Sustainable Agriculture Development in Algeria (2000–2024): Indicators, Innovation, and Challenges.

التنمية الزراعة المستدامة في الجزائر(2000-2024): المؤشرات، الابتكار والتحديات.

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Abstract:

This study examines the structural transformation and sustainability performance of Algeria's agricultural sector during the period 2000–2024, a phase marked by substantial public investment and a sectoral contribution to GDP averaging nearly 14%. Adopting a descriptive-analytical methodology, the research relies on longitudinal data derived from official national and international databases to evaluate the extent to which agricultural policy frameworks align with sustainable development objectives.

The findings reveal a significant structural paradox within the sector. Although aggregate agricultural output has experienced measurable expansion, the sector continues to exhibit pronounced volatility in annual value-added growth, persistent structural underinvestment, and a declining capacity to absorb labor. Agricultural employment fell from approximately 21% to less than 10% of total national employment over the study period. In addition, agricultural and food exports remain weak, unstable, and marginal, consistently representing less than 2.5% of total national exports.

The study argues that achieving genuine agricultural resilience and long-term resource sustainability requires a fundamental transformation of the prevailing development model. Such a transformation must integrate domestic Agri-Tech innovation ecosystems with high-value international industrial partnerships capable of enhancing productivity, technological diffusion, and export competitiveness. Accordingly, the study recommends: (1) modernizing rural storage, transport, and logistics infrastructure to minimize post-harvest losses; (2) introducing targeted fiscal and financial incentives to accelerate the adoption of precision and climate-smart agricultural technologies; (3) expanding non-conventional water resource management systems, particularly desalination and wastewater reuse; and (4) reforming administrative, regulatory, and agricultural finance frameworks to attract foreign direct investment, especially in large-scale southern desert agriculture initiatives.

Keywords: Sustainable Development; Agricultural Technology; Food Security; Algeria.

JEL Classification Codes: Q01; Q18; O13; O55.

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الملخص:

تتناول هذه الدراسة مسار التحول الهيكلي وأداء الاستدامة في القطاع الزراعي الجزائري خلال الفترة 2000–2024، وهي مرحلة تميزت بحجم معتبر من الاستثمارات العمومية وبلوغ مساهمة القطاع في الناتج المحلي الإجمالي ما يقارب 14%. وتعتمد الدراسة على المنهج الوصفي-التحليلي، بالاستناد إلى بيانات زمنية مستمدة من قواعد بيانات وطنية ودولية رسمية، بهدف تقييم مدى انسجام السياسات الزراعية مع أهداف التنمية المستدامة.

وتكشف النتائج عن مفارقة هيكلية واضحة داخل القطاع. فعلى الرغم من تسجيل نمو ملموس في حجم الإنتاج الزراعي الإجمالي، لا يزال القطاع يعاني من تقلبات حادة في معدلات نمو القيمة المضافة الزراعية، واستمرار ضعف الاستثمار الهيكلي، إلى جانب تراجع قدرته على استيعاب اليد العاملة، حيث انخفضت نسبة التشغيل الزراعي من حوالي 21% إلى أقل من 10% من إجمالي التشغيل الوطني خلال فترة الدراسة. كما تبقى الصادرات الزراعية والغذائية محدودة وغير مستقرة، إذ لم تتجاوز مساهمتها 2.5% من إجمالي الصادرات الوطنية.

وتخلص الدراسة إلى أن تحقيق مرونة زراعية حقيقية واستدامة طويلة الأمد للموارد يتطلب تحولًا جذريًا في نموذج التنمية المعتمد، من خلال دمج منظومات الابتكار الزراعي التكنولوجي المحلية مع شراكات صناعية دولية ذات قيمة مضافة عالية، بما يسهم في تعزيز الإنتاجية ونقل التكنولوجيا وتحسين القدرة التنافسية للصادرات الزراعية. وبناءً على ذلك، توصي الدراسة بـ: (1) تحديث البنية التحتية الريفية الخاصة بالتخزين والنقل والخدمات اللوجستية للحد من خسائر ما بعد الحصاد؛ (2) اعتماد حوافز مالية وجبائية موجهة لتسريع تبني تقنيات الزراعة الدقيقة والزراعة الذكية مناخيًا؛ (3) توسيع أنظمة إدارة الموارد المائية غير التقليدية، خاصة تحلية المياه وإعادة استخدام المياه المعالجة؛ و(4) إصلاح الأطر الإدارية والتنظيمية ومنظومات التمويل الزراعي بهدف جذب استثمارات أجنبية مباشرة ذات جودة عالية، لا سيما في مشاريع الزراعة الصحراوية الكبرى في الجنوب الجزائري.

الكلمات المفتاحية: التنمية المستدامة؛ التكنولوجيا الزراعية؛ الأمن الغذائي؛ الجزائر.

تصنيفات JEL: O55؛ O13؛ Q18؛ Q01.

1. Introduction.

Sustainable agricultural development in Algeria has increasingly emerged as a strategic imperative, driven by profound structural transformations within the national economy and persistent volatility in global hydrocarbon markets. Since the early 2000s, particularly following the launch of the National Agricultural Development Plan (PNDA) in 2000, Algeria has pursued an ambitious institutional agenda aimed at revitalizing its agricultural sector and positioning it as a cornerstone of national food security and partial self-sufficiency. Over the past two decades, the sector has evolved from a predominantly subsistence-oriented system into a more dynamic macroeconomic component, contributing significantly to GDP and, in certain periods, surpassing the performance of key manufacturing and service subsectors.

However, this quantitative expansion has been accompanied by mounting structural and environmental constraints that raise serious concerns regarding long-term sustainability. Accelerating climate change, acute water scarcity, progressive soil degradation, and continued dependence on imported technological inputs have collectively exposed deep vulnerabilities across the agricultural value chain. These interconnected challenges foreground a central

research question: how can Algeria reconcile the macroeconomic imperative of enhancing agricultural productivity with the ecological necessity of preserving finite natural resources, while simultaneously ensuring social equity across rural and desert regions? This question is framed within the classical three-pillar model of sustainable development, which emphasizes the balanced integration of economic efficiency, environmental sustainability, and social inclusion.

In response to these structural pressures, the Agricultural Sector Roadmap 2020-2024 has introduced a renewed policy orientation aimed at accelerating structural transformation. This strategy prioritizes the development of high-yield desert agriculture, the integration of digital and precision farming technologies, and the mobilization of both domestic and foreign investment at scale. In parallel, public policy has increasingly recognized innovation-driven Agri-Tech startups as key actors in driving modernization, productivity gains, and systemic efficiency improvements. Against this background, the present study examines the evolutionary trajectory of Algeria's agricultural sector from 2000 to 2024. It evaluates the extent to which national agricultural policies align with internationally recognized sustainability frameworks, with particular attention to the emerging role of technological innovation and global strategic partnerships as catalysts for a more resilient and resource-efficient agricultural system.

1.1. Problem Statement.

Despite substantial public capital injections and successive waves of regulatory reform since 2000, Algeria's agricultural sector continues to exhibit persistent structural and environmental rigidities that constrain its long-term performance. In this context, the central research question of this study is formulated as follows:

To what extent do macroeconomic and sectoral indicators reflect genuine sustainable agricultural development in Algeria over the period 2000–2024, and what are the principal structural, environmental, and institutional constraints that hinder the achievement of long-term sustainability within the sector?

1.2. Research Objectives

The primary objective of this study is to critically assess the sustainability trajectory of Algeria's agricultural sector. To achieve this overarching aim, the study pursues the following specific objectives:

- To analyze longitudinal trends in key sustainable agriculture indicators in Algeria between 2000 and 2024, with particular emphasis on macroeconomic performance, value-added generation, and labor market dynamics.

- To identify and evaluate the environmental, economic, and institutional constraints contributing to structural volatility and limiting qualitative sectoral growth.

- To examine the role of digital transformation and the Agri-Tech startup ecosystem in modernizing agricultural practices, particularly within the policy framework of the 2020–2024 strategic planning cycle.

1.3. Methodology

This study adopts a descriptive-analytical research design to assess the state of sustainable agriculture in Algeria over a 24 years period (2000–2024). The descriptive component establishes an empirical baseline of sectoral evolution through the analysis of key macroeconomic indicators, including GDP contribution, value-added shares, employment structure, and agrifood export performance.

The analytical component complements this by interpreting observed trends in relation to evolving institutional frameworks, environmental pressures, and policy shifts. To ensure robustness and empirical validity, the study relies on secondary data obtained from authoritative sources, including the World Bank, the Food and Agriculture Organization (FAO), and the Algerian Ministry of Agriculture and Rural Development.

1.4. Research Plan and Hypotheses

1.4.1. Research Framework and Plan

The study is organized around a multi-phase analytical framework designed to examine the determinants, performance dynamics, and structural constraints of sustainable agriculture in Algeria. It conceptualizes the interaction between public policy interventions, environmental and economic shocks, and technological innovation (including Agri-Tech startups and international strategic partnerships) over a 24 years horizon.

The empirical analysis is structured into three sequential phases: (1) the period 2000–2010, which examines the macroeconomic and institutional foundations established under the National Agricultural Development Plan (PNDA); (2) the period 2011–2020, which analyzes structural volatility, labor market transformation, and sectoral resilience to climatic and policy-related pressures; and (3) the period 2021–2024, which evaluates the transition toward a technology-driven agricultural model centered on Agri-Tech development, desert agriculture expansion, and foreign direct investment integration.

1.4.2. Research Hypotheses.

To address the central research question in a structured and empirically testable manner, the study formulates four core hypotheses grounded in the economic, environmental, and technological dimensions of agricultural sustainability:

H1: Agricultural value-added remains unstable despite public investment, due to climatic and environmental constraints.

H2: Agricultural growth is increasingly disconnected from employment due to mechanization and rural–urban migration.

H3: Higher agricultural production has not improved export competitiveness, as agrifood exports remain marginal.

H4: Agri-Tech innovation and international partnerships are key drivers of agricultural transformation, especially in desert agriculture.

2. Theoretical Framework

This chapter develops the conceptual foundation of sustainable agricultural development by integrating sustainability theory, socio-ecological systems approaches, and contemporary literature on agricultural transformation. It aims to establish a comprehensive analytical framework explaining the interaction between environmental, economic, institutional, and technological factors in shaping agricultural sustainability.

2.1 Concept of Sustainable Development

The concept of sustainable development was formally defined by the World Commission on Environment and Development as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED,1987, p. 43). This definition established intergenerational equity as a central principle, emphasizing the need to balance present economic expansion with the preservation of long-term natural and social resources. Despite its global influence, scholars have noted the broad and variable interpretation of the concept of "needs" across different societies and historical contexts.

Accordingly, sustainable development represents an integrated framework based on balancing economic growth, social equity, and environmental protection. Its effectiveness depends on the interaction between economic, institutional, environmental, social, and technological dimensions. Sustainable agriculture is structured around three core pillars: the economic dimension, which promotes growth and structural development; the environmental dimension, which focuses on the sustainable management of natural resources; and the social dimension, which seeks to ensure equity, poverty reduction, and access to essential public services (Hajjam & Tari, 2020, pp. 127–131).

2.2 Concept of Sustainable Agricultural Development

Sustainable agricultural development refers to agricultural systems that ensure long-term productivity while integrating environmental protection, economic viability, and social equity. The FAO defines it as the conservation of land, water, and genetic resources while maintaining economic and social sustainability (Food and Agriculture Organization, 2013, p. 5). Similarly, Pretty (2007) emphasizes farming approaches that promote biodiversity, preserve soil fertility, and reduce dependence on external synthetic inputs (Pretty, 2007, p. 447).

Thus, sustainable agriculture integrates:

- Productivity (food security)
- Environmental protection (resource conservation)
- Social well-being (rural livelihoods)

2.3 Systemic Dimensions and Operational Metrics

To operationalize sustainable agriculture as an empirical concept, this study applies a multidimensional framework derived from the Food and Agriculture Organization (FAO, 2025, p. 11). Instead of focusing only on production output, the approach relies on integrated sustainability indicators encompassing economic, environmental, nutritional, social, and institutional dimensions. The main analytical dimensions and their corresponding indicators are presented in Table 1. These dimensions can be summarized as follows:

Table (1): *Dimensions of Sustainable Agricultural Development*

Pillar	*Description*
Economic	*Focuses on productivity, income generation, efficiency, and long-term economic viability of the agricultural sector.*
Environmental	*Concerns the sustainable management of natural resources, including soil, water, biodiversity, and ecosystem preservation.*
Social	*Addresses equity, rural livelihoods, poverty reduction, food security, and access to essential services.*
Nutritional	*Emphasizes food quality, dietary diversity, and improved nutritional outcomes for populations.*
Institutional	*Relates to governance quality, policy frameworks, institutional capacity, and regulatory effectiveness in the agricultural sector.*

Source: *Food and Agriculture Organisation (FAO, 2025)*

2.4 Strategic Objectives of Sustainable Agricultural Development

Sustainable agricultural development aims to balance long-term productivity with environmental stewardship, economic resilience, and social equity for present and future generations.

Its core objectives include:

- Sustainable Productivity: Securing global food safety and nutrition without depleting finite natural resources (Arslan et al., 2024, p. 18).
- Ecological Protection: Supporting vital natural processes, specifically soil regeneration and nutrient cycling (Zain et al., 2024, p. 5).
- Economic Viability: Mitigating financial risks and ensuring long-term stability for farmers, particularly smallholders (Von et al., 2023, p. 48).
- Climate & Market Resilience: Maximizing resource-use efficiency to help agricultural systems withstand climate shifts and market volatility (Lee & Romero, 2023, p. 94).
- Socioeconomic Development: Driving rural growth and poverty reduction to generate employment and lower inequality.

2.5 Theoretical Architecture: Core Pillars of Sustainable Food Systems

Sustainable agricultural development is based on an integrated system of interdependent pillars that ensure long-term productivity, resilience, and adaptability of food systems. These dimensions collectively balance food security with environmental sustainability.

The framework includes environmental sustainability, economic viability, social equity, technological innovation, and institutional governance. Environmental sustainability focuses on ecosystem preservation and resource restoration (Arslan et al., 2024, p. 14), while economic viability emphasizes circular bioeconomy approaches that enhance efficiency and profitability (von Lampe et al., 2023, p. 42). Social equity promotes inclusive development and fair access to food systems (IFAD, 2021, p. 28). Technological innovation enhances productivity through climate-smart tools and digital agriculture (Liu & Qiang, 2023, p. 115), and institutional governance ensures policy coherence and alignment with climate objectives (Lee & Romero, 2023, p. 86).

Together, these pillars reinforce systemic resilience and enable agricultural systems to better respond to environmental and socio-economic shocks (Wong et al., 2022, p. 55).

2.6 The Concept and Dimensions of Food Security

Food security emerged as a critical global issue in the 1970s, particularly in response to the world food crisis, which exposed the inability of many countries to ensure a stable and adequate food supply for their populations. At that time, the discussion was largely centered on food availability at national and global scales, an approach strongly emphasized during the 1974 World Food Conference.

However, this supply-focused perspective was gradually reconsidered as it became evident that increased food production alone was insufficient to eliminate hunger and malnutrition. Scholars and policymakers began to recognize that food insecurity was also shaped by socioeconomic factors, particularly unequal access to food, poverty, and disparities in income

and resources. This evolution broadened the understanding of food security into a more complex and multidimensional framework (FAO, 2024).

In contemporary discourse, food security is closely aligned with global sustainability agendas, especially Sustainable Development Goal 2 (SDG 2), which aims to eradicate hunger, achieve food security and improved nutrition, and promote sustainable agricultural systems by 2030 (Guiné et al., 2021, p. 3).

According to the Food and Agriculture Organization (FAO, 1996), food security is achieved when all individuals, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs for a healthy and active life. This definition is commonly structured around four interdependent dimensions: **food availability**, referring to adequate supply; **food access**, relating to the ability of individuals to obtain food; **food utilization**, concerning the proper biological use of food for nutrition; and **stability**, which ensures consistent access to food over time (World Bank, 2024).

3. Empirical Evaluation of Algeria's Agricultural Indicators (2000–2024)

3.1. Sectoral Contribution to Gross Domestic Product (GDP)

The trajectory of agriculture's contribution to Algeria's Gross Domestic Product (GDP) over the period 2000–2024 reflects a structurally evolving sector influenced by shifting public policies, climatic variability, and broader macroeconomic reorientation toward diversification. As illustrated in Table 2, the sector experienced a period of relative stagnation and fluctuation in the early 2000s, followed by a clear structural upward shift from the mid-2010s onward.

Table (2): Agriculture Value Added as a Share of GDP (%)

Years	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***
%	*8,89*	*8,41*	*8,46*	*7,72*	*6,56*	*6,37*
Years	***2007***	***2008***	***2009***	***2010***	***2011***	***2012***
%	*6,33*	*5,55*	*8,01*	*7,53*	*7,08*	*8,03*
Years	***2013***	***2014***	***2015***	***2016***	***2017***	***2018***
%	*9,12*	*9,41*	*10,53*	*11,07*	*11,03*	*11,24*
Years	***2019***	***2020***	***2021***	***2022***	***2023***	***2024***
%	*11,48*	*12,83*	*11,24*	*10,65*	*13,37*	*13,96*

***Source**: Author's calculations based on World Bank Development Indicators (2025).*

The evolution of Algeria's agricultural GDP share between 2001 and 2024 reveals a clear long-term upward trajectory, though marked by periodic fluctuations. In the first phase (2001–2010), the indicator declined to its lowest levels, reflecting structural and economic constraints that weighed on sectoral performance. The second phase (2011–2020) was characterized by recovery and steady improvement, with the average rising above 10%, signaling gradual progress in agricultural productivity and the impact of supportive policies. The most recent period (2021–2024) demonstrates accelerated growth, achieving the highest average of 12.31%, despite minor variations. Overall, the trend points to a progressive strengthening of the sector, moving from instability toward more resilient and consistent growth.

3.2. Agriculture Value-Added Dynamics

Despite the upward trend in aggregate output, the agricultural sector exhibits pronounced instability in annual value-added growth rates, highlighting its sensitivity to environmental shocks and structural constraints. As shown in Table 3, growth performance is highly irregular, alternating between periods of rapid expansion and contraction.

Table (3): **Annual Growth of Agricultural Value Added (%)**

Years	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
%	12,8	0,9	11,7	3,7	2,9	8,7
Years	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
%	2,1	-3,4	23,5	6,3	9,7	9,7
Years	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
%	12	3,1	7	1,6	-4	3,3
Years	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
%	2,6	2,8	-2,2	5,2	3	5,3

Source*: Author's calculations based on World Bank Development Indicators (2025).*

This volatility indicates that while the sector has expanded in scale, it has not achieved structural stabilization. Growth remains episodic and highly dependent on climatic conditions, reinforcing the absence of resilient long-term productivity mechanisms.

3.3 Employment and Labor Allocation Trends

The agricultural sector's share of total national employment demonstrates a persistent downward structural trend, reflecting broader economic transformation and ongoing rural-to-urban migration. As shown in Table 4, the sector's labor absorption capacity has declined significantly over the study period.

Table (4): **Agricultural Employment Share (%)**

Years	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
%	21,72	21,75	21,72	21,34	19,65	18
Years	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
%	16,37	14,93	13,34	12	10,77	10,35
Years	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
%	9,93	9,35	8,85	8,54	10,16	10,11
Years	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
%	10,01	10,47	10,28	10,17	9,85	9,66

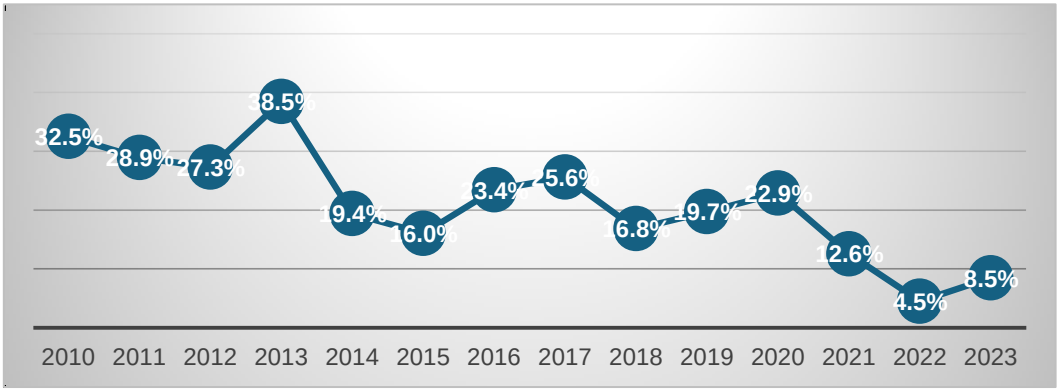
Source*: Author's calculations based on World Bank Development Indicators (2025).*

The evolution of agriculture's contribution to employment in Algeria over 2001–2024 reveals a clear and sustained downward trend. In the early 2000s, the sector accounted for over 21% of total employment, highlighting its key role in rural labor absorption. Between 2007 and 2012, this share declined steadily, driven by structural economic change, rural-to-urban migration, and increasing mechanization in agricultural production. From 2013 onwards, the employment share stabilized at around 10%, with limited fluctuations and no significant recovery. Overall, the findings indicate a marked reduction in agriculture's relative employment importance, reflecting a broader structural shift in labor allocation across the economy.

3.4 Performance of Food Products within the Export Framework

The performance of food products within Algeria's non-hydrocarbon export structure between 2010 and 2023 is characterized by marked volatility and an overall weakening trend. The share reached a peak of 38.5% in 2013, followed by a sustained decline over the subsequent decade, falling to a low of 4.5% in 2022 before partially recovering to 8.5% in 2023. As illustrated in Figure (1), these fluctuations highlight the fragility of the agrifood export base and underscore the need for structural and strategic policy interventions to enhance its competitiveness within the non-oil export framework.

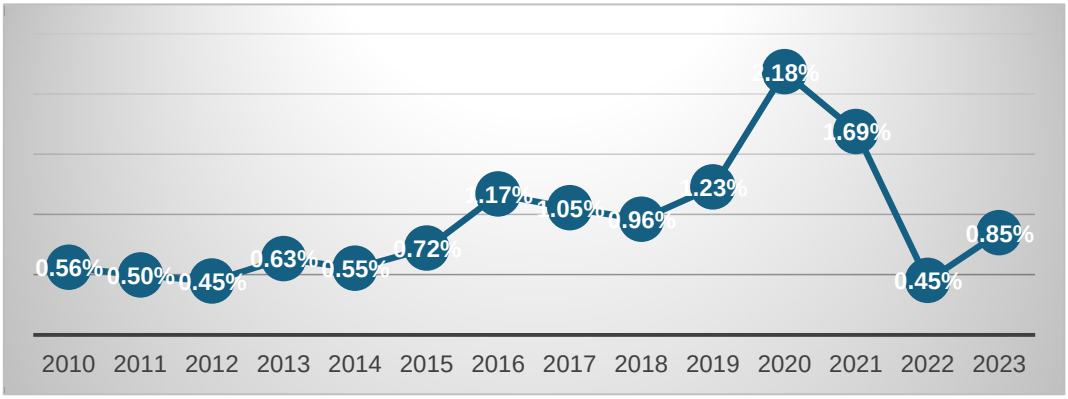
Figure (1): Food Exports as a Share of Non-Hydrocarbon Exports (2010–2023)



***Source**: Author's calculations based onWorld Bank Development Indicators (2025).*

During the same period, food exports as a proportion of total national exports remained marginal, consistently below 2.5%, despite a temporary increase in 2020 that was not sustained in subsequent years. This pattern confirms the limited integration of the agrifood sector into Algeria's broader export structure and its weak diversification capacity relative to other export sectors, as shown in Figure (2).

Figure (2): Food Exports (% of Total Exports) (2010–2023).



***Source**: Author's calculations based on World Bank Development Indicators (2025).*

Overall, these patterns highlight a persistent structural weakness in export diversification and limited international competitiveness of the agrifood sector.

3.5 The Emerging Ecosystem of Agri-Tech Startups and Strategic Alliances

In response to structural constraints and environmental pressures, Algeria has progressively initiated a transition toward technology-driven agricultural modernization, supported by emerging Agri-Tech ecosystems and strategic international partnerships.

3.5.1 Agri-Tech Ecosystem

A growing network of domestic startups is contributing to agricultural modernization through digital innovation tailored to arid and semi-arid :

- FARM Ai: Deploys drones and artificial intelligence for automated crop monitoring and early disease detection, enhancing precision in input application and yield protection.
- Nabatik: Provides a mobile-based diagnostic platform using image recognition to identify plant diseases and deliver localized agronomic recommendations.
- AkT-FARMS: Utilizes satellite imagery and drone data to generate high-resolution soil and crop maps, enabling precision irrigation and fertilization strategies.

3.5.2 International Strategic Alliances

Parallel to domestic innovation, Algeria has strengthened its agricultural modernization strategy through international cooperation aimed at technology transfer and large-scale agro-industrial development :

- Algerian–Italian Cooperation: The Bonifiche Ferraresi initiative integrates land reclamation with precision agriculture and advanced irrigation systems in southern regions.
- Algerian–American Partnerships: Joint ventures focus on large-scale cereal and feed production supported by modern storage, fertilization, and mechanization systems.
- Algerian–Turkish Cooperation: Development of integrated agro-industrial value chains and processing infrastructure in southern provinces such as Adrar.
- Algerian–Qatari Partnership: The Baladna Algeria project in Adrar enhances domestic dairy production capacity and supports import substitution.

4. Economic Interpretation and Discussion of Results

The empirical evidence over the 2000–2024 period reveals a structurally heterogeneous and persistently volatile agricultural system shaped by macroeconomic distortions, climatic vulnerability, labor market shifts, and emerging technological transformation.

4.1 GDP–Value Added Divergence

A clear structural paradox emerges between the rising share of agriculture in GDP and the instability of its value-added performance. This divergence is mainly driven by hydrocarbon-cycle effects that distort relative sectoral composition, alongside continued exposure to climatic shocks linked to limited irrigation capacity. These combined dynamics confirm Hypothesis 1 (H1).

4.2 Labor Reallocation Dynamics

The decline in agricultural employment from 21.72% to 9.66% reflects a significant structural transformation. However, labor has primarily shifted toward low-productivity services and public-sector employment rather than industrial development. This pattern is reinforced by mechanization and public wage incentives, which reduce agricultural labor demand while increasing urban pull factors, thereby supporting Hypothesis 2 (H2).

4.3 Export Marginality

Agrifood exports remain structurally weak, accounting for less than 2.5% of total exports. This limited performance is explained by high production and logistics costs, fragmented supply chains, and weak compliance with international quality standards. These constraints significantly undermine international competitiveness, confirming Hypothesis 3 (H3).

4.4 Technological Leapfrogging

Recent trends indicate an emerging process of technological leapfrogging driven by Agri-Tech startups and foreign direct investment. The integration of digital technologies—such as artificial intelligence, satellite monitoring, and precision irrigation—directly into traditional farming systems enables the sector to bypass intermediate stages of modernization. In parallel, vertically integrated agro-industrial investments improve scale efficiency, reduce costs, and enhance value-added retention, thereby supporting Hypothesis 4 (H4).

5. Conclusion and Recommendations

A longitudinal evaluation of Algeria’s agricultural sector from 2000 to 2024 reveals a significant evolution in national policy frameworks aimed at promoting sustainability. Although the sector's contribution to GDP indicates clear quantitative growth, a persistent gap remains between strategic policy design and its practical efficiency on the ground. To bridge this gap and accelerate the transition toward a resilient, knowledge-based agricultural model, the following targeted policy recommendations are proposed:

a. Infrastructure and Supply Chain Modernization

- Develop regional cold-chain systems and automated storage facilities located near key production zones to reduce post-harvest losses and improve logistical efficiency.
- Strengthen rural transport infrastructure to better integrate remote production areas with urban wholesale and distribution markets, thereby reducing structural bottlenecks in supply chains.

b. Acceleration of Digital Transformation and Technology Adoption

- Implement targeted financial incentives, including innovation grants and fiscal exemptions, to accelerate the diffusion of precision agriculture technologies among small-scale producers.
- Reinforce agricultural extension systems through specialized training programs focused on the use of digital tools for soil management, crop monitoring, and productivity optimization.

c. Sustainable Water Resource Management

- Expand the deployment of climate-resilient irrigation technologies, such as automated drip systems and IoT-based soil moisture monitoring, to enhance water-use efficiency.
- Increase investment in non-conventional water resources, including solar-powered desalination of brackish water and wastewater reuse systems, particularly in arid and semi-arid regions.

d. Financial Access and Investment Facilitation

- Simplify agricultural credit mechanisms through flexible, state-backed guarantee schemes tailored to the needs of smallholders and Agri-Tech enterprises.
- Establish an enabling investment framework to attract foreign direct investment, with a focus on technology transfer, seed innovation, and integrated agro-industrial development projects in southern regions.

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