -5.989								

Source: Authors' calculations using STATA 17.

2. Econometric Results: ARDL Regression Analysis

Table 6 : ARDL (1,1,1,2,2,1) regression

VARIABLES	ADJ	Long-Run	Short-Run
D.NEt			3.219* (1.495)
D.AMRi			14.13*** (3.176)
D.POPGr			160.8** (59.81)
LD.POPGr			-176.2** (59.27)
D.z			25.03(18.39)
LD.z			-9.027** (3.585)
D.z_NEt			-3.145* (1.531)
NEt		0.874 (0.614)	
AMRi		-13.60*** (3.216)	
POPGr		18.27** (6.674)	
z		30.80*** (9.098)	
z_NEt		-0.745 (0.625)	
L.FPi	-1.367*** (0.228)		
Constant			66.22*** (11.94)
Observations	27	27	27
R-squared	0.848	0.848	0.848



	Durbin-Watson d-statistic (6, 29) = 2.015416		
	Breusch-Godfrey LM test for autocorrelation	H0: no serial correlation	Prob > chi2 = 0.9539
	White test	Ho: homoskedasticity	Prob > chi2 = 0.5631
	Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1		

Source: Authors' calculations using STATA 17. Data from World Bank's World Development Indicators.

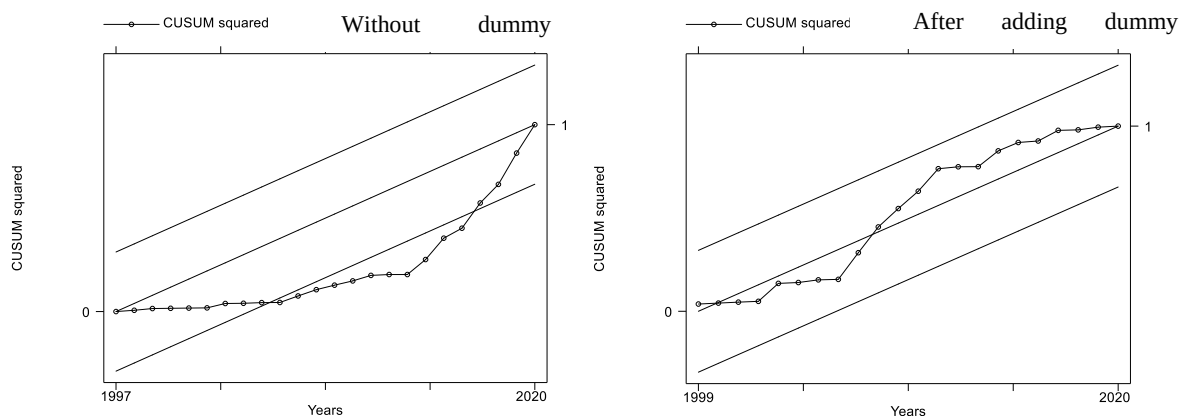
The ARDL(1,1,1,2,2,1) model was estimated to analyze both the short-run dynamics and long-run relationships between food production (FPI) and its determinants: internet penetration (NET), agricultural raw material imports (AMRI), population growth (POPGr), and the error correction term (z). The model exhibits a high explanatory power, with an R-squared value of 0.848, indicating that approximately 84.8% of the variation in food production is explained by the included variables.

Long-Run Coefficients :

- **Internet Penetration (NET):** The coefficient (0.874) is positive but statistically insignificant ($p > 0.1$), suggesting that, in the long run, internet adoption has a limited direct impact on food production. This may reflect Algeria's historically low internet penetration during much of the study period.
- **Agricultural Raw Material Imports (AMRI):** The coefficient (-13.60***) is negative and highly significant ($p < 0.01$), confirming that reliance on imported inputs undermines long-run food production. This aligns with Algeria's structural dependency on foreign agricultural inputs.
- **Population Growth (POPGr):** The coefficient (18.27**) is positive and significant ($p < 0.05$), indicating that population growth drives long-run food demand, necessitating increased production.
- **Error Correction Term (z):** The coefficient (30.80***) is positive and highly significant ($p < 0.01$), reflecting the speed of adjustment to long-run equilibrium.

Short-Run Dynamics :

- **Internet Penetration (D.NET):** The coefficient (3.219*) is positive and marginally significant ($p < 0.1$), suggesting that short-term increases in internet adoption may boost food production, possibly through improved access to information and markets.
- **Agricultural Raw Material Imports (D.AMRI):** The coefficient (14.13***) is positive and highly significant ($p < 0.01$), indicating that short-term increases in imports temporarily enhance food production, likely by addressing input shortages.
- **Population Growth (D.POPGr):** The coefficient (160.8**) is positive and significant ($p < 0.05$), while its lagged term (LD.POPGr, -176.2**) is negative and significant, reflecting the complex interplay between population growth and food production in the short run.
- **Error Correction Term (D.z and LD.z):** The coefficients (-9.027** and -3.145*) are negative and significant, confirming the model's convergence to long-run equilibrium.

**Figure 4 :The cusum stability test before and after adding the dummy variables**

Source: Authors' calculations using STATA 17.

Figure 4 represents the cusum stability test of the model before and after using the dummy variables where it is clearly seen that the cusum square test with dummy variables lies comfortably within the 5% boundary which leads us to state that the model is stable. However, when we run the test without the break dummy variables the graph displays a deviation out of the 5% significance boundary which led us to prove that the chosen break point has a significant impact on our model.

IV. Discussion and conclusions

This study examined the role of internet penetration in enhancing Algeria's food production, using a structural break ARDL approach to account for nonlinearities and policy shifts. The findings reveal nuanced relationships between internet adoption, agricultural productivity, and structural challenges, offering critical insights into the intersection of digital transformation and food security in resource-dependent economies.

The marginally significant short-term impact of internet penetration ($D.NET = 3.219^*$) aligns with global evidence that ICT adoption enhances agricultural productivity through improved information access and market linkages (Chen et al., 2022; Ma et al., 2022). For instance, farmers in Algeria may leverage mobile platforms to optimize input purchases or access real-time weather forecasts, mirroring efficiency gains observed in China and Vietnam (Kaila & Tarp, 2019b; Yang et al., 2023). However, the statistically insignificant long-term coefficient ($NET = 0.874$) diverges from studies in countries like Bangladesh and Morocco, where sustained ICT integration has driven lasting productivity improvements (Das et al., 2016).

These findings suggest that internet adoption alone is insufficient to catalyze agricultural transformation. Instead, complementary investments in rural digital



literacy, localized e-agriculture platforms, and policy integration are critical to unlocking ICT's long-term potential.

The paradoxical role of agricultural imports—short-term boon (D. AMRI = 14.13***) versus long-term burden (AMRI = -13.60***)—reflects Algeria's entrenched reliance on foreign inputs. While imports temporarily alleviate input shortages (e.g., fertilizers, machinery), their long-term negative impact mirrors global critiques of import-dependent food systems (FAO, 2023).

To mitigate these risks, Algeria must prioritize input substitution through domestic fertilizer production, drought-resistant seed development, and partnerships with agritech firms.

The positive long-term coefficient for population growth (POPGr = 18.27*) underscores the urgency of aligning agricultural output with demographic trends. With a population growth rate of 1.75% and urbanization accelerating, Algeria faces mounting pressure to adopt climate-smart intensification practices. These findings echo Konfo et al., (2023) who argue that population growth necessitates innovation-driven productivity gains.

To conclude, Algeria stands at a crossroads: its digital transformation offers unprecedented opportunities to modernize agriculture, yet structural bottlenecks threaten to perpetuate food insecurity. By aligning ICT policies with agricultural imperatives, Algeria can harness internet adoption to break the cycle of import dependency, mitigate population pressures, and achieve sustainable food sovereignty. These lessons hold relevance for resource-dependent economies globally, where digital and agricultural policies are often pursued in isolation.

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